EVALUATION OF RISK BASED CORRECTIVE ACTION TO ADDRESS DIELDRIN IN GROUNDWATER AT STUDY AREA 52 NTC ORLANDO FL

2/2/2005

TETRA TECH

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0205-N005

February 2, 2005

Commander, Southern Division
Naval Facilities Engineering Command
ATTN: Ms. Barbara Nwokike, Code ES33
P.O. Box 190010
2155 Eagle Drive
North Charleston, SC 29419-9010

Reference: CLEAN Contract No. N62467-94-D-0888
Contract Task Order No. 0281

Subject: Evaluation of RBCA Technical Memorandum – Study Area 52
Naval Training Center, Orlando, Florida

Dear Ms. Nwokike:

Please find enclosed the Technical Memorandum outlining the potential use of Global Risk-Based Corrective Action as a remedy for Study Area 52.

If you have any questions or comments, please contact me at (865) 220-4730 or Teresa Grayson at (865) 220-4701.

Sincerely,

Steven B. McCoy, P.E.
Task Order Manager

SBM:tko

Enclosure

c: Mr. David Grabka, FDEP
Mr. Gregory Fraley, USEPA Region 4
Mr. Steve Tsangaris, CH2M Hill
Mr. Allan Jenkins, Tetra Tech NUS
Ms. Teresa Grayson, Tetra Tech NUS
Ms. Renna Warren, Tetra Tech NUS
Mr. Mark Perry, Tetra Tech NUS
Ms. Debra M. Humbert, Tetra Tech NUS (cover letter only)
File/db

Subject: **Evaluation of RBCA to Address Dieldrin in Groundwater Study Area 52, Naval Training Center, Orlando, Florida**

To: Barbara Nwokike, SOUTHDIV

From: Allan Jenkins, TtNUS

Copies: Steve McCoy, TtNUS
Teresa Grayson, TtNUS
Renna Warren, TtNUS
File

Date: February 2, 2005

1.0 INTRODUCTION

This memorandum presents an analysis of the site conditions at Study Area 52 (SA 52) and the potential use of Global Risk-Based Corrective Action (RBCA) as a remedy for the site. The historical and current site conditions were reviewed in accordance with the RBCA Flow Charts that were most recently published with the Draft (October 12, 2004) Chapter 62-780, F.A.C., Contaminated Site Cleanup Criteria Rule, Risk Impact Statement (i.e., "Global RBCA" rule). The intent of this analysis is to assist the Orlando Partnering Team (OPT) in making a recommendation for a path forward for SA 52.

Because groundwater is currently impacted with dieldrin greater than the FDEP Groundwater Cleanup Target Level (GCTL) of 0.005 micrograms per liter (µg/L), and because the site is unlikely to reach levels below the GCTL without intervention in the foreseeable future, the site is ineligible for RBCA No Further Action (NFA) closure without controls (i.e., Level I). Therefore, since the Navy has expressed willingness to implement institutional and/or engineering controls on the property, the site was further assessed under RBCA Level II criteria (see Attachment A). To qualify for NFA with controls, but without conducting a risk assessment, the following criteria shown on the RBCA Level II Flow Charts were briefly evaluated:

- Free Product (not present or indicated, no further assessment)
- Soil: Human Health/Direct Contact
- Soil: Leachability
- Groundwater

2.0 SITE GEOLOGY AND HYDROGEOLOGY

Site Geology

Boring logs and site-specific geologic data were not provided in the Environmental Site Screening Report (ESSR) (HLA, March 1999). However, the investigation of SAs 18 and 50, located due east of SA 52, included shallow monitoring wells and the geologic data from those borings logs are considered representative of conditions at SA 52. The SA 18 and SA 50 boring logs show 1 to 2 feet of dark brown, fine to silty, fine sand underlain by 2 to 3 feet of grey to light brown fine sand followed by brown, silty fine sand. The maximum depth of observation was 14 feet below grade.

Site Hydrogeology

Monitoring wells at SA 52 typically show a water level ranging between 2 to 5 feet below grade and demonstrate the presence of a shallow, unconfined aquifer. The saturated zone penetrated by the wells consists of fine to silty, fine sand. Groundwater elevation data from the wells at the site consistently shows an eastward or northeastward direction of groundwater flow with an average gradient of around 0.005 feet/feet. Low flow purging of the wells (e.g., 100 ml/min) prior to groundwater sampling typically results in less than 0.4 feet of drawdown in the wells. Over-development pumping of well OLD-52-13 in June 2002 was able to sustain a rate of 2.5 gallons per minute without dewatering the well. Assuming an isotopic, homogeneous aquifer with a 10-feet saturated zone, a porosity of 0.30, and steady-state, near 90 percent drawdown during pumping, the hydraulic conductivity was back-calculated to be around 10 feet/day for the shallow aquifer zone.

3.0 SOIL

The concentrations of pesticides detected in soil exceeded the FDEP cleanup criteria during the site screening conducted in 1996. The site screening was followed by an interim remedial action (IRA), which consisted of the removal of contaminated soil. The IRA was completed in September 1997. The area surrounding former Building 7261 was excavated to a depth of 2 feet below ground surface (bgs) and some areas were excavated to 4 feet bgs (it was noted that groundwater was encountered at this depth). The objective of the excavation was to remove soil that exceeded the EPA residential RBCs for pesticides (e.g., 40 micrograms per kilogram [µg/kg] for dieldrin; the FDEP SCG was 70 µg/kg at that time). Sixteen confirmation samples were collected at depths of approximately 2 feet and 4 feet bgs. Based on these results, an additional localized area was excavated to 4 feet bgs and a seventeenth confirmation sample was collected.

At the completion of excavation, all confirmation samples at 2 feet depth showed dieldrin concentrations below the residential and industrial SCTLs; several confirmation samples at 4 feet depth exceeded the these SCTLs for dieldrin, DDD, and DDT near the center of the site (i.e., at the water table). However, all of these sample locations were covered with 2 or more feet of clean fill. The 1997 confirmation sample results also showed that three samples located within the area excavated to 2 feet depth and five samples within the area excavated to 4 feet depth exceed the dieldrin SCTL for leaching to groundwater (i.e., 4 µg/kg); two samples at 4 feet depth exceeded the leaching SCTLs for DDD and/or DDT. The dieldrin concentrations in six of these eight samples ranged from 8.09 to 56.1 µg/kg with two hot spot locations showing <6600 and 13,900 µg/kg at the water table adjacent to former Building 7261 (i.e., in the immediate vicinity of well OLD-52-13).

4.0 GROUNDWATER

The pesticide dieldrin in groundwater exceeds the Florida GCTL of 0.005 µg/L at one of three monitoring wells that are regularly monitored. To date, the two remaining wells that are regularly sampled, and one monitoring well that has been historically sampled, have shown concentrations that have been below the detection limit (0.1 µg/L) or below the current GCTL (prior to 1998 the GCTL was 0.1 µg/L). The historical maximum concentration of dieldrin in groundwater at SA 52 (5.6 J µg/L) was observed in October 1997 shortly after soil excavation was completed. Thereafter, dieldrin concentrations typically ranged between about 0.01 and 0.4 µg/L in eight samples collected between 1998 and 2000.

Between April 2001 and February 2004 (most current data), the concentration of dieldrin in well OLD-52-13 has ranged from 0.01 to 2.2 µg/L in groundwater. The maximum concentration was observed in March 2002. Subsequent samples collected in June 2002, September 2002, December 2002, March 2003, and February 2004 have demonstrated lower concentrations (<0.1 to 0.01J µg/L) although a clear downward trend has not been observed. These more recent samples have exceeded the GCTL but have remained below the Natural Attenuation Default Source concentration of 0.5 µg/L for dieldrin in F.A.C. Chapter 62-777, Table 4. A tag map showing the sampling data for the past two years is provided in Figure 1.

DDD was detected only once, in January 2000, at a concentration of 0.28 J µg/L, slightly greater than its GCTL of 0.1 µg/L. It was not detected during any of the other sampling events listed above.

5.0 RBCA LEVEL II ANALYSIS

Soil: Human Health/Direct Contact

As presented in Section 3, surface soils (i.e., 0-2 feet depth) containing concentrations of dieldrin greater than the residential SCTL of 70 µg/kg (and other pesticides) were excavated in 1997 and the area reclaimed with clean fill. In addition, all confirmation samples at 2 feet depth met the residential criteria. Only two samples locations at 4 feet depth exceeded both the residential and industrial SCTLs, but they are covered by 2 or more feet of clean fill. Therefore, the site currently meets the Level II criteria for Human Health/Direct Contact.

Soil: Leachability

As presented in Section 3, three soil samples located within the area excavated to 2 feet depth and five samples within the area excavated to 4 feet depth exceed the dieldrin SCTL for leaching to groundwater (i.e., 4 µg/kg); two samples at 4 feet depth also exceeded the SCTL for DDD and DDT. Because of this site condition, either RBCA Level II Options IIA or IIB are deemed most appropriate for SA 52. Option IIA requires the calculation of an alternate leachability-based soil CTLs. The advantage of this option is that site-specific soil properties can be used to determine the alternate CTL that may result in a higher SCTL than the default value of 4 µg/kg. To effectively pursue this option some site soil samples (e.g., three to six samples using split spoons) must be collected and analyzed for specific properties such as: soil bulk density, soil particle density, moisture content, fraction of organic carbon in soil, water-filled porosity, and air-filled porosity. All or a portion of these analysis may be performed. It is the author's professional judgment that the results of the fraction of organic carbon in soil analysis is the data mostly likely to impact (i.e., increase the CTL) the calculation of the alternate SCTL.

For Option IIB a few site soil samples would be collected (e.g., three to six samples using split spoons) and directly analyzed in a laboratory for their ability to leach dieldrin to groundwater. The SPLP leaching procedure would be used for the analysis. The leaching data would then be used to specify an alternate SCTL that is protective of groundwater. Due to many complex physical and chemical reactions in soil that can retard the leaching process, and based on site historical groundwater data showing relatively low concentrations, it is expected that this analysis would result in an alternate SCTL greater than the default SCTL value.

It should be noted that since a risk assessment is not being performed (i.e., not proposed at the present time), the calculation (Option IIA) and/or specification (Option IIB) of the alternate SCTL assumes that the groundwater meets the default GCTL of 0.005 µg/L of dieldrin in groundwater. The goal of either option is to justify an alternate SCTL that is higher than the existing soil concentrations at SA 52 and eliminate soil leaching as a pathway of concern for groundwater.

Groundwater

As presented above, groundwater at the site contains dieldrin concentrations, over time, that consistently exceeds the GCTL. The RBCA Level II Option IID is deemed the most appropriate path forward for groundwater. Three criteria must be demonstrated to meet the requirements of Option IID:

1. Demonstration (historical or modeling) that dieldrin in groundwater at the property boundaries will not exceed the default GCTL,
2. The contamination is limited to the source area (contamination <1/4 acre) and is not migrating from the localized source area (minimum 1 year GW monitoring required), and
3. No impact or potential impact to on-site surface water.

Historical groundwater monitoring data have not detected dieldrin in three perimeter monitoring wells located within approximately a 50-foot radius of impacted well OLD-52-13. The source area plume is interpreted to have a radial extension of approximately 30 feet, or to be no greater than approximately 2,800 square feet, or 0.06 acre. The monitoring data and hydrogeologic conditions (e.g., low permeability soils, low hydraulic gradient) also suggest that the plume, for practical purposes, is stable. Multiple rounds of water level data have shown that the water table flow direction is toward the north and/or east and there is very little potential for the plume to impact any surface water body. In summary, all three of the requirements are significantly satisfied with the existing site data. The only exception appears to be that the perimeter wells are located somewhat beyond the site boundary (approximately 30 feet downgradient of OLD-52-13) and do not directly demonstrate the absence of, or lack of migration of, the plume to the site boundary. Also, because the groundwater seepage velocity is estimated to be low at SA 52 (e.g., 91 feet per year) and dieldrin transport in groundwater is typically highly retarded, monitoring data from the existing perimeter wells may not allow definition of the plume in a timely manner. Furthermore, fate and transport modeling of dieldrin in groundwater is a critical element in demonstrating that criteria 1 and 2 above are fully meet.

In summary, the installation and sampling of two to four monitoring wells is recommended to better define the plume. The collection and analysis of aquifer matrix (i.e., soil) samples collected during well installation should include parameters that will improve the site-specific modeling of dieldrin fate and transport, such as: soil bulk density, soil particle density, and fraction of organic carbon in soil. Following well installation and development, up to three wells should be slug tested to estimate a site-specific value of aquifer hydraulic conductivity to support the fate and transport modeling. And, at minimum of two quarters of groundwater monitoring of the source and site boundary wells must be conducted.

6.0 PRELIMINARY FATE AND TRANSPORT MODELING

Contaminant transport modeling for predicting dieldrin migration in groundwater at SA 52 has been identified as a critical path for the use of a RBCA at the site. Based on previous discussions with the OPT, screening-level modeling was conducted to evaluate the groundwater sampling frequency required to effectively monitor the plume at SA 52; the results of that modeling are presented here to support the evaluation of RBCA for the site.

The screening-level modeling focused on the transport of dieldrin from the known most-contaminated area of the site (well OLD-52-13) to the nearest site boundary (i.e, the property line located approximately 30 ft to the northeast of well OLD-52-13). Because land use controls and groundwater restrictions for parcels adjoining SA 52 might not provide adequate protection of human health and the environment, the rate of dieldrin plume migration and potential for the plume to extend beyond the site boundary in the future were used as primary factors in evaluating a sampling frequency. Simulation of the transport of dieldrin in the shallow aquifer at SA 52 was performed using the Bioscreen Natural Attenuation Decision Support System, Version 1.4 that was developed by Groundwater Services, Inc., Houston, Texas, for the Air Force Center for Environmental Excellence (AFCEE) Technology Transfer Division at Brooks Air Force Base. Bioscreen is an easy-to-use screening model that simulates transport of chemicals in groundwater based on the Domenico analytical solute transport model, and the model has the ability to simulate advection, dispersion, adsorption, and aerobic decay and anaerobic reactions. For the simulation of dieldrin at SA 52, only the “solute transport without decay” option (i.e., no degradation) in Bioscreen was used for the analysis; that is, only advection, dispersion, absorption to soil are responsible for the transport of dieldrin over time in the aquifer. As a conservative measure an infinite source of dieldrin was assumed for the source area. Copies of the Bioscreen input/output sheets are provided in Attachments B and C.

Inputs for the Bioscreen modeling were selected based on site-specific observations and data, data from nearby SAs, and from literature values. The input values used and their rationale are presented in Attachment B, Table 1. Because the concentration of dieldrin at well OLD-52-13, which is considered to be the source area, has fluctuated over time, the Bioscreen model was run using two different source concentrations. A concentration of 0.09 µg/L that was measured in February of 2004 was used to represent the most current known conditions; the model input/output sheets are provided in Attachment B. The recent, highest concentration of 2.2 µg/L that was observed in March of 2002 was used to represent a “high source” concentration; the model input/output sheets for this simulation are provided in Attachment C. For both modeling simulations, either the results at, or bracketing, 5 years are provided and the results for a subsequent model time increment that shows when the concentration of dieldrin is predicted to reach the GCTL of 0.005 μg/L (i.e., 0.000005 mg/L) at the property line are provided.

The Bioscreen modeling results for the current and high source concentration conditions provided in the attachments show that the concentration of dieldrin is not predicted to reach the GCTL at the property line within five years from current conditions. For the current site conditions and assuming a constant source concentration the model indicates that the GCTL would be reached at the property line between at about 32 years. For the high source concentration conditions the model indicates that the GCTL would be reached at the property line between at about 20 years. It is noteworthy that the hydraulic conductivity value used in the simulations was estimated from relatively short-term pumping conducted at well OLD-52-13 (and is considered conservatively high). If a value for hydraulic conductivity consistent with well slug tests conducted at nearby SA 17 were used in the simulations, then the time to reach the GCTL at the property line would be on the order of several hundred years.

7.0 CONCLUSIONS AND RECOMMENDATIONS

An analysis of the site conditions at SA 52 suggests that the use of RBCA, following the Level II Risk Management Option, is likely to be a successful method to achieve a NFA (with controls) for the site. This path forward does not require that a risk assessment be conducted; however, some additional site characterization and the collection of site-specific data to support the determination of alternate soil leachability-based CTLs and groundwater fate and transport modeling are required.

The preliminary Bioscreen model predictions and the site historical sampling showing that dieldrin has not been detected in any of the wells surrounding well OLD-52-13 at the site suggest that the dieldrin plume is stable and that the plume is not likely to migrate beyond the site boundaries. Optimization of the modeling effort based on the proposed site data collection is expected to demonstrate an even lower likelihood that the plume will migrate beyond the site boundaries.

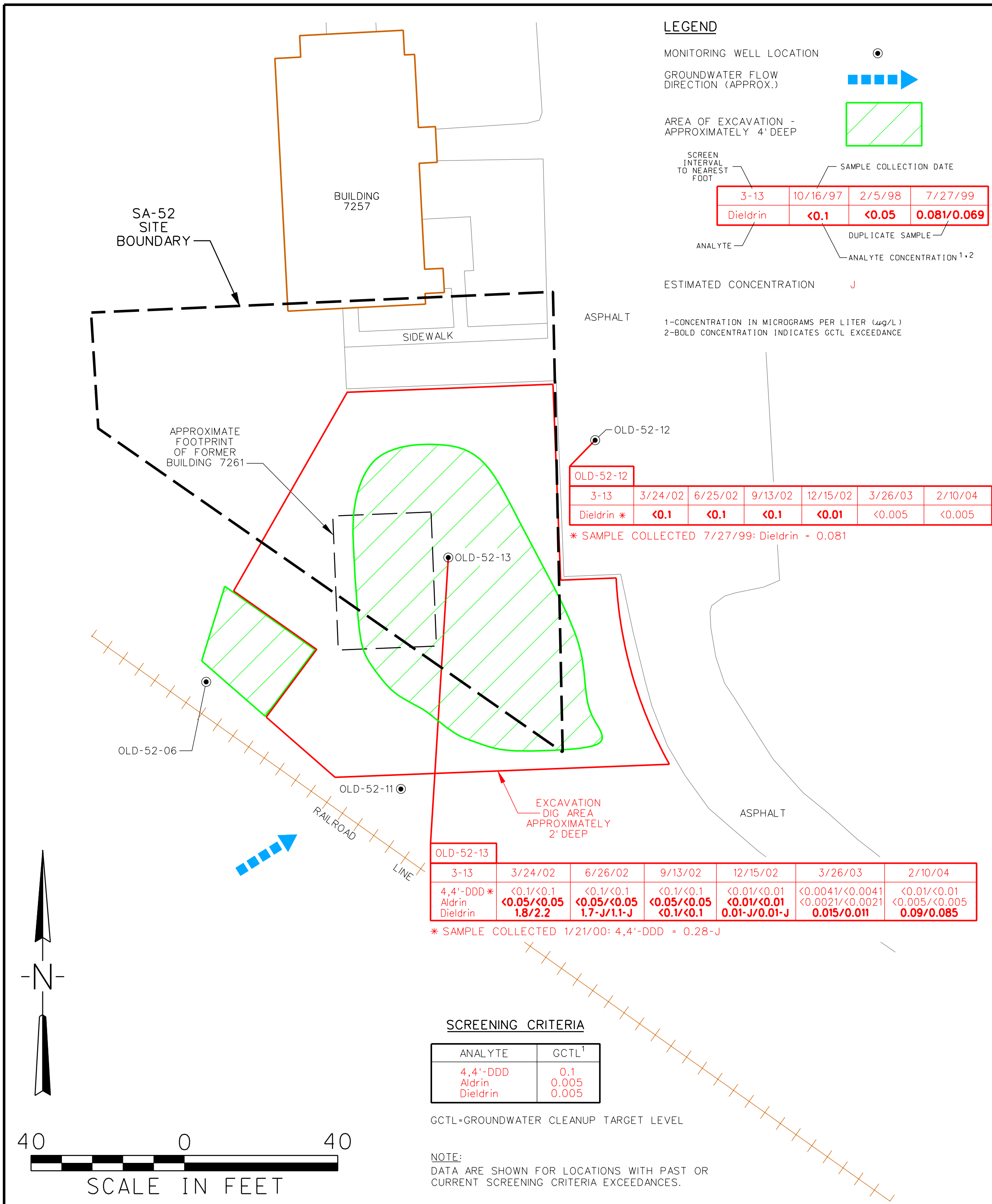
As has been discussed by the Orlando Partnering team, a groundwater sampling frequency of five years is deemed adequate to detect the migration of dieldrin from the site source area to the property line. However, following the installation of new site boundary wells a more aggressive sampling program consisting of semiannual sampling may be appropriate to obtain the data necessary to demonstrate that conditions are appropriate for a RBCA risk assessment and a recommendation for “No Further Action (with controls).

As outlined above, the most difficult requirement of the proposed Level II Risk Management Option, without a risk assessment, is considered to be the justification of the alternate SCTL for leaching to groundwater (based on meeting the default groundwater GCTL). If this requirement can not be met using the data collection and analysis proposed in this memo, than a risk assessment can be conducted with the data. The goal of the risk assessment would be to justify a less restrictive GCTL which would allow a less restrictive alternate SCTL. Preparation of a risk assessment will require additional level of effort; however, most if not all of the data collection proposed above would be required to support the risk assessment. Similar to the above discussion for the Level II evaluation, groundwater modeling is considered to be the critical pathway in the risk assessment to demonstrate that a higher GCTL would be protective of human health and the environment.

One other option for SA 52 that has been suggested is Monitored Natural Attenuation (MNA). MNA is an acceptable strategy for site rehabilitation under Global RBCA. However, there are certain requirements that may prove difficult (though not necessarily impossible) to demonstrate for dieldrin, such as:

- Show that the physical, chemical, and biological characteristics of dieldrin and its transformation products are conducive to natural attenuation,
- The available data must show an overall decrease in the contamination, and
- Demonstrate that the site is anticipated to achieve the applicable NFA criteria as a result of NA in five years, or less; or show that dieldrin has the capability to degrade including the estimation of an annual milestone of contaminant reductions and a time frame for compliance.

CAD FILE NO./DATE: P:\Oak Ridge Drafting\NTC Orlando\sa52-017H.dgn 12-15-04 JFF



3-13	10/16/97	2/5/98	7/27/99
Dieldrin	**<0.1**	**<0.05**	**0.081/0.069**

OLD-52-12

3-13	3/24/02	6/25/02	9/13/02	12/15/02	3/26/03	2/10/04
Dieldrin *	**<0.1**	**<0.1**	**<0.1**	**<0.01**	<0.005	<0.005

* SAMPLE COLLECTED 7/27/99: Dieldrin = 0.081

OLD-52-13

3-13	3/24/02	6/26/02	9/13/02	12/15/02	3/26/03	2/10/04
4,4'-DDD *	<0.1/<0.1	<0.1/<0.1	<0.1/<0.1	<0.01/<0.01	<0.0041/<0.0041	<0.01/<0.01
Aldrin	**<0.05/<0.05**	**<0.05/<0.05**	**<0.05/<0.05**	**<0.01/<0.01**	<0.0021/<0.0021	<0.005/<0.005
Dieldrin	**1.8/2.2**	**1.7-J/1.1-J**	**<0.1/<0.1**	**0.01-J/0.01-J**	**0.015/0.011**	**0.09/0.085**

* SAMPLE COLLECTED 1/21/00: 4,4'-DDD = 0.28-J

SCREENING CRITERIA

ANALYTE	GCTL[1]
4,4'-DDD	0.1
Aldrin	0.005
Dieldrin	0.005

GCTL=GROUNDWATER CLEANUP TARGET LEVEL

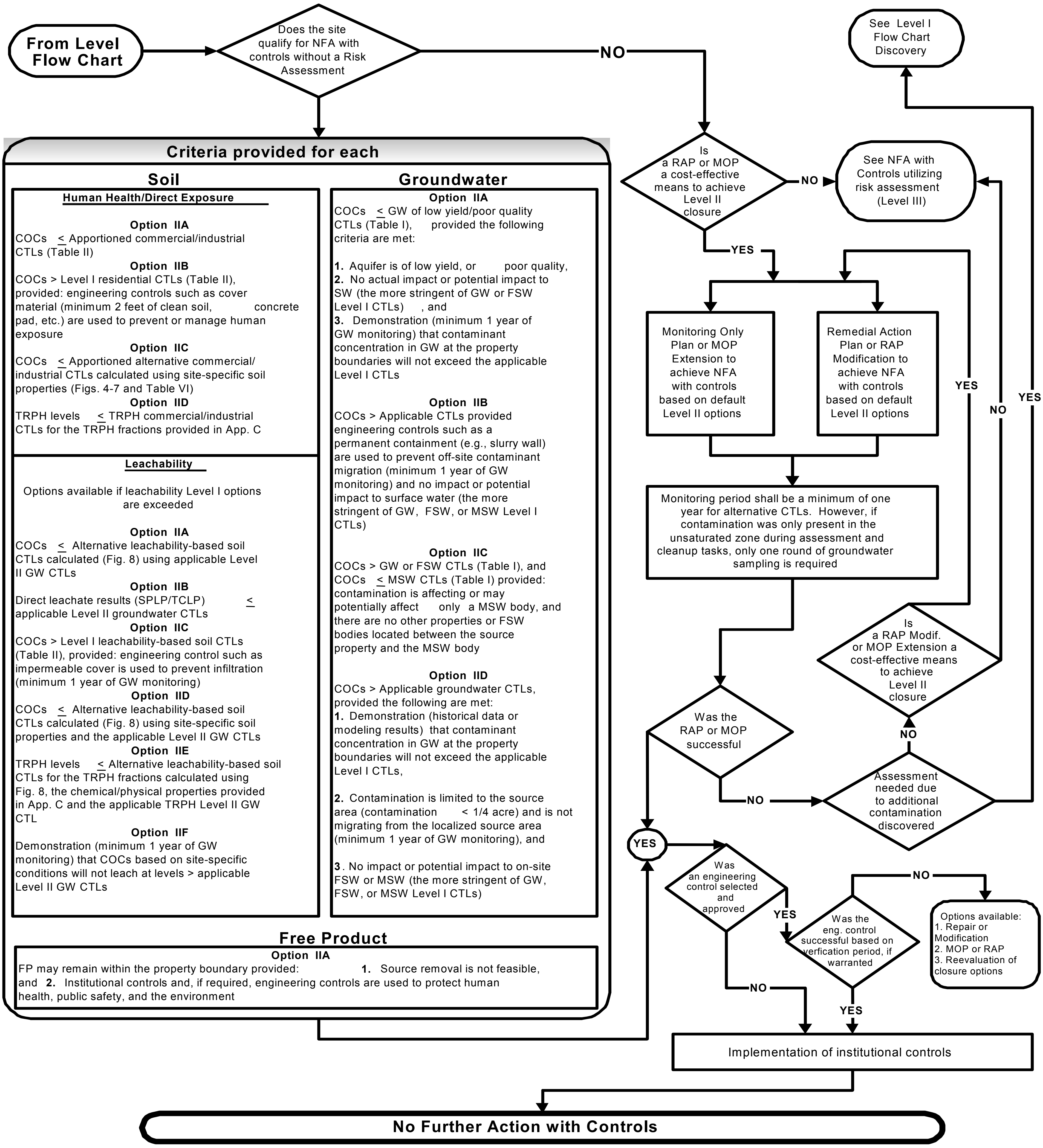
NOTE:
DATA ARE SHOWN FOR LOCATIONS WITH PAST OR CURRENT SCREENING CRITERIA EXCEEDANCES.

DRAWN BY JFF	DATE 12-15-04	GROUNDWATER EXCEEDANCES FEBRUARY 2004 STUDY AREA 52 - McCOY ANNEX NAVAL TRAINING CENTER ORLANDO, FLORIDA	CONTRACT NO. N62467-94-D-0888
CHECKED BY TKG	DATE 12-15-04		OWNER NO. N4443
REVISED BY ---	DATE --------		APPROVED BY --- DATE --------
SCALE AS NOTED	NAVFAC		DRAWING NO. FIGURE 1 / REV. 0

ATTACHMENT A

RBCA LEVEL II FLOW CHART

Draft Contaminated Site Cleanup Criteria Risk Based Corrective Action (RBCA) Flow
Risk Management Options - Level II



Definitions

Apportioned: The adjustment of CTLs such that for non-carcinogen contaminants that affect the same target organ(s) the hazard index is 1 or less and for carcinogens the cumulative lifetime excess cancer risk is 1.0 E-6; **COCs:** Contaminants of Concern; **CTLs:** Cleanup Target Levels; **FP:** Free Product; **FSW:** Freshwater Surface Water; **GW:** Groundwater; **Low Yield:** Aquifer that has an average hydraulic conductivity of less that 1 ft/day and a maximum yield of 80 gals/day; **MSW:** Marine Surface Water; **NFA:** No Further Action; **Poor Quality:** Affected groundwater with background concentrations that exceed Florida's Primary or Secondary Drinking Water Stds; **PQL:** Practical Quantitation Limit; **SPLP:** Synthetic Precipitation Leaching Procedure; **TCLP:** Toxicity Characteristic Leaching Procedure.

Note 1: Best achievable detection limit shall be the PQL.

Note 2: Figures 1, 2, 3A, 4, 5, 6, 7, and 8, and Tables I, II, and VI are provided in Chapter 62-777, FAC. Appendix C is provided in the technical report.

Note 3: Flow Process provided to assist in understanding the Contaminated Site Cleanup Criteria RBCA flow process. Chapter 62-780, FAC, shall be utilized for final interpretation of the rule and

Proposal 06/06/2003

ATTACHMENT B

BIOSCREEN INPUTS – TABLE 1

BIOSCREEN MODELING RESULTS

February 2004 Source Concentration

- **40-Yr. Simulation Input Sheet**
- **40-Yr. Simulation, 4-Year Output**
- **40-Yr. Simulation, 8-Year Output**
- **40-Yr. Simulation, 32-Year Output**

TABLE 1

BIOSCREEN MODELING INPUTS

PARAMETER	VALUE	SOURCE	COMMENTS
Chemical			
Dieldrin source concentration	0.090 µg/L	February 2004 results for well OLD-52-13; assume no source degradation	Maximum concentration of 2.0 µg/L was observed in March 2002
Plume length	30 ft	Estimated from site monitoring data	Based on absence of dieldrin in wells located at ~50 feet
Partition coefficient, Koc	2.14E04	F.A.C. 62-777, Technical Report, Table 4 (Saranko, 1999)	Used by FDEP to calculate SCTLS
Fraction of organic carbon, foc	0.001	F.A.C. 62-777, Technical Report, Table 4 (Saranko, 1999)	Default used by FDEP to calculate SCTLS
Solute half-life	0.0082 years	(Howard, et. al., 1991)	Maximum literature value used
Hydrogeologic			
Hydraulic conductivity, K	10 ft/day	Estimate: back-calculated from 2.5 gpm dewatering pumping conducted at well OLD-52-13 in January 2002.	High value compared to slug test results at nearby SA 17; results in relatively faster transport of dieldrin
Hydraulic gradient, i	0.005	Site water level monitoring data	Average of four most recent water level monitoring events between June 2002 and March 2003
Porosity, n	0.2	Within literature range for silty sand	Model requires effective porosity which is a portion of total porosity

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

SA 52 NTC Orlando
Dieldrin-impact
Run Name

Data Input Instructions:

115 → 1. Enter value directly....or
or 2. Calculate by filling in grey
0.02 cells below. (To restore formulas, hit button below).

Variable* → *Data used directly in model.*

20 → *Value calculated by model.* *(Don't enter any data).*

1. HYDROGEOLOGY

Seepage Velocity*	*Vs*	90.5	*(ft/yr)*
or		or	
Hydraulic Conductivity	*K*	3.5E-03	*(cm/sec)*
Hydraulic Gradient	*i*	0.005	*(ft/ft)*
Porosity	*n*	0.2	*(-)*

2. DISPERSION

Longitudinal Dispersivity	*alpha x*	2.5	*(ft)*
Transverse Dispersivity*	*alpha y*	0.2	*(ft)*
Vertical Dispersivity*	*alpha z*	0.0	*(ft)*
or		or	
Estimated Plume Length	*Lp*	30	*(ft)*

3. ADSORPTION

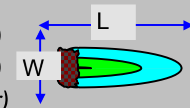
Retardation Factor*	*R*	182.9	*(-)*
or		or	
Soil Bulk Density	*rho*	1.7	*(kg/l)*
Partition Coefficient	*Koc*	21400	*(L/kg)*
FractionOrganicCarbon	*foc*	1.0E-3	*(-)*

4. BIODEGRADATION

1st Order Decay Coeff*	*lambda*	8.5E+1	*(per yr)*
or		or	
Solute Half-Life	*t-half*	0.0082	*(year)*
or Instantaneous Reaction Mode			
Delta Oxygen*	*DO*	0	*(mg/L)*
Delta Nitrate*	*NO3*	0	*(mg/L)*
Observed Ferrous Iron*	*Fe2+*	0	*(mg/L)*
Delta Sulfate*	*SO4*	0	*(mg/L)*
Observed Methane*	*CH4*	0	*(mg/L)*

5. GENERAL

Modeled Area Length*	30	*(ft)*
Modeled Area Width*	30	*(ft)*
Simulation Time*	40	*(yr)*



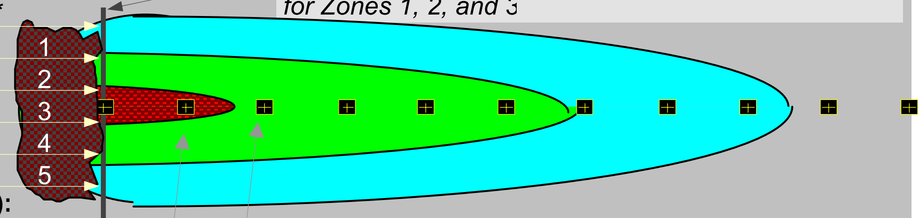
6. SOURCE DATA

Source Thickness in Sat.Zone* 5 *(ft)*

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3

Source Zones:

Width* (ft)	Conc. (mg/L)*
4	0.0000225
6	0.000045
10	0.00009
6	0.000045
4	0.0000225



View of Plume Looking Down

Source Halflife (see Help):

Infinite	Infinite	*(yr)*
Inst. React.	1st Order	
Soluble Mass	infinite	*(Kg)*
In Source NAPL, Soil		

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)											
Dist. from Source (ft)	0	3	6	9	12	15	18	21	24	27	30

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | **View Output**

RUN ARRAY | **View Output**

Help | Recalculate This Sheet

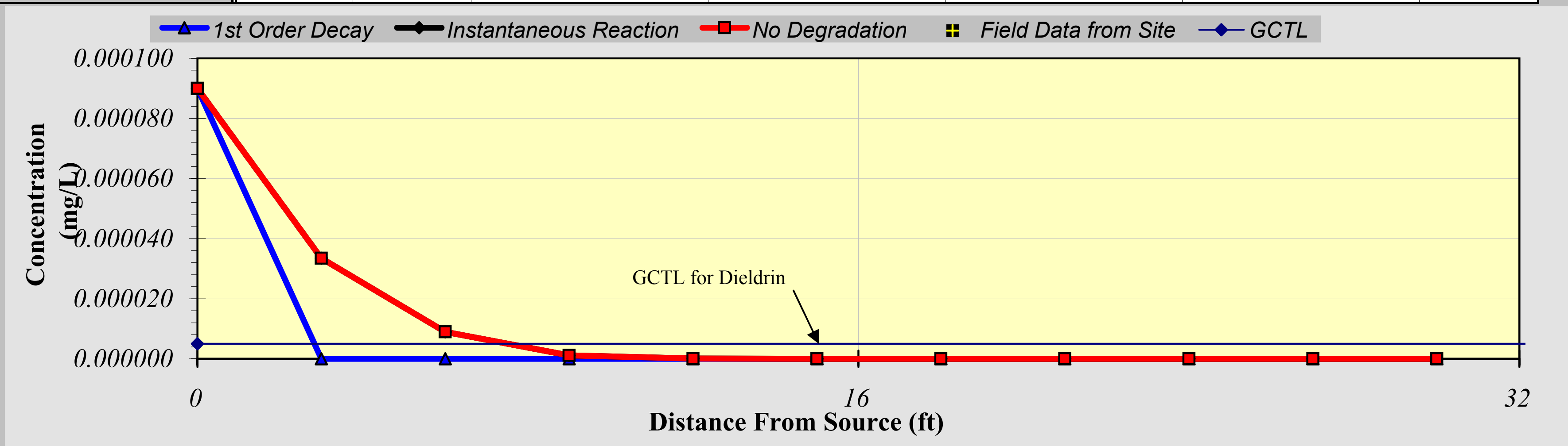
Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	3	6	9	12	15	18	21	24	27	30
No Degradation	0.000090	0.000034	0.000009	0.000001	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
1st Order Decay	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Inst. Reaction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site											



Replay Animation

Next Timestep

Prev Timestep

Time:

4 Years

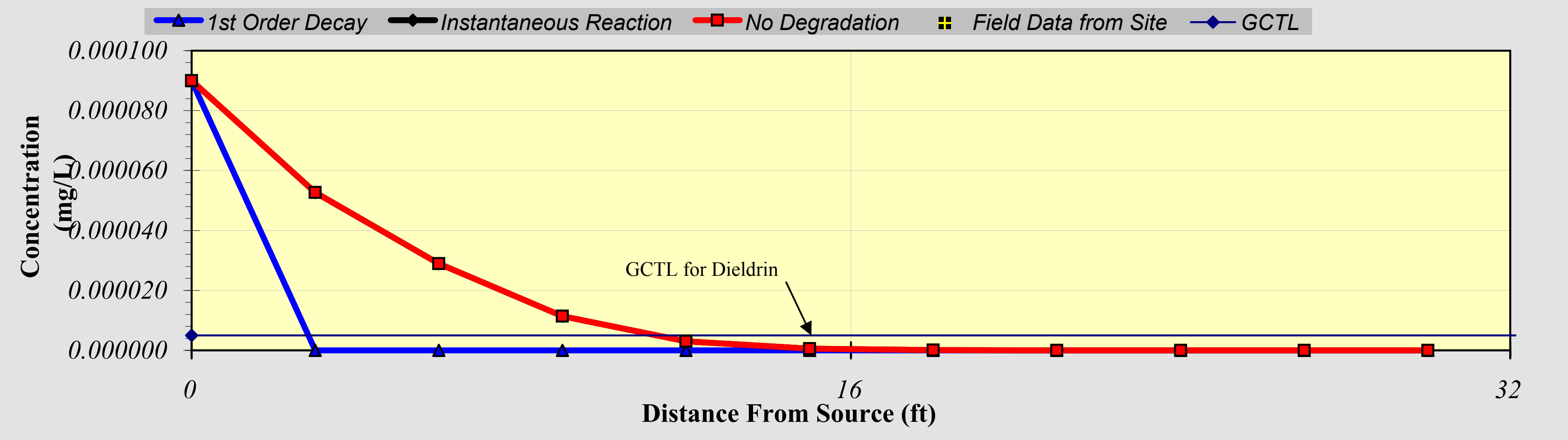
Return to Input

Recalculate This Sheet

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	3	6	9	12	15	18	21	24	27	30
No Degradation	0.000090	0.000053	0.000029	0.000011	0.000003	0.000001	0.000000	0.000000	0.000000	0.000000	0.000000
1st Order Decay	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Inst. Reaction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site											



Replay Animation

Next Timestep

Prev Timestep

Time:

8 Years

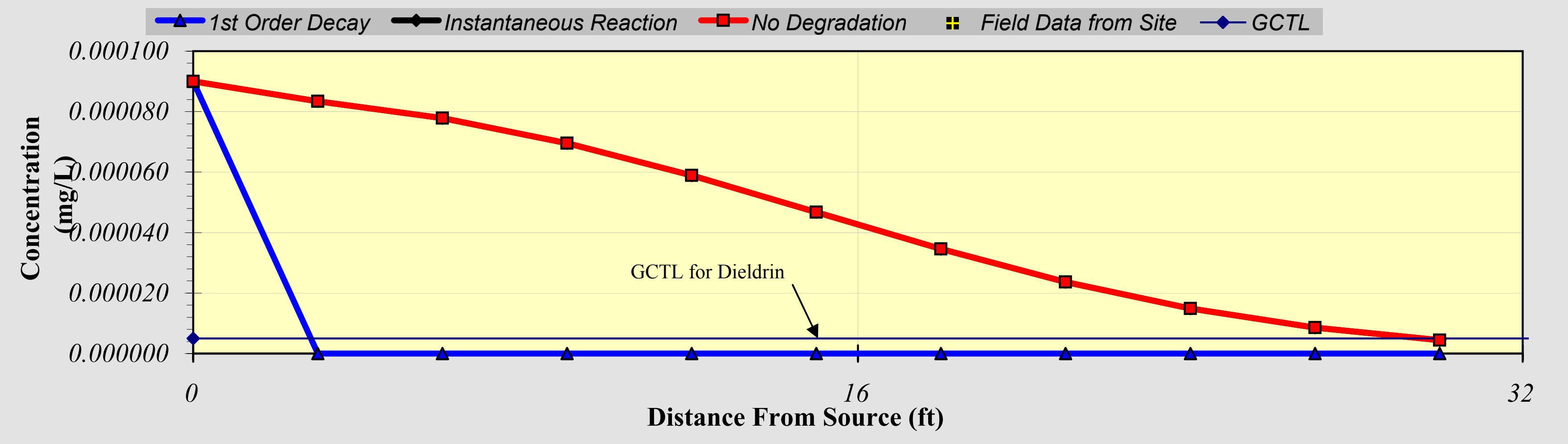
Return to Input

Recalculate This Sheet

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	3	6	9	12	15	18	21	24	27	30
No Degradation	0.000090	0.000083	0.000078	0.000070	0.000059	0.000047	0.000035	0.000024	0.000015	0.000009	0.000004
1st Order Decay	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Inst. Reaction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site											



Replay Animation

Next Timestep

Prev Timestep

Time: 32 Years

Return to Input

Recalculate This Sheet

ATTACHMENT C

BIOSCREEN MODELING RESULTS

March 2002, High Source Concentration

- **25-Yr. Simulation Input Sheet**
- **25-Yr. Simulation, 5-Year Output**
- **25-Yr. Simulation, 8-Year Output**
- **25-Yr. Simulation, 20-Year Output**

BIOSCRN-SA52-dieldrin-impact-30 ft (high source).XLS

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

SA 52 NTC Orlando
Dieldrin-impact
Run Name

Data Input Instructions:

115	1. Enter value directly....or
or	2. Calculate by filling in grey cells below. (To restore formulas, hit button below).
0.02	
Variable*	Data used directly in model.
20	Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY

Seepage Velocity*	*Vs*	90.5	*(ft/yr)*
or		or	
Hydraulic Conductivity	*K*	3.5E-03	*(cm/sec)*
Hydraulic Gradient	*i*	0.005	*(ft/ft)*
Porosity	*n*	0.2	*(-)*

2. DISPERSION

Longitudinal Dispersivity	*alpha x*	2.5	*(ft)*
Transverse Dispersivity*	*alpha y*	0.2	*(ft)*
Vertical Dispersivity*	*alpha z*	0.0	*(ft)*
or		or	
Estimated Plume Length	*Lp*	30	*(ft)*

3. ADSORPTION

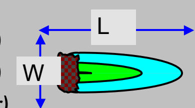
Retardation Factor*	*R*	182.9	*(-)*
or		or	
Soil Bulk Density	*rho*	1.7	*(kg/l)*
Partition Coefficient	*Koc*	21400	*(L/kg)*
FractionOrganicCarbon	*foc*	1.0E-3	*(-)*

4. BIODEGRADATION

1st Order Decay Coeff*	*lambda*	8.5E+1	*(per yr)*
or		or	
Solute Half-Life	*t-half*	0.0082	*(year)*
or Instantaneous Reaction Mode			
Delta Oxygen*	*DO*	0	*(mg/L)*
Delta Nitrate*	*NO3*	0	*(mg/L)*
Observed Ferrous Iron*	*Fe2+*	0	*(mg/L)*
Delta Sulfate*	*SO4*	0	*(mg/L)*
Observed Methane*	*CH4*	0	*(mg/L)*

5. GENERAL

Modeled Area Length*	30	*(ft)*
Modeled Area Width*	30	*(ft)*
Simulation Time*	25	*(yr)*



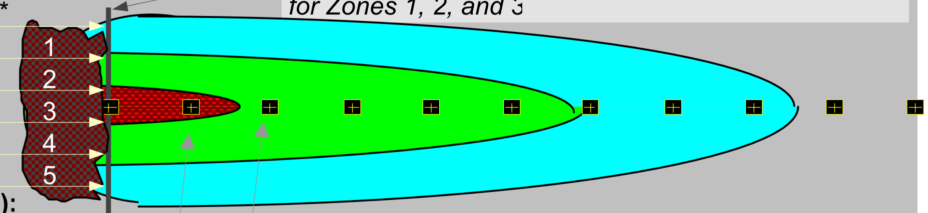
6. SOURCE DATA

Source Thickness in Sat.Zone* 5 *(ft)*

Source Zones:

Width* (ft)	Conc. (mg/L)*
4	0.0005
6	0.001
10	0.002
6	0.001
4	0.0005

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Source Halflife (see Help):

Inst. React.	1st Order	
Infinite	Infinite	*(yr)*

Soluble Mass infinite *(Kg)*
In Source NAPL, Soil

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)											
Dist. from Source (ft)	0	3	6	9	12	15	18	21	24	27	30

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | **View Output**

RUN ARRAY | **View Output**

Help

Recalculate This Sheet

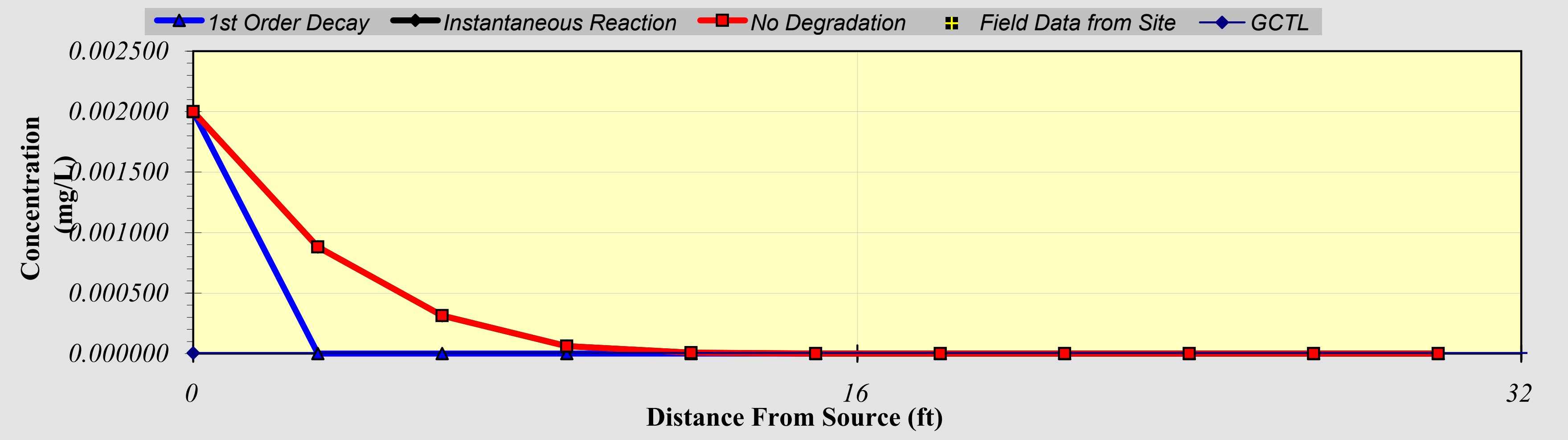
Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	3	6	9	12	15	18	21	24	27	30
No Degradation	0.002000	0.000881	0.000313	0.000062	0.000006	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
1st Order Decay	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Inst. Reaction	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site											



Replay Animation

Next Timestep

Prev Timestep

Time:

5 Years

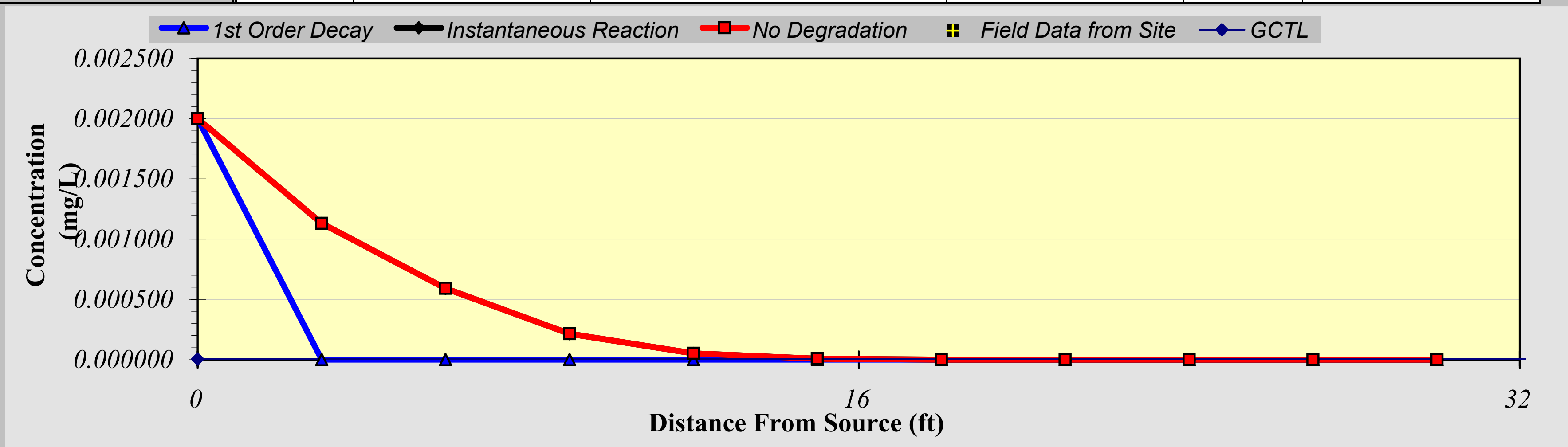
Return to Input

Recalculate This Sheet

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	3	6	9	12	15	18	21	24	27	30
No Degradation	0.002000	0.001132	0.000592	0.000215	0.000052	0.000008	0.000001	0.000000	0.000000	0.000000	0.000000
1st Order Decay	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Inst. Reaction	0.002	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site											



Replay Animation

Next Timestep

Prev Timestep

Time:

8 Years

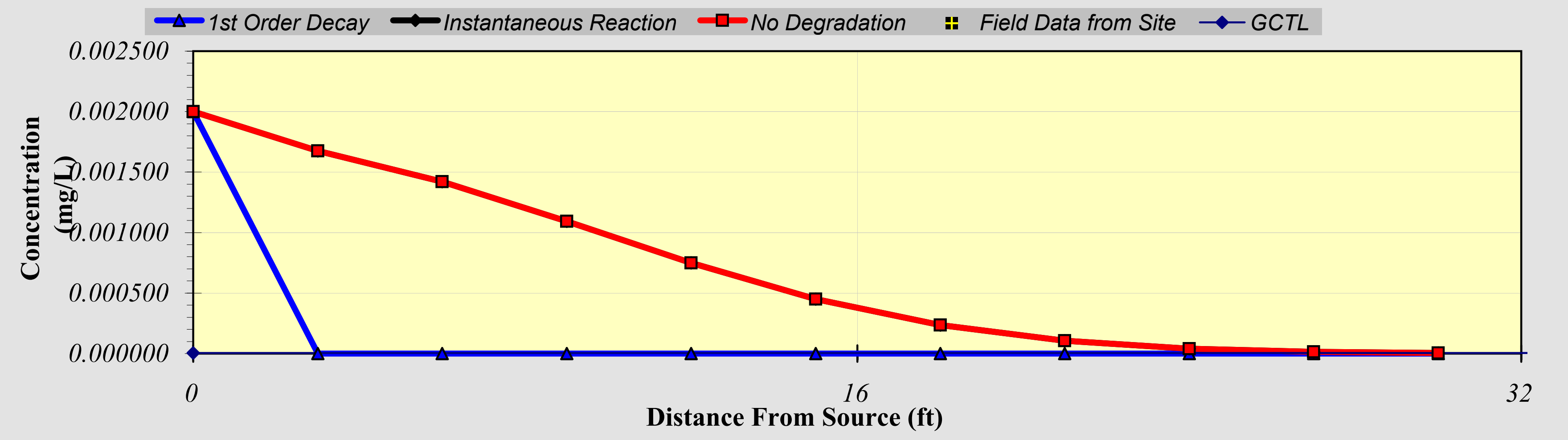
Return to Input

Recalculate This Sheet

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	3	6	9	12	15	18	21	24	27	30
No Degradation	0.002000	0.001676	0.001420	0.001092	0.000749	0.000451	0.000236	0.000106	0.000041	0.000013	0.000004
1st Order Decay	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Inst. Reaction	0.002	0.002	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site											



Replay Animation

Next Timestep

Prev Timestep

Time: 20 Years

Return to Input

Recalculate This Sheet