SITE NO. 1-30-001

(NAME) Old Bethpage Landfill

(LOCATION) Nassau Co. - Oyster Bay

1.0 CONSULTANTS FILE

1.1 Work Plans

2.0 TITLE 3 GRANT AND/OR AMENDMENT, STATE SUPERFUND AGREEMENT, ROD, SITE LISTING/DELISTING PACKAGE

3.0 CONTRACTORS FILE

4.0 CONTRACT DOCUMENTS

5.0 INSPECTION

6.0 MANIFESTS

7.0 SAMPLING

8.0 CONTRACTOR LOGS

9.0 CORRESPONDENCE

10.0 PHOTOGRAPHS

11.0 NON-FOIL/CONFIDENTIAL DOCUMENTS

OLD BETHPAGE SOLID WASTE DISPOSAL COMPLEX
TOWN OF OYSTER BAY, NY

REMEDIAL ACTION PLAN

GROUNDWATER REMEDIATION PROGRAM CALCULATIONS

PREPARED BY:

LOCKWOOD, KESSLER & BARTLETT, INC.
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SYOSSET, NY 11791

GERAGHTY & MILLER
125 BETHPAGE ROAD
PLAINVIEW, NY 11803

LKB LOCKWOOD KESSLER & BARTLETT, INC.
CONSULTING ENGINEERS - SYOSSET, N.Y.

PROJECT: OBSWDC | SHEET NO. ______ OF ______
SUBJECT: RAP | BY: TCH | DATE: 10/5/89
JOB NO.: 8086-01 | CHKD. BY ______ | DATE ______

OBSWDC GROUNDWATER REMEDIATION PROGRAM CALCULATIONS

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TREATMENT PROCESS CALCULATION SUMMARY

THE PROPOSED GROUNDWATER TREATMENT PLANT HAS BEEN DESIGNED TO REMOVE VARIOUS VOLATILE ORGANIC COMPOUNDS (VOC'S), IRON (Fe) AND MANGANESE (Mn) FROM A CONTAMINATED GROUNDWATER PLUME LOCATED IN THE BETHPAGE STATE PARK GOLF COURSE.

THE FOLLOWING CALCULATIONS SHOW THAT THE THREE PROCESSES SELECTED (AIR STRIPPER, PRESSURE FILTERS AND ACTIVATED CARBON COLUMNS) WILL SUCCESSFULLY REMOVE THE ABOVE CONTAMINANTS TO THE MORE STRINGENT OF CURRENT NYS AND EPA GROUNDWATER QUALITY REGULATIONS.

THESE PROCESSES WILL OPERATE OVER A RANGE OF FLOWS LISTED BELOW:

AIR STRIPPER	1.5 - 2.25 MGD
PRESSURE FILTERS	1.5 - 2.05 MGD
ACTIVATED CARBON COLUMNS	1.5 - 2.03 MGD

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AIR STRIPPER DESIGN

THE PROPOSED OBSWDC AIR STRIPPER WAS DESIGNED UTILIZING DATA OBTAINED DURING A PILOT STUDY WHICH WAS APPLIED TO CURRENT MASS TRANSFER THEORY. THE PILOT STUDY WAS PERFORMED ON JULY 1, 1987 BY HYDRO GROUP, INC.

THE AIR STRIPPER WAS DESIGNED BASED ON TREATING THE FOLLOWING LIST OF VOLATILE ORGANICS WHICH ARE EXPECTED TO BE PRESENT IN THE AIR STRIPPER INFLUENT WATER. PROPOSED EFFLUENT CONCENTRATIONS REPRESENT THE MORE STRINGENT OF THE NYS & EPA GROUNDWATER QUALITY STANDARDS WHICH ARE CURRENTLY IN EFFECT.

Contaminants	Influent	Effluent	% Removal Required
Organics (ug/1)			
Vinyl Chloride	68.0	1.0	98.5
1,1 - Dichlorethane	178.0	5.0	97.2
1,2 - Dichlorethane	8.7	0.8	91.0
1,1 - Dichlorethene	1.2	0.07	94.0
1,2 - Dichlorethene	273.0	5.0	98.2
Trichloroethylene	14.4	5.0	65.0
Benzene	90.0	Non-Detect.	98.9
Dichlorobenzene (Ortho & Para)	6.3	4.7	25.0
Ethylbenzene	272.0	50.0	82.0
Tetrachlorethene	4.0	0.7	82.0
Xylene	32.3	5.0	84.8
Chlorobenzene	5.7	5.0	12.3
Chloroethane	25.0	5.0	80.0

AIR STRIPPER DESIGN PARAMETERS

DESIGN FLOW = 1050 GPM = 1.5 MGD
MAXIUM FLOW ALLOWABLE = 1575 GPM = 2.25 MGD *

AIR STRIPPER DIAMETER = 8'-0"

LIQUID LOADING RATE = $L = \frac{Q}{a} = \frac{Q}{\pi d^2/4}$

DESIGN $L = \frac{1050 \text{ GPM}}{\pi (8)^2/4} = 20.89$ GPM/SF

MAXIMUM $L = \frac{1575 \text{ GPM}}{\pi (8^2)/4} = 31.34$ GPM/SF

AIR TO WATER RATIO = A/Q = 60:1 (PILOT STUDY)

AIR FLOW RATE = $A = 60 \times Q$

DESIGN $A = 60 \times \frac{1050 \text{ GPM}}{7.48 \text{ FT}^3/\text{GAL}} = 8{,}422$ CFM/SF

MAXIMUM $A = 60 \times \frac{1575 \text{ GPM}}{7.48 \text{ FT}^3/\text{GAL}} = 12{,}634$ CFM/SF

GAS LOADING RATE = $G = \frac{A}{a}$

DESIGN $G = \frac{8422}{\pi 8^2/4} = 167.56$ CFM/SF

MAXIMUM $G = \frac{12{,}634}{\pi 8^2/4} = 251.34$ CFM/SF

TOWER MEDIA = 2" DIA JAEGER TRIPACKS

* THE AIR STRIPPER WAS DESIGNED USING A SAFETY FACTOR OF 1.5 TO ACCOMODATE A MAXIMUM FLOW OF 2.25 MGD

MASS TRANSFER THEORY FOR AIR STRIPPERS

TOWER PACKING HEIGHT (Z)

$$Z = HTU \times NTU$$

$$HTU = \frac{L}{K_L a}$$

$$NTU = \left(\frac{R}{R-1}\right) \ln\left[\frac{\left(\frac{C_{in}}{C_{out}}\right)(R-1) + 1}{R}\right]$$

$$R = \frac{H}{P_t} \times \frac{G}{L} \times 0.00764$$

WHERE:

HTU = HEIGHT OF THE TRANSFER UNITS
NTU = NUMBER OF TRANSFER UNITS
L = LIQUID LOADING RATE (CFM/SF)
$K_L a$ = MASS TRANSFER COEFFICIENT (MIN^{-1})
R = STRIPPING FACTOR
C_{in} = INFLUENT CONCENTRATION (ug/l)
C_{OUT} = EFFLUENT CONCENTRATION (ug/l)
H = HENRY'S LAW CONSTANT (ATM)
G = GAS LOADING RATE (CFM/SF)
P_t = OPERATING PRESSURE (ATM)

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AIR STRIPPER DESIGN CRITERIA

CONTAMINANT	INF. CONC. (µg/l)	EFF. CONC. (µg/l)	H (atm)	K_La (sec⁻¹)	R	SAFETY FACTOR	Z (FT)
VINYL CHLORIDE	68.0	1.0	359,100	0.01400	16,461.14	1.50	21.05
1,1-DICHLOROETHANE	178.0	5.0	262	0.00950	12.93	1.50	27.81
1,2-DICHLOROETHANE	8.7	0.8	61	0.00650	2.80	1.50	33.29 *
1,1-DICHLOROETHENE	1.2	0.07	9,500			1.50	
1,2-DICHLOROETHENE	273.0	5.0	300	0.01120	13.75	1.50	26.37
TRICHLOROETHYLENE	14.4	5.0	450	0.01100	20.63	1.50	6.84
BENZENE	90.0	NON-DETECT	240	0.01030	11.00	1.50	32.82
DICHLOROBENZENE (ORTHO & PARA)	6.3	4.7	109	0.00385	5.00	1.50	5.46
ETHYLBENZENE	272.0	50.0	323	0.00950	14.81	1.50	12.89
TETRACHLOROETHENE	4.0	0.7	1,100	0.01500	50.42	1.50	8.19
XYLENE	32.3	5.0	70.5			1.50	
CHLOROBENZENE	5.7	5.0	228	0.01010	10.45	1.50	1.00
CHLOROETHANE	25.0	5.0	822	0.01410	37.68	1.50	8.07

* MAXIMUM PACKING HEIGHT REQUIRED IS 33.29 FT FOR 1,2 DICHLOROETHANE

USE PACKING HEIGHT OF 35.00 FT

AIR STRIPPER DESIGN CONCLUSIONS

THE PROPOSED AIR STRIPPER WILL BE 8'-0" IN DIAMETER WITH A MEDIA BED DEPTH OF 35'-0". THE AIR STRIPPER IS DESIGNED TO REMOVE THE PREVIOUSLY LISTED CONTAMINANTS TO THE MORE STRINGENT OF CURRENT NYS & EPA EFFLUENT LIMITATIONS FOR A RANGE OF WATER FLOWS RATES OF 1.5 MGD TO 2.25 MGD AT CORRESPONDING AIR FLOW RATES OF 8,422 CFM TO 12,633 CFM.

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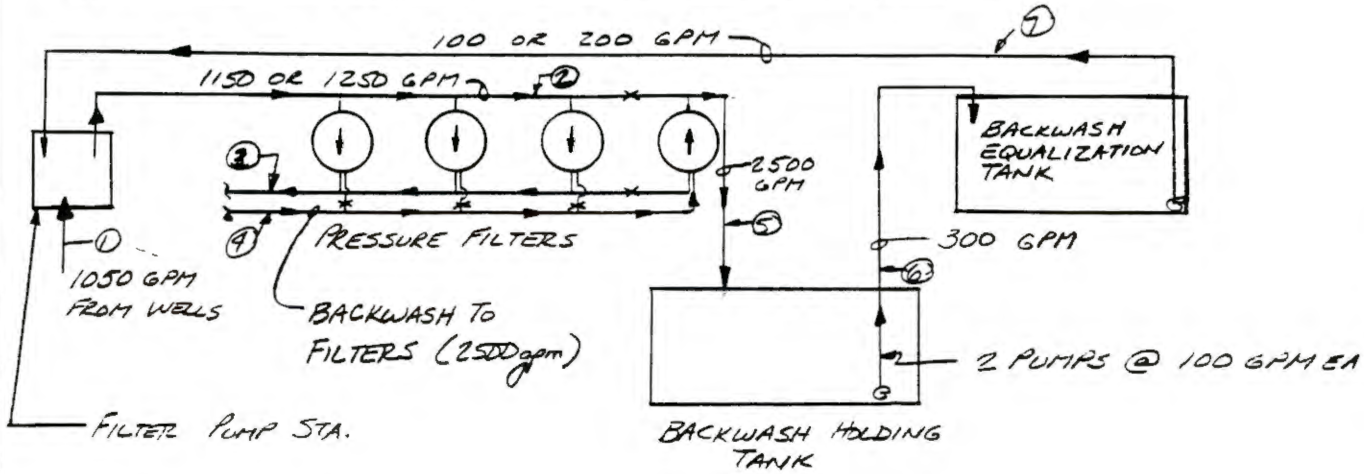
PRESSURE FILTER DESIGN

PRESSURE FILTERS PROCESS FLOW DIAGRAM



FLOW SCHEME DURING BACKWASH OF FILTER #4

FLOWS:

1 - INCOMING FLOW FROM RECOVERY WELLS (1050 GPM)
2 - INFLUENT FLOW TO PRESSURE FILTERS (1150 OR 1250 GPM)
3 - EFFLUENT " FROM " " " "
4 - CLEAN BACKWASH FLOW TO PF #4 (2500 GPM)
5 - DIRTY " " FROM " " "
6 - TRANSFER PUMPS TO BACKWASH EQUALIZATION TANK (300 GPM)
7 - BACKWASH EQUALIZATION TANK WATER PUMPED TO FILTER PUMP STATION (100 OR 200 GPM)

NOTE: PRESSURE FILTER DESIGN CALCULATIONS PERFORMED FOR RECIRCULATION FLOWS OF BOTH 100 & 200 GPM

I DESIGN THEORY

REMOVE IRON & MANGANESE THROUGH OXIDATION USING A MANGANESE GREENSAND PRESSURE FILTER WHICH IS CONTINUOUSLY REGENERATED BY FEEDING A PREDETERMINED AMOUNT OF POTASSIUM PERMANGANATE ($KMnO_4$). SINCE $KMnO_4$ IS COSTLY, CHLORINE SHOULD BE USED PRIOR TO $KMnO_4$ INJECTION TO OPTIMIZE OXIDATION & REDUCE CHEMICAL COSTS.

II STOICHIOMETRY

- USING BOTH CHLORINE & $KMnO_4$ THE CONCENTRATIONS OF EACH REQUIRED TO OXIDIZE Fe & Mn ARE:

$$mg/l\ Cl_2 = mg/l\ Fe$$

$$mg/l\ KMnO_4 = (0.2 \times mg/l\ Fe) + (2 \times mg/l\ Mn)$$

- IF CHLORINE WERE NOT USED, THE AMOUNT OF $KMnO_4$ REQUIRED WOULD BE:

$$mg/l\ KMnO_4 = (1 \times mg/l\ Fe) + (2 \times mg/l\ Mn)$$

- SINCE $KMnO_4$ IS VERY EXPENSIVE, USE BOTH Cl_2 & $KMnO_4$
- pH REQUIRED TO OXIDIZED Fe & Mn RAPIDLY:

  Fe OXIDATION @ pH = 7.0 - 7.5

  Mn OXIDATION @ pH = 8.5

  THEREFORE, pH SHOULD BE ADJUSTED FROM 5.5 TO 8.5 BY USING NaOH (CAUSTIC SODA)

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III STANDARD RECOMMENDED MANGANESE GREENSAND PRESSURE FILTER DESIGN PARAMETERS:

BED TYPE : DUAL MEDIA
ANTHRACITE - MIN. 15-18 IN
GREENSAND - MIN. 15-24 IN

FILTRATION RATE : 2-5 GPM/SF (LOWER RATES REQ'D FOR HIGH LEVELS OF IRON)

BACKWASH RATE : 12 GPM/SF (ENOUGH FOR 40% BED EXPANSION)

MAXIMUM PRESSURE DROP : 10 PSI

AIR/WATER SCOUR : AIR RATE : 0.8-2.0 CFM/SF
WATER RATE : 4-5 GPM/SF

RAW WATER RINSE : FOR 3-5 MIN AFTER BACKWASH

BED CAPACITY : 500-700 GRAINS/SF (BASED ON $KMnO_4$ DEMAND)

IV MANGANESE GREENSAND PRESSURE FILTER DESIGN PARAMETERS CONSIDERED

PRESSURE FILTER No. & SIZE: 4 @ 8'-DIA 30' LONG (HORIZONTAL FILTERS)

BED TYPE: DUAL MEDIA
ANTHRACITE - 21"
GREENSAND - 15"

FILTRATION RATE: NORMAL FLOW = 1050 GPM
MAX. FLOW (W/RECIRCULATION) = 1250 GPM

NORMAL FILTRATION RATE: $\frac{1050 \text{ GPM}}{4 \times 0.84 \times 8' \times 30'}$
(ACCOUNTS FOR AVE. CROSS SECT AREA)
= 1.30 GPM/SF ok

MAX. FILTRATION RATE = $\frac{1250 \text{ GPM}}{4 \times 0.84 \times 8' \times 30'}$

= 1.55 GPM/SF ok

BACKWASH RATE: 12 GPM/SF × 0.84 × 8' × 30'

= 2419 GPM SAY 2,500 GPM ok

AIR/WATER SCOUR: AIR RATE - USE 2.0 CFM/SF × 0.84 × 8' × 30'
= 403 CFM SAY 400 CFM

WATER RATE USE $\frac{1250 \text{ GPM}}{0.84 \times 8' \times 30'}$ = 6.2 SCFM/SF
ok

V DETERMINE MAXIMUM HYDRAULIC FLOW RATE FOR PRESSURE FILTERS

CASE No.	GROUNDWATER CONTAMINENTS		MAXIMUM HYDRAULIC LOADING	MAXIMUM PLANT INFLUENT FLOW	RECIRCULATING FLOW
	Fe	Mn			
1	2 mg/l	0.5 mg/l	2,371 gpm	2,271 gpm	100 gpm
2	5 mg/l	1.0 mg/l	2032 gpm	1,832 gpm	200 gpm
3	8 mg/l	1.0 mg/l	1,423 gpm	1,223 gpm	200 gpm

- THE MAXIMUM HYDRAULIC LOADING RATE IS BASED ON THE AMOUNT OF TIME IT TAKES TO PUMP OUT THE BACKWASH HOLDING TANK
  AT 100 GPM IT TAKES 300 MIN (5 HRS)
  AT 200 GPM IT TAKES 150 MIN (2.5 HRS)
  THEREFORE, THE MOST OFTEN A BACKWASH SEQUENCE CAN OCCUR IS EITHER ONCE EVERY 5 OR 2.5 HRS.

CONCLUSION:

THE PRESSURE FILTERS ARE DESIGNED TO REMOVE THE ABOVE LISTED CONTAMINANTS UP TO A MAXIMUM HYDRAULIC LOADING RATE OF:

1,423 GPM

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CASE No. 1

FOR INFLUENT CONTAINING 2 mg/l Fe & 0.5 mg/l Mn
AND A RECIRCULATION FLOW OF 100 gpm
DETERMINE THE MAXIMUM HYDRAULIC LOADING RATE FOR
4 PRESSURE FILTERS

ASSUME NO DILUTION FROM RECIRCULATING FLOW TO BE CONSERVATIVE

$KMnO_4$ DEMAND = (1 × 2 mg/l Fe) + (2 × 0.5 mg/l Mn)

= 3 mg/l / 17.1 = 0.175 grains/gal

At 600 grains/sf loading / 0.175 gpg = 3420.8 gal/sf

At 100 gpm max frequency of backwash = 300 min
or every 1200 min for each filter

MAXIMUM HYDRAULIC LOADING RATE =

$\frac{3420.8 \text{ gal/sf}}{1200 \text{ min}}$ = 2.85 gpm/sf × 4 filters × 208 SF/FILTER

= 2,371 gpm

MAXIMUM INFLUENT LOADING RATE (NOT INCLUDING RECIRCULATION)

= 2,371 gpm - 100 gpm

= **2,271 gpm**

CASE No. 2

FOR INFLUENT CONTAINING 5 mg/l Fe & 1.0 mg/l Mn AND A RECIRCULATION FLOW OF 200 gpm DETERMINE THE MAXIMUM HYDRAULIC LOADING RATE FOR 4 PRESSURE FILTERS

ASSUME NO DILUTION FROM RECIRCULATING FLOW TO BE CONSERVATIVE

$KMnO_4$ DEMAND = (1 × 5 mg/l Fe) + (2 × 1.0 mg/l Mn)

= 7 mg/l / 17.1 = 0.41 grains/gal

At 600 grains/sf loading / 0.41 gpg = 1465.6 gal/sf

At 200 gpm max frequency of backwash = 150 min or every 600 min for each filter

MAXIMUM HYDRAULIC LOADING RATE =

$\frac{1465.6 \text{ gal/sf}}{600 \text{ min}}$ = 2.44 gpm/sf × 4 filters × 208 SF/FILTER

= 2,032 gpm

MAXIMUM INFLUENT LOADING RATE (NOT INCLUDING RECIRCULATION)

= 2,032 gpm - 200 gpm

= **1,832 gpm**

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CASE No. 3

FOR INFLUENT CONTAINING 8 mg/l Fe & 1.0 mg/l Mn
AND A RECIRCULATION FLOW OF 200 gpm
DETERMINE THE MAXIMUM HYDRAULIC LOADING RATE FOR
4 PRESSURE FILTERS

ASSUME NO DILUTION FROM RECIRCULATING FLOW TO BE CONSERVATIVE

$KMnO_4$ DEMAND = (1 × 8 mg/l Fe) + (2 × 1.0 mg/l Mn)

= 10 mg/l / 17.1 = 0.58 grains/gal

At 600 grains/sf loading / 0.58 gpg = 1026 gal/sf

At 200 gpm max frequency of backwash = 150 min
or every 600 min for each filter

MAXIMUM HYDRAULIC LOADING RATE =

$\frac{1026 \text{ gal/sf}}{600 \text{ min}}$ = 1.71 gpm/sf × 4 filters × 208 sf/filter

= 1,423 gpm

MAXIMUM INFLUENT LOADING RATE (NOT INCLUDING RECIRCULATION)

= 1,423 gpm - 200 gpm

= **1,223 gpm**

VI DETERMINE THE PRESSURE FILTER RUN LENGTHS FOR EACH CASE IN SECTION V

PRESSURE FILTER RUN LENGTHS ARE BASED ON THE AMOUNT OF IRON & MANGANESE PRECIPITATED OUT ON THE MEDIA BED WHICH WOULD CAUSE A 10 PSI PRESSURE DROP THROUGH THE FILTER. ONCE THIS TIME IS DETERMINED THROUGH FILTER OPERATION, THE FILTER BACKWASHES ARE SET ON A TIMED BASIS AND STAGGARED SO THAT ONE FILTER IS BACKWASHED AT A TIME.

FILTER RUN LENGTHS ARE ESTIMATED ON THE FOLLOWING PAGES FOR THE 3 CASES LISTED IN SECTION V. THESE CALCULATIONS ARE BASED ON THE KNOWN QUANTITY OF $KMnO_4$ ON THE FILTER BED WHICH WILL PRECIPITATE THE MAXIMUM AMOUNT OF IRON & MANGANESE PRIOR TO BACKWASHING AS DESCRIBED ABOVE.

CONCLUSION:

THE PROPOSED FILTRATION SYSTEM HAS BEEN DESIGNED FOR SEVERAL SCENARIOS TO REMOVE A RANGE OF IRON (2-8 MG/L) AND MANGANESE (0.5-1.0 MG/L) CONCENTRATIONS TO CURRENT ACCEPTABLE (NYS & EPA) EFFLUENT STANDARDS OF 0.3 mg/l Fe AND 0.05 mg/l Mn AT VARIOUS FLOWS.

CASE No. 1

1/2

2 mg/l Fe + 0.5 mg/l Mn
R = 100 gpm

PRESSURE FILTER RUN LENGTHS

DESIGN FLOW = 1050 gpm
RECIRCULATED FLOW = 100 gpm (MAX = 200 gpm)

INFLUENT CONCENTRATION = 2-5 mg/l Fe + 0.5 - 1.0 mg/l Mn
MAX = 8 mg/l Fe + 1.0 mg/l Mn

LIMITING RUN LENGTH FACTOR = PUMP OUT (OF B.W HOLDING TANK) @ $\frac{30000 \text{ GAL}}{100 \text{ gpm}}$ = 300 min = 5 hrs

AT 2 mg/l Fe + 0.5 mg/l Mn @ 1050 gpm + 100 gpm

MASS BALANCE ON RECIRCULATED FLOW

- INCOMING FLOW
  1050 gpm @ 2 mg/l Fe + 0.5 mg/l Mn
- RECIRCULATED FLOW FROM SETTLING TANK
  100 gpm @ :

	(GAL) VOLUME		(mg/l) SOLUBLE Fe	(mg/l) SOLUBLE Mn
DRAIN WATER	1,400	@	2	0.5
LOW RATE BACKWASH	1,250	@	0	0
HIGH RATE BACKWASH	25,000	@	0	0
RAW WATER RINSE	1,320	@	2	0.5
	28,970 GAL			

MASS BALANCE:

$$\text{SOLUBLE Fe CONC} = \frac{(1400 \text{ GAL})(2 \text{ mg/l Fe}) + (1320 \text{ GAL})(2 \text{ mg/l Fe})}{28{,}970}$$

$$= 0.19 \text{ mg/l Fe}$$

$$\text{SOLUBLE Mn CONC} = \frac{(1400 \text{ GAL})(0.5 \text{ mg/l Mn}) + (1320 \text{ GAL})(0.5 \text{ mg/l Mn})}{28{,}970}$$

$$= 0.05 \text{ mg/l Mn}$$

100 gpm @ 0.19 mg/l Fe + 0.05 mg/l Mn

CASE No. 1 (CONT'D)

2/2

2mg/l Fe = 0.5 mg/l Mn
R = 100 gpm

MASS BALANCE ON TOTAL FLOW TO PRESSURE FILTERS

1050 gpm @ 2 mg/l Fe + 0.5 mg/l Mn

100 gpm @ 0.19 mg/l Fe + 0.05 mg/l Mn

$$\text{Soluble Fe Conc} = \frac{(1050\text{ gpm} \times 2\text{ mg/l}) + (100\text{ gpm} \times 0.19\text{ mg/l})}{1150\text{ gpm}}$$

$$= 1.85\text{ mg/l Fe}$$

$$\text{Soluble Mn Conc} = \frac{(1050\text{ gpm} \times 0.5\text{ mg/l}) + (100\text{ gpm} \times 0.05\text{ mg/l})}{1150\text{ gpm}}$$

$$= 0.46\text{ mg/l Mn}$$

PRESSURE FILTER RUN LENGTHS

FOR COMBINED INFLUENT CONTAINING 1.85 mg/l Fe + 0.46 mg/l Mn

$KMnO_4$ DEMAND = (1 × mg/l Fe) + (2 × mg/l Mn)

= (1 × 1.85) + (2 × 0.46)

= 2.77 mg/l / 17.1 = 0.162 grains/gal

AT 600 GRAINS/SF LOADING / 0.162 GRAINS/GAL

= 3,702 GAL/SF

AT 1.38 GPM/SF LOADING RATE:

$$\frac{3702\text{ GAL/SF}}{1.38\text{ gpm/sf}} = 2683\text{ min} = 44.71\text{ hrs}$$

$$\frac{44.71\text{ hrs}}{4\text{ filters}} = 11.18\text{ hrs} > 5\text{ hrs ok}$$

THEREFORE, FOR FOUR FILTERS, ONE BACKWASH IS REQUIRED EVERY 11.18 HRS

CASE No. 2

114

5 mg/l Fe & 1.0 mg/l Mn
R = 100 gpm

PRESSURE FILTER RUN LENGTHS

DESIGN FLOW = 1050 gpm
RECIRCULATED FLOW = 100 gpm (MAX = 200 gpm)

INFLUENT CONCENTRATION = 2-5 mg/l Fe + 0.5-1.0 mg/l Mn
MAX = 8 mg/l Fe + 1.0 mg/l Mn

LIMITING RUN LENGTH FACTOR = PUMP OUT @ $\frac{30000 \text{ GAL BW}}{100 \text{ GPM}}$ = 300 MIN = 5 HRS
(OF BW HOLDING TANK)

AT 5 mg/l Fe + 1.0 mg/l Mn @ 1050 gpm + 100 gpm

MASS BALANCE ON RECIRCULATED FLOW

- INCOMING FLOW
  1050 gpm @ 5 mg/l Fe + 1.0 mg/l Mn
- RECIRCULATED FLOW FROM SETTLING TANK
  100 gpm @:

	(GAL) VOLUME		(mg/l) SOLUBLE Fe	(mg/l) SOLUBLE Mn
DRAIN WATER	1,400	@	5	1.0
LOW RATE BACKWASH	1,250	@	0	0
HIGH RATE BACKWASH	25,000	@	0	0
RAW WATER RINSE	1,320	@	5	1.0
	28,970			

MASS BALANCE:

$$\text{SOLUBLE Fe CONC} = \frac{(1400 \text{ GAL})(5 \text{ mg/l Fe}) + (1320 \text{ GAL})(5 \text{ mg/l Fe})}{28{,}970}$$

$$= 0.47 \text{ mg/l Fe}$$

$$\text{SOLUBLE Mn CONC} = \frac{(1400 \text{ GAL})(1.0 \text{ mg/l Mn}) + (1320 \text{ GAL})(1.0 \text{ mg/l Mn})}{28{,}970}$$

$$= 0.10 \text{ mg/l Mn}$$

100 gpm @ 0.47 mg/l Fe + 0.10 mg/l Mn

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CASE NO. 2 (CONT'D)

2/4

5 mg/l Fe + 1.0 mg/l Mn
R = 100 gpm

MASS BALANCE ON TOTAL FLOW TO PRESSURE FILTERS

1050 gpm @ 5 mg/l Fe + 1.0 mg/l Mn

100 gpm @ 0.47 mg/l Fe + 0.10 mg/l Mn

SOLUBLE Fe CONC = $\frac{(1050\text{ gpm} \times 5\text{ mg/l}) + (100\text{gpm} \times 0.47\text{mg/l})}{1150\text{ gpm}}$

= 4.61 mg/l Fe

SOLUBLE Mn CONC = $\frac{(1050\text{gpm} \times 1.0\text{ mg/l}) + (100\text{gpm} \times 0.10\text{mg/l})}{1150\text{ gpm}}$

= 0.92 mg/l Mn

PRESSURE FILTER RUN LENGTHS

FOR COMBINED INFLUENT CONTAINING mg/l Fe + mg/l Mn

$KMnO_4$ DEMAND = (1 × mg/l Fe) + (2 × mg/l Mn)

= (1 × 4.61) + (2 × 0.92)

= 6.45 mg/l / 17.1 = 0.38 grains/gal

AT 600 GRAINS/SF LOADING / 0.38 GRAINS/GAL

= 1590 GAL/SF

AT 1.38 GPM/SF LOADING RATE:

$\frac{1590\text{ GAL/SF}}{1.38\text{gpm/sf}}$ = 1152 min = 19.2 hrs

$\frac{19.2\text{ hrs}}{4\text{ filters}}$ = 4.80 hrs < 5 hrs NO GOOD

TRY 200 GPM RECIRCULATION FLOW

CASE No. 2 (CONT'D)

3/4

5 mg/l Fe & 1 mg/l Mn
R = 200 gpm

PRESSURE FILTER RUN LENGTHS

DESIGN FLOW = 1050 gpm
RECIRCULATED FLOW = 200 gpm (MAX = 200 gpm)

INFLUENT CONCENTRATION = 2-5 mg/l Fe + 0.5 - 1.0 mg/l Mn
MAX = 8 mg/l Fe + 1.0 mg/l Mn

LIMITING RUN LENGTH FACTOR = PUMP OUT @ $\frac{30,000 \text{ GAL}}{200 \text{ GPM}}$ = 150 MIN = 2.5 HRS

AT 5 mg/l Fe + 1.0 mg/l Mn @ 1050 gpm + 200 gpm

MASS BALANCE ON RECIRCULATED FLOW

- INCOMING FLOW
  1050 gpm @ 5 mg/l Fe + 1.0 mg/l Mn
- RECIRCULATED FLOW FROM SETTLING TANK
  200 gpm @ :

	(GAL) VOLUME		(mg/l) SOLUBLE Fe	(mg/l) SOLUBLE Mn
DRAIN WATER	1,400	@	5	1.0
LOW RATE BACKWASH	1,250	@	0	0
HIGH RATE BACKWASH	25,000	@	0	0
RAW WATER RINSE	1,320	@	5	1.0
	28,970			

MASS BALANCE:

$$\text{SOLUBLE Fe CONC} = \frac{(1400 \text{ GAL})(5 \text{ mg/l Fe}) + (1320 \text{ GAL})(5 \text{ mg/l Fe})}{28{,}970}$$

$$= 0.47 \text{ mg/l Fe}$$

$$\text{SOLUBLE Mn CONC} = \frac{(1400 \text{ GAL})(1 \text{ mg/l Mn}) + (1320 \text{ GAL})(1 \text{ mg/l Mn})}{28{,}970}$$

$$= 0.10 \text{ mg/l Mn}$$

200 gpm @ 0.47 mg/l Fe + 0.10 mg/l Mn

CASE No. 2 (CONT'D) 4/4

5 mg/l Fe & 1.0 mg/l Mn
R = 200 gpm

MASS BALANCE ON TOTAL FLOW TO PRESSURE FILTERS

1050 gpm @ 5 mg/l Fe + 1.0 mg/l Mn
200 gpm @ 0.47 mg/l Fe + 0.10 mg/l Mn

$$\text{Soluble Fe Conc} = \frac{(1050\text{ gpm} \times 5\text{ mg/l}) + (200\text{gpm} \times 0.47\text{ mg/l})}{1250\text{ gpm}}$$

$$= 4.28\text{ mg/l Fe}$$

$$\text{Soluble Mn Conc} = \frac{(1050\text{gpm} \times 1.0\text{ mg/l}) + (200\text{gpm} \times 0.1\text{ mg/l})}{1250\text{ gpm}}$$

$$= 0.86\text{ mg/l Mn}$$

PRESSURE FILTER RUN LENGTHS

FOR COMBINED INFLUENT CONTAINING mg/l Fe + mg/l Mn

$KMnO_4$ DEMAND = (1 × mg/l Fe) + (2 × mg/l Mn)
= (1 × 4.28) + (2 × 0.86)
= 6.0 mg/l / 17.1 = 0.35 grains/gal

AT 600 GRAINS/SF LOADING / 0.35 GRAINS/GAL
= 1710 GAL/SF

AT 1.5 GPM/SF LOADING RATE:

$$\frac{1710}{1.5\text{ gpm/sf}} = 1140\text{ min} = 19\text{ hrs}$$

$$\frac{19\text{ hrs}}{4\text{ filters}} = 4.75\text{ hrs} > 2.5\text{ hrs ok}$$

THEREFORE, FOR FOUR FILTERS, ONE BACKWASH IS REQUIRED EVERY 4.75 HRS

14

CASE No. 3

2 mg/l Fe & 1.0 mg/l Mn
R = 100 gpm

PRESSURE FILTER RUN LENGTHS

DESIGN FLOW = 1050 gpm
RECIRCULATED FLOW = 100 gpm (MAX = 200 gpm)

INFLUENT CONCENTRATION : 2-5 mg/l Fe + 0.5 - 1.0 mg/l Mn
MAX = 8 mg/l Fe + 1.0 mg/l Mn

LIMITING RUN LENGTH FACTOR = PUMP OUT @ (OF BW HOLDING TANK) $\frac{30,000 \text{ GAL}}{100 \text{ gpm}}$ = 300 MIN = 5 HRS

AT 8 mg/l Fe + 1.0 mg/l Mn @ 1050 gpm + 100 gpm

MASS BALANCE ON RECIRCULATED FLOW

- INCOMING FLOW
  1050 gpm @ 8 mg/l Fe + 1.0 mg/l Mn

- RECIRCULATED FLOW FROM SETTLING TANK
  100 gpm @ :

	(GAL) VOLUME		(mg/l) SOLUBLE Fe	(mg/l) SOLUBLE Mn
DRAIN WATER	1,400	@	8	1.0
LOW RATE BACKWASH	1,250	@	0	0
HIGH RATE BACKWASH	25,000	@	0	0
RAW WATER RINSE	1,320	@	8	1.0
	28,970			

MASS BALANCE:

$$\text{SOLUBLE Fe CONC} = \frac{(1400 \text{ GAL})(8 \text{ mg/l Fe}) + (1320 \text{ GAL})(8 \text{ mg/l Fe})}{28{,}970}$$

$$= 0.75 \text{ mg/l Fe}$$

$$\text{SOLUBLE Mn CONC} = \frac{(1400 \text{ GAL})(1.0 \text{ mg/l Mn}) + (1320 \text{ GAL})(1.0 \text{ mg/l Mn})}{28{,}970}$$

$$= 0.10 \text{ mg/l Mn}$$

100 gpm @ 0.75 mg/l Fe + 0.10 mg/l Mn

CASE No. 3 (CONT'D)

2/4

8 mg/l Fe ≡ 1.0 mg/l Mn
R = 100 gpm

MASS BALANCE ON TOTAL FLOW TO PRESSURE FILTERS

1050 gpm @ 8 mg/l Fe + 1.0 mg/l Mn
100 gpm @ 0.75 mg/l Fe + 0.10 mg/l Mn

$$\text{Soluble Fe Conc} = \frac{(1050\text{ gpm} \times 8\text{ mg/l}) + (100\text{gpm} \times 0.75\text{ mg/l})}{1150\text{ gpm}}$$

$$= 7.37\text{ mg/l Fe}$$

$$\text{Soluble Mn Conc} = \frac{(1050\text{gpm} \times 1.0\text{ mg/l}) + (100\text{gpm} \times 0.10\text{mg/l})}{1150\text{ gpm}}$$

$$= 0.92\text{ mg/l Mn}$$

PRESSURE FILTER RUN LENGTHS

FOR COMBINED INFLUENT CONTAINING 7.37 mg/l Fe + 0.92 mg/l Mn

$$KMnO_4\text{ DEMAND} = (1 \times \text{mg/l Fe}) + (2 \times \text{mg/l Mn})$$

$$= (1 \times 7.37) + (2 \times 0.92)$$

$$= 9.21\text{ mg/l} / 17.1 = 0.54\text{ grains/gal}$$

AT 600 GRAINS/SF LOADING /0.54 GRAINS/GAL

= 1114.06 GAL/SF

AT 1.38 GPM/SF LOADING RATE :

$$\frac{1114\text{ GAL/SF}}{1.38\text{ gpm/sf}} = 807\text{ min} = 13.45\text{ hrs}$$

$$\frac{13.45\text{ hrs}}{4\text{ filters}} = 3.36 \quad 5\text{ hrs} \quad \underline{\text{No Good}}$$

TRY 200 GPM RECIRCULATION FLOW

3/4

CASE NO. 3 CONT'D

8 mg/l Fe + 1.0 mg/l Mn
R = 200 gpm

PRESSURE FILTER RUN LENGTHS

DESIGN FLOW = 1050 gpm
RECIRCULATED FLOW = 200 gpm (MAX = 200 gpm)

INFLUENT CONCENTRATION = 2-5 mg/l Fe + 0.5 - 1.0 mg/l Mn
MAX = 8 mg/l Fe + 1.0 mg/l Mn

LIMITING RUN LENGTH FACTOR = PUMP OUT OF (OF BW HOLDING TANK) $\frac{30,000 \text{ GAL}}{200 \text{ gpm}}$ = 150 MIN = 2.5 HRS

AT 8 mg/l Fe + 1.0 mg/l Mn @ 1050 gpm + 200 gpm

MASS BALANCE ON RECIRCULATED FLOW

- INCOMING FLOW
  1050 gpm @ 8 mg/l Fe + 1.0 mg/l Mn
- RECIRCULATED FLOW FROM SETTLING TANK
  200 gpm @ :

	(GAL) VOLUME		(mg/l) SOLUBLE Fe	(mg/l) SOLUBLE Mn
DRAIN WATER	1,400	@	8	1.0
LOW RATE BACKWASH	1,250	@	0	0
HIGH RATE BACKWASH	25,000	@	0	0
RAW WATER RINSE	1,320	@	8	1.0
	28,970			

MASS BALANCE:

$$\text{SOLUBLE Fe CONC} = \frac{(1400 \text{ GAL})(8 \text{ mg/l Fe}) + (1320 \text{ GAL})(8 \text{ mg/l Fe})}{28{,}970}$$

$$= 0.75 \text{ mg/l Fe}$$

$$\text{SOLUBLE Mn CONC} = \frac{(1400 \text{ GAL})(1.0 \text{ mg/l Mn}) + (1320 \text{ GAL})(1.0 \text{ mg/l Mn})}{28{,}970}$$

$$= 0.10 \text{ mg/l Mn}$$

200 gpm @ 0.75 mg/l Fe + 0.10 mg/l Mn

CASE No. 3 (CONT'D) 4/4

8 mg/l Fe & 1.0 mg/l Mn
R = 200 gpm

MASS BALANCE ON TOTAL FLOW TO PRESSURE FILTERS

1050 gpm @ 8.0 mg/l Fe + 1.0 mg/l Mn
200 gpm @ 0.75 mg/l Fe + 0.10 mg/l Mn

SOLUBLE Fe Conc = $\frac{(1050 \text{ gpm} \times 8 \text{ mg/l}) + (200 \text{ gpm} \times 0.75 \text{ mg/l})}{1250 \text{ gpm}}$

= 6.84 mg/l Fe

SOLUBLE Mn Conc = $\frac{(1050 \text{ gpm} \times 1.0 \text{ mg/l}) + (200 \text{ gpm} \times 0.1 \text{ mg/l})}{1250 \text{ gpm}}$

= 0.86 mg/l Mn

PRESSURE FILTER RUN LENGTHS

FOR COMBINED INFLUENT CONTAINING mg/l Fe + mg/l Mn

$KMnO_4$ DEMAND = (1 × mg/l Fe) + (2 × mg/l Mn)
= (1 × 6.84) + (2 × 0.86)
= 8.56 mg/l / 17.1 = 0.50 grains/gal

AT 600 GRAINS/SF LOADING / 0.50 GRAINS/GAL
= 1198.6 GAL/SF

AT 1.5 GPM/SF LOADING RATE:

$\frac{1199 \text{ GAL/SF}}{1.5 \text{ gpm/sf}}$ = 799 min = 13.3 hrs

$\frac{13.3 \text{ hrs}}{4 \text{ filters}}$ = 3.34 hrs > 2.5 hrs ok

THEREFORE, FOR FOUR FILTERS, ONE BACKWASH IS REQUIRED EVERY 3.34 HRS

LKB LOCKWOOD KESSLER & BARTLETT, INC.
CONSULTING ENGINEERS - SYOSSET, N.Y.

PROJECT: DBSWDC
SUBJECT: RAP
JOB NO.: 3086-01
SHEET NO. 1 OF 5
BY: MJM DATE 9/18/88
CHKD. BY: JSS DATE 9/22/88

1- GENERAL CONSIDERATIONS - ACTIVATED CARBON

The objective of this process unit is to remove VOC's remaining in the effluent after air stripping process.

Physical adsorption of particles is obtained through activated carbon.

The activated carbon system has been designed operating in parallel, however, flexibility for series operation has been also provided.

LKB LOCKWOOD KESSLER & BARTLETT, INC.
CONSULTING ENGINEERS - SYOSSET, N.Y.

PROJECT OBSWDC SHEET NO. 2 OF 5
SUBJECT RAP BY MJM DATE 1/18/88
JOB NO. 8086-01 CHKD. BY JSS DATE 9/22/88

ACTIVATED CARBON - DESIGN PARAMETERS

Number of Units = 3
Operating in parallel

Design flow rate = 1,050 GPM
Flow rate / unit = 350 GPM
Empty bed contact time = 10-15 min
Backwash flow = 1200 gpm (for 15 min)

Recommended overflow rate = 4-6 gpm/ft²
Recommended carbon capacity/unit = 20,000 lbs
Diameter = 10 ft
Height = 15 ft ⇒ straight height = 12.5 ft

$$\text{Vol}_{\text{req'd}} = 1{,}050\ \frac{\text{gal}}{\text{min}} \times 15\ \text{min} = 15{,}750\ \text{gal}$$

$$\text{Vol}_{\text{req'd}} = 15{,}750\ \text{gal} \times \frac{1\ \text{ft}^3}{7.48\ \text{gal}} = 2{,}105.6\ \text{ft}^3$$

$$\text{Vol/unit} = \frac{2{,}105.6\ \text{ft}^3}{3} = 701.87\ \text{ft}^3/\text{Unit}$$

$$\text{Area} = \frac{\pi D^2}{4} = 78.54\ \text{ft}^2/\text{unit}$$

$$\text{Overflow rate} = \frac{350\ \text{gpm/unit}}{78.54\ \text{ft}^2/\text{unit}}$$

$$\text{Overflow rate} = 4.46\ \text{gpm/ft}^2$$ ⇐ OK!

$$H = \text{height} = \frac{701.83\ \text{ft}^3/\text{unit}}{78.54\ \text{ft}^2/\text{Unit}} = 8.94\ \text{ft}$$ ⇐ (Height of carbon media for E.B.C.T. = 15 min)

Max. flow allowable through Unit = $6\ \text{gpm/ft}^2 \times 78.54\ \text{ft}^2 = 471.0\ \text{gpm}$

Max. flow allowable through Activated carbon process:

Q_{max} = 471.00 gpm/unit × 3 Units =

| Q_{max} = 1,413.00 gpm | ⟸ Max flow allowable

VOLUME OF CARBON MEDIA PROVIDED (for 20,000 Lbs of Carbon)

$Vol_{provided}/_{unit}$ = 78.54 ft² × 8.5 ft* = 667.59 ft³/unit

$Vol_{provided}/_{unit}$ = 667.59 $\frac{ft^3}{unit}$ × $\frac{7.48\ gal}{ft^3}$ = 4,993.57 gal/unit

$Vol_{provided}$ = 4,993.57 $\frac{gal}{Unit}$ × 3 Units =

$Vol_{provided}$ = 14,980.72 gal

Empty bed Contact time at max. flow condition

$T_{Qmax} = \frac{Vol_{provided}}{Max\ flow} = \frac{14{,}980.72\ gal}{1{,}413.00\ gal/min}$

T_{Qmax} = 10.6 min OK!

Empty bed Contact time at Design flow Condition

$T_{Qdesign} = \frac{Vol.\ provided}{Design\ flow} = \frac{14{,}980.72\ gal}{1{,}050.00\ gal/min}$

$T_{Qdesign}$ = 14.27 min OK!

* See page 5

LKB LOCKWOOD KESSLER & BARTLETT, INC.
CONSULTING ENGINEERS - SYOSSET, N.Y.

PROJECT OB=NDC SHEET NO. 4 OF 5
SUBJECT RAP BY MJM DATE 5/18/88
JOB NO. 3036-01 CHKD. BY JSS DATE 9/22/88

CHECKING THE PRESSURE DROP THROUGH UNIT

ΔP – Pressure drop across unit (psi)

ΔH – Headloss across unit (ft)

K = Headloss coefficient -

V = Velocity (fps)

$$\Delta H = K \frac{V^2}{2g}$$

$$\Delta H = \Delta P \times 2.3093$$

$$Q = 350 \frac{gal}{min} \times \frac{1\ min}{60\ sec} \times \frac{ft^3}{7.48\ gal} = 0.78\ cfs.$$

$$A = \frac{\pi D^2}{4} = \frac{\pi \times (10)^2}{4} = 78.54\ ft^2$$

$$V = \frac{Q}{A} = \frac{0.78\ cfs}{78.54\ ft^2} = 0.00993\ fps$$

$$\Delta H = \frac{K \times (0.00993)^2\ ft^2/sec^2}{2 \times 32.17\ ft/sec^2}$$

$$\Delta H = 1.5329 \times 10^{-6}\ ft \times K$$

Using $\Delta P = 3$ PSI (As per Manufacturer's and technical publication recommendations)

$\Delta H = 3\ psi \times 2.3093 = 6.93\ ft$ ⇒ (for 350 GPM through ea. unit in parallel)

therefore, $K = \frac{6.93\ ft}{1.5329 \times 10^{-6}\ ft}$

$K = 1.06 \times 10^{-5}$ ⇐ OK! for Calgon 8×30 Mesh Media

ACTIVATED CARBON - FREEBOARD COMPUTATION

Straight height = 12.5 ft.

Recommended Carbon capacity/unit = 20,000 lbs.

Apparent density of carbon = 0.48 g/cm^3

$0.48 \ g/cm^3 \times 62.43 = 29.97 \ lbs/ft^3$

$\frac{20,000 \text{ lbs}}{29.97 \text{ lbs}/ft^3} = 667.41 \ ft^3$ ⟸ Volume of Carbon

= Height of carbon in unit:

$V = A \times h = \frac{\pi D^2}{4} \times h$

$h = \frac{667.41 \ ft^3 \times 4}{(10)^2 ft^2 \times 3.14} = 8.5 \ ft$ ⟸ Min. height of Carbon/Unit

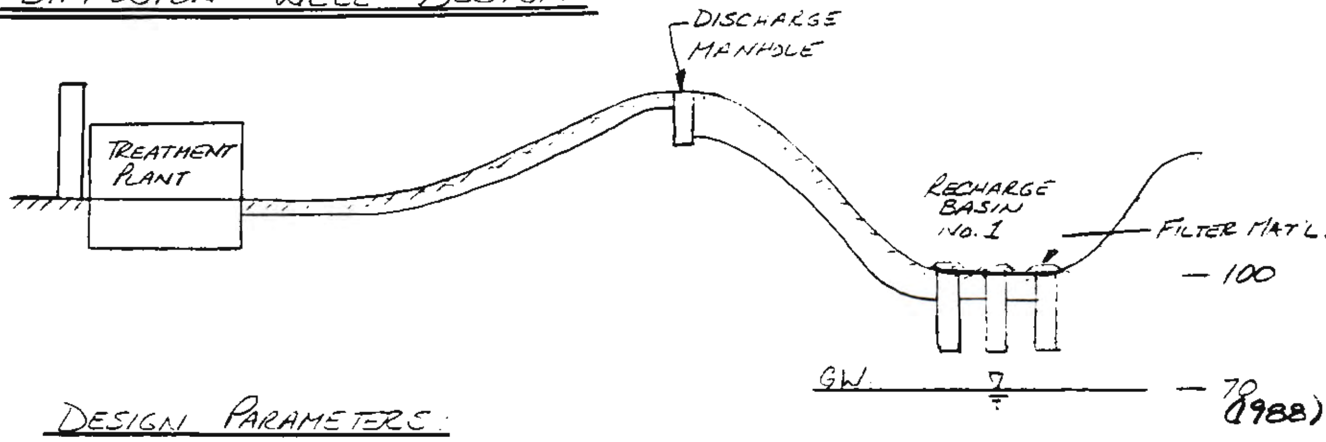
Min. freeboard provided for bed expansion = 1.5 ft ⇒ 18% Bed expansion

Max. freeboard provided for bed expansion = 4.0 ft ⇒ 47% Bed expansion

CONCLUSIONS

The proposed Activated Carbon System has been designed to remove VOC's remaining in the effluent after Air Stripping process, for a maximum of 1,413 gpm and recommended maximum overflow rate of 6 gpm/ft^2

DIFFUSION WELL DESIGN



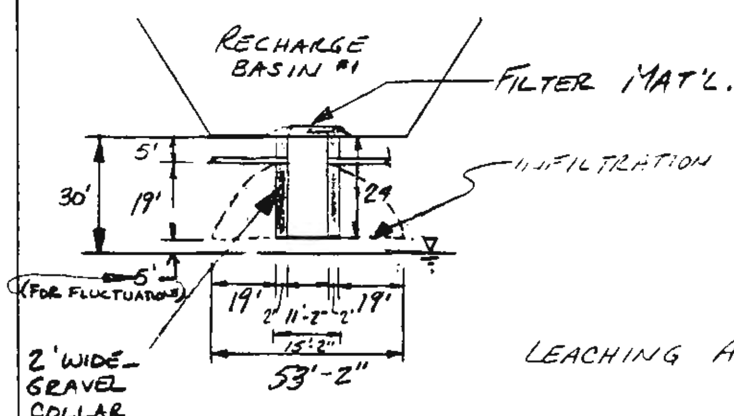
DESIGN PARAMETERS:

DIFFUSION WELL SIZE - 10'-0" ID, 11'-2" OD (CARLSON)

GROUNDWATER ELEV. = 70' (1988 SOIL BORING CONTRACT)
74.7' (1979 SOIL BORING CONTRACT) ← USE 75' TO ACCOUNT FOR SEASONAL FLUCTUATIONS

AVAILABLE DEPTH = 100' - 75' = 25' ← SAY 24' USE 4-6' HIGH RINGS

SATURATED PERMEABILITY (K_s) = 1.00 FT/HR
(SEE CALCULATIONS)



INFILTRATION AREA = $\frac{(53'\text{-}2")^2}{4}\pi$

= ~~2220.36~~ SF

.08 2

LEACHING AREA = $\frac{\pi d^2}{4} + \pi d H = \frac{\pi}{4}(15.17')^2 + \pi(15.17')(19)$

= 1086.24 SF

USE LEACHING AREA FOR CALCULATIONS TO BE CONSERVATIVE

WATER DEPTH = 19'

NOTE: 24' OF TOTAL DEPTH IS AVAILABLE
19' OF DEPTH IS AVAILABLE FOR FREE DISCHARGE

LOCKWOOD KESSLER & BARTLETT, INC.
CONSULTING ENGINEERS - SYOSSET, N.Y.

PROJECT OBSWDC SHEET NO. 2 OF 18
SUBJECT GROUNDWATER REMEDIATION BY TCH DATE 1/12/89
JOB NO. 2086-02 CHKD. BY JSS DATE 1/16/89

NYSDOT METHOD OF RECHARGE BASIN & LEACHING BASIN DESIGN*

$Q = N\sqrt{t}\,A$

$N = \dfrac{2K_t\,(H + \psi_n)}{\sqrt{\pi\alpha}}$

$\psi_n = 0.30$
$n = 0.33$
$S_n = 0$
$S_t = 0.5$
$t = 24$ hrs

$K_t = \dfrac{K_S}{2} = \dfrac{1.0 \text{ FT/HR}}{2} = 0.5$ FT/HR

$\alpha = \dfrac{K_t}{\theta_t - \theta_n} = \dfrac{0.5}{0.165 - 0}$

$\theta_t = S_t \times n = 0.5 \times 0.33 = 0.165$

$\theta_n = S_n \times n = 0$

$\alpha = 3.03$

$N = \dfrac{2(0.5)(19 + 0.30)}{\sqrt{\pi\, 3.03}}$

$N = 6.26$

$Q_{OUT} = 6.26\sqrt{24}\,(1086)$
$= 33{,}288.36$ FT^3/DAY - DIFFUSION WELL

* THE NYSDOT METHOD OF DESIGN IS BASED ON DETERMINING THE SOIL PERMEABILITY (K_S) THROUGH THE USE OF SIEVE ANALYSES PERFORMED ON SOIL BORING SAMPLES.

CALCULATIONS FOR K_S ARE LOCATED ON p. 9-18

DETERMINE No. OF DIFFUSION WELLS FOR VARIOUS DESIGN FLOWS

Q_1 = 1.5 MGD (DESIGN FLOW) = 200,535 FT^3/DAY

No. OF WELLS REQ'D = $\dfrac{200{,}535 \ FT^3/DAY}{33{,}288 \ FT^3/DAY \cdot WELL}$

= 6.0 WELLS

Q_2 = 1.8 MGD = 240,642 FT^3/DAY

No. OF WELLS REQ'D = $\dfrac{240{,}642 \ FT^3/DAY}{33{,}288 \ FT^3/DAY \cdot WELL}$

= 7.2 WELLS

SAY 8 WELLS

Q_3 = 2.0 MGD (MAX FLOW) = 267,380 FT^3/DAY

No. OF WELLS REQ'D = $\dfrac{267{,}380 \ FT^3/DAY}{33{,}288 \ FT^3/DAY \cdot WELL}$

= 8.0 WELLS

AT 60' O.C. THE MAXIMUM LEACHING DEPTH IS

$$\frac{(60' - 15.17')}{2} = 22.41' \quad \text{SAY } 22.5'$$

MAXIMUM OUTFLOW FROM 22.5' LEACHING DEPTH:

LEACHING AREA $= \frac{\pi}{4}(15.17)^2 + \pi(15.17)(22.5)$

$= 1,253$ SF

$$N = \frac{2(0.5)(22.5 + 0.3)}{\sqrt{\pi \times 3.03}}$$

$= 7.39$

$Q = 7.39\sqrt{24}(1,253)$

$= 45,364$ CF/DAY/WELL

$Q_{TOTAL} = 8$ WELLS $\times$ 45,364 CF/DAY/WELL

$= 362,912$ CF/DAY

$= 2.71$ MGD

SAFETY FACTOR:

DESIGN FLOW: $\frac{2.71 \text{ MGD}}{1.5 \text{ MGD}} = 1.81$

MAX DESIGN FLOW: $\frac{2.71 \text{ MGD}}{2.0 \text{ MGD}} = 1.36$

LOCKWOOD KESSLER & BARTLETT, INC.
CONSULTING ENGINEERS - SYOSSET, N.Y.

PROJECT: OBSWDC
SUBJECT: GRP
JOB NO.: 8086-02
SHEET NO. 5 OF 18
BY: TCH DATE 2/14/89
CHKD. BY: JSS DATE 2/16/89

DIFFUSION WELL DESIGN

LEACHING DEPTH (FT)	INFILTRATION AREA DIA. (FT)	LEACHING AREA (SF)	N	Q_{WELL} (CF/DAY)	NO. OF WELLS THAT FIT*	NO. OF WELLS REQ'D. AT DESIGN FLOWS: 1.5 MGD		1.8 MGD		2.0 MGD	
22.5	60'-0"	1,253	7.39	45,364	8	5	ok	6	ok	6	ok
21.0	57'-2"	1,182	6.26	39,962	8	5	ok	6	ok	7	ok
19.0	53'-2"	1,086	6.26	33,288	8	6	ok	8	ok	8	ok
17.5	50'-2"	1,015	5.77	28,681	8	7	ok	9	NG	10	NG
15.0	45'-2"	896	4.96	21,762	10	10	ok	11	NG	13	NG
14.0	43'-2"	847	4.63	19,232	10	11	NG	13	NG	14	NG
13.0	41'-2"	800	4.31	16,901	11	12	NG	15	NG	16	NG
12.5	40'-2"	777	4.15	15,781	11	13	NG	16	NG	17	NG

CHECK THE EFFECT OF ADDING 3 DIFFUSION WELLS ON THE ABILITY OF RECHARGE BASIN NO. 1 TO RECHARGE STORMWATER

RECHARGE BASIN NO. 1 - DETERMINE AVAILABLE STORAGE VOLUME

PLANIMETER : $(2" \times 2") = \left(\frac{0296 + 0293}{2}\right)$ UNITS

$= 0294.5$ UNITS

SCALE = 1" = 40'
2" = 80'

$(2")^2 = (80')^2 = 6400$ SF

SCALE FACTOR $= \frac{6400 \text{ SF}}{294.5 \text{ UNITS}} = 21.73$ SF/UNIT

SURFACE AREA

ELEV. 100 (BOTTOM) : AREA $= \frac{(0608 + 0610)}{2}$ UNITS $= 0609$ UNITS

$= 13,235$ SF

ELEV. 110 : AREA $= \frac{(2693 + 2692)}{2}$ UNITS $= 2692.5$ UNITS

$= 58,513$ SF

ELEV. 120 : AREA $= \frac{(3697 + 3704)}{2}$ UNITS $= 3700.5$ UNITS

$= 80,418$ SF

RECHARGE BASIN #1 CAPACITY

RECHARGE BASIN STORAGE VOLUME

ELEV. 100 → ELEV. 110 (CONSTANT SLOPE)

$$\text{VOL.} = \left(\frac{13{,}235 + 58{,}513}{2}\right)10'$$

$$= 358{,}740 \text{ CF}$$

ELEV. 110 → ELEV. 120 (CONSTANT SLOPE)

$$\text{VOL.} = \left(\frac{58{,}513 + 80{,}418}{2}\right)10'$$

$$= 694{,}655 \text{ CF}$$

TOTAL VOLUME IN BASIN EL. 100 → EL. 120 = 358,740 + 694,655 CF

= 1,053,395 CF

STORMWATER VOLUME = 699,465 CF FOR THE DESIGN STORM EVENT USED

REMAINING BASIN VOLUME = 1,053,395 CF - 699,465 CF
= 353,930 CF

DETERMINE WATER SURFACE ELEV. FOR DESIGN STORM

699,465 - 358,740 = 340,725 CF
(ST. VOL.) - (VOL. TO EL. 110) (MUST BE STORED HIGHER THAN EL. 110)

$$\frac{340{,}725 \text{ CF}}{699{,}655 \text{ CF}} = 0.490$$

STORMWATER ELEV. = ELEV. 110 + 0.490 (120 - 110)

= ELEV. 114.9

STORMWATER DEPTH = 114.9 - 100

= 14.9 FT

LKB LOCKWOOD KESSLER & BARTLETT, INC.
CONSULTING ENGINEERS - SYOSSET, N.Y.

PROJECT OBSWDC — SHEET NO. 8 OF 18
SUBJECT GRP — BY TCH DATE 2/14/89
JOB NO. 8086-02 — CHKD. BY JSS DATE 2/16/89

USE NYSDOT RECHARGE BASIN DESIGN CRITERIA TO DETERMINE No. OF DAYS REQUIRED TO DISSIPATE STORMWATER VOLUME

DEPTH = 14.9 FT. ELEV = 114.90

$H/2 = D/2 = 7.45$ FT ELEV @ $H/2$ = 107.45

SURFACE AREA @ $H/2$ = 13,235 SF (@ EL. 100) + $\frac{7.45}{10}(58,513 - 13,235)$ SF

= 46,967 SF

AVAILABLE SURFACE AREA FOR INFILTRATION

= 46,967 SF − INFILTRATION AREA FOR DIFFUSION WELLS

= 46,967 SF − $8 \times \left[\frac{\pi}{4}(60')^2\right]$

2827 SF

14,137 SF

= 32,830 SF AVAILABLE

STORMWATER INFILTRATION PER DAY

$Q = N\sqrt{t}\,A$

$N = 2K_t(H + \psi_n)/\sqrt{\pi\alpha}$

$K_t = K_s/2 = 1.0/2 = 0.5$ FT/HR

$\psi_n = 0.30$
$n = 0.33$
$S_n = 0$
$S_t = 0.5$
$K_s = 1.0$

$\theta_t = S_t \times n = 0.5 \times 0.33 = 0.165$
$\theta_n = S_n \times n = 0$

$\alpha = K_t/(\theta_t - \theta_n) = 0.5/(0.165 - 0) = 3.03$

$N = 2(0.5)(7.45 + 0.30)/\sqrt{\pi \times 3.03} = 2.51$

$Q = 2.51\sqrt{24}\,(32,830\ \text{SF})$

= **403,690 CF/DAY**

No. OF DAYS TO DISSIPATE STORM = $\frac{699,465\ \text{CF}}{403,690\ \text{CF/DAY}}$ = **1.73 DAYS**

LKB LOCKWOOD KESSLER & BARTLETT, INC.
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PROJECT OBSWDC SHEET NO. 9 OF 10
SUBJECT GROUNDWATER REMEDIATION BY PC DATE 1/10/89
JOB NO. 8086-02 CHKD. BY TCH DATE 1/11/89

RECHARGE BASIN No. 1 PERMEABILITY DETERMINATION

REF: - PROCEDURE FOR OBTAINING SATURATED PERMEABILITY OF COHESIONLESS SOILS - JOHN REAGAN (8/20/80) NYSDOT - REGION 10
- SIEVE ANALYSIS GRAIN SIZE DISTRIBUTION GRAPHS FOR RECHARGE BASIN No. 1 BORINGS RB-1, RB-3 & RB-5.

GRAIN SIZE DISTRIBUTION CURVES

BORING	DEPTH	D_{60} (mm)	D_{30} (mm)	D_{10} (mm)	
RB-1	14'-16'	0.31	0.23	0.14	Lt.Br. fine/med. Sand, tr. Silt
RB-1	30'-32'	0.40	0.27	0.14	" " " " " " "
RB-3R	10'-12'	0.38	0.28	0.20	Br. fine/med Sand, tr. Silt
RB-3R	20'-22'	0.37	0.26	0.15	Lt Br. fine/med Sand, tr. Silt
RB-5	16'-18'	0.65	0.34	0.21	Lt Br. Crse/Fine Sand, little f.gr., tr. Silt
RB-5	28'-30'	0.45	0.30	0.18	Lt Br. f/med Sand, tr. Silt.

	DEPTH	$C_u = \frac{D_{60}}{D_{10}}$	$C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$	UNIF. SOIL CLASS	% PASS 200 SIEVE	SPOON BLOWS /6"
RB-1	14-16	2.21	1.22	SP	6	10-12-17-27
RB-1	30-32	2.86	1.30	SP	7	8-26-41-53
RB-3R	10-12	1.90	1.03	SP	4	10-28-49-33
RB-3R	20-22	2.46	1.21	SP	6	15-100/5"
RB-5	16-18	3.09	0.85	SP	4	42-37-48-49
RB-5	28-30	2.50	1.11	SP	5	15-45-100/5½"

LKB LOCKWOOD KESSLER & BARTLETT, INC.
CONSULTING ENGINEERS - SYOSSET, N.Y.

PROJECT OBSWDC SHEET NO. 10 OF 18
SUBJECT GROUNDWATER REMEDIATION BY PC DATE 1/10/89
JOB NO. 2082-02 CHKD. BY TCH DATE 1/11/89

DETERMINE PERMEABILITY (K_s)

FROM FIGURE #1 OBTAIN:

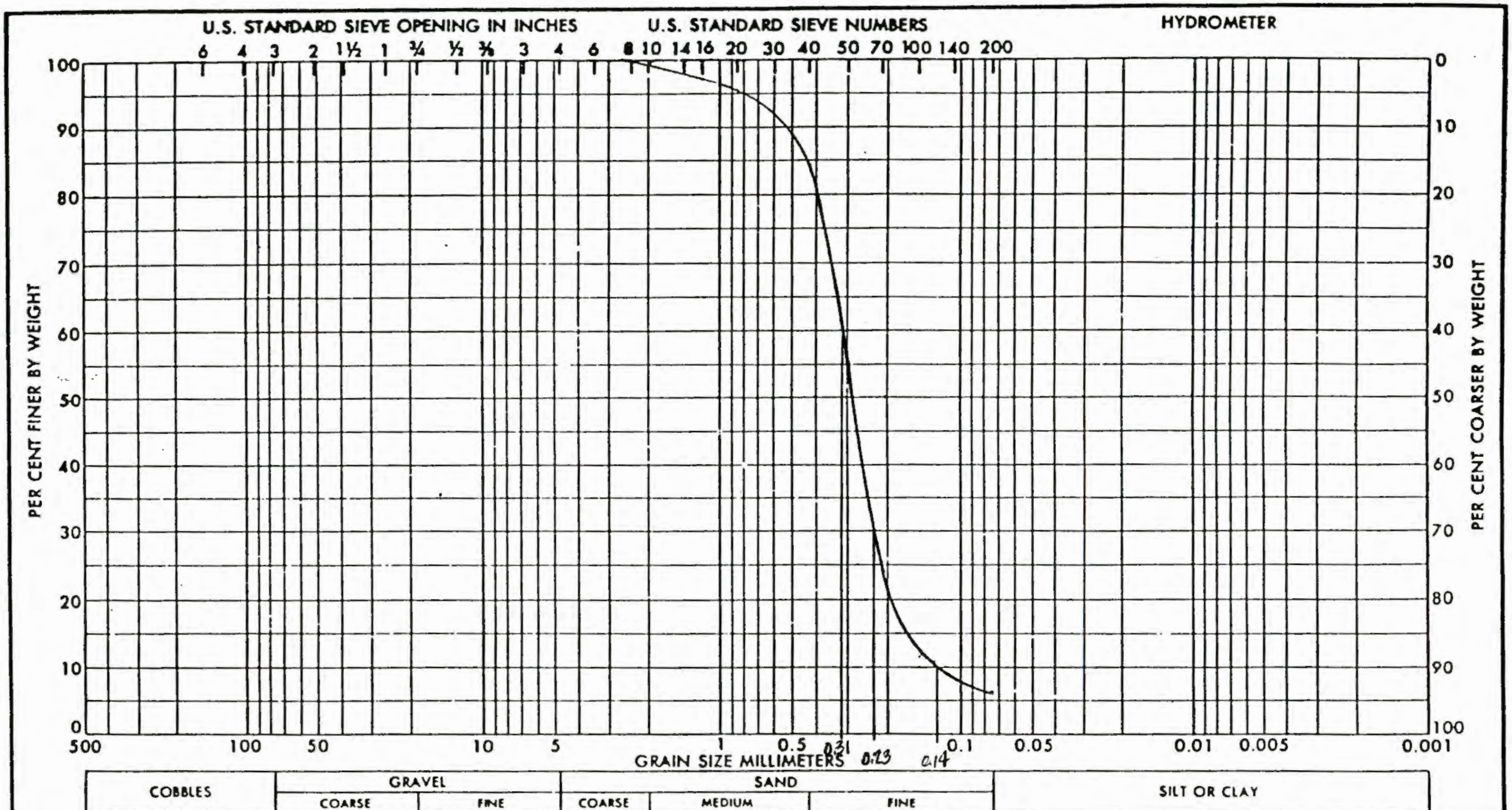
	Blows/ft N_{SPT}	Rel. Dens. D_R	Poros. n
ALL SAMPLES	20	62%	0.36

$$K_s = \frac{K_{max} - D_R(K_{max} - K_{min})}{24}, \ \text{FT/HR}$$

FROM NOMOGRAPH

BORING		K_{min} (ft/day)	K_{max} (ft/day)	K_s
RB-1	14-16	4	55	1.00 FT/HR
RB-1	30-32	5	55	1.02 "
RB-3R	10-12	9	125	2.26 "
RB-3R	20-22	5	63	1.15 "
RB-5	16-18	14	130	2.47 "
RB-5	28-30	9	100	1.85 "

USE K_s = 1.00 ft/hr



SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
	14'-16'	light brown fine/ medium SAND, trace silt				

GRADATION CURVES

PROJECT Warren George Inc.
Lockwood Kessler & Bartlett
AREA OBSWDC
BORING NO. RB-1
DATE Nov. 7,1988

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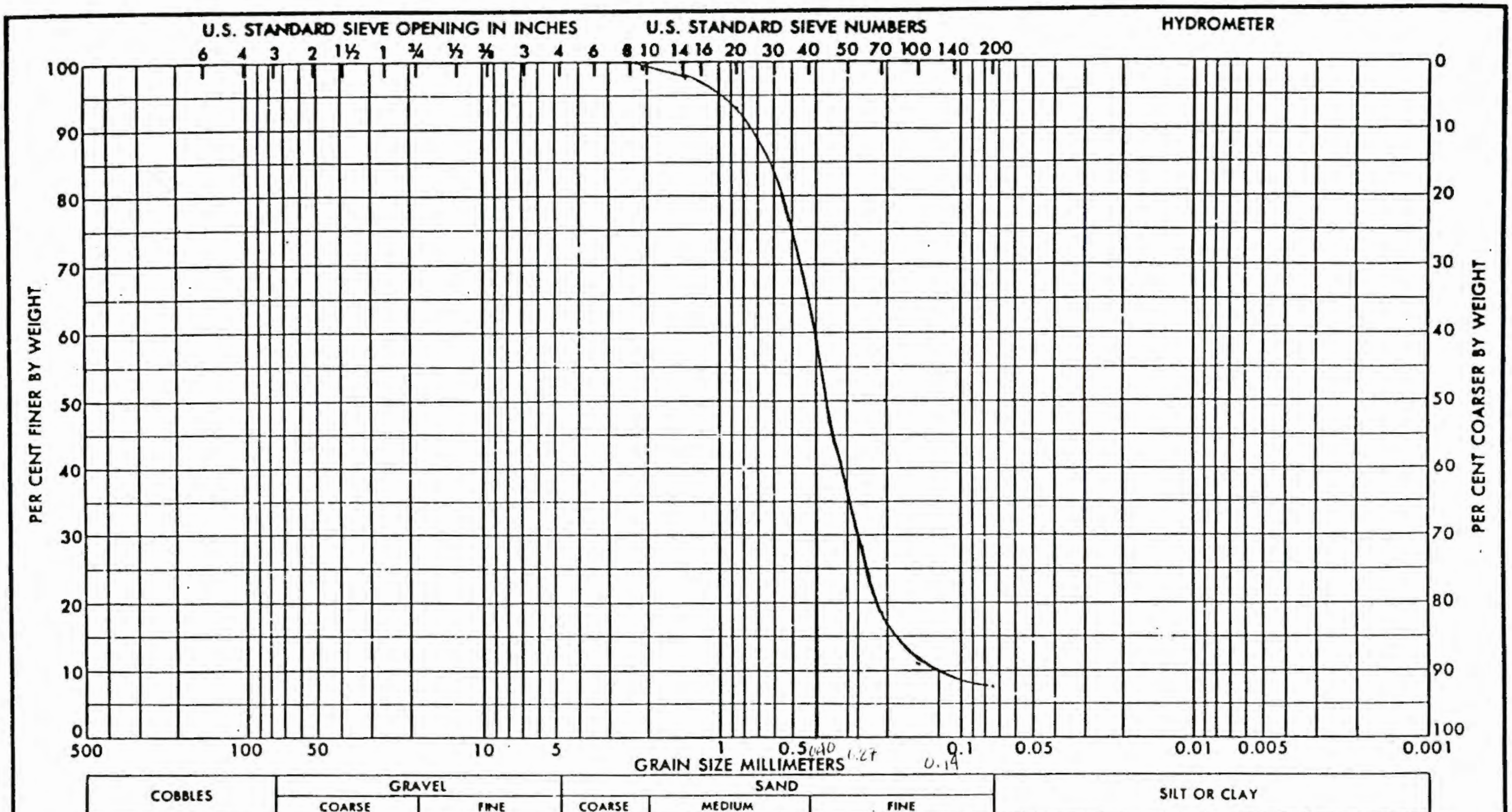
11/10

JOHNSON SOILS ENGINEERING LABORATORY



SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
	30'-32'	light brown fine/ medium SAND, trace silt				

GRADATION CURVES

PROJECT Warren George Inc.
Lockwood Bartlett & Kessler

AREA OBSWDC

BORING NO. RB-1

DATE Nov. 7,1988

JOHNSON SOILS ENGINEERING LABORATORY

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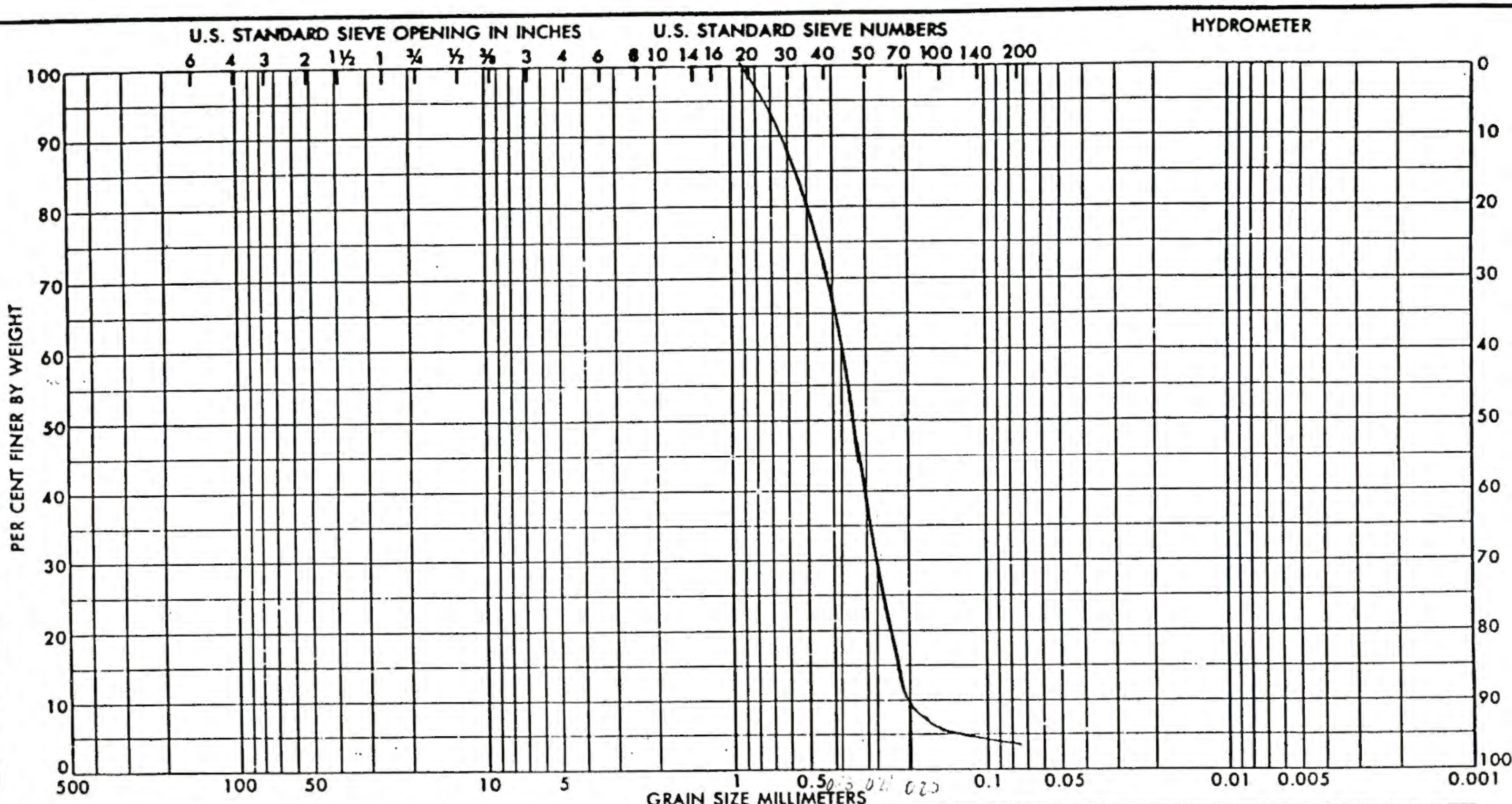

COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
	10'-12'	brown fine/medium SAND, trace silt				

PROJECT Warren George Inc.

Lockwood Bartlett & Kessler

AREA OBSWDC

BORING NO. RB-3R

DATE Nov. 7,1988

GRADATION CURVES

JOHNSON SOILS ENGINEERING LABORATORY

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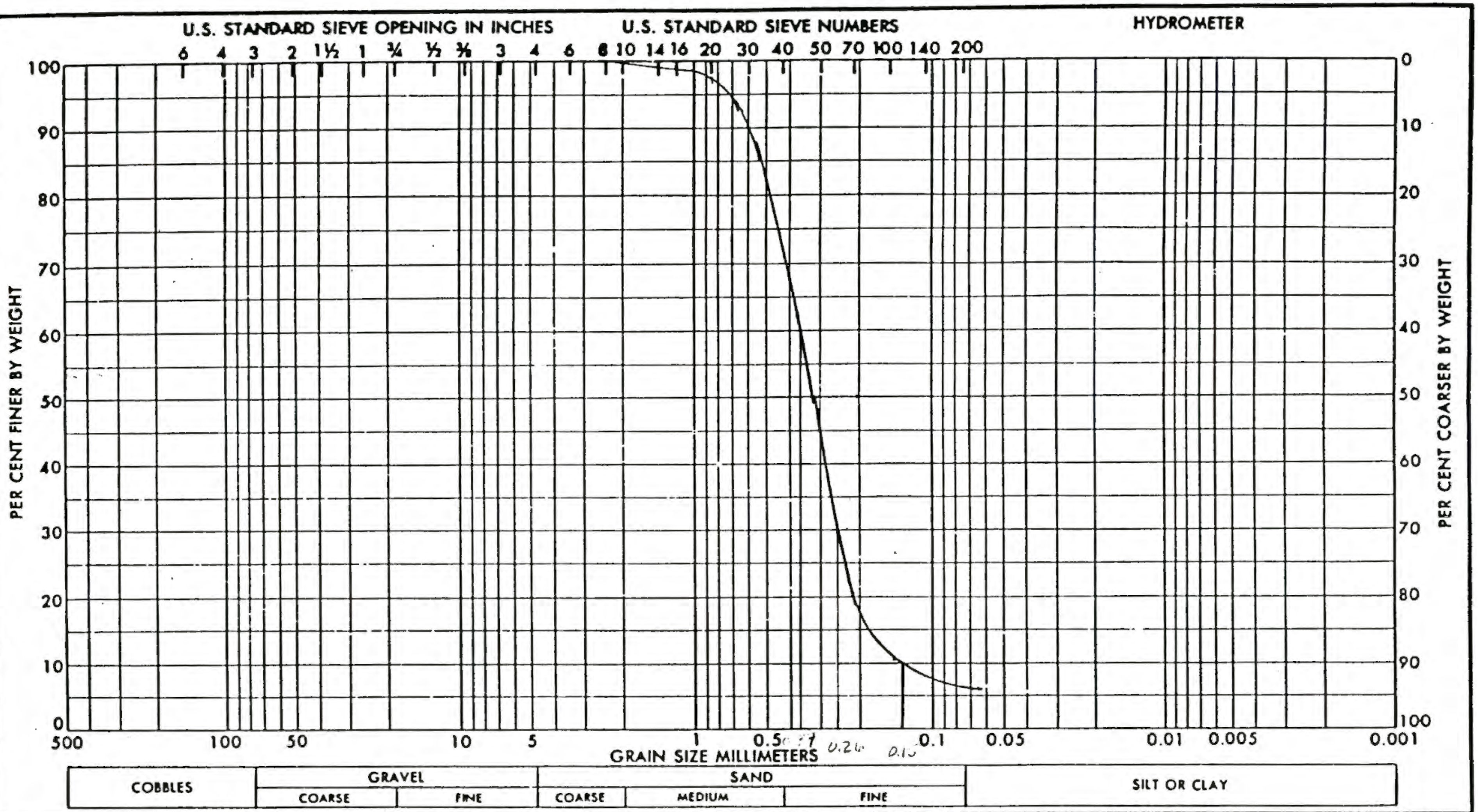

SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
	20'-22'	light brown fine/ medium SAND, trace silt				

GRADATION CURVES

PROJECT	Warren George Inc.
	Lockwood Kessler & Bartlett
AREA	OBSWDC
BORING NO.	RB-3R
DATE	Nov. 7,1988

JOHNSON SOILS ENGINEERING LABORATORY

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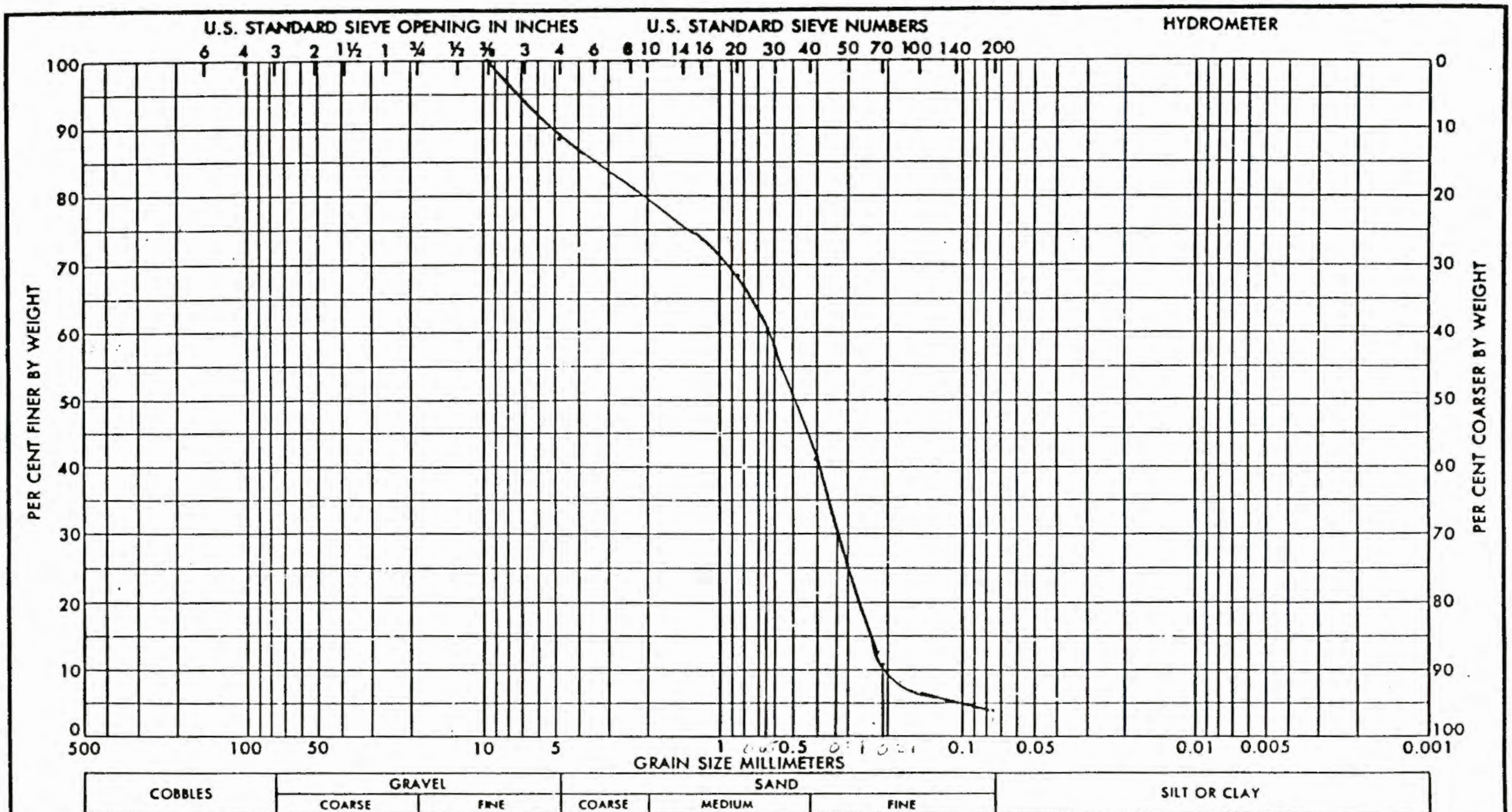


SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
	16'-18'	light brown coarse/ fine SAND, little fine gravel, trace silt				

GRADATION CURVES

PROJECT Warren George Inc.
Lockwood Bartlett Kessler

AREA OBSWDC

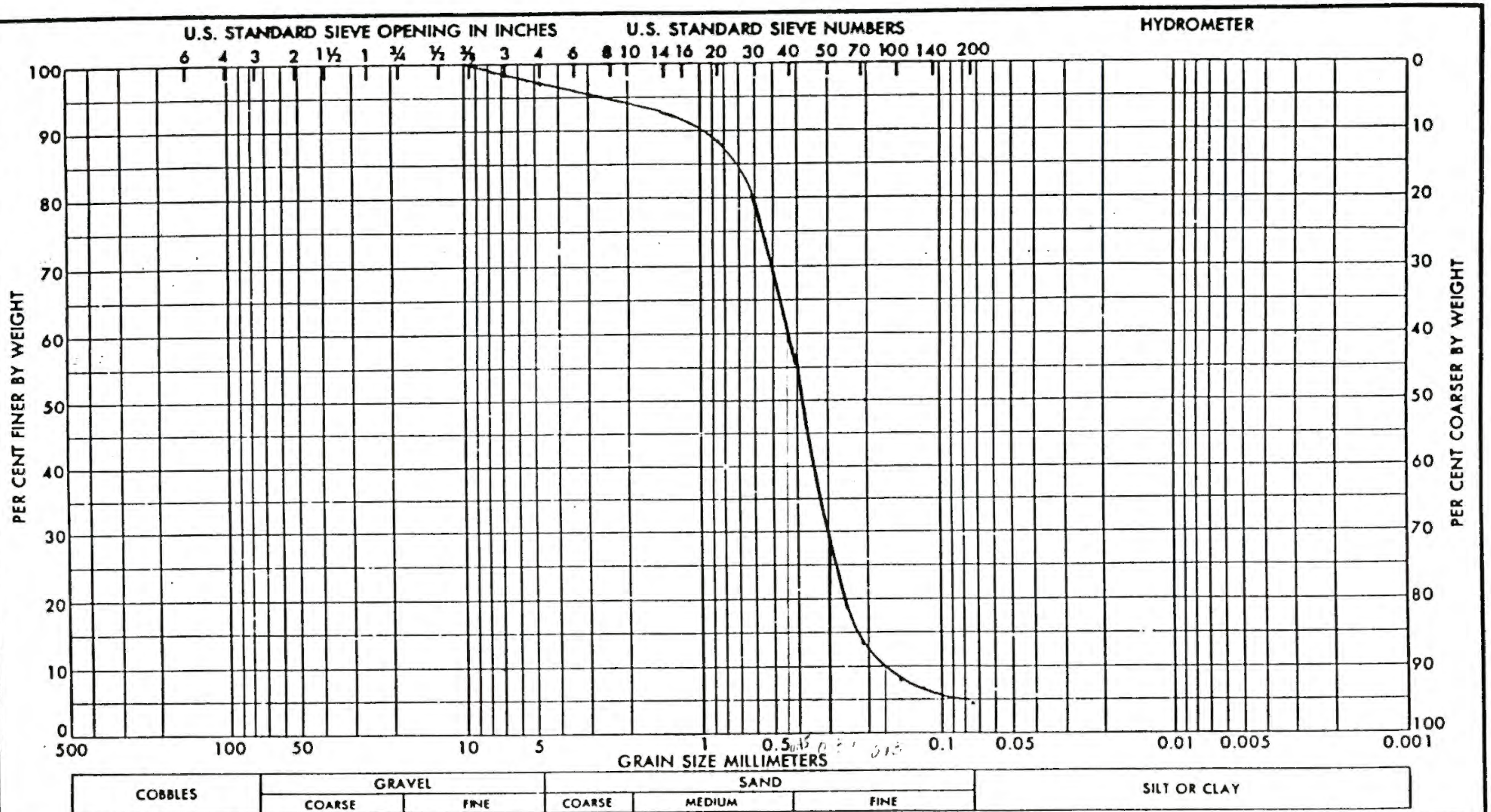
BORING NO. RB-5

DATE Nov. 7,1988

-45-

15/18

JOHNSON SOILS ENGINEERING LABORATORY



SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
	28'-30'	light brown fine/ medium SAND, trace silt				

GRADATION CURVES

PROJECT Warren George Inc.

Lockwood Kessler & Bartlett

AREA OBSWDC

BORING NO. RB-5

DATE Nov. 7,1988

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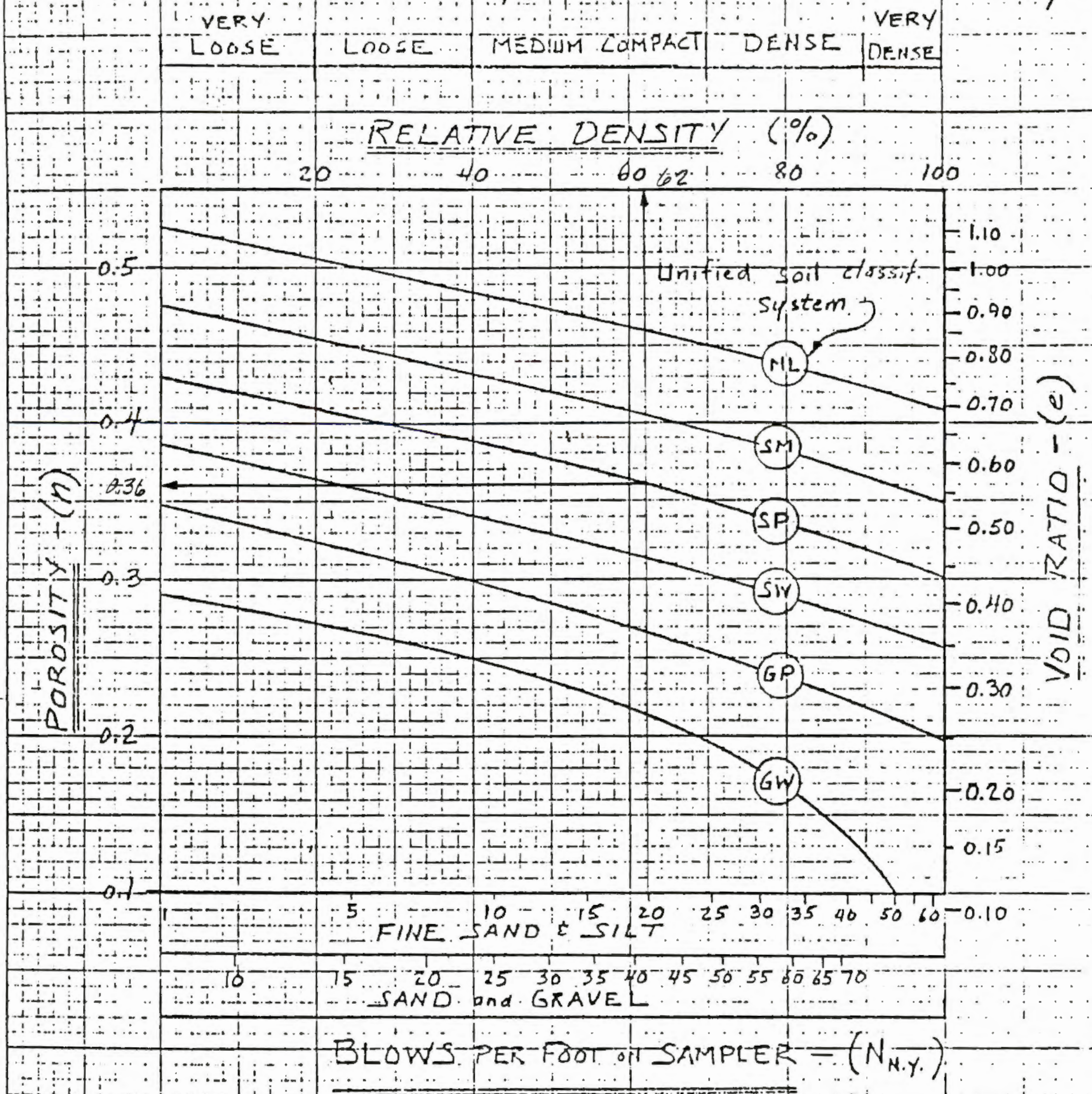


	HAMMER WT	HAMMER DROP	ENERGY
N.Y.	300#	18 IN.	450# FT
STD	140#	30 IN	350# FT

FIGURE # 1

DPW

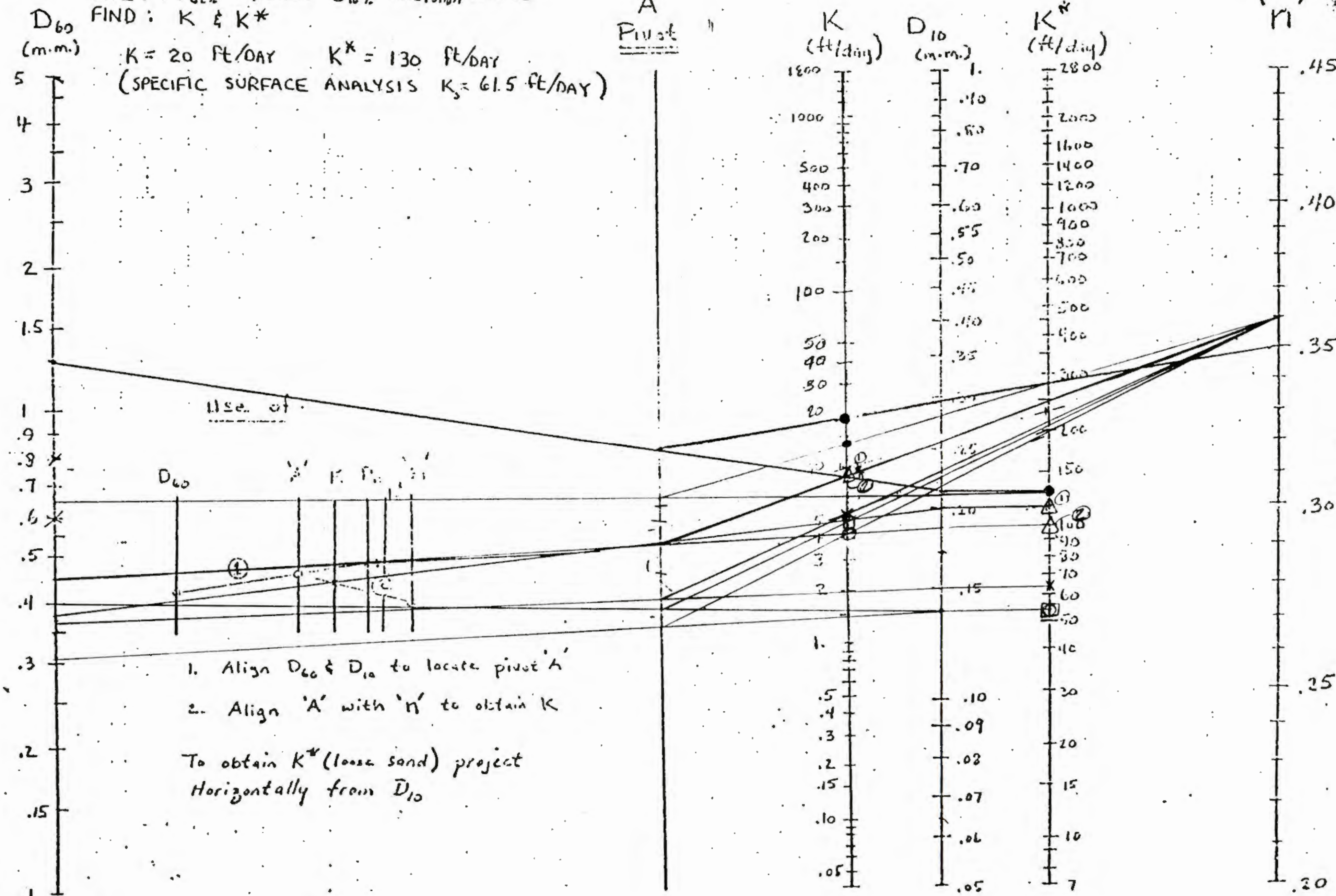
EXAMPLE PROBLEM

GIVEN : $D_{60\%}$ = 1.30mm $D_{10\%}$ = 0.215mm n = .35

FIND : K & K*

K = 20 ft/DAY K* = 130 ft/DAY

(SPECIFIC SURFACE ANALYSIS K_s = 61.5 ft/DAY)



1. Align D_{60} & D_{10} to locate pivot 'A'
2. Align 'A' with 'n' to obtain K

To obtain K* (loose sand) project Horizontally from D_{10}

BORINGS

O - RB1 × - RB3
□ - RB1 • - RB5
Δ¹ - RB3 Δ² - RB5

Coefficient of Saturated Conductivity - Sands

GROUNDWATER PRODUCTION WELL DESIGN

GERAGHTY & MILLER'S RESPONSE TO NYSDOL
COMMENTS ON THE FINAL DESIGN PLAN FOR
THE GROUND-WATER REMEDIATION PROGRAM AT
THE OLD BETHPAGE SOLID WASTE DISPOSAL COMPLEX

NYSDOL Comment: Provide a copy of the calculations used to determine the pumping rate required to achieve the necessary drawdown in the pumping wells.

Geraghty & Miller Response: Several methods were used as part of an effort to determine the pumping rate required to achieve the drawdown necessary to create and maintain a hydraulic barrier to the flow of ground water at the downgradient edge of the total volatile organic compound (TVOC) plume attributable to the Old Bethpage Landfill. Calculations made as part of this analysis were performed by a computer; therefore, copies of the computations are not available. However, the following summary was prepared in an attempt to provide the NYSDOL with information on how the recommended remedial alternative was developed.

Three separate methods (i.e., numerical, analytical, and field testing) were used to develop and verify the alternative recommended to remediate the TVOC plume at the Old Bethpage Solid Waste Disposal Complex (OBSWDC). A description of each method, the limitation(s) of the method, and the results obtained is provided below.

Numerical Methods

Numerical methods employed included the development and use of two different models; a ground-water flow model (to assess drawdown effects accompanying hypothetical remedial scenarios) and a ground-water solute transport model (to determine the fate of contaminants already in the ground-water system).

The ground-water flow model used was the basic Aquifer Simulation Model (PLASM), modified for water-table conditions, as described by Prickett and Lonnquist, (1971). The model uses the finite-difference numerical method to obtain approximate solutions to the equations that define ground-water flow. The flow model was constructed using hydrogeological data obtained from published sources augmented by field data obtained during the OBSWDC offsite drilling and monitoring programs. Input data include water-level elevations, hydraulic conductivity, elevation of "bottom" of the water-table aquifer, transmissivity, storativity, recharge, and model imposed boundary conditions. The region included in the numerical flow model encompasses an area which is 12,000 feet by 14,500 feet and is represented by a rectangular grid of 18 columns and 20 rows. The variably spaced grid was superimposed over a map of the aquifer. A fine grid spacing (500 foot grid interval) is used within the area of the plume to provide greater detail. Coarser grid spacings of 2000 foot grid intervals are employed further away from the area of concern (TVOC plume) to complete the flow system and establish boundaries beyond the impacts from aquifer stresses (i.e., pumpage). The model accounts for changes in transmissivity and hydraulic gradient resulting from pumpage; however, it should be noted that the model's simulation presents optimistic results with respect to pumping rates, because the model simulates the aquifer as if the bottom of the system is located 300 feet below the water-table surface (i.e., the approximate thickness of the TVOC plume). Hence, flow to the remedial wells in the model is horizontal. However, under field conditions, the bottom of the system is approximately 700 ft below the water-table surface; therefore, partially penetrating wells would be used to remediate the plume. Hence, in addition to the predominant horizontal movement of water, some water would move vertically up to the wells. Thus more water than that calculated by the model may have to be pumped to offset this vertical component of flow. Additional details on the construction and calibration of the flow model are provided in Appendix A of the Remedial Action Feasibility Study, (Lockwood, Kessler & Bartlett, and Geraghty & Miller 1987). Modeling results are provided below.

Prior to simulating remedial pumpage scenarios using the numerical flow model, preliminary values on the number of wells and potential pumpage rates were calculated analytically. In addition, analytical calculations of drawdown from partially penetrating wells and the areas of ground-water contribution to wells pumping in an aquifer with uniform flow (i.e., capture zone) were made. Pumpage rates per well from 500,000 to 1,625,000 gallons per day (gpd) and transmissivities ranging from 200,000 to 350,000 gallons per day per foot (gpd/ft) were used in these analytical techniques. Based on an analysis of limiting flow lines, when drawdown exceeded 0.5 ft at the edge of the plume and the areas of ground-water contribution to the pumping wells overlapped, the number, locations, and pumpage rates were considered to be potentially successful in controlling the plume. Additional information on the analytical techniques employed and the results obtained are provided below in the analytical methods section. The flow model was then used (since it approximates field conditions more accurately than the analytical techniques [as it accounts for changes in transmissivity and hydraulic gradient due to pumpage]) to simulate values of the number of wells and the total pumpage rate obtained from the analytical calculations, as well as several other remedial scenarios, to determine the configuration and rate that best captured the TVOC plume.

Based on the flow model results (as corroborated by the analytical analyses), it appears that the minimum pumpage required to intercept the TVOC plume is approximately 1.5 million gallons per day (mgd). The 1.5 mgd is divided among five wells, each pumping 300,000 gpd. Lower pumpage rates and/or fewer wells were judged ineffective to capture the plume.

In an attempt to verify the results of the numerical flow model and the analytical analyses, a ground-water solute transport model was developed. The solute transpont model used is the "Random-Walk" Solute Transport Model described by Prickett, Naymik, and Lonnquist (1981). According to Prickett, Naymik, and Lonnquist (1981), solute transport is based on dissolved constituent concentrations in the ground water being equivalent to a finite number of discrete particles. A simulation is begun with this model by introducing a suitable number of particles (representing a finite amount of contaminant mass) into the ground-water velocity field obtained from the head distribution simulated using PLASM. The two principal mechanisms which can alter contaminant concentration in ground water, dispersion, and dilution and mixing, are included in the numerical code (Prickett, Naymik and Lonnquist, 1981). Particles are introduced at random over a specified area and period of time ("time step"). Transport of these particles through the flow field is divided into two stages. In the first stage, ("advective stage"), the particles are moved in the direction of ground-water flow in sequential time steps and the distance moved in each time step is equal to the ground-water velocity multiplied by the duration of the time step. In the second "dispersive stage", the model assumes that dispersion in a porous medium can be considered a random process tending toward a normal distribution. Each particle is given a random dispersive displacement based on the values of the longitudinal and transverse dispersion coefficients, the distance moved in the advective stage, and a fractional random number that is greater than zero and less than one (probable locations of particles, however, are considered only out to six standard deviations on either side of the mean. On a practical basis, the probability is low of a particle moving beyond that distance). Finally, the distance moved in the dispersive stage is added to the distance moved in the advective stage and the new location coordinates for each particle in the flow field are shown at the end of each new time step.

The transport model was constructed by utilizing PLASM and adding the appropriate data needed to solve the tranport equation. The TVOC plume was approximated by first calculating the total mass of solute in the (contoured) plume, and then using the correct combination of particles and particle mass to reproduce the field interpreted condition. Each of these particles is moved by ground-water flow, and the assigned mass represents a fraction of the total mass of chemical constituent involved. The dispersion parameters were obtained from Pinder's 1973 solute transport model of chromium contamination on Long Island. Values that define retardation and decay were obtained from published sources, when included in the model.

Once constructed, the solute transport model was used to simulate ground-water quality conditions at locations around and downgradient of the landfill under unabated (current) and abated flow conditions using various values for natural retardation and decay (removal) processes. The simulations were carried out by assuming that the discharge of contaminants from the landfill occurs at a continuous and constant rate of 3.3 pounds per day (lbs/d) or 1206 pounds per year (lbs/yr) for a period of five years, after which no additional solute is leached into the aquifer. Time zero is taken from the point of completion of the cap over the unlined landfill, at which time it is assumed that almost 100 percent of precipitation is diverted from entering the landfill. Thus, a period of five years means five years after capping the landfill (i.e., if the cap was completed in the year 1990, then five years signifies the year 1995). By mutual agreement of technical representatives of the Town of Oyster Bay (TOB) and NYSDOL, the modeling detection limit employed was 50 parts per billion (ppb); the principal reason for this was that field-interpreted data indicated that the positions of the 50 ppb and 0 ppb contour lines were identical, within the accuracy of the modeling grid. Additional considerations in establishing the modeling lower limit at 50 ppb include the data and conditions needed to define a plume at lower, more refined values, for example: numerous wells would be needed, closely spaced on a horizontal and vertical grid; the analytical technique used yields different detection limits; variability in the water column, etc.

Results of the solute transport model for the unabated scenarios suggest that the TVOC plume attributable to the Old Bethpage Landfill would not move south of Melville Road;

results for the abated scenarios clearly indicate that the TVOC plume can be contained within the boundaries of the State Park, using the five well system operating at a total pumpage rate of approximately 1.5 mgd. These results corroborate those obtained from the numerical flow model and the analytical analyses.

Analytical Methods

Since the numerical flow model assumes full penetration of the aquifer by the remedial wells, analytical methods were employed to analyze various remedial scenarios involving partially penetrating remedial wells and the resultant capture zone. The analytical methods employed utilize equations that define the geometry of the cone of influence (i.e., drawdown) from a partially penetrating pumping well in a uniform flow field (i.e., capture zone analysis) as presented in Todd (1980). Calculations were made using the stagnation point formula and the expression for the boundary of the region producing inflow to a pumping well in a uniform field for several remedial scenarios. The computer code that calculates drawdown under conditions of partially penetrating wells was obtained from Walton (1962). Limiting flow lines were then calculated to approximate the area of the flow system within the capture zone of one pumping well. Superposition of the resulting capture zone was then used to approximate the number of wells necessary to capture the TVOC plume attributable to the Old Bethpage Landfill. When the plume outline was entirely contained within the limiting flow lines, hydraulic control of the plume was considered complete. Based on an analysis of the limiting flow lines, when drawdown impacts exceeded 0.5 ft at the edge of the plume, and the area of ground water contribution to the remedial wells overlapped (i.e., the individual capture zones overlapped), the number of wells, location of wells, and pumpage rate were considered to be potentially successful in controlling the TVOC plume.

Based on the results of the partial penetration and capture zone analyses, it appears that complete capture of the TVOC plume attributable to the Old Bethpage Landfill can be obtained with five remedial wells, located at the toe of the plume (i.e., downgradient edge), pumping a total of approximately 1.5 mgd. These results support and corroborate those obtained from the numerical model which because it accounts for changes in transmissivity and hydraulic gradient, approximates field conditions more accurately than does the analytical techniques.

Field Methods

To verify the numerical modeling and analytical analyses performed (as described above) and to provide additional data for remedial system design, a test production well and two observation wells were installed, and a 120-hour aquifer test was conducted at the site. Information on well installation, aquifer test design and conduct, and analysis of the data obtained are presented in Geraghty & Miller's report (1987). Results of the aquifer test are summarized below.

Input values for transmissivity (240,000 gpd/ft) and storativity (0.05) used in the numberical models were verified by the aquifer test which produced transmissivity values in the range of 227,000 to 247,000 gpd/ft, and a storage coefficient of 0.05. This supports the feasibility of ground-water plume remediation as determined by the model. Distance drawdown calculations using Theis' equation (Q = 208 gpm, t = 2 weeks) indicate a drawdown of 0.5 ft at a radius of approximately 350 ft from the pumping well. This confirms and illustrates that the area of the pumping well capture zone predicted by the model is conservative. Thus pumpage at the rates predicted by the model will result in a larger capture zone and the withdrawal of more water than necessary to remediate the plume. In addition, water quality data collected throughout the aquifer test demonstrates that both the areal location of the well and the screened interval are appropriate for intercepting the full thickness of the TVOC plume attributable to the Old Bethpage Landfill.

NYSDOL Comment: Provide the procedure to be used to verify that the amount of drawdown obtained is sufficient to create and control the hydraulic barrier.

Geraghty & Miller Response: The procedure to be used to verify that the amount of drawdown, achieved through operation of the remedial system, is sufficient to create and control the hydraulic barrier is specified in Section II, Part A of the Remedial Action Plan (RAP). To summarize, creation and control of the hydraulic barrier will be demonstrated by monthly water-level measurements taken in adjacent monitoring wells. Water levels will be converted to elevations (relative to mean sea level) and plotted on several base maps, according to well depth. Contour lines (indicating areas of equal hydraulic potential) and limiting flow lines (indicating the effective capture zone) will then be drawn for each depth interval. These maps will then be used to show, by comparison of the size and location of the capture zone in relation to the TVOC plume, that drawdown sufficient to create and control the hydraulic barrier, regardless of seasonal fluctuations, has been created and maintained by operation of the remedial system.

NYSDOL Comment: The ground-water monitoring plan should include the location and design of the additional upgradient monitoring well required to be installed between the recharge area and the Plainview Water District.

Geraghty & Miller's Response: The upgradient monitoring well required to be installed between the recharge area and the Plainview Water District shall be installed at the approximate location shown on Figure 1. The well shall be installed and designed as described below. The hollow-stem auger method will be used to drill an 8-inch diameter borehole approximately 20 ft into the water table (approximately 90 ft below land surface). During drilling operations, split-spoon core samples will be collected at 5-ft intervals from land surface to the final borehole depth, and a core log prepared by the on-site geologist. When the borehole has been drilled to the specified depth, a geophysical log (both natural gamma and electric) will be run.

All well construction materials, including casing, screen, and backfill materials shall be installed within the hollow-stem augers; augers shall be slowly removed as backfill materials are added. The upgradient monitoring well shall be constructed of new, commercially manufactured, 4-inch I.D., NSF-grade, schedule 40 PVC well casing and screen. The screen shall be 20 ft in length and be continuous slot with openings of 0.020 inches (i.e., 20 slot). Both the well casing and screen shall be internally threaded. All joints shall be made up so that when tight, all threads are buried in the lip of the casing or screen. No glues, solvents, or detergents shall be used in well construction. The screen shall be set approximately 18 ft into the water table to allow for seasonal fluctuation in water levels, and any mounding effects which may occur. A Jessie Morie™ No. 1 or equivalent gravel pack shall be installed in the annular space between the well screen and borehole wall to approximately 5 ft above the top of the screen. A 2 ft thick bentonite pellet seal shall then be installed, followed by the installation (via tremie pipe) of a thick bentonite slurry. The bentonite slurry shall be installed to approximately 2 ft below land surface; all bentonite products used shall be 100 percent polymer free. A 6-inch diameter protective steel casing with a hinged locking cover shall then be cemented in place over the well. The well will be developed with a submersible pump, surge block, air/water jet and air-lift pumping, or any combination of the above until it produces clear, sediment-free water to the extent possible.

REFERENCES

Geraghty & Miller, Inc. 1987. OBSWDC Aquifer Test for Evaluating Hydraulic Control of Leachate Impacted Ground Water, Old Bethpage, Long Island, New York, 12 p.p.

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Pinder, G.F. 1973, A Galerkin-Finite Element Simulation of Ground-Water Contamination on Long Island, New York, Water Resources Research, Vol. 9, No. 6, p. 1657-1669.

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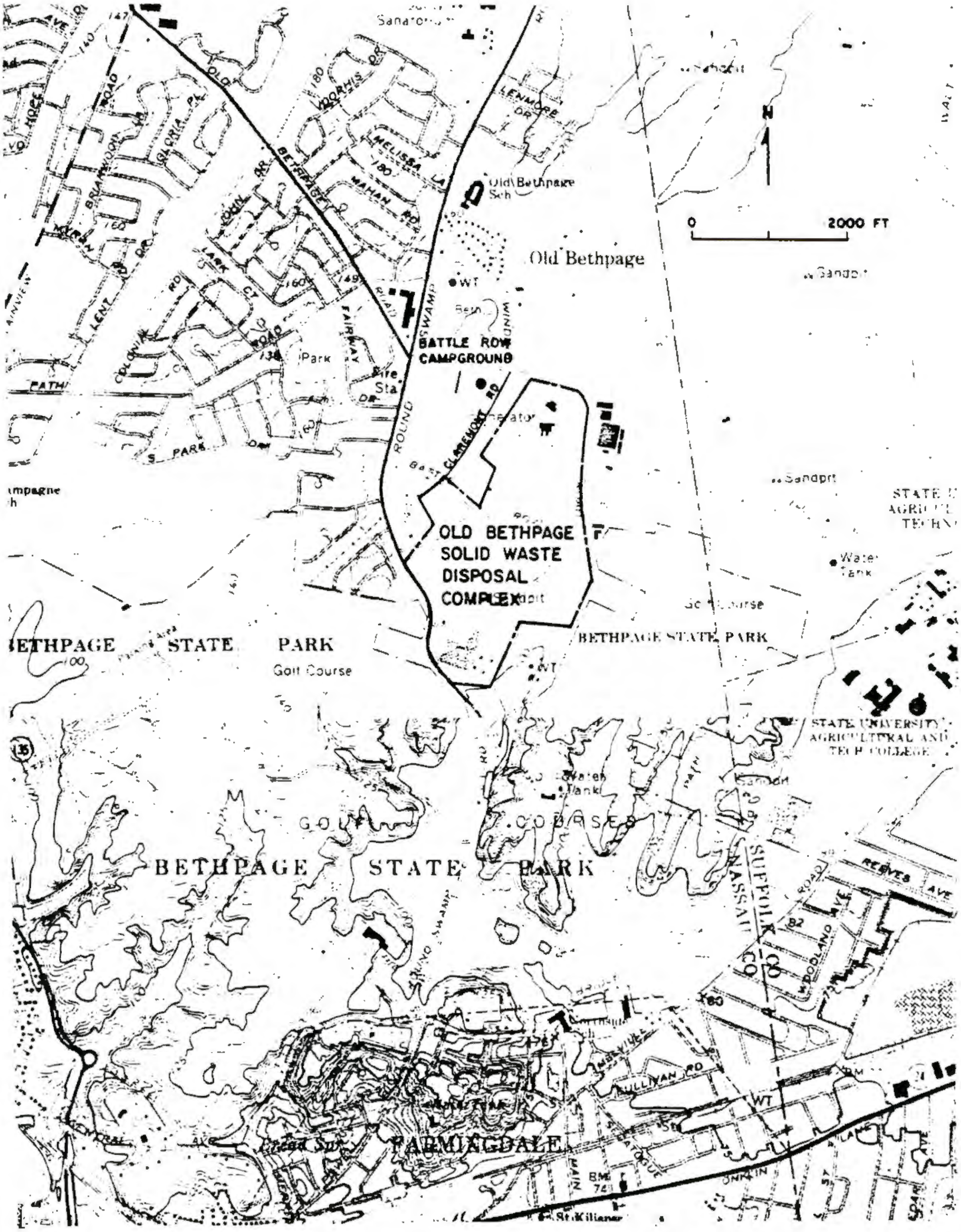
Remedial Action Plan for the OBSWDC, Appendix A of the Final Consent Decree Re: New York State v. Town of Oyster Bay, et al., dated May 18, 1988.

Todd, David Keith. 1980. Groundwater Hydrology, 535 p.

Walton, William C. 1962. Selected Analytical Methods for Well and Aquifer Evaluation, Illinois State Water Survey Bulletin 49, Urbana, Illinois, 81 p.

GERAGHTY & MILLER, INC. Ground-Water Consultants	COMPILED BY: C. SANGIOVANNI	DATE: 3-89	SCALE: SHOWN	PREPARED FOR: LOCKWOOD, KESSLER & BARTLETT, INC. AND TOWN OF OYSTER BAY, NEW YORK
	PREPARED BY: G. SCHAFFNER	FILE NO: NY0340RA05		
	PROJECT MGR.: C. SANGIOVANNI			



APPROXIMATE PROPERTY BOUNDARIES OF THE OLD BETHPAGE SOLID WASTE DISPOSAL COMPLEX

● APPROXIMATE LOCATION OF THE PROPOSED UPGRADIENT MONITORING WELL

SUBJECT: APPROXIMATE LOCATION OF THE PROPOSED UPGRADIENT MONITORING WELL FOR THE OLD BETHPAGE LANDFILL GROUND-WATER REMEDIATION PROGRAM

FIGURE 1

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