FINAL REPORT

CATTLE DIP VAT ASSESSMENT PROGRAM

A SUMMARY REPORT

Prepared for
Florida Department of Environmental Protection
2600 Blair Stone Road
Tallahassee, Florida 32399-2400

January 1995

Woodward-Clyde

Woodward-Clyde Consultants
3676 Hartsfield Road
Tallahassee, Florida 32303

Woodward-Clyde Consultants

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February 6, 1995

Mr. Bill Martin, P.G.
Manager
Site Investigation Section
Florida Department of Environmental Protection
2600 Blair Stone Road
Tallahassee, Florida 32399-2400

RE: Final Summary Report: Cattle Dip Vat Assessment Program

Dear Bill:

Enclosed are seventy copies of the referenced report. Also included are one unbound original with color figures and one unbound original with black and white figures. This report provides a summary of the cattle dip vat assessment program conducted to date. We appreciate the opportunity to assist you with this project.

Sincerely,

Philip J. Ciaravella
Project Manager

Jeffry R. Wagner, P.G.
Consulting Hydrogeologist

PJC/JRW/bmg
Enclosure

cc: Michelle Dean, P.G.
Marvin Collins, Ph.D.
Gary M. Wantland, P.E.
Tom Kwader, Ph.D., P.G.

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EXECUTIVE SUMMARY

In an attempt to address questions raised by the Legislature, the Florida Department of Environmental Protection (FDEP) initiated a cattle dipping vat site assessment program in July 1994. This program is an effort to gather more information about cattle dip vat sites and to assess the potential human and environmental risks imposed by these sites. Twelve sites were investigated to determine if the former cattle dipping practices had impacted soils in the vicinity of the selected vats and to assess the actual or potential impacts to the ground water and/or nearby surface waters.

From 1906 through 1961, the federal government required the treatment of cattle with pesticides to eradicate the cattle fever tick. Cattle could not be shipped out of state unless they had been dipped in an arsenical dip and declared tick free. More than 3500 cattle dip vats were constructed by governmental entities (federal, state, and local) to control the disease. The primary problem associated with the cattle dip vats is that many sites that used to be in rural areas are now developed. Investigations of some vat sites have indicated the presence of soil and ground water contamination, and issues of environmental impacts due to contamination have been raised.

The assessments for the cattle dip vat program were separated into two phases. The Phase I assessments were intended to determine if soil and ground water contamination were present at a particular site and focused on the highest probable area for contaminants, i.e. the immediate area of the dip vat. The primary focus of the Phase II assessments was to better define the horizontal and vertical extent of soil and ground water contamination so that estimates could be made of the volume of soil or area of ground water requiring remediation. This information will be used to develop interim risk management strategies and cost estimates for remediating other contaminated cattle dip sites.

The results of the investigation indicate that soil and ground water contamination by arsenic is the most common problem associated with dip vats. Land use categories and acceptable levels to determine the relative risk and priority for remediating cattle dip vat sites were developed by FDEP as part of this program and are presented as Section 5.0 of this report[1]. The acceptable levels were based on the expected degree of contact with soil and water at the site, given current and expected land use. An acceptable concentration for a cattle dip vat soil contaminant of concern in a remote, relatively inaccessible site with little human contact may be very different from an acceptable soil contaminant for a playground. The categories developed by the FDEP range from the highest risk category of "Residential" (involves potential contact on a full-time or nearly full-time basis) to "Restricted II" (involving infrequent site contact). Intermediate categories are "Commercial/Industrial" and "Restricted I." Of the 12 sites investigated presently, two sites are considered to be Residential, one to be Commercial/Industrial, two to be Restricted I and seven to be Restricted II.

Phase I investigation costs range from $14,000 to $36,000. The Phase II investigations range in cost from $24,000 to $190,000. Analytical costs are the single largest cost item of the assessments and may represent over 80% of the cost of an assessment. The costs of remediating the dip vats can range from $40,000 to $450,000 depending on the levels of contaminants and whether or not it is necessary to pump and treat ground water. Interim risk management strategies may be used to reduce the risk to acceptable levels until cleanup is needed.

Based on the method developed to prioritize clean-up of the cattle dip vat sites, this program has identified 11 out of 12 sites which have exceeded the appropriate acceptable soil concentration and will require consideration for soil remediation. The order in which these identified sites will be addressed is determined by the total risk score; therefore, the order to complete assessment and soil remedial action is as follows:

- Okaloosa-Walton Community College (Residential)
- Lake Arbuckle (Restricted II)
- Jay Livestock Market (Commercial/Industrial)
- Tosohatchee State Reserve (Restricted II)
- Myakka River State Park (Restricted II)
- Dudley Farm Historic Site (Residential)

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[1]Section 5.0 of this report was prepared by Ligia Mora-Applegate (FDEP) and Dr. Stephen Roberts (University of Florida).

- Lake Kissimmee State Park (Restricted I)
- Cecil Webb Wildlife Management Area (Restricted II)
- St. Marks (Restricted I)
- Blackwater River State Forest (Restricted II)
- Walker Ranch (Restricted II)
- Paynes Prairie (Restricted II)

Although the Walker Ranch site is considered a Restricted II site, the concentrations of arsenic detected in the soil samples collected at this site were below the acceptable level for arsenic in soils at Restricted II sites; however, the soils may need their leachate potential evaluated by TCLP. Additionally, ground water contamination by arsenic was detected at the site and may require ground water remediation.

The Walker Ranch site was the only extensive ground water contaminant plume identified during this study. Exceedances for arsenic, DDE, DDD, toxaphene, and benzene in ground water each occurred one time at different sites. The MCL for arsenic was exceeded at 5 sites. Extensive ground water contamination does not appear to be associated with the other 11 sites.

1.0 INTRODUCTION

In September 1993, the Florida Department of Environmental Protection (FDEP) suspended enforcement activities related to cattle dip vat sites. In general, this action was the result of liability issues associated with these sites.

Consequently, during the 1994 Florida Legislative Session, House Bill 1959 and Senate Bill 2550 were introduced to provide funding to inventory, prioritize, and develop procedures to assess and remediate cattle dip vat sites in Florida. These bills also provided release from liability for certain property owners and provided for rulemaking related to the cattle dip vat sites. However, these bills were not passed as part of the 1994 Legislation.

In an attempt to address questions raised by the Legislature, FDEP initiated an Assessment Program in July 1994. The findings of the cattle dip vats assessment will be submitted and reviewed by a 1995 Legislative Subcommittee.

The Cattle Dip Vat Assessment Program is an effort to gather more information about cattle dip vat sites and to assess the potential human and environmental risk imposed by these sites. The objective of the program was to identify 12 to 15 sites that would represent the various hydrogeologic settings existing statewide. The identified sites would be investigated to determine if the former cattle dipping practices had impacted soils in the vicinity of the selected vats and assess the actual or potential impacts to the ground water or nearby surface waters. Primarily because of liability issues, the cattle dip vat program was restricted to assessing cattle dip vats located on state-owned lands. A second objective was related to risk, i.e., if a site has been impacted, what are the potential risks to public health and the likelihood of contamination of ground water supplies? Methods for assessing these risks and prioritizing cattle dip vat sites were developed by FDEP and University of Florida as part of this program and are presented in section 5.0 of this report.

In July 1994, Woodward-Clyde Consultants was retained by FDEP to carry out the assessment of 12 sites on state properties. The cattle dip vat sites assessed for the FDEP program included sites in Santa Rosa, Walton, Wakulla, Alachua, Orange, Osceola, Manatee, Polk, and Charlotte Counties.

Because of the limiting factor of selecting only sites on state-owned property, it was difficult to achieve the objective of assessing sites for each hydrologic setting within Florida. The sites selected may not completely represent all of the vat contaminants, conditions, or environments; however, they are typical of the many settings found in the state and are representative of potential pathways and impacts to the ground water and surface water resources. Figure 1 shows the distribution and associated hydrogeologic settings for the study sites.

1.1 HISTORY OF CATTLE DIPPING PRACTICES IN FLORIDA

In the early 1900s an infectious disease seriously impacted the cattle industry in 15 southern and southwestern states. Cattle tick fever is a disease which causes parasites known as piroplasms to develop in the blood of cattle. The parasitic activity can eventually cause death or permanent physiological damage to the host animal. Ticks were the common carriers of this disease. Recognition of this fact led to the creation of the tick eradication program.

From 1906 through 1961, the federal government required the treatment of cattle with pesticides to eradicate the cattle fever tick. Cattle could not be shipped out of the state unless they had been dipped in an arsenical dip and declared tick free. To eradicate the ticks on infested pastures, the cattle would remain in the pasture and would be disinfected at regular intervals, usually every 2 weeks, by dipping the cattle.

More than 3500 cattle dip vats were constructed by governmental entities (federal, state and local) to control the disease. The vats were constructed according to USDA plans and specifications. Commonly these vats were 25 - 30 feet (ft) in length and 2.5 - 3.5 ft wide. The narrower vats usually indicate construction in the early 1900s, while the wider ones were constructed in the latter period of eradication (1930 - 1940s). Generally, the smaller vats were used for the smaller scrub cattle and the wider vats for larger hybrid breeds of cattle. The common practice was to run the cattle through the vat. One end of the vat has a drop-off where the cattle entered and could not back up, while the other end has steps

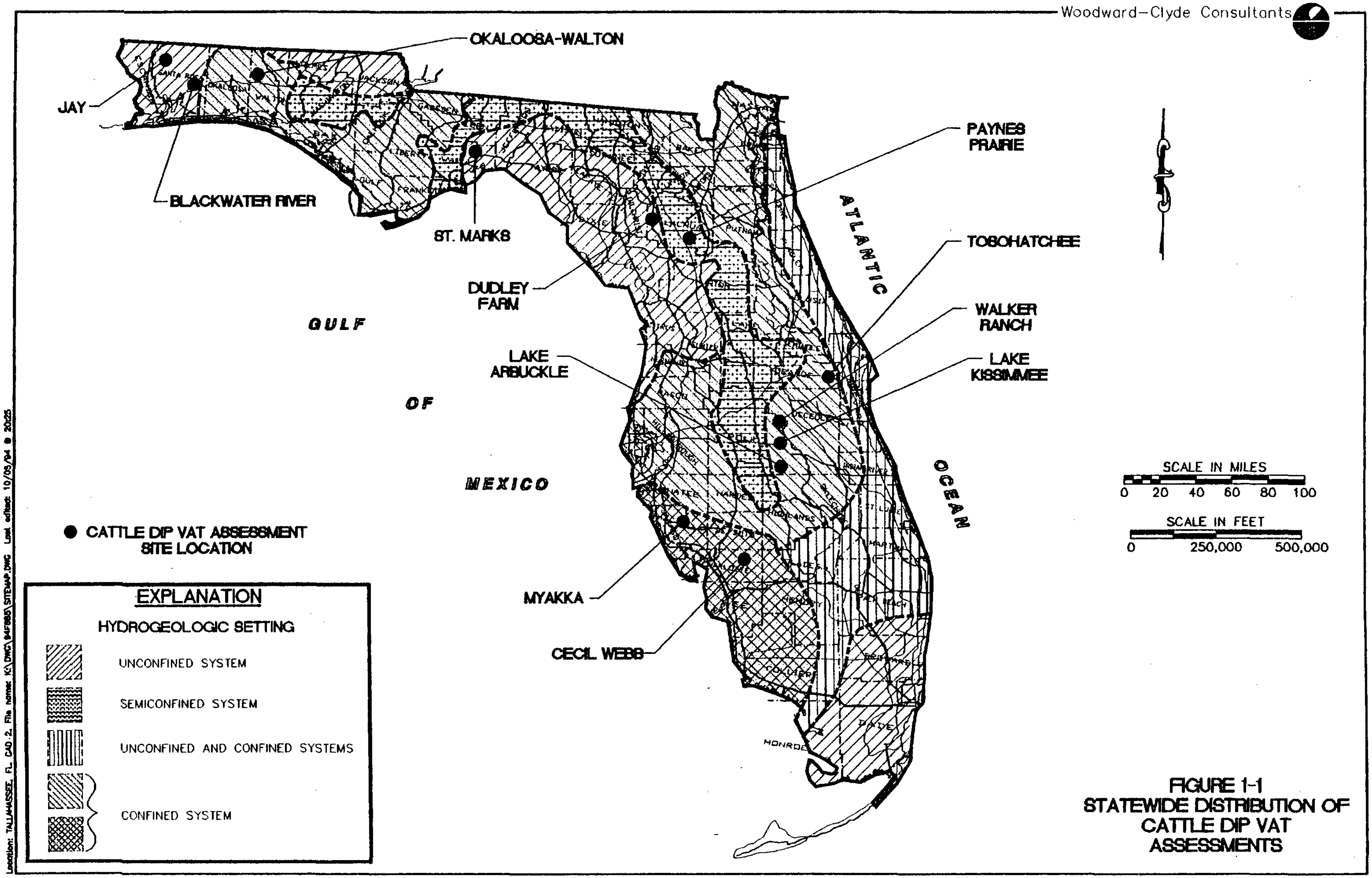


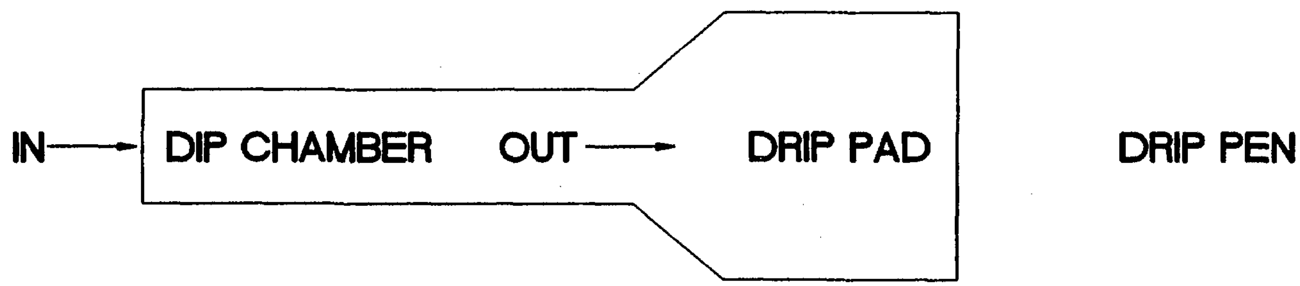
FIGURE 1-1
STATEWIDE DISTRIBUTION OF CATTLE DIP VAT ASSESSMENTS

where the cattle could climb out. The cattle were dunked into the arsenical/pesticide solutions by using sticks to submerge the cattle so that the head and ears were dipped. Therefore, the vats generally are 4 - 5 ft in depth and can range from 3.5 - 6.5 ft. As the cattle exited the vat, a drip pad on the order of 12 ft by 15 ft caught the drippings. A typical cattle dip vat is shown in Figure 2. Some of the drip pads were constructed with curbs which allowed the drippings to be caught and funneled back to the vat. From the drip pad the cattle entered the drip pen, which is a fenced area about 50 ft x 50 ft. In this area, the cattle were inspected. Ticks discovered were sometimes painted on the cattle or removed. The cattle could be moved for shipping or turned back to pastures from this pen.

The cattle dipping solution used between 1906 and about 1940 consisted usually of a mixture of about 24 pounds of sodium carbonate, 8 pounds of arsenic trioxide, and 1 gallon of pine tar, mixed with water. The water source varied from supply wells in the immediate vicinity of the vat to barrels of water transported to the site. Mixtures used after about 1940 included arsenic with DDT or HCH (a.k.a. BHC) or chlorinated hydrocarbons. The approved USDA dipping solutions consisted of an arsenical solution containing 0.18% arsenic in an appropriate carrier. Carriers typically included water, fuel oil, kerosene, or other oils or oily material. The State of Florida allowed the use of DDT and chlordane in addition to or in conjunction with the arsenical materials.

The last widespread outbreak of the disease in cattle is reported to have been in August 1939. There were several small outbreaks. During the latter part of the program some counties (Palm Beach, Martin, Indian River, and Hillsborough Counties) were regulated instead of being quarantined. The last outbreak was in 1960, however, the State of Florida maintained an active dipping program until October 1961. The tropical variety of the fever tick found in Central and South Florida was more difficult to eradicate because of its ability to use deer as a host. This led to the elimination of numerous deer in South Florida during the late 1930s. Many of the vats have not been used for over 50 years. The secondary uses of the vats are not as well documented, but uses as mixing areas for pesticides and swimming holes for children have been reported.

The primary problem associated with the cattle dip vats is that many sites that used to be in rural cattle pastures are now in areas of development. Issues of public health and environmental impacts due to contamination of soil and ground water have been raised.



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TYPICAL CATTLE DIP VAT

FIGURE 2

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Investigations of some of the vat sites have indicated soil and ground water contamination present. Because of the costs and liabilities associated with the vats, many property owners are now reluctant to investigate these sites or even identify vat locations.

2.0
ASSESSMENT PROGRAM

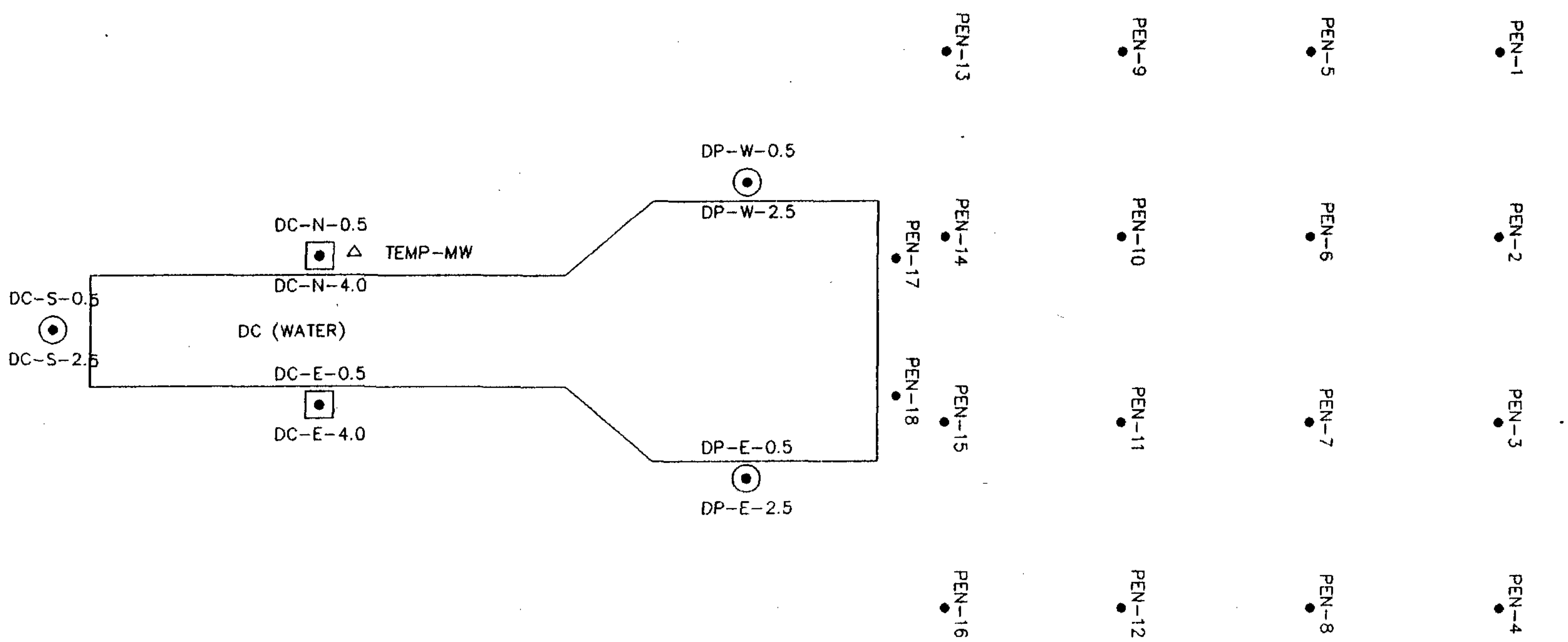
2.1 GENERAL SCOPE OF WORK

Most of the cattle dip vat locations selected for this assessment have dip vats intact, and in some cases, pens and fencing are still present. Others have major portions of the concrete vat or drip pad broken and collapsed; however, the vat and drip pads are still identifiable. For other sites, the vat has been previously removed or paved over. These conditions present today at these study sites are probably typical of many of the vat sites existing throughout the State of Florida.

In order to evaluate the impact of the cattle dip vats to the environment, assessments were performed at the selected sites focusing on the soil and ground water media. Where possible, previous information existing for a site was used to guide the scope of work developed during the assessment. However, only two of the 12 sites selected had existing information. In general, the scope of work completed for the Phase I sites followed guidance developed by FDEP, which was modified slightly based on conditions encountered in the field.

The assessments for the cattle dip vat program were separated into two phases. The Phase I assessments focused on the immediate cattle dip vat area, the drip pad area and the drip pen area. The typical layout for the Phase I assessments is shown in Figure 3. For the Phase II assessments, the primary focus was to better define the horizontal and vertical extent of known contamination so that estimates could be made of the volume of soil or area of ground water requiring remediation. These estimates could then be used for developing strategies for assessing and remediating other contaminated cattle dip vat sites.

The identified sites where assessments were conducted include the Blackwater River State Park (Santa Rosa County); Jay Livestock Market in Jay (Santa Rosa County); Okaloosa-Walton Community College in DeFuniak Springs (Walton County); St. Marks Wildlife



LEGEND

TEMP-MW = TEMPORARY MONITORING WELL

DP = DRIP PAD

DC = DRIP CHAMBER

PEN = DRIP PEN

E = DIRECTION

2.5 = DEPTH OF SAMPLE

● = SOIL SAMPLE LOCATION

△ = TEMPORARY MONITORING WELL

○ = SOIL SAMPLE COLLECTED AT 0.5 FT. BLS AND 2.5 FT. BLS

□ = SOIL SAMPLE COLLECTED AT 0.5 FT. BLS AND 4.0 FT. BLS

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TYPICAL PHASE I SAMPLING PLAN

FIGURE 3

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Refuge (Wakulla County); Dudley Farm Historic Site and Paynes Prairie Reserve, both near Gainesville (Alachua County); Lake Kissimmee State Park near Lake Wales (Polk County); Lake Arbuckle State Forest near Frostproof (Polk County); Tosohatchee State Reserve (Orange County); Walker Ranch near Kissimmee (Osceola County); Myakka River State Park near Sarasota (Manatee County); and Cecil Webb Wildlife Management Area (Charlotte County). A total of 10 sites were assessed as a Phase I investigation . Phase II assessments occurred at 5 sites. These sites included Walker Ranch, Okaloosa-Walton Community College, Lake Arbuckle State Forest, Dudley Farm, and Tosohatchee State Reserve.

2.2 PHASE I APPROACH

The objective of each Phase I assessment was to determine if contaminants existed at the cattle dip vat site. The approach for investigating the site was to focus on the most likely areas for contaminants to exist, i.e. the immediate vicinity of the vat and the area immediately adjacent to the drip pad area. The vat area is considered to be the most likely area for spills from the vat to occur and also the most likely area for sludge from the vat to be drained or disposed. The drip pad area is the area where the cattle moved to after exiting the vat. Drippings from the cattle would have been the greatest and most concentrated in this area. As the cattle moved away from the pad, the dripping would have become more dispersed.

The field work performed to assess each location consisted of collecting soil samples; water samples from the vat, if present; ground water samples, if water table existed less than 10 ft below land surface; samples from surface water sources, if present in the immediate area; and ground water samples from nearby water supply wells.

2.2.1 Soil Sampling

The same general soil sampling plan was used at each Phase I site. A general soil sampling plan is presented as Figure 3. All samples were collected with a stainless steel hand auger and homogenized in a stainless steel bowl. Approximately 31 soil samples were collected at each site. A background sample was also collected at each location to establish the background concentrations of each analyte. The sampling conducted at each site is presented below in detail.

1. **Dip Chamber Area:** Soil samples were collected from three sides of the Dip Chamber. Two samples were collected from each location: 0-0.5 ft below land surface (bls) and 4 ft bls (approximately the bottom of the chamber). If soil/sediment was present in the dip chamber, a sample was also collected.

2. **Drip Pad Area:** Soil samples were collected from both sides of the Drip Pad. The samples were collected from 0 - 0.5 ft bls and 2 - 2.5 ft bls at each location.

3. **Drip Pen Area:** 18 samples were collected from the Drip Pen area. The samples were collected from the edge of the drip pad and within the assumed pen area. For those sites where fencing does not still exist, it was assumed each drip pen was 40 ft x 40 ft. The samples were collected from a grid based on 10-ft centers. Each sample was collected from 0 -1 ft bls.

4. **Background Soil Sample:** A background soil sample was collected from each site. The samples were collected at least 500 ft from the cattle dip vat. The background samples were collected from 0 - 1 ft bls.

2.2.2 Water Samples

A temporary monitoring well was installed on the topographically downgradient side of each cattle dip vat to a depth of 12 ft bls. Each temporary well was installed with a hand auger, constructed of 2-inch diameter PVC casing and screen, and developed. Samples were collected from these wells and from other existing wells, if present, in the vicinity of each cattle dip vat. For those sites where the vat contained water, water samples were collected.

2.2.3 Laboratory Analysis

The soil and water samples collected during the Phase I assessments were analyzed for: organochlorine pesticides (Method 8080), semivolatile organics (Method 8270), volatile organics (Method 8260), and selected metals (arsenic, lead, chromium, cadmium, iron, and copper). All analyses were conducted by Savannah Laboratories and Environmental Services, Inc. in Tallahassee, Florida. Based on the results of the first six Phase I assessments, the analyte list was modified to include only organochlorine pesticides (Method 8080) and arsenic during the subsequent Phase I assessments. Although other organics are potentially present at the cattle dip vat sites, they do not appear to be typical cattle dip vat site contaminants of concern. The organochlorine pesticides and arsenic compounds are by far the most likely to influence remediation at these sites.

2.3 PHASE II APPROACH

Phase II investigations were conducted at five sites to evaluate the extent of soil and ground water contamination at sites characterized by different types of contamination and different hydrogeologic settings. The Phase II assessments consisted of expanded soil sampling programs and, in some cases, the installation of monitoring wells. Soil samples were collected from expanded grids established at each site and from greater depths (than the Phase I assessments) to evaluate the vertical extent of contaminated soil.

2.4 ESTIMATED ASSESSMENT COSTS

The estimated costs of the Phase I and Phase II assessments are based on the actual costs of the assessments performed to date. These costs were used to develop a range of costs for typical Phase I and Phase II assessments.

2.4.1 Phase I

The average costs to implement the Phase I scope of work developed by FDEP are about $36,000. A breakdown of these costs is provided below and summarized in Figure 4.

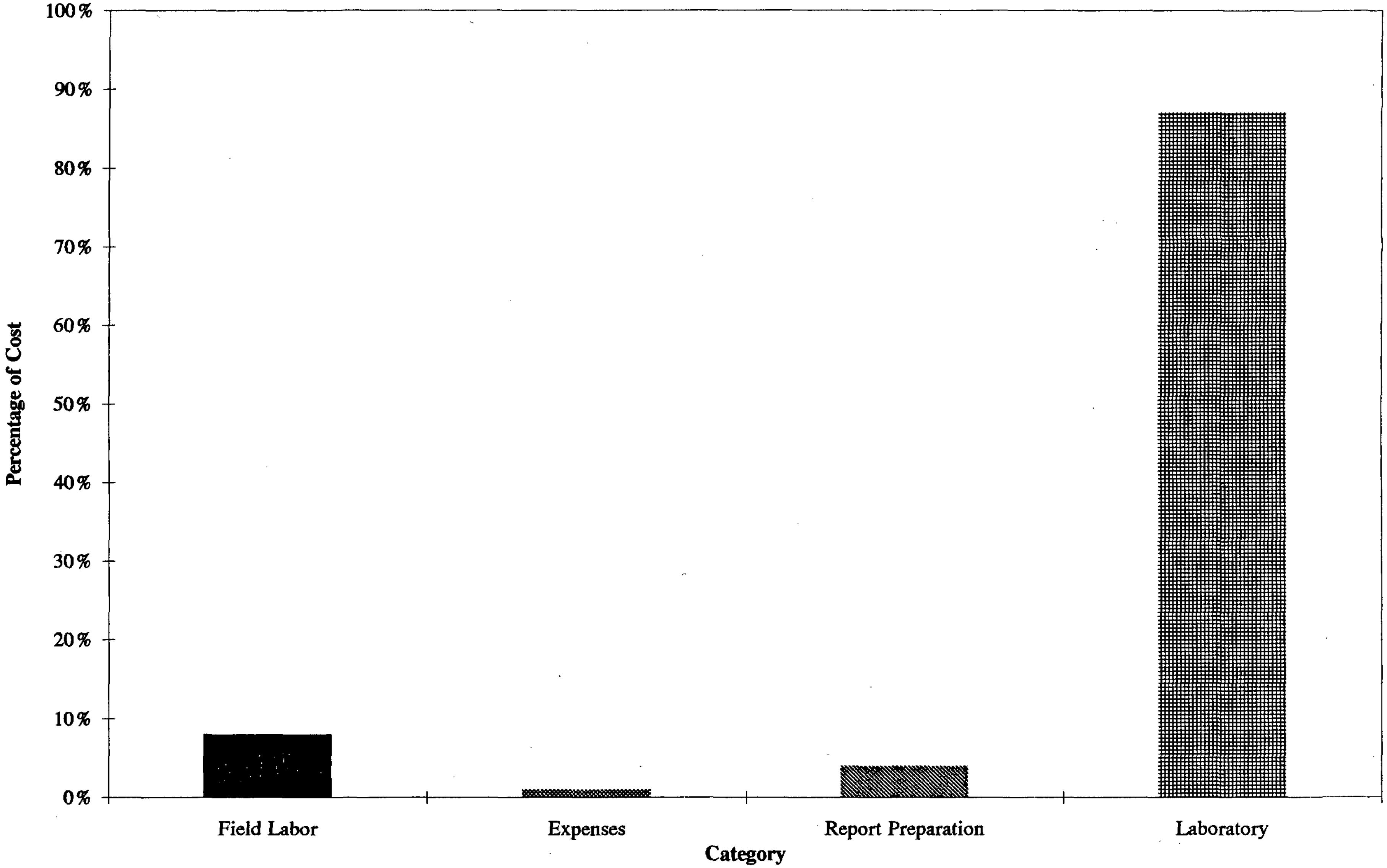
BREAKDOWN OF PHASE I COSTS			
Category	No. of Hours	Average Labor Rate Cost[2] ($/hour)	Total
Field	42[1]	65	2730
Report	20	70	1400
Expenses			450
Laboratory			31,365
			Total: $35,945

1 The field hours are based on two people in the field and include 20 hours of travel time

2 Fully burdened average labor rate

The largest single cost item for the Phase I assessments was the laboratory costs. The laboratory costs represent 87% of the cost of a Phase I assessment. The laboratory costs presented include the cost of analyzing each sample for the following parameters:

Figure 4
Cost Breakdown of Phase I CDV Assessments
Total Average Cost = $36,000



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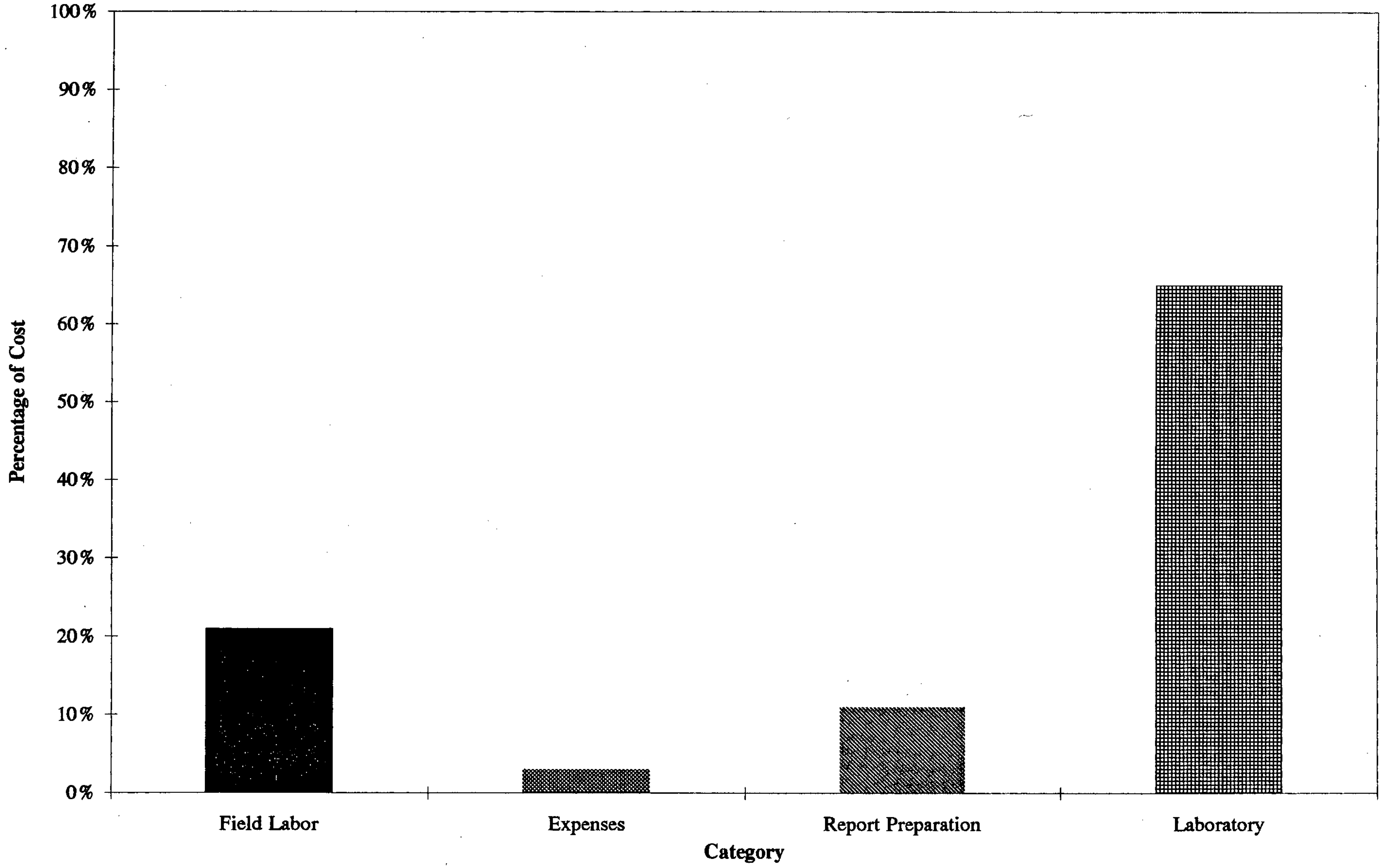
LABORATORY COSTS				
Parameter	Cost ($)		Number of Samples	
	Soil	Water	Soil	Water
Volatile Organics	250	230	31	2
Semivolatiles	460	430	31	2
Pesticides	200	175	31	2
Arsenic	45	45	31	2
Total	955	880	31	2

The two most expensive parameter groups in the initial Phase I assessments were the semivolatile and volatile organic compounds. The cost of analyzing 31 soil samples from each site for these compounds is 70% ($22,010) of the total laboratory costs for each Phase I assessment. The data collected during the 10 Phase I assessments indicated semivolatile and volatile organic compounds were present in less than 3% of the soil samples collected. Deleting these parameters from the analyte list for the soil samples reduced the average total cost of a Phase I assessment by $14,000 to $22,010. A breakdown of the typical modified Phase I costs is presented as Figure 5. However, during the initial assessment of any CDV site, 10-15% of the samples should have analytical methods 8260 and 8270 to determine the absence of these compounds before deleting them from the parameter list.

2.4.2 Phase II

The costs of the Phase II assessments vary considerably more than the Phase I assessments. The scope and costs of the Phase II assessments are dependent on the findings of the Phase I assessment or other previous investigations. The range of costs for proposed and implemented Phase II investigations during this program was $24,000 to $190,000. The costs of the Phase II investigations are dependent on the magnitude of the sampling, the laboratory costs and the cost of monitoring well construction. The lower end Phase II costs were for a site where only soil samples were analyzed for arsenic and no monitoring wells

Figure 5
Cost Breakdown of Modified Phase I Assessments
Total Average Cost = $14,000



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were constructed. The high end Phase II costs were for an investigation which included soil sampling and monitoring well construction. In addition, samples collected at these types of sites were analyzed for volatile and semivolatile organic compounds. A breakdown of the Phase II costs is provided on Table 1. This table illustrates the range of costs to be expected for Phase II investigations and the factors influencing these costs. A description of example types of investigations for each cost is presented below:

Investigation A: Collection of soil samples for arsenic analysis only. Approximately 150 soil samples were collected from depths up to 15 ft bls. No water samples were collected.

Investigation B: Collection of 27 soil samples, and 7 ground water samples. The soil and ground water samples were analyzed for organochlorine pesticides and arsenic. Ten temporary and 5 permanent monitoring wells were installed.

Investigation C: Collection of 45 soil samples and 4 ground water samples. All of the soil samples were analyzed for organochlorine pesticides and arsenic. Eight of the soil samples were also analyzed for volatile and semivolatile compounds. One monitoring well was installed and an existing supply well was sampled.

Investigation D: Collection of 36 soil samples and 17 ground water samples. All of the water samples were analyzed for arsenic. Nineteen of the soil samples and 8 of the water samples were analyzed for semivolatiles, volatiles, and organochlorine pesticides. Ten temporary monitoring wells and 5 permanent monitoring well were installed.

Investigation E: Collection of 131 soil samples and 5 ground water samples. Soil samples were analyzed for arsenic and organochlorine pesticides. Water samples were also analyzed for volatile organic compounds. Ten temporary monitoring wells were installed by hand.

TABLE 1

SUMMARY OF CATTLE DIP VAT PHASE II INVESTIGATION COSTS

Example Type	Field Work Labor ($65/Hour)[1]		Subcontractor Costs		Expenses (Equipment/ per diem) ($)	Report ($70/Hour)[1]		Total Cost
	Hours	Cost ($)	Driller ($)	Lab ($)		Hours	Costs	
Investigation A	140	9100	0	6700	4200	58	4060	24,060
Investigation B	116	7540	6300	7800	1500	84	5880	29,020
Investigation C	140	9100	2500	19,400	4200	148	10,360	45,560
Investigation D	138	8970	7000	25,000	2000	124	8680	51,650
Investigation E	200	13,000	0	34,000	4000	84	5880	56,880
Investigation F	590	38,350	20,000	80,000	20,000	365	25,550	183,900

1 Average Fully Burdened Labor Rate

Investigation F: Collection of 101 soil samples. All of the soil samples were analyzed for arsenic and organochlorine pesticides. Twenty four soil samples were also analyzed for volatile and semivolatile organic compounds. In addition, approximately 20 samples were to be prepared for analysis of organochlorine pesticides, if necessary. Thirty ground water samples were also collected and analyzed for volatile and semivolatile organic compounds, organochlorine pesticides, and filtered and unfiltered metals. Twelve monitoring wells were installed.

3.0 ASSESSMENT FINDINGS

3.1 PHASE I

Approximately 310 soil samples and 18 water samples were collected during the Phase I assessments. Water samples collected during the Phase I assessments were collected from temporary monitoring wells installed at each dip vat (if ground water was present). Six water samples were collected from inside the dip vat chamber where water was present. Supply wells were also sampled, if present within 500 ft of the dip vat. No surface water samples were collected because surface water bodies were not found within 500 ft of the dip vats. The results of the Phase I assessments indicate that arsenic was the cattle dip vat analyte which most commonly exceeded the Cattle Dip Vat soil screening concentrations (CDV SSC). The CDV SSCs are presented in Table 2. The Primary Drinking Water Standard for arsenic was also exceeded more often than any other drinking water standard or minimum criteria. In general, the Phase I results indicate the distribution of soil and ground water contamination is not extensive, with the highest concentrations generally occurring in proximity to the cattle dip vat area. The results of the Phase I investigations are described below in greater detail.

Soil

The results of the soil sample analyses were compared to the CDV SSCs established by the FDEP to assist in the planning of Phase I and Phase II assessments. During the preparation of this report, FDEP developed acceptable soil concentrations (ASCs) to assist in evaluating specific land use scenarios. These values are presented in Table 3. The methods used to establish these concentrations are described in detail in Section 5.0 of this report. The first step in evaluating the data collected was to determine the land use category for each site. The land use category of each of the 12 sites evaluated is presented below:

TABLE 2

SOIL SCREENING CONCENTRATIONS*

Contaminant	Soil[1]	Groundwater[2]
Arsenic	0.7	.05
DDT	3.0	.0001
DDD	3.0	.0001
DDE	3.0	.0001
Toxaphene	1.1	.003
Benzo [a] Pyrene	0.16	.002
Benzo [K] fluoranthene	1.60	
Dibenzo {A,H] Anthracene	0.16	

1: milligrams per kilogram (PPM)
2: milligrams per liter (PPM)

* Levels were established per Doug Jones' memo dated 9/22/93.

TABLE 3

ACCEPTABLE SOIL CONCENTRATIONS FOR FLORIDA CATTLE DIP SITES

	Based on Direct Contact[a]				Based on Leaching to:[a]	
Chemical	**Residential**	**Commercial/ Industrial**	**Restricted I**	**Restricted II**	**Groundwater**	**Surface Water**
Arsenic	0.7	3	5	36	[b]	[b]
Chlordane	0.8	3	5	38	2	0.005* (0.0006)
DDT	3	12	20	150	0.5	0.005
DDE	3	11	20	140	0.2	[c]
DDD	5	17	30	210	0.2	[c]
alpha HCH	0.2	0.5	1	8	0.002	[c]
beta HCH	0.6	2	4	29	0.005	0.002
gamma HCH	0.8	3	5	38	0.006	0.002
Toxaphene	1	3	6	44	0.04	0.017* (0.000002)

[a] all soil concentrations in mg/kg
[b] leachability of this metal is assessed through TCLP (Toxicity Characteristic Leaching Procedure)
[c] no surface water standard is available for this chemical
* based on MDL (Method Detection Limit), MDL values provided by Silky Labie, FDEP
( ) toxicity-based value if lower than MDL

<u>Residential</u>
Okaloosa-Walton Community College
Dudley Farm

<u>Commerical\Industrial</u>
Jay Livestock Market

<u>Restricted I</u>
Lake Kissimmee State Park
St. Marks Wildlife Refuge

<u>Restricted II</u>
Myakka River State Park
Tosahatchee State Reserve
Cecil Webb Wildlife Management Area
Paynes Prairie
Lake Arbuckle State Forest
Walker Ranch
Blackwater State Forest

The Okaloosa-Walton Community College and Dudley Farm sites are considered to fall under the residential classification based on the proximity of the site to nearby residences. Because of the isolated nature of the sites investigated, most of the sites fall under Restricted II category. The findings of the investigations as compared to the classification of each site are presented in Figures 6 and 7. Figure 6 summarizes the exceedances of the cattle dip vat ASCs at the sites classified as "Residential", "Commercial/Industrial" and "Restricted I." The exceedances at the sites classified as "Restricted II" are summarized on Figure 7. Figure 6 illustrates that arsenic is the analyte which most commonly exceeds its ASC at the sites classified as Residential or Commercial/Industrial. The Residential ASC for arsenic was exceeded in 87% of the soil samples collected at the Okaloosa-Walton site; the Commercial/Industrial ASC was exceeded in 63% of the samples collected at the Jay

Figure 6
Percentage of Samples Which Exceeded The Applicable Soil Screening Concentration

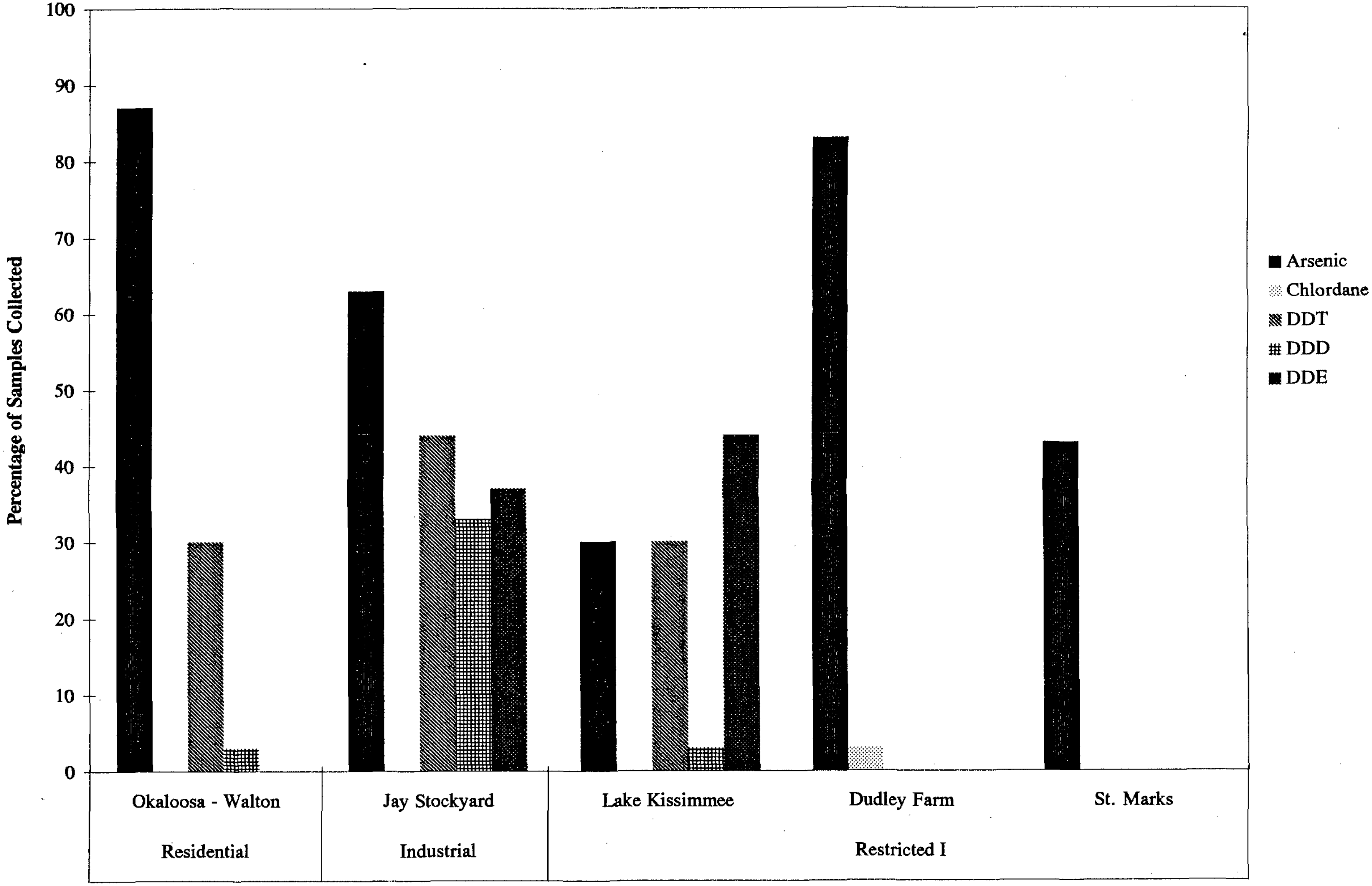

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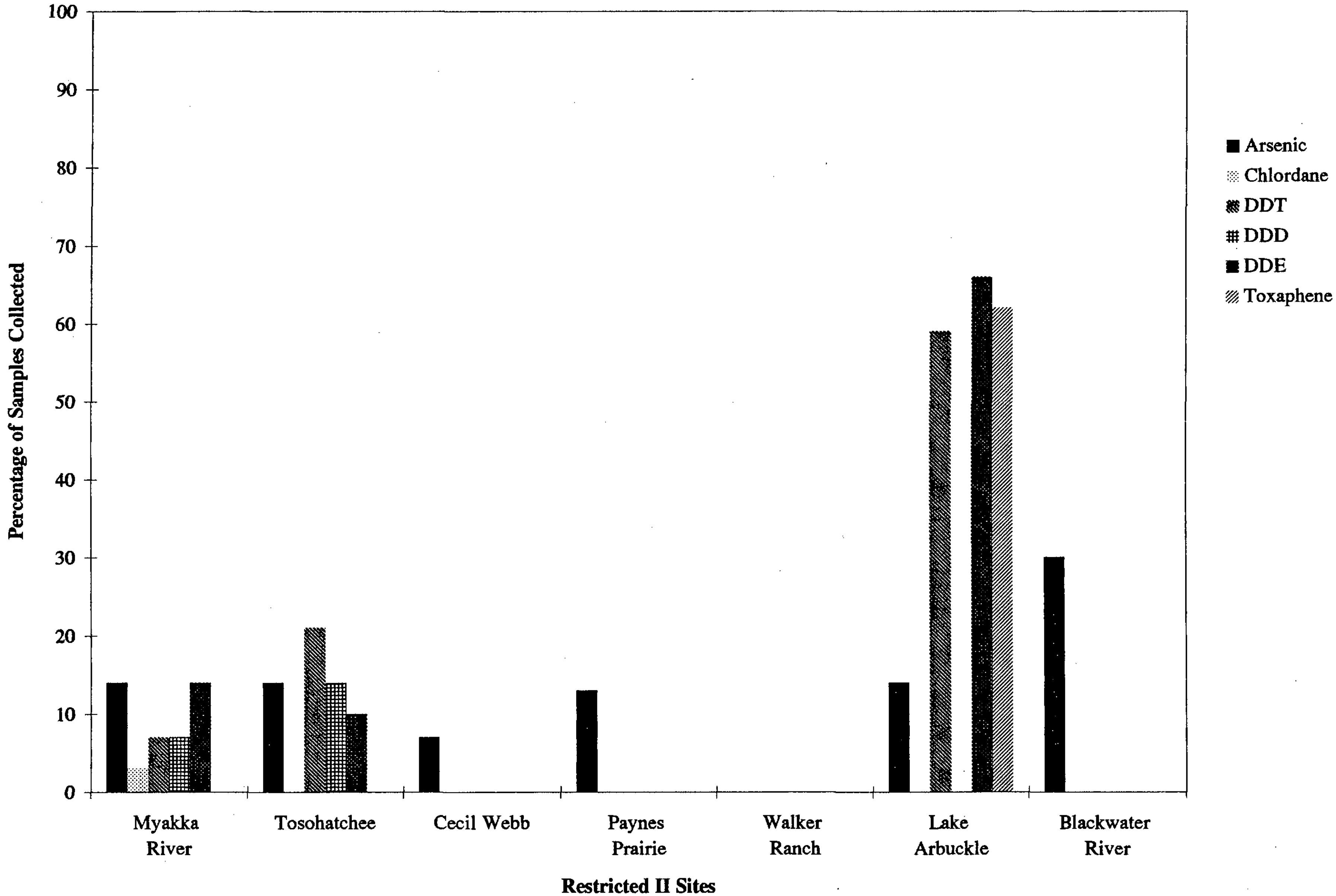
Figure 7
Percentage of Samples Which Exceeded The Applicable Soil Screening Concentration



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Livestock site. Figure 6 also illustrates DDT exceeded the ASC at 30% of the samples collected at the Residential site and 44% of the samples collected at the Commercial/Industrial sites.

Figure 7 illustrates the percentage of soil samples in which the ASCs were exceeded. This percentage generally decreases at the sites classified as Restricted II. In general, arsenic is the most common analyte which exceeded its ASCs at these sites and was the only parameter which exceeded its ASCs at 3 of the 7 sites classified as Restricted II. The ASCs for DDT, DDD, and DDE were exceeded at 4 of the 9 sites classified as Restricted I or Restricted II. The ASCs for toxaphene and chlordane were each exceeded at different Restricted I sites. The ASC for chlorodane was exceeded at one residential site.

The other potential cattle dip vat analytes detected in soil samples are summarized in Figure 8. These data indicate that the base/neutral acid extractable organic compounds and volatile organic compounds are not commonly found at the cattle dip vat sites investigated. It should be noted that the HCH isomers, dieldrin and other pesticides have the potential to exist at cattle dip vat sites as some assessments have shown.

Water

The results of the water sample analyses are summarized in Figure 9. Arsenic was the cattle dip vat analyte which most often exceeded the applicable standard. The Primary Drinking Water Standard for arsenic was exceeded in 55 percent (10 samples) of the samples collected. Of the 10 exceedances, 5 occurred in water samples collected from the dip chamber and 5 occurred in ground water samples collected from temporary wells.

DDD, DDE, and toxaphene each exceeded their applicable maximum contaminant level and minimum criteria in one ground water sample. The maximum contaminant levels for DDD and toxaphene were exceeded in the water sample collected from the temporary well at one site. DDD, DDE, DDT, and toxaphene were not detected in water samples collected from the dip chambers. Benzene was detected in ground water at one site. This indicates

Figure 8
Phase I CDV Assessments
Other Analytes Detected in Soil

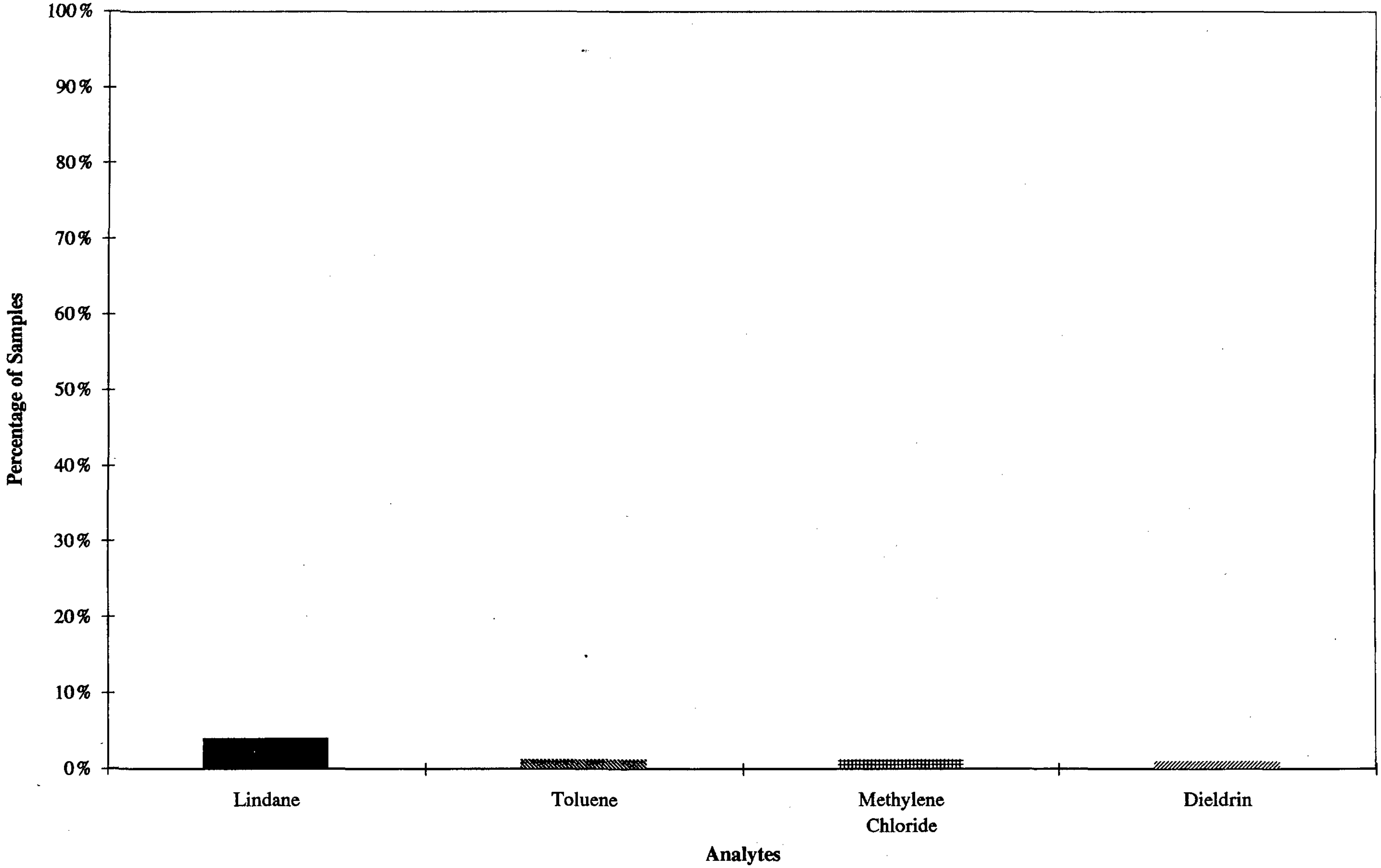

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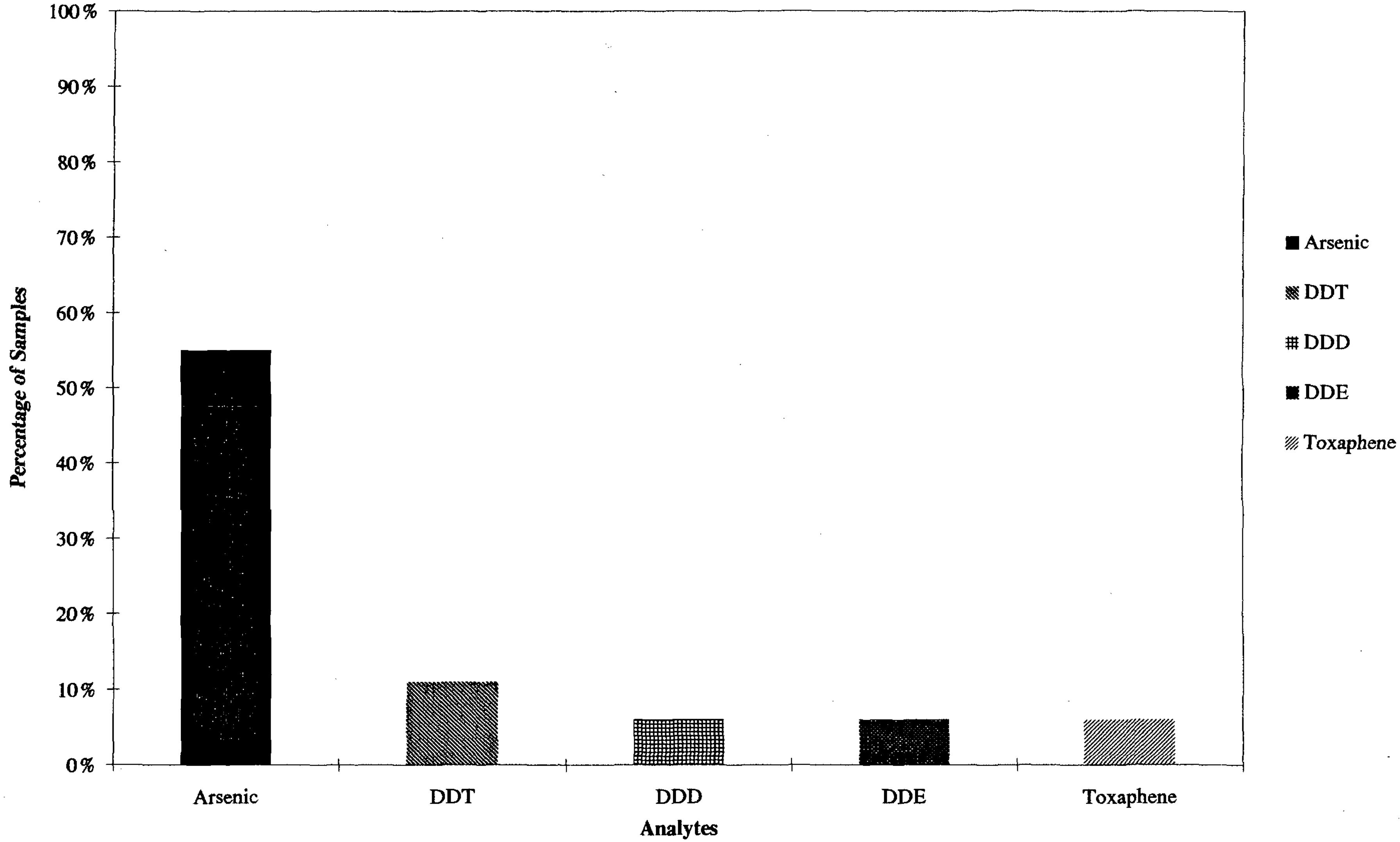
Figure 9
Phase I CDV Assessments
Summary of CDV Analyte Exceedances in Water



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contaminated soil around the cattle dip vat is a more likely source of ground water contamination than water in the dip chamber.

3.2 PHASE II

The data collected during the Phase II investigations indicate the impact of the cattle dip vats on soils is limited in areal and vertical extent, especially with respect to organochlorine pesticides. These compounds may be found in high concentrations near the dip vats, but the concentrations generally drop below the ASC within 10 to 15 ft of the dip vat. These compounds generally have a low solubility in water and are not typically found in ground water unless very high concentrations are present in the soil. DDT and toxaphene were detected in one water sample collected during the Phase II assessment conducted at the Lake Arbuckle site. This occurred in the well adjacent to the cattle dip vat. The data collected indicate the lateral extent of ground water contamination by organochlorine pesticides is not widespread at these sites.

The only extensive plume of ground water contamination was detected at the Walker Ranch. At this site, a plume of dissolved arsenic was detected in the upper surficial aquifer. This plume extended approximately 250 ft downgradient of the cattle dip vat and was approximately 100 ft wide. This plume was not detected in the lower surficial aquifer at the site, indicating the organic-rich hard pan layer at the site may be restricting the migration of dissolved arsenic into the lower surficial aquifer.

The data collected during the Phase I and Phase II investigations indicate ground water contamination by arsenic is more likely than by the organochlorine pesticides. If present, ground water contamination by arsenic is more likely to be more extensive in hydrogeologic settings characterized by sandy quartz sands (Walker Ranch) than clayey sands (Dudley Farm).

The data collected at the Phase II locations also indicate the extent of soil contamination by arsenic is likely to be more extensive than contamination by the cattle dip vat organochlorine pesticides. The concentrations of the cattle dip vat organochlorine pesticides detected were generally below the ASCs within 15 ft of the cattle dip vat. Arsenic contamination in soils is generally more extensive; concentrations above the ASCs were found up to distances of 60 ft away from the cattle dip vat. Sixty feet represents the maximum distance samples were collected from the cattle dip vats during the Phase II investigations. Exceedances of the ASC for arsenic were also found at greater depths than for the organochlorine pesticides. The ASC for the organochlorine pesticides were not exceeded below 5 ft bls. The concentrations of arsenic detected in samples collected from up to 15 ft bls exceeded the ASC.

4.0
CURRENT PROCEDURES FOR ADDRESSING CATTLE DIPPING SITES

Current Cattle Dip Vat Site Regulation

Prior to September 1993, cattle dip vat sites were handled through normal environmental enforcement procedures. This usually involved a consent order agreement between FDEP and the owner of the property where the cattle dip vat was located. However, liability issues related to the vats have necessitated that FDEP initiate an interim approach in dealing with cattle dip vat sites. Enforcement activities were suspended for these sites on a temporary basis.

This interim approach outlined that if no probable exposures are observed, the site will be assessed and remediated at a later date, either when land use changes are proposed or based on a priority ranking process.

Factors influencing the ranking process are as follows:

- The site is located within 1,000 ft of developed properties.
- The site is located in a position that is within 10 vertical feet to the occurrence of ground water.
- The distance to a potable drinking water supply well is less than 1,000 ft.
- The present land use or anticipated land use (i.e. currently agricultural with plans to develop to residential).

If one or more of the first three factors is present, or the land use is not restricted, the site would qualify for immediate assessment action. If current land use results in unacceptable exposure, then the FDEP may require one or more of the following:

- Eliminate any activity generating dust
- Consider the need for fencing and posting area
- Contact FDEP district office

5.0

PROPOSED METHODS FOR PRIORITIZING FLORIDA CATTLE DIP SITES FOR ASSESSMENT AND CLEAN UP

Introduction

Among the thousands of cattle dip sites within Florida, it is anticipated that there will be significant variability in terms of the potential human health hazards and environmental impacts. Since it is impractical, and probably unnecessary, to remediate all of these sites at once, a scheme to rapidly evaluate sites and prioritize them for cleanup is needed. This document describes a method which uses human health and environmental risk-based criteria to quickly evaluate sites and categorize them in terms of the immediacy with which assessment and remediation should occur. This approach will permit allocation of limited resources first to sites of greatest human health and environmental concern.

The proposed method relies upon a careful investigation of the site, including measurements of contamination of relevant environmental media. In all cases, this will involve an evaluation of potential soil and ground water contamination, but may also entail an assessment of surface water and sediment contamination at some sites. Another important consideration is the manner in which individuals may come in contact with the site, both now and in the future. Along with contaminant concentrations, the degree of contact with contaminated environmental media determines the extent of exposure at the site, and therefore, the risk of adverse health effects.

The essence of the procedure is that contaminant concentrations measured at the site are compared with acceptable, risk-based criteria. These acceptable criteria will, in some cases, depend upon current and anticipated land use. If contaminant concentrations are all below levels of concern, remediation will be unnecessary. Unacceptable concentrations of one or more contaminants will indicate the need for remediation. The relative priority for remediation will be a function of the number of contaminants present at unacceptable concentrations, the degree to which acceptable concentrations are exceeded, and whether the unacceptable exposures are occurring now or are projected to occur at some time in the future. The risk-based criteria to be used for site evaluation and the prioritization scheme are described in the sections below.

Site Evaluation Criteria

When evaluating an individual cattle dip site, consideration must be given to not only the scope of contamination (i.e., environmental media affected, the identities and concentrations of contaminants present, area and depth of contamination, etc.), but also factors which influence the types and extent of human contact with the site. Site evaluation must take into consideration both current and reasonably anticipated future land use, particularly in regard to the types of individuals who may come in contact with the site, the nature of this contact, and its frequency and duration. These factors are important in determining not only the immediacy of a potential health threat, but also, in some cases, what constitutes an acceptable level of contamination. An acceptable concentration of arsenic in soil in a remote, relatively inaccessible site with little human contact, for example, may be very different from an acceptable soil arsenic level for a playground.

Site evaluation criteria have been developed for nine contaminants most commonly found at cattle dip sites in Florida. These are:

- arsenic
- chlordane
- DDT
- DDE
- DDD
- alpha hexachlorocyclohexane (α HCH)
- beta hexachlorocyclohexane (β HCH)
- gamma hexachlorocyclohexane (γ HCH or Lindane)
- toxaphene

Soils. Risk-based ASCs have been developed for four different exposure scenarios which are intended to encompass the range of different land uses in terms of frequency and duration of site contact. These four scenarios are:

Residential- involves potential site contact on a full-time, or nearly full-time, basis by adults and children. Includes primary residences, school yards, private campgrounds permitting extended-stay (e.g. several months/year) occupants, etc.

Commercial/industrial- involves potential site contact by adults on a regular basis for an extended period of time. Includes most work sites with full-time employees; also includes agricultural land use in situations where farming practices result in frequent site contact.

Restricted I- involves extensive, but less than full-time contact with the site. Includes parks or recreational areas that receive heavy use (soccer and baseball fields, parks and picnic areas close to residential areas); and agricultural sites where farming practices result in moderate site contact (approx. 100 days/yr).

Restricted II- involves infrequent site contact. Examples may include campgrounds in state parks, hiking trails away from population areas, and agricultural sites where farming practices result in very limited site contact (two weeks total per year or less).

Acceptable soil concentrations corresponding to each of these exposure scenarios are listed in Table 3. For a given site, soil contaminant concentrations should be evaluated in terms of the scenario(s) which most closely fits current land use and human activity patterns. Concrete etc. and other barriers to contact should be taken into consideration. Plausible future land use should also be evaluated, using criteria for any and all scenarios that are applicable. Since these criteria are based upon direct contact with soil, only contaminant measurements taken in the top 2 feet of soil should be used for comparison.

The method for developing risk-based soil criteria applicable to direct contact with soil is shown in Table 4. Simultaneous exposure through incidental ingestion of soil, dermal contact with soil, and inhalation of contaminated soil-derived particulates, as well as contaminants volatilized from soil, is assumed. The exposure assumptions inherent in each of the four exposure scenarios are also tabulated here. Both cancer and non-cancer health endpoints were evaluated. For each of the chemicals in each of the scenarios, the acceptable concentration based on potential carcinogenicity was less than the acceptable

Table 4. Calculation of Acceptable Soil Concentrations Based on Direct Contact

for carcinogens:

$$Cs = \frac{TR \times BW \times AT}{EF \times ED \times FC \times \left[\left(SF_o \times IR_o \times 10^{-6} kg/mg \right) + \left(SF_d \times SA \times AF \times DA \times 10^{-6} kg/mg \right) + \left(SF_i \times IR_i \times \left(\frac{1}{VF} + \frac{1}{PEF} \right) \right) \right]}$$

for non-carcinogens:

$$Cs = \frac{THI \times BW \times AT}{EF \times ED \times FC \times \left[\left(\frac{1}{RfD_o} \times IR_o \times 10^{-6} kg/mg \right) + \left(\frac{1}{RfD_d} \times SA \times AF \times DA \times 10^{-6} kg/mg \right) + \left(\frac{1}{RfD_i} \times IR_i \times \left(\frac{1}{VF} + \frac{1}{PEF} \right) \right) \right]}$$

	Residential		**Commercial/Industrial**		**Restricted I**		**Restricted II**	
	carc	non-carc	carc	non-carc	carc	non-carc	carc	non-carc
TR	1E-06	NA	1E-06	NA	1E-06	NA	1E-06	NA
THQ	NA	1	NA	1	NA	1	NA	1
BW (kg)	62	15	70	70	35	35	35	35
AT (days)	25550	2190	25550	9125	25,550	3,650	25,550	3,650
EF (days/yr)	350	350	250	250	100	100	14	14
ED (yr)	30	6	25	25	10	10	10	10
FC	1	1	1	1	1	1	1	1
IRo (mg/day)	120	200	50	50	100	100	100	100
SA (cm2)	4855	1800	2300	2300	3200	3200	3200	3200
AF (mg/cm2)	0.2	0.2	0.6	0.6	0.6	0.6	0.6	0.6
DA	chem-spec	chem-spec	chem-spec	chem-spec	chem-spec	chem-spec	chem-spec	chem-spec
IRi (m3/day)	15	10	20	20	10	10	10	10
VF (m3/kg)	chem-spec	chem-spec	chem-spec	chem-spec	chem-spec	chem-spec	chem-spec	chem-spec
PEF (m3/kg)	6.31E+08	6.31E+08	6.31E+08	6.31E+08	6.31E+08	6.31E+08	6.31E+08	6.31E+08
RfDo	NA	chem-spec	NA	chem-spec	NA	chem-spec	NA	chem-spec
RfDd	NA	chem-spec	NA	chem-spec	NA	chem-spec	NA	chem-spec
RfDi	NA	chem-spec	NA	chem-spec	NA	chem-spec	NA	chem-spec
SFo	chem-spec	NA	chem-spec	NA	chem-spec	NA	chem-spec	NA
SFd	chem-spec	NA	chem-spec	NA	chem-spec	NA	chem-spec	NA
SFi	chem-spec	NA	chem-spec	NA	chem-spec	NA	chem-spec	NA

concentration based on non-cancer endpoints. Only the value based on carcinogenicity is presented in Table 3.

In some cases, the acceptable concentration estimated based on potential health effects was less than the reliable limit of quantitation for that chemical in soil. In such instances, the method detection limit (MDL) is presented in Table 3 rather than the health-based number. These values are identified by footnote.

In addition to hazards posed by direct contact, contaminated soil may also be important as a source to ground water. If there is evidence of migration of contaminants from soil to ground water (i.e., the presence of soil contaminants in ground water), site soils should also be evaluated in terms of leaching to ground water. For each of the selected chemicals, an acceptable soil concentration based on leaching to ground water is also listed in Table 3. The only exception is arsenic. When ground water contains elevated arsenic concentrations, soils should be evaluated by TCLP. If there is a surface water body in contact with, or near, contaminated soils, soil concentrations should also be evaluated in terms of potential leaching to surface water. Concentrations in soil that would be acceptable under these circumstances are also listed in Table 3.

The method for calculating acceptable soil concentrations based on leaching to ground water or surface water is shown in Table 5. Calculations for leaching to ground water are based on Florida primary and secondary drinking water standards and minimum criteria. Calculations for leaching to surface water are based on Florida surface water standards, when available. It should be noted that, in some cases, the acceptable concentration calculated using this method is lower than that which can be accurately quantitated using current technology. In these instances, the MDL is presented in Table 3 in place of the calculated value.

Ground Water. Contaminant concentrations in ground water should be compared with the Florida primary and secondary standards and minimum criteria. These are listed in Table 6.

Table 5. Equation for Deriving Acceptable Soil Concentrations Based on Leaching to Groundwater or Surface Water.

$$Cs = Cw\left[K_d + \frac{(\theta_w + \theta_a H')}{\rho_b}\right]$$

where Cs = acceptable soil concentration

Cw = target soil leachate concentration (mg/L). In the case of groundwater, this is 10-times the current Florida primary or secondary standard, or minimum criteria. In the case of surface water, this is 10-times the current Florida surface water standard.

Kd = soil-water partition coefficient (cm^3/g), which is foc x Koc for organics

θ_w = water-filled soil porosity (L_{water}/L_{soil}); 0.3 default

θ_a = air-filled soil porosity (L_{air}/L_{soil}), 0.13 default

ρ_b = dry soil bulk density (kg/L), 1.5 default

Koc = organic carbon partition coefficient (cm^3/g), chemical-specific

f_{oc} = organic carbon content of soil (g/g), 0.002 (0.2%) default

H' = dimensionless Henry's Law constant, chemical-specific

TABLE 6

GROUNDWATER AND SURFACE WATER STANDARDS AND MINIMUM CRITERIA AND SEDIMENT SCREENING CRITERIA FOR FLORIDA CATTLE DIP SITES

Chemical	Sediment (mg/kg)	Groundwater (μg/L)	Surface Water (μg/L)
Arsenic	7.24	50	50
Chlordane	0.005* (0.002)	2	0.2* (0.00059)
DDT	0.001	0.1	0.02* (0.001)
DDE	0.002	0.1	-
DDD	0.001	0.1	-
alpha HCH	-	0.05	-
beta HCH	-	0.1	0.05* (0.046)
gamma HCH	0.0004* (0.0003)	0.2	0.06
toxaphene	-	3	0.7* (0.0002)

* based on MDL. MDLs provided by Silky Labie, Bureau of Quality Assurance
( ) toxicity-based value in parenthesis if lower than MDL
\- no criteria available

Toxicity=based sediment values from Approach to the Assessment of Sediment Quality in Florida Coastal Water, D.D. MacDonald, 1994. Scheduled to be released by FDEP on February, 1995.

Groundwater criteria from Chapter 62-520 and 62-550, FAC.

Surface water criteria from Chapter 62-302, FAC

Sediment. If there is a surface water body on or near the site which may have been impacted, sediment concentrations should be compared with available criteria. Table 6 lists sediment criteria currently available from the State for some of the contaminants commonly found at CDV sites. It should be used for screening purposes; toxicity bioasseys may be appropriate.

Surface Water. If there is evidence that contaminated ground water is discharging to surface water, ground water concentrations nearest the surface water body should be compared with surface water standards. Table 6 lists surface water standards currently available for common cattle dip vat contaminants.

How many comparisons are needed? For soils, surficial soil should always be evaluated for risk from direct human contact. Minimally, this would entail comparison with criteria from a single scenario representing the most extensive site contact. If current and future land uses may be different, and in particular if land use changes may result in more extensive human contact, comparison with criteria from more than one scenario may be indicated.

Evaluation of each site should also include a determination as to whether or not unacceptable ground water contamination exists. This involves comparison of ground water concentrations with a single set of existing criteria (see above).

The necessity for other comparisons depends upon the site. Surface and subsurface soils should be evaluated based on leaching potential if there is evidence of ground water contamination or the potential to impact nearby surface water bodies. A nearby surface water body would also indicate the need for an evaluation of sediment using existing criteria.

Proposed Ranking Scheme

Sites with unacceptable contamination, based on a screening comparison with land use-specific guidance concentrations described below, are placed in one of three priority categories according to the degree of human health and environmental threat posed by the site. These are:

Priority I - Highest priority. Concentrations of contaminants present pose unacceptable human health or environmental threats under current or imminent site use circumstances. Examples would include situations in which contaminated ground water is currently used as a drinking water source or is discharging to surface water. Also included would be situations in which there is known human contact with soils contaminated in excess of appropriate ASCS relative to the land use. Within this category, sites should be ranked according to the extent to which contaminant concentrations exceed acceptable limits.

Priority II - Intermediate priority. Concentrations of contaminants present are within acceptable limits based on current (or imminent) land use circumstances, but would be unacceptable for plausible, near-term land uses. An example might be a site with soil contamination acceptable under a current, Restricted II-type land use, but would be unacceptable if land use changed to residential in response to growth of a nearby town. Another example might be a situation in which there is contamination of a surficial aquifer with concentrations exceeding Florida primary or secondary standards, but no current use of the aquifer for drinking water purposes. Sites within this category should be ranked according to the extent of contamination and the likelihood that land use change resulting in increased exposure will occur in the near future.

Priority III - Lowest priority. Concentrations of contaminants present are within acceptable limits based on current and reasonable near-term land use, but would be unacceptable under plausible long-term changes in land use. An example would be a site in a remote area with contamination acceptable for all but residential or industrial/commercial land use. Sites within this category should be ranked according to the extent of contamination and the likelihood that land use over the long term will result in increased exposure and potential for toxicity. An important consideration for ranking within this group (and Priority II, as well), is the extent to which future land use can be controlled.

For Priority I sites, a priority score based on potential human health effects can be derived through comparison of measured contaminant concentrations with relevant criteria. For each contaminant for which the surficial soil (0-2 ft) concentration exceeds the ASC's for the current land use, the extent of exceedance is calculated:

$$\frac{\text{Concentration present}}{\text{ASC}}$$

The exceedance ratio for each of these chemicals are then added together to get a total exceedance score for the soil. If ground water currently is used as a drinking water source, the same procedure should be performed. For each contaminant present at a level which exceeds its acceptable concentration, the exceedance ratio is calculated. Again, the exceedance ratios are summed to get a total exceedance score for ground water. This score should be added to the score for surficial soil to get a total score for the site. The higher the score, the greater the priority - based on potential human health impacts - within the Priority I category.

The procedure for calculating ratios and summing them to derive a priority score is possible because all of the contaminants on the cattle dip vat list are carcinogens, and their risks are regarded as being directly proportional to their concentration and additive among chemicals. Some of the guidance concentrations are based on technical issues rather than risk. In these instances, a risk-based value (rather than a value based on MDL, for example) should be used in calculating the exceedance ratio. Soil guidance values based on leachability represent potential future impacts rather than the immediate potential for adverse health effects. For this reason, comparisons with leachability-based soil concentrations should not be used to derive the human health risk priority score. The site rankings based on total risk score are presented below:

Ranking (Based on Total Risk Score)	
Site	**Score**
Okaloosa-Walton	16.5
Lake Arbuckle	13.1
Jay	8.8
Tosohatchee	2.7
Myakka River	2.4
Dudley Farm	0.2
Lake Kissimmee	0.1
Cecil Webb	0.07
St. Marks	0.01
Blackwater	0.01
Walker Ranch	0.005
Paynes Prarie	0.001

6.0 REMEDIATION ALTERNATIVES

Depending on the present or anticipated land use classification and the degree of soil and ground water contamination, the current property owner may be required to remediate the soil and ground water or use interim risk management strategies to reduce risk to the acceptable levels presented in Table 3.

Of the 12 cattle dip vat sites studied, 8 soil and 6 ground water compounds were detected which are believed to be related to the operation of the former cattle dip vats. The following sections discuss the compounds detected and compare the concentrations detected to the ASCs developed by FDEP for this program and ground water screening levels as specified in Chapters 62-520 and 62-550 FAC.

6.1 ACCEPTABLE SOIL CONCENTRATIONS

The ASCs developed by FDEP and presented in Section 5.0 of this report will serve as the target levels for remediation of soils at cattle dip vat sites. The target concentrations will depend on the classification of each site (i.e. Residential, Commercial/Industrial, Restricted I, or Restricted II). The sites at which the target goals for each classification were exceeded are summarized in Figures 6 and 7. If the concentration for a particular compound exceeds the acceptable level for the site classification, then that site will become a candidate for remediation. These data indicate the land use classification and arsenic will likely be the driving forces for soil remedation at each site. The appropriate ASC for arsenic was exceeded at 11 of the 12 sites investigated.

The ASCs for organochlorine pesticides were exceeded at 7 sites. However, the ASCs for these compounds were not exceeded at any site where the ASC for arsenic was not also exceeded.

6.2 GROUND WATER CRITERIA

The applicable drinking water standards and guidance concentrations for the cattle dip vat-related compounds are summarized in Table 7. The Primary Drinking Water Standard (PDWS) for arsenic was exceeded at 7 of the 10 sites where ground water samples were collected. The PDWSs for toxaphene and benzene were exceeded in one sample. The applicable guidance concentration for DDT was exceeded in two samples. The guidance concentrations for DDD and DDE were also exceeded in one sample. These data indicate arsenic is the contaminant of concern in the ground water. The typical method of remediating ground water contaminated by arsenic is treatment by precipitation. Organochlorine pesticides may be treated by carbon absorption or chemical oxidation.

6.3 REMEDIATION COSTS

The costs associated with assessing and cleaning up a cattle dip vat is dependent upon many factors, such as the types of compounds used at the cattle dip vat, length of time in use, hydrogeologic conditions, and condition of existing vat. Cleanup costs can be divided into:

1. Costs associated with site assessment (soil and ground water) and development of a remedial action plan

2. Costs associated with remedial activities (i.e excavation, transportation, and disposal of soils and ground water pump and treat, if necessary)

Depending upon site factors mentioned above, the cost of a CDV site assessment and preparation of a remedial action plan is estimated to range between $100,000 and $350,000. Sites having only arsenic present will tend to be at the lower end of this range and sites with organic compounds at the upper end of this range.

TABLE 7

CDV-RELATED GROUND WATER CONTAMINANT STANDARDS

Contaminant	MCL (mg/L)	Florida Guidance Concentration (mg/L)	Number of Sites* With At Least One Exceedance
Arsenic	0.05		7
Endrin	0.002		-
Lindane	0.0002		-
Methoxychlor	0.04		-
Toxaphene	0.003		1
2,4-D	0.07		-
2,4,5-TP (Silvex)	0.05		-
Chlordane	0.002		-
Heptachlor	0.0004		-
DDT		0.0001	2
DDD		0.0001	1
DDE		0.0001	1
Benzene	0.001	0.001	1

MCL = Maximum Contaminant Level for ground water pursuant to Chapter 62-520, listed in 62-550 FAC

* Note: Of the 12 sites in this study, 10 had at least one ground water sample analyzed for these compounds.

Soil excavation, transportation, and disposal costs are directly related to: 1) the volume of material to be removed and 2) the required disposal option depending upon the types of compounds and concentrations present. The Toxicity Characteristic Leaching Procedure (TCLP) and Universal Treatment Standard (UTS) limits will affect the cost of soil disposal by dictating the options available for disposal of the excavated soil. The TCLP and UTS limits for the chemicals of concern are presented in Table 8. Based on the concentrations present in the soil and the TCLP and UTS limits, the following actions may be applicable to a site:

1. Soils above the UTS levels must be removed from the site and transported to an approved facility for incineration (most expensive).

2. Soils with concentrations below the UTS limits but above the TCLP level may be taken to an approved hazardous waste disposal landfill facility.

3. Contaminated soils above the cleanup level but below the UTS and TCLP levels can be disposed of at an approved landfill. This alternative is the least expensive of the excavate, transport, and dispose options.

As an example, the estimated costs of excavating, transporting, and disposing of 100 cubic yards (or 140 tons) of soil from an example site located in Central Florida under the three action levels are presented below:

- Soil contaminated above cleanup levels but below TCLP levels. Disposal to an industrial landfill 300 miles away.

Excavation	$14,000
Transportation	$11,400
Disposal	$3200
Total	$28,600 or $286/cubic yard

- Soil contaminated above TCLP but below UTS levels. Disposal is to hazardous landfill in Pinewood, South Carolina (400 miles).

TABLE 8

TCLP AND UTS STANDARDS AND OCCURRENCES AT CATTLE DIP VATS STUDIED

Parameter	TCLP[2] (mg/L)	UTS[1] (mg/kg)	Number of Sites With At Least One Exceedance of UTS
Inorganic			
Arsenic	5.0	N/A	N/A
Organic			
Endrin	0.02	0.13	
Lindane	0.4	0.066	
Methoxychlor	10.0	0.18	
Toxaphene	0.5	2.6	1
2,4-D	10.0	10.0	
2,4,5-TP (Silvex)	1.0	7.9	
Chlordane	0.03	0.26	1
Heptachlor	0.008	0.066	1
DDT	N/A	0.087	5
DDD	N/A	0.087	3
DDE	N/A	0.087	4

mg/l = milligrams per liter

1)Universal Treatment Standard, RCRA, in effect 12/19/94
2)Toxic Characteristic Leaching Procedure (being replaced by UTS for most organic compounds)

Note: TCLP tests not conducted on CDV samples collected for this study
N/A: Not Applicable

- Soil contaminated above TCLP but below UTS levels. Disposal is to hazardous landfill in Pinewood, South Carolina (400 miles).

Excavation	$14,000
Transportation	$11,400
Disposal	$37,500
Total	$62,900 or $629/cubic yard

- Soil contaminated with inorganic above TCLP and UTS standards. Disposal is to an incinerator in Arkansas.

Excavation	$14,000
Transportation	$26,400
Disposal (little or no debris)	$98,000
(medium debris)	$140,000
(heavy debris)	$245,000
Total:	$138,000 to 285,000 or $1380 to $2850/ cubic yard

The range of costs for excavation, transportation, and disposal of 100 cubic yards of soil located in Central Florida, depending on concentration and compounds is $28,600 to $285,000.

The above cost relates only to soils and does not reflect the cost of pumping and treating ground water. However, costs can range from $25,000 - $200,000+ for installation of a ground water treatment system and $5,000 - $20,000 or more per year to operate and maintain a treatment system.

Therefore, the total costs of site assessment, preparation of a remedial action plan, and soil remediation ranges from about $130,000 to $600,000. If ground water requires remediation, the total costs may range from about $154,000 to $800,000 plus annual operation and maintenance.

7.0 REFERENCES

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