ENGINEERING CONTROLS

Final Report
Florida Contaminated Soils Forum

Engineering Controls Focus Group
June 7, 1999, amended

The Engineering Controls Focus Group was created to: (1) consider the adequacy of engineering controls available for use at contaminated sites; (2) summarize the types of engineering controls currently available; (3) evaluate the effectiveness of engineering controls in protecting human health, and the environment; and (4) evaluate the ability of engineering controls to achieve Risk-Based Corrective Action (RBCA) criteria at contaminated sites.

The participates wish to thank the Department of Environmental Protection's staff for their efforts in arranging and convening the forums, and Co-Chairs, Mr. Doug Jones and Mr. Tim Varney, for their leadership and direction.

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Submitted to: Contaminated Soils Forum
Prepared by: Engineering Controls Focus Group

June 7, 1999, amended

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I. STATEMENT OF ASSIGNMENT

At the Contaminated Soils Forum (CSF) meeting on August 19, 1998, a focus group was created to consider the adequacy of engineering controls available for use at contaminated sites. On October 2, 1998, the first draft of this paper was presented to the CSF for comments and discussion. The focus group was requested to expand upon the paper as a result of the discussion. At the December 3, 1998, meeting a second and final draft was distributed for comments. Based on those comments this final report was prepared. The goals of the focus group were to summarize types of engineering controls currently available, summarize sites presently using engineering controls in Florida, evaluate the stewardship of sites, and to evaluate engineering controls' effectiveness in protecting human health and the environment. The ability of engineering controls to achieve Risk-Based Corrective Action (RBCA) criteria at contaminated soil sites are also of consideration.

II. CONCLUSIONS AND RECOMMENDATIONS OF THE FOCUS GROUP

A. The focus group has identified engineering controls that can eliminate human exposure pathways to contaminated soils. These controls are based on existing technologies that are readily available and can be effective provided they are properly constructed and maintained. Some engineering controls may require that Construction Quality Assurance be provided to ensure they are installed as designed. The initial construction costs associated with implementing many of these controls appear reasonable and achievable. Costs for long-term care would also appear to be manageable. However, in some instances, the long-term care costs associated with operating and maintaining the engineering controls may be prohibitive when compared to other alternatives such as source removal.

B. In order to be effective, engineering controls must be appropriately monitored and maintained. Very long term monitoring and maintenance, "stewardship" can be anticipated for most sites that implement engineering controls, especially if, the controls are used at a site where the contaminants are not expected to degrade naturally. Consequently, stewardship of a site must be remedy specific and supported by effective institutional controls. Inspection programs also must be implemented, funded, and administered effectively in order to ensure proper operation and maintenance.

III. INTRODUCTION TO ENGINEERED CONTROLS

The following narratives on two types of engineering barriers are included. The reader should keep in mind that this focus group paper concentrated on controls that are effective in protecting human health and the environment from contaminated soils. However, the paper would not be complete without at least mentioning types of engineering controls for contaminated groundwater. Engineering controls are constructed containment barriers or systems that control one of the following:

A. Downward migration, infiltration or seepage of surface runoff and rain; or

B. Natural leaching/migration of contaminants through the subsurface over time.

C. Examples of engineering controls that may be used to prevent the above two conditions include the following:

1. Caps. Caps may be constructed of clay or chemically resistant geosynthetic materials.

2. Engineered bottom barriers. This is a recent development in which an impervious horizontal stratum is created below an existing contaminated site (i.e., landfill), when no aquitard exists, by grouting or other techniques.

3. Immobilization processes. These processes involve the binding of contaminants into a solid that is resistant to leaching. The following three processes are examples used for immobilizing contaminants in soil:

   a. *In-situ solidification.* In this process contaminants are physically bound or enclosed within a stabilized mass.

   b. *In-situ stabilization.* Stabilization is accomplished by inducing chemical reactions between a stabilizing agent and the contaminated soil to reduce contaminant mobility.

   c. *Encapsulation*. Encapsulation involves the complete coating or enclosure of a toxic particle or waste agglomerate with a new substance, e.g., the additive or binder.

4. Vertical barriers. This type of barrier is used to prevent horizontal migration of groundwater. Vertical barriers are typically used to control sources of contaminants are soil-bentonite, soil-cement-bentonite, cement-bentonite, sheet pile (steel or high-density polyethylene [HDPE]), and clay barriers.

IV. TYPES OF ENGINEERED CONTROLS

A. Caps:

1. A cap design should at a minimum include the following layers:

   - A base soil layer to support the other layers
   - A low-permeability layer (1×10^{-7} cm/sec or less)
   - A drainage layer
   - A soil cover, including a vegetative layer

   a. A gas collection and venting layer maybe required to control off gases. In industrial areas, a parking lot or other alternative surface can be constructed over the soil cover.

   b. The primary objective of a cap is to minimize infiltration into the contaminated soils of a site and isolate the contaminated soils from human exposure and the environment. The design of the cap should consider the following factors:

   - Stability of the contaminated soil
   - Settlement
   - Stability of the cap system
   - Drainage / Erosion control features
   - Infiltration
   - Gas management

For further explanation and discussion on the application of cap technology refer to Evaluation of Subsurface Engineered Barriers at Waste Sites, Environmental Protection Agency document, EPA-542-R-98-005, July 1998

B. Engineered bottom barriers: Engineered bottom barriers are a recent development and the techniques associated with implementing these barriers under existing contaminated sites are still in development. **Note:** This paper does not include additional details on this technique due to the very limited data available at time of writing.

C. Immobilization: “The basic principle of [immobilization] is the binding of constituents of concern into a solid that is resistant to leaching. The mechanism by which this occurs depends upon the type of [immobilization] process. Two of the most common are lime/pozzolan-base processes and portland cement-based processes.” (U.S. EPA, 52 FR 29991).

   1. *Stabilization* - - “A process by which a waste is converted to a more chemically stable form. The term entails the use of a chemical reaction to transform the toxic component to a new non-toxic compound or substance.” (U.S. EPA, PB92-963351, June 1990).

2. *Solidification* - - "A process in which materials are added to a liquid or semiliquid waste to produce a solid. It may or may not involve a chemical bonding between the toxic contaminant and the additive." (U.S. EPA, PB92-963351, June 1990).

3. *Encapsulation* - - "A process involving the complete coating or enclosure of a toxic particle or waste agglomerate with a new substance, e.g., the additive or binder. Microencapsulation is the encapsulation of individual particles. Macroencapsulation is the encapsulation of an agglomeration of waste particles or microencapsolated materials." (U.S. EPA, PB92-963351, June 1990).

The effectiveness of immobilization depends on the type and amount of binder (additives) used. The greater the amount of binder used, the higher the cost of treating the soil. For further explanation and discussion on the application of these processes refer to the Summary of Treatment Technology Effectiveness for Contaminated Soil, Environmental Protection Agency document, PB92-963351, June 1990.

D. Vertical Barriers

1. Vertical barriers are classified into various categories. The most common ones are listed below:

   - Barriers installed with slurry trenching technology
   - Thin walls
   - Deep soil mixing
   - Grout walls
   - Sheet pile walls
   - Liners

For further explanation and discussion on the application of these vertical barrier technologies refer to Evaluation of Subsurface Engineered Barriers at Waste Sites, Environmental Protection Agency document, EPA-542-R-98-005, July 1998

V. LIMITATIONS AND ASSUMPTIONS

Engineering Controls cover a wide array of actions to contain or otherwise limit the spread of contamination in the environment. The focus group has limited the scope of its effort to the consideration of engineering controls for contaminated soil. The focus group also assumes that these engineering controls will be supported by institutional controls when implemented. Implementation of various engineering barriers whether the control is a subsurface or surficial barrier will require commitment from the responsible party for stewardship.

A. Soil Properties

1. The term ‘soil” may include reuse materials.

B. Contaminant Properties

1. The contaminant concentration is below the Leachability Cleanup Target Level of the Soil Cleanup Target Levels (SCTLs) of Chapter 62-777, F.A.C. or meets alternative cleanup levels (otherwise remediation is required). Thus, only direct exposure to the contaminated soil is of concern.

2. The soil exceeds the residential Direct Exposure (DE I) SCTL (otherwise treatment or engineering control is not required).

3. The horizontal extent of the contamination plume in the soil has been defined and the plume will not expand.

C. Site Characteristics

1. Before deciding if the use of an engineering control in conjunction with an institutional control can be cost-effectively used for site remediation, the person responsible for the decision must make sure that (1) all affected property owners are in agreement and will accept the institutional control selected; and (2) that the selected control measures are compatible with the current and projected future use of the land and the affected groundwater or surface water, and that the control measures are compatible with the local comprehensive plan.

D. Stewardship

1. The long term stewardship of cleanup sites requires three significant issues be addressed before implementation of an engineering control at a site. These issues include (1) financial stability of the entity implementing the control; (2) the legal, contractual and regulatory context in which stewardship is maintained; and (3) the response mechanisms that deals with any monitoring activity of the engineering control if the control fails to provide adequate protection. For additional reading on stewardship see, A concept for the preservation of engineering and institutional controls at cleanup sites, Marc C. Bruner, October 30, 1998.

2. Many of the readers may ask, “What is the criteria for an entity to be considered financially stable?” This question is an important one in determining the practicability and the implementation of a engineering control. However, this

paper does not attempt to set limits or define the criteria for providing financial stability.

VI. FLORIDA SPECIFIC USES OF ENGINEERING CONTROLS BY PROGRAMS

A. Landfills

1. The Bureau of Solid and Hazardous Waste was surveyed for information on the type and approximate number of liners that are currently implemented within the State. The following breakdown presents a summary:

- For Bottom Liners:
  a. single compacted clay liners: 5-10 sites
  b. single geomembrane liners: 10-20 sites
  c. single composite liners (i.e., geomembrane plus clay): 20-30 sites
  d. double liners: 20 sites
  e. slurry walls: 8 sites

- Top Cap for Closure:
  a. single compacted clay liner: 10-20 sites
  b. single geomembrane liner: 10-20 sites
  c. geosynthetic clay liner (GCL): 5-10 sites

- Other Engineering Controls:
  a. leachate interceptor trench: 3 sites

2. General Discussion:

Single compacted clay liners would have an in-place hydraulic conductivity usually between 10-7 and 10-8 cm/sec. The geomembrane used most often in bottom liner applications at Florida MSW landfills, 60-mil HDPE, should have a useful life of at least 200+ years. The State of Florida no longer allows a single clay or single geomembrane bottom liner systems. All newly permitted cells have to be constructed with either a composite liner (geomembrane over compacted clay) or a double liner (two geomembranes separated by a leakage detection system).

The slurry wall landfills were constructed in Florida during the days of a single liner requirement. The wall was typically constructed with bentonite and native soils, keyed into a bottom continuous clay layer and had a thickness of at least three feet. The slurry walls usually were designed to have a hydraulic conductivity of 10-7 cm/sec or less.

GCLs are a relatively new product constructed with a 0.25 inch layer of bentonite between two geotextiles. These products can be rolled out at a landfill in 15-foot wide sheets. They are easier to install than compacted clay but lack the thickness of compacted clay. In spite of their thinness, these products seem to perform well when used properly and can have a hydraulic conductivity as low as 10-9 cm/sec. Florida has allowed the use of this product in top caps and also under the second geomembrane in double liner systems. GCLs have not been allowed in place of the compacted clay for a composite bottom liner.

At least three older landfills have leachate interceptor trenches downgradient from the landfill. This engineering control functions primarily to limit off-site migration of leachate from the landfills.

B. Petroleum Program

1. The Bureau of Petroleum Storage Systems was surveyed for information on the type and approximate number of engineering controls that are currently implemented within its program. See attached Table III.

C. Dry Cleaning and Hazardous Waste Program

1. The Bureau of Waste Cleanup was surveyed for information on the type and approximate number of engineering controls that are currently implemented within the referenced program. See attached Table III.

D. RCRA Program

1. The Bureau of Solid and Hazardous Waste was surveyed for information on the type and approximate number of engineering controls that are currently implemented within the referenced program. See attached Table III.

VII. DEFINITIONS

The focus group proposes the following definition for engineering controls:

“Engineering controls means modifications to a site to reduce or eliminate the potential for contaminant migration and exposure to contaminants. Examples of modifications include physical or hydraulic control measures, capping, point-of-use-treatments, or slurry walls.”

This proposed definition is the statutory definition of engineering controls under Florida's Brownfields and Dry Cleaning programs, and has been selected by the group for consistency with those rules. Definitions for engineering controls that have been developed by others are provided in Attachment A.

VIII. EVALUATION OF ENGINEERING CONTROL TECHNOLOGY

Based on the assumptions stated above, the focus group compiled a list of engineering control technologies that are likely to be considered for use. The group has also attempted to list some advantages and disadvantages of these controls.

Table 1 Engineering Control Technologies

ENGINEERING CONTROL	ADVANTAGES	DISADVANTAGES	COMMENTS
Cover Technologies: General	• physical barrier • easy to implement • easy to monitor • generally compatible with Industrial and commercial land uses • performance depends on maintenance • performance depends on design	• contamination is hidden • requires institutional controls • performance depends on maintenance • performance depends on design • may restrict the exchange of soil and atmospheric gases	a
Cover: Soils	• aesthetically acceptable • inexpensive • repairable	• susceptible to erosion • barrier easily breached • not appropriate for control of volatile contaminants • possibility of cross-contamination by contact • revegetation maintenance •	a
Cover: Asphalt and mixed materials	• Can be engineered to meet site requirements	• not permanent • may require storm water management • may be aesthetically unacceptable •	a
Cover: Clay liner	• Can be engineered to meet site requirements	• not permanent • may require storm water management	a
Cover: Synthetic membranes	• inexpensive • repairable • Can be engineered to meet site requirements	• not permanent • may require storm water management • requires extensive preparation of subgrade	a

ENGINEERING CONTROL	ADVANTAGES	DISADVANTAGES	COMMENTS
Cutoff Wall Technologies: General	• physical barrier • controls horizontal migration of contaminants	• Specialty contractors may be required to install	
Cutoff: Slurry wall	• proven technology • economical • long term solution • low maintenance		
Cutoff: Grout curtain	• long term solution • low maintenance	• more expensive that slurry walls • Specialty contractors required to install • uncertainty of complete cutoff	
Cutoff: Sheet pilings	• compatible with loose soils • no excavation • low maintenance	• effective depths of 50 feet or less • Specialty contractors required to install • susceptible to corrosion	
Cutoff: Synthetic membranes	• better control of soil gas and groundwater migration	• excavation required • Specialty contractors required to install • difficult to install • material compatibility	
Security Measures: General	• inexpensive for short-term application • easy to monitor • easy to inspect and verify • generally compatible with existing industrial and commercial land uses	• unreliable over long term due to changing land uses • high frequency of inspection required • susceptible to accidental or unwanted intrusion • cost could be prohibited for long term application	
Security: Fence	• easy to install • inexpensive • may be effective over short term if coupled with manned 24-hour security	• not reliable over long term • level of protection depends on public not trespassing	

	ADVANTAGES	**DISADVANTAGES**	
Security: Guard	easy to implement implemented quickly may be effective over short term if coupled	• not reliable over long term • level of protection depends on public not trespassing	
Security: Public notices	inexpensive	ineffective and unreliable attracts attention to the problem	

April 1994). The manual includes extensive discussion of Surface Sealing methods and design considerations.

Table 2 (Draft)
Institutional / Engineering Controls to Qualify for a NFA With Conditions for Soil in the Petroleum Program

	Deed Restrictions to Keep Site in Commercial/Industrial Use	Engineering control of Pavement Along with Deed Restriction to Maintain Pavement	Deed Restrictions to Not Permanently Change Grade of Site to within 2 Feet of Contaminated Soil	Engineering Controls of Adding 2 Feet of Clean Soil Along with Deed Restriction to Maintain	Deed Restrictions to Properly Dispose of Soil if Every Excavated
Soil contamination in top 2 feet greater than DE I but less than DE II SCTLs	O	O	N/A	O	M
Soil contamination in top 2 feet greater than DE II SCTLs	N/A	O	N/A	O	M[B]
Soil contamination greater than DE I but less than DE II SCTLs only deeper than 2 feet below surface	O	O[A]	O	N/A	M
Soil contamination greater than DE II SCTLs only deeper than 2 feet below surface	N/A	O[A]	O	N/A	M[B]
Soil contamination greater than DE I but less than alternative SCTLs justified pursuant to Rule 62-770.650, F.A.C.	Institutional control to keep in use consistent with parameters used to justify alternative SCTLs for Direct Exposure				M

M - Mandatory to get a NFA with conditions.

O- One of two or more options to get a NFA with conditions. One of the options (O) in a row must be selected in addition to the mandatory (M) deed restriction.

A - It may be possible to agree to always maintain an engineering control of pavement on the site regardless of whether the site is ever regraded to within two feet of the contaminated soil in lieu of keeping the site commercial / industrial or in lieu of agreeing to always maintain two feet of clean soil above the level at which contaminated soil begins.

B - For this situation the deed restriction will also have to stipulate that if subterranean construction activities are ever implemented on the site, construction workers will be notified that contamination exists and that they may need to use proper protective equipment based on OSHA requirements.

Table III
State of Florida Sites with Institutional Controls or Engineering Controls

	Control Type	Site Type	Site Name	Site Category	Street Address	Facility ID #
1	Deed Restriction/Restrictive Covenant	Enforcement	General Electric/RCA	Electrical Mfg.	3900 RCA Blvd., Palm Beach Gardens	N/A
2	Deed Restriction/Restrictive Covenant	Enforcement	Wal-Mart #973	Herbicide/Agri.	Okeechobee Rd. and McNeil Rd., Ft. Pierce	N/A
3	Deed Restriction/Restrictive Covenant	Enforcement	Governor's Landing	Herbicide/Golf Crse	Cross Rip Rd. and Gomez Ave., Hobe Sound	N/A
4	Deed Restriction/Restrictive Covenant	Enforcement	Pompano Harness Track	Herbicide/Golf Crse	1800 SW 36th St., Pompano	N/A
5	Deed Notice	Enforcement	SafetyKleen	Industrial Solvents	1855 SW 4th Ave. Bldg B,Bay 30, Delray Beach	N/A
6	Deed Notice	Enforcement	SafetyKleen	Industrial Solvents	7875 NW 54th St., Miami	N/A
7	Restrictive Covenant	Enforcement	Terminex	Pesticides	12700 Automobile Rd., Clearwater, Pinellas Co.	Comet Prj. 66088
8	Declaration to Deed	Enforcement	San Carlos Golf Club	Pesticides	7420 Constitution Circle, Fort Myers, FL 33903	FLD982115925
9	Deed Restriction/Restrictive Covenant	Enforcement	Pepper's Steel	Steel/Metal/Electrical Processing	11002 NW South River Dr., Medley	N/A
10	County Ordinance	Enforcement	Lofton Creek Landfill	Landfill	Yulee, Nassau County	OGC # 93-3218
11	Restrictive Covenant	Enforcement	Gator Bowl	Petroleum Products	Adams & Bay St., Jacksonville, Duval County	169700819 OGC # 94-2674
12	Deed Restriction/Restrictive Covenant	Enforcement/NPL	BMI Textron	Electrical Mfg.	2232 Silver Beach Rd.,Lake Park	N/A
13	Deed Restriction/Restrictive Covenant	Enforcement/NPL	Chemairspray	Herbicide/Agri.	Hwy 98, Pahokee	N/A
14	Deed Restriction/Restrictive Covenant	Enforcement/NPL	Woodbury Chemical	Industrial Chemical	13920 SW 248th St., Princeton	N/A
15	Conservation Easement	NPL	Pioneer Sand	PCB's and Terpenes	Saufley Field Rd, 1/2 mile W of Blue Angel Parkway, Pensacola	FLD 005 611 6965

	Control Type	Site Type	Site Name	Site Category	Street Address	Facility ID #
16	Deed Notices	Permit	Florida Tile Industries, Inc.*	Chemical Process	One Sikes Rd., Lakeland, FL 33801	FLD 004 091 583
17	Deed Notices	Permit	Wenczel Tile Company of Florida, Inc. **	Chemical Process	6608 S. Westshore Blvd., Tampa, FL 33616	FLD 042 468 355
18	Deed Notices	Permit	Kaiser Aluminum & Chemical**	Chemical Processing	2400 Old Highway 60, Mulberry, FL 33860	FLD 004 106 811
19	Deed Notices	Permit	Petro Chemical Products, Inc.**	Chemicals & Solvents	2910 W Beaver St., Jacksonville, FL 32203	FLD 020 982 716
20	Deed Notices	Permit	Munters Corporation **	Corrugated Impregnated Paper	108 Sixth St., SE, Fort Myers, FL 33907	FLD 984 241 075
21	Deed Notices	Permit	General Components, Inc.**	Electroplating	7425 124th Ave., N. Largo, FL 34643	FLD 004 088 258
22	Deed Notices	Permit	DMB/Sarasota, I, L.P. (Loral) **	Electroplating Solvents	6000 Fruitville Rd., Sarasota, FL 34232	FLD 083 200 998
23	LUCAP	Permit	U.S. NAS - Jacksonville **	Electroplating, Solvent Wastewater Treatment	Jacksonville, FL 32212	FL6 170 024 412
24	Deed Notices	Permit	Ashland Chemical - N. Miami**	Industrial Chemicals & Solvents	200 NE 181 St., Miami, FL 33269	FLD 059 861 344
25	Deed Notices	Permit	Borden, Inc., - Lakeland **	Industrial Solvents	1004 Combee Rd., Lakeland, FL 33804	FLD 000 605 519
26	Deed Notices	Permit	Safety-Kleen - Delray **	Industrial Solvents	1855 SW 4th Ave., Bldg. B Delray Beach, FL 33447	FLD 000 776 757
27	Deed Notices	Permit	Safety-Kleen - Tallahassee**	Industrial Solvents	3082 W. Tharpe St., Tallahassee, FL 32303	FLD 000 776 773
28	Deed Notices	Permit	Arizona Chemical Co., Inc.*	Industrial Solvents	2 Everitt Ave., Panama City, FL 32604	FLD 004 065 926
29	Deed Notices	Permit	Safety-Kleen - Altamonte Springs **	Industrial Solvents	505 Plumosa Ave., Altamonte Springs, FL 32701	FLD 097 837 983
30	Deed Notices	Permit	Safety-Kleen - Miami **	Industrial Solvents	7875 NW 54th St., Miami, FL 33160	FLD 980 840 086

	Control Type	Site Type	Site Name	Site Category	Street Address	Facility ID #
31	Deed Notices	Permit	GNB **	Industrial Waste	3521 S. 50th St., Tampa, FL 33619	FLD 000 608 083
32	Deed Notices	Permit	Trak Microwave**	Industrial Wastewater	4726 Eisenhower Blvd., Tampa, FL 33634-6391	FLD 004 093 621
33	Deed Notices	Permit	Northrop Grumman, St. Augustine**	Industrial Wastewater	5000 U.S. 1 N., Bldg. 40, St. Augustine, FL 32095	FLD 046 771 952
34	Deed Notices	Permit	Florida DOT Fairbanks **	Landfill, Acid Solvents, Road Parts, Road Debris	8000 NE 51st St., Gainesville, FL 32601	FLD 980 799 050
35	Deed Notices	Permit	Lockheed Martin - Orlando**	Landfill, Wastewater Treatment Sludge	5600 Sand Lake Rd., Orlando, FL 32819	FLD 060 240 207
36	Deed Notices	Permit	Pine Hills Landfill *	Landfill/Dump	4200 John Young Hwy., Orlando, FL 32809-9205	FLD 984 178 095
37	Deed Notices	Permit	Jacksonville Shipyard *	Sandblast Grit Generated from Repair of Ships (Lead-Based Paint)	13911 Atlantic Blvd., Jacksonville, FL 32225	FLD 137 358 974
38	Deed Notices	Permit	Refined Metals*	Smelting Operations	2640 Capitola St., Jacksonville, FL 32209	FLD 080 677 347
39	Deed Notices	Permit	Primex Technologies**	Smokeless Powder	St. Marks, FL 32355	FLD 047 096 524
40	Deed Notices	Permit	Avesta Sheffield Pipe Co.**	Spent Pickle Liquor	1101 N. Main St., Wildwood, FL 32785	FLD 064 675 978
41	Deed Notices	Permit	Solutia, Inc.**	Synthetic Fibers & TSD Facility	3000 Old Chemstrand Rd., Cantonment, FL 32533	FLD 071 951 966
42	LUCAP	Permit	U.S. NAS - Pensacola **	Wastewater Treatment	Naval Air Station, Pensacola, FL 32508-5303	FL9 170 024 576
43	Deed Notices	Permit	Envirotech Southeast, Inc.**	Wastewater Treatment	1819 Albert St., Jacksonville, FL 32202	FLD 101 877 875
44	Deed Notices	Permit	Southern Wood Piedmont**	Wood Processing Waste	900 North Center St., Baldwin, FL 32234	FLD 004 053 405

	Control Type	Site Type	Site Name	Site Category	Street Address	Facility ID #
45	Well Permitting Restriction	State Action	Escobio	Metals (Mercury)	1907 St. John St, Tampa	Comet Prj. 65908
46	Restrictive Covenant	Voluntary	Gateway/Hercules	Arsenic	13133 34th St. Clearwater, Pinellas Co.	Comet Prj. 101454
47	Restrictive Covenant	Voluntary	US Agrichem	PCBs	Rockland Mine, Polk Co.	Comet Prj. 100971
48	Deed Notice	Voluntary	Harbour Island	Pesticides	Island Walk, Tampa	Comet Prj. 67909
49	Deed Restriction/Restrictive Covenant	Voluntary	Newman Oil Company	Petroleum	1484 5th Avenue South (US Hwy 41), Naples, FL 33942	118626231
50	Restrictive Covenant	Voluntary	Williams Capri Marine	Petroleum	250 Capri Blvd, Naples	118626236
51	Deed Restriction/Restrictive Covenant	Voluntary	Joe Daniel, Inc.	Petroleum	1640 N.W. 58th Avenue Miami, FL	138628922
52	Restrictive Covenant	Voluntary	Emmanuel, Sheppard & Condon, P.A.	Petroleum	110 West Romana Street, Penscacola,	179800572
53	Restrictive Covenant	Voluntary	Madison Street Corp.	Petroleum	Railroad and Madison Street, Tallahassee	379101772
54	Restrictive Covenant	Voluntary	Pomco Associates, Inc.	Petroleum	4015 S Terminal St., Palmetto 34221	418624385
55	Restrictive Covenant	Voluntary	Woll Residence	Petroleum	6501 Bayou Hammock, Longboat Key 34221	419800329
56	Deed Restriction/Restrictive Covenant	Voluntary	CSXT/J.E. Simms Distributors	Petroleum	1020 Southeast First Terrace Ocala, FL	428841823
57	Restrictive Covenant	Voluntary	Days Inn - Landstreet	Petroleum	1851 Landstreet, Orlando	489045605
58	Restrictive Covenant	Voluntary	Central Auto	Petroleum	1665 Central Avenue, St. Pete	529201894
59	Restrictive Covenant	Voluntary	Harmon Brothers	Petroleum	1000 6th Street Sountwest, Winter Haven 33882	538732766

	Control Type	Site Type	Site Name	Site Category	Street Address	Facility ID #
60	Restrictive Covenant	Voluntary	Racquet Club Warehouse	Petroleum	5061-5079 N.E. 13th Ave, Oakland Park, Fl	069401793
61	Declaration of Deed	Enforcement	Country Club of Naples	Pesticides	185 Burning Tree Drive, Naples, FL 33942	FLD982096521

* ***Post Closure Permit/No remediation at site***

** ***Post Closure Permit/Remediation ongoing at site***

LUCAP - ***Land Controls Assurance Plan***

Table 4
Summary of Liner Types

Liner		Characteristics	Range of costs	Advantages		Disadvantages
Soils						
	Compacted clay	Compacted mixture of onsite soils to a permeability of 10-7 cm/sec	L	High cation exchange capacity; resistant to many types of leachate		Organic or inorganic acids or bases may solubilize portions clay structure
	Soil bentonite	Compacted mixture of onsite soil, water, and bentonite	L	High cation exchange capacity; resistant to many types of leachate		Organic or inorganic acids or bases may solubilize portions clay structure
Admixes						
	Asphalt concrete	Mixtures of asphalt cement and high-quality mineral aggregate	M	Resistant to water and effects of weather extremes; stable on side stapes; resistant to acids, bases, and inorganic salts		Not resistant to organic solvent partially or wholly soluble in hydrocarbons; does not have good resistance to inorganic chemicals; high gas permeability
	Asphalt membrane	Core layer of blown asphalt blended with mineral fillers and reinforcing fibers	M	Flexible enough to conform to irregularities in subgrade; resistant to acids, bases, and inorganic salts		Ages rapidly in hot climates; not resistant to organic solvents, particularly hydrocarbons
	Soil asphalt	Compacted mixture of asphalt, water, and selected in-place soils	L	Resistant to acids, bases, and salts		Not resistant to organic solvent particularly hydrocarbons

Liner		Characteristics	Range of costs	Advantages		Disadvantages
	Soil cement	Compacted mixture of portland cement, water, and selected in-place soils	L	Good weathering in wet-dry/freeze-thaw cycles; can resist moderate amount of alkali, organics, and inorganic salts		Degraded by highly acidic environments
Polymeric						
	Butyl rubber	Copolymer of isobutylene with small amounts of isoprene	M	Low gas and water vapor permeability; thermal stability; only slightly affected by oxygenated solvents and other polar liquids		Highly swollen by hydrocarbon solvents and petroleum oils difficult to seam and repair
	Chlorinated polyethylene	Produced by chemical reaction between chlorine and high-density polyethylene	M	Good tensile strength and elongation strength; resistant to many inorganics		Will swell in presence of aromatic hydrocarbons and oils
	Chlorosulfonate polyethylene	Family of polymers prepared by reacting polyethylene with chlorine and sulfur dioxide	H	Good resistance to ozone, heat, acids, and alkalis		Tends to harden on aging; Low tensile strength; tendency to shrink from exposure to sunlight; poor resistance to oil
	Elasticized polyolefins	Blend of rubbery and crystalline polyolefins	L	Low density; highly resistant to weathering, alkalis, and acids		Difficulties with Low temperature and oils

Liner		**Characteristics**	**Range of costs**	**Advantages**		**Disadvantages**
	Epichlorohydrin rubbers	Saturated high molecular weight, atiphatic polyethers with chloromethyl side chains	M	Good tensile and tear strength; thermal stability; tow rate of gas and vapor permeability; resistant to ozone and weathering; resistant to hydrocarbons, solvents, fuels, and oils		None reported
	EthyLene propylene rubber	Family of terpolymers of Ethylene, propylene, and nonconjugated hydrocarbon	M	Resistant to dilute concentrations of acids, alkalis, silicates, phosphates, and brine; tolerates extreme temperatures; flexible at low temperatures; excellent resistance to weather and ultraviolet exposure		Not recommended for petroleum solvents of halogenated solvents
	Neoprene	Synthetic rubber based on chloroprene	H	Resistant to oils, weathering, ozone, and ultraviolet radiation; resistant to puncture, abrasion, and mechanical damage		None reported
	polyethylene	Thermoplastic polymer based on Ethylene	L	Superior resistance to oils, solvents, and permeation by water vapor and gases		Not recommended for exposure to weathering and ultraviolet conditions

Liner		Characteristics	Range of costs	Advantages		Disadvantages
	polyvinyl chloride	Produced in roll form in various widths and thicknesses; potymerization of vinyl chloride monomer	L	Good resistance to inorganics; good tensile, elongation, puncture, and abrasion resistant properties; wide ranges of physical properties		Attacked by many organics, including hydrocarbons, solvents, and oils; not recommended for exposure to weather and ultraviolet Light condition.
	Thermoplastic elastomers	Relatively new class of polymeric materials ranging from highly polar to nonpolar	M	Excellent oil, fuel, and water resistance with high tensile strength and excellent resistance to weathering and ozone		None reported

L - $1.12 to $4.78 per square meter ($1 to $4 installed costs per square yard) in 1981 dollars;
M - $4.78 to $9.57/m2 ($4 to $8 per square yard);
H - $9.57 to $14.35/m2 ($8 to $12 per square yard).

ATTACHMENT A

Definitions of Engineering Controls From Other States

Engineering controls have been defined by others. Their definitions are included below because they demonstrate the existence of a general consensus regarding our definition, and they generally support the focus group's conclusions and recommendations.

Most of the following definitions consider engineering controls for both soil and groundwater contamination. Wherever the definitions include provisions that specifically address direct exposure to soil, that verbiage is included. It is not known whether the authors of these definitions include or even consider the universe of reuse materials or soil gas issues.

1. (State of Ohio, Voluntary Action Program, Rule 3745-300-09,) Engineering controls include, without limitation, fences, cap systems, cover systems, and landscaping. Engineering controls must be:

(i) Effective at eliminating or mitigating exposures to all receptor populations sufficient to meet the risk goals and applicable standards;
(ii) Effective and reliable for the climatic conditions and activities at the property to which the control will be applied;
(iii) Reliable during the period of time which the control is used to achieve and maintain applicable standards; and
(iv) Capable of being monitored and maintained as required by an operation and maintenance plan or agreement developed in accordance with the remedy rule in order to ensure that the control remains effective.

2. (State of California Environmental Protection Agency, Department of Toxic Substances Control, "Recognize The Use of Deed Restrictions and Engineering Site Mitigation Program", Publication Date: March 18, 1998) Engineered controls are defined as measures to control or contain migration of hazardous substances or to prevent, minimize or mitigate environmental damage which may otherwise result from a release or threatened release, including, but not limited to, caps, covers, dikes, trenches, leachate collection systems, treatment systems, and groundwater containment systems or procedures.

3. Under the State of Illinois Tiered Approach to Corrective Action (TACO) Objectives, Engineered Barriers are defined as follows ("Fact Sheet 5: Engineered Barriers", February 1997):

An engineered barrier limits exposure and/or controls migration of contaminants. A barrier may be natural or human-made, but its effectiveness must be verified by engineering practices.

For an exposure (and therefore, a risk) to occur, three factors must be present: 1) contaminants; 2) and exposure route; and 3) a receptor.

The purpose of an engineered barrier is to limit exposure by cutting off the route. The type of barrier used is based on the exposure route being intercepted and the barrier's effectiveness in doing so.

Examples of systems not acceptable as engineered barriers include natural attenuation, fencing, and point of use water treatment.

For both the soil ingestion and inhalation exposure routes, barriers can prevent human exposure to contaminated media. The two types of barriers acceptable for both of these routes are caps and permanent structures. A clean soil cover is also acceptable for the soil ingestion route.

Caps used to prevent soil ingestion and /or inhalation are similar to those required for the migration to groundwater pathway, and may be constructed with the same materials. Caps for this use, however, are intended to prevent the upward migration of soil and vapors instead of the downward infiltration of water.

Permanent structures may provide adequate protection from contamination in instances where the contaminants have migrated beneath the structure or when a structure is built above the contamination.

A clean soil cover may be used to prevent the ingestion of contaminated soil provided that the clean cover is at least three feet thick. Clean cover consists of materials that have contaminant levels not exceeding the applicable Tier I residential remediation objectives.

TACO also allows the proposal of other types of barriers if it can be demonstrated that the proposed barrier is as effective as those discussed herein.

4. The Wisconsin Department of Natural Resources considers engineering controls under the heading "Soil Performance Standards". The following is an excerpt from their interim guidance *(Wisconsin Bureau for Department of Remediation and Natural Resources Redevelopment, PUBL RR-528-97, March 1997)*

A soil performance standard requires a certain level of performance for a remedial action that is implemented and maintained at a site or facility with soil contamination, such that any contamination that exceeds applicable standards is contained and remediated and does not pose a threat to public health, safety or the environment. To qualify for selection, a remedial action with an established soil performance standard must be maintained permanently or until applicable standards are achieved, unless it is replaced by another remedy, so that public health and the environment are protected. Soil performance standards can be applied only in cases where the soils are treated in-situ at a site or facility. Contaminated soil that has been excavated must be managed as a solid or hazardous waste.

Soil performance standards may provide the basis for case closure. Examples of performance standards include placing a barrier cap over contaminated soil which will limit infiltration and will be maintained and repaired for as long as necessary to protect human health and the environment, or demonstrating that natural attenuation of groundwater contains and remediates the contaminants leached from soils (i.e. demonstrating that the contaminant plume is stable or shrinking due to natural attenuation). In these examples, reduced infiltration or the natural attenuation processes are "performing" to contain and remediate the environmental contaminants. Once a performance standard has been established, no further action with regard to the contaminated soil is necessary as long as the conditions that are required by or affect the performance standard are maintained.

(The Wisconsin guidance addresses the issue of direct exposure to soil as follows.)

Exposure or Migration Pathways - When choosing a remedial action for soil cleanup, all exposure or migration pathways must be addressed. There are a number of pathways not addressed in this guidance (vapor movement, utility trenches, etc.). Each site is unique and the specific pathways of concern must be determined for each site.

The most common pathways for soil contamination that may be of concern at a specific site or facility are direct contact with soil contaminants through inhalation or ingestion and contaminant leaching to groundwater. These pathways are addressed below. It must be emphasized that all applicable exposure or migration pathways must be assessed at each site and the remedial approach must address each applicable pathway.

Protection from Direct Contact With Soil Contaminants - A soil performance standard to protect human health from direct contact would typically involve capping the contaminated soil with an appropriate barrier and ensuring that the barrier is maintained until the direct contact threat no longer exists (i.e., generic or site specific residual contaminant level soil standards are met). Impermeable barriers may consist of compacted clay, geomembranes, asphalt or concrete roadways and parking lots, building foundations, etc. If the contaminants are not likely to leach from the soil (e.g., PCBs), permeable barriers may be acceptable for limiting direct contact exposure. Permeable barriers such as three (3) feet of soil and permeable geotextile liners may be used, where appropriate. A direct contact performance standard will generally require long term maintenance to protect a barrier cap from cracking, erosion, freeze/thaw damage, animal damage, and other damage that may compromise the effectiveness of the barrier. Barrier caps will require a regular (at least annual) inspection and maintenance program, including the regular repair and/or replacement of any cracked or deteriorated areas. Responsible parties and their consultants must include, as part of their evaluation of remedies that rely on such barriers, a discussion of how necessary inspection and maintenance will be assured (otherwise, they can not assume that the barrier will continue to be effective).

To ensure that future owners/users of the site or facility are aware of the soil performance standard and the maintenance requirements, a deed restriction may be required. Generally, a deed restriction should be required if maintenance is necessary for an extended period of time. If a deed restriction is necessary, it must be recorded at the Register of Deeds office before the Department can issue a close-out letter under s. NR 726.05(8)(a), Wis. Adm. Code. In accordance with s. NR 722.09(5), Wis. Adm. Code, institutional controls (such as deed restrictions) may not be selected as the sole remedial action at a site or facility unless recycling, treatment or engineering controls are not technically or economically feasible.

Direct contact with contaminated soils at depth is also possible if subsurface excavation of the contaminated soil occurs. Therefore, even if surface soils are not contaminated, a performance standard must be established to limit direct contact exposure to subsurface contamination. A deed restriction may be required to prohibit excavation or to ensure that precautions are taken (e.g., use of personal protective equipment) if excavation does take place. A deed restriction should generally be required if a significant direct contact risk will remain for many years.

5. The United States Army Corps of Engineers (USACE) defines engineering controls ("Technical Guidelines for Hazardous and Toxic Waste Treatment and Cleanup Activities", April 1994) as:

CONTROL AND CONTAINMENT TECHNOLOGIES

Definition. Control and containment technologies are those remedial systems that are used primarily for management of contaminants onsite and to prevent excursions to the air or ground water.

Applicability. Control and containment remedial techniques are usually undertaken where the volume of waste or hazard associated with the waste makes it impractical or impossible to dispose of the contamination offsite to a secure landfill site or to treat the waste or contaminated material onsite. In some cases, portions of waste materials have been removed, but the residual contamination in soil and ground water must be contained onsite. Remedial techniques generally are used for onsite containment with processes such as flushing of an aquifer or natural biological degradation accounting for the actual destruction of contaminants. Site control and containment remedial techniques are often implemented along with treatment systems to minimize the volume of material requiring treatment. For example, if leachate seeps from the site it must be treated, and control of run-on and percolation through the site can reduce the volume of water that must be collected and treated.

ATTACHMENT B

References

REFERENCES

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