HARTMAN & ASSOCIATES, INC.

engineers, hydrogeologists, surveyors & management consultants

PRINCIPALS:

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June 22, 2001

HAI #99-395.08
File 12.0

Osceola County Board of County Commissioners
One Courthouse Square
Suite 4700
Kissimmee, Florida 34741

Subject: Facility Demand/Justification of Need
Proposed Oak Hammock Landfill

Dear Commissioners:

When considering the issue of locating a new landfill facility in a community, like the proposed OMNI Waste Landfill, the first course of action should be to analyze the need, or demand, for such a facility. A landfill represents an extremely intrusive use in the community, with potentially harmful results upon such areas as property values, air and water quality, and transportation systems. Additionally, a state-of-the-art, class I facility requires an investment of millions of dollars to construct, develop, and operate.

Given the tremendous impact that a class I solid waste facility will have on the community, it seems to be a reasonable expectation that such a "needs analysis" would be completed prior to the initiation of zoning and development permit approvals. Many states, and most of the larger Florida counties apply a need test to all new landfills. The need for an Osceola County Landfill, that will close in the year 2005, was pointed out by applicant's submittals. However, OMNI provided no information on the need for a "regional" landfill, or alternatives for Osceola's waste disposal. Information such as this is a basic need for the County decision-makers when deliberating a public policy decision of this magnitude. In order to assist in the evaluation of this landfill proposal, Hartman & Associates, Inc. has completed a survey of landfill facilities in the central Florida region in order to provide a perspective on the need for additional landfill capacity.

The following table provides survey results of each County surrounding Osceola, its' solid waste disposal methodology, the number of years of current or proposed landfill capacity, and in place waste flow controls.

County	Class I Landfill	Incinerator	# of Years of Estimated LF Capacity	Waste Franchise Flow Controls
Osceola	X		4	N/A
Orange	X		25	Partial
Brevard	X		15	No Export
Indian River	X		50	No Export
Okeechobee	X		50	No Export
Highlands	X		150	No Export
Polk	X		54	No Export
Lake		X	Unlimited	No Export, except Tavares

It is clear from this data that there is insufficient landfill capacity in Osceola County to address its own solid waste needs after the year 2005. When the County is required to secure additional solid waste disposal capacities, it may explore inter-local arrangements with surrounding counties, competitively select a disposal service (ITN process), or determine at that time that the construction of a new County landfill is necessary and in the best interest of the community.

The data, supported by discussions with representatives of each County, also clearly indicates that the entire central Florida region has sufficient solid waste disposal capacities to meet its collective and individual needs for the foreseeable future. However, OMNI estimates that up to 2000-2500 tons per day of out-of-county waste will be received from adjoining counties, generating "host fee" revenue for Osceola County. Based on our survey of adjacent County municipal solid waste flow controls, the only possibility for a significant waste impact would be Orange County; which is in the process of strengthening their franchise agreement controls. Therefore, if OMNI holds to their "adjoining County" waste flows permit condition, the host fee to Osceola County will be minimal.

Since it is apparent that this proposed facility is not needed to meet the needs of the residents of adjacent counties in the region, who is it intended to serve? Only approximately 500 tons of waste per day is contributed by Osceola County; where is the remaining solid waste volume going to come from? It would appear that the new landfill would be reliant upon importing garbage from other parts of the state, or the country, in order to develop a waste stream of sufficient size to make the project feasible. This raises a number of public policy issues for the County to consider.

- Should Osceola County residents be made to suffer the impacts of this facility in order to provide for solid waste disposal to unknown areas of the state?

- Should the St. Johns River and Lake Washington basin, a major potable water supply source for central Florida, and local shallow drinking wells be endangered in order to provide landfill capacity that is unwarranted, unjustified and unnecessary?

- Does Osceola County want to be the "dumping ground" for populations outside the County and region?

- Since this landfill has no "captive" local waste stream and will have to competitively capture solid waste tonnages from other areas, there is an incentive to construct the cheapest landfill capacity possible to lower tipping fees?

Conclusion:

It is HAI's conclusion that the proposed landfill facility is "non-essential" to meeting the solid waste needs of Osceola County and/or the central Florida region and that adjacent County waste flow controls will make the promised host-fee minimal. Further, the lack of a demonstrated need places this proposal into a speculative category that raises numerous public policy questions and issues for the County to consider.

Very truly yours,

Hartman & Associates, Inc.

Hartman & Associates, Inc.
201 E. Pine St., Suite 1000
Orlando, FL 32801
Engineering Business #5814
Gerald C. Hartman, P.E.
Florida Registration #27703

James E. Golden, P.G.
Senior Hydrogeologist/Associate

Gerald C. Hartman, P.E.
President

State of FLORIDA
County of ORANGE

BEFORE ME, the undersigned authority, personally appeared Gerald C. Hartman, P.E. and James E. Golden, P.G. who first by me being duly sworn has read the foregoing document and has personal knowledge of the facts and matters stated in it, and that each of these facts and matters are true and correct.

SWORN to and SUBSCRIBED before me this 22nd day of June, 2001.

Sondra A. Shepard
Signature of Notary Public

Sondra A. Shepard
(Print Notary Name)
My commission expires: March 8, 2002
Commission No.: CC722537

AFFIX NOTARY STAMP

Sondra A Shepard
My Commission CC722537
Expires March 8, 2002

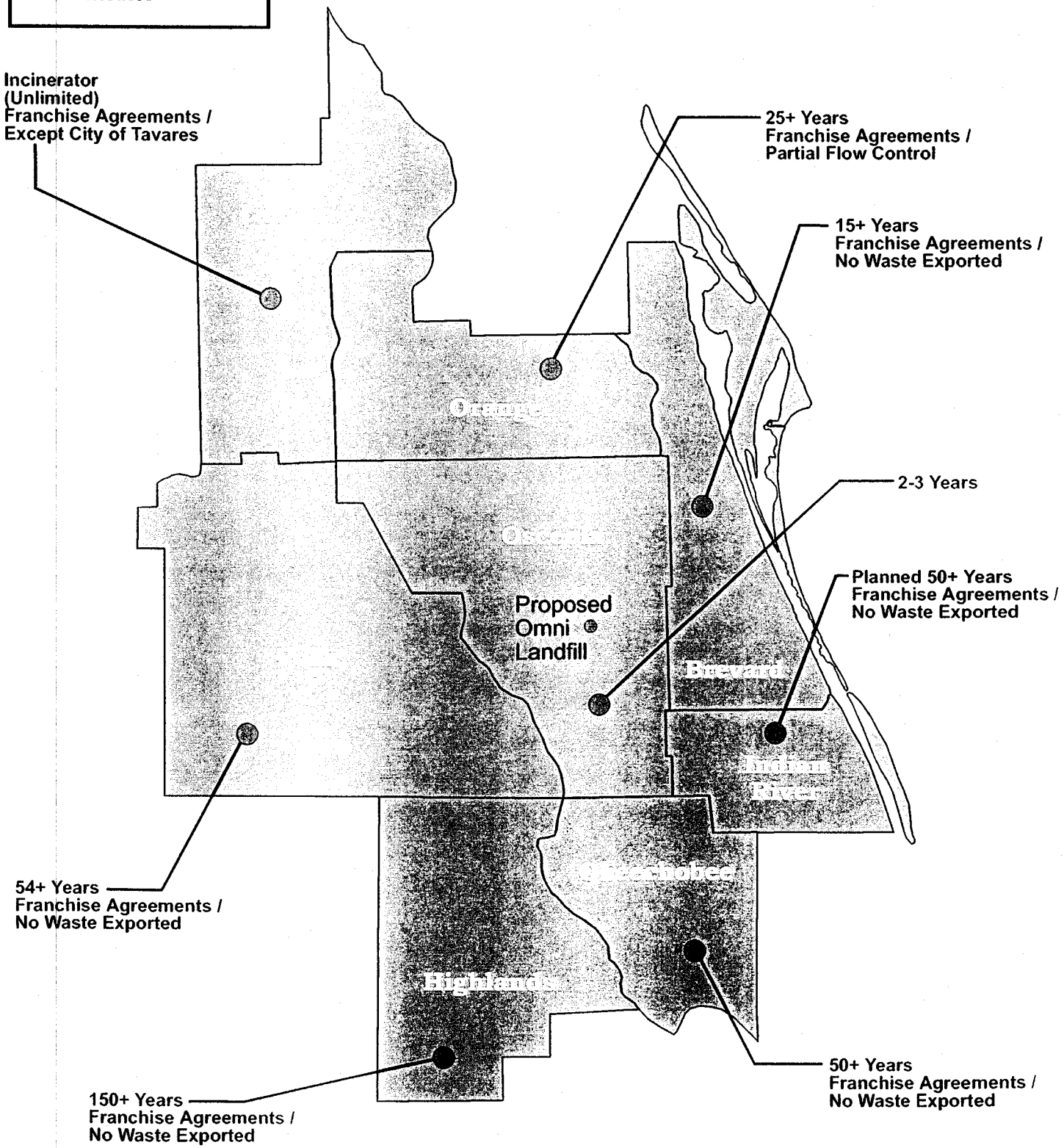
☑ Personally known, or
☐ Produced Identification
Type of Identification Produced:

JEG/sas/99-395.08/corresp/Osceola.jeg.doc

**Complete Or Partial "Flow Control"
Has Been Achieved Through Franchises
Or Interlocal Agreement In Each County**

Total Landfill Capacity

**Up to 150 years
+ Incinerator**



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engineers, hydrogeologists, surveyors & management consultants

201 EAST PINE STREET · SUITE 1000 · ORLANDO, FL 32801

**CENTRAL FLORIDA
DISPOSAL FACILITIES
CAPACITY AND FLOW CONTROL**

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June 22, 2001

HAI # 99-395.08
File 12.0

Mr. Ken Shipley, Chairman
Board of County Commissioners
Osceola County
One Courthouse Square
Suite 4700
Kissimmee, Florida 34741

Subject: Landfill Siting Analysis Criteria versus Proposed Omni Class I Landfill Site Osceola County, Florida

Dear Commissioners:

On June 26, 2000 I testified at the hearing where your Commission denied the Oak Hammock Landfill Conditional Use Application. I am a Florida Registered Professional Geologist and have practiced in Florida for over twenty years as a Solid Waste Management and Environmental Consultant. I have provided landfill siting consulting services throughout Florida for municipal and private clients. In support of your denial, it is my opinion that the proposed landfill as sited is likely to adversely impact Osceola County's water resources.

In order to choose the most suitable potential landfill location, water supply protection is the highest ranked criteria with land use lower on the list. Your Comprehensive Plan has recognized the County's Bass Road Class I landfill as an "uncontrolled hazardous waste site" and lists the attached contaminants discharged; documenting that landfills can be significant pollution sources.

Specifically, the proposed sanitary landfill (pollution source) site fails four (4) of the basic landfill siting criteria: 1) the site is adjacent to a water body - Bull Creek; 2) the site is located in a proposed public land, or a public park, the proposed Big Bend Swamp/Holopaw Ranchlands CARL Project; 3) the site is located within an area of wetland systems; and, 4) the site is located in an area where major truck traffic will have to pass through an incorporated area, St. Cloud, to and from the centroid of waste generation which is northern Osceola County from the site.

When we evaluated the proposed Oak Hammock Landfill site against the typical weighting criteria for siting a sanitary landfill we find that it would receive significantly negative ratings for five of the weighting criteria: 1) Surface Water Resources and Connections - site is within the drainage basin of Lake Washington and St. Johns Marshes Class I drinking waters and a designated future water supply area by SJRWMD 2020 Plan; 2) Occurrence of Wetlands -

significant wetland systems occur on the site that may be impacted; 3) Unique or Rare Natural Areas - site is on the CARL acquisition site list and is surrounded by Wildlife Management Areas and other public lands; 4) Threatened and Endangered Species - 16 threatened and endangered species exist or potentially exist on the site and in the surrounding public land; and, 5) Adjacent Land Uses - agricultural land uses are incompatible, cattle raising, and fish farms are incompatible with the proposed landfill use. These negative weighting factors alone would be enough to disqualify this potential landfill site from the siting process of any other Florida county. The risk to protected surface water resources and the direct connections that the Bull Creek and Crabgrass Creek have from the site to these protected surface waters make the surface water weighting criteria even more important in this situation.

Historical Landfill Siting Studies

The proposed Oak Hammock Sanitary Landfill site area has been previously studied by both Osceola and Brevard Counties as potential location for sanitary landfill in the past. In the early 1980s Osceola County conducted a landfill siting analysis that resulted in the ultimate location of the South Port Landfill. Osceola County's consultants at that time rejected eastern Osceola County because of the sensitive water resources and the pristine natural habitats.

Likewise, Brevard County's consultants in 1991, when attempting to locate an alternative South County solid waste management facility, rejected all potential sites within the St. Johns and Lake Washington drainage basins. For example, site area "C" was removed from the Brevard County site analysis process primarily because, "surface water runoff and approved discharges from the site (landfill) would flow from the site into the St. Johns River at the headwaters of Lake Washington a (Class I surface water)." "This characteristic was consistent with the intent to not consider geographic areas that drained into Class I drinking waters."

For a similar reason, site "D" was removed from the search area, because it also discharges into the watershed of a Class I surface waters, Lake Washington. The Brevard County study stated, "it was generally considered unacceptable to locate a major solid waste management facility in the watershed of a Class I surface waters (drinking water), "it was also considered important to avoid development of a major solid waste management facility within the Class I water quality planning segments of western Brevard County. The two sites mentioned were only approximately four miles due east of the proposed Oak Hammock landfill site, which is also within the Lake Washington drainage basin.

If Osceola County historically has decided not to site a landfill in this area, and Brevard County also has made the Lake Washington drainage basin an exclusionary zone for their proposed sanitary landfills, we believe that Osceola County should not now allow the siting of a sanitary landfill, the proposed Oak Hammock, in this area.

I trust that this evaluation has assisted you in your decision in that you will also consider this a noncompatible land use based on the aforementioned landfill citing criteria. If you have any questions, please do not hesitate to call.

Very truly yours,

Hartman & Associates, Inc.

James E. Golden, P.G.
Senior Hydrogeologist, Associate

STATE OF FLORIDA
COUNTY OF ORANGE

BEFORE ME, the undersigned authority, personally appeared James E. Golden, P.G., who first by me being duly sworn has read the foregoing document and has personal knowledge of the facts and matters stated in it, and that each of these facts and matters are true and correct.

SWORN to and SUBSCRIBED before me this 22nd day of June, 2001.

Sondra A. Shepard
Signature of Notary Public

Sondra A. Shepard
(Print Notary Name)
My commission expires: March 8, 2002
Commission No.: CC 722537

AFFIX NOTARY STAMP

Sondra A Shepard
My Commission CC722537
Expires March 8, 2002

☑ Personally known, or
☐ Produced Identification
Type of Identification Produced:

JEG/sas/99-395.08/corresp/Shipley.jeg

Attachments

SITE/CONTAMINANTS	HIGHEST REPORTED CONCENTRATIONAL (1) (ug/1) (2)	PROMULGATED OR PROPOSED MCL (3) (ug/1)
Animal Diagnostic Laboratory (FDL980845556)		
Formaldehyde	300	---
Ethylbenzene	8,530	680
Toluene	320	2,000
1,2-Dichloroethane	165	Zero
Osceola County Landfill (FLD980945325)		
Benzene	285	Zero
Chlorobenzene	71	---
Dichlorodifluoromethane	7	---
Chloroform	7	---
1,2-Dichloropropene	177	---
T-1, 3-Dichloropropene	7	---
T-1, 2 Dichloropropene	74	---
1,1 Dichloropropene	88	---
Trichloroethane	276	---
1,1, 1-Trichloroethene	18.3	200
1,1, 2-Trichloroethene	1.0	---
Ethylbenzene	140	680
Methylene Chloride	4,060	---
Carbon Tetrachloride	9.2	Zero
Toluene	330	2,000
Vinyl Chloride	34	Zero
Chloromethane	12	---
Bromoform	16	---
Lead	139	20
Chromium	90	50
Endrin	2	0.2
Lindane	3	4
2,4, 5-TP	0.3	10
2,4-D	5.6	70

Source: Florida Dept. Of Environmental Regulation. Osceola County Contaminants identified at Uncontrolled Hazardous Waste Sites. 1988 printout, as contained in HDR Engineering, Inc. Osceola County. Conservation Element: Report on Wetlands, Surface Waters, Groundwater Supply/Demand and Air Quality. October 1988.

Notes: (1) Highest reported concentrations are based on assessment reports and other supporting documents. They are not necessarily representative of current levels.
(2) Ug/l = micrograms per liter
(3) MCL = maximum contaminant

DON'T RELY ON THE FDEP TO ENFORCE ENVIRONMENTAL REGULATIONS

- **ORANGE CITY VS. GEL C&D LANDFILL**
  City has been forced to place a moratorium on landfills and to file suit to close the landfill that has had confirmed groundwater contamination for over 20 years. The FDEP is considering a permit renewal for the landfill.

- **VOLUSIA COUNTY VS. KLENK C&D LANDFILL**
  Volusia County is developing their own Solid Waste ordinance to regulate landfills, as a result of the failure of the FDEP to do so. Volusia County had to request the State Division of Law Enforcement to arrest the operator.

- **BREVARD COUNTY VS. ROYAL OAK (DELTA) LANDFILL**
  The landfill had disposed of unauthorized wastes. When FDEP Solid Waste Section would not adequately enforce their rules, the County filed a permanent injunction to close the landfill.

- **OSCEOLA COUNTY VS. A.M. BEST LANDFILL**
  Landfill was forced to close due to continuous odor problems.

- **ORANGE COUNTY**
  Developed their own solid waste ordinance in 1991 when the FDEP failed to shut down open dumps throughout the County.

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July 10, 2001

Via Hand Delivery

Ms. Vivian F. Garfein, Esquire
District Director
Florida Department of Environmental Protection
Central District
3319 Maguire Boulevard, Suite 232
Orlando, Florida 32803

Subject: May 1, 2001 Insufficient Enforcement Letter to Osceola BCC

Dear Ms. Garfein:

We have retracted the subject letter to the Osceola Board of County Commissioners, see attached. We have nothing but the utmost respect for you and your staff. Please accept our sincere apology for the content of this letter and it's release.

Very truly yours,

Hartman & Associates, Inc.

Jennifer L. Deal, E.I.
Engineer

James E. Golden, P.G.
Senior Hydrogeologist/Associate

n/hydro/jld/garfein

Attachment

cc: James Bradner, FDEP

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July 10, 2001

Via Facsimile/U.S. Mail

Osceola County Board of County Commissioners
One Courthouse Square
Suite 4700
Kissimmee, Florida 34741

Subject: **OMNI LANDFILL CONDITIONAL USE PERMIT**
OCCURRENCES OF INSUFFICIENT ENFORCEMENT
FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION
CENTRAL DISTRICT SOLID WASTE PROGRAM OFFICE

Dear Commissioners:

We are retracting our letter to the Board dated May 1, 2001 on the subject topic.

Very truly yours,

Hartman & Associates, Inc.

Jennifer L. Deal, E.I.
Engineer

James E. Golden, P.G.
Senior Hydrogeologist/Associate

n/hydro/jld/bcc

cc: Vivian Garfein, FDEP

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May 1, 2001

HAI #99-395.08
File 12.0

Osceola County Board of County Commissioners
One Courthouse Square
Suite 4700
Kissimmee, FL 34741

SUBJECT: OMNI LANDFILL CONDITIONAL USE PERMIT
OCCURRENCES OF INSUFFICIENT ENFORCEMENT
FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION
CENTRAL DISTRICT SOLID WASTE PROGRAM OFFICE

Dear Commissioners:

When considering the issue of locating a new landfill in a community, like the OMNI Waste Landfill, relying on other government agencies for enforcement of environmental regulations should be carefully considered and evaluated based on past performance.

The lack of trust in the FDEP's and other Agency's environmental stewardship that the Osceola County Commissioners expressed at the June 26, 2000 BCC hearing on OMNI is justified by the general lack of enforcement of environmental regulations in the FDEP's Central District, that has jurisdiction over Osceola County. The following is a brief review, based on file reviews at the FDEP's Central District office, of types of enforcement actions and case studies that show that for whatever reason local government was left to deal with bad landfills when the FDEP did not ensure compliance.

The Department's Enforcement Manual describes several tools available when enforcement of State rules is necessary. The following are some examples.

- Non-compliance Letter – Used when minor violations are observed and the Department does not intend to pursue a consent agreement or penalties. If the facility does not come into compliance, a Notice of Violation should be issued.

- Warning Letter – Used when more serious violations are observed and the Department does intent to pursue a consent agreement or penalties. If the facility does not come into compliance or an agreement cannot be reached, a Notice of Violation or a Case Report should be the next step.

- Notice of Violation – Used if there is insufficient time to send a warning letter or a program-specific deadline for initiating formal enforcement must be met. If the facility fails to request an informal conference or fails to file a petition for a hearing, a Final Order should be issued.

- Case Report – Used when the facility refuses to cease an ongoing violation involving a potential health threat or significant environmental harm to seek entry of a temporary injunction. Also used when the facility does not comply with the terms of a consent agreement or Final Order.

Additionally, Rule 62-4.100(3), FAC states that a permit may be revoked for violation of laws, Department orders, rules, or permit conditions.

Based on a preliminary review of the FDEP files, there have been several instances where the Department neglected to use the appropriate tools to enforce its own rules and local governments had to take action.

GEL Corp. C&D Landfill, Orange City, Volusia County, FL

The City of Orange City is considering issuing a temporary moratorium on landfills until a Solid Waste Ordinance can be adopted so that violations at facilities such as this can be resolved in a satisfactory manner.

GEL Corp. is a construction and demolition debris disposal facility located on top of an old, unlined open dump in Orange City, Volusia County, Florida.

Since October 1998, this facility has had numerous violations of Department rules including disposal of unauthorized wastes, failure to submit a groundwater monitoring plan, and failure to obtain financial assurance. These violations lead to the issuance of several non-compliance letters and one warning letter. The result of the warning letter was a consent agreement between the facility and the Department that was petitioned by the City of Orange City. By the time the petition was withdrawn, the groundwater monitoring and financial assurance issues had been resolved. However, the facility continued to accept unauthorized wastes during this time. This facility has also received more than 100 odor complaints in this same time period.

There is known off site groundwater contamination emanating from this facility. This was confirmed by testing paid for by the City of Orange City who wants the landfill closed.

The operator of this facility has not given any demonstration of a good faith effort to resolve the issues regarding disposal of unauthorized wastes or objectionable odor control. The Department has no evidence that this facility will be able to operate within the standards required by the

Florida Administrative Code. However, the Department is considering the issuance of an operations permit renewal as opposed to revocation of the currently expired permit.

Royal Oak Ranch C&D, d.b.a. Delta Resources, Titusville, Brevard County

Brevard County issued a temporary injunction to stop operations at this facility and is pursuing a permanent injunction.

This facility is a construction and demolition debris disposal facility located in Titusville, Brevard County, Florida. On February 1, 1999, Delta Resources (sometimes referred to as Delta Recycling in Department files) took over operation of the facility under a lease agreement with the owner.

By March 1999, representatives of the Department had received anonymous complaints that unauthorized wastes were disposed at the site. This was confirmed by a Department inspection. Due to the nature of the alleged disposed wastes, an inspection was conducted by the Department's Division of Law Enforcement. A non-compliance letter was issued by the Department's Solid Waste Section for their portion of the inspection. Several additional non-compliance letters were issued by the Department since then for disposal of unauthorized wastes, disposal of waste in a wetland, and failure to keep copies of permits and similar required documents on site. In November 1999, former employees of Delta informed the Department's Division of Law Enforcement of the locations of specific unauthorized wastes that were disposed at the facility. The result was another inspection conducted by this Division. The inspection resulted in felony and misdemeanor charges against the operator and one of the vice presidents of Delta. However, the Department's Solid Waste Section only issued a warning letter for their portion of the inspection. The result of the letter was a consent agreement between Delta and the Department including civil penalties. Delta voluntarily cleaned up the facility to the satisfaction of the Department and has agreed to close the facility for its own reasons. A permanent injunction against operation of the facility was initiated by Brevard County since the FDEP was not taking strong enough action. Prior to the decision to close the facility, the Department postponed taking any action until resolution of the injunction issue.

Klenk C&D, Volusia County, FL

Volusia County is considering the adoption of a Solid Waste Ordinance in order to ensure that violations at facilities such as Klenk C&D are resolved.

This facility is a construction and demolition debris disposal facility located in unincorporated Volusia County.

The Department issued a Warning Letter to the owner of the facility for violations of Department rules including failure to submit a request for a permit modification, failure to submit a groundwater monitoring plan, failure to obtain financial assurance, and disposal of unauthorized wastes. The result of this letter was a consent agreement between the owner and the Department. In May 2000, the Department issued a non-compliance letter to the owner informing him that he was in violation of the consent order for disposal of numerous unauthorized wastes and that stipulated penalties were in effect. The Department received no response. Three additional letters were issued regarding the violations and still no response from the owner or his legal counsel was received. The Volusia County Environmental Management brought the violations to the attention of the county code board in order to initiate a resolution, however, this effort was unsuccessful. The Department's Division of Law Enforcement, at the request of Volusia County, performed surveillance on the facility and the result was the arrest of the owner for acceptance of unauthorized wastes. However, the Department's Solid Waste Section is considering issuance of a permit to bring waste to the facility for the purpose of sorting and recycling instead of revocation due to continued non-compliance.

Orange County

In 1992, Orange County developed their own landfill ordinance that allows the County to enforce compliance with local and State regulations. The ordinance was initially developed because the FDEP would not act to shut down open dumps in the Taft and Pine Hills areas of Orange County. After numerous lawsuits and code enforcement cases in the mid to late 1980s the County was finally successful in shutting down most of the problem landfills. Orange County's ordinance is evidence of how a local government has acted to take control over solid waste pollution sources, when the State agencies have not.

Very truly yours,

Hartman & Associates, Inc.

Jennifer L. Deal, E.I.
Engineer

5/1/2001

James E. Golden, P.G.
Senior Hydrogeologist/Associate

JLD/sas/99-395.08/corresp/OsceolaCounty

cc: R. Dean Cannon, Jr., Esq., GHR

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June 21, 2001

HAI#99-395.08

Mr. James E. Golden, P.G.
Hartman & Associates, Inc.
201 E. Pine Street, Suite 1000
Orlando, Florida 32801

Subject: Water Resource Report for June 25, 2001 Hearing

Dear Mr. Golden:

This letter supplements my previous letter report dated June 5, 2000 with its attachments as well as the exhibits presented at the hearing on June 26, 2000. This letter also considers the direct testimony at that hearing and cross examination as found on Osceola Court Reporters transcript pages 128 through 141. Since that time, I have had the opportunity to do additional investigations concerning water resources as related to the Oak Hammock Landfill conditional use application.

Also subsequent to the hearing, I have reviewed the draft agreement to settle litigation between OMNI and the County. The draft agreement I believe was referring to a potential public hearing on May 14, 2001, which actually will be conducted on June 25, 2001. I cannot comment as to the substance of that hearing since it has not been conducted. The insights and substantial competent evidence which would be presented at that hearing would be reviewed and considered with other factors by the Board of County Commissioners.

Also in the draft agreement, there are additional conditions. Those additional conditions include environmental impairment liability insurance of not less than $2,000,000.00, a guarantee of 30-years of landfill capacity reserved for the County's use, and an acceptance of a proposal dated April 18, 2000 to the County from OMNI, which I have not reviewed, a host community fee of $2.00/per ton for any out of County waste accepted, hiring current County employees displaced by the closing of the County's existing landfills, reimbursement to the County for a County inspector in an amount not-to-exceed $50,000/yr. to oversee the operations at OMNI, rights to acquire and/or take over the landfill if OMNI constructs it and permanently ceases to operate it, the County's review and approval required for assignment of the landfill by OMNI, a 60-day right of first refusal at the purchase price, terms and conditions negotiated by OMNI to a third party and a commitment to only accept landfill waste in the County and from adjoining counties.

My review of the above does not impact the technical or water resource aspects of none of the proposed activity being considered for land use approval.

My research included additional considerations for water resource matters. The American Water Works Association Research Foundation in its report, Effective Watershed Management for Surface Water Supplies, referenced attached hereto, page 66 under Prohibited Land Uses, states, "Certain land uses inherently present a high risk of contamination for water supplies. Landfills may contain a variety of hazardous materials and pose a serious threat to surface water and groundwater supplies." The American Water Works Association in its watershed management considers landfills as a prohibited land use within potable drinking watershed development. Such development is contrary to the water source and water resource protection aspects of the proper watershed management for potable drinking water sources. The American Water Works Association continues on page 151 of this reference to state, "Watersheds do not respect political boundaries. For watersheds that cover several jurisdictions, lack of uniform land use controls is the most significant barrier to effective watershed protection." Osceola County does recognize in its Comprehensive Plant that surface watersheds do not respect political boundaries. As stated earlier in my June 26, 2000 testimony, Brevard County does not provide for landfills within the watershed of Lake Washington. Since this proposed landfill is within Osceola County, the second sentence of the quote from page 151, AWWA, is directly applicable.

To state that the State of Florida has sufficient agencies and regulatory control to regulate and address the watershed management aspects for drinking water supplies, is simply not the case. Land use controls that are primarily administered by the local governments such as Osceola County, have the initial burden relative to siting and land use. As Table A-4, page 192 from the above referenced text demonstrates, the State of Florida administers only one column of the five columns necessary for complete drinking watershed management programs. This national text includes several key studies concerning failure of watershed management and pollution and/or abandonment of water supply sources.

American Water Works Association Manual Practice No. M-19 - Emergency Planning for Water Utility Management states pages 38 and 39 that "watersheds are best left undisturbed. Watersheds should be monitored to determine whether conditions exist that could contribute to disaster hazards. Such conditions include illegal dumps, a buildup of flammable material, hazardous materials spills, and construction activities that cause erosion." Continuing in the Manual of Practice, the goals and objectives include three basic steps: "Prevent chemical accidents from occurring by identifying potential causes and taking corrective action," as well as to prepare for such accidents and to protect the public in the event of such accidents. The prevent, prepare, protect are the three measures for this manual practice. (Reference page 52)

The American Water Works Association Manual Practice M-48 – Waterborne Pathogens also address the issue. On the first page of this Manual Practice, it states: "The first step to ensure safe water is to assess current levels of contaminants, both chemical and microbiological, in source waters. Next a program of protection, education, and improvements to contain these contaminants is begun. Then water treatment plant performance must be enhanced by optimizing treatment processes, and the distribution system must be closely monitored to provide high quality water to the customer." The first step in safe drinking water is to assess current level contaminants and throughout this text, this manual practice to keep additional contaminants from the potable drinking water sources.

In reviewing the County's Comprehensive Plan Objective 7-D.2.3, page 7D-26 states: "Implement policies which recognize the hydrogeologic characteristics of potable water resources which do not observe political boundaries so that the water policies of adjacent jurisdictions may have profound impacts upon this County's resources and its ability to plan for its growth and development." Also, the converse of Objective 7-D.2.3 is true, the County's decisions relative to water resources may have impacts on other entities due to the fact that water resources do not observe political boundaries.

The conservation element of 9J-5.013(2)(c)1. addresses implementation activities for "protection of water quality by restriction of activities known to adversely affect the quality and quantity of identified water sources including existing cones of influence, water recharge areas and water wells." The conservation element requires the County to have at least one or more policies to protect water quality by the restriction of activities known to adversely effect water sources.

Under page 8-5, IV, Data Inventory (1)(a) Surface Waters, third paragraph, last sentence, states: "other streams, notably Bull Creek, Crabgrass Creek, and Blue Cypress Creek have not been subject to extensive modification remaining relatively in original condition."

Page 8-11, under the Surface Water Quality Section A.(7), last two sentences state: "The DER (FDEP) Reports on Water Quality from Jane Creek and Bull Creek. All have low levels of nitrogen, phosphorous and BOD."

Under (B), Known Hazardous Waste Problems Affecting Surface Water, also on page 8-12, identifies the Osceola County Landfill site no. FLD 90845325. Page 8-14 presents the highest reported concentrations versus the promulgated or proposed MCLs for various constituents, the vast majority of pollution constituents are shown on page 8-14 from the Osceola County Landfill.

In addition to the above, I have contacted Mr. Robert Klaproth to inquire whether his previous letter was still in place or whether he had retracted it. Mr. Klaproth stated to me that not only

was his previous letter still in place, but that he had also been contacted by the OMNI-Oak Hammock Engineers relative to his letter following the June 26, 2001 hearing. He stated to those representatives that the letter remains in place and the position of the Melbourne Water Department was that they did not wish the development of a regional landfill within its drinking watershed. Mr. Klaproth also stated to me that he plans to write an additional letter concerning this topic and submit it to the Board of County Commissioners.

The State of Florida, along with numerous counties, has, as its goal, policies to provide safe, clean water to its inhabitants. Objective E, point 22 of the Florida State Comprehensive Plan of 1977 states that the state must "protect the water quality and functions of water bodies from degradation by the pumping or transfer of nutrients and/or pollution...." The goal of water protection occurs in numerous county plans as well. The Brevard County plan states that "Brevard County shall pursue a potable water supply which does not deplete the freshwater resource and is safe, environmentally sound, and efficient," and the Orange County plan states that "a goal of Orange County is to ensure the provision of potable water in a cost effective and environmentally sound manner and concurrent with development." Also, the Hardee County plan lists one of its goals as "[ensuring] an adequate supply of potable water...without adversely affecting the quantity and quality of the County's environmental resources."

Landfills are a potential pollutant of groundwater resources. Landfills are a storage place for solid wastes, which are defined by the Florida Administrative Code as "sludge from a waste treatment facility, water supply treatment plant, or air pollution control facility; or garbage, rubbish, refuse, or other discarded material, including solid, liquid, semi-solid, or contained gaseous material resulting from domestic, industrial, commercial, mining, agricultural, or governmental operations." According to the Utilities Element of the Florida Comprehensive Plan, "solid waste disposal can degrade underground water supplies...." The Orange County Comprehensive Plan also recognizes landfills as potential pollutants, such as when it cautions against the release of stormwater runoff from a landfill due to the groundwater table's shallow depth. The City of Orlando outlawed landfills within the city for their harmful nature. The City's comprehensive plan states, "when landfills are located in aquifer recharge areas and/or potable water well field, they can cause contamination of local water resources." Landfills also have a history of polluting surrounding groundwater in Osceola County. The Bass Road Landfill has contaminated ground water both "beneath the landfill site and in two locations adjacent to the site's western boundary."

The references are attached at the end of this report and are summarized below:

The Florida Department of Administration, Division of State Planning. The Florida State Comprehensive Plan. Tallahassee: The Florida Department of Administration, Division of State Planning, 1977.

The Florida Department of Administration, Division of State Planning. The Florida State Comprehensive Plan. Tallahassee: The Florida Department of Administration, Division of State Planning, 1977.

Board of County Commissioners Orange County, Florida. Comprehensive Policy Plan Solid Waste Element. Orange County: Board of County Commissioners Orange County, Florida, 1991.

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City of Orlando Planning and Development. Growth Management Plan: Solid Waste. Orlando: City of Orlando Planning and Development, 1991.

City of Orlando Planning and Development. Growth Management Plan: Potable Water. Orlando: City of Orlando Planning and Development, 1991.

Board of County Commissioners Hardee County, Florida. Hardee County Comprehensive Plan: Sanitary Sewer, Solid Waste, Drainage, Potable Water and Natural Groundwater Aquifer Recharge Element. Hardee County: Board of County Commissioners Hardee County, Florida,1991.

Board of County Commissioners Brevard County, Florida. Brevard County Comprehensive Plan: Solid Waste Management Element. Brevard County: Board of County Commissioners Brevard County, Florida, 1988.

Board of County Commissioners Brevard County, Florida. Brevard County Comprehensive Plan: Potable Water Element. Brevard County: Board of County Commissioners Brevard County, Florida, 1988

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June 22, 2001

HAI# 99-395.08

Mr. James E. Golden, P.G.
Hartman & Associates, Inc.
201 E. Pine Street, Suite 1000
Orlando, Florida 32801

Subject: Proposed Oak Hammock Landfill
Stormwater Management System

Dear Mr. Golden:

We have been asked to look at the stormwater management system as proposed in the technical manual prepared by Post, Buckley, Schuh & Jernigan (PBSJ) and in the transcripts and information provided from the previous hearings. We understand that the project does not have final detailed plans as the applicant is only seeking a conditional use approval to allow the landfill within the zoning area. However, without basic cross sections and preliminary design information, much of the concerns we have been asked to address are limited to the information provided to date. Typical sections of the containment berm, perimeter swale, borrow pit, stormwater detention facilities, showing topographical relationship to Bull Creek and the landfill should be available even at this conceptual level as the environmental concerns of the landfill relative to Bull Creek remain a concern.

Design Storm and Rainfall Events

Much discussion has ensued regarding the design of the landfill project relative to the existing codes of St. Johns River Water Management District (SJRWMD), South Florida Water Management District (SFWMD), Osceola County, and Florida Department of Environmental Protection (FDEP). Although we acknowledge that the applicant will have to obtain permits from each of these jurisdictional agencies and we have no reason to doubt that they intend to comply with the regulations of each of the permitting entities, the concerns of the objectors stems in part as the real possibilities that harmful environmental impact may occur even if the project is permitted by all of the appropriate entities. It should be noted that this is not a project where the failure of the containment berm or the inadvertent discharge of polluted waters would sheetflow to less sensitive land uses. This site contains the potential for impacts to directly affect a significant surface waterbody (Bull Creek) which feeds the Class I waters of Lake Washington (a

regional raw water supply for drinking water). The proximity of Bull Creek raises the most significant concerns.

We understand that the applicant intends to design the project to meet the 10-year, 25-year, and 100-year storm events (1 to 3 days). The rainfall amounts associated with these storm events proposed by the applicant vary from approximately 7-inches to 14-inches. We have investigated various rainfall events in the past 100-years from the three closest NOAA stations as summarized: Orlando recorded 14-inches of rain in three days in October 1950; 10½ inches in Titusville and Orlando in one day in June 1960; 11½ inches in one day in Titusville in June 1945; 13-14 inches in three days in Titusville in both October 1950 and June 1968; 12½ inches in Ft. Drum in September 1963 and 9 inches in one day in Ft. Drum in March 1996. We note, however, that extreme localized rain storm events do occur that defy the statistics utilized by hydrologists and stormwater engineers for regulatory purposes.

Although the 100-year/1-day storm produces approximately 10-inches of rainfall, it should be noted that Florida has experienced numerous storm events exceeding 20-inches. The record rainfall reported in Florida in one day was nearly 40-inches in Yankeetown, Florida due to a hurricane in September 1950 (38.7-inches). Similarly, Trenton, Florida received 30-inches in one day in October 1941 due to a tropical disturbance. Although many of these rainfall events are due to hurricanes and tropical disturbances, there are numerous rainfall events greater than 20-inches that have been recorded throughout Florida's history as well. Examples of some non-tropical storm events that are noteworthy occurred in Key West in November 1980 (23.3-inches) and in Fernandina Beach in November 1969 with 22-inches. Not all of the locations of these extreme statistics were in coastal areas. Trenton, for an example, which posted 30-inches of rain in one day, is approximately the same distance inland as this landfill site is proposed from the east coast. The objectors to this application are not suggesting that all landfills should be designed for standards greater than the 100-year storm event, but rather when assessing the risks to valuable water resources, we note that there have been single day storm events in Florida that have produced as much as three to four times as much rain as in a 100-year storm event.

Time to Impact Surface Water

It was noted in the application that the applicant referred to the soils as being highly nonpermeable, and thus, the time for potential pollutants in the soil to reach Bull Creek was in the order of three years. Based upon the typical permeability in Smyrna fine sands (0.6 to 20 feet per day) and the 200-foot setback, we anticipate the actual travel time to be in the ballpark of 100 days. Once the polluted groundwater is intercepted by Bull Creek, the time to travel from Bull Creek to Lake Washington would occur rapidly (we estimate approximately 1 day).

Leachate and Water Quality Concerns

The applicant has admitted that one would expect approximately 6% likelihood of leakage in the landfill liners. The stormwater management plan recommends the construction of facilities, which exceed standard landfill design. The applicant commits to designing the Pollution Abatement facilities to Outstanding Florida Waters (OFW) Criteria as well as using other Best Management Practices (BMP's) such as littoral zone planting in the borrow pits. Although these measures are commendable, it should be noted that leachate will inevitably leak into the surficial aquifer and surface stormwater system. Since the surficial aquifer is relatively high with respect to the ground surface, one would expect the borrow pits, deeper stormwater management systems, and Bull Creek will intercept this polluted ground water. The applicant has maintained that the stormwater system will be a detention type facility, which must then discharge to the neighboring water resources.

It is important to note that meeting or even exceeding stormwater management criteria in the State of Florida does not imply that the pollutants will be entrapped within the system and/or and completely removed by the stormwater treatment facilities. The State of Florida, for permitting purposes, has a "presumptive criteria" which assumes that meeting stormwater management regulations will eliminate approximately 80% of the pollutants in standard treatment facilities and approximately 95% in OFW designed treatment facilities. Thus, the presumption is that is "acceptable" to have between 5% and 15% of the total pollutants not removed by the stormwater facilities and discharged to downstream water receiving bodies.

For landfills located next to a less important resources and land uses, such "acceptable" pollutant pass-through may be acceptable. However, such discharges into sensitive surface waterbodies such as Bull Creek, which feeds a potable water supply, should be considered with higher scrutiny.

To further illustrate this point, we note that the 80% pollutant removal efficiency and 95% pollutant removal efficiency presumed by the State does not mean that all pollutants in the water column are removed at that same efficiency. It is simply an average. For an example, suspended solids and heavy metals are typically removed at higher values than those given by the presumptive assumption. However, total nitrogen (TN) and total phosphates (TP) are typically removed at much lower percentages. Reports have shown that the pollutant removal efficiency of TN is only 15% to 25% in dry detention areas and borrow pits, respectively and 25% to 65% when considering TP. Many other constituents such as copper and lead yield similar poor results (35-75%). Thus, you may have as much as 15% to 85% of constituents pollutants not removed by a stormwater treatment system discharging to Bull Creek or its associated wetlands. Landfills are an extremely concentrated source of undesirable pollutant constituents. This information is pointed out not to suggest that 100% pollutant removal efficiency is necessary for stormwater

discharges from landfill sites, but rather to focus scrutiny on what is an acceptable pass-through of potentially polluted groundwater when the receiving waterbody is a sensitive surface waterbody such as Bull Creek.

Stormwater and Groundwater Monitoring

The applicant has maintained that they suspect that during the permitting process, they will be obligated by governmental entities to provide groundwater and surface water monitoring locations to ensure compliance with the permits. It is presumed that the wells will be placed in such a manner and readings taken in such a manner that if a problem does occur on the site that the landfill will make the necessary adjustments to correct the problem. Unfortunately, once the contamination is observed in the groundwater monitoring wells, it is likely to be too late to prevent it from reaching the surface waters of Bull Creek and adjoining wetlands which ultimately feed Lake Washington.

Floodplain Concerns

The applicant has agreed to move the landfill out of the 100-year floodplain. We commend the applicant for this positive course of action. Furthermore, the applicant has proposed to construct 16-foot high berms to ensure that the Bull Creek does not flood into the landfill and commingle landfill water with floodplain water. We caution, however, their analysis is based on the FEMA floodplain maps, which show the floodplains as unstudied Zone "A". It has been our experience that when detailed studies of riparian floodplains and their adjoining wetlands are completed that the actual floodplain delineation and flood elevations can vary significantly from those "approximately" delineated on the mapping. We have been involved in many studies where the floodplains have increased or decreased in size in any given area. Therefore, even though the intent of the project as shown by the applicant is admirable, it is possible on a more detailed floodplain study of this site if performed and accepted by FEMA (such as a Letter of Map Revision or LOMR) that the actual floodplain areas near the landfill site could increase or decrease in size.

Very truly yours,

Hartman & Associates, Inc.

William D. Musser, P.E., P.H.
Vice President

WDM/sma/99-395.08/corresp/SMS-2.wdm.doc

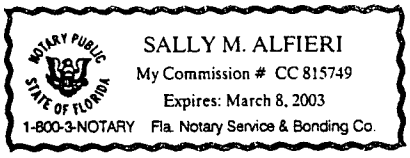
State of FLORIDA
County of ORANGE

BEFORE ME, the undersigned authority, personally appeared William D. Musser, P.E. who first by me being duly sworn has read the foregoing document and has personal knowledge of the facts and matters stated in it, and that each of these facts and matters are true and correct.

SWORN to and SUBSCRIBED before me this 22 day of June, 2001.

Sally M. Alfieri
Signature of Notary Public

SALLY M. ALFIERI
(Print Notary Name)



My commission expires: March 8, 2003

Commission No.: CC 815749

AFFIX NOTARY STAMP

☑ Personally known, or

☐ Produced Identification

Type of Identification Produced:

_____

Selected References:

Fernald, Howard A.; and Patton, Donald J. Water Resource Atlas of Florida. Florida State University, Tallahassee, Florida, 1984.

Harper, Harvey H. "Pollutant Removal Efficiency for Typical Stormwater Management Systems in Florida. " Proceedings of the Stormwater Issues and Approaches for the Next Millennium Conference, Florida Water Environment Association, Orlando, Florida, December 3, 1998.

National Oceanic and Atmospheric Administration (NOAA). Climatological Data Annual Summary. 1939-2001.

Soil Survey of Osceola County. United States Department of Agriculture – Soil Conservation Service. April 1979.

Omni

Fluet Report re Double Liner

TECHNICAL NOTE

Conceptual Design Considerations for the Proposed Omni Waste Oak Hammock Landfill

prepared for

Mr. T. J. Salopek, President
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(904) 246-1157

by

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31 May 2000

6 June 00

TECHNICAL NOTE

Conceptual Design Considerations for the Proposed Omni Waste Oak Hammock Landfill

J. E. Fluet, Jr., P.E.

1. INTRODUCTION

The purpose of this technical note is to define the critical conceptual design considerations for the liner system at the proposed Omni Waste Oak Hammock Landfill. A conceptual design is prepared during the early stages of the permitting process. It contains enough detail for the applicant, the regulators, and the public, to assess the feasibility, compliance and safety of the design. Permits which are approved based on a conceptual design contain conditions which require the regulators to approve the detailed designs as they become available. This allows the applicant to determine whether the project will be allowed prior to spending the large sums required for a detailed design. Following issuance of the conditional permit, the detailed design is prepared and undergoes another extensive regulatory approval process.

A conceptual design defines the liner system components in sufficient detail to allow a determination that a safe, practical, affordable, and functional liner system can be constructed. Although a conceptual design does not specify brand names or material properties (these types of specifications come later in the detailed design stage), it includes a liner system layout, requirements for minimum material performance properties, and sufficient calculations to ensure that the liner system is feasible, safe, practical, affordable and functional. The conceptual design calculations quantify the *minimum* performance of the liner system. The detailed design calculations, therefore, often show even better performance.

Although the analytical method used to quantify the performance of a liner system is quite complex, the concept is quite simple: the calculations show how much of the leachate the liner system intercepts, and how much of the leachate leaks into the ground.

1.1 Liner System Layout

A cross-section of this Omni's proposed system is shown in Figure 1. From top to bottom, the liner system comprises:

- a lift of protective "select waste" containing no linear elements or other objects which might damage the liner system;
- a two foot thick protective layer of sand, which also serves as a redundant leachate collection system;
- a geocomposite primary leachate collection system (LCS);
- a top composite liner comprising
  - an HDPE geomembrane, which is the upper component, and
  - a Geosynthetic Composite Liner (GCL), which is the lower component of the top composite liner;
- a geocomposite secondary leachate collection system (2LCS);
- a bottom composite liner comprising
  - an HDPE geomembrane, which is the upper component, and
  - a GCL, which is the lower component of the bottom composite liner; and,
- a layer of compacted foundation soil.

1.2 Analytical Method

The analytical method calculates:

- how much leachate is generated in the landfill,
- how much of that leachate is collected by the LCS,
- how much of the leachate leaks through the top composite liner into the 2LCS,
- how much of the leachate is collected by the 2LCS, and
- how much of the leachate leaks through the bottom composite liner into the ground.

The method also calculates the probability that there will be no leakage into the ground (this "probability of zero leakage" is explained in detail later in this report).

2. LEACHATE GENERATION

All calculations of leachate leakage rates naturally begin with a determination of the quantity of leachate generated in the landfill and the rate at which it enters the LCS. The rate at which leachate enters the LCS, called the "impingement rate", is then converted to a maximum depth, or hydraulic head, of leachate in the LCS, and it is this hydraulic head which is the driving force behind the leakage through the top composite liner.

The most common method used to determine the amount of leachate generated in a landfill is the Hydraulic Evaluation of Landfill Performance (HELP) computer model provided by the US EPA. The model is based on the precipitation rates and the evapotranspiration rates at the landfill location, as well as the materials used in the landfill and the design of the landfill; and

the model provides a very conservative (overstated) prediction of leachate generation (impingement rate). Although the model does produce a very good conservative estimate of leachate generation, it only provides broad indications of liner system performance, hence the need to perform all of the following calculations. For a landfill located in Osceola County, the HELP model predicts an impingement rate of approximately 12 inches/year. This result may be compared to a commonly used "rule of thumb" to determine the worst case of leachate impingement rate. The rule of thumb states that the impingement rate, q_i , may be estimated as follows,

q_i = 40% of Average Annual Precipitation or 25% of Worst Week Precipitation **[1]**

Using this rule of thumb, the impingement rate would be approximately 20 inches of leachate/year. However, since this is a conceptual design, which should be very conservative, we will consider the worst annual precipitation, rather than the average annual precipitation. Using a worst year precipitation of 80 inches/year, the most conservative estimate of leachate generation would be 32 inches/year, which is equal to 2.6×10^{-8} m/s.

3. DEPTH OF LEACHATE IN THE LCS

The driving force which causes leachate to leak through a hole in a liner is the "hydraulic head" of leachate in the overlying LCS. For shallow slopes (less than 8^{o}), the hydraulic head is equal to the depth of leachate. The maximum depth of leachate, D_{max} , is calculated using an equation developed by Giroud [2], where

$$D_{max} = L\{ [4 (q_i/k) + \tan^2\beta]^{0.5} - \tan\beta \} / 2 \cos^2\beta \qquad \textbf{[2]}$$

and the terms of the equation are shown in Figure 2.

Conservatively assuming that the hydraulic conductivity of the geocomposite LCS is 1.0 cm/s, the leachate removal pipes are spaced 100 m apart, and the post-settlement slope of the liner system is 2%, Equation [2] produces a maximum depth of leachate in Omni's proposed LCS of approximately 6.5 mm. This depth may be compared to the maximum depth allowed under the DEP rules of 300 mm, indicating a very well designed LCS.

4. LEAKAGE THROUGH THE TOP COMPOSITE LINER

The leakage through a composite liner is determined using equations developed by Giroud and Bonaparte for the EPA. These equations were later simplified and improved by the same authors [2]. For a circular hole and medium contact with the subgrade, the current version of the equation may be expressed as

$$Q_l = 0.6 [1 + 0.1 (h/t_s)^{0.95}] a^{0.1} h^{0.9} k_s^{0.74}, \quad [3]$$

where

Q_l = flow rate through the composite liner (m^3/s),
h = hydraulic head above geomembrane (m),
t_s = thickness of the lower component of the composite liner (m),
a = area of circular hole in the geomembrane (m^2), and
k_s = hydraulic conductivity of the lower component of the composite liner.

This equation is not dimensionally homogeneous and must be used with the units shown in parentheses.

Conservatively assuming the hydraulic conductivity of the GCL to be 1 x 10^{-8} cm/s, an area of 1.0 cm^2 per hole , and 5 holes per acre, the leakage through the top composite liner into the 2LCS in this case is 0.013 gallons per acre per day (gpad). This is only approximately 2 ounces per acre per day.

It is interesting to note here that the LCS does not continuously receive leachate. Because the landfill is operated with only a small "working face" open to precipitation, and because it does not rain every day, any given spot in the LCS is only periodically "impinged" upon. Furthermore, the geocomposite LCS is so permeable that any leachate entering the LCS flows downhill to the leachate removal sumps within a matter of hours. Each time the LCS receives leachate, it is exposed to leachate while the leachate is draining away, and the total elapsed time for all exposures is called the "residence time" of the leachate. This residence time can then be compared to the travel time through the top composite liner which underlies the LCS. Leachate enters the top composite liner through a hole in the geomembrane component and then permeates through the GCL component which underlies the geomembrane. In this case, the travel time for the leachate to permeate through the GCL is more than a year. Each time the LCS receives leachate, the leachate is drained away within a matter of hours, yet the leachate would have to be present for more than a year to permeate all the way through the underlying composite liner; i.e., in order for leachate to penetrate the underlying composite liner, the total residence time of leachate in the LCS would have to add up to a year or more. If the total leachate residence time in the LCS is less than the travel time through the GCL, then the leachate will never penetrate the primary composite liner and there will be no leakage at all into the 2LCS.

5. LEAKAGE THROUGH THE BOTTOM COMPOSITE LINER

The rate of leakage through the bottom composite liner into the ground is determined by first calculating whether the 2LCS is flooded; then, if it is not flooded, calculating the hydraulic head (depth) of leachate in the 2LCS. (If it is flooded, the procedure is much more complex.)

The hydraulic head of leachate in the 2LCS is the driving force for leakage through the bottom liner and is used to calculate that leakage.

5.1 Determining Whether the 2LCS is Flooded

The flooding criterion compares the flow into the 2LCS to the hydraulic conductivity and thickness of the 2LCS and is given by

$$Q_1 \leq k_{2LCS}\, t_{2LCS}^2 \qquad [4]$$

where

Q_1 = flow rate through the hole in the primary liner (m^3/s)
k_{2LCS} = hydraulic conductivity of the 2LCS (m)
t_{2LCS} = thickness of the 2LCS (m)

In this case, $(k_{2LCS}\, t_{2LCS}^2)$ exceeds Q_1 by three orders of magnitude, so there is no danger of flooding.

5.2 Depth of Leachate in the 2LCS

Since the 2LCS is not flooded, the average depth of leachate, D_{ave} is given by

$$D_{ave} = 1.5\, L \tan\beta \,/\, \{ [\, 1 + 2\, L \sin\beta\, (\, k/Q_1 \,)^{0.5} \,]^{1.5} - 1 \} \qquad [5]$$

the terms having all been defined above.

In this case, the average depth is only 6×10^{-4} mm. It is noteworthy that the depth of leachate in the 2LCS is four orders of magnitude (10,000 times) less than the depth in the LCS. Thus, the residence time in the 2LCS is very small compared to that in the LCS and, therefore, very small when compared to the travel time through the bottom composite liner. Accordingly, there is a very high probability that the residence time in the 2LCS will never approach the travel time through the bottom composite liner; therefore, there will likely be no leakage at all through the bottom composite liner into the ground.

5.3 Leakage Through The Bottom Composite Liner

If there is any leakage through the bottom composite liner, that leakage, Q_2 , is given by the same equation as the leakage through the top composite liner,

$$Q_2 = 0.6\, [\, 1 + 0.1\, (\, h/t_s \,)^{0.95} \,]\, a^{0.1}\, h^{0.9}\, k_s^{0.74} \qquad [6]$$

Once again assuming the hydraulic conductivity of the GCL is equal to 1 x 10^{-8} cm/s, five 1.0 cm^2 round holes per acre, and moderate contact with the subgrade, the leakage rate from the proposed liner will be a fraction of an ounce per acre per *year* (0.001 gpay). This can be thought of as a few *drops per acre per year!*

6. Probability of Zero Leakage Into the Ground

With any double liner system, there is a possibility that the hole(s) in the bottom liner will not be located in the path of the flow in the 2LCS, i.e., if the top liner and bottom liner hole(s) are not aligned, there will be no leakage through the bottom liner because the leachate flowing in the 2LCS will encounter no hole(s) through the bottom liner When the 2LCS is not flooded, the floor of the 2LCS (the top surface of the bottom liner) is not completely covered with leachate. The leachate in the 2LCS enters through discrete hole(s) in the top liner and then spreads out in a parabolically shaped flow path as it travels downhill towards the leachate removal system and sumps. The only portion of the bottom liner (the floor of the 2LCS) which is covered by leachate is the portion within this parabolically shaped path. This is called the "wetted area" of the 2LCS. By comparing the wetted area of the 2LCS to the total area of the 2LCS, it is possible to calculate the probability that any hole(s) in the bottom liner will be located in the wetted area. The percent probability that the holes are not in the wetted area is the probability of zero leakage, i.e., the probability that the landfill will not leak at all. This probability of zero leakage only occurs with double liner systems, and is a tremendous advantage of double liner systems over single liner systems. In the case of a double liner system with a top composite liner, the probability of alignment is especially low, because the top composite liner leaks so little that the resulting flow path in the 2LCS is quite narrow.

6.1 Maximum Wetted Area of the 2LCS

When the 2LCS is not flooded, the maximum wetted area, A_{wmax} , is given by

$$A_{wmax} = \{2\, Q_1 / 3\, k_{2LCS} \sin^2 \beta\} \{ [\, 1 + (2\, L \sin \beta / (Q_1 / k_{2LCS})^{0.5}) \,]^{1.5} - 1\} \qquad [7]$$

where

A_{wmax} = the maximum wetted area in the 2LCS from one hole in the primary liner (m^2)
Q_1 = the flow rate into the 2LCS from leakage through the primary liner (m^3/s)
k_{2LCS} = the hydraulic conductivity of the 2LCS (m/s)
β = the slope of the 2LCS (m/m)
L = the maximum length of the flow path, i.e., one half the distance between leachate removal pipes (m)

In this case, the maximum wetted area is 49 m^2.

6.2 Probability of Zero Leakage

Knowing the maximum wetted area, the probability of zero leakage into the ground, P_0 , is

$$P_0 = (1 - N A_{wmax} / 4047) 100 \quad [8]$$

where

P_0 = the percent probability of zero leakage into the ground
N = the predicted number of holes per acre, and
A_{wmax} = the maximum wetted area in the 2LCS from one hole in the primary liner (m^2)

This equation is not dimensionally homogeneous and must be used with the units shown in parentheses.

With Omni's proposed liner, there is a 94% probability that there will be no leakage at all into the ground.

7. COMPARISON TO REGULATORY MINIMUM DESIGN STANDARDS

It is interesting to compare the performance of Omni's proposed design to the federal (EPA) and Florida minimum design standards. The comparisons are shown in Table 1.

7.1 Federal Minimum Design Standard

The federal minimum design standard is a composite liner with an overlying LCS, as shown on Figure 3. The LCS must limit the hydraulic head to one foot, and the composite liner must have a lower component which is at least 2 feet thick with a minimum hydraulic conductivity of 1×10^{-7} cm/s.

Using these values, along with the other parameters selected for Omni's conceptual design, the leakage into the ground with the federal design is 767 gallons per acre per year, as compared to a few drops per acre per year for the liner system proposed by Omni.

It is also noteworthy that, because the federal standard for the hydraulic head in the LCS (maximum of 1 ft.) is the hydraulic conductivity equivalent to sand, the LCS requires many months to remove the leachate, so it is always wet; i.e., the leachate never completely drains off until the landfill is closed, and the residence time is the life of the landfill. Therefore there is little or no residence time benefit with the federal design, and the probability of zero leakage is very small.

7.2 Florida Double Liner Standard

The Florida double liner standard (DLS) is shown on Figure 4. Using the parameters shown in Figure 4, along with the same parameters selected for this conceptual design, the leakage into the ground with the Florida DLS design is 44 gallons per acre per year, as compared to a few drops per acre per year for the Omni liner system.

Furthermore, with the Florida DLS design, there is little residence time benefit because of the relatively high hydraulic conductivity of the soil underlying the bottom geomembrane; and the probability of zero leakage from the Florida double liner system is only 51%, as compared to 94% for the Omni double liner system.

8. CONCLUSIONS

Although the analytical process followed in this technical note may seem complex, the conclusions to be drawn are simple and straightforward.

- The comparison to the federal and Florida minimum design standards clearly shows the superior performance of the Oak Hammock liner system design.
- Because it is a double liner system, there is a significant probability (94%) that the Oak Hammock landfill liner system will have zero leakage into the ground.
- Because the Oak Hammock liner system includes two composite liners, there is a very high probability that the total residence time in the leachate collection systems will be much less than the travel time through the composite liner(s). Therefore, there will be a very high probability of zero leakage into the ground.
- Even in the highly unlikely event that the Oak Hammock liner system does leak, it will only leak a few drops per acre per year, and will have no measurable impact on the groundwater.

Furthermore, the assumptions used in this analysis were very conservative, as shown in Table 2, which compares the assumed values with more typical values. These extra-conservative assumed values were chosen for the conceptual design in order to ensure that the ultimate performance of the liner system meets or exceeds the performance predicted by the conceptual design. During the detailed design phase of this project, more realistic values will be used for each parameter, and the results will show even better performance for the liner system.

The final conclusion, therefore, is that the Oak Hammock landfill is unlikely to leak at all, and if it does, it will do so at a rate of only a few drops per acre per year.

9. REFERENCES

1. Fluet, J. E., Jr., Badu-Tweneboah, K., and Khatami, A., "A Review of Geosynthetic Liner System Technology", Waste Management and Research, Copenhagen, Denmark, Vol. 10, No. 1, 1992, pp. 47-65.

2. Giroud, J.P., et. al., "Special Issue on Liquid Migration Control Using Geosynthetic Liner Systems", Geosynthetics International, Vol. 4, Nos. 3 & 4, 1997, IFAI, Roseville, MN, USA

3. Giroud, J.P., and Fluet, J.E., Jr., "Quality Assurance of Geosynthetic Lining Systems", *Geotextiles and Geomembranes,* Vol. 3, No. 4, 1986, pp. 249-287.

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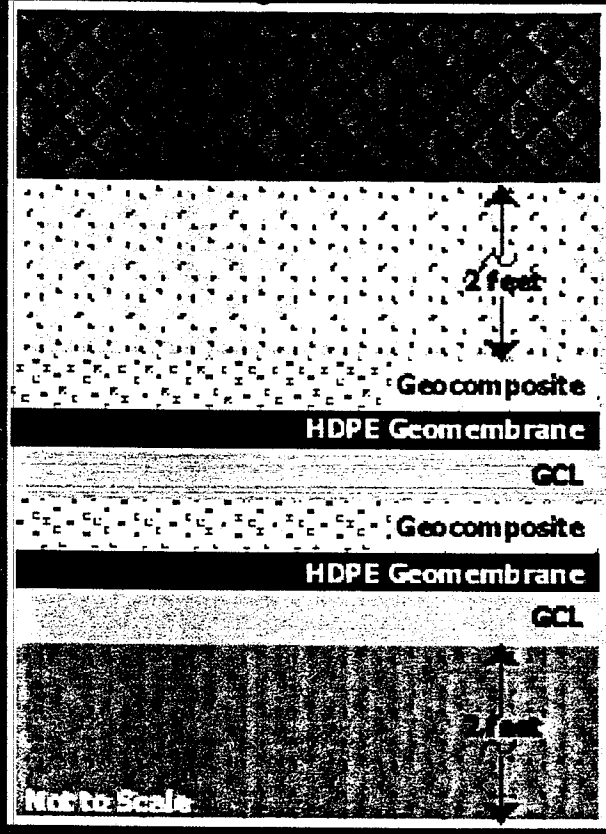
Performance Parameter	Federal Standard	Florida DLS Standard	Oak Hammock
Leakage Into The Ground (gallons per acre per year)	767	44	0.001
Probability Of Zero Leakage From Residence Time Benefit	Small	Small	Very High
Probability of Zero Leakage From DLS	None	51%	94%

Table 1: Comparison of Oak Hammock Design to Federal and Florida Minimum Design Standards

Parameter	Assumed Value	Typical Value
Impingement Rate	32 inches/year	12 inches/year
LCS/2LCS Pipe Spacing	100 m (328 ft)	61 m (200 ft)
k_{LCS}/k_{2LCS} (geocomposite)	1 cm/s	20 cm/s
k_{GCL}	1×10^{-8} cm/s	1×10^{-9} cm/s
Number of Liner Holes/Acre	5	3
Area of Holes in Liner	1.0 cm^2	0.1 cm^2

Table 2: Assumed Values vs Typical Values

Figure 1: Cross Section of Proposed Liner System



Select Waste

Sand Protective Layer (Back-up LCS)

LCS

Top Composite Liner

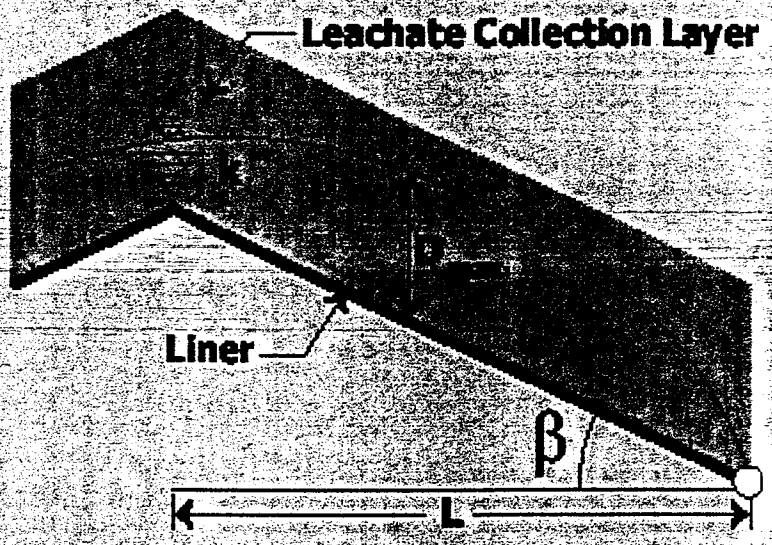
2 LCS

Bottom Composite Liner

Compacted Foundation Soil

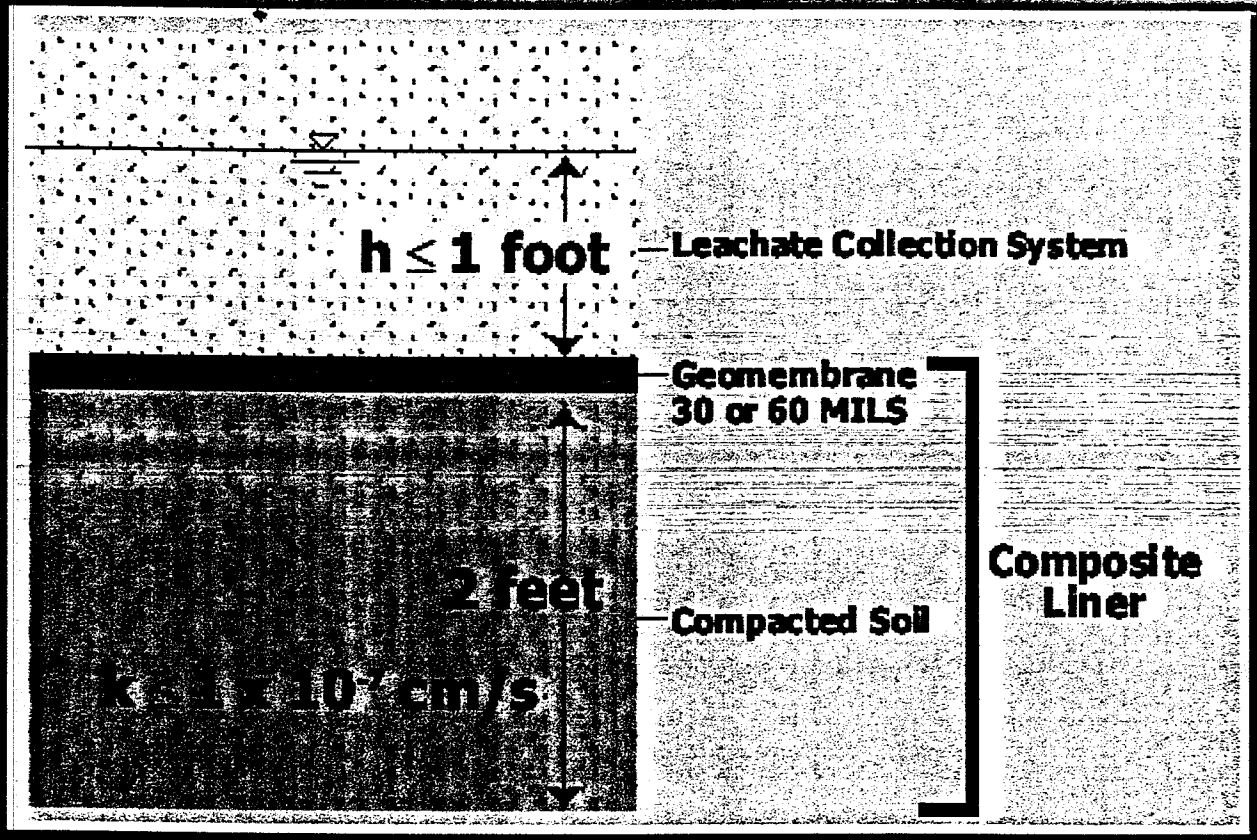
Figure 2: Giroud's Equation

to Calculate Depth of Leachate In LCS



$$D_{max} = L\{ [4 (q_i / k) + \tan^2\beta]^{0.5} - \tan\beta \} / 2 \cos^2\beta$$

Federal Minimum Design Standard



Florida Double Liner Standard