DLD Rec'd 4/10/97

40-7604

BP CHEMICALS

BP Chemicals Inc.
Ft. Amanda Road
P.O. Box 628
Lima, Ohio 45802-u628
(419) 226-1200

VIA OVERNIGHT MAIL

Mr. Sam Nalluswami
Low-Level Waste and Decommissioning Projects Branch
Division of Waste Management
Office of Nuclear Materials and Safeguards
United States Nuclear Regulatory Commission
Two White Flint North
11545 Rockville Road
North Bethesda, MD 20852

December 10, 1996

Re: License No. SUB-908
Docket No. 040-07604

Subject: Mixed Waste Pond Closure Project
Field Change No. 016

Dear Sir:

In accordance with the mixed waste pond closure project field change approval procedure (BPCI Administrative Procedure AP-02), BP Chemicals, Inc. (BPCI) herewith submits for NRC review proposed Field Change No. 016. This field change will provide a detailed specification for a french drain to be installed in the west anchor trench of Cell #1. The french drain will intercept infiltrating water originating from unknown sources to the west of the cell to prevent the water from leaking under the liner. The proposed design will maintain adequate stability of the anchor trench and liner system.

Included for your review is a copy of Dames & Moore Calculation No. BUF-96-112.

Your concurrence for this proposed field change is requested. This proposed field change has also been submitted to Ohio EPA. If there are any questions, please give me a call at (419) 226-1299.

Sincerely,

William M. Rupert, PE
Project Manager

cc: Ed Kulzer, USNRC Region 3
Jim Ottarson, Ohio EPA
Ruth Vandegrift, ODH

1/1
NL10

BP CHEMICALS, INC.
MIXED WASTE POND CLOSURE PROJECT

FIELD CHANGE REQUEST FORM

Field Change Number: 016 **Date:** 10/31/96

Subject: French Drain for West Side of Cell No. 1

Description: Provide a French Drain to intercept water infiltration from unknown source west of Cell No. 1.

Justification: Uncontrolled infiltration could leak under liner. Proposed Anchor Trench Design allows installation of French Drain in Anchor Trench while maintaining adequate stability of the trench and liner system.

Attachments: D & M Calculation BUF-96-112

Requested by: W. M. Rupert BPCI 10/21/96
Signature Company Date

BPCI Project Approvals

Dames & Moore Certifying Engineer	Robert R. Blickwedehl	(Yes) No	12/6/96
	Signature	Approval	Date
BPCI Radiation Safety Officer	NOT APPLICABLE	Yes No	—
	Signature	Approval	Date
BPCI HSE Manager	NOT APPLICABLE	Yes No	—
	Signature	Approval	Date
BPCI Project Manager	[signature]	(Yes) No	12/9/96
	Signature	Approval	Date

Regulatory Agency Concurrence

Ohio EPA Concurrence		Yes No	
	Signature	Concur	Date
NRC Concurrence		Yes No	
	Signature	Concur	Date

BP CHEMICALS, INC.

MIXED WASTE POND CLOSURE PROJECT

FIELD CHANGE REQUEST FORM

Field Change No. 016 Date: 10-31-96

Subject: ANCHOR TRENCH WITH FRENCH DRAIN FOR WEST SIDE OF V-1 CELL.

Description: CONSTRUCT ANCHOR TRENCH ALONG WEST EDGE OF V-1 CELL IN ACCORDANCE WITH SKETCH ON SHEET 2 OF ATTACHED CALCULATION BUF-96-112. LOCATE INVERT OF DRAIN AND COLLECTION SUMP IN ACCORDANCE WITH ATTACHED SKETCHES. PROVIDE CLEANOUT AT EACH END PER ATTACHED SKETCH.

Justification: FRENCH DRAIN IS REQUIRED TO INTERCEPT SHALLOW GROUNDWATER TO PREVENT LEAKAGE UNDER LINER. REVISED ANCHOR TRENCH DESIGN MAINTAINS ADEQUATE STABILITY AS IS SHOWN BY ATTACHED CALCULATIONS.

Attachments:
- LAYOUT - FRENCH DRAIN - V-1 CELL (1 SHEET)
- FRENCH DRAIN DETAILS (1 SHEET)
- CALCULATION BUF-96-112 (14 SHEETS)

Initiator: [signature] DAMES & MOORE 10/31/96

Signature Company Date

Field Change Request Form

Field Change No. 016 Date: 10-31-96

Subject: ANCHOR TRENCH W/ FRENCH DRAIN FOR WEST SIDE OF V-1 CELL

BPCI Approvals

Dames & Moore Certifying Engineer	Signature	Yes (No) Approval	10/31/96 Date
BPCI Radiation Safety Office	Signature	Yes No Approval	Date
BPCI HSE Manager	Signature	Yes No Approval	Date
BPCI Project Manager	Signature	Yes No Approval	Date

Regulatory Reviews

Ohio EPA Concurrence	Signature	Yes No Concurrence	Date
NRC Concurrence	Signature	Yes No Concurrence	Date

Calculation

DAMES & MOORE
A DAMES & MOORE GROUP COMPANY

3065 Southwestern Boulevard
Suite 202
Orchard Park, NY 14127
716 675 7130 Tel
716 675 7137 Fax

Job No: **22007-011-120 / 6055** Calculation No: **BUF-96-112** Date: **October 31, 1996**

Subject: Design of Anchor Trench with French Drain

Purpose: Prepare a design for an anchor trench with a French drain which will fit between the west edge of the V-1 cell and the existing foundation for the Leachate Collection System Tanks. This distance is 21.5 feet.

Index:

References:

1. Koerner, R.M., 1990, *Designing with Geosynthetics*, Prentice Hall, Englewood Cliffs, New Jersey.
2. Richardson, G.M. and Koerner, R.M., 1987, "Geosynthetic Design Guidance for Hazardous Waste Landfill Cells and Surface Impoundments, U.S. Environmental Protection Agency, EPA/600/2-87/097.
3. Seelye, E.E., 1960, *Design, Databook for Civil Engineers*, John Wiley & Sons, New York.
4. IT Corporation, 1996, "Site Characterization Report, BP Chemicals Inc., SWMU 98, SWMU 102, AN-1 Area and Drum Storage Area, Lima, Ohio. IT Project No. 766527.
5. Hancor, Inc., 1995, "Drainage Handbook", Findlay, Ohio.

Approach:

Use design methods outlined in reference 1 and 2 with data from manufacturer's cut sheets and frictional properties cited in reference 1. Design needs to construct French drain after anchor trench is partially complete so that it is not necessary to place different materials next to each other. Design load should consider downdrag force on geotextile resulting from the compaction of a lift of uncompacted sludge and the underlying sand filter and the weight of the bulldozer which will be used to compact the stabilized sludge.

Prepared by:

Signature 10/31/96 Date

Checked by:

Signature Date

DAMES & MOORE

Job No. 22007-013-121/5054 Job MIXED WASTE POND CLOSURE

Client BP CHEMICALS, INC. Subject ANCHOR TRENCH W/ FRENCH DRAIN

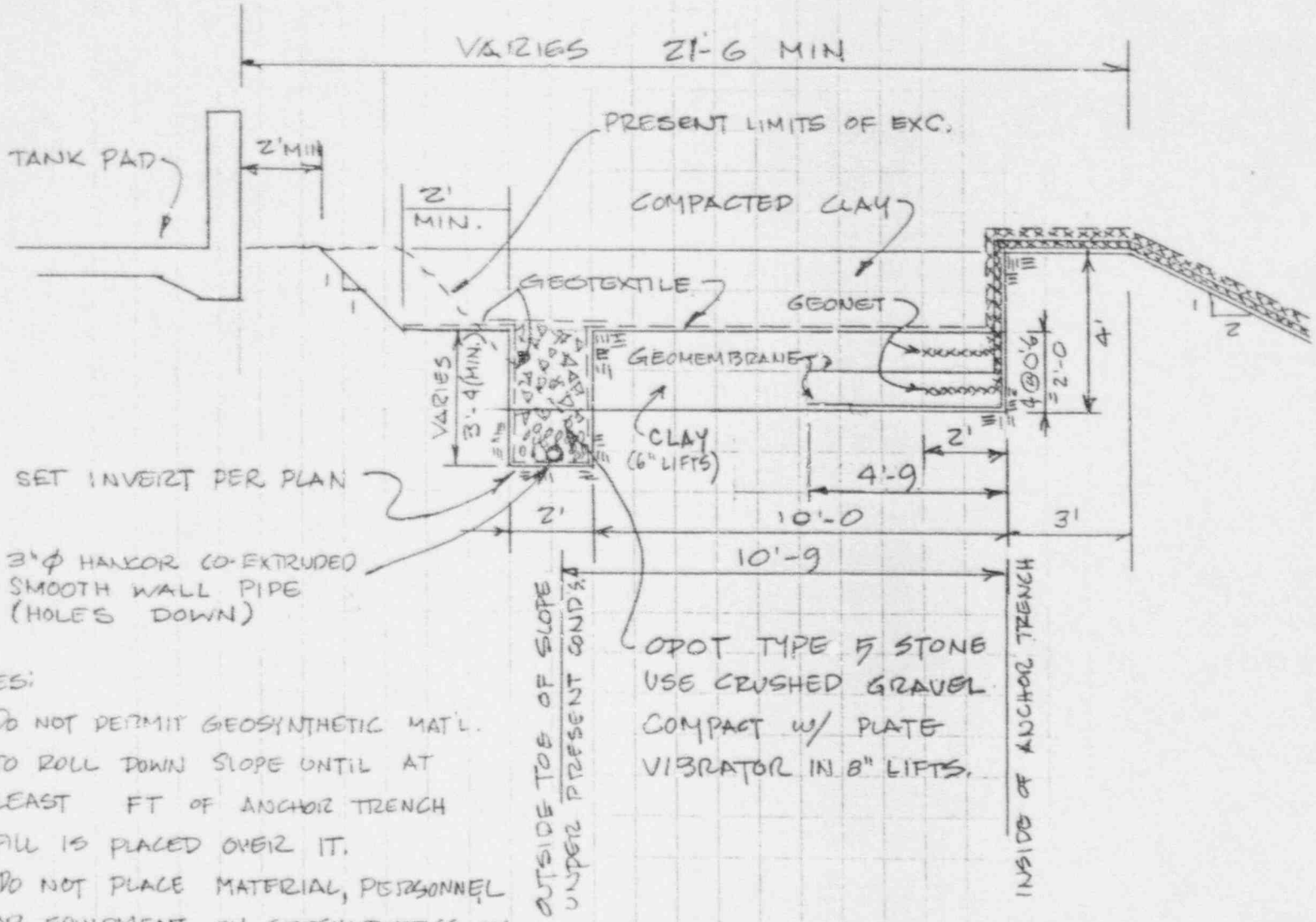
Sheet No. 2 OF 14

Calc. No. BUF-96-112

Rev. No. 0.00

By RZB Date 10/31/96

Chk'd. Date



NOTES:

1. DO NOT PERMIT GEOSYNTHETIC MAT'L. TO ROLL DOWN SLOPE UNTIL AT LEAST FT OF ANCHOR TRENCH FILL IS PLACED OVER IT.
2. DO NOT PLACE MATERIAL, PERSONNEL OR EQUIPMENT ON GEOSYNTHETICS ON SLOPE UNTIL ANCHOR TRENCH IS COMPLETE

PROPOSED FRENCH DRAIN/ANCHOR TRENCH SECTION

CONSTRUCTION SEQUENCE

THIS DISCUSSION ASSUMES PRESENT EXCAVATION IS AS SHOWN ON SHEET 2 OF CALCULATIONS. PROCEED AS FOLLOWS:

1. CLEAN AND DRESS EXCAVATION
2. PLACE BOTTOM GEOMEMBRANE*
3. PLACE AND COMPACT A 6" THICK (COMPACTED) LAYER OF CLAY BETWEEN INSIDE OF ANCHOR TRENCH AND OUTSIDE EXCAVATION LIMITS
4. PLACE BOTTOM GEONET*
5. PLACE AND COMPACT A 6" THICK LAYER OF CLAY PER STEP 3.
6. PLACE UPPER GEOMEMBRANE*
7. PLACE AND COMPACT A 6" THICK LAYER OF CLAY PER STEP 3.
8. PLACE UPPER GEONET.*
9. PLACE AND COMPACT A 6" THICK LAYER OF CLAY PER STEP 3.
10. EXCAVATE 2' (MIN.) BENCH AT OUTSIDE EDGE OF ANCHOR TRENCH.
11. EXCAVATE 2' WIDE TRENCH TO ELEVATION SHOWN ON PLAN
12. PLACE GEOTEXTILE STARTING AT OUTSIDE OF ANCHOR TRENCH. PLACE LINER IN 2 FT. WIDE TRENCH SO IT CONFORMS TO TRENCH BOTTOM. KEEP GEOTEXTILE ROLLED IN ANCHOR TRENCH.

13. PLACE PIPE IN TRENCH AND BACKFILL TRENCH WITH STONE

14. PLACE GEOTEXTILE OVER STONE. NO SEAM REQ'D

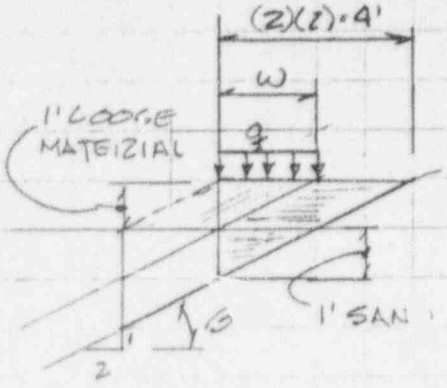
15. MOVE GEOTEXTILE ROLL TO RUNNOUT AREA. PLACE AND COMPACT CLAY TO BACKFILL TRENCH TO GRADE

* DO NOT PERMIT MATERIAL TO BE ROLLED DOWN SLOPE UNTIL AT LEAST FT. OF ANCHOR TRENCH FILL IS PLACED OVER IT.

ANALYSIS

GEOTEXTILE

- SLOPE = 2:1 ANGLE $\theta = \tan^{-1}(1/2) = 26.6°$



- SIZE OF LOOSE MATERIAL WHICH IMPOSES FRICTION ON GEOTEXTILE DUE TO LACK OF LATERAL SUPPORT IS 1' OF SAND AND 1' OF UNCOMPACTED STABILIZED SLUDGE. MATERIAL BELOW IS LATERALLY SUPPORTED BY MATERIAL ON CELL INTERIOR.

- MATERIAL WILL BE PLACED AND COMPACTED WITH A DOZER. PER SCOTT WALTER OF SYRACUSE SUPPLY (716) 694-7200, THE FOLLOWING APPLY TO A CAT D-6

TRACK WIDTH $w = 24" = 2'$
PAD PRESSURE = $q = 8.82$ PSI = 1,270 PSF.

- COMPUTE TOTAL VERTICAL FORCE ON GEOTEXTILE, ASSUME UNIT WT OF SAND AND STABILIZED SLUDGE ARE 120 LB/FT³

$F = (\frac{1}{2})(2)(4)(120) + (2)(1270) = 3,020$ LB

- ASSUME THAT UPPER GEONET AND GEOTEXTILE FUNCTION AS A SINGLE UNIT, BUT WITH ENTIRE LOAD CARRIED BY THE GEOTEXTILE. ASSUMPTION IS BASED ON RIDGE FORMATION BY SOIL PRESSING THE GEOTEXTILE INTO THE GEONET AND LOCKING ANY SLIPPAGE BETWEEN THE TWO MATERIALS.

- BASED ON TYPICAL PROPERTIES FROM REF. 1 (SEE SH 6), USE FOLLOWING FRICTION ANGLES:

  SAND TO GEOTEXTILE $\delta = 24°$ (WOVEN SLIT FILM → CONCR. SAND)

  GEONET TO HDPE: $\delta = 10°$ (WOVEN SLIT FILM → HDPE, NEGLECT TEXTURE, WHICH IS CONSERVATIVE)

- COMPUTE TENSION IN GEOTEXTILE AS DOWNDRAG FROM SAND AND LOAD FROM BULLDOZER LESS FRICTION MOBILIZED BETWEEN GEONET AND HDPE.

$$T = (3020)(\cos 26.6°)(\tan 24°) - (3020)(\cos 26.6°)(\tan 10°)$$
$$= 1202 - 476 = 726 \text{ LB/FT} = 61 \text{ LB/IN}$$

- PER SPECS FOR SYNTHETIC INDUSTRIES 400R, THE MATERIAL TO BE USED, (SEE SH. 7), THE WIDE WIDTH TENSILE STRENGTH IS 400 LBS/IN.

$$\text{DESIGN RATIO} = \frac{400}{61} = 6.6 > 2.0 \quad \text{OK}$$

- CHECK ANCHOR TRENCH CAPACITY

  - ASSUME COMPACTED CLAY WEIGHS 110 LB/FT^3 AND GRAVEL IN DRAIN WEIGHS 120 LB/FT^3.

  - BASED ON TYPICAL PROPERTIES FOR WOVEN SLIT FILM AND OTTAWA SAND (SH. 6) ASSUME $\delta = 24°$ FOR GRAVEL

CALCULATION SHEET

JOB No: 22007-013-121/5054

CALC. No: BUE-96-112

REV: 0.00 DATE: 10/31/96

ORIG: [illegible]

CK: _____ DATE: _____

SHEET: 6 OF 14

DAMES & MOORE

...UES AND EFFICIENCIES (IN PARENTHESES) FOR (a) ... (b) GEOMEMBRANE-TO-GEOTEXTILE, AND COMBINATIONS*

friction angles

	Soil types		
	Concrete sand (ϕ = 30°)	Ottawa sand (ϕ = 28°)	Mica schist sand (ϕ = 26°)
	24° (0.77)	20° (0.68)	24° (0.91)
rough	27° (0.88)	—	25° (0.96)
smooth	25° (0.81)	—	21° (0.79)
CSPE	25° (0.81)	21° (0.72)	23° (0.87)
HDPE	18° (0.56)	18° (0.61)	17° (0.63)

(b) Geomembrane-to-geotextile friction angle

	Geomembrane				
		PVC			
Geotextile	EPDM	Rough	Smooth	CSPE	HDPE
nonwoven, needle-punched	23°	23°	21°	15°	8°
nonwoven, melt-bonded	18°	20°	18°	21°	11°
woven, monofilament	17°	11°	10°	9°	8°
woven, slit film	21°	25°	24°	13°	10°

(c) Soil-to-geotextile friction angle

	Soil types		
Geotextile	Concrete sand (ϕ = 30°)	Ottawa sand (ϕ = 28°)	Mica schist sand (ϕ = 26°)
nonwoven, needle-punched	30° (1.00)	26° (0.92)	25° (0.96)
nonwoven, melt-bonded	26° (0.84)	—	—
woven, monofilament	26° (0.84)	—	—
woven, slit film	24° (0.77)	24° (0.84)	23° (0.87)

Source: After Martin, et al. [8]

*Efficiency values in parentheses are based on the relationship $E = (\tan \delta)/(\tan \phi)$

on smooth geotextiles giving the lowest friction values. For reference purposes, Part c of Table 5.5 gives the soil-to-geotextile friction values that are necessary for slope design of lined slopes with geotextiles under or over the liner.

The frictional behavior of geomembranes placed on clay soils is of considerable importance in the composite liners of waste landfills. Current requirements are for the

SOURCE: REF 7

82,500

Engineering Specifications

The geosynthetic reinforcement shall be a REINFORCER™ woven geotextile containing heavy monofilament (warp) and fibrillated (fill) yarns. The individual yarns shall be woven into a unique twill pattern to form a strong geotextile with superior hydraulic properties.

All yarns of the geotextile shall be stabilized against ultraviolet degradation and resistant to biological and chemical environments normally found in soils. The geosynthetic reinforcement shall conform to minimum average roll (MARVs) values listed below:

MINIMUM AVERAGE ROLL VALUES (MARVs)

PROPERTY	TEST METHOD	200R	400R	
MECHANICAL				
Wide Width Tensile Strength	ASTM D-4595	35X35 kN/m (200x200 lbs/in)	70x70 kN/m (400x400 lbs/in)	
Wide Width Elongation	ASTM D-4595	8 x 8%	14 x 12%	
Puncture Strength	ASTM D-4833	535 N (120 lbs)	620 N (140 lbs)	✓
Mullen Burst	ASTM D-3786	5170 kPa (750 psi)	8270 kPa (1200 psi	
Trapezoidal Tear	ASTM D-4533	580 x 580 N (130 x 130 lbs)	820 x 845 N (185 x 190 lbs)	close
HYDRAULIC				
Apparent Opening Size (AOS)	ASTM D-4751	0.425 mm (40 US Std Sieve)	0.600 mm (30 US Std Sieve)	n/a
Permittivity, ψ	ASTM D-4491	0.25 sec^{-1}	0.60 sec^{-1}	
Water Flow Rate	ASTM D-4491	610 l/min/m^2 (15 gpm/ft^2)	1830 l/min/m^2 (45 gpm/ft^2)	close
ENDURANCE				
UV Resistance (% retained @ 500 hours)	ASTM D-4355	80%	80%	ok
PHYSICAL				
Polymer Type	—	PP	PP	✓
Roll Size	Measured	4.6 x 91.5 m (15' x 300')	4.6 x 91.5 m (15' x 300')	
Roll Area	Calculated	418 m^2 (500 yd^2)	418 m^2 (500 yd^2)	

HIGHER STRENGTH — COMING SOON

Synthetic Industries, Inc.
Geosynthetic Products Division
4019 Industry Drive
Chattanooga, TN 37416 USA
TOLL FREE: (800) FIX-SOIL OR (800) 621-0444
(423) 899-0444

DISTRIBUTED BY:

CALCULATION SHEET

JOB No: 22007-013-121/5054

CALC. No: BUF-96-112

REV: 000 DATE: 10-31-96

ORIG: R. BLICKWEDEHL

CK: _____ DATE: _____

SHEET: 7 OF 14

DAMES & MOORE

SYNTHETIC INDUSTRIES

GEOSYNTHETIC PRODUCTS DIVISION

Smart Solutions in Synthetics™

- BASED ON TYPICAL PROPERTIES FOR CLAY SOILS (SH 9) USE LOWEST VALUE FOR HDPE $\delta = 15°$ FOR FRICTION AGAINST CLAY. THIS IS VERY CONSERVATIVE BECAUSE IT NEGLECTS THE IRREGULAR SURFACE OF THE GEOTEXTILE.

- FOR SECTION AT 2' DEPTH

$\delta' = (110)(2) = 220$ PSF

$F = (220)(2 + 10.75)(\tan 15°) =$ 751 LB

- FOR WALLS OF TRENCH, ASSUME $K_o = 0.7$ AT REST COEF.

$\delta' = (2)(110) + \left(\frac{3.33}{2}\right)(120) = 420$ PSF

$F = (2)(3.33)(420)(0.7)(\tan 24°)$ 871 LB**

- FOR BOTTOM OF TRENCH

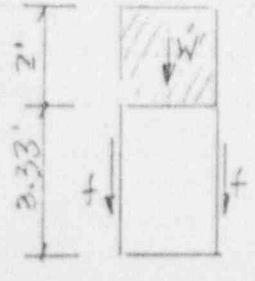
$\delta' = (2)(110) + (3.33)(120) = 620$ PSF

$F = (2)(620)(\tan 24°) =$ 552 LB

2,174 LB

- DESIGN RATIO = $\frac{2,174}{726} = 2.99 > 2.0$ OK

** BECAUSE FRICTION ON CLAY SIDE OF GEOTEXTILE IS LESS, CK FOR BLOCK UPLIFT OF TRENCH ($\delta = 15°$)



$W = (2)(2)(110) =$ 440

$2f = (2)(3.33)(2 + \frac{3.33}{2})(110)(0.7)(\tan 15°) =$ 503

943 LB

943 > 871 LB ∴ SLIPPAGE ALONG GRAVEL CONTROLS

SHEET 11,

CALCULATION SHEET

JOB No: 22007-013-121/5054

CALC. No: BUF-96-112

REV: 0.00 DATE: 10/31/96

ORIG: Z BLICKWEDEHL

CK: _____ DATE: _____

SHEET: 9 OF 14

DAMES & MOORE

VALUES AND EFFICIENCIES (IN PARENTHESES) FOR VARIOUS
IUS GEOMEMBRANES [9]

	Soil no. 1 ML-CL				Soil no. 2 CL-ML			
	c	E_r (%)	ϕ	E_ϕ (%)	c	E_r (%)	ϕ	E_ϕ (%)
	9.0	100	38	100	12.0	100	34	100
	c_a	E_r (%)	δ	E_ϕ (%)	c_a	E_r (%)	δ	E_ϕ (%)
Geomembrane-to-soil								
PVC	8.5	94	39	100	3.7	31	23	69
CPE	8.0	89	40	100	3.2	27	24	71
EPDM	5.0	55	33	87	5.0	42	23	67
HDPE	5.0	82	26	68	2.0	17	23	67
Embossed HDPE	9.0	100	35	92	11.0	92	29	58

	Soil no. 3 CL				Soil no. 4 SP-CH			
Description	c	E_r (%)	ϕ	E_ϕ (%)	c	E_r (%)	ϕ	E_ϕ (%)
Soil-to-soil	20	100	30	100	25	100	24	100
	c_a	E_r (%)	δ	E_ϕ (%)	c_a	E_r (%)	δ	E_ϕ (%)
Geomembrane-to-soil								
PVC	14.0	70	16	53	7.0	28	24	100
CPE	13.0	65	17	57	8.0	32	23	96
EPDM	8.0	40	23	77	7.5	30	20	83
HDPE	14.0	70	15	50	3.0	12	21	88
Embossed HDPE	18.0	90	27	90	15.0	60	26	100

	Soil no. 5 CL-SP			
Description	c	E_r (%)	ϕ	E_ϕ (%)
Soil-to-soil	28	100	22	100
	c_a	E_r (%)	δ	E_ϕ (%)
Geomembrane-to-soil				
PVC	12.0	43	17	77
CPE	10.0	36	19	86
EPDM	9.0	32	18	82
HDPE	14.0	50	15	68
Embossed HDPE	16.0	57	23	100

Note: c and c_a are in units of kN/m^2, ϕ and δ are in degrees.

SOURCE: REF #

GEOMEMBRANE

- LOAD PICKED UP BY GEOMEMBRANE, FROM SHEET 5 IS 476 LB. ASSUME HALF IS TRANSFERRED TO LOWER GEONET.

$$T = (1/2)\,476 = 238 \text{ LB/FT} = 20 \text{ LB/IN}$$

- FROM DATA ON SHEET 11 FOR 60 MIL HDPE, TENSILE STRENGTH @ YIELD = 130 LB/IN

$$\text{DES. RATIO} = \frac{130}{20} = 6.5 > 2 \quad \text{OK.}$$

- FROM DATA ON SHEET 9, USING LOWEST FRICTION ANGLE FOR EMBOSSED HDPE TO CLAY $\delta = 25°$. RESISTING FORCE OF ANCHOR TRENCH IS.

$$F = (3)(110)(\tan 25°)(4.75) = 731 \text{ LB}$$

$$\text{DES. RATIO} = \frac{731}{238} = 3.1 > 2 \quad \text{OK}$$

GEONET

- GEONET DOES NOT CARRY LOAD FROM OVERLYING MATERIALS. CHECK FOR ITS OWN WEIGHT PLUS PERSON.

- FROM DATA ON SHEET 12, A 300' X 14' ROLL WEIGHS 840 LB SO UNIT WEIGHT OF GEONET IS $840/(300 \times 14) = 0.20 \text{ LB/FT}^2$

- SLOPE HEIGHT IS 30 FT. ASSUME PERSON WEIGHS 200 LB. DOWNWARD FORCE IS

$$F = (30/\sin 26.6)(0.2) + 200 = 214 \text{ LB.}$$

GSE Lining Technology, Inc.

MINIMUM PROPERTIES FOR STANDARD TEXTURED HDPE GEOMEMBRANES: GSE™ FRICTIONFLEX®, TEXTURED HYPERFLEX® AND GSE™ HDT

Property	[1] Test Method	[4] 30	40	60	80	100
minimum thickness [mil]	ASTM D 751,	27	36	54	72	90
average thickness [mil]	D 1593 or D 5199	30	40	60	80	100
density [g/cc]	ASTM D 792 (B) or D 1505	0.940	0.940	0.940	0.940	0.940
carbon black content [%]	ASTM D 1603	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0
carbon black dispersion	ASTM D 3015	A1, A2, B2	A1, A2, B2	A1, A2, B2	A1, A2, B2	A1, A2, B2
Tensile Properties:	ASTM D 638 Type IV, 2 ipm					
tensile strength @ yield [ppi]	NSF 54 modified	65	86	130	173	216
[3] tensile strength @ break [ppi]		(38)	162 (50)	243 (75)	324 (100)	405 (125)
elongation @ yield [%]	(1.3" gauge length)	13	[1] 13	13	13	13
[3] elongation @ break [%]	(2.5" gauge length)	(120)	560 (120)	560 (120)	560 (120)	560 (120)
tear resistance [lb.]	ASTM D 1004	22	30	45	60	75
puncture resistance [lb.]	FTMS 101 Method 2065	39	52	80		
ESCR [hours]	ASTM D 1693, B	1500	1500	1500		
dimensional stability [% change]	ASTM D 1204 (1 hr. @ 100 °C)	±2	±2	±2		

[1] GSE utilizes test equipment and procedures which enable effective and economical confirmation that the product will conform to specifications based on the noted proce change without prior notification.

[2] The flat cast line can achieve, when necessary, ± 5% of nominal thickness except for < 60 mil; co-extruded lines can achieve a range of -10% to +15% of nominal thickness.

[3] Values in parenthesis correspond to the MARV (minimum average roll value) for co-extruded textured material.

[4] 30 mil FrictionFlex®, textured HyperFlex® is a nonstandard product

For environmental lining solutions...the world comes to GSE™
A Gundle/SLT Environmental, Inc. Company

Prepared By:
Melody A. Adams

CALCULATION SHEET

JOB No: 22007-013-121/5054
CALC. No: BUF-96-112
REV: 0.00 DATE: 10/31/96
ORIG: R. BLICKWEDEHL
CK: _____ DATE: _____
SHEET: 11 OF 14

DAMES & MOORE

SPECIFICATIONS FOR GUNDNET® XL-14

Gundnet is a high quality formulation of High Density Polyethylene containing approximately 97.5% polymer and 2.5% of carbon black, anti-oxidants and heat stabilizers. The product was designed specifically for exposed conditions. It contains no additives or fillers which can leach out and cause embrittlement over time.

TYPICAL PROPERTIES*	TEST METHOD	GUNDNET XL-14
Roll Length (typical)		300 ft.
Roll Width (typical)		14 ft.
Roll Weight (typical)		840 lbs.
Specific Gravity (g/cm³ minimum)	ASTM D1505	.94
Melt Flow Index (g/10 minutes) (maximum)	ASTM D1238 Condition E	0.3
Thickness (minimum)	ASTM D374 at Strand intersection	5.0-6.5 mm 200 mil-265 mil .200-.265 in.
Percent Carbon Black (minimum)	ASTM D1603	2%
Transmissivity (minimum)	ASTM D4716 10,000 psf compressive load between two layers of Gundline HD; 0.25 Gradient	10 g/min./ft. or 2×10^{-3} m²/sec.

*Note: All values are typical test results, unless stated otherwise.

ROLL PROPERTIES FOR FABRI-NET®

TYPICAL PROPERTIES*	TEST METHOD	FABRI-NET
Roll Length (typical)		100 ft.
Roll Width (typical)		6.5 ft. [1]
Roll Weight (typical)		194 lbs. [2]
Specific Gravity of Net (g/cm³) (minimum)	ASTM D1505	.94
Melt Flow Index of Net (g/10 minutes) (maximum)	ASTM D1238 Condition E	0.3
Thickness of Net (minimum)	ASTM D374 at Strand Intersection	5.0-6.5 mm 200 mil-265 mil
Percent Carbon Black of Net (minimum)	ASTM D1603	
Permeability of Geotextile (cm/second) (typical)	ASTM D4491	
Pty Adhesion (pounds/inch)	ASTM F904 2" x 8" @ 2 ipm	

*Note: All values are typical test results, unless stated otherwise.

1) Width with geotextile overlap is 7 ft.
2) This is the weight for Fabri-Net double-sided with 6 ounce geotextile only. Bonding geote weight value.

Gundnet and Fabri-Net are rolled on 6" I.D. hollow cores. Each Gundnet roll is provided with a sling to aid handling on site. Fabri-Net is wrapped in a protective plastic bag. Dimensions and weights are approximate. Custom lengths available on request.

Gundle Lining Systems Inc

Gundle®

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CALCULATION SHEET

JOB No: 22007-013-121/5054
CALC. No: BUF-96-112
REV: 0.00 DATE: 10/31/96
ORIG: R. BLICKWEDEH
CK: _____ DATE: _____
SHEET: 12 OF 14

DAMES & MOORE

5

- ASSUME FRICTION CHARACTERISTICS SIMILAR TO GEOTEXTILE DESIGN ON SHEET 5 SINCE GEONET DATA ARE NOT AVAILABLE.

$$T = (214)(\cos 26.6^\circ)(\tan 25^\circ) - (214)(\cos 26.6^\circ)(\tan 10^\circ)$$
$$= 89 - 34 = 55 \text{ LB/FT} = 4.6 \text{ LB/IN.}$$

- ASSUME FRICTION ANGLE $\delta = 25^\circ$ FOR GEONET, SAME AS TEXTURED HDPE. RESISTING FORCE OF ANCHOR TRENCH

$$P = (2.5)(110)(\tan 25^\circ)(2) = 256 \text{ LB}$$

$$\text{DES. RATIO} = \frac{256}{55} = 4.6 > 2 \quad \text{OK}$$

DAMES & MOORE

Sheet No. 14 OF 14
Calc. No. BUF-96-112
Rev. No. 0.00
By RZB Date 10/16/96
Chk'd. Date

Job No. 17-2007-018-121/5054 Job MIXED WASTE POND CLOSURE
Client BP CHEMICALS, INC Subject ANCHOR TRENCH W/FRENCH DRAIN

DRAINAGE DESIGN

- ASSUME SOIL IS SANDY CLAY LOAM.

- FROM TABLE A OF P. 18-07 OF REF. 3, FOR DRAIN 3-4' IN DEPTH DIST. BETWEEN DRAINS = 65-75'. DRAINED WIDTH IS 1/2 OF THIS = 38'

- TRENCH LENGTH = 31+30.75
  - 29+72.50
  158.25

- DRAINED AREA = (38)(158.25) = 6,013 FT^2 = 0.14 ACRE.

- FROM TABLE B OF P 18-07 OF REF 3, FOR 30-40" OF RAIN PER YEAR (AVG. ANNUAL RAINFALL FOR SITE IS 35.7"/YR, PER TABLE 3-1 OF REF. 4), SUBSURFACE RUNOFF IS 0.0147 CFS/ACRE

  $Q = (0.0147)(0.14) = 0.002$ CFS.

- ASSUME PIPE SLOPE IS SAME AS ANCHOR TRENCH SLOPE

  $= \frac{858.0 - 856.3}{(31+25.5) - (29+71.0)} = 0.011 = 1\%$

- FROM FIGURE 3-3 OF REF. 5 3" HANCOR SMOOTHWALL PIPE IS MORE THAN ADEQUATE. FROM P. 3-9 OF REF 5

  $Q = KS^{2.5} = (1.3)\sqrt{0.01} = 0.13$ CFS. OK.

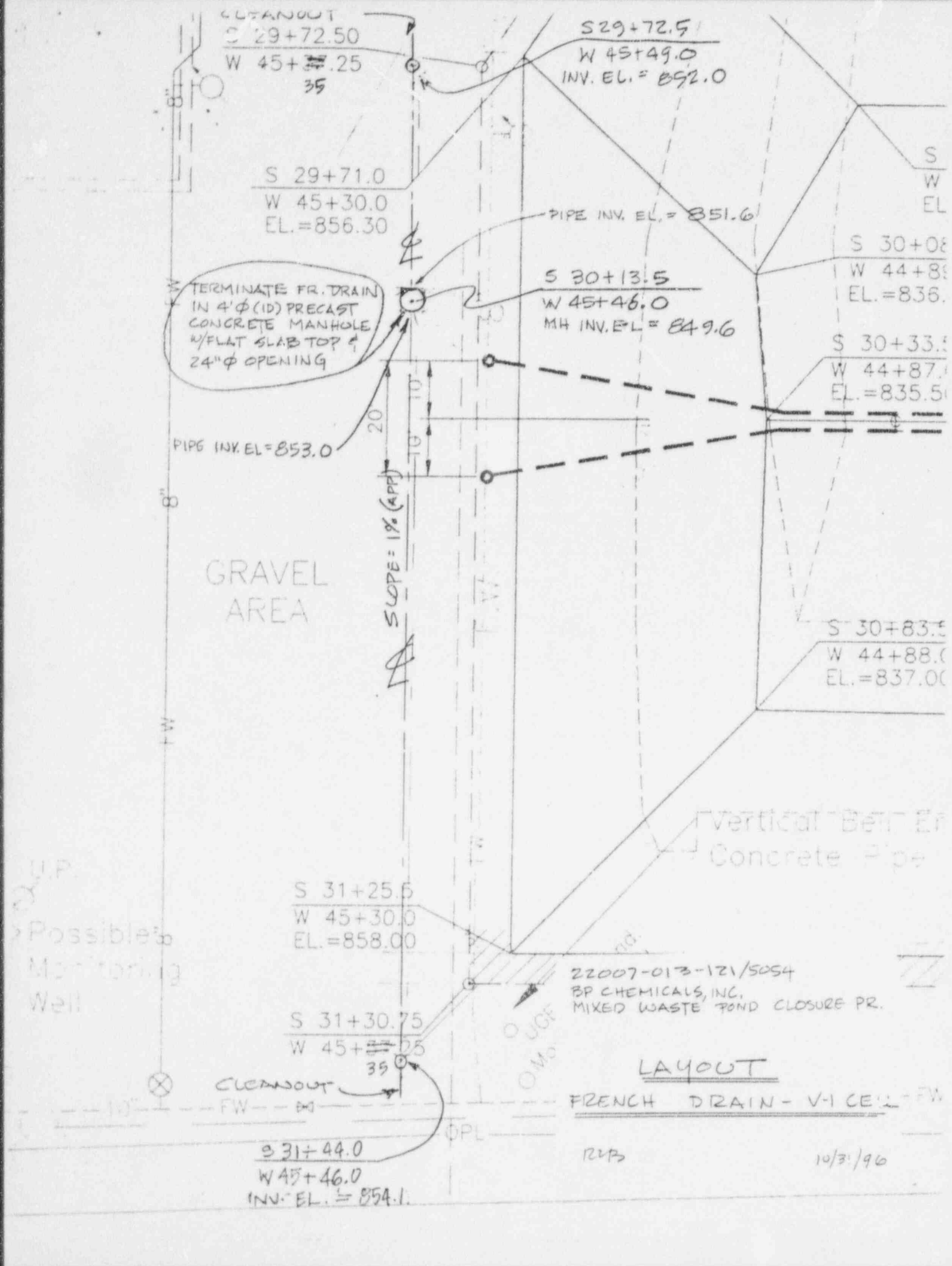
- PROBLEM → FLOW IS WELL BELOW DESIGN CAPACITY SO SILT CLOGGING MIGHT BE AN ISSUE. NEED CLEANOUTS.

- PUMP SET POINTS

  HOURLY FLOW = (.002)(60)(60) = 7.2 FT^3

  FOR 4'Ø MH. 1 HR FLOW = 0.6 FT.

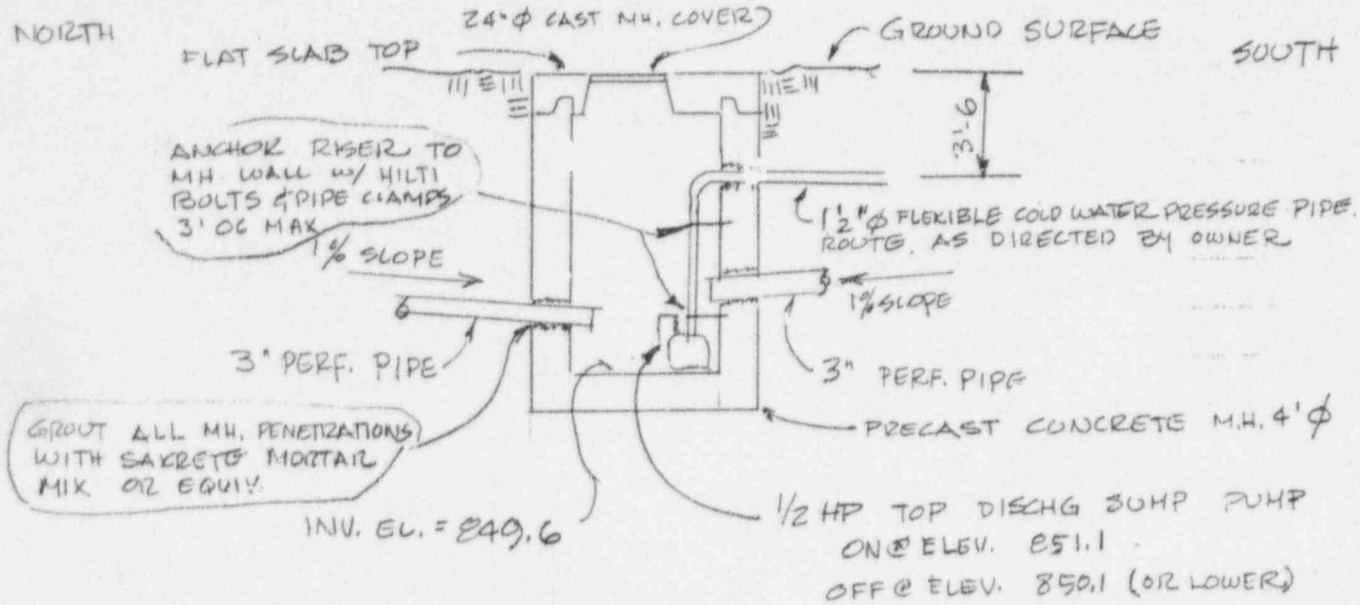
  MAKE SUMP 2' DEEP W SET PTS @ 6" & 1'-0


CLEANOUT
S 29+72.50
W 45+35.25
S 29+71.0
W 45+30.0
EL.=856.30
S29+72.5
W 45+49.0
INV. EL.= 852.0
PIPE INV. EL.= 851.6
S 30+13.5
W 45+46.0
MH INV. EL= 849.6
TERMINATE FR. DRAIN IN 4'φ (ID) PRECAST CONCRETE MANHOLE W/FLAT SLAB TOP & 24"φ OPENING
PIPE INV. EL=853.0
20
10
10
SLOPE = 1% (APPX)
GRAVEL AREA
S 30+08
W 44+89
EL.=836.
S 30+33.5
W 44+87.
EL.=835.5
S 30+83.5
W 44+88.0
EL.=837.00
Vertical Bent Er
Concrete Pipe
S 31+25.6
W 45+30.0
EL.=858.00
Possible Monitoring Well
22007-013-121/5054
BP CHEMICALS, INC.
MIXED WASTE POND CLOSURE PR.
S 31+30.75
W 45+35.25
CLEANOUT
S 31+44.0
W 45+46.0
INV. EL.= 854.1
LAYOUT
FRENCH DRAIN - V-1 CE
RLB
10/31/96

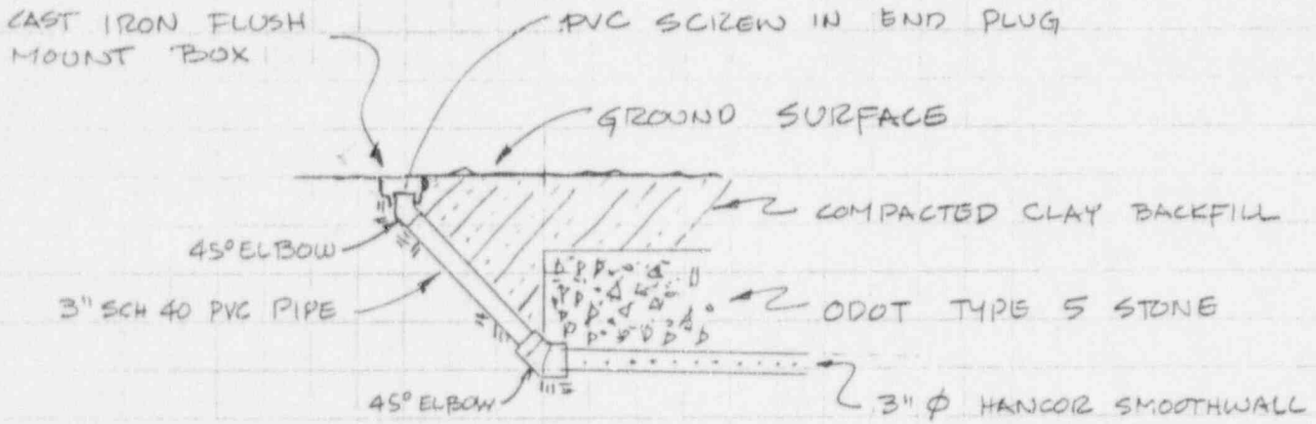
DAMES & MOORE

Sheet No.
Calc. No. N/A
Rev. No. 0.00
By RZB Date 10/31/96
Chk'd. Date

Job No. 22007-013121/5054 Job MIXED WASTE POND CLOSURE
Client BP CHEMICALS, INC. Subject FRENCH DRAIN DETAILS



MANHOLE INSTALLATION



CLEANOUT DETAIL