BECKER ENVIRONMENTAL 7 Inc.

ACCELERATING BIOREMEDIATION USING A PARTICULAR SURFACTANT

By
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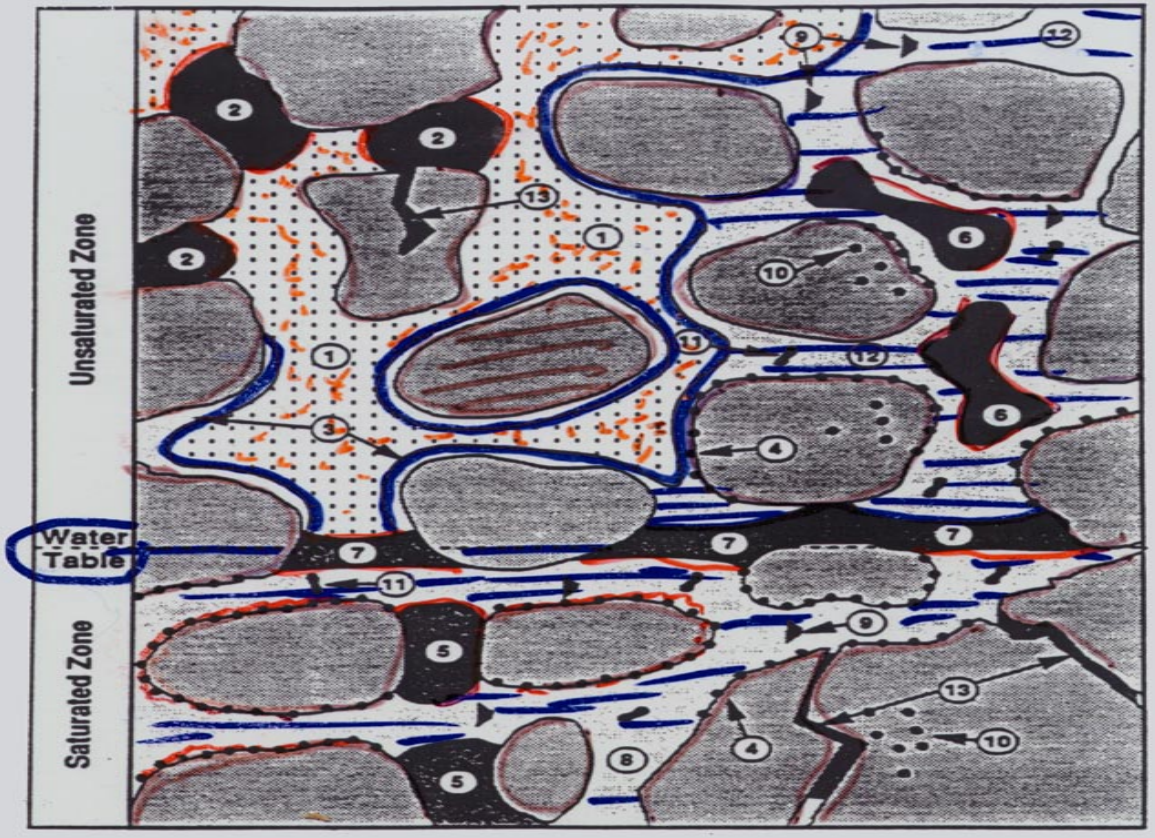
DISPOSITION OF NAPL'S IN THE SOIL MATRIX



Source: Lyman, Reidy & Levy. 1991.

Figure 3. Loci Schematic

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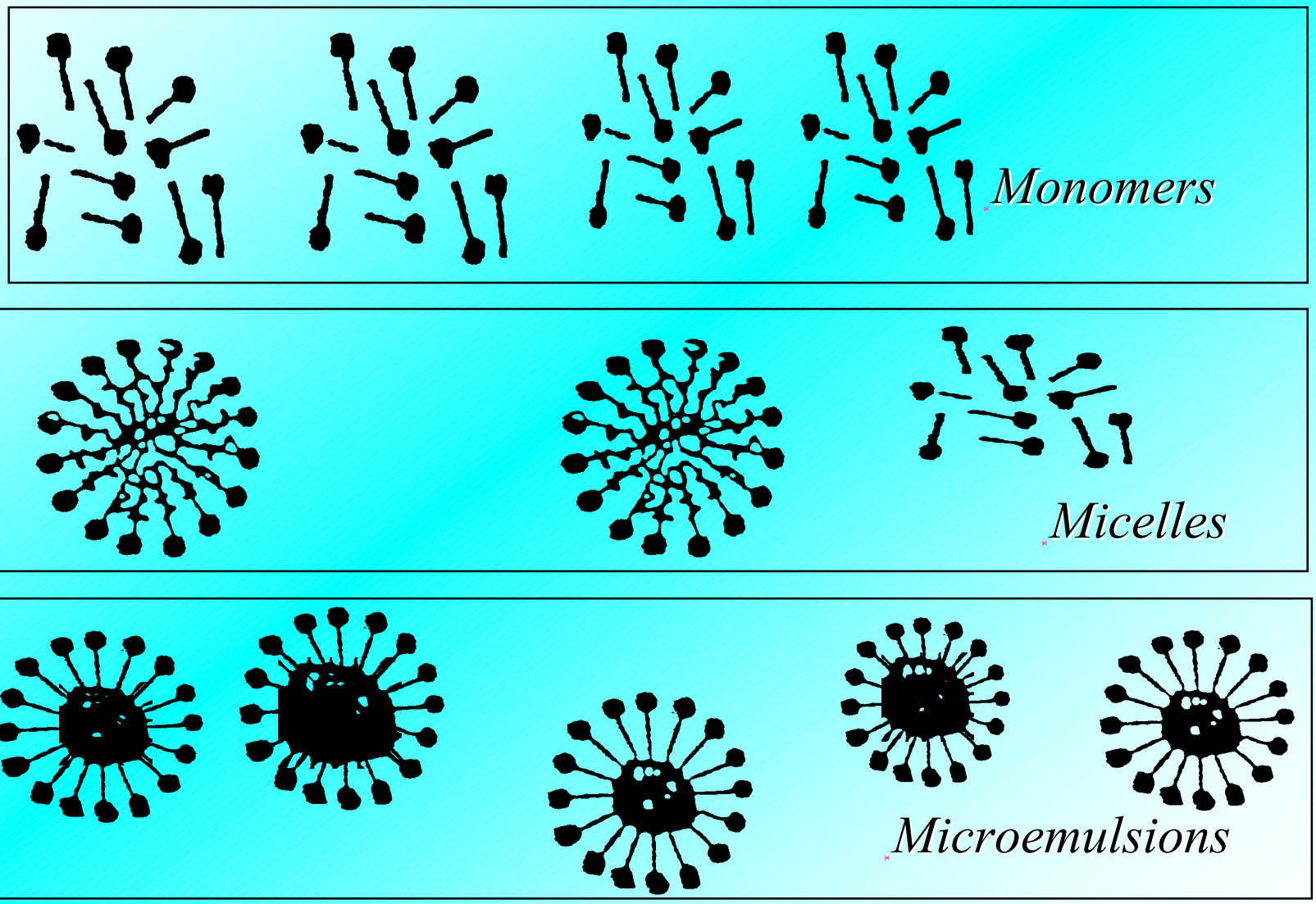
Surfactants



USING A SURFACTANT

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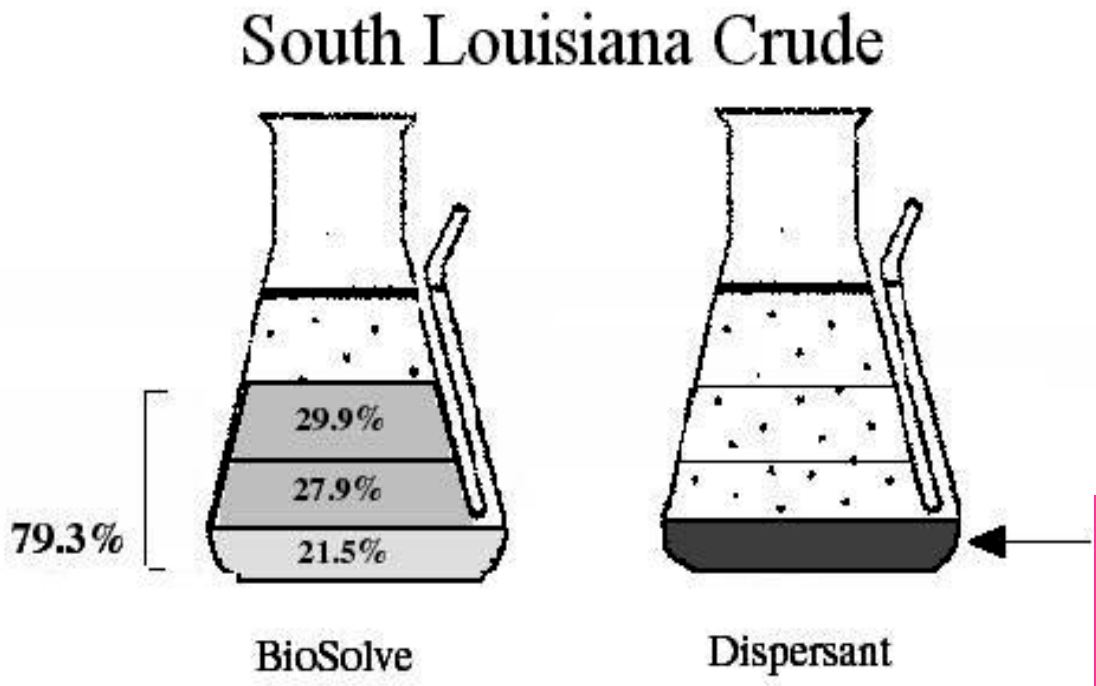
Swirling Flask Dispersant Effectiveness Test using (1-10) South Louisiana Crude

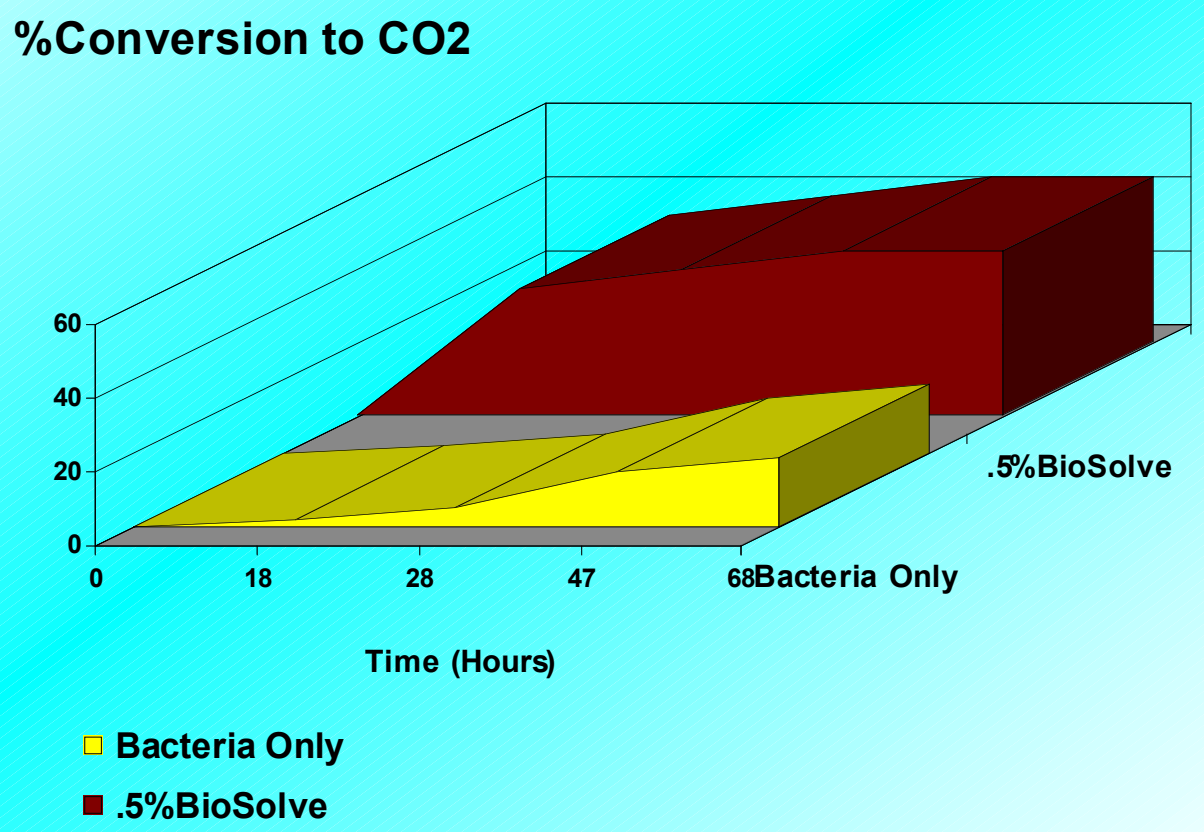


40 CFR Part 300 requires 45% minimum oil dispersion to lower 30 mls.

89.8%	% Oil in the lower 30 mls. of current listed dispersants as of 3/97
63.4%	
54.7%	
68.0%	
84.1%	

BioSolve (1-5) does not sink oils like dispersants (1-10) are designed to do. Even at twice the concentration. BioSolve is designed to allow the hydrocarbons to remain buoyant for recovery or biodegradation.

CO_2 CONVERSION WITH & WITHOUT SURFACTANT



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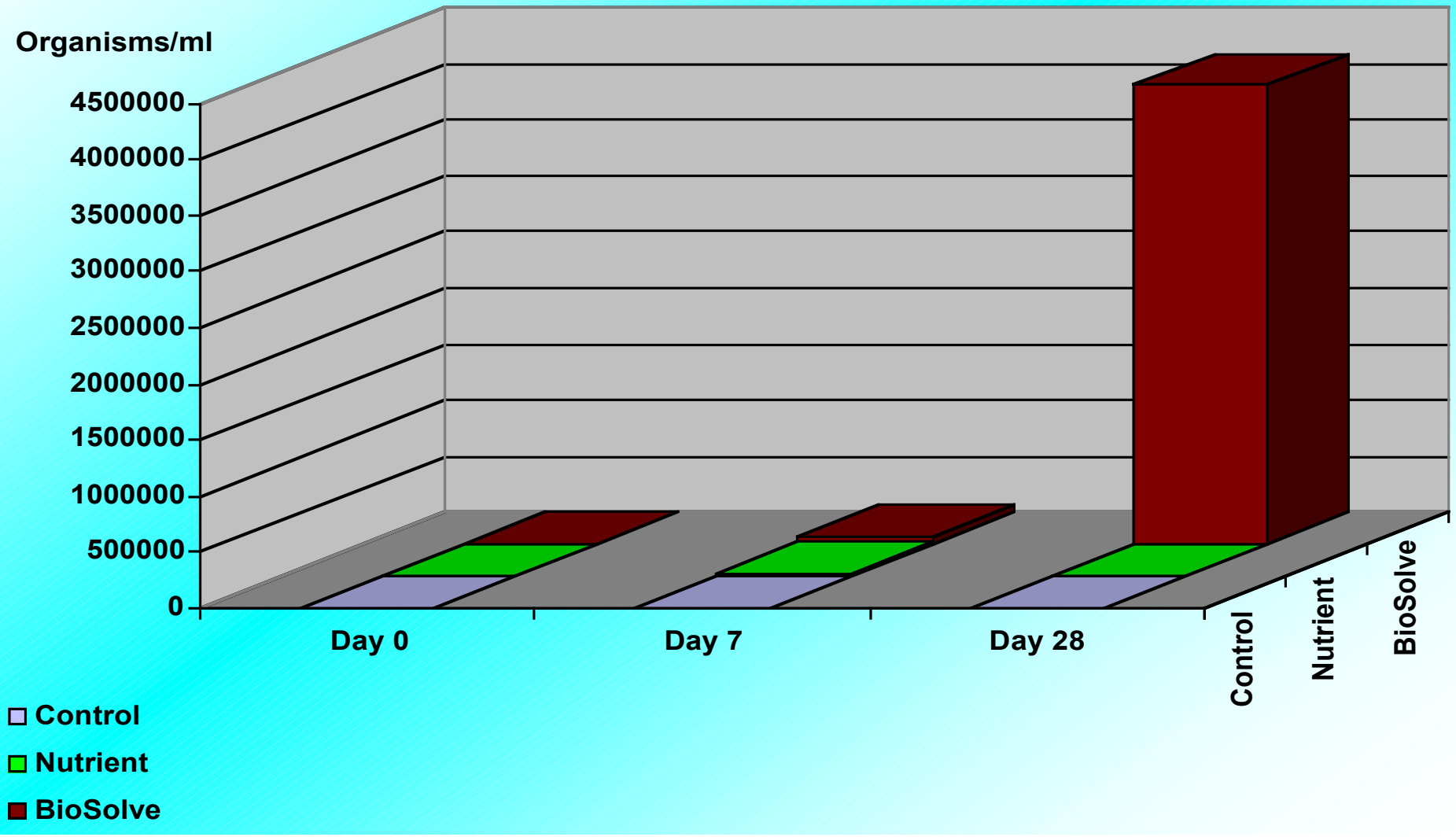
MICROBIOLOGICAL ENUMERATION of HYDROCARBON DEGRADERS



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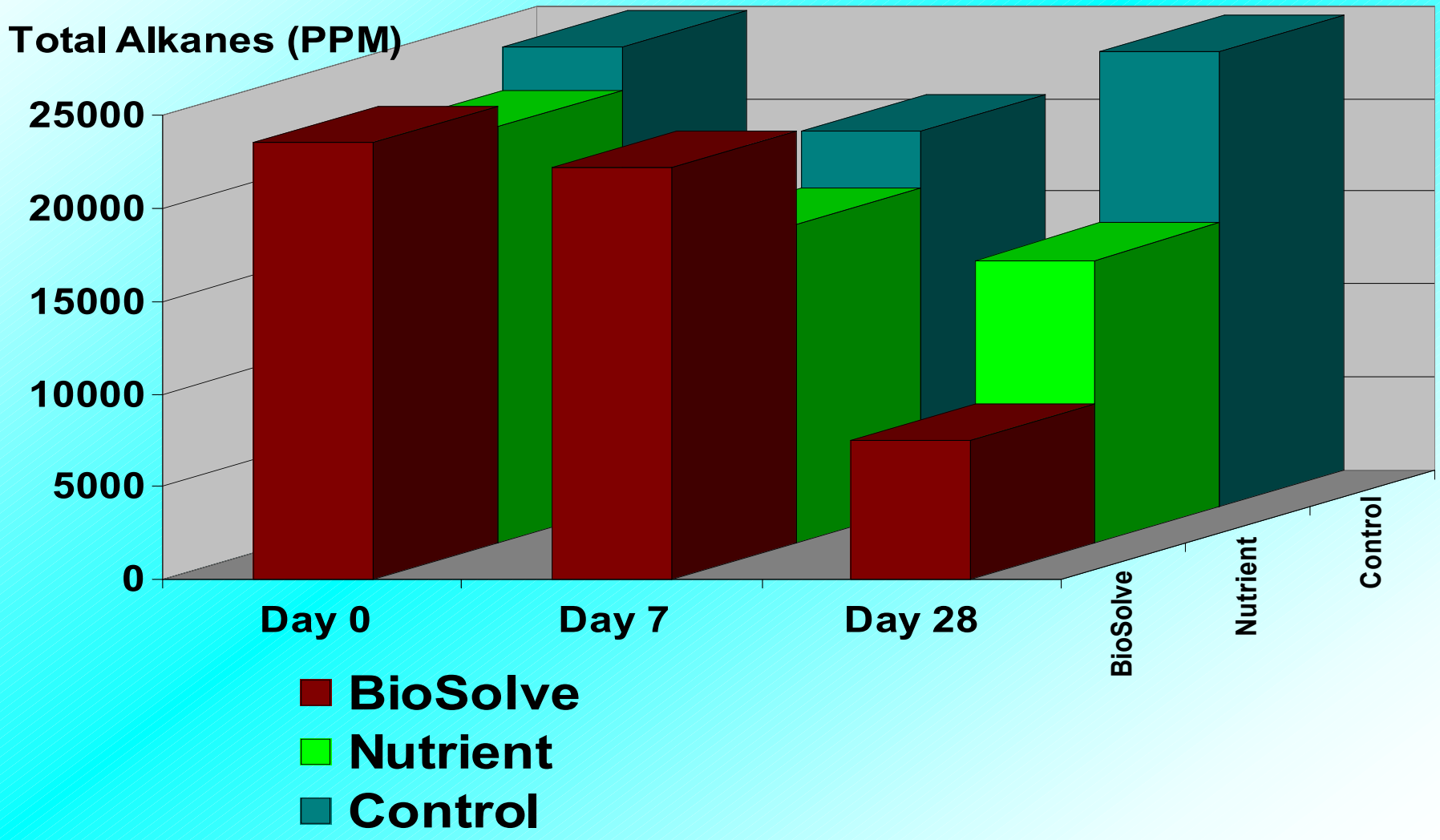
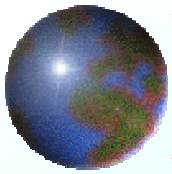
SURFACTANT EFFECT on ALKANE DEGRADATION





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PROTOCOL for CO2 PRODUCTION TESTS USING SURFACTANT

- MIX SOIL & DIVIDED INTO TWO = PARTS
- ADD = PARTS RADIOACTIVE CARBON MARKED CONTAMINANT
- ADD = PARTS WATER, ONE PART WATER ONLY AND PART WATER + SURFACTANT
- ENCLOSE AND MEASURE CO2 CONVERSION
- 5 TESTS W/ DIFFERENT CONTAMINATES AND/OR DIFFERENT LEVELS OF CONTAMINATION

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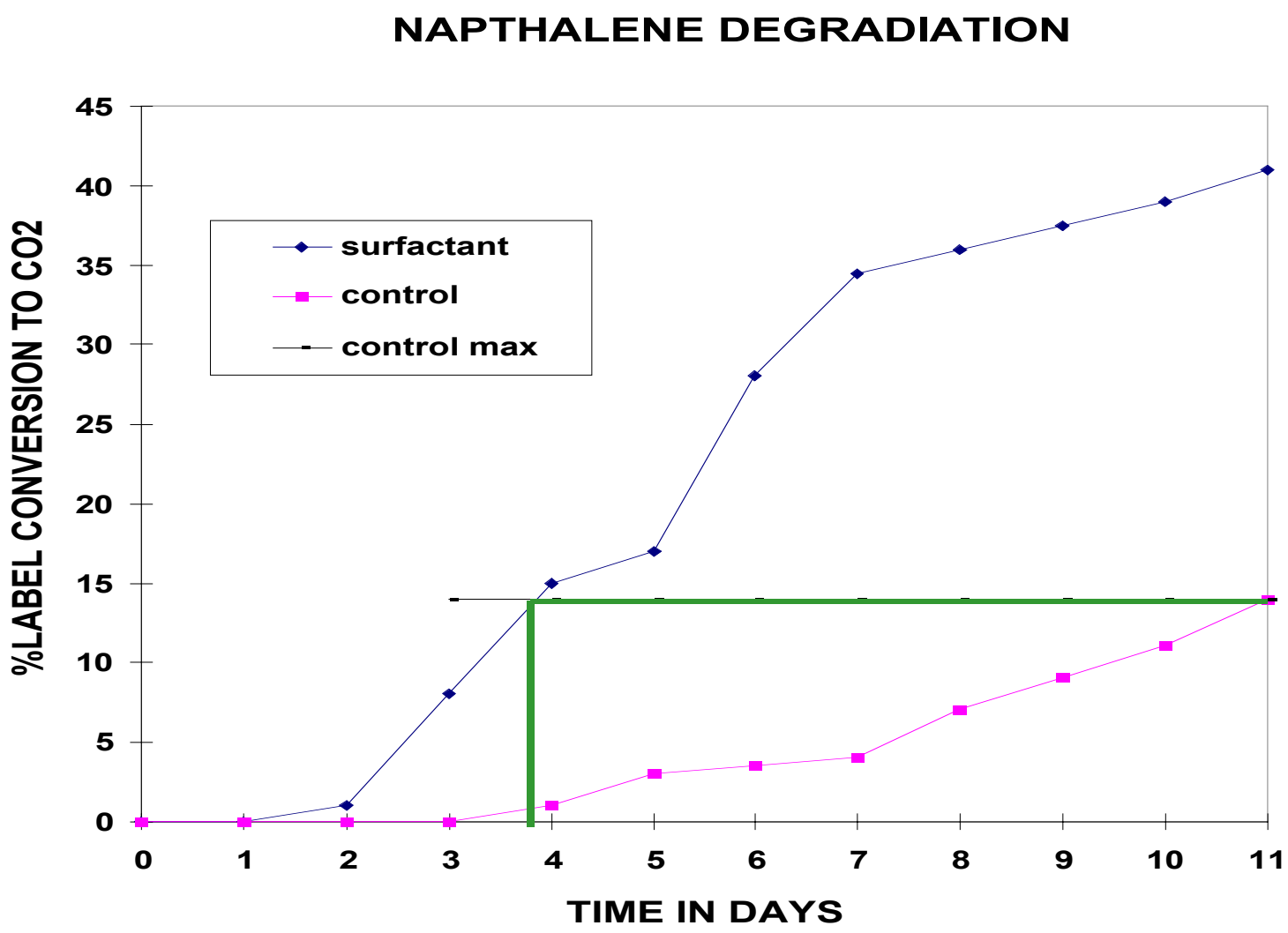
TEST #1. LIGHT REFINED HYDROCARBON



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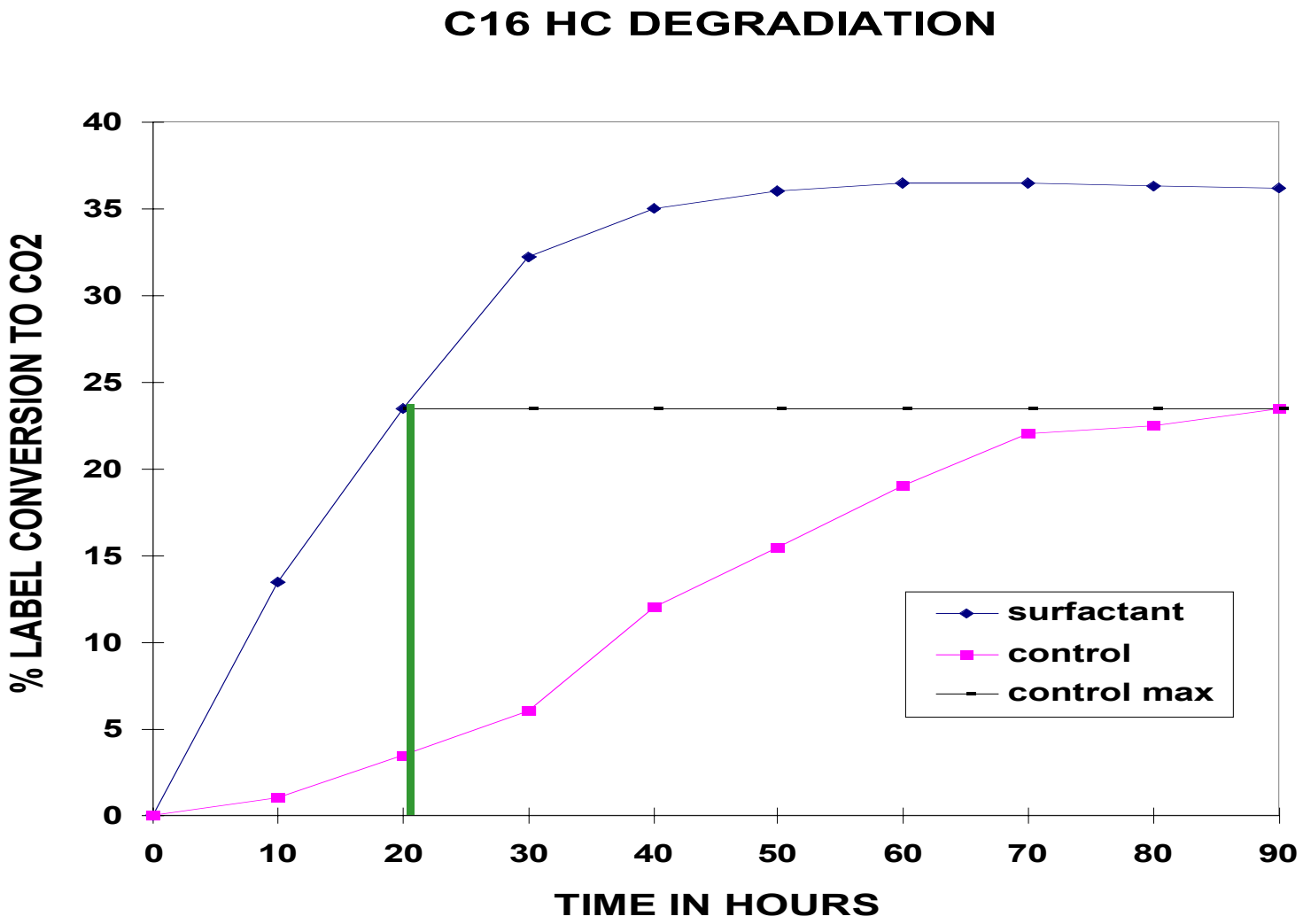
TEST #2 CRUDE OIL CONTAMINATION



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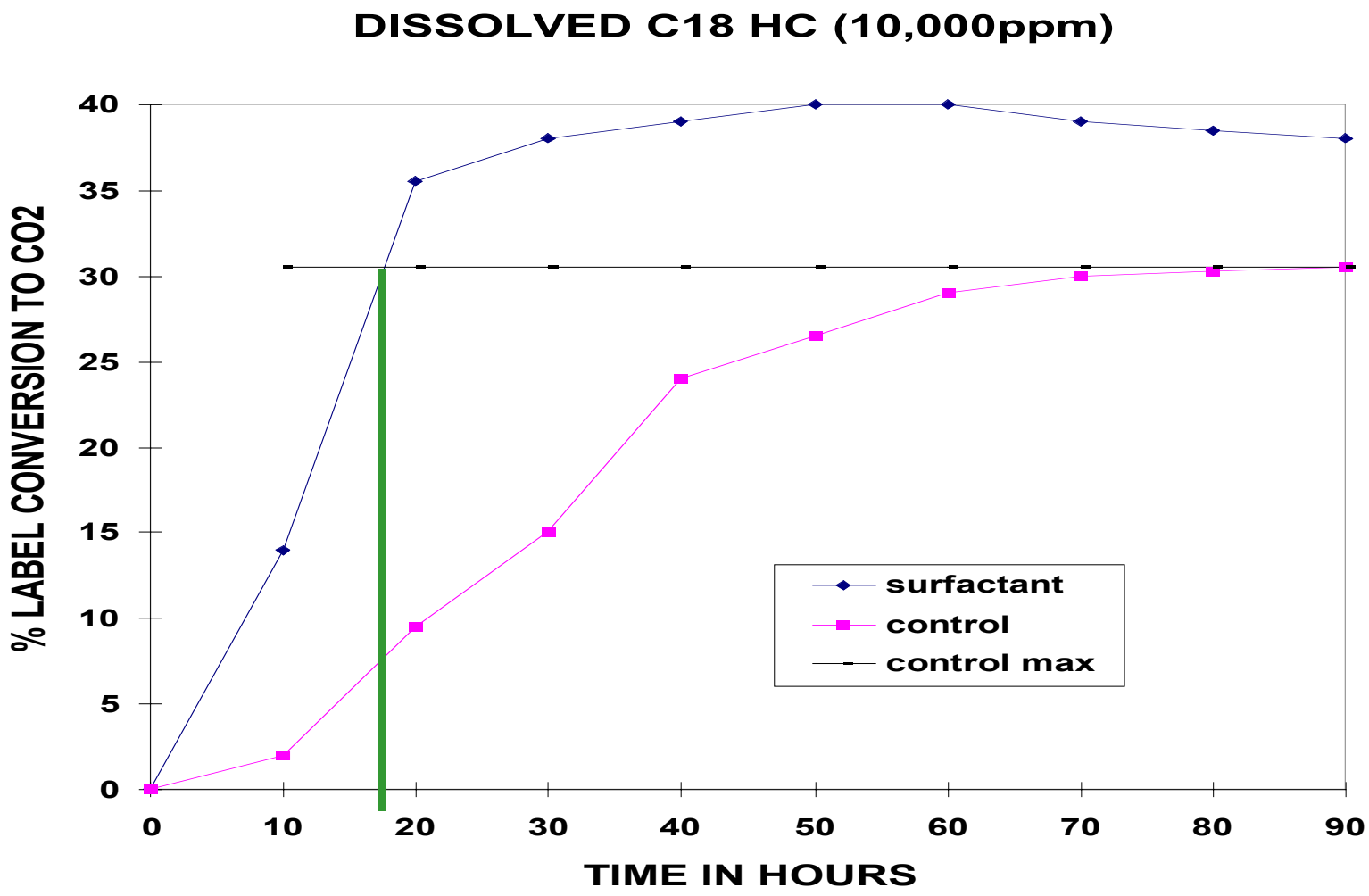
TEST #3 HEAVY CRUDE OIL ON WET SOIL



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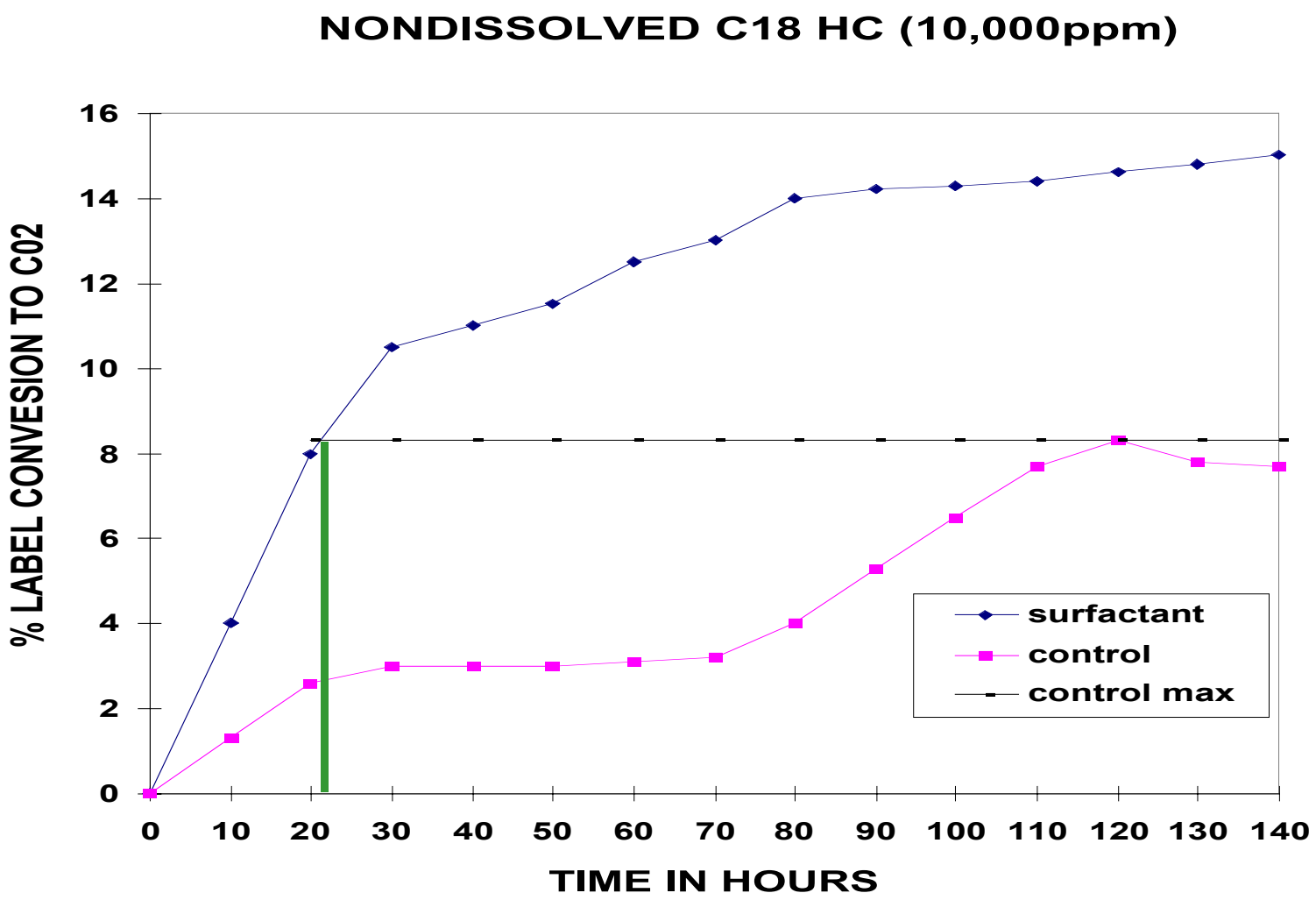
TEST #4 HEAVY CRUDE OIL ON DRY SOIL



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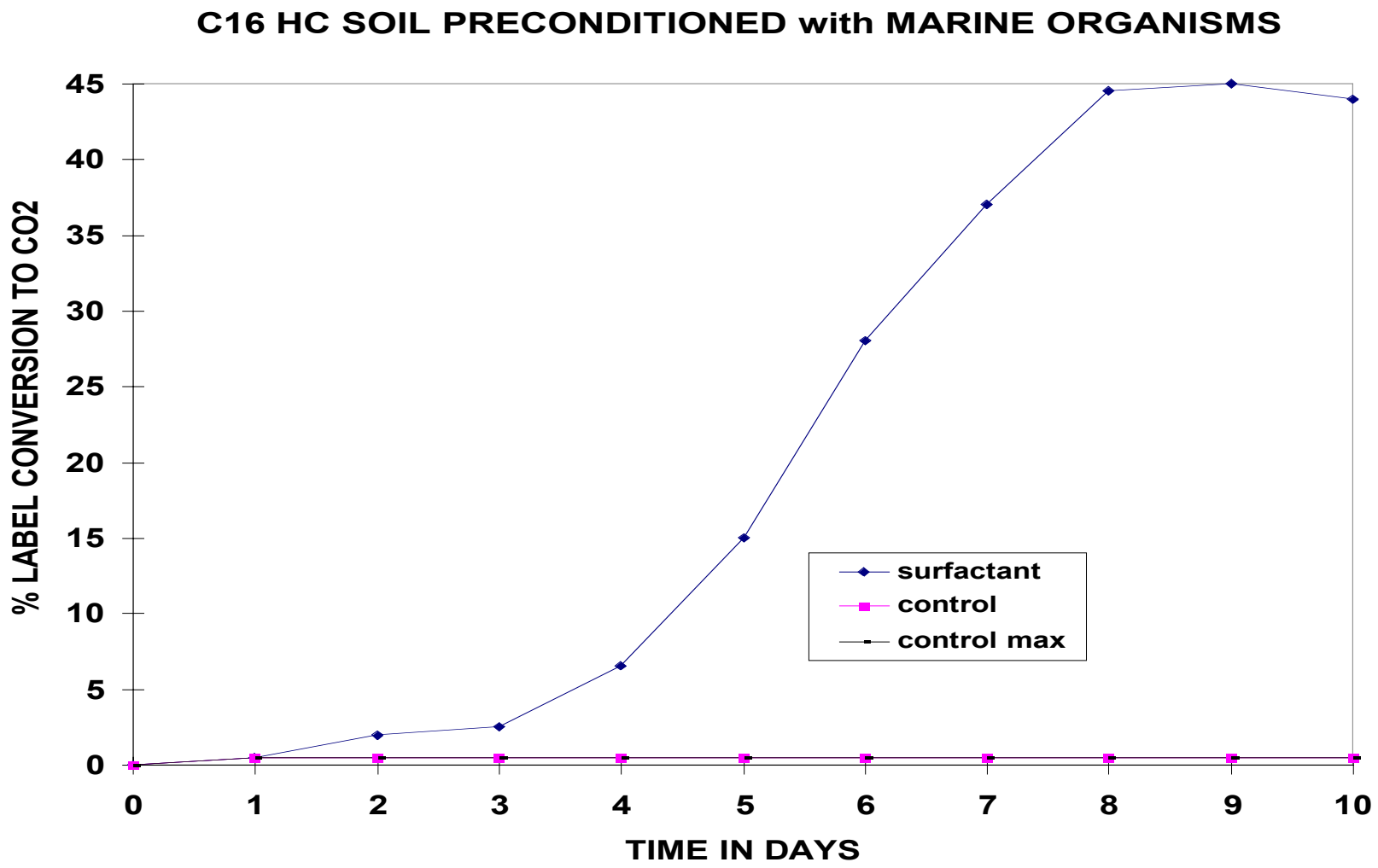
TEST #5 HEAVY CRUDE OIL ON BEACH SAND



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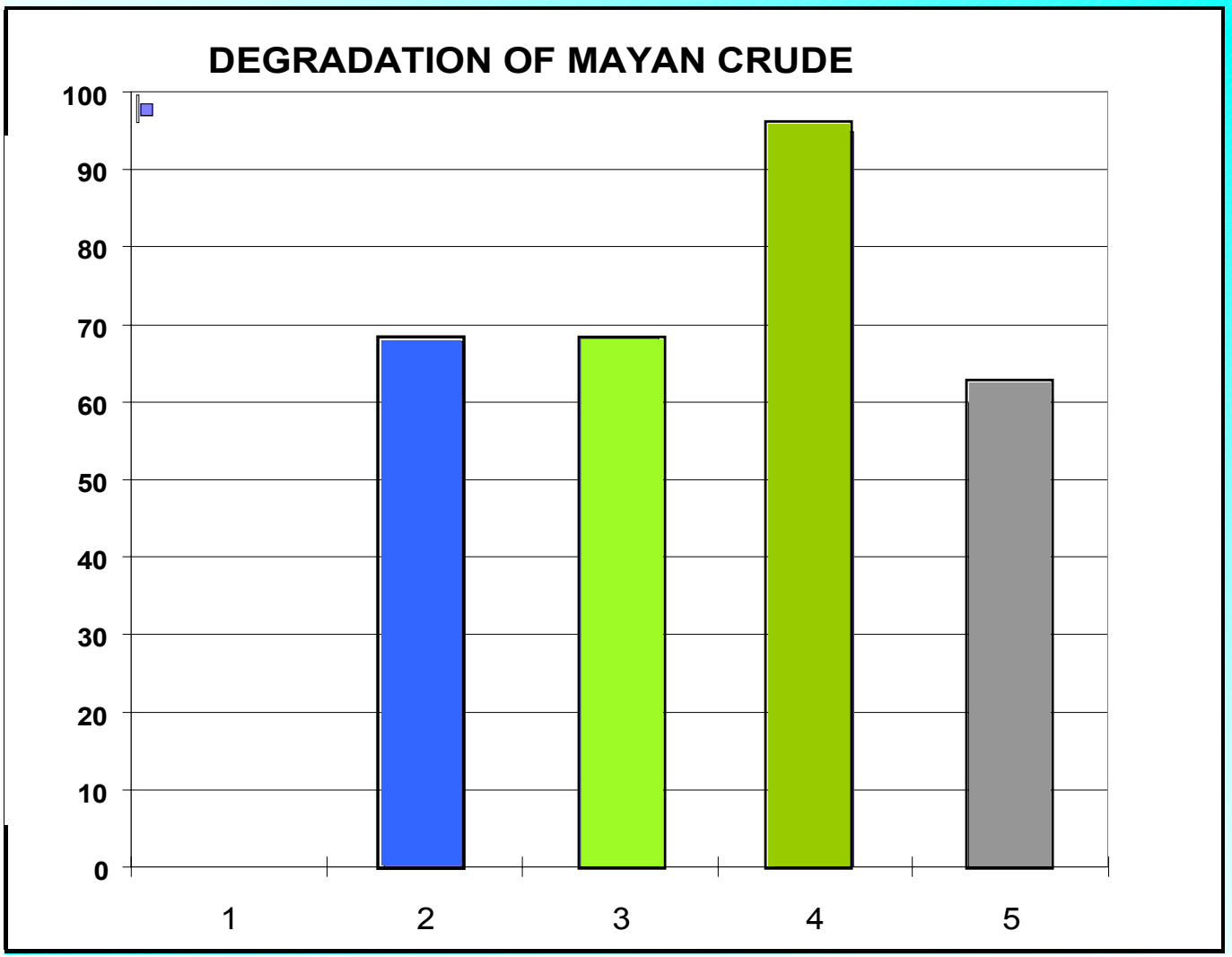
COMPARISON of % DEGRAGIATION of TWO SURFACTANTS & CONCENTRATION



 # 1 contaminated soil

#2 microorganisms, nutrients & aeration;

#3 microorganisms, nutrients , aeration and 0.5% BioSolve

#4 microorganisms, nutrients and aeration and 5.0% BioSolve.

#5 microorganisms, nutrients, aeration and another surfactant

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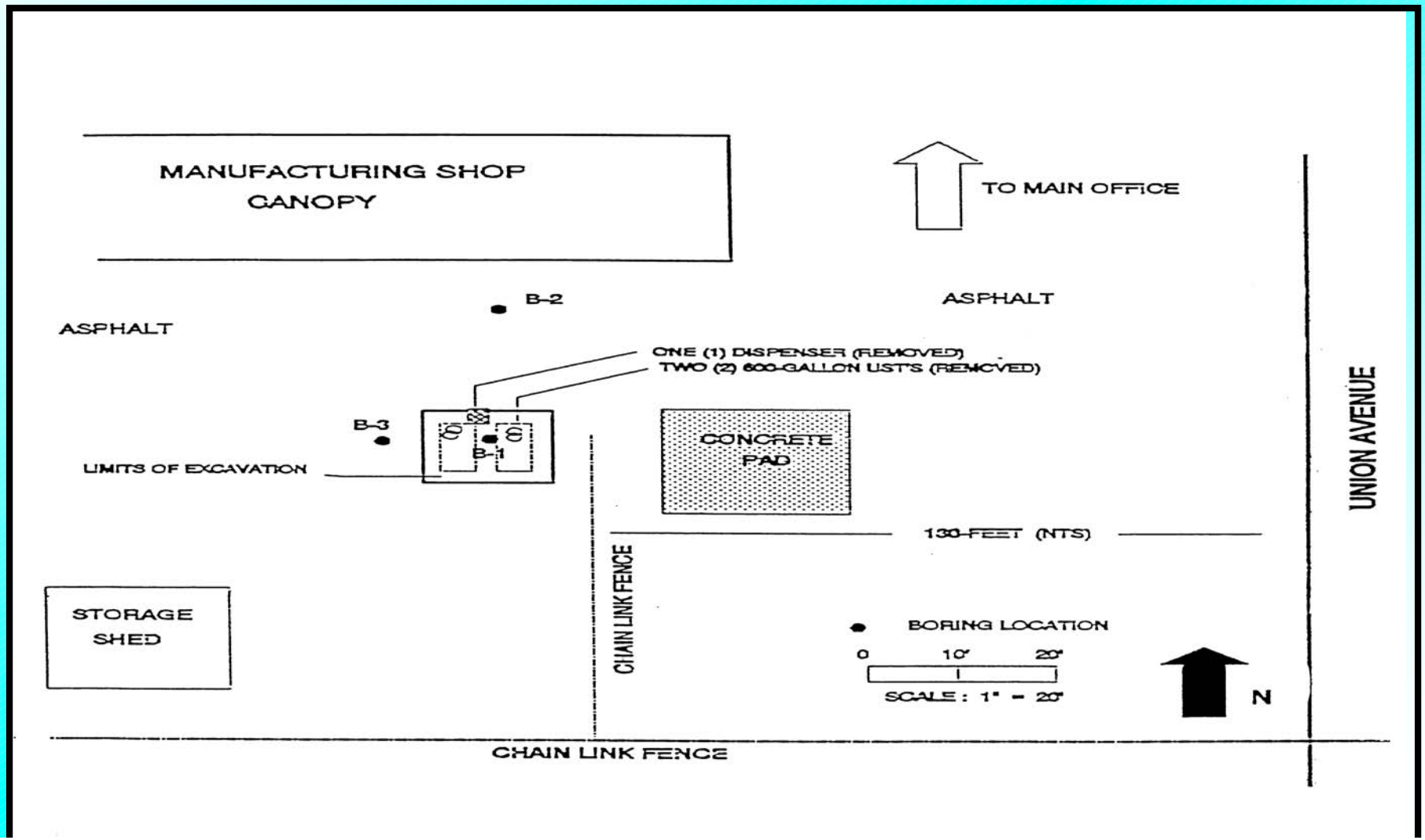
CASE STUDY OF IN-SITU BIOREMEDIATION with a SURFACTANT



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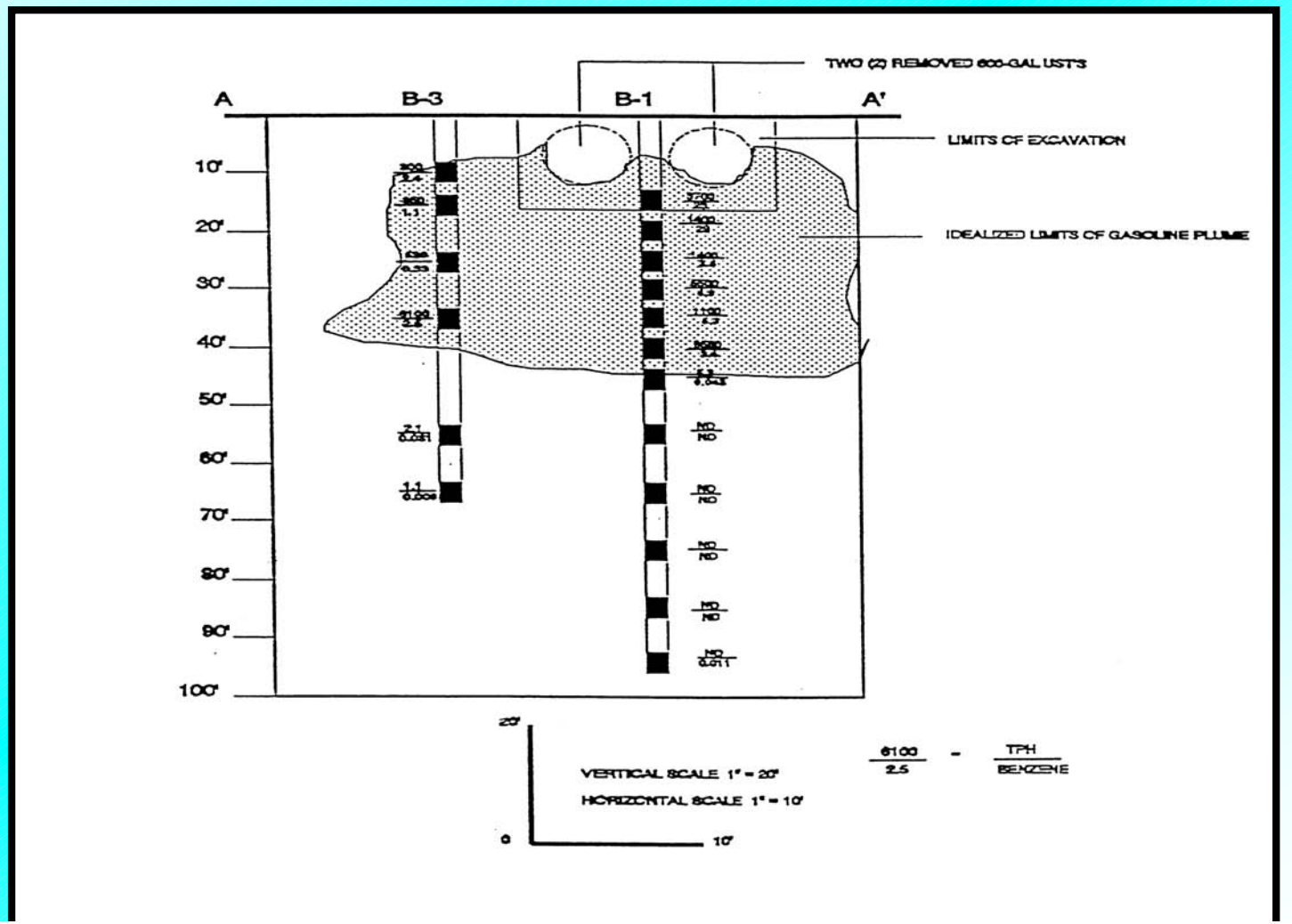

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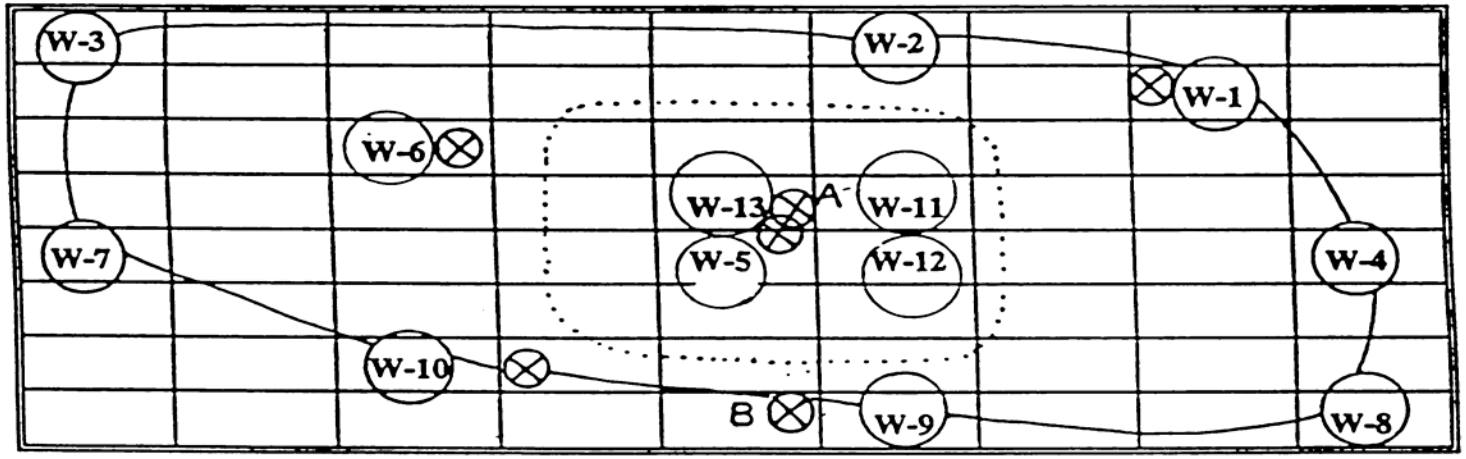
CASE STUDY OF IN-SITU BIOREMEDIATION with a SURFACTANT

SITE PLAN

LEGEND (NOT TO SCALE)

SAMPLING SPOT
PLUME AREA
INOCULATION/MONITORING WELLS

ERNST MANUFACTURING SITE - GRID LAYOUT OF MONITORING WELL LOCATIONS



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EVENT DATE	DESCRIPTION of ACTIVITY	VOC in ppm LOW	AVE	HIGH
8/6/93	Wells installed and intial reading	210	4100	9600
8/7/93	Initial nutrient and water addition on new wells	200	3835	8750
8/9/93	Second nutrient treatment. Vapor recovery installed	200	2925	8500
8/17/93	2% BioSolvetm to all but one well OVA/PID VOC readings	9	1230	10000
8/18/93	Inoculation of microorganisms, nutrients and BioSolve			
8/20/93	OVA/PID readings for VOC's	10	119	1000
9/10/93	Inoculation of nutrients and BioSolve			
9/22/93	Inoculation of nutrients and BioSolve OVA/PID readings	18	177	1500
10/1/93	Inoculation of nutrients and BioSolve			
10/6/93	Inoculation of nutrients and BioSolve OVA/PID readings	10	45	350
10/13/93	OVA/PID readings for VOC's	15	54	104
10/21/93	OVA/PID readings for VOC's	14	49	200
10/28/93	OVA/PID readings Inoculation of nutrients and BioSolve	12	31	110
11/15/93	OVA/PID readings for VOC's	10	36	120
11/30/93	OVA/PID readings for VOC's	10	31	86
12/07/93	OVA/PID readings Inoculation of nutrients and BioSolve	10	38	100
12/22/93	OVA/PID readings for VOC's and soil sample	10	26	105
1/10/94	Inoculation of nutrients and BioSolve			
1/20/94	OVA/PID readings Inoculation of nutrients and BioSolve	5	22	80
2/10/94	OVA/PID readings for VOC's	8	16	50
2/25/94	OVA/PID readings for VOC's	5	12	28
3/01/94	**SOIL TESTS WERE BELOW DETECTABLE LIMIT**	.005	.005	.005
5/15/94	SITE CLOSED			

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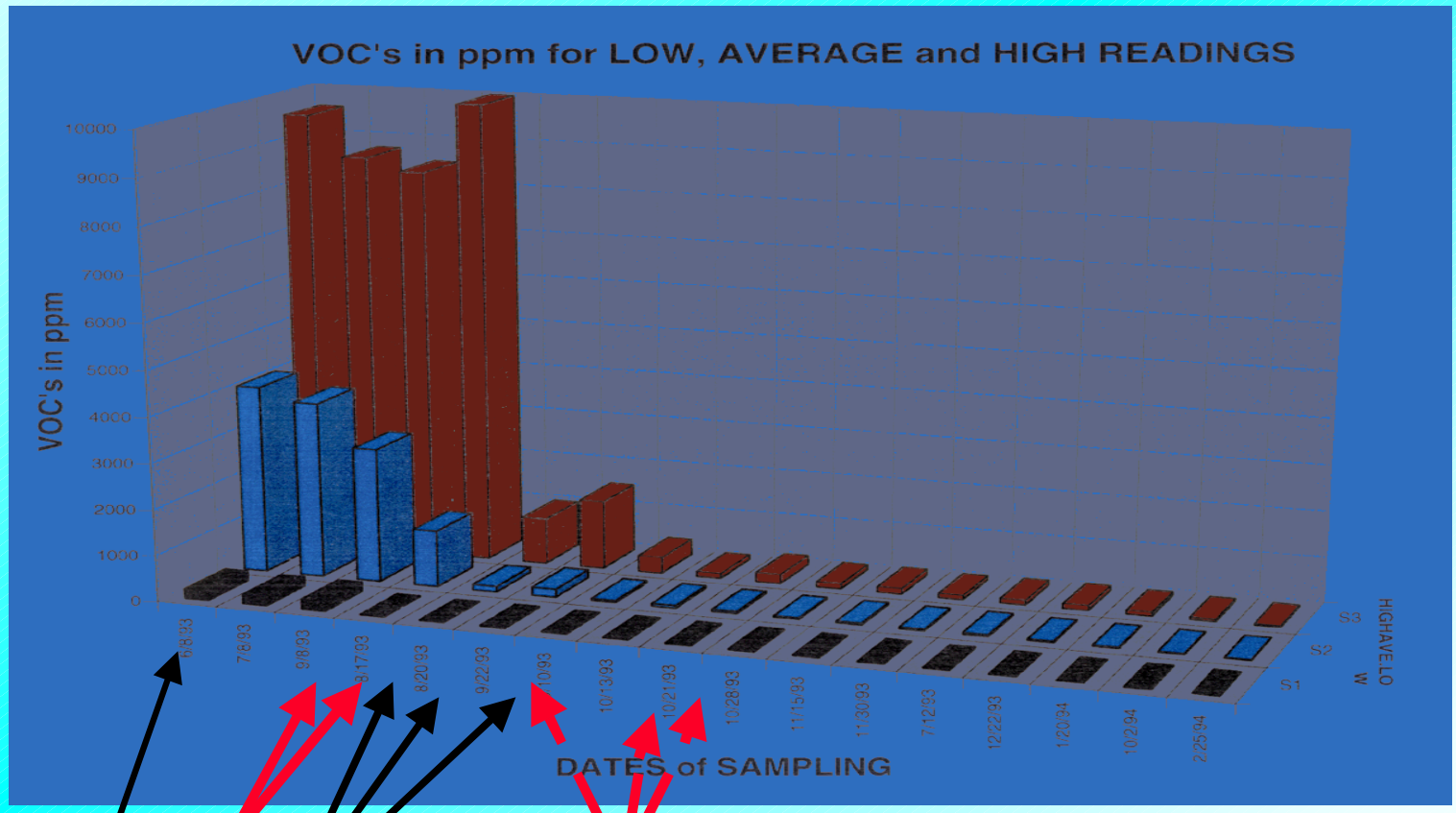
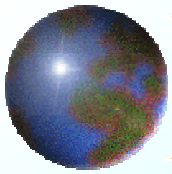
CASE STUDY OF IN-SITU BIOREMEDIATION SURFACTANT



BIOSOLVE ADDED ON THESE DATES

NUTRIENTS & WATER ADDED ON THESE DATES



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SERVICE STATION CASE STUDY

5/29/93-4/16/97- LNAPL under former pump island

Manually bailed no change

No receptors, urban area and no cost effective permanent remedial system

3 monitoring wells & soil borings 11SFx0.03F = 170gals.

7/23/97 Inject 250 gals. of 2% BioSolve® and and surge blocked

7/24/97 2 wells manifolded to vacuum truck

35.74# of HC vapor +255 gals of emulsion recovered

8/11/97 No LPH detected

9/2/97 No LPH detected

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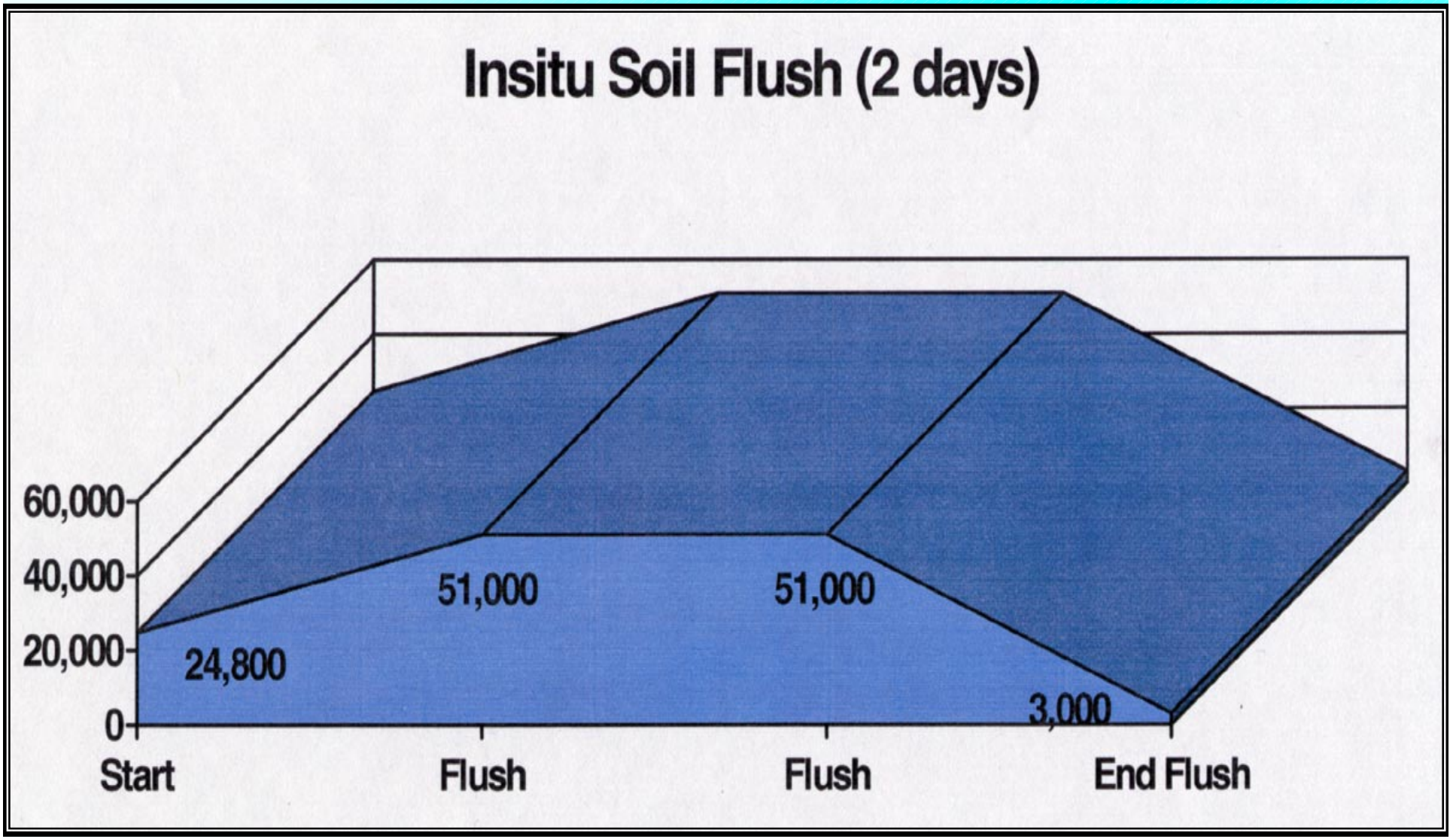
SOIL FLUSHING UNDER RAILROAD TRACKS



The End

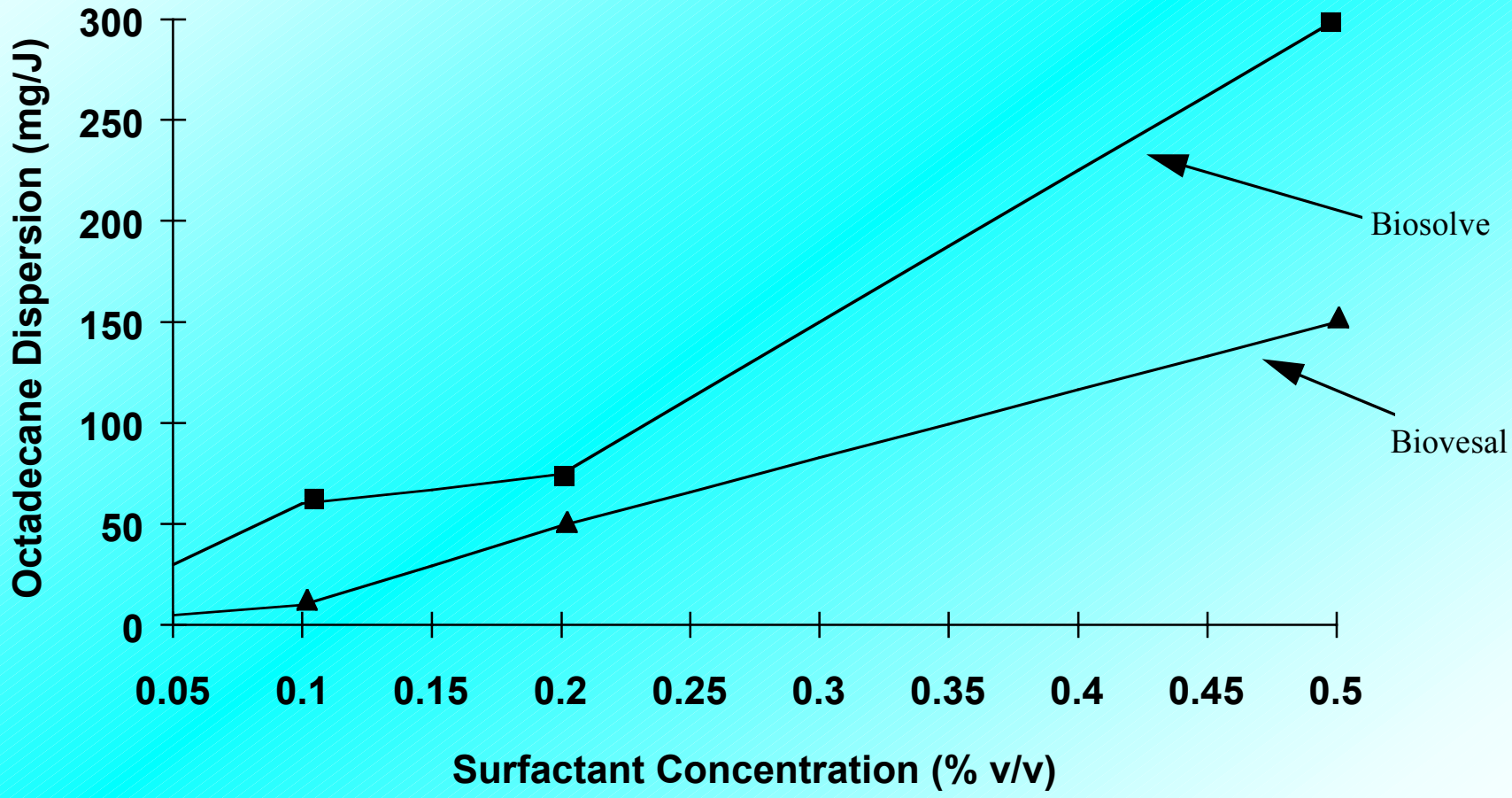
DISPOSITION OF NAPL'S IN THE SOIL MATRIX

→Evaporate and stay in the vapor phase,

→Dissolved into the soil moisture

→Adsorb onto solid surfaces

2 SURFACTANTS AQUEOUS DISPERSION of OCTADACANE



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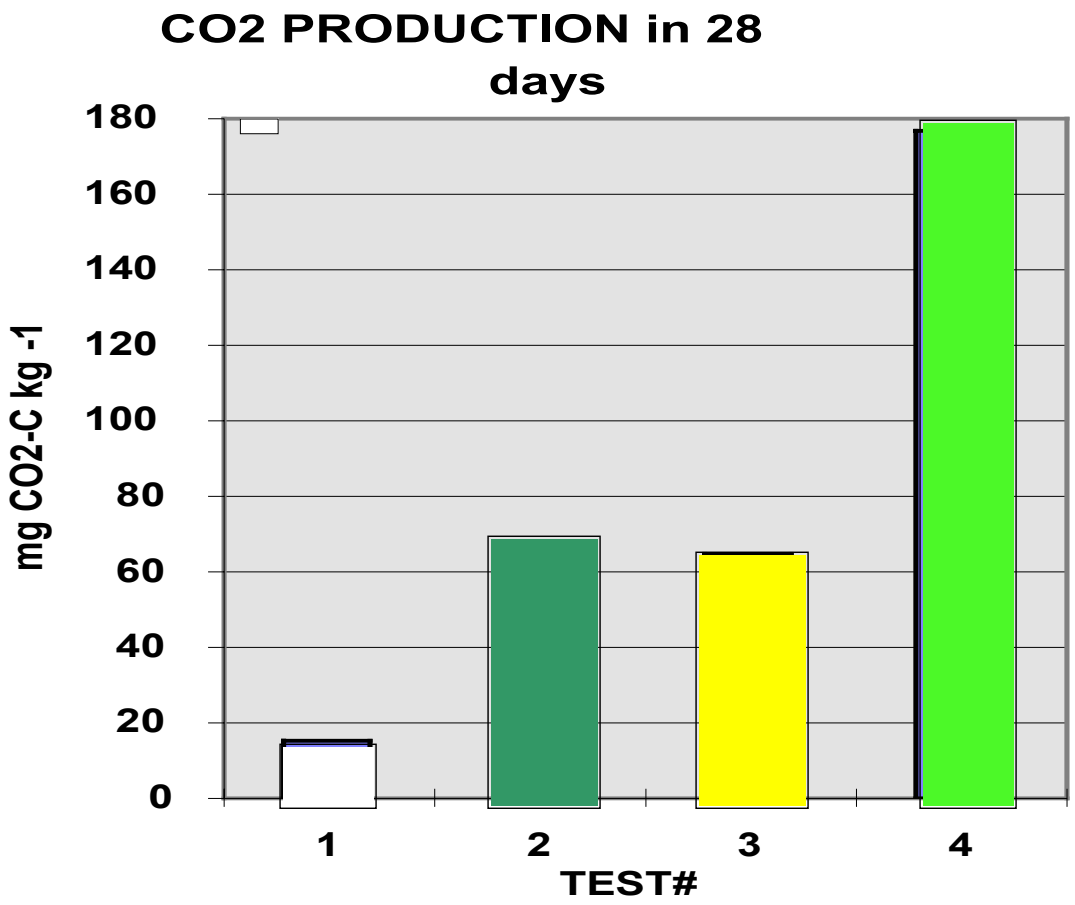

TESTS

#1 STERILE SOIL + H2

#2 STERILE SOIL + H2O + BIOSOLVE

#3 STERILE SOIL + H2O + OIL

#4 STERILE SOIL + H2O +0IL + BIOSOLVE

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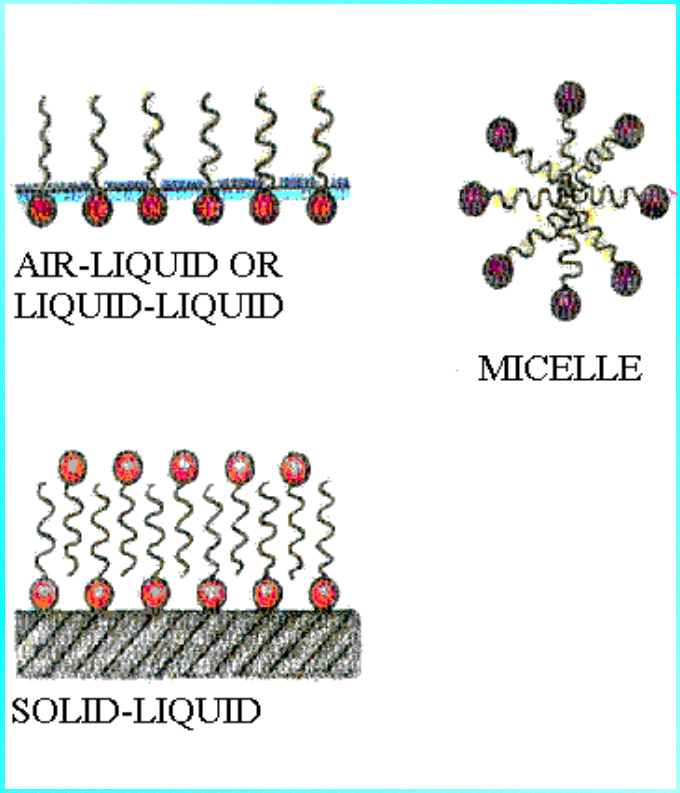
How BioSolve ® Works

Hard surface degreasers can form a variety of micelles types.

Foams "line up like soldiers" to create a film on top of the fuel



BioSolve's ® surfactants form spherical micelles which surround the hydrocarbon molecules forming microemulsions

Patented Technology

BioSolve's ® patented blend of surfactants creates an emulsification and an encapsulation

- One surfactant solublizes oil, but is non-water soluble
- The other surfactant solublizes the emulsion into the water

The BioSolve ® Difference

- Dispersants create droplets
  - Droplets are large particles
- BioSolve ® creates microemulsions
  - University testing measuring solublized oil concluded that BioSolve's ® microemulsion size particles were similar to a naturally occurring bacterium's biosurfactant microemulsions
    - University of Alabama