Comments on
Alachua County Department of Public Works'
Landfill Siting Process and Selection of Site E as
Best Available Site for County Landfill

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INTRODUCTION

We were contracted by the Greater Monteocha Community Action Association to conduct independent, third-party review of the adequacy of the process used by the Alachua County Department of Public Works to rank sites for a new proposed landfill, and to select Site E as the best available site for that landfill. In conducting this review, we reviewed the materials provided to us by the Greater Monteocha Community Action Association which included,

DER, Florida Department of Natural Resources landfilling regulations, DER 1993 Solid Waste Management Facilities 17-701, January (1993).

CH2M HILL, "Evaluation of Candidate Site Selection Process," Technical Memorandum No. 1, report to Alachua County Public Works Department and Solid Waste Facility Siting Advisory Committee, approved by SWFSAC February 20, (1992).

CH2M HILL, "Identification of Integrated Solid Waste Management Systems," Working Paper No. 2, report to Alachua County Public Works Department and the Solid Waste Facility Siting Advisory Committee, November (1992).

CH2M HILL, "Candidate Site Ranking," Technical Memorandum No. 3, report to Alachua County Public Works Department and Solid Waste Facility Siting Advisory Committee, approved by SWFSAC June 18 (1992).

CH2M HILL, "Evaluation and Modeling of the Floridan Aquifer System in the Vicinity of the Murphree Well Field," Technical Memorandum No. 4, report to Alachua County Public Works Department, March (1993).

Carter, J. H., "CH2M HILL's Technical Memorandum No. 2 on Results of the Nominal Group Technique (NGT) Workshop," letter and report to Office of Waste Management, Public Works Department, Alachua County, Gainesville, FL, May 14 (1992).

Carter, J. H., "Alternative Systems Analysis," letter and CH2M HILL report to Solid Waste Facility Siting Advisory Committee, Public Works Department, Alachua County, Gainesville, FL, February 22 (1993).

Author unknown, "Attachment 2 'Recommendation on Protection of Shallow and Intermediate Drinking Water Resources,'" revised November 5, 1992, accepted by SWFSAC (1992).

Alachua County Staff, "Alachua County Staff Responses to the Greater Monteocha Community Action Association's (GMCAA's) Environmental Concerns, as Presented to the Alachua County Environmental Protection Advisory Committee on January 12 (1993)."

Kurtz, M. L., letter to B. Fernandez, Gainesville Regional Facilities, Alachua County, Gainesville, FL, May 11 (1993).

Gainesville Regional Utilities, "Evaluation of Alachua County's Proposed Solid Waste Management Facility Sites E, M, and U," March 22 (1993).

Alachua County Office of Waste Management, "Summary of Contract Status," Alachua County Office of Waste Management, Gainesville, FL (1993).

Padgett, D.A., "Using `DRASTIC' to Improve the Integrity of Geographical Information System Data Used for Solid Waste Management Facility Siting: A Case Study," Department of Geography, University of Florida, Gainesville, FL, letter and report to P. Wheat, March 10 (1993).

Alachua County, "Agreement for Professional Consulting Services between Alachua County and SCS Engineers," Alachua County, Gainesville, FL, April 27 (1993).

Boyes, S. R., "Fracture Trace Analysis of a Proposed Landfill Site (Site `E'), Monteocha, Alachua County, Florida," GeoSolutions, Inc., Gainesville, FL, May 25 (1993).

Greater Monteocha Community Action Association, "Monteocha Neighborhood News," January (1993).

Hallbourg, R. R., Delfino, J. J. and Miller, W. L., "Organic Priority Pollutants in Groundwater and Surface Water at Three Landfills in North Central Florida," Water, Air, and Soil Pollution 65:307-322 (1992).

Miscellaneous newspaper clippings regarding the siting of a new landfill in Alachua County near Gainesville, FL.

The comments presented below are based on a review of those documents as well as our professional experience in reviewing the environmental and water resource impacts of many municipal solid waste (MSW) landfills located in various parts of the US and other countries over the past 25 years. A summary of our expertise and experience is presented below. Additional information on our qualifications to undertake this review is presented in the appendix to this report.

OVERVIEW CONCLUSION

The focus of our review has been an evaluation of whether the Alachua County Board of County Commissioners and Solid Waste Facility Siting Advisory Committee (SWFSAC) have been provided sufficient reliable information to make an appropriate determination of the potential public health, environmental, groundwater resource and other impacts of the proposed Site E landfill as the "best available site" for a new landfill in Alachua County.

It is our conclusion that the County Department of Public Works and their consultants have not adequately and reliably reported on the potential impacts of siting the proposed landfill at Site E. This has caused Site E to be ranked significantly higher than it would have been had adequate and reliable information been provided to SWFSAC.

We also conclude that the process that has been used to select the proposed landfill site is significantly flawed and does not reliably consider the long-term impacts of the chemical contaminants in the solid waste that will be deposited in the landfill on the water resources, public health and the environment in the vicinity of the landfill.

It is our recommendation that no further work should be done in attempting to justify the use of Site E or any other site until a much better understanding of the potential impacts of placing the proposed landfill at this location could have on the water resources, public health and the environment in the vicinity of the proposed landfill at this site.

DISCUSSION OF SPECIFIC ISSUES

Florida's Solid Waste Management Regulations

One of the first areas of concern in the review of a proposed landfill siting process, proposed landfill location and proposed landfill design is the adequacy of the state's regulations governing landfill siting, design, operation, closure and especially post-closure care in protecting groundwater resources, including public health and the environment, from the potentially significant adverse impacts of the chemicals that are present in today's municipal solid wastes. The Florida DER (1993) embraces the "dry tomb" landfilling of MSW. By that approach, an attempt is made to seal off - entomb - the wastes from moisture that would generate leachate by lining the landfill and covering it when full with a low-permeability cover. Appurtenances such as leachate collection and removal systems are incorporated to try collect leachate that will be generated in the near-term; groundwater monitoring is required in an attempt to signal the failure of the systems. As discussed by Lee and Jones (1992a) (enclosed in the appendix), the "dry tomb" landfilling technology as is currently being practiced with a single composite liner and groundwater monitoring wells spaced hundreds or more feet apart, is fundamentally flawed in its ability to protect groundwater quality from pollution by MSW leachate for as long as the waste components in today's municipal solid wastes are a threat to groundwater quality. At best it postpones groundwater pollution; it will not prevent it. Furthermore, the performance requirements of the Florida regulations (DER, 1993) do not necessarily require the attainment of groundwater quality protection from impaired use by landfill derived chemicals.

We have found through our work in various states and in other countries that there is a variety of differing degrees of groundwater quality protection provided in MSW landfilling regulations.

California, for example, has had MSW landfilling regulations since 1984 that have included a performance standard that the waste constituents in the landfill shall not impair the beneficial uses of the waters of the state for as long as the wastes represent a threat. As discussed below, the current Florida regulations do not necessarily provide this duration of protection.

In the mid-1980's, several states including New York and New Jersey adopted requirements for double-composite-lined landfills for municipal solid waste management since it was recognized that single-composite liners of the type that the US EPA specified in the RCRA Subtitle D regulations promulgated in November 1991 (and as discussed below, those that have been adopted by the Florida Department of Environmental Regulation in January 1993 (DER, 1993)) will not necessarily provide for true, long-term protection of groundwater quality from pollution by landfill leachate. Subsequently, Pennsylvania and more recently Michigan have adopted or are in the process of adopting double-composite liner requirements for MSW landfills. Further, recently the California Water Resources Control Board staff concerned with helping to develop revised regulations governing landfilling of MSW in the State, recommended double-composite-liner requirements for the types of landfills being used today to better protect groundwater from pollution by landfill leachate.

From our review we find that the current Florida Department of Environmental Regulation regulations as amended in January 1993, do not necessarily provide a high degree of protection for groundwater quality from pollution by landfill leachate. Some of the key problem areas in the regulations that contributed to that conclusion are discussed below. Consideration of those regulations is particularly pertinent to a review of the landfill siting process that has been conducted by Alachua County Department of Public Works since that department proposes to construct a landfill that will meet the regulatory requirements set forth by DER (1993). (see Technical Memorandum No. 4 CH2M HILL (1993) discussed below).

DER (1993) states on page 5, section 17-701.100 Intent,

"The intent of this rule is to establish standards for the construction, operation, and closure of solid waste management facilities to minimize their threat to public health and the environment, and to implement the provisions of the Florida Solid Waste Management Act, Sections 403.701-403.715, Florida Statutes."

DER (1993) states on page 16 in Section 17-701.300 Prohibitions,

"(1) General prohibition...

(b) No person shall store or dispose of solid waste in a manner or location that causes air quality standards to be violated or water quality standards or criteria of receiving waters to be violated."

DER (1993) states on page 27 in Section 17-701.340 General Criteria For Landfills,

"(1) Performance standards. A landfill shall be designed, constructed, operated, maintained, closed, and monitored throughout its design period to control the movement of waste and waste

constituents into the environment so that ground water and surface water quality standards and criteria of Chapters 17-3 and 17-302, F.A.C., will not be violated beyond the zone of discharge specified for the landfill."

Rather than protecting groundwater from landfill leachate-pollution for as long as wastes represent a threat (which in a lined, "dry tomb" landfill of the type being developed in Florida today will be forever) (see discussion by Jones-Lee and Lee (1993) in the appended papers and reports), landfills in Florida only have to minimize the threat to public health and the environment by preventing violations of the state's water and air quality standards. While that is the approach adopted in the US EPA Subtitle D regulations, it is not necessarily protective of groundwater or air quality. As discussed by Jones-Lee and Lee (1993), municipal solid wastes contain a wide variety of chemicals as non-conventional pollutants that are present in landfill leachate that could be highly hazardous and deleterious to public health and groundwater quality for use as a domestic water supply that are not regulated by drinking water standards (MCL's).

The same type of situation applies to volatile chemicals in today's municipal solid wastes. There is a large number of volatile chemicals present in municipal solid wastes which are emitted from landfills in landfill gasses which can be hazardous and deleterious to air quality that are not regulated by current air quality standards.

There are approximately 60,000 chemicals in use in the United States today; fewer than 200 of these are regulated with respect to domestic water supply water quality. Municipal landfill leachate contains a wide variety of organics measured by total organic carbon that are not specifically identified in a study of leachate-pollution of groundwater. To allow pollution of groundwater by municipal landfill leachate, as the state of Florida apparently does, up to the drinking water MCL does not properly protect the public from the hazards to domestic water supply water quality of the non-conventional pollutants. Since there are known to be unidentified, uncharacterized contaminants that could be of public health concern in MSW landfill leachate, it is prudent public health policy to assume that any contamination of a groundwater by municipal landfill leachate could represent a significant public health threat to those who use the contaminated groundwater as a domestic water supply source, even if the concentrations of measured constituents do not exceed any of their respective MCL's.

In the case of the proposed Site E landfill, there are two major water resource protection issues that need to be considered in landfill siting: the Murphree well field that obtains water from the Floridan aquifer system which is the water supply for the city of Gainesville, and the shallow aquifer system that is the water supply for individuals who live in the vicinity of the proposed Site E landfill, as well as other entities such as churches that use these waters as a domestic water supply source. According to Brady (1993), there are at least 100 residential wells within a mile of the Site E boundary. The construction of a landfill should require that both the public and private water supplies be protected *ad infinitum* from pollution by landfill leachate.

In several sections on page 16 of DER (1993) mention is made of requirements for "permanent" leachate control methods. For example, in Section 17-701.300 (2)(b), it is stated,

"(2) Disposal. Unless authorized by a Department permit or site certification in effect on January 6, 1993, no solid waste shall be stored or disposed of by being placed:...

(b)In any area where the absence of geological formations or subsurface features would allow for the unimpeded discharge of waste or leachate to ground or surface water. A person may dispose of solid waste in such an area upon demonstration to the Department that permanent leachate control methods will result in compliance with water quality standards under Chapters 17-302 and 17-520, F.A.C.;"

As discussed below, however, the landfill owner/operator may be required to provide for only 30 years of post-closure care. Leachate from municipal solid waste landfills of the type that would be developed under these regulations ("dry tombs") will almost certainly be a threat to groundwater quality forever, certainly many thousands of years. In light of the nature and duration of leachate generation by MSW landfills, it is evident that the regulation's use of the word "permanent" leachate control is inconsistent with the provision for only temporary control provided in the 30-year post-closure care specification set forth in the regulations (see below). The temporary post-closure care requirement provided by DER (1993) is grossly inadequate to protect groundwater quality from pollution by landfill leachate for as long as MSW represent a threat.

The Section 17-701.300 (1) Prohibition section (2)(c) (page 16) also provided that no solid waste shall be stored or disposed of by being placed:

"(c) Within 500 feet of an existing or approved shallow water supply well unless disposal takes place at a facility for which a complete permit application was filed or which was originally permitted before the shallow water supply well was in existence;"

It is surprising that such a section is in the regulation since basically it could allow a landfill owner/operator to pollute groundwater under adjacent properties if he "gets there first" with pollution before a well is installed on the adjacent property. Appropriate regulations that provide for protection of groundwater quality would stipulate protection of groundwater quality from use-impairment for as long as the wastes represent a threat; for a "dry tomb" MSW solid waste landfill this would effectively be forever. As discussed above, meeting the MCL's (drinking water standards) does not ensure protection of groundwater quality for domestic water supply purposes, from MSW landfill leachate-pollution. It is well-known that the ability to use groundwater for domestic water supply can readily be destroyed by MSW landfill leachate without any drinking water MCL's being exceeded. It is for this reason that some states, including California, have adopted regulations that focus on protection of groundwaters from use-impairment by landfill-derived constituents, rather than simply on meeting drinking water MCL's for those few chemicals in MSW landfill leachate that could render a groundwater unusable for domestic water supply, for which such values exist, i.e., are regulated.

On page 29 of DER (1993), Section 17-701.340 (4) Local Requirements states,

"(c) The minimum horizontal separation between waste deposits in a landfill and the landfill property boundary shall be 100 feet, measured from the toe of the proposed final cover slope."

It is unbelievable that a state would adopt regulations in 1993 that would allow a landfill owner/operator to deposit wastes approximately 100 feet from adjacent properties. In considering the impact of a landfill on adjacent owners' use and enjoyment of their properties, it is important to consider the impacts during the active life of the landfill, i.e., during the time when wastes are received at the landfill, as well as during the post-closure period, which should extend for as long as the wastes represent a threat. It has been known for many years that owners/users of properties with a mile or more of a MSW landfill experience significant adverse impacts on the use and enjoyment of their properties during the active life of a landfill, owing to the operations of the landfill. Those adverse impacts include odors, fugitive litter, noise, truck traffic, etc. Further, during the active life and after closure, significant potential problems can occur to impair use and enjoyment of adjacent properties owing to landfill gas and leachate-contamination of groundwater. The active deposition of wastes within a few hundred feet of adjacent properties will almost certainly cause significant adverse impacts on those adjacent properties that, de facto, condemn the uses of the properties.

It is such inadequate provisions that have led to the massive solid waste management "crisis" in the US; owing to inadequate protection, individuals who own properties near a proposed landfill justifiably vigorously oppose the siting of the landfill. Such individuals are often labeled as "NIMBY's" ("Not In My Back Yard") with the attendant implications of unjustified, selfish interest and disregard for the needs for waste disposal. The fact is, however, that landfills as typically operated today are significantly adverse to the owners and users of adjacent properties; in many situations the "NIMBY" position is justified. The proper way to address "NIMBY's" is to operate landfills so that they do not adversely affect uses and value of adjacent and nearby properties, and do not adversely affect air quality and groundwater quality at any time in the future. Providing less protection than this is providing garbage generators with "disposal" for costs less than those needed to properly manage the wastes so they do not adversely impact anyone.

In addition to significantly changing the way in which solid wastes are managed during the active life of the landfill to control adverse impacts, there is need for substantial land buffers owned by the landfill owner/operator. In most locations, a landfill owner-owned land buffer of a mile or more about the area in which wastes are deposited and adjacent properties is needed to mitigate the impacts of the landfill operations during its active life. This means that the construction of a new landfill would require the purchase of adjacent lands to provide the necessary land buffer. This is part of the cost of developing a landfill today, and should be borne directly by those who generate the waste for deposition at the landfill.

On page 29 of DER (1993), Section 17-701.400 Landfill Construction Requirements states,

"(1) Minimum design standards. The requirements of this rule are the minimum standards for constructing a landfill. Nothing in this rule shall be construed to prevent the Department from imposing more stringent standards as necessary to protect the environment and the public health and safety due to site specific conditions and types of wastes to be disposed of in the landfill or solid waste disposal unit. An applicant whose landfill design meets the design standards of this rule will be presumed to provide reasonable assurance that the performance standards of Rule 17-701.340(1), F.A.C., will be met."

and

"(3) Landfill liner requirements. Landfills shall be constructed with composite or double liners, and a leachate collection and removal system."

Section (3)(b) describes the composite liner as having a geomembrane of at least 60 mil thickness, and a soil layer consisting of at least 2 feet material with a permeability of 10^{-7} cm/sec.

Section (3)(c) (page 31) describes the double liners that are allowed; two geomembranes with a leak detection system between are allowed.

Section (4) (page 33) describes the requirements for the leachate collection and removal system as follows.

"Leachate collection and removal system. Landfills shall have a leachate collection and removal system that is designed, constructed, maintained, and operated to collect leachate and convey it to collection points for removal."

Section (4)(b) on page 34 states in part,

"The primary leachate collection and removal system shall have a granular drainage layer above the top geomembrane liner, at least 12 inches thick, with a hydraulic conductivity of not less than $1x10^{-3}$ cm/sec, overlain with an additional 12 inches of soil or other material approved by the Department to provide a total protective layer 24 inches thick, that is chemically resistant to the waste and leachate."

The minimum permeability of the leachate collection and removal system is far less than what should be allowed to minimize biological clogging of this system by MSW-derived constituents. This issue is discussed in the materials appended to these comments.

Section 17-701.400(12) on Landfills and Groundwater (page 45) permits the issuance of permits for the construction of a landfill in which the bottom of the wastes are below the watertable. That practice can significantly increase the potential for leachate generation and groundwater pollution.

Beginning on page 56, Section 17-701.510 Water Quality and Leachate Monitoring Requirements states with regard to (2) water quality monitoring plan and system,

"(b) The water quality monitoring system shall be installed and consist of: a sufficient number of ground water wells installed at appropriate locations and depths to yield ground water samples from the uppermost aquifer, as well as other aquifers reasonably expected to be affected by the landfill; surface water monitoring points installed at locations to yield samples of surface water that may be affected by the landfill; and leachate monitoring points to yield representative leachate samples. All sampling and analysis activities shall be performed by organizations that have Comprehensive Quality Assurance Plans approved in accordance with Rule 17-160.300(8), F.A.C."

That Section's (3) on groundwater monitoring specifies,

"(a) Two or more detection wells shall be located, and within zone of discharge hydraulically downgradient from the solid waste disposal unit, to detect leachate releases. These wells shall be located no more than 50 feet from the edge of the solid waste disposal unit, unless site specific conditions make such placement impractical. These wells shall be capable of monitoring each solid waste disposal unit as it is operated."

and on page 57 with regard to monitoring wells, Section (d),

"3. Well spacing shall be spaced at no greater than 500 feet apart across the downgradient direction of ground water flow, and no greater than 1500 feet apart across the upgradient direction of ground water flow, in the uppermost aquifer within the zone of discharge, unless site specific conditions support the use of alternate well spacing. Conditions to be considered include, but are not limited to, ground water flow directions and rates, estimated longitudinal and transverse dispersivity rates, proximity to or presence of sensitive environments and ground water users, nature of the wastes, method of disposal, and the proposed design and size of the facility."

While the groundwater monitoring system described in the regulations as noted above may give the superficial appearance of being adequate to detect failure of the landfill liner when it occurs, an understanding of groundwater monitoring, the expected nature of liner leakage, and expected nature of migration of leachate in an aquifer system shows that that monitoring system will not likely detect liner failure before widespread pollution of groundwater has occurred.

The DER (1993) monitoring requirements are grossly deficient for detecting leachate-pollution of groundwater before widespread pollution occurs. As discussed by Lee and Jones (1993) (see appendix) in order for monitoring systems of the type that DER outlined to have any significant potential to detect groundwater pollution before widespread pollution of groundwater beneath adjacent property owners' lands has occurred, a "picket fence" of vertical monitoring wells would have to be constructed at intervals of no more than a few feet across the downgradient monitoring face of the landfill, well-within the landfill property.

The fundamental problem with the approach outlined by the DER is that it does not consider the manner in which lined landfills leak, the manner in which leachate migrates in the saturated and unsaturated zone, or the sampling characteristics of the monitoring wells used. The presumptions of the DER monitoring approach is that leachate leaks rather uniformly across the bottom of the landfill and moves as a wide front through the aquifer. In reality, however, leachate initially leaks from lined landfills through holes, tears, and other imperfections and other areas of high permeability in the liner; the leachate moves as narrow finger-plumes a few feet in width in the unsaturated and saturated areas of the aquifer and through fractures in the aquifer. Conventional vertical monitoring wells draw water from a few-foot radius about the well. Therefore monitoring wells spaced hundreds of feet apart are unlikely to detect the finger-plumes of incipient leakage of a lined landfill at fifty feet from the edge of the waste management unit as required by DER (1993). The proposed landfill groundwater monitoring program provides very little protection of groundwater quality from leachate-pollution.

Section 17-701.600 (5)(g) Final Cover Design states on page 69,

"1. Lined landfills and Class III landfills shall have a barrier soil layer 18 inches thick, with a maximum permeability of $1x10^{-5}$ cm/sec, emplaced in 6-inch thick lifts. A final, 18-inch thick layer of soil that will sustain vegetation to control erosion shall be placed on top of the barrier layer. Unlined Class I and Class II landfills shall have a final cover consisting of a final, 18-inch thick layer of soil that will sustain vegetation to control erosion, placed on top of the barrier layer, and a barrier soil layer 18 inches thick, emplaced in 6-inch thick lifts, with a permeability of $1x10^{-7}$ cm/sec or less."

"3. A geomembrane may be used as an alternative to the low-permeability soil barrier for a final cover, constructed to preclude rainfall infiltration into the landfill. A geomembrane used in final cover shall be a semi-crystalline thermoplastic at least 40 mils thick or a non-crystalline thermoplastic at least 30 mils thick with a maximum water vapor transmission rate of 2.4 $g/(m^2xday)$, have chemical and physical resistance to materials it may come in contact with, and withstand exposure to the natural environmental stresses and forces throughout the installation, seaming process, and settlement of the waste during the closure and long-term care period. A protective soil layer at least 24 inches thick shall be put on top of the geomembrane. Material specifications, installation methods, and compaction specifications shall be adequate to protect the barrier layer from root penetration, resist erosion, and remain stable on the final design slopes of the landfill. This layer shall include top soil or soils that will sustain vegetative growth. In some cases, a drainage layer may be required between the cap (soil and geomembrane layer) and the top soil layer."

As discussed in the appended papers and reports, achieving the prescribed cover characteristics at the time of construction will not preclude moisture from entering a landfill and generating leachate. Since the wastes in a "dry tomb" landfill will not be prevented from contact with moisture and thus from generating leachate, leachate-pollution of groundwater will be a threat forever.

If landfills are sited where groundwater could be polluted by landfill leachate, (i.e., the landfill area is hydraulically connected to waters that are used or could be used at any time in the future for domestic water supply purposes), and if the landfill is designed as prescribed by the regulations (i.e., the landfill system only somewhat postpones groundwater pollution), it is essential that perpetual funding be available to properly address the inevitable failure of the landfill containment system. However, review of the DER (1993) regulations in this regard show them to be not only inadequate, but also discouraging for providing the perpetual care and funding that will be required to provide true protection of groundwater resources that stand to be adversely affected by municipal solid waste "dry tomb" landfills.

DER (1993) provisions for Long Term Care provided in Section 17-701.620 beginning on page 73, include

"(1) Long-term care period. The owner or operator of any landfill which receives wastes after January 6, 1993, shall continue to monitor and maintain the facility in accordance with an approved closure plan for 30 years from the date of closing. Before the expiration of the long-

term care monitoring and maintenance period, the Department may extend the time period if the closure design or closure operation plan is found to be ineffective.

(2) Reduced long-term care period. The owner or operator of a landfill may apply to the Department for a reduced long-term care schedule if reasonable assurance is provided to the Department that there is no threat to human health or the environment and if the landfill:

(a) Has been constructed and operated in accordance with approved standards, and has a leachate control system and a liner;

(b) Was closed with appropriate final cover, vegetative cover has been established, and a monitoring system has been installed;

(c) Has a 10-year history after closure of no violations of water quality standards or criteria detected in the monitoring system, and no increases over background water for any monitoring parameters which may be expected to result in violations of water quality standards or criteria;"

On page 76, Section 17-701.630(3) Cost Estimates states,

"(a) For the purposes of determining the amount of proof of financial responsibility that is required in subsections (5) and (6) of this section, the owner or operator shall estimate the total cost of closure for the permitted portions of the landfill or for those portions of the landfill for which a construction permit is sought, for the time period in the landfill operation when the extent and manner of its operation make closing most expensive. The annual cost of long-term care shall be estimated and listed separately, and multiplied by 30 years. The owner or operator shall submit the estimates, together with all necessary justification, to the Department for approval along with the proof of financial responsibility. The costs shall be estimated by a professional engineer for a third party performing the work, on a per unit basis, with the source of estimates indicated."

As discussed by Lee and Jones (1992b) (appended), the 30-year post-closure care period specified in the DER regulations is based on a technically incorrect analysis of the period of time during which municipal solid wastes in a lined landfill would represent a threat to groundwater quality. The 30-year post-closure care period incorporated into RCRA requirements by the US EPA evolved out of the belief that gas production (fermentation of fermentable organics with production of landfill gas (CO_2 and methane)) occurs for a period of about 30-years after a classical, unlined sanitary landfill has stopped receiving wastes. That estimate has essentially no relevance to the period of time during which today's municipal solid wastes deposited in lined "dry tomb" landfills undergo fermentation-gas production, or to the period of time during which leachate will be generated by such an MSW landfill.

The manner in which much garbage is now frequently packaged in the home - in plastic bags - greatly extends the period over which gas production can occur because of the inability of moisture that enters the classical sanitary landfill without a low permeability to come in contact with all of the garbage, thereby allowing gas production to proceed. The bacteria that produce landfill gas need moisture to carry out the process. As discussed by Lee and Jones (1992a,b), a

"dry tomb" landfill is developed in concept to minimize entrance of moisture into the landfill, at least for the first 30 years after closure; well-designed, constructed, and maintained covers, especially those that incorporate flexible membranes (plastic sheeting), can be effective in reducing entrance of moisture into a landfill as long as the landfill is above the watertable and the plastic sheeting has no holes in it through which moisture could pass. It is entirely possible that gas production that occurs in the landfill prior to closure will terminate or proceed at only a very low rate following closure due to the low moisture content of the waste; this stasis of gas production could continue for as long as the landfill cover is effectively maintained. Gas production will resume, however, when the owner/operator or individuals responsible for the maintenance of the cover fail to prevent the entrance of sufficient precipitation moisture into the landfill to provide the bacteria the moisture needed for their fermentation processes.

Another fundamental error made by the US EPA in its establishment of a 30-year post-closure care period was its assumption that once fermentation - gas production - ceases, the buried wastes are no longer a threat to groundwater quality. First, fermentation only acts on certain fermentable organics; not all organics are subject to fermentation; many hazardous and otherwise deleterious components in an MSW landfill (e.g., heavy metals, salts) are not rendered innocuous by fermentation.

Second, the long-term impacts of a municipal solid waste landfill are not restricted to those associated with fermentation gas. The US EPA did not properly consider the chemistry of the processes that occur in lined MSW landfills that result in the leaching of chemicals that lead to groundwater pollution. Like fermentation, the generation of leachate also depends on moisture, but leachate is generated by a significantly different and separate set of chemical and biochemical reactions. While gas production in the classical sanitary landfill in which the wastes were not bagged in plastic, would take place from 20 to 50 years or so, the generation of leachate from such facilities is well-known to take place for hundreds to thousands of years. As discussed in the appended materials, the literature shows that landfills developed in the Roman Empire more than 2,000 years ago are still producing leachate. An analysis of the chemical processes that occur within a classical sanitary landfill shows that leachate generation should proceed for at least hundreds and more likely several thousand years or more. In a "dry tomb" landfill in which entrance of moisture is initially restricted, the potential for leachate generation remains. Once moisture is allowed to enter the wastes, whenever that occurs, leachate will be generated. The longer the engineered containment components maintain their conceptual integrity, the longer leachate generation will be postponed. Without question, the 30-year post-closure provision of the US EPA RCRA requirements is short-sighted and will not ensure protection of groundwater quality and resources for as long as the wastes in a lined "dry tomb" landfill represent a threat.

The incorporation of a 30-year post-closure care period in landfilling regulations such was done in the Florida DER January 1993 regulations, reflects a lack of understanding or concern about long-term impacts of MSW landfills on groundwater quality. There is no question about the fact that a landfill cover will not function effectively for as long as the wastes represent a threat to prevent moisture from entering the landfill. There is also no question about the fact that the leachate collection removal system and the liner containment system under the landfill will not be effective in collecting all leachate that will be generated within the landfill. It is expected that some leachate leakage through the liner will start to occur shortly after the landfill is put in

operation. Over time the liner properties will continue to deteriorate; the barrier to leachate transport to the underlying aquifer system provided in concept by the liner system will diminish with time.

The US EPA Solid Waste Disposal Criteria (US EPA, 1988a) developed as part of the promulgation of Subtitle D regulations for landfilling of MSW (regulations that were ultimately released by the US EPA on October 9, 1991), recognized the inability of liner and leachate collection systems as being developed to provide for long-term control of leachate transport. The US EPA (1988a) stated,

"First, even the best liner and leachate collection system will ultimately fail due to natural deterioration, and recent improvements in MSWLF (municipal solid waste landfill) containment technologies suggest that releases may be delayed by many decades at some landfills."

The US EPA Criteria for Municipal Solid Waste Landfills (US EPA, 1988b) stated,

"Once the unit is closed, the bottom layer of the landfill will deteriorate over time and, consequently, will not prevent leachate transport out of the unit."

From the post-closure care funding requirements prescribed in DER (1993) (quoted earlier), it is clear that insufficient funds are made available in the DER regulations to provide for proper *ad infinitum* maintenance and replacement of the cover as needed for as long as the wastes represent a threat.

Dr. Robert Ham at the University of Wisconsin, has worked for many years on municipal landfill issues and recently stated (Ham, 1993),

"While modern landfills incorporate many improvements over previous facilities, the driving forces shaping landfill design now and in the future are unfortunately not based on sound technical and managerial principles and could lead to future problems. The trend to drier landfills, thereby prolonging decomposition, is of special concern in this regard."

It is widely recognized in the solid waste management field that the US EPA made a serious error in promulgating Subtitle D regulations which support the use of "dry tomb" landfills. Many in the Agency recognize that error and are pursuing alternative landfill designs and landfilling approaches that will ultimately enable the construction of landfills that will in fact protect groundwater resources for as long as the wastes represent a threat. Landreth, Chief US EPA Municipal Solid Waste and Residuals Management Branch, recently summarized the US EPA efforts in developing alternative approaches to the "dry tomb" landfilling approach (Landreth, 1993).

The authors are highly involved in work with groups in Toronto, Canada where the city of Toronto and suburban areas are in the process of siting several landfills for managing municipal solid wastes from the 3.5 million people of that area. The "dry tomb" landfilling approach will not be used; the design of the landfill will be such that it provides a very high degree of groundwater quality protection where waste treatment will be incorporated into the landfill

design and operation. We understand that L. Miller at the University of Florida in Gainesville as well as a number of others across the U.S. is active in research on alternative methods of landfill and municipal solid waste so that the landfills do not represent significant threats to groundwater quality *ad infinitum*. The situation in the Toronto area is not different from what could be achieved in the Gainesville area, should there truly be interest in protecting groundwater quality for as long as the wastes represent a threat.

As quoted above, DER (1993) Section 17-701.620 on long-term care described the requirements for long-term care and the conditions under which long-term care requirements can be reduced for a particular landfill. Those provisions allow the owner/operator of a landfill to be relieved of responsibility for care and contingencies for the inevitable groundwater pollution that will occur at the landfill, even before the end of a 30-year post-closure period. There can be little doubt that landfill owner/operators will be able to demonstrate a *"10-year history after a closure of no violations of water quality standards or criteria detected in the monitoring system, and no increases over background water for any monitoring parameters which may be expected to result in violations of water quality standards or criteria."* as allowed by provision (2)(c) of Section 17-701.620 to reduce the long-term care period. That level of performance of a liner system of the type required would be expected.

Not specified in the regulations, however, is who will be responsible for covering the costs of protecting groundwater quality after the post-closure care period. Who will cover the costs of protecting groundwater quality in the 31st year after the owner/operator is no longer responsible? As mentioned above, the state of California's approach is to require post-closure care for as long as the municipal solid wastes represent a threat, which as has come to be understood, will be forever. The state of Florida's approach is grossly deficient compared to that needed to truly protect groundwater quality from pollution by landfill leachate.

The permitted design of the landfill in accord with the January 1993 DER regulations only postpones groundwater pollution; it will not prevent it. As indicated above, states including New York, New Jersey, Pennsylvania, and Michigan have developed, or are in the process of developing regulations that specify landfill liner systems that are far more protective of groundwater quality than those adopted by the Florida DER in January 1993. While the Florida DER regulations give the impression of providing protection of groundwater from use-impairment, understanding the significance and capabilities of the systems that could be used in meeting DER (1993) regulations, the characteristics of the processes that occur in lined MSW landfills and of landfill leachate, and the impact of MSW landfill leachate-associated contaminants on domestic water supply water quality, shows that the DER regulations will allow significant adverse impacts on adjacent and nearby properties during the active life of the landfill and will be significantly adverse to the use of groundwater resources hydraulically connected to the landfill area for domestic water supply purposes. This situation has to be considered in a technically valid landfill siting process.

Overall Assessment of Adequacy of DER (1993) Landfill Regulations in Protecting Public Health, Environment, and Groundwater Resources from Adverse Impact by Wastes

It is clear that the DER (1993) regulations discussed above cannot be relied upon to protect the public health or environment of individuals who reside on, work in, or otherwise use lands near an active or closed landfill permitted under them. The zone of impact of such a landfill, in which there will be significant adverse impacts on individuals within the zone of impact of the landfill, will likely extend for a mile or more from the area of waste deposition.

In light of the landfill design, construction, groundwater monitoring, etc. allowed under the DER (1993) regulations, the post-closure care provisions cannot be relied upon to ensure significant protection of groundwater quality from landfill-derived contaminants for as long as the wastes represent a threat, which will be effectively forever. Groundwaters hydraulically connected to the landfill area stand to be destroyed for use for domestic water supply purposes by leachate-derived constituents. As discussed above, by adopting its January 1993 regulations the DER (1993) has opted to continue allowing garbage "disposal" for prices that do not cover the total costs of MSW management; the cheaper disposal is achieved, however, at the public health, welfare, economic, and resource expense of those who live on or otherwise use properties near the landfill and of future generations' groundwater resources in the area of influence of the landfill. Because of the inadequacies of the landfilling regulations it is essential that groundwater quality protection be achieved through proper landfill siting.

The basic issue that we have been asked to address is whether there is sufficient, reliable information to support the selection of Site E in Alachua County as the best available site for a municipal solid waste landfill to serve the city of Gainesville and others in that area. If that site does not have characteristics that provide a high degree of natural protection for the quality of groundwaters potentially impacted that could be used for domestic purposes at any time in the future, the site is not suitable for a landfill of the type that can be permitted under DER January 1993 regulations, which, as discussed below, is the type of landfill the Alachua County Department of Public Works personnel would plan to construct at the site. Presented below is a discussion of landfill siting issues based on our experience in having been involved in such issues at a variety of locations in the US and other countries. Also presented is our review of the materials that have been provided to us of the information that has been provided to the public and its representatives (the Board of County Commissioners and the SWFSAC on the characteristics of Site E as the best available site for the County's proposed landfill.

Overview of Landfill Siting Processes

The public has become accustomed to paying a few cents per person per day to have its municipal solid waste "disappear" from homes or commercial establishments. The providing of garbage "disposal" for the lowest possible cost has resulted in inadequate protection of the public health and welfare of those who own or use property in the vicinity of a landfill. The zone of potential impact of MSW landfills typically extends for a mile to, in some cases, several miles from the landfill. Significant, highly offensive odors, litter, unsightliness, truck traffic, etc. as listed in Table 1 can extend for considerable distances from the landfill.

It is well-known that property values near landfills are adversely affected for considerable distances. Hirshfeld *et al.* (1992) recently reviewed this issue and reported that their studies showed that property values are decreased measurably for distances of three to four miles from a

landfill. When the active waste deposition area of landfills is allowed within a few hundred to a thousand feet or so of adjacent properties, as is allowed in Florida, there is no doubt that significant adverse impacts will be experienced by those who own or use these properties.

Further the landfill gas emissions represent a threat to public health, through air and water transport, and a significant hazard to the public through explosions. Landfill leachate (garbage juice) is well-known to contain a variety of highly hazardous and otherwise deleterious chemicals. As discussed above, once a groundwater is contaminated by MSW leachate, it should be considered unusable for domestic water supply purposes, even if all of the drinking water standards (MCL's) are met.

In examining the appropriateness of the landfill siting process used by a particular political jurisdiction, we have found that there is a number of issues which need to be addressed up-front before developing the details of the siting process. One of the fundamental issues that needs to be reliably addressed before siting is conducted is whether it is truly the intent of the landfill owner/operator to prevent the significant adverse impacts that municipal solid waste landfills of the type being developed today. All of the adverse impacts listed in Table 1 with the possible exception of truck traffic, can be controlled through proper siting and landfill design, operation, closure and post-closure care. It is simply a question of economics. Municipal solid waste management has typically been done in such a way as to minimize the cost of having a garbage generators' waste disappear from their property. A substantial part of these costs, public health and environmental burdens, however, has been shifted to the "public" in the vicinity of the landfill. While the operation of landfills can be conducted in such a way as to have essentially no adverse impact on nearby property owners/users, it requires a significantly different approach in the operations of the landfill and in acquisition of adequate buffer lands owned by the landfill owner to isolate the landfill operations and impacts from adjacent property owner/users than is being followed typically today.

With respect to groundwater pollution control, it is possible to reliably design, construct, operate, close, and monitor landfills so that there is little possibility of groundwater pollution in the vicinity of the landfill for as long as the wastes represent a threat, i.e. forever. However, following conventional minimal prescriptive standards of current regulations does not ensure, and in fact will rarely achieve, such protection. While, as discussed above, some states, such as California, adopted regulations many years ago that require that the landfills developed not have an adverse impact on the beneficial uses of waters in the vicinity of the landfill for as long as the wastes represent a threat, thus far the implementation of these regulations at the local regional level has not, in general, led to this degree of protection. Therefore not only must a regulation stipulate groundwater protection from use-impairment by landfill-derived constituents for as long as the wastes represent a threat, but also there must be a strong will and adequate financial support for the regulatory agencies to implement the regulations in accord with the performance standards established within them. It is our understanding that the Florida DER, like regulatory agencies in many other states, is not provided with adequate funds to properly implement the regulations that are adopted by the agency. This is a significant factor that should be considered in any landfill siting process since not only must the regulations be appropriate to protect groundwater quality from leachate pollution for as long as the waste represents a threat, but also the regulations must be implemented to reliably achieve this performance standard. Failure to

implement the regulations to protect groundwater quality means that a significantly different approach has to be taken in the siting of landfills than in a situation where the regulatory agencies are adequately funded and have the will to carry out groundwater quality protection from pollution by landfill leachate.

According to US EPA Subtitle D requirements, all landfills constructed after October 9, 1993 will have to be lined for the purpose of "preventing/controlling" groundwater pollution. It is imperative that in any review of a landfill siting process consideration be given to whether those responsible for siting are reliably informed about the ability of the liners that are being used today (plastic sheeting and compacted soil layers) to prevent leachate from passing through them for as long as the wastes represent a threat. The state of California was one of the first states to adopt requirements for liners for MSW landfills; in 1984 it adopted a minimum prescriptive liner design that consisted of one foot of compacted soil that had a maximum permeability at the time of construction of $1x10^{-6}$ cm/sec. A number of landfills have been developed in the state with that minimum prescriptive standard. It has been obvious that meeting the minimum prescriptive standard would at best only delay groundwater pollution by landfill-derived contaminants by a few months to a year or so. Other states, like Wisconsin, have adopted requirements for much thicker clay-soil liners. For many municipal solid waste leachate constituents, the thicker soil liner only somewhat increases the delay of groundwater pollution occurs; it will not prevent it.

Because of the inherent permeability of compacted soil-clay liners, regulatory agencies have been allowing plastic sheeting as an alternative to, or supplement for, clay liners for landfills. Until October 9, 1993, when the Subtitle D regulations become effective, it is possible in some areas to construct a landfill liner with only plastic sheeting as a liner. However, it has been known since the mid- to late-1980's that plastic sheeting alone as a liner is very ineffective and, in fact, can leak leachate at rates greater than that of clay-soil liners, through holes in the sheeting that are developed at the time of construction, after the landfill is in operation, or over time as the landfill liner materials deteriorate.

In an effort to try to overcome the inherent limitations of a clay-soil liner and plastic sheeting, the US EPA has adopted the requirement of a composite liner which is a combination of the two types of liner materials that are frequently used today. While in theory a composite liner will leak at a much lower rate at the time of construction than either plastic sheeting or compacted soil alone, in practice it is well-known that it is only a matter of time until composite liners also fail to prevent significant leachate from passing through them. These issues are discussed in detail in the appendix to this statement (Lee and Jones 1992a). An understanding of the characteristics of municipal solid wastes today, the characteristics of municipal landfill leachate, the ability of plastic sheeting and compacted soil layers either alone or together to prevent leachate migration through them for as long as the wastes represent a threat, and the transport of contaminants in groundwater systems, as well as the impact of municipal landfill-derived constituents that are present in leachate on public health, the environment and groundwater resources, shows that landfills of the type that involve the use of a single composite liner, such as is allowed in Florida's January 1993 DER regulations and the US EPA Subtitle D regulations, that at best, depending on the quality of construction, will only postpone groundwater pollution; they will not prevent it.

A key issue that has to be addressed in connection with the review of the adequacy of a landfill siting process is the ability of the groundwater monitoring systems to detect groundwater pollution before widespread pollution occurs. It could be that a highly reliable groundwater monitoring system could be developed for a landfill to detect the liner leakage before widespread groundwater pollution occurs under adjacent properties. However, as discussed by Lee and Jones-Lee (1993) (as well as by others as referenced by Lee and Jones-Lee, 1993), today's groundwater monitoring systems involving vertical monitoring wells spaced hundreds or so feet apart have a very low reliability of detecting groundwater pollution before widespread pollution of groundwaters has occurred under adjacent properties.

As discussed in the appended materials, it is not necessary, and indeed it is of questionable appropriateness, to rely on detection of groundwater pollution for the determination that the composite liner has failed to prevent significant leachate passage through it. Liner leak detection systems can and are being used to detect liner failure. Such an approach, however, is not incorporated into either the Florida DER or the US EPA Subtitle D regulations. As provided for in both of those sets of regulations, groundwater pollution has to occur before action is required to be taken to prevent further transport of leachate through the failed liner system. This is an important factor that has to be considered as part of a reliable landfill siting process.

In addition to detection of when the liner fails in order to prevent widespread groundwater pollution, a regulatory system has to be in place that is, in fact, effectively implemented shortly after liner failure is detected to prevent widespread groundwater pollution. Many states have had regulations for years that require that groundwater pollution by municipal landfills be stopped as soon as it is detected and the aquifer cleaned up to a maximum extent possible. Few states have implemented such regulations however. Existing landfills continue to pollute groundwaters year after year even though the state's regulations prohibit this pollution. That situation reflects a lack of will on the part of the regulatory agencies to enforce their own regulations arising out of the fact that enforcing the regulations is judged to be too expensive. As discussed in the appended materials, municipal landfill leachate from small landfills can pollute very large amounts of groundwater in a short period of time, rendering it unusable for domestic water supply purposes in perpetuity. There is one 80-acre landfill in the San Gabriel Basin of southern California with which we are familiar that in a 10-year period has destroyed over $100 million worth of groundwater rendering it unusable for domestic purposes. Not only is the groundwater unusable, but also the aquifer area that has been contaminated by MSW leachate is unusable for future water supply. That landfill has generated a groundwater contamination plume that is spreading at a rate of more than 500 feet/year. The regulatory agencies are not requiring the landfill owner to stop this pollution. This situation is not atypical of what is found across the country. If it is too expensive for today's society to clean up the pollution from the landfills that they have contributed wastes to and therefore helped to contribute to the groundwater pollution, why is there any reason to believe that future societies will be any more willing to spend the necessary funds to prevent groundwater pollution from municipal landfill leachate when it is detected?

Another key component that needs to be considered in any landfill siting process is the recognition by the regulatory authorities and the public that municipal solid waste landfills of the "dry tomb" type that are being developed today represent a threat to groundwater quality forever. This issue is discussed in the appendix. If the regulations such as US EPA Subtitle D and DER

(1993) only provide for post-closure care for 30 years after the landfill stops receiving wastes, there is little likelihood that groundwater pollution will be prevented when the liner system fails to prevent leachate transport through it. The approach that was adopted in California requiring that the landfill post-closure period be as long as the wastes represent a threat - which come to be recognized to be forever - is the approach that should be adopted and reliably implemented if there is interest in protecting groundwater quality from municipal landfill leachate pollution.

We have found that landfill applicants are misleading the public when they tell the public as part of securing permission to site a landfill in an area and trying to overcome NIMBY's opposition to the landfill based on groundwater pollution issues, that the new, high-tech, modern "dry tomb" landfills with a single composite liner, monitoring wells spaced up to 500 or more feet apart, and 30 years of post-closure care, will be protective of groundwater quality. It is obvious that such claims have no technical validity. Such landfills at best only postpone groundwater pollution; they will not prevent it. As discussed in the appended materials, it is readily possible today to develop municipal solid waste landfills that have a very high probability of preventing groundwater pollution for as long as the wastes represent a threat. It cannot be done with the conventional design of a single composite lined landfill of the type allowed in DER 1993 and US EPA Subtitle D.

The inability to site landfills to meet local needs is leading to the development of large, regional landfills (mega-landfills) that accept garbage generated hundreds to a thousand miles or more from the landfill. One of the common, appropriate concerns of citizens in a particular political jurisdiction who face the siting of a landfill in their area is the potential for the comparatively small landfill of adequate capacity to address the area's waste disposal needs for decades, to become a "mega-landfill" that will serve as a regional landfill for the state, or accept wastes from other political jurisdictions. While repeated attempts have been made by local governmental entities and states to develop regulations to prevent inter-county and inter-state transport of solid waste, the US Supreme Court has repeatedly struck down such regulations and has made it clear that it is not possible to restrict the garbage input to a landfill to only those residents in the jurisdiction in which the landfill is located. New York and New Jersey have been hauling garbage to Midwest states such as Ohio, Indiana, and Illinois, since the late 1980's. The rail haul of garbage for distances of a thousand or more miles is now being implemented. Recently, the residents of Contra Costa County, California found it was cheaper to haul garbage to Utah for disposal than to dispose of it in a new local landfill permitted in 1992.

There are several factors that can contribute to the potential for what was intended to be an area landfill to become a regional mega-landfill, that relate to the amount of garbage available for the landfill. The economics of landfill operation depend on the availability of a certain rate of garbage flow into the landfill. At some locations, commitments are made as part of securing funds (bonding) for a landfill for the receipt of certain amounts of waste at the landfill. This is of importance since it influences the funding (financial rating) of the project. There have been numerous examples over the past several years where county or other local jurisdictions have constructed waste management facilities such as landfills, incinerators, etc., in which as part of securing funding, the political representatives of the area obligated the jurisdiction to a certain income derived from the waste disposal in the facility. However, once in operation, the waste management unit did not receive the anticipated waste load and as a result there were significant

financial problems associated with the project. In order to secure the needed waste load, the facilities have had to expand their service area. We am aware of a number of incinerator projects which, in order to meet the financial obligations associated with acquisition of funds for support of the project, had to become a regional facility accepting garbage from other areas beyond those it was originally intended to serve.

Waste load short-falls can also occur as a result of increasing promotion of the "3 R's" - reduce, reuse, recycle. In some areas it is anticipated that "3 R" activities will reduce the waste stream going to landfills by as much as 50%. Thus, even for situations in which appropriate estimates had been made of the waste loads to an area landfill, changing patterns of waste generation can affect the economic realities of waste management units and thereby promote the development of regional mega-landfills.

The financial and economic issues that have to be addressed as part of funding for a landfill or other waste management development project should be clearly understood by the public and its representatives and subject to public review and comment during the planning feasibility phases of the project, including landfill siting.

It is clear that a landfill of the type that Alachua County proposes to construct to meet Alachua County's needs for 50 to 100 years could readily become a regional landfill to which garbage from other areas in Florida and/or other states would be transported over a shorter time period. This would increase the adverse impacts on adjacent and nearby property owners, and significantly reduce the period of time during which the County's waste disposal needs can be met by the landfill. Great care must be exercised in the development of the County's new landfill to be certain that the Board of County Commissioners does not trap the County residents into accepting a facility that on the surface appears to satisfy the County's waste disposal needs for many decades but in reality makes Alachua County the dumping grounds for garbage throughout the southeastern US and significantly diminishes the active life of the landfill.

Typically those who are responsible for managing municipal solid wastes in the political jurisdiction in an effort to overcome NIMBY have developed strategies that involved citizen's group siting committees who serve as advisors in helping select the site for a landfill. The siting committee basically receives input from the departments of public works staff and their consultants. One of the first issues that we typically review in evaluating the appropriateness of a landfill siting process is to examine the approach that was used by the siting committee in evaluating the significance of various adverse impact factors such as those listed in Table 1 in the siting process. We also examine the reliability of the information provided by the public works staff and their consultants who worked for the department of public works in addressing the ability of the proposed landfill to control-eliminate the various problems that are of legitimate concern to those who own or otherwise use properties near a proposed landfill. More times than not we have found that the site selection process is highly flawed because the site selection committee is not given reliable information on how well the landfill will protect groundwater quality, control landfill gasses, odors, litter, seagulls, vectors, rodents and the other problems listed in Table 1.

Another key factor in helping to evaluate the reliability of the information provided to the siting committee on the control of the adverse impacts of a proposed landfill is the cost of landfilling. The authors were recently involved in a landfill review process where the local public agency was proud of the fact that they had kept the costs of the landfill operations to $16/ton. While that may be highly desirable for the public who generates the waste, it is disastrous for the public who owns or attempts to use the properties near the landfill. At a cost of $16/ton for disposal, it is not possible to reliably address the control of contaminants and other adverse impacts associated with the landfill operations. It is the authors' experience that at least an additional $30-40/ton in tipping fees needs to be added to the classical sanitary landfill tipping fees in order to begin to provide significant groundwater quality protection from landfill leachate pollution. Added to that will have to be costs associated with the acquisition of adequate land buffers, proper policing to control litter, etc. Further, for some sites the additional construction of roads to handle the garbage truck traffic, road maintenance, etc. all have to be built into the tipping fees. In addition, there is the cost associated with the collection of the garbage and transportation to the landfill. While a number of these costs are site specific, based on the authors' experiences, it is likely that costs based on the order of at least $75/ton, and in some instances $100 or more/ton, will be required to properly construct, operate, close and provide post-closure care for a municipal solid waste landfill. In some cases the costs are even higher than this--particularly at highly unsuitable sites. Since each person generates about a ton of garbage a year, an average household consisting of three people can expect to spend something in the order of $1/day for the disposal of their solid waste.

There will be some who will claim that spending $1/household/day for municipal solid waste management is too expensive since this would result in a significant increase in their garbage bill from what they have been used to paying in the past. It is important to note, however, that what they have been paying in the past is typically far less than the true cost of solid waste management where these costs have been passed on to the property owners/users near the solid waste management facility and on to future generations to be exposed to the public health, environmental and other hazards of the landfill and to try to clean up the groundwater resources once they have become polluted by landfill leachate.

There is a tremendous legacy of groundwater pollution costs that is not being addressed today across the United States from municipal landfills. Someday regulatory agencies across the country will start to address these problems through a "municipal landfill superfund." It will then become realized that the cheaper-than-real-cost garbage disposal that has been practiced in the past has been tremendously short-sighted, and that if society had paid the true cost at the time they had deposited their wastes in the landfill, they would not now be facing massive costs of trying to clean up contaminated groundwaters because of inadequate siting, design, construction, operation, closure and post-closure care. In summary, expenditures of less than about $80-100/ton for solid waste management will in most instances lead to significant adverse impacts on the property owners and its users near the landfill.

There are naturally protective sites where there is no groundwater to pollute or the character of the groundwater is such that it or the groundwaters to which it is hydraulically connected are not suitable for domestic purposes. Under the conditions of a naturally protective site, it is possible

to significantly reduce the cost of solid waste management and still protect groundwater resources.

Another area that we frequently investigate in evaluating a landfill siting process and the selection of a landfill site is how well the agency/company that is responsible for managing municipal solid wastes in the region has operated landfills under their jurisdiction in the past and currently. If the agency's landfills have been good neighbors to adjacent property owners/users, there is somewhat of a chance that future operations might also result in a good neighbor policy where the operations of the landfill are not significantly adverse to nearby property owners and users. If those responsible for guiding the siting of the landfill have a history of problems associated with landfills they have currently or have previously managed, then there is little likelihood that the new landfill is going to be managed-regulated any better.

A disturbing trend has been evolving over the years by those responsible for landfill siting in which attempts are made to make the siting process "scientific" and "defensible." Typically the site selection committee will be steered by the public works department and their consultants into a numeric ranking procedure where the various ranking criteria are "selected" by the committee and then arbitrary scores are assigned to the significance of each of the criteria. This ranking process then is applied to various sites under consideration, and a site with the best overall score is selected for further study. While there are a variety of processes that evolve out of decision theory that could be used to select a landfill site, the numeric scoring process that is frequently used is a ploy by those who must find a place to manage the solid waste, i.e. the departments of public works, to try to give technical credibility to a somewhat arbitrary process. It is certainly inappropriate to claim that there is any technical validity to assigning a certain score to one of the siting parameters and then averaging the site specific score for a site with a different score from another parameter that are not related in some way. The siting process becomes especially flawed when the site selection committee who is developing the process and conducting site evaluations are not provided with reliable information on the impact of the proposed landfill on nearby property owners/users.

One of the first issues that a site selection committee has to address in selecting a site is whether the landfill will, in fact, protect the interests of those who own or use properties near the landfill for as long as the wastes and landfill operations represent a threat. Basically if the landfill had to be sited next to a site selection committee member's home, there would likely be a different attitude and approach toward site selection than is typically used today. If groundwater quality is not to be protected but only postponed until pollution occurs, this should be explicitly understood at the initiation of the site criteria development. In this way the site selection committee can make appropriate adjustments in the significance of natural protection vs. sites which are vulnerable to the inevitable pollution of groundwaters by landfill leachate by single composite lined landfills of the type that are allowed today.

Often in landfill siting processes exclusions are made of areas near which the landfill cannot be sited, such as political boundaries, schools, churches, urban areas, public parks, etc. Any time exclusions of this type are incorporated into the landfill siting process it is clear that this process is biased against the rural property owner-user in favor of cheaper-than-real-cost garbage disposal for the urban dweller. While in today's society urban dwellers have been able to benefit

from initial cheaper-than-real-cost garbage disposal at the expense of the rural property owner-user's public health, welfare, environmental quality and economic interests, this approach is becoming recognized for what it is a flawed siting approach.

Review of the CH2M HILL's "Evaluation of Candidate Site Selection Process," Technical Memorandum No. 1, July 15, 1992.

CH2M HILL has been working with the Alachua County Department of Public Works to develop information to be used by a citizen's site selection advisory committee to select sites for a new landfill in the county. Under the guidance of the County Department of Public Works, the site selection committee adopted a numeric scoring approach for ranking various criteria that the committee deemed appropriate in selecting a site for the new landfill. Numeric scoring approaches are not infrequently used to try to simplify highly complex technical environmental quality issues; to individuals who are not technically trained in or familiar with the relative significance of various potential impacts of landfills on uses of nearby lands, and air and water resources in the vicinity of the landfill, the numeric scoring-ranking procedure used by the County may appear to be technically defensible. However, it is recognized in the technical community that such approaches are not necessarily technically valid, are subject to considerable biases built into the ranking based on the information presented to the site selection committee, and most significantly are arbitrary in assigning relative numeric scores to the various potentially significant areas of concern in selecting a site. It is clear, for example, that it is inappropriate to give comparative scores to the importance of future generations' groundwater resources and the presence of aboriginal culture remnant artifacts - on a scale of 1 to 10 or some other scale contrived to yield a numeric score that can be mechanically plugged into the site selection process.

In the case of the Alachua County matter, on page 1-4, paragraph 2 of CH2M Hill Technical Memorandum it is stated that the Citizens' Site-Selection Advisory Committee considered water quality protection to be the most important category consideration for site selection. In order to enable the use of a numeric ranking system, that concern was assigned a point value; the number of points was arbitrarily set at 59 points out of the total of 100. This means that in that ranking system more than 40% of the score is assigned to other issues.

A significant, fundamental problem with the site selection process is that the site-selection committee was informed by CH2M HILL and the County Public Works staff that the landfill containment system would be protective of groundwater quality when, in fact, the landfill liner containment system that will be used will, at best, only postpone groundwater pollution by landfill leachate. The public would also be led to believe that the landfill would necessarily have to be protective of surface and groundwater quality if it met the DER (1993) requirements, which it presumably would. Would the site selection committee have ranked natural groundwater quality protection higher if it had been provided with more reliable information on the ability of the landfill that would be constructed to protect groundwater quality for as long as the wastes represent a threat? If reliable protection of water quality is ensured by meeting the January 1993 DER regulations as they will be enforced, why should "water" be given consideration in the ranking of sites for landfills?

We have been involved in review of many numeric ranking procedures for landfill site selection and have typically found that such procedures give inadequate attention to the long-term groundwater quality protection issues. The reason that DER modified its regulations in January 1993 was the concern for groundwater quality protection. We have repeatedly observed site-selection committees locking into sites for a proposed landfill using such numeric scoring approaches, long before a proper evaluation has been conducted of the primary factors governing the long-term impacts that the proposed landfill will have on the groundwater resources, public health and the environment in the vicinity of the landfill. If groundwater quality protection is to be achieved, the site selection process should focus on the issues of real concern, and not let peripheral or irrelevant issues dominate the selection process.

We have repeatedly observed situations in which landfill proponents, such as county departments of public works who have the responsibility for solid waste management for the region and their consultants who have an interest in supporting the county public works administrator's position or suffer the consequences to future consulting, have provided public-based site-selection committees with inaccurate, unreliable, or misleading information on the ability of the current regulations to protect groundwater quality from landfill derived contaminants. There are few members of such committees who have the expertise and experience in the deficiencies of current "dry tomb" landfilling approaches to be able to make an independent judgment of the ability of a particular "dry tomb" landfill of the type that can be permitted under the DER 1993 regulations to protect groundwater resources from pollution by landfill leachate for as long as the wastes represent a threat.

While such deficiencies in "dry tomb" landfills are widely recognized among the professionals who understand the nature of municipal solid wastes, the processes that occur in MSW landfills, the ability of liners of the type being used today to prevent groundwater pollution by landfill leachate for as long as the wastes represent a threat, and the impact of municipal solid waste landfill leachate on public health, the environment, and groundwater resources hydraulically connected to the landfill area, there are few in departments of public works who understand and can deal with these issues. There is, however, growing coverage of these issues and problems in the technical literature as well as in the public works literature. For example, over the past several years Abraham Michaels' "Solid Waste Forum" included in the *Public Works*magazine has discussed many of the significant problems with "dry tomb" landfills in providing long-term groundwater quality protection. A number of the our papers and reports have been reviewed in that Forum.

Some members of departments of public works have contacted me to obtain additional information that discusses the fundamental flaws in the "dry tomb" landfills of the type being developed today that adversely affect their ability to provide true, long-term protection of groundwater quality. Overall, the site selection processes typically used for landfills, including the one that was used in Alachua County, are not technically valid if they do not reliably consider the impacts of the landfill operations on adjacent and nearby property owners' use and enjoyment of their lands, and of the landfilled wastes on groundwater resources during the landfill life and in perpetuity after closure.

On page 1-3 under the "Purpose of the Siting Process" CH2M HILL states,

"The new SWMF [Solid Waste Management Facility] *is to be a state-of-the-art facility that will serve the county's solid waste management needs for at least 50 years. Because siting a SWMF is a sensitive issue involving environmental, health, and economic concerns, the resolution states that the committees were formed to help the BOCC* [Board of County Commissioners] *`foster an environment in Alachua County that will enhance the safety and provide essential services for all citizens of the county, thus promoting the public welfare.'"*

From the landfilling approach that will be used, that section quoted should be extended to include, "while eventually polluting groundwater quality in the upper and lower aquifers in the vicinity of the landfill and be significantly detrimental to the public health, and welfare, the environment, and the economic interests of the property owners/users near the landfill."

It is evident from the information presented in Table 1-I "Evaluation Criteria and Respective Point Values" (page 1-5) that the siting process in Alachua County has no technical validity, while giving an appearance of technical substance to the lay and non-critical professionals. The so-called "criteria" items are largely unreliable or inappropriate; the comparative "point values" are arbitrary. It is absurd and highly misleading to assign decimal-fraction accuracy to the "point values" for the various criteria. As indicated above, a fundamental premise of the siting of landfills is that they will meet the DER regulations for protection of water quality and protect nearby property owners/users from adverse impact during the active life of the landfill, and that meeting the DER regulations ensures that protection. If these assumptions are correct, there would be no need to place a high priority in siting to low population density in the surrounding area. If a landfill truly had no adverse impacts during its active life and post-closure care period on nearby property owners-users, why should it not be located next to a public park or in a densely populated area? Why should the value of adjacent land be considered less important when it is an individual's property than when it is a public park?

The issue of the "water" evaluative criteria were noted in Table 1-I as well as on page 1-9. As noted above, if meeting the DER regulations ensures protection of surface and groundwater quality, why should "water" issues be given consideration in the siting of landfills? Why was location near a major natural waterbody a consideration in the site selection process? Again, if by their design and operation, landfills are not adverse to surface or groundwaters for as long as the wastes represent a threat (as one would be led to believe by the regulations and CH2M HILL), why would there be need to prevent their location near surface waterbodies? Similarly, if groundwater quality protection were ensured by meeting the DER regulations, why would there be need to consider distance to public or community water supplies in the siting of a landfill? All these siting considerations do, in reality, is first to recognize that the regulations will not ensure protection of water quality and use and enjoyment of adjacent and nearby properties, and second to attempt to select sites that may postpone, somewhat, the manifestation of groundwater quality problems.

The fact is that if a landfill cannot be developed and operated so it is appropriate for location in densely populated areas where the majority of the waste generators are located, it cannot be considered appropriate for location next to others' properties in more sparsely populated areas. Landfills can be constructed to protect the environment at almost all sites, but not at the cheaper-than-real costs being paid now for garbage "disposal."

On page 1-6 CH2M HILL states that there was inadequate information to include the 100-year flood plain protection issue for some areas. I believe that the 100-year flood plain is a mandatory consideration requirement set forth by the US EPA in its Subtitle D regulations. How can sites be ranked reliably when there is inadequate information to make a reliable assessment about whether the site is within a 100-year flood plain? Clearly the site selection process is significantly flawed if information on exclusionary requirements such as a 100-year flood plain is not available for all sites during site selection.

In Table 1-I the "maximum thickness of the Hawthorn Formation" is listed as a site selection evaluative criterion. In the discussion of that criterion on page 1-9 it is stated,

"Because it was impossible for the Staff Technical Committee to determine the general structure of the Hawthorn Formation, sections of it were evaluated for being continuous, perforated, or not present."

Again it is clear that the site selection process was flawed with respect to groundwater quality protection for the deeper Floridan aquifer system. As was recognized in the discussion, it is not the thickness of the Hawthorn Formation that is critical to protection of groundwaters from landfill leachate pollution; it is the ability of the formation to prevent the transport of leachate through it to pollute the groundwaters under it for as long as the wastes represent a threat, i.e. forever. The issue is not thickness but whether there is a hydraulic connection between the two aquifer systems. The fact that there is a deeper aquifer system that is a major water supply for the city of Gainesville near a proposed landfill site adds to the concern about suitability of placing any landfill in that area. To conduct a landfill siting process without properly evaluating whether the Hawthorn Formation is truly protective and to rely on the public works staff and consultants to estimate whether the Hawthorn Formation provides true natural protection of the underlying aquifer in the site selection process is highly inappropriate and further demonstrates a flawed nature of the site selection process.

The importance of groundwater quality protection in the site selection process mandates that reliable information be available before a best available site is selected. It is important that the natural integrity of the Hawthorn Formation be reliably evaluated before selecting a site that is located near an existing or potential domestic water supply well field for a metropolitan area. Furthermore, the fact that wells penetrate the Hawthorn Formation in the vicinity of a proposed landfill is of great concern. It is well-known that wells that penetrate "impervious" layers often serve as conduits for transport of contaminated groundwaters from an upper to a lower aquifer or vice-versa in the case of deep-well injection of wastes.

While it is sometimes stated by landfill proponents and others not knowledgeable in the properties of the seals of the type used today such as cement or bentonite clay, that the well based hydraulic connection between aquifers can be eliminated by sealing the well(s), it is becoming recognized that well sealing is not always effective at the time that it is done and that over time the properties of the seals deteriorate and allow a hydraulic connection to be reestablished between the two aquifers. As discussed in a subsequent section of these comments, the interconnection of aquifers by wells is a common problem. The problem of pollution of the lower aquifer by the surface aquifer system has already occurred several times in the area near

Site E. These characteristics and concerns, rather than the thickness of the Hawthorn Formation, should be used as a major criterion in site selection. Far too much emphasis was placed in the site selection on the thickness of the Hawthorn Formation for the protection of deeper groundwater quality than should have been especially when there was already well-documented evidence that the Hawthorn Formation has already been breached several times by hazardous chemicals disposed on the land in the vicinity of the well field.

Much greater attention should have been paid in the early steps of the site-selection process to the potential for the pollution of the shallow water aquifer and the city of Gainesville's municipal water supply well field by landfill leachate. While the materials developed by CH2M HILL claim that a high priority was given to groundwater quality protection in site selection, in fact true groundwater quality protection was not reliably considered.

Page 1-9 lists as criteria, "Maximizes distance to public water supplies" and "Maximizes distance to community water supplies" (where community water supply is defined as a water supply that has more than 15 service connections). It is shocking that the individual water supplies of homeowners and property users on adjacent and nearby properties were ignored in the site selection process. It is unbelievable to us that a landfill site selection would be made ignoring the rights of an individual property owner/user to a contaminant-free water supply in selecting a site for a landfill that will take 50 years of wastes from the county.

While the DER (1993) regulations had not been adopted when the site selection process was started, and while we do not know if the previous regulations required protection of groundwater quality from exceedances of MCL's, clearly if the site selection process were based on a presumption that MCL's would not have to be met at individual homeowners' wells in the vicinity of the landfill, then the site selection should be re-done in light of the DER requirements that groundwaters must be protected from exceedances of MCL's in drinking water irrespective of whether the water serves one person or a large city.

The DER (1993) regulations recognize the need to protect an individual property owner's water supply. All groundwaters have to be protected at least to the degree necessary so that no groundwater quality standard (MCL) is exceeded beyond the area defined by the regulations for a particular landfill. This does not allow the pollution of water supply wells that have fewer than 15 connections. While the DER regulations require that MCL's not be exceeded (provided that the monitoring program detects the pollution before it reaches a water supply well), the DER regulations do not protect public water supplies, community water supplies, or individual water supplies from pollution by contaminants for which there are no standards-MCL's. Furthermore, protection afforded by the DER (1993) regulations from those contaminants that do have MCL's is very limited since the regulations require that the pollution of the groundwater by landfill leachate be detected in a monitoring well before it reaches a water supply well; the monitoring system that DER will allow to be constructed will have a very low probability of detection of groundwater pollution before wide spread pollution occurs.

It is clear that the site selection process was highly flawed with respect to evaluation and ranking water quality issues that are of great importance to future generations who will use and/or own lands near the landfill as well as the city of Gainesville and possibly other communities who

would want to use the groundwaters that could be impacted by the landfill *ad infinitum*, as a domestic water supply source.

The overriding issue in this site selection process was economics for those who generate the wastes. The site selection criteria set forth largely ignore the economic impact of this process and landfill siting on those who use lands in the vicinity of a proposed landfill in rural areas in favor of those who generate the waste from urban areas.

Page 1-13. The first paragraph states,

"Difficulties were encountered by the CSSAC when available maps and other information were hard to assimilate using the evaluative criteria or when needed information was not available."

Without reliable information, how can a site selection process be deemed reliable? From our review of the information provided, the claim made on page 1-13,

"Our review of the CSSAC's site selection process indicated that the development and application of the exclusionary factors and evaluative criteria were generally performed in an objective, scientific manner."

is clearly without foundation. Such a claim could lead those who do not truly understand the scientific method to believe that the site selection approach used has technical validity; it does not. It is pseudo-science and highly arbitrary and, in some cases, capricious in ranking factors and sites for selection.

On the bottom of page 1-14, CH2M HILL states,

"We recommend that absence of the Hawthorn Formation be an exclusionary factor for the regional screening effort and that structure be evaluated on a site-specific basis."

Again, if the landfill were designed, constructed, operated, and closed to protect groundwater quality for as long as the wastes represent a threat, why would the Hawthorn Formation be needed to protect domestic water supplies? Obviously CH2M HILL staff know, or should have known, that the landfills that are going to be constructed at the site, even in accordance with state regulations, will not be protective of groundwater quality for as long as the wastes represent a threat. Was this information provided to the site selection committee? If not, why not?

On page 1-16 CH2M HILL recommends that the landfill

" Shall not be located within a municipal boundary".

While CH2M HILL did not discuss this point, it appears that CH2M HILL realizes that municipal landfills of the type that could be constructed have significant adverse impacts on individuals who live or work at, or otherwise use properties near the landfill during its active life and post-closure period. Since the wastes that will be deposited in the landfill are generated primarily within municipal boundaries, why should those wastes not be deposited within the

municipal boundary and affect those who are the primary source of generation? Adoption of this approach would clearly provide for far greater protection of public health and environmental quality than the approaches being used in which the burdens of the landfill, including the public health and welfare, economic, and environmental consequences, are shifted to rural residents so that the municipal residents who are the primary source of the waste can have cheaper-than-real-cost garbage disposal.

With respect to Resolution 89-46 "Establishing the Citizens' Site-Selection Advisory Committee," it is clear that the Board of County Commissioners was not provided reliable information on the very significant technical deficiencies in the site-selection process that the County Department of Public Works and CH2M HILL proposed for use as part of their consideration in adoption of this resolution.

Comments on the "Identification of Integrated Solid Waste Management Systems," Working Paper No. 2, Prepared by CH2M HILL, November 1992

Page 2-2, Table 2-1 lists the SWFSAC's (Solid Waste Facility Siting Advisory Committee) goals for evaluation of solid waste management systems for Alachua County's new SWMF. The goals include the following,

Reduce negative impacts to the environment by meeting or exceeding all current environmental regulations.

Maximize buffer zones and reduce negative aesthetic impacts to the environment.

Implement safe, reliable technologies that protect the environment.

Minimize costs, while protecting the surrounding environment.

Several of the goals use the word "minimize" to describe the goal for addressing adverse impacts and the word "maximize" to describe the affording of protection. These goals do not embrace the need to provide for unequivocal protection of adjacent and nearby property owners and users from the adverse impacts of the landfill. Any time a waste management system is established to only "minimize" adverse impacts, but not prevent or correct them, it is clear that those responsible for establishing the program are going to continue to minimize costs to those who generate the wastes in urban areas at the expense of the rural property owner/users interests in public health, environmental quality, aesthetic quality of life, economics, and groundwater resources. The adverse impacts of municipal solid waste management by landfilling can be controlled through siting, adequate buffer lands, waste treatment and management technology, and landfill design, operation, closure, and post-closure care. It is possible to develop landfills that would be "good neighbors" and truly afford protection of public health and the environment. The approach, however, being used in Alachua County is not one that fosters that degree of protection. Instead, the economic interests of those who generate the wastes plays a dominant, if not the dominant, role in defining the degree of so-called environmental protection for those who stand to be impacted by the waste management approaches.

Throughout my (G.F. Lee) over thirty year professional career I have frequently been involved as an advisor to international, federal, state and local regulatory agencies in helping to develop environmental quality protection regulations. Through this experience I learned to be highly skeptical about project advocates' statements concerning the project being developed so as to "meet existing regulations." It is well known by those familiar with development of regulations and standards that often factors other than public health, ground and surface water quality, and the environmental protection are dominant factors in determining the degree of protection afforded by achieving the regulations. It is also well known that many regulations and standards lag technical knowledge about the impact of contaminants on public health and the environment by many years, sometimes decades.

It should be obvious that there is no need to state as CH2M HILL did on page 2-2 that the new landfill in the Alachua County will meet regulations. Would a county department of public works propose to construct a landfill that would not meet regulations? Rather than misleading the public on this issue by implying that the regulations are adequate, the county department of public works and their consultants should discuss the adequacy of the regulations in providing true public health, environmental quality, groundwater resource protection, and the protection of nearby property owners/users' use and enjoyment of the property that is within the zone of impact of the proposed landfill. The county staff and CH2M HILL should have also discussed the fact that a number of states have found that landfilling regulations adopted by DER in 1993 are not adequate to protect groundwater quality from leachate pollution for as long as the wastes represent a threat. With such information the site selection committee and the public could potentially make informed decisions about the selection of appropriate siting criteria and the evaluation of their relative significance in the site selection process. Without this information, the site selection process is technically flawed, since the site selection committee and the public were not provided reliable information upon which to make informed decisions in developing the process and its implementation.

CH2M HILL presents its "engineering criteria" in Table 3-2. It is not clear from the information provided that they have properly evaluated the true environmental impacts of the various programs that they have proposed for consideration.

"Candidate Site Ranking," Technical Memorandum No. 3, prepared by CH2M HILL, June 1992. CH2M HILL states on page ES-2,

"The goal of the candidate site ranking process was to identify the best available site. With the identification of Site E, that goal has been realized."

The report went on to claim that the process was *"value-driven," "well thought-out," "rational,"* and*"objective and defensible."* A proper review of the process shows that the selection of Site E above other sites was, contrary to that claim, arbitrary and capricious; it was certainly not well thought-out, rational, objective or defensible. As discussed above, the site selection process is technically flawed; inadequate, unreliable or insufficient information was provided upon which Site E was selected above other sites. If proper consideration had been given in developing the site-selection process, Site E would not have been selected as the best possible site. From the information supplied, it is a highly vulnerable site to long-term

groundwater pollution problems. The failure to properly establish a reliable site-selection process has caused Site E to be ranked high, when in fact it should have been given a much lower ranking even applying the flawed ranking process. The failure to include consideration of individual property owners' wells water supply quality in the site-selection process, alone, is sufficient to dismiss the process as technically invalid. The fact that the site selection committee was not reliably informed about significant adverse impacts that the proposed landfill could have on water supply water quality, and on adjacent property owners/users' use and enjoyment of property, public health, environment, and groundwater resources, renders the site selection process technically invalid, and arbitrary and capricious.

Table 3-3 on page 3-10 indicates that the water supply wells in the shallow aquifer could not be measured due to lack of available information. This is yet another aspect of the process that is flawed.

On page 3-22 under the heading, "Ground Water Resources" it is stated,

"Site E received a rating of 5 (the highest rating achievable) for all three of the ground water criteria."

That statement would sound to someone who does not understand the details of the process used, that use of Site E would be protective of groundwater. However, understanding the nature and technical aspects of the siting process the groundwater quality issues associated with landfills of the type proposed reveals that considering that site protective disregards the pollution of the shallow water aquifer by the landfill that would cause individual homeowners-users to have to abandon their wells. It would also require the acceptance that the Hawthorn Formation has no connections between the upper aquifer and lower aquifer; that assumption is known not to be true. The claims made in the report regarding the foundation of the selection of Site E on the basis of groundwater protection are without technical merit. The high "rating" of that site is an artifact of an inappropriate site selection and scoring process developed by the county and its consultants which fails to properly represent long-term groundwater quality issues.

Page A-4 defines "site buffer" as "A 1/4-mile-wide perimeter beyond the site boundary." That 1/4-mile buffer is discussed at several locations in the various technical memoranda. As discussed above, a 1/4-mile "buffer" is insufficient to mitigate the significant adverse impacts on adjacent and nearby property owners/users of municipal solid waste landfills of the type that the County proposes to construct. There will be significant adverse impacts, including decreased property values, odors, litter, airborne public health hazards, truck traffic, etc. that will occur beyond the 1/4-mile buffer.

Evaluation and Modeling of the Floridan Aquifer System in the Vicinity of the Murphree Well Field, Technical Memorandum No. 4, prepared by CH2M HILL, March 1993.

On page iv of the Executive Summary under the heading, "Findings," it states,

"CH2M HILL concludes that the use of Site E is compatible with either a northward expansion of the Murphree well field or the installation by GRU of an eastern satellite well field for the following reasons:

The Hawthorn Formation is of significant thickness at Site E. Available data indicate that this formation will act as an effective barrier between the surficial and Floridan aquifers at Site E. No information available to date indicates the presence of discontinuities of the Hawthorn Formation at Site E."

A critical review of the information available raises significant questions about the appropriateness of CH2M HILL's conclusion that Site E is compatible with the Murphree well field. The fact that no information was available that indicated discontinuities in the Hawthorn Formation does not mean that an adequate investigation has been conducted to properly determine whether discontinuities exist. That finding simply says that no problems were found, but they have not reliably looked for problems yet.

Another "Finding" of CH2M HILL is

" The estimated range of total travel times for non-reactive groundwater particles to migrate from Site E to the Murphree well field (approximately 140 to 440 years for the northward expansion and approximately 340 to 500 years for the satellite well field) is long in comparison to the 5- to 20-year travel time normally considered adequate for establishing well field protection zones. Thus, adequate response time would exist in the unlikely event that corrective actions were required."

CH2M HILL has again not properly presented the issues. First, there can be little doubt that there will be transport of leachate-contaminated groundwaters from the Site E landfill, should it be constructed, to the Floridan aquifer. It would indeed be highly unusual that a geological formation such as the Hawthorn Formation would represent a truly impermeable barrier that would protect the Floridan aquifer system from pollution from the upper aquifer *ad infinitum*. As discussed above, Site E is not a suitable site for a landfill based on the fact that the shallow water aquifer would not be protected from pollution. That, coupled with the fact that the Gainesville water supply could be destroyed for domestic use at some time in the future because of leachate-pollution of the aquifer, should have caused Site E to be considered of low suitability as a candidate site. The fact that an opposite conclusion was reached, purportedly on the basis of groundwater considerations, demonstrates the highly flawed nature of the site-selection process that was conducted by the County and CH2M HILL.

CH2M HILL's statement that only 5 to 20 years' travel time is normally considered adequate for establishing well field protection zones is not in accord with our experience. First, it is very important to point out that in evaluating the adequacy of a 5 to 10-year period it is important to consider when the period will start, i.e., how effectively the incipient pollution will be detected. Second, even with a very elaborate, very expensive array of groundwater monitoring wells constructed in the Floridan aquifer in the region where pollution could occur, it could be that pollution of the Floridan aquifer could exist for many decades without detection. Further, as discussed above, many of the monitoring wells could serve as conduits for leachate-

contaminated groundwater to pass from the upper aquifer to the Floridan aquifer, and therefore could and would be expected to enhance the pollution potential of the Floridan aquifer from a Site E landfill.

This problem is like the problem described above of trying to monitor groundwater for pollution caused by leaks through holes in landfill liners. There will not be general, widespread pollution of the Floridan aquifer when the pollution first occurs. The pollution will occur through discontinuities and cracks, down well casings, or through other areas where there is a hydraulic connection between the upper aquifer system and the Floridan aquifer. This pollution will result in the movement of initially very small, narrow fingers of polluted water towards the GRU wells that supply the city of Gainesville. It is highly unlikely that CH2M HILL's 5 to 10-year period would be adequate to detect that pollution even with a very elaborate system of monitoring wells in the Floridan aquifer.

CH2M HILL also attempts to justify the selection of Site E over Sites M and U because of Site M's reportedly "thinner" Hawthorn layer, and Site U's greater potential for sink holes. It is my understanding, as discussed below, that the sink hole issue has not been properly addressed at Site E. Further, CH2M HILL is arguing both sides of the issues when they say in one case, the thickness of the Hawthorn layers is not the issue, yet in another that the thickness of the Hawthorn layer justifies one site over another.

An argument could be made that it would be better not to have the Hawthorn layer there unless it could be established that there were no conduits, either natural or manmade, through which leachate-contaminated groundwater that would occur in the upper aquifer could pollute the lower aquifer. It is going to be difficult enough to monitor the upper aquifer to detect pollution before widespread pollution occurs. The fact that pollution of the Floridan aquifer will occur in relatively small distinct areas of unknown location compound the problem of trying to monitor groundwater pollution of the Floridan aquifer to detect pollution before widespread pollution occurs. It is possible that the only way that pollution of the Floridan aquifer will be detected is after people of future generations in Gainesville consume and are adversely affected by leachate-contaminated groundwater.

On page v of the Executive Summary CH2M HILL states as another "finding,"

" A SWMF at Site E would be designed with a composite or double liner and a leachate collection and removal system, as well as a groundwater monitoring system. Such materials and equipment provide significant protection to groundwater resources and have been effective in reducing groundwater contamination from landfills."

That "finding" is a gross distortion of information that would be very misleading to those relying on the results of CH2M HILL's analysis. As discussed earlier, if the groundwater quality and resource protection afforded by the landfill system were so effective, the issue of groundwater quality would not be of any relevance to the siting of a landfill. The author of that finding should have known that it has been well-established and recognized by the US EPA that a single-composite liner will not protect groundwater quality for as long as the wastes represent a threat. The GRU well field for the city of Gainesville, whether located where it is now or moved to

another location, is a resource that has to be protected forever, not just for the 30 years or so now required by the DER 1993 regulations for post-closure care.

As discussed above as well as in the appended materials, the landfill liner system described by CH2M HILL in the above-quoted paragraph will, at best, only postpone groundwater pollution by landfill leachate for a few tens of years. Contrary to the statement made by CH2M HILL, there is no evidence to support the claim of such liners' being effective in reducing groundwater contamination from landfill for the long-term. The finding quoted, however, does not mention a time period over which CH2M HILL claims that the liners will be effective in "reducing" groundwater pollution. If the authors of the report mean that the landfill systems will reduce groundwater pollution from landfills for some period of time after installation, then the "finding" is misleading the Board of County Commissioners and the public since any credible discussion of this issue would frame it not in terms of Site E, but of protecting groundwater quality for as long as wastes in the groundwater that could be sited at Site E, or for that matter any of the other sites within the County, would be a threat to groundwater quality, i.e. forever.

There are significant questions being raised about the true value of the lined landfills in protecting groundwater quality. As discussed by Lee and Jones (1992a), today's dry tomb landfilling approach is providing the public with a false sense of security that groundwater quality is being protected. Basically what is being done with the "dry tomb" approach requirements, however, is to effect a short-term (tens of years) delay in groundwater pollution, with in many situations, the creation of an essentially impossible task of detecting the incipient leachate leakage and groundwater pollution, and burden to maintain, in perpetuity, a cover on the landfill that does not allow entrance of moisture. The threats to groundwater resources caused by this situation are exacerbated by the false or misleading claims of "protection" and claims of the unlikeliness that the systems will leak, to a public who wants to "believe" but also wants its garbage to "disappear" at little cost.

At least with unlined landfills it was possible to detect pollution shortly after it occurred and then begin to direct efforts to control it. With lined landfills, many decades to possibly even a hundred years or so may pass before the monitoring systems that are being used today will detect the pollution of groundwaters at the landfill. Some think that it is better to know when pollution occurs and start to correct it than to not know - and to be mislead to believe that it will likely never occur - until widespread general pollution of an aquifer system and loss of groundwater resources have occurred.

On page vi of the Executive Summary CH2M HILL recommends,

"Results of the Murphree well field pump test and subsequent modeling indicate that the development of a SWMF at Site E is compatible with both a northward expansion of the Murphree well field and development of a satellite well field to the east. Because of these results, CH2M HILL recommends that Alachua County continue with the evaluation of Site E for use as a location for the new SWMF."

Rather than being a recommendation based on technically sound information, it is a project-advocacy statement that is not supported by the information available. As more information is

gathered about Site E and its potential to pollute the water resources of the region, it becomes clear that the evaluation that shows that Site E is the best available site is technically flawed and did not properly consider long-term groundwater quality issues. The combination of the pollution of the near-surface aquifer system coupled with the Floridan aquifer system makes Site E an unsuitable site for a landfill that would only be used a last resort with a significant different type of landfill than that proposed by the County staff.

Beginning on page 1-1 through page 1-2, CH2M HILL presents a discussion that attempts to justify the site-selection process that was used by the County Department of Public Works to select Site E as the best available site. Contrary to statements made, and as documented herein, the siting process was not rational or objective, and certainly was not defensible; it was arbitrary and, in some cases, capricious and designed to find a site irrespective of the long-term impacts of the construction of the proposed landfill on nearby property owners/users and the water resources of the region as well as the city of Gainesville.

Page 2-4, Section 2 on the hydrogeology of Alachua County provides information on some of the characteristics of the so-called Hawthorn Formation. From the information provided there is even greater concern now about the potential of the Hawthorn Formation to be an ineffective barrier to the transport of leachate-contaminated groundwaters that will occur in the upper aquifer, to the lower aquifer. The fact that the Hawthorn layer is also a water supply and has aquifer properties is of significant concern.

Figure 3-1 shows the large number of wells in the vicinity of Site E, that penetrate the Hawthorn to the Floridan aquifer. Those wells could readily serve as conduits for leachate-contaminated groundwater between the upper near-surface aquifer and Floridan aquifer.

In the section "Results" on page 5-1 it is stated,

"The groundwater levels in the shallow wells showed no discernible influence from the Murphree well field aquifer test, indicating that the Hawthorn clays provide effective isolation and protection between the shallow and Floridan aquifers. These data suggest that the Hawthorn Formation at Site E would act as an effective protective barrier to the Floridan aquifer in the event of a release of leachate from a SWMF."

That statement goes far beyond what can be reliably stated from the existing information. A very limited study was conducted on the potential for significant interconnection exists between the two aquifers. A one-day pump test at the high rate of pumping used is not sufficient to properly determine whether significant connections exist.

On page 5-2, CH2M HILL attempts to further justify selection of Site E by claiming that heavy metals would not be expected to pass through the Hawthorn Formation to any measurable extent; it notes the reaction sites in the formation for geochemical and biological processes to degrade contaminants or retard their migration. We have considerable familiarity with contaminant transport in groundwater systems as a result of my (G. F. Lee) having taught aquatic chemistry in graduate level environmental engineering programs for 30 years where one of the issues discussed was that of contaminant reactions and transport in aquifers of various types. While

what CH2M HILL states is correct to some extent, it is not appropriate to assert or imply that all contaminants from municipal solid waste landfill leachate will be degraded or retarded within the Hawthorn Formation should the connection exist between the two beyond that of the existing wells that already penetrate through the Hawthorne Formation. If the primary mode of transport is through interconnecting wells, then there would be little retardation, biotransformation, etc. Further, natural "cracks" through this system could also provide pathways that would not provide any significant opportunity for reactions that could prevent contaminants derived from the landfill from reaching the Floridan aquifer and the Murphree well field.

It would be inappropriate to follow up on CH2M HILL's suggestion of additional testing "to better assess their attenuative potential of Site E;" transport of contaminants through such a layer will not be such that such testing would reliably indicate attenuation capacity. Those of us familiar with such issues know that testing of this type would be a waste of money since it could never be done in a way that could show the negative - that there would be no possibility of significant contaminant transport from the municipal landfill through the upper aquifer through the Floridan to the Murphree well field.

On page 5-2 under the heading, "Leachate Containment Systems" it is stated,

"Unlike landfills of the past, which were typically unlined pits into which garbage was dumped, landfills designed to comply with current regulatory standards feature strong, well-engineered liners and leachate collection systems. These liner and leachate collection systems significantly reduce groundwater contamination from landfills and are accepted by the solid waste industry and regulatory agencies as the best available technology for leachate containment.

Current regulations, such a Subtitle D of the Resource Conservation and Recovery Act and the Florida Administrative Code (FAC), require containment systems that use more than a single liner. Two types of containment systems are currently specified by the FAC: a double liner system and a composite liner system, both of which provide backup components that protect against leakage and greatly reduce the escape of leachate from a landfill.

Any leakage that occurs from a double- or composite-lined landfill is typically minimal for several reasons. Generally, leakage would occur from small perforations, which do not impact the performance of the remaining intact areas of the liner. Also, the leachate and removal systems are designed to prevent significant volumes of leachate from collecting and remaining in the bottom of the landfill, further minimizing the overall potential for leakage."

This section on leachate containment presents a very distorted and unreliable view of the degree of public health protection provided by landfills that could be permitted under DER (1993) regulations. As discussed above, at best a single-composite liner that those regulations specify will only postpone by a few tens of years when widespread groundwater pollution will occur. Further, CH2M HILL has totally ignored the longer-term considerations such as those cited above in the US EPA's comments on its own regulations, regarding the deterioration of the ability of the liner system to prevent leachate transport through it. The statements made quoted above are clearly Site E project-advocacy statements, are not supported by the technical information available, and significantly distort the information that should have been presented

in discussing the suitability of the landfill containment systems that can be permitted under the current DER regulations. As discussed above in the analysis of regulations, the landfill containment system is not protective of public health, the environment or groundwater quality. CH2M HILL's claims that the leakage is typically minimal for several reasons because of the small perforations, etc. applies to when the liner is new; they do not apply for as long as the wastes represent a threat or as long as the city of Gainesville or others who use groundwaters in the vicinity of the landfill for water supply purposes want leachate-free groundwater.

On page 5-3, CH2M HILL discusses that the current Murphree well field is under the influence of existing contamination from several sites. Information concerning the nature and extent of that contamination was not provided. It is likely to be significantly different from municipal landfill leachate. Municipal landfill leachate is a soup of chemicals at very high concentrations, many of which are unidentified and uncharacterized in terms of hazards that could adversely affect domestic water supply water quality and public health. It could be that the existing contamination is from well-known chemicals whose transport and impacts are readily discernable. It may also be that those contaminants could be readily controlled by water treatment. Further information is needed in order to make a proper comparison between the existing contamination by the industrial sites of the Floridan aquifer and the Murphree well field.

On page 5-5 at the end if the first paragraph, CH2M HILL for the mentions long-term protection of the source integrity where the issue of moving the GRU water supply well field is discussed. That concern for long-term protection of groundwater quality should also have been applied to the landfill siting process. It is inappropriate to only consider it in moving the well field as CH2M HILL has done.

On the bottom of 5-5 CH2M HILL again presents inadequate and incomplete information on contaminant transport from Site E through the Hawthorn Formation to the Floridan aquifer. This is another pro-project advocacy statement that does not properly present the technical information that CH2M HILL knew or should have known in developing its report. A proper presentation of this information would show that there are hazardous and otherwise deleterious contaminants in municipal landfill leachate that are not attenuated to any significant extent in groundwater aquifer systems of this type. To focus the attention of the reviewers on a few contaminants that may be attenuated under idealized transport is highly misleading and inappropriate.

We have been concerned for many years about the distortion of technical information to give the appearance of technical foundation for technically unreliable positions taken by landfill applicants, and the providing of misleading and inadequate information to review boards on the long-term potential of the proposed landfill to pollute groundwater in the vicinity of the landfill. As part of my (G. F. Lee) presentation of short-courses on landfills and groundwater quality protection issues on behalf of various professional organizations such as the American Society of Civil Engineers, I was asked after a short-course presentation in New York City last January by a member of the American Society of Civil Engineers group developing a series of papers on professional ethics in the environmental quality management field, to develop a paper discussing professional ethics issues in landfill siting. A preprint copy of this paper, entitled, "Practical Environmental Ethics: Is There an Obligation to Tell the Whole Truth?" is appended.

It has become very clear that there is a significant, consistent pattern that has evolved among many consultants who work on behalf of landfill applicants of providing only half-truths and partial information which supports their clients' position, and failing to provide the public and decision-makers with the whole truth so that they would be able to understand the issues relevant to siting of a particular landfill at a particular site. We have recommended that in siting of landfills, the applicant and its consultants be required to provide plausible worst-case scenario evaluations for failure of the landfill containment and groundwater monitoring system, etc. to protect groundwater quality for as long as the wastes are a threat. It is only with this type of evaluation can the public, decision-makers, and Board of County Commissioners properly understand and evaluate the complex issues involved. CH2M HILL has followed the course of action in support of the county Public Works staff that is typically followed by consultants who work for landfill applicants of providing only information that the applicant wants the decision-makers to hear, rather than providing the "whole truth" on the issue. This is strongly contrary to professional ethics set forth through the National Society of Professional Engineers and the American Society of Professional Engineers, where in the cases of public safety the consultant is obligated to provide the "whole truth" on proposed projects, such as landfills. If a consultant does not know the whole truth, then he/she should not be the consultant on the project since the whole truth on landfill liner containment systems is well-known by professionals in the field.

As discussed above, a number of states--New York, New Jersey, Pennsylvania, Michigan, and the California Water Resources Control Board Staff--have all indicated that a single composite liner of the type that can be constructed under the DER January 1993 regulations only postpone groundwater pollution; it will not prevent it. Why did CH2M HILL not discuss these issues? It is obvious that the County Department of Public Works staff did not want these issues discussed. This situation raises significant issues about the credibility of the process that has been followed, beginning with the siting and now reporting, on the hydraulic connections between the Site E proposed landfill and the water supply for the city of Gainesville. Providing the "whole truth" would have involved CH2M HILL discussing the fact that it is well-known today that municipal landfill leachate contains a variety of contaminants which are not attenuated in Hawthorne Formation, and even for contaminants that are attenuated, the most likely path of transport through the Hawthorn Formation is through fractures or high permeability pathways, including existing or abandoned wells in which during the time of passage there would be little opportunity for attenuation for even those contaminants that are readily attenuated.

On page 5-9, CH2M HILL states in its Conclusions,

"The use of Site E for siting a SWMF is compatible with a northward expansion of the Murphree well field or with installation of an eastern satellite well field and the continued use of the Murphree well field."

As discussed in this report that quoted statement is not factual and does not represent a proper investigation and evaluation of the information that is available on these issues.

On page 5-9 and at several other locations throughout the Technical Memorandum No. 4, CH2M HILL attempts to justify Site E over other sites based on longer travel times. Longer travel times simply mean longer periods of time before pollution occurs. However, since Gainesville will

likely want to continue to use the Floridan aquifer *ad infinitum* as a water supply, additional travel time does not represent any significant additional safety from pollution of the well field, especially under conditions where it will be very difficult to monitor the pollution of the Floridan aquifer by leachate derived from the Site E landfill.

There is no question that at least for the three sites for which CH2M HILL has provided information, location of a landfill of the type that DER will now allow through its January 1993 regulations at any of these three is highly inappropriate and should not be done. From the information available, none of these sites are suitable sites for a landfill of this type. This statement should not be interpreted to mean that there is need to put in a landfill of this type in one of these sites; it does mean that there is need to start over again with respect to the site selection process, considering the true ability of lined landfills of the type being developed today to protect groundwater quality for as long as the wastes represent a threat in the site selection process. It could also mean that a significantly different type of solid waste management approach should be adopted in the Alachua County area, since it could be that a proper evaluation of sites would show that there is no site within the county that is appropriate for this type of landfill.

On page 5-10 CH2M HILL concludes,

"A SWMF at Site E would be designed with a composite or double liner and a leachate collection and removal system, as well as a groundwater monitoring system. Such materials and equipment provide significant protection to groundwater resources and have been effective in reducing groundwater contamination from landfills."

By that statement, CH2M HILL has once again provided misleading information on the ability of the liner and leachate collection and removal systems to protect groundwater quality for as long as the wastes represent a threat. In none of the documents I have reviewed in this matter has CH2M HILL properly addressed the real groundwater quality issues associated with lined "dry tomb" landfills; to the contrary, it has repeatedly provided inadequate, unreliable, and inappropriate information to the Board of County Commissioners and the public on these issues.

Page A-1 discusses the shallow aquifer and states,

"The shallow aquifer, also known as the surficial aquifer or the water table aquifer, is composed of sand and clayey sand usually 20 to 50 feet thick. This aquifer provides water to low-yield driven, jetted, or dug wells. Water levels are generally within 25 feet of land surface. Wells completed in the shallow aquifer are mostly undocumented because permits are normally not obtained or required, and many wells are owner-constructed."

The facts that wells are owner-constructed, shallow, and yield only enough water for an individual homeowner do not mean that they are not important to the homeowners or that pollution of the upper aquifer can or should be allowed. From the information provided in the DER (1993) regulations it does not appear that the state of Florida will allow the Alachua County Department of Public Works to pollute the shallow aquifer with landfill leachate above the

MCL's for drinking water constituents in order to save money for the waste generators in Alachua County who would contribute solid waste to the landfill.

At the bottom of page A-1 it states with reference to the Hawthorn Formation,

"However, locally the unit contains one or more zones of gravelly sand or permeable limestone that produce sufficient water for domestic supplies."

The discussion of the Hawthorn Formation in that section indicates that it is not the thick, massive barrier to contaminant transport, but rather is an aquifer system in itself.

From the discussion of the Hawthorn and Floridan aquifer systems presented on pages A-1 through A-5, it is clear that these systems are,

1) subject to pollution and surface contamination,

2) of such complex hydrogeology as to make prediction of the contaminant transport through them very difficult to accomplish in a reliable manner, and

3) create a virtually impossible situation for reliably monitoring to detect incipient pollution by landfill leachate from the uppermost aquifer system.

GRU Involvement in Landfill Site-Selection Process

In a letter dated May 11, 1993 to Bob Fernandez, Manager, Alachua County, Michael R. Kurtz, General Manager of the Gainesville Regional Utilities (GRU) discusses some of the significant problems that have existed in the way in which the County has proceeded to evaluate the potential impacts of a proposed landfill in the vicinity of the Murphree well field. His letter provides additional insight into the inappropriateness of the site-selection process used by the County Department of Public Works and documents some of the unreliable information that the County has been providing on these issues.

It is somewhat surprising that since CH2M HILL is the engineering firm not only for the County in solid waste matters, but also for GRU in water supply matters, greater attention was not given by and more reliable information was not provided to, the siting committee on the potential for the proposed Site E landfill to pollute the Gainesville water supply well field. Clearly CH2M HILL was aware, or should have been aware, of the high vulnerability of the Gainesville water supply well field to pollution by landfill leachate. Further, it should have been aware of the significant pollution of the aquifer that the city of Gainesville uses as a water supply source; contaminants that were disposed of near the land's surface polluted not only the upper aquifer, but passed through the Hawthorn Formation and polluted the lower Floridan aquifer which is used by the city for its water supply. There is certainly no reason to believe that because the Hawthorn Formation is of a particular thickness in the vicinity of the GRU well field that the formation provides significant isolation of the lower aquifer from the upper aquifer. The available information clearly showed that pollutants in the upper aquifer are readily transferable

to the lower aquifer. This kind of information should have been included in the landfill site-selection process.

Evaluation of the Alachua County's Proposed Solid Waste Management Facility Sites E, M, and U, Gainesville Regional Utilities, March 22, 1993.

In Section II of this "Evaluation" document, GRU states that Dames and Moore (1983) found no Floridan contamination from the Fairbanks FDOT landfill site. However, it notes that unexpected water level responses were obtained during a pump test in 1992 and that traces of breakdown products from TCE were found in the Floridan; it indicates that these chemicals had reached the Floridan from the interconnecting wells. This kind of problem was discussed above; the reporting of it by GRU indicates the unreliability of statements made by CH2M HILL on behalf of the County Department of Public Works indicating the lack of connections between the upper aquifer system and the Floridan.

At the Cabot Carbon site a similar type of situation was found. In that case a 90-year old abandoned well on the Koppers site allowed creosote to be transported from the upper aquifer to the Floridan.

Similarly at the PCR site, traces of TCE and breakdown products were found in a Floridan well. Again, the transport appears to be via interconnecting wells. Does the County and CH2M HILL know of all interconnecting wells that exist in the area in which the Site E landfill, if permitted, could pollute groundwaters so it would be interconnected to the Floridan at any time as long as the wastes in the landfill are a threat? Obviously not. Why was this issue not discussed by CH2M HILL and the County? It should have been.

In Section IV on Evaluation Criteria, GRU is critical of the County's site-selection process as it relates to travel time selected in the evaluation criteria. GRU states that the CH2M HILL approach for estimating Floridan travel times used models that make inappropriate assumptions, and points out that the aquifer is characterized by fractures and that order of magnitude deviation from the travel time predictions is possible.

In its "Discussion," GRU states,

"GRU staff agrees that Site E, M or U can be constructed in a manner to provide levels of groundwater protection normally considered adequate for siting of such facilities. However, staff believes it is appropriate to consider the size of the population potentially effected when comparing sites. Accordingly, although Site E could be considered `good enough', staff believes it would be prudent to select a more hydrogeologically favorable site as related to the single largest municipal water supply, serving roughly two-thirds of Alachua County's population (approximately 130,000 people)."

Further in its Section VI "Recommendations," GRU staff states,

"The City Commission request that the Alachua County Commission discontinue further consideration of Site E."

Our review of these issues, which was done independently before I reviewed the GRU comments of March 22, caused me to independently come to the same conclusions reached by the GRU staff. Site E is not a suitable site for a large municipal landfill. While GRU only indicates that it considered its domestic water supply in the Floridan, in addition consideration of the pollution of the shallow surficial aquifer and its impact on domestic water supply wells of individual homeowners should have been made in evaluation of the potential for pollution in site selection.

Boyes, S. R., May 25, 1993, comments "Fracture Trace Analysis of a Proposed Landfill Site (Site `E'), Monteocha, Alachua County, Florida

On behalf of the Greater Monteocha Community Action Association, through the firm of GeoSolutions, Inc., Boyes performed a fracture trace analysis of the proposed landfill Site E. Fracture analysis is of concern because of the karst terrain in the County. Such terrains are notorious for allowing unpredictable and rapid transport of contaminants. Of particular concern near Site E is the potential for unidentified sinkholes to exist which are not obvious from the land surface.

I (G. F. Lee) have some familiarity with using fracture trace analysis through work that I have done with others in landfill siting matters in other parts of the country. This methodology has been shown to be a powerful tool in identifying unrecognized geological features that significantly increase the hazard of siting a landfill at a particular location because of the potential of rapid transport of contaminants that are released from the landfill to water supplies of concern.

On page 3 Mr. Boyes notes that his access to the property for Site E was denied by the landowner. This is of great concern since such information as was being collected by Mr. Boyes apparently does not exist elsewhere and is an important component of assessing the suitability of the site. If Site E is to be considered further for a landfill, the landowner should be required to allow ground truth information to be developed for what Mr. Boyes terms on page 6 to be the potential for sinkholes to exist. There he states,

"Detailed review of the USGS topographic map and aerial photography indicates the location of six apparent sinkholes within Site `E'. Figure 3 provides an aerial photograph indicating the locations of the six sinkholes and wetland areas which appear to have been formed by karst processes."

In addition to his concern about the apparent presence of sinkholes within Site E, Mr. Boyes indicates that there is a major linear fracture trace traversing the Site E area, indicating the presence of a subterranean geological feature that crosses the Site. He states on page 10 with regard to that feature,

"The feature appears to be a well developed cavernous system contained in the limestones of the Floridan aquifer. The feature has, in geologic time, caused numerous sinkholes to form."

Mr. Boyes concludes on page 10,

"The characterization of Site `E' as being the best location for a landfill in Alachua County is inaccurate."

While I do not know Mr. Boyes or his capabilities and qualifications to conduct the work that he reported on in his May 25, 1993 report, from my knowledge of similar systems, it appears that the results of his investigation are entirely appropriate; they serious questions about the suitability of Site E for a large regional landfill as proposed by the County Public Works staff. Certainly before any further work is done in promoting Site E or claiming it to be a suitable site for a landfill (much less the best location), the issue he raised need to be addressed; site access should be allowed for suitable investigation for what appears to be a fracture trace indicating a series of paleo-sinkholes in the Floridan system.

Alachua County Staff Responses to the GMCAA's Environmental Concerns, as Presented to the Alachua County Environmental Protection Advisory Committee on January 12, 1993.

GMCAA expressed concern about the vulnerability of residential wells to pollution. In response, the County staff states,

"With this information, a facility can be designed that will have state-of-the-art protection and detection systems, providing security for all wells in the area."

No information was presented to clarify what the staff means by "state-of-the-art protection," or its interpretation of protection of wells, etc. Without such information it is impossible to judge the reliability of the statement. From the statements made by CH2M HILL on behalf of the County concerning the landfill design in Technical Memorandum No. 4, March 1993, it is clear that what the County staff call "state-of-the-art" design and protection is not truly "state-of-the-art." In fact, it is far from it. Furthermore, as discussed elsewhere, the issue is not whether the system is "state-of-the-art," the issue is whether the system will protect groundwater quality from use-impairment for as long as the wastes represent a threat.

With respect to landfill design, Daniel and Koerner (1991) discussed what is commonly considered to be state-of-the-art landfill design; this is a double-composite-lined system, similar to that used in New York, New Jersey, and being adopted in Michigan. In Michigan, the lower composite liner serves not as a containment liner but rather as a leak detection system for the liner. A similar system was proposed by the California Water Resources Control Board staff as the approach that should be used in California to protect groundwater quality from landfill leachate-pollution. The system that CH2M HILL indicates on behalf of the County, that would be used is one that meets current DER regulations; as discussed earlier, those requirements are substantially less than state-of-the-art.

With respect to monitoring, there is no state-of-the-art groundwater monitoring system that will protect groundwater drawn by wells in the vicinity of the landfill. As discussed in the appended paper by Lee and Jones-Lee (1993b) which drew from work done by Cherry (1990) and others of several years ago, it is obviously impossible to reliably monitor groundwater in the vicinity of lined landfills for incipient leachate-pollution using vertical monitoring wells. From the

information provided, it appears that the staff's statement was simply made to be in support of the project; it is without technical foundation.

GMCAA expressed concern about the siting process' having been conducted without an adequate information base founded in site-specific evaluations. The staff responded that it is impractical, unnecessary, and an enormous expense for the Committee to ask the citizens to fund the studies needed to provide the information base needed to develop a reliable landfill siting process. Once again, the staff's statements reflect an attitude that those who generate the garbage should be able to pay less for garbage "disposal" than the true costs for management, and shift the burden for the balance to those in the vicinity of the landfill where the wastes would be deposited. As noted above, we have been involved in the review of many landfill siting processes in which "boards of supervisors" who ultimately have to make the decisions on landfill sites are trapped into accepting bad sites because inadequate attention was given early in the siting process to potential groundwater pollution issues. This is what is happening here with respect to Site E. From the available information, it appears that Site E is a very poor site for a landfill. However, the County staff and consultants are bending over backwards to try to portray technical substance in, and justification for, the selection of this site as the best available site.

GMCAA expressed concern that Site E is not statistically better than other sites. The staff responded that this process is used to rank sites relative to each other and then the top-ranked site is examined in detail. It is highly inappropriate to restrict detailed examination to the top-ranked site, especially when the initial ranking was done without adequate and important information. This could readily result in the County's either being trapped into a bad site since they will not want to start over, or having to spend the funds necessary to evaluate other sites.

GMCAA expressed concern about the wisdom of siting based on a "worst-case" scenario. The staff's "response" did not address the "worst-case" scenario issue. "Worst-case" scenario siting should have been practiced; that is, rather than using overly optimistic characteristics and assumptions about Site E in evaluating the site, plausible "worst-case" scenario conditions and problems with the site and failures of the landfill liner containment system should have been used to evaluate what could occur at the site. Through the evaluation of the plausible "worst-case" scenario it would have been possible for the site-selection committee and the Board of County Commissioners to understand, up-front, the potential problems of the sites and make an intelligent decision based on this understanding.

The staff states in responding to the "worst-case" scenario evaluation approach,

"The landfill portion of the facility will be a lined disposal area, sized to meet the needs of Alachua and Gilchrist Counties."

Again, the staff provided unreliable information to the public on these issues. A lined facility does not mean that it is protective. Lined landfills, including those that are permitted under DER (1993) regulations, will not be protective of groundwater resources for as long as the wastes represent a threat. At best, the liner systems only somewhat postpone groundwater pollution.

Attachment 2, "Recommendations on Protection of Shallow and Intermediate Drinking Water Resources"

In the first paragraph on page 1 of that document it is stated,

"The protection of shallow and intermediate aquifer supply wells is no longer a site ranking criterion. During criteria development, the shallow well protection issue was changed to a site evaluation criterion to be addressed during the detailed site specific investigation. Site specific information and facility design and permitting considerations will be used to avoid or minimize impacts to shallow and intermediate aquifer wells."

That quoted statement again points to the clearly inappropriate approach used in the site-selection process of not considering up-front one of the most important issues that should have been used in site selection, namely the evaluation of the potential to cause pollution of shallow wells near the proposed facility. That is the water supply that is most vulnerable to pollution by landfill-derived contaminants. It is the water supply that DER (1993) regulations require be protected at least to the point of not having exceedances of MCL's at the point of monitoring of the groundwater. By not considering this matter in the initial site-selection process as one of the most important items, the process has now become seriously flawed. It is inappropriate and irresponsible to relegate consideration of the issue of shallow aquifer protection to sometime after-the-fact as proposed in that document.

It is also stated on page 1,

"Secondly, the facility and the groundwater monitoring system will be designed and constructed to protect the groundwater resources of the County. The facility will be designed and constructed to prevent contamination. The monitoring system will be designed and constructed to detect and handle a problem should one ever occur."

That statement is party rhetoric, not based on fact. As discussed in these comments, the assurances of protection reflected in the quoted statement cannot be given based on meeting the requirements set forth in the DER (1993) regulations.

Attachment 2 that accompanies this cover page is riddled with misrepresentations of the ability of landfills of the type being developed today under federal and state (including DER, 1993) regulations to protect groundwater from pollution by landfill leachate for as long as the wastes represent a threat. The Facility Design Factors for the liner system discussed on page 3 are not protective of groundwater quality. The author of Attachment 2 either does not understand, or has deliberately misled the siting committee and the public on, these issues. The same applies to the statements made on page 4 regarding the Groundwater Monitoring Program. These monitoring programs will not detect incipient groundwater pollution from lined landfills with a high degree of protection before widespread pollution occurs. Similarly, on the Facilities Closure section, 30 years is an infinitesimally small portion of the post-closure care that will be needed.

In the Summary of the document it is stated,

"The protection of safe drinking water supplies was an extremely important concern for SWFSAC during their development of siting criteria. The protection of all ground water resources is also a major focus of state and federal rules regulating the design and operation of solid waste management facilities. The recommended approach to ground water protection clearly addresses both the committee's intent and the regulatory mandates, providing a comprehensive, long term program to protect ground water resources from leachate contamination and assures local residents safe drinking water supply."

That quoted statement is misleading, inaccurate, and unreliable. While statements are made that the shallow groundwater system will be protected when the approaches that are outlined for landfill liner design, monitoring, etc. are followed, it is clear that they will not and cannot be protected with the Counties proposed approach for landfilling of MSW.

Appended to this statement is a series of sheets discussing various issues such as water supply wells in the shallow aquifer. Considerable attention is given in those sheets, and in the document, to the travel time to the nearest well. We have reviewed groundwater quality protection issues pertaining to on the order of 30 or so landfills. In all the work that we have done over the years on landfill siting and evaluation of impacts, we have never encountered travel time issues as an important factor. We are somewhat amazed that it has become such an important factor in this process. Travel time appears to have been introduced into these proceedings without adequate understanding of its true significance. Obviously travel times are important in situations in which there are major differences among sites, such as where in one site travel time to the nearest possible well is a few years compared to another site where the travel time could be thousands of years. However, to try to make a distinction between travel times of tens to hundreds of years as is being done in this site-selection process is inappropriate. First, as GRU has pointed out, estimating travel times from the meager information that is available or that could even be developed as part of more detailed investigations is highly tenuous at best. Orders of magnitude errors could readily develop in making such estimates. Second, travel time is only of significance if there is adequate warning in order for action to be taken to prevent the contamination of well water by leachate. The adequacy of the warning is related to the reliability of the groundwater monitoring. Since it is not possible to reliably monitor groundwater pollution from lined landfills or through leakage through the Hawthorn Formation, travel time has very little meaning. As discussed above, the travel time starts from the day the first significant amount of leachate passes through the liner. This could be delayed a few tens of years if there is good quality construction in the liner and the wastes are placed in the landfill properly so as not to disrupt the liner. Delaying by even tens to even hundreds of years the time when pollution reaches an individual homeowner or municipal water supply well is not groundwater quality protection; it is simply a guise to enable siting of inadequately designed, constructed, operated, and closed landfills in areas where there are vulnerable water supplies.

It is also important to note that a key part of any travel time assessment is the ability and funding to halt the generation and spread of polluted groundwater, once detected, before it contaminates wells. DER does not require that sufficient funds be set aside to take appropriate corrective action for as long as the wastes represent a threat. County boards of supervisors across the country are finding themselves in serious financial trouble; there is considerable reluctance to earmark, much less spend, funds to correct groundwater pollution caused by landfills that have

been inappropriately sited, constructed, operated, maintained, and closed. There are more than 50,000 landfills in the United States today; well over 75% of them are currently polluting groundwaters. All of them are under supervision of some local governmental entity such as a county Board of Supervisors, and regional as well as state and federal regulatory authorities. Very few of them are receiving the attention that is mandated by the regulations to stop groundwater pollution at existing landfills and to take corrective action to clean up the aquifer. If this is not being done today, what reason is there to believe that future county boards of supervisors are going to be any more able or willing to spend taxpayers' funds to address problems of the lined landfills that are being developed today when they occur 25, 50, 100 years from now? These are issues that needed to be considered as part of the siting process so that the siting committee and the public clearly understand what they are approving when they select a particular site for the proposed landfill.

Pagett Report on DRASTIC

D. Padgett (1993) submitted a report to Penny Wheat of the Alachua County Board of County Commissioners dated March 10, 1993 on the use of the "DRASTIC" approach to improve the reliability of siting landfills in Alachua County. We are familiar with DRASTIC and the issues that this approach addresses, namely the protection of groundwater quality from contaminants derived from surface sources. While DRASTIC was not originally intended for landfill siting, it can provide considerable insight into issues that should be addressed in selecting a landfill site where natural barriers are to be used to prevent groundwater pollution by landfill leachate. The parameters in DRASTIC are common technical sense with respect to what is known today on the factors influencing the transport of contaminants from land surface areas to groundwaters. While we have not evaluated the appropriateness of using DRASTIC in the selection of one site over another in Alachua County, clearly the parameters that are discussed in DRASTIC with respect to the uppermost aquifer which is the one that is required by the US EPA to be protected are important and should have been incorporated into the siting process. The exclusion of the surface water aquifer system from consideration by the County did as discussed by Padgett skew the siting to Site E. While we are not in a position at this time to support Padgett's relative ranking of the sites since we have not made a detailed review of the information on the other sites, we can strongly support Padgett's conclusions that the site selection process that was used by the County was technically invalid.

Groundwater Pollution at Existing County Landfills

Hallbourg *et al.* (1992) reported on the organic priority pollutants in groundwater and surface water at three landfills in north central Florida. Two of the landfills that were studied, Alachua Southwest Landfill and Alachua Northeast Landfill, were in Alachua County. They found that a variety of VOC's and other constituents from the landfills had polluted groundwaters in the vicinity of the landfill. Some of the contaminants that were found, such as vinyl chlorine, are of great concern because they are known human carcinogens and because the concentrations found were well-above the drinking water standards established by the US EPA. It is clear from the work of Hallbourg *et al.* that the County's Northeast and Southwest landfills are now polluting groundwaters with highly hazardous chemicals. Further, the contaminants of concern are contaminants that are highly mobile and would be attenuated little in the aquifer systems of the

County. The findings of Hallbourg *et al.* are similar to what is being found in today's municipal landfill leachate. Such leachate contains a wide variety of hazardous, conventional, and non-conventional pollutants that can render groundwater unusable for domestic purposes.

The high concentrations of the VOC's found by Hallbourg *et al.* in the groundwaters near the County's existing landfills are of particular significance since those chemicals can readily pass through the intact liners that the County proposes to use for their new landfill at Site E. Sakti *et al.* (1991) of the University of Wisconsin found that such chemicals can pass through an intact, flexible membrane liner in a few days. While significant water transport must pass through holes in the liner, those chemicals readily dissolve into the liner materials and move out the other side where there are no holes. This situation further points to the inappropriateness of the County's and CH2M HILL's position that the liners that will be used for their proposed Site E landfill will be protective of groundwater quality.

The facts are that a wide variety of contaminants, including volatile chemicals (organic solvents) many of which are suspected or known human carcinogens, can pass through these liners by chemical dissolution. Others can pass by advective processes through holes in the FML that typically occur shortly after construction and increase in numbers and size with deterioration of the landfill liner properties. The compacted soil part of the composite liner will not prevent the transport of those chemicals through it. It only slow down when groundwater pollution occurs by landfill leachate.

Agreement for Professional Consulting Services between Alachua County and SCS Engineers

A review of the Scope of Services for the third-party review of the siting process between the County and SCS Engineers shows that it was designed to significantly support the County Public Works' siting process that selected Site E as the "best available site." That contractual arrangement is fundamentally flawed since the key issue in the siting process, namely protection of water quality, is not specifically delineated to be addressed by SCS Engineers. Having been involved in a number of such reviews, I know the problems of trying to conduct a truly independent review on behalf of a project advocate, such as the County Department of Public Works. Being in this position can limit the firm's freedom to be truly objective. In this case, the very department supporting the siting process is in control of the review. It becomes essentially impossible to maintain objectivity without jeopardizing the potential to do future work on similar projects for other clients. The contractual arrangement precludes SCS from doing work for Alachua County for a two-year period and thereby superficially eliminates the appearance of a conflict of interest on the part of SCS Engineers. However, firms that undertake work of this type usually come to realize that if they report the whole truth on the issues such as these, their ability win contracts with other counties and other landfill applicants will likely be impaired. This is evidenced, for example, in careful language about the protection afforded by a landfill; as discussed above, such discussion is often limited to claims of meeting regulatory requirements.

We have also observed that many consulting firms whose primary income is derived from working with landfill applicants will not work with water utilities in evaluating the impact of a proposed landfill on groundwater quality, even though they have no conflict of interest in that particular landfill matter. The problems surrounding side-stepping the whole truth about the

ability of today's "dry tomb" landfills to truly protect groundwater quality for as long as the wastes represent a threat have become so pervasive that, as discussed above, Dr. Jones-Lee and I were asked to develop a professional paper specifically addressing this professional ethics issue. While to my knowledge we have had no previous contact with anyone from CH2M HILL or SCS Engineers who is under contract with Alachua County, I know that these firms in other parts of the country derive substantial amounts of income in working for landfill applicants; they would, therefore, have to resist significant pressure to bend to the County's Department of Public Works' positions on the issues under review. I have worked for county departments of public works in a number of issues and know the pressures that can be brought on a consultant to achieve compatibility in presentations and reports with pre-conceived positions.

By the way the SCS contract was established by the County Department of Public Works, the most important issue that should be addressed in any landfill siting review was excluded from discussion. That issue - the ability of the proposed landfill to protect groundwater resources for as long as the wastes represent a threat - has to be considered in any credible landfill siting process. As discussed above, while it is possible to design, construct, operate, close, maintain, and monitor a landfill to achieve high degrees of groundwater quality protection for as long as the wastes represent a threat, the landfill proposed by the County Department of Public Works (which would apparently meet the current DER regulations) will not achieve that level of protection. If the Department of Public Work were convincingly and demonstrably dedicated from the outset to constructing, operating, closing, and maintaining a landfill that has little potential for groundwater pollution, to the detection of liner failure before significant groundwater pollution/use-impairment occurs, and to establishing a dedicated trust fund from disposal fees that would ensure that sufficient funds were available *ad infinitum* to protect groundwater from pollution by landfill leachate, then a significantly different approach could be considered toward siting landfills than the one that must be taken when siting a landfill of the type that the County proposes to construct. While the County can claim that it will protect groundwater quality, as the staff has done in a number of documents that are reviewed above, it is clear that that is simply a paper claim that has little possibility of being achieved at Site E.

The first question that should be asked in a review of the adequacy and reliability of the siting process is - will the landfill that the County proposes to construct with a single-composite liner and a conventional groundwater monitoring program as required by DER, protect groundwater quality for as long as the wastes represent a threat. While as discussed above, landfill proponents often make tacit, or even overt, assurances of protection of groundwater quality by citing compliance with existing regulations, they do not address the real technical issues of whether the regulations, or specifically the particular landfill design, operation, maintenance, etc. at the particular site, are adequate to protect beneficial uses of groundwater for as long as the wastes represent a threat. That is the real issue of concern to those concerned about protection of groundwater quality and is the issue that SCS Engineers should address as part of a credible third-party review.

CONCLUDING REMARKS

The January 1993 landfilling regulations adopted by DER are inadequate to ensure protection of groundwater quality for as long as the municipal solid wastes in a landfill represent a threat. By

not requiring sufficient groundwater protection measures, the state is allowing garbage "disposal" for expenditures less than those that would be necessary to provide protection of groundwater quality and of the use and enjoyment of adjacent and nearby properties. This means that the true costs of the landfilling approach adopted by the state are not being paid by the garbage generators; they are being subsidized by those who will have to suffer the consequences and eventually pay the costs of groundwater pollution and remediation, and replacing lost groundwater resources.

A landfill constructed at Site E in accordance with the regulations can be a significant threat to the shallow water aquifer and deeper aquifer effectively forever. Since there is a large number of individual homeowners' wells, as well as the water supply for the city of Gainesville in the vicinity of the landfill in the zone of potential impact of the proposed Site E landfill, great caution should be exercised in constructing a landfill of the type proposed at that site.

While some may try to claim that our views are biased because we are supported by those who oppose landfills, we are willing and stand ready for competent peer review in a public arena of our positions on the ability of landfills of the type the County proposes to site at Site E to protect groundwater for as long as wastes represent a threat. We are highly confident that such a review will show that our position--that it is only a matter of time until groundwater pollution occurs at this site--will be supported by an independent, truly third-party review by competent individuals knowledgeable in the chemical characteristics of municipal landfill leachate, the processes that occur in landfills, the ability of landfill liners of the type being developed today to prevent landfill-derived contaminants from passing through them for as long as wastes represent a threat, the ability of groundwater monitoring systems of the type that could be constructed under the DER 1993 regulations employing monitoring wells spaced up to 500 feet apart to detect pollution of groundwaters before widespread pollution occurs, and the ability to mediate MSW landfill-leachate-contaminated groundwaters once pollution is detected.

If anyone who reviews these comments disputes the technical information or positions reflected in them or in the appended materials, we request that they delineate the points of contention in writing with any supporting documentation that they feel supports their views, for our review and comment in accord with standard professional peer review approaches.

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