PERMIT ATTACHMENT J

ACTION LEAKAGE RATE AND RESPONSE ACTION PLAN
from documentation
in support of the Permit Application

Prepared for:

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ACTION LEAKAGE RATE AND RESPONSE ACTION PLAN FOR LANDFILL PHASE 1, 2, AND 3 AND EVAPORATION POND TRIASSIC PARK WASTE DISPOSAL FACILITY CHAVES COUNTY, NEW MEXICO

November 1999

Revision 2

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1.0 INTRODUCTION

An Action Leakage Rate (ALR) and Response Action Plan (RAP) for the proposed Triassic Park Hazardous Waste Facility landfill and evaporation pond is required under 40 CFR Parts 264.302 and 304. A three phased landfill and a two phased evaporation pond have been proposed as part of a RCRA Part B Permit Application dated November 1997. This report presents proposed ALRs based on the landfill and evaporation pond specific designs and calculation methodologies recommended by EPA. The ALR, as defined in the final rule published in January 29, 1992, is the maximum design flow rate that the leak detection and removal system (LDRS) may remove without the fluid head on the bottom liner exceeding one foot. The RAP describes the steps to be taken in the event the ALR is exceeded in the landfill or the evaporation pond. The RAP specifies the initial notifications, steps to be taken in response to the leakage rate being exceeded, and follow-up reports.

2.0 PROPOSED LANDFILL DESIGN

This section briefly describes aspects of the landfill designs relevant to the ALR and the RAP. Engineering drawings and technical specifications are included in the Revised Part B Permit Application dated November 1997.

2.1 LINER DESIGN

The landfill liner system consists of a single and composite liner. The liner system which applies to the base and slopes of the landfill is described below (from top to bottom).

- A minimum 2-foot thick protective soil layer.
- A leachate collection system consisting of:
  - ◊ a double sided geocomposite (geonet with a layer of geotextile bonded to both sides, transmissivity ≥ 2×10^{-4} m^2/sec).
- A primary liner consisting of:
  - ◊ 60-mil high density polyethylene (HDPE) geomembrane.
- A leak detection and removal system consisting of:
  - ◊ a double sided geocomposite (geonet with a layer of geotextile bonded to both sides, transmissivity ≥ 1.2×10^{-4} m^2/sec) .
- A secondary composite liner consisting of :
  - ◊ 60-mil HDPE geomembrane
  - ◊ a geosynthetic clay liner (GCL) with $k \leq 5 \times 10^{-9}$ cm/sec (bentonite sandwiched between two layers of geotextile)
- Six inches of prepared subgrade.

The liner system in the sump area differs from the liner system in the landfill base and slope areas due to the inclusion of drainage gravel ($k \geq 1.0$ cm/sec) and compacted clay ($k \leq 1 \times 10^{-7}$ cm/sec) in the base area of the leachate collection and removal sump and the leak detection and removal sump. The liner system in the landfill sump area is illustrated on Drawing No. 16, sump cross sections, Drawing No. 18, vadose, LDRS, LCRS cross sections and details - phase 1A.

2.2 LEACHATE COLLECTION AND REMOVAL SYSTEM, LEAK DETECTION AND REMOVAL SYSTEMS, AND VADOSE MONITORING SYSTEM

The gecomposite leachate collection and removal system (LCRS) installed above the primary geomembrane will collect liquid above the geomembrane and transmit it to the LCRS collection sump.

The leak detection and removal system (LDRS) installed above the secondary geomembrane will detect and collect liquid above the geomembrane and transmit it to the LDRS sump. The vadose monitoring sump will detect and collect fluid leakage from the LDRS sump.

2.2.1 LEACHATE COLLECTION AND REMOVAL SYSTEM

Liquid entering the LCRS will come from rainfall which percolates through the waste thereby generating leachate. The function of the LCRS is to transport this liquid to the sump where it can be removed so that hydraulic head on the primary liner is minimized.

Components of this system, in addition to those described above, include a lateral 8-inch diameter drainage pipe located along the minimum grade line in the floor of the landfill, an 18-inch diameter HDPE sump collection and slope riser pipe, and a 24-inch diameter steel vertical riser pipe. The floor pipe and slope riser pipe will be surrounded by a gravel envelope, separated from the surrounding soil by an 8 oz. non-woven geotextile filter. The vertical riser pipe system, which will extend from the center of the LCRS sump vertically through the waste and cover system, provides a second access to the LCRS from which leachate can be removed. Accumulated liquids will be removed from the leachate collection sump by pumping either through the slope riser pipe or through the vertical riser pipe. A submersible pump will be used for leachate removal.

2.2.2 LEAK DETECTION AND REMOVAL SYSTEM

The potential sources of liquid entering the LDRS include primary liner leakage and consolidation water from the primary sump's clay liner. To meet the design requirements, the leak detection system must be able to collect and transmit liquid to the leak detection sump so that it can be removed.

The LDRS will be installed above the secondary composite liner on the landfill base and sideslopes. Should liquid enter the detection system, it will drain toward the collection sump via the LDRS drainage geocomposite and drainage pipe. Once in the sump, the liquid can be detected and removed via a riser pipe which extends up the slope of the landfill to the surface. The liquid will be pumped to the surface by a submersible pump.

2.2.3 VADOSE MONITORING SUMP

Sources of liquid entering the vadose sump include secondary liner leakage and consolidation water from the secondary sump's clay liner. The purpose of the vadose monitoring sump is to detect and remove leakage passing through both the primary and secondary liner systems. As with the LCRS sump and LDRS sump described above, liquid in the vadose sump will be pumped to the surface by a submersible pump.

3.0 PROPOSED EVAPORATION POND DESIGN

This section briefly describes aspects of the evaporation pond design relevant to the ALR and the RAP. Engineering drawings and technical specifications are included in the Revised Part B Permit dated November 1997.

3.1 LINER DESIGN

The evaporation pond liner system consists of a single and a composite liner. The liner system which applies to the base and slopes of the evaporation pond is described below (from top to bottom).

- A primary liner consisting of:
  - ◊ 60-mil HDPE geomembrane
- A leak detection system and removal system consisting of:
  - ◊ A geonet drainage layer (transmissivity $\geq 5 \times 10^{-3}$ m^2/sec) .
- A secondary composite liner consisting of :
  - ◊ A 60-mil HDPE geomembrane
  - ◊ A 3 foot thick compacted clay liner (CCL) with $k \leq 1 \times 10^{-7}$ cm/sec

The liner system in the sump area differs from the liner system elsewhere in the pond due to the inclusion of drainage gravel and geotextile cushion layers in the LDRS layer. Drawing No. 32, Evaporation Pond LDRS Plan and Details illustrates the liner sump liner system arrangement.

3.2 LEAK DETECTION AND REMOVAL SYSTEM AND VADOSE MONITORING SYSTEM

3.2.1 Leak Detection and Removal System

Liquid entering the LDRS will be the result of primary liner leakage. To meet design requirements, the LDRS must be able to collect and transmit liquid to the leak detection sump so that it can be removed.

The LDRS will be installed above the secondary composite liner on the evaporation pond floor and sideslopes. Should liquid enter the LDRS, it will drain toward the collection sump where it can be detected and removed via a slope riser pipe which extends up the side slope of the evaporation pond to the surface. The liquid will be pumped to the surface by a submersible pump.

3.2.2 Vadose Monitoring System

Sources of liquid entering the vadose sump include secondary liner leakage and consolidation water from the secondary clay liner. The purpose of the vadose monitoring sump is to detect and remove leakage passing through the secondary liner systems. As with the LDRS sump described above, liquid in the vadose sump will be pumped to the surface by a submersible pump.

4.0 POTENTIAL SOURCES OF FLOW FROM THE LEAK DETECTION AND REMOVAL SYSTEM

Before ALRs and a RAP can be established for the potential sources of flow from the LDRS of the landfill and evaporation pond must be understood and the magnitudes of flow from the potential sources should be estimated. This understanding of the potential sources and magnitudes of flow is also useful in planning for the potential flow quantities and in identifying unusual flow conditions.

4.1 POTENTIAL SOURCES OF FLOW FROM THE LANDFILL LDRS

Potential source of flow from the landfill LDRS are:

- Precipitation that enters the leak detection layer during construction (hereafter referred to as construction water).
- Water expelled from consolidation of the clay components of the composite primary liner during landfill operations (hereafter referred to as consolidation water).
- Leakage through the primary liner.

These potential sources of liquid have been discussed in detail in the technical papers by Gross et al. (1990) and Bonaparte and Gross (1990). An evaluation of potential sources and magnitudes of flow from each of the sources discussed above is presented below:

Substantial flow rates of construction water are possible; however, since geocomposites do not exhibit significant capillarity, it is likely that the flow of construction water from the geocomposite and sump drainage gravel will be complete before waste placement begins.

The average consolidation water flow rate is dependent on the area, thickness, and degree of saturation of the primary clay component in the sump area; and rate of waste filling. Because the sump primary clay component is very small (limited to the sump area), consolidation water volumes are not expected to be significant.

The potential for leakage through the primary liner is the basis for the ALR and is discussed in Section 5.0.

4.2 POTENTIAL SOURCES OF FLOW FROM THE OF THE EVAPORATION POND LDRS

The source of flow from the evaporation pond LDRS is restricted to leakage through the primary geomembrane. Similar to the landfill, construction water will likely be removed from the LDRS prior to placement of waste liquids in the pond. Since there is no primary clay component in the pond liner system, consolidation water is not a potential source of liquids in the LDRS.

5.0 ACTION LEAKAGE RATE DETERMINATION

5.1 INTRODUCTION

As presented in Code of Federal Regulations, Title 40, Part 264, Rule '264.302 (40 CFR Rule 264.302):

> *The action leakage rate is the maximum design flow rate that the leak detection and removal system (LDRS) can remove without the fluid head on the bottom liner exceeding 1 foot. The action leakage rate must include an adequate safety margin to allow for uncertainties in the design (e.g., slope, hydraulic conductivity, thickness of drainage material), construction, operation, and location of the LDRS, waste and leachate characteristics, likelihood and amount of other sources of liquids in the LDRS and proposed response actions (e.g., the action leakage rate must consider decreases in the flow capacity of the system over time resulting from siltation and clogging, rib layover and creep of synthetic components of the system, overburden pressures, etc.).*

In other words, the ALR is the maximum design flow rate, including a safety factor, that the leak detection system can remove without the head on the bottom liner exceeding 1 ft.

5.2 DETERMINATION OF ACTION LEAKAGE RATE: LANDFILL

5.2.1 Equation for Geocomposite Flow Capacity

The leak detection drainage layer consists of a double sided geocomposite (geotextile/geocomposite/geotextile). The maximum flow rate from a single hole in the primary HDPE liner that a geocomposite drainage layer can convey without the fluid head on the secondary liner exceeding a predetermined level is given by the following equation (USEPA 1992)

$Q = k*D*(2h-D)$ (Equation 1)

where:

Q = the flow rate through a single hole in the primary liner;
k = the hydraulic conductivity of the leakage detection geocomposite drainage layer;
h = the head on the secondary liner; and
D = thickness of leak detection drain layer (geocomposite).

5.2.2 Design Parameters

Hydraulic Conductivity

The technical specifications require that over the base and side slopes of the landfill the geocomposite of the LDRS have a hydraulic transmissivity of at least 2.2×10^{-4} m^2/sec when subjected to testing conditions which include stress, hydraulic gradient, and boundary conditions similar to those anticipated in the field. The thickness of the geocomposite of the LDRS is 0.2 in. Using the specified hydraulic transmissivity of 2.2×10^{-4} m^2/sec (and adjusting the transmissivity by a total factor of safety of 3.3 to account for creep, chemical clogging, and sediment clogging) and geocomposite thickness of 0.2 in. results in a calculated hydraulic conductivity of 1.3 cm/sec for the LDRS geocomposite drainage layer over the base of the landfill. Hydraulic transmissivity test results confirming that the specified geocomposite has this calculated hydraulic conductivity are required in the specifications and CQA Plan.

Head on Secondary Liner

The current Federal regulations require that the head on the liner should not exceed one foot. Therefore, one foot will be used for the calculated maximum head build-up on the secondary liner and the calculation of the ALR.

Geocomposite Thickness

A one foot head on the secondary liner does not mean that the flow thickness in the geocomposite is one foot (the geocomposite thickness is only 0.2 in.), it only means that the fluid pressure in the geocomposite directly beneath the hole in the primary liner could be equivalent to one foot of fluid head.

5.2.3 Discussion of Proposed Action Leakage Rates

The proposed ALR of 900 gpad is greater than the 100 gpad suggested by the USEPA (USEPA, 1992) for landfill units that are built to the minimum design specifications presented in 40 CFR Part 264 for the LDRS. This ALR (100 gpad) was developed by USEPA using calculations similar to those presented in this document. However, the proposed LDRS design for the Triassic Park landfill includes a geocomposite drainage layer with a hydraulic transmissivity at least two orders of magnitude greater than that required to meet the minimum design specifications (granular drainage layer) presented in CFR Part 264. With this greater hydraulic transmissivity, the geocomposite drainage layer is capable of conveying much greater flow rates without the fluid head on the secondary liner exceeding one foot. As a result, the proposed ALRs calculated using the equation given in USEPA (1992) are substantially greater than 100 gpad. However, consistent with 40 CFR Part 264, the proposed ALRs have been established to ensure that the maximum fluid head on the secondary liner is not in excess of one foot. This is demonstrated by the calculations presented in Appendix G-1. Therefore, the proposed ALRs are consistent with the requirements of 40 CFR Part 264, and the designs for the landfill are appropriate.

5.3 DETERMINATION OF ACTION LEAKAGE RATE: EVAPORATION POND

5.3.1 Equation for Geocomposite Flow Capacity

The leak detection drainage layer consists of a geonet. The maximum flow rate from a single hole in the primary liner that a geonet drainage layer can convey without the fluid head on the secondary liner exceeding a predetermined level is given by the Equation 1 presented in Section 5.2.1.

5.3.2 Design Parameters

Hydraulic Conductivity

The technical specifications for the evaporation pond geonet require that over the base and the side slopes of the evaporation pond the geonet of the LDRS have a hydraulic transmissivity of at least 5×10^{-3} m^2/sec when subjected to testing conditions which include stresses, and hydraulic gradient and boundary conditions similar to those anticipated in the field. Using the specified hydraulic transmissivity of 5×10^{-3} m^2/sec and (and adjusting the transmissivity by a total factor of safety of 5.1 to account for intrusion, chemical slogging, biological clogging, and sediment clogging) geonet thickness of 0.2 inches, the calculated hydraulic conductivity is 20 cm/sec. Hydraulic transmissivity test results confirming that the specified geonet has this calculated conductivity are required in the specifications and the CQA plan.

Head on Secondary Liner

Similar to the landfill LDRS regulations, the head on the evaporation pump liner should not exceed one foot. Therefore, one foot will be used for the calculated maximum head build-up on the secondary liner and the calculation of the ALR. Also, as with the landfill LDRS, one foot of head is interpreted to mean an equivalent fluid pressure of one foot rather than a one foot increase in fluid elevation.

5.3.3 Action Leakage Rate

Action Leakage Rate Calculation

Using Equation 1 and the design parameters listed above the maximum flow rate that the LDRS geocomposite drainage layer at the base of the evaporation pump can convey from a single hole in the primary layer is calculated to be approximately 13,000 gallons per acre per day (gpad). For the pond area this is approximately 9,000 gpd. The calculations are attached as Appendix G-1.

Design LDRS Sump Flow Capacity

The flow rate listed above is for the case of flow entering the drainage layer from a single hole in the primary liner. In order to determine if the LDRS sump has sufficient capacity to remove and therefore to detect the flow from a single hole in the primary liner, an analysis was carried out for the LDRS sump capacity.

The construction materials and layout for the LDRS sump are shown on Drawings 28 to 32. The calculations for the capacity of the LDRS sump presented in Appendix G-2 and indicate that the sumps can safely remove flows of approximately 75,600 gpd. This exceeds the expected flow capacity of LDRS geonet layer from a single hole in the primary liner; therefore, the sump could detect a leak of this magnitude.

5.3.4 Discussion of Proposed Action Leakage Rates

The proposed ALR of 1000 gpad is equivalent to the EPA recommended maximum and is substantially less then the calculated maximum. The ALR, as proposed by EPA, generally refers to values with units of gallons per acre per day (gpad). The calculated flow rates for the LDRS net layer for a single hole in the primary liner system are presented in units of gallons per day. However, if the value is divided by the pond area, the flows are reported in gallons per acre per day.

5.4 DETERMINATION IF THE ACTION LEAKAGE RATE IS EXCEEDED

Determination if the ALR is exceeded in either the landfill or evaporation pond will be conducted in accordance with 40 CFR 264.302(b). Each week during the active life and closure period of landfill and each week during the active life of the evaporation pond, the weekly flow rates into each LDRS sump (based on the results of the LDRS monitoring) will be converted to average daily flow rates per unit area (gpad). Each month during the landfill post-closure care period (i.e., after the final cover is installed), the monthly flow rates into each LDRS sump will be converted to average daily flow rates per unit area. The ALR is exceeded, if the average daily flow rate into a LDRS sump is greater than the ALR assigned to that sump. If the ALR is exceeded, the response actions described in Section 7.0 will be implemented by the Triassic Park facility.

6.0 LEAK DETECTION AND REMOVAL SYSTEM MONITORING

The flow of liquid removed from each leak detection sump will be monitored either with a flow meter or using a container of known volume and a stop watch.

In accordance with 40 CFR 264.303 and 40 CFR 264.222, the volume of liquid removed from each leak detection system sump in the landfill and evaporation pond will be recorded at least once each week during the active life. Liquid volumes will also be recorded once each week for the landfill LDRS sumps during the closure period.

During the landfill post-closure care period, the volume of liquid removed from each leak detection system sump will be recorded at least monthly. If the liquid level in the sump stays below the pump operating level, i.e., one foot above the bottom liner, for two consecutive months, the level of liquid in the sump must be recorded at least quarterly. If the liquid level in the sump stays below the pump operating level for two consecutive quarters, the level of liquid in the sump will be recorded at least semi-annually. However, if at any time during the post-closure care period the pump operating level is exceeded for a sump on quarterly or semi-annual recording schedules, monthly recording of the volume of liquid removed from the sump will be reinstated. This will continue until such time that the liquid level in the sump again remains below the pump operating level for two consecutive months.

7.0 RESPONSE ACTIONS

In accordance with 40 CFR 264.223 and 40 CFR 264.304, if the ALR is exceeded for the LDRS sump in either the landfill or evaporation pond, the Triassic Park facility will:

- Notify the NMED in writing of the exceedance within 7 days of the determination;
- Submit a preliminary written assessment to NMED within 14 days of the exceedance determination, as to the amounts of liquids, likely sources of liquids, possible location, size, and cause of any leaks, and short-term actions taken and planned.
- Determine, to the extent practicable, the location, size, and cause of any leak;
- Determine whether waste receipt should cease or be curtailed, whether any waste should be removed from the unit for inspection, repairs, or controls, and whether or not the unit should be closed;
- Determine any other short-term and long-term actions to be taken to mitigate or stop any leaks;
- Within 30 days after the notification that the action leakage rate has been exceeded, submit to NMED the results of the determinations described above, the results of the actions taken, a description of the actions planned;
- Monthly, as long as the action leakage rate continues to be exceeded, submit a report to NMED summarizing the results of any remedial actions taken and planned; and
- In making the determinations described in this section, either conduct the following investigation or document why such an investigation is not needed:
    - ◊ Assess the source and amount of liquid from each source collected in the sump.
    - ◊ Conduct a hazardous constituent analysis of the liquid collected in the sump and use the results to help identify the source(s) of the liquid and possible location of any leaks as well as the potential hazard associated with the liquid and its mobility.
    - ◊ Assess the seriousness of any leaks in terms of potential for escaping into the environment.
    - ◊ Closure of the pond per 40 CFR 264.223(b)(4).

8.0 REFERENCES

Bonaparte, R and Gross, B.A., "Field Behavior of Double-Liner Systems", *Waste Containment Systems* Construction, Regulation, and Performance, ASCE Geotechnical Special Publication No. 26, Nov 1990, pp. 52-83.

Giroud, J.P., Gross, B.A., and Darrasse, J., "Flow in Leachate Collection Layers" to be published, 1993.

Gross, B.A., Bonaparte, R., and Giroud, J.P., "Evaluation of Flow from Landfill Leakage Detection Layers", *Proceedings, Fourth International Conference on Geotextiles,* Vol. 2, The Hague, June 1990, pp. 481-486.

USEPA, "*Action Leakage Rates for Leak Detection Systems"*, EPA/580-R-92004, Jan 1992, 69 p.

USEPA, Federal Register, Volume 57, No. 19, Wednesday, January 29, 1992 *Rules and Regulations,* pp 3462 - 3482

APPENDIX G-1

LANDFILL ALR CALCULATION

TERRAMATRIX INC.
Calculation Cover Sheet

Sheet 1 of 1

Project Title: Triassic Park

Project No. 602-0200

Calculation Title: Landfill Action Leakage Rate

	Name	Date
Prepared By:	J. Kendall	10/6/97
Checked By:	J. Pellicer	13-Nov-97
Reviewed By:	P. Corser	14 Nov 97
QA Review:		

Revisions	Date	By	Checked By	Reviewed By	QA Review

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Project Name: TRIASSIC PARK HW FACILITY - LF ALR
Project Number: 602-0200 Sheet 1 of 40
Prepared By: K Date: 10/6/97
Checked By: J. Pellicer Date: 3-Nov-97

TITLE: TRIASSIC PARK LANDFILL ACTION LEAKAGE RATE

OBJECTIVE: DETERMINE ACTION LEAKAGE RATE (ALR) FOR THE TRIASSIC PARK HAZARDOUS WASTE FACILITY LANDFILL

REFERENCES:

1. USEPA, FEDERAL REGISTER, VOL 57 NO 19, WEDNESDAY JANUARY 29, 1992, RULES AND REGULATIONS, pp 3462-3477
2. USEPA, "ACTION LEAKAGE RATES FOR LEAK DETECTION SYSTEMS" EPA/530-R-92004, JANUARY 1992.
3. CODE OF FEDERAL REGULATIONS, TITLE 40, PART 264.302
4. BEAR, JACOB, "HYDRAULICS OF GROUNDWATER", McGRAW-HILL, 1979. pp 74-89.
5. TERRAMATRIX/MONTGOMERY WATSON, TRIASSIC PARK HAZARDOUS WASTE FACILITY DRAWINGS AS FOLLOWS:

DRAWING NO.	DRAWING TITLE	DATE
6	ULTIMATE LANDFILL EXCAVATION PLAN	NOV 97
12	LINER DETAILS	↓
15	SUMP PLAN VIEW	
16	SUMP CROSS-SECTIONS	
17	TYP. SUMP DETAILS	
18	CROSS-SECTION + DETAILS	↓

6. TERRAMATRIX/MONTGOMERY WATSON, TRIASSIC PARK HAZARDOUS WASTE FACILITY SPECIFICATIONS AS FOLLOWS:

SPEC NO	SPEC TITLE	DATE
02224	DRAINAGE GRAVEL	NOV 97
02710	GEOCOMPOSITE	NOV 97

7. MANUFACTURER'S PRODUCT SPECIFICATIONS AND TEST DATA AS FOLLOWS:

A. NSC, "TEX-NET TRANSMISSIVITY CHARTS", TEX-NET TN 3002/1125 (PLATE/FRICTION SEAL/TN3002CN/1125/FRICTION SEAL/PLATE)

B. ADS, "TECHNICAL NOTE 2.109 RE: FLOW CAPACITY", 3/1/95.

8. MINIMUM EPA REQUIREMENTS FOR GEOSYNTHETIC DRAINAGE LAYERS IN LANDFILLS: 3×10^{-5} m²/sec (REF 1. p 3468)

9. KOERNER, ROBERT M., "DESIGNING WITH GEOSYNTHETICS" 3rd ED., PRENTICE HALL, ENGLEWOOD CLIFFS, NJ, 1994.

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METHOD:

1. ALR IS DEFINED BY FEDERAL LAW AS:

REF 3.) 40 CFR PART 264.302

§ 264.302 Action leakage rate.

(a) The Department shall approve an action leakage rate for landfill units subject to § 264.301(c) or (d). The action leakage rate is the maximum design flow rate that the leak detection system (LDS) can remove without the fluid head on the bottom liner exceeding 1 foot. The action leakage rate must include an adequate safety margin to allow for uncertainties in the design (e.g., slope, hydraulic conductivity, thickness of drainage material), construction, operation, and location of the LDS, waste and leachate characteristics, likelihood and amounts of other sources of liquids in the LDS, and proposed response actions (e.g., the action leakage rate must consider decreases in the flow capacity of the system over time resulting from siltation and clogging, rib layover and creep of synthetic components of the system, overburden pressures, etc.).

(b) To determine if the action leakage rate has been exceeded, the owner or operator must convert the weekly or monthly flow rate from the monitoring data obtained under § 264.303(c), to an average daily flow rate (gallons per acre per day) for each sump. Unless the Department approves a different calculation, the average daily flow rate for each sump must be calculated weekly during the active life and closure period, and monthly during the post-closure care period when monthly monitoring is required under § 264.303(c).

2. FLOW RATE INTO LEAK DETECTION SYSTEM CAN BE DETERMINED FROM THE FOLLOWING EQN CITED IN REF 1, p. 3474 AND DEVELOPED FOR GEONET DRAINAGE LAYERS CITED IN REF 2, p 12, (EQN 3).

$Q = K \cdot D(2h - D)$ WHERE

Q = FLOW RATE IN LEAK DETECTION SYSTEM RESULTING FROM 1 HOLE PER ACRE (GPAD)

K = HYDRAULIC CONDUCTIVITY OF DRAINAGE LAYER (FT/SEC)

FOR GEONET: $K = T/t$

WHERE T = TRANSMISSIVITY OF GEONET (FT^2/SEC)

t = THICKNESS (FT)

h = HEAD ON LINER (FT)

D = LEAK DETECTION LAYER THICKNESS (FT)

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METHOD (CONTINUED)

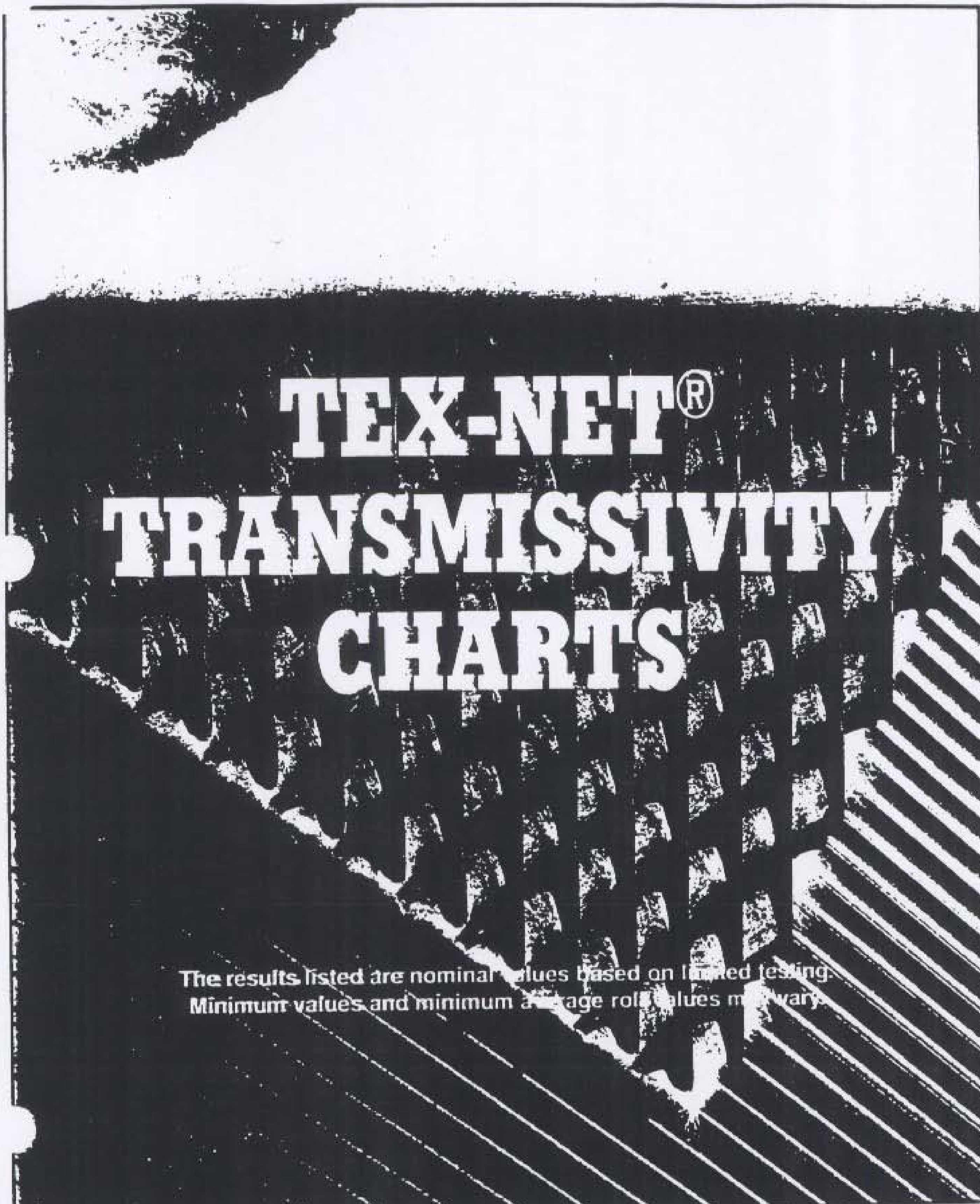
3. GEOCOMPOSITE TRANSMISSIVITY (OR FLOW RATE) CORRECTIONS FOR INTRUSION OF ADJAC MATERIALS (REF 9. PP 402-423)

GEOCOMPOSITE MANUFACTURERS TYPICALLY REPORT TRANSMISSIVITY (OR FLOW RATE) DA BASED ON ASTM 4716-87 TEST PROCEDURES CONDUCTED AT VARIOUS RANGES OF OVERBURDEN PRESSURES (NORMAL LOADS), HYDRAULIC GRADIENTS, AND MATERIAL LAYER ARRANGEMENTS. FOR THIS DATA TO BE APPLICABLE, THE TEST CONDITIONS MUST BE REPRESENTATIVE OF ACTUAL DESIGN AND OPERATING CONDITIONS. THEREFORE, APPROPRIATE FACTORS OF SAFETY MUST BE APPLIED TO MANUFACTURER'S DATA TO ACCOUNT FOR TEST PROCEDURE DIFFERENCES. FURTHER, HYDRAULIC TESTING OF THE SELECTED GEOCOMPOSITE SHOULD BE CONDUCTED UNDER ACTUAL DESIGN AND OPERATING CONDITIONS TO CONFIRM THAT THE FACTORS OF SAFETY APPLIED TO MANUFACTURER'S DATA ARE ADEQUATE.

4. CHECK LDRS PIPE FLOW CAPACITY VS LDRS INFLOW
CHECK LDRS SUMP FLOW CAPACITY VS LDRS INFLOW

REF TA

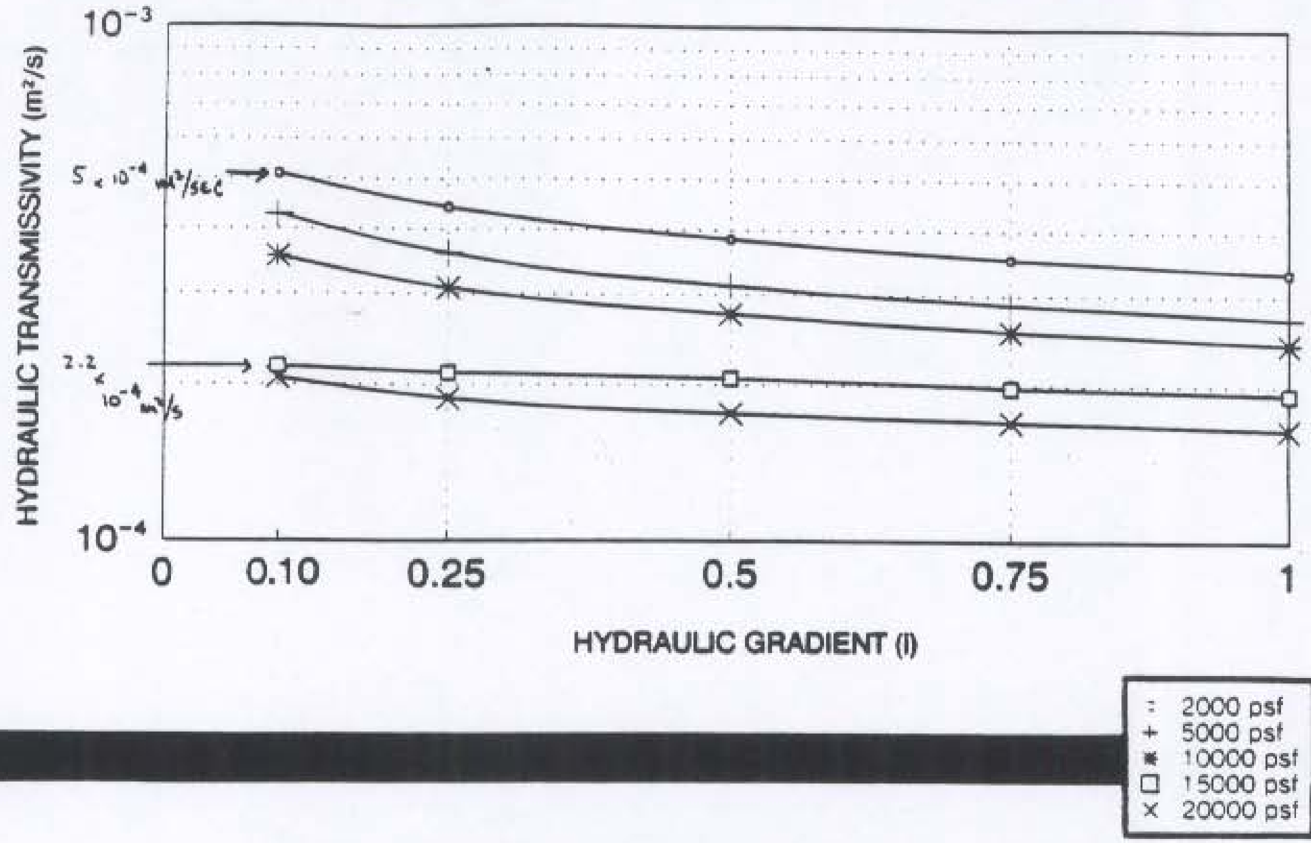
NSC
National Seal Company



REF 7A
602-0200
JK
10/6/97

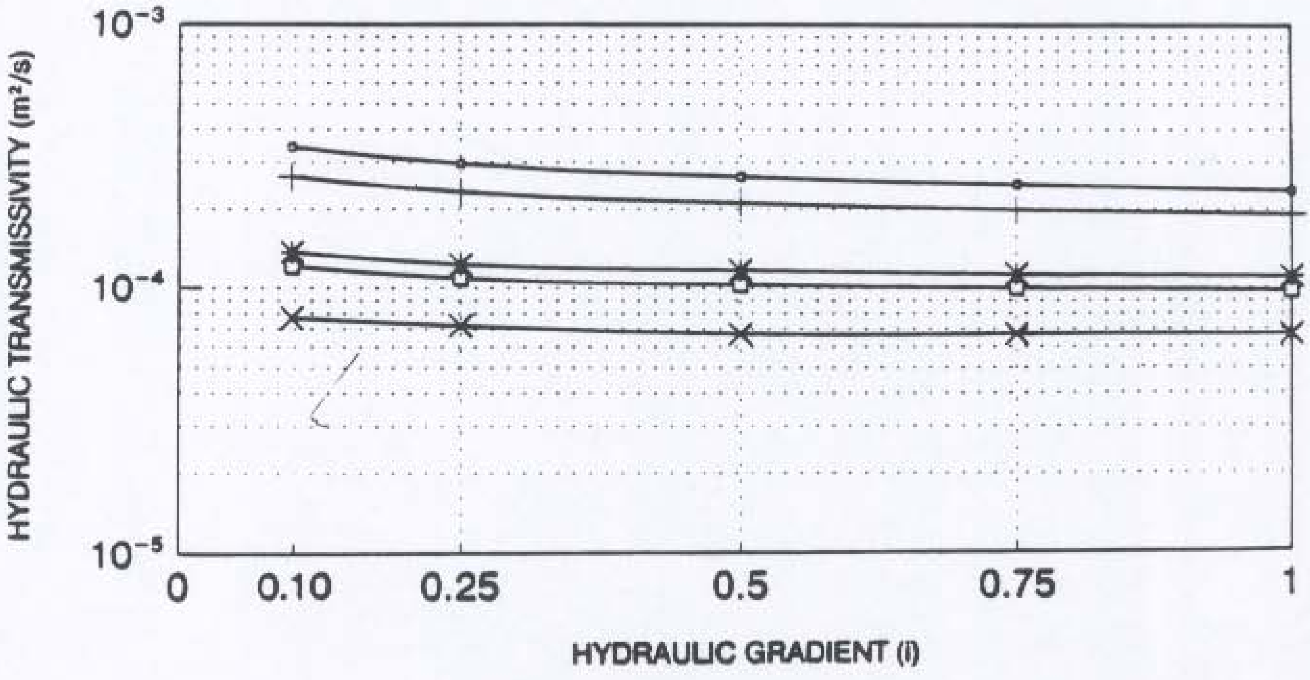
TEX-NET TN3002/1125

plate/FRICTION SEAL/TN3002/1125/FRICTION SEAL/plate



TEX-NET TN3002CN/1125

plate/FRICTION SEAL/TN3002CN/1125/FRICTION SEAL/plate



REF. 7A

SPECIFICATION – Minimum Average Roll Values

Raw material	PN2000 polyethylene	PN3000 polyethylene	PN3000CN polyethylene
Weight (lbs/ft²) ASTM D5261	0.100	0.162	0.140
Thickness (inches) ASTM D5199	0.160	0.200	0.200
Density (g/cm³) ASTM D1505	0.940	0.940	0.940
Tensile strength (lb/in) ASTM D5035	30	45	32
Carbon black (%) ASTM D4218	2	2	2
Porosity (%), Nom.	83	80	76
Roll with (feet), Nom.	7.54 & 14.5	7.54 & 14.5	7.54 & 14.5
Standard roll length (feet), Nom.	300	300	300
Area per roll (ft²), Nom.	2262 & 4350	2262 & 4350	2262 & 4350

The transmissivity results listed on the preceding pages were determined in compliance with ASTM D4716-87 test procedure. The transmissivity was measured using water @ 20°C (68°F) with a seat time of one hour. Values may vary, based on dimensions of the transmissivity specimen and specific laboratory.

CONVERSION FACTORS FOR TRANSMISSIVITY UNITS

$1 m^2/s$ = 1 cubic meter/second/meter width/unit gradient
$1 m^2/s = 10^3$ liters/second/meter width/unit gradient
$1 m^2/s = 6 \times 10^4$ liters/minute/meter width/unit gradient
$1 m^2/s = 10.76\ ft^2/second$
$1 m^2/s = 646\ ft^2/minute$
$1 m^2/s$ = 4830 gallons/minute/foot width/unit gradient

$1\ ft^2/second$ = 1 cubic foot/second/foot width/unit gradient
$1\ ft^2/second = 9.3 \times 10^{-2} m^2/s$
$1\ ft^2/minute$ = 1 cubic foot/minute/foot width/unit gradient
$1\ ft^2/minute = 1.55 \times 10^{-3} m^2/s$
1 gpm/foot width/unit gradient = $2.07 \times 10^{-4} m^2/s$
1 liter/minute/meter width/unit gradient = $1.66 \times 10^{-5} m^2/s$
100 liters/minute/meter width/unit gradient = $1.07\ ft^2/min.$

NSC

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ASSUMPTIONS

1. GEOCOMPOSITE TRANSMISSIVITY

FROM REF 7A., CHART FOR TEX-NET TN 3002./1125. MINIMUM TRANSMISSIVITY REPORTED IS 2.2×10^{-4} / m^2/SEC @ NORMAL PRESSURE = 15,000 PSF AND HYDRAULIC GRADIENT OF 0.1, TEST SECTION WAS PLATE/FRICTION SEAL/TN 3002 CN/1125/FRICTION SEAL/PLATE.

ADJUST TRANSMISSIVITY CITED ABOVE FOR DIFFERENCES BETWEEN MANUFACTURER'S TEST CONDITIONS AND ACTUAL DESIGN CONDITIONS. APPLY FS IN A MANNER SIMILAR TO APPROACH SUGGEST BY KOERNER (REF. 9, PP 413-414)

$FS_{INTRUSION}$: SINCE TEST CONDITIONS ALLOW FOR INTRUSION OF GEOTEXTILE FROM ABOVE AND BELOW THE GEONET AND NORMAL PRESSURES ARE CONSISTENT WITH DESIGN (120 FT WASTE × 110 lb/CFT = 13,200 PSF), USE $FS_{IN} = 1$.

FS_{CREEP}: SINCE TEST CONDITIONS MAY REPRESENT SHORT DURATIONS, USE $FS_{CR} = 1.5$

$FS_{CHEMICAL\ CLOGGING}$: SINCE LEACHATE FROM WASTES OF A WIDE CHEMICAL VARIETY MAY BE PRESENT, USE $FS_{CC} = 1.5$.

$FS_{BIOLOGICAL\ CLOGGING}$: SINCE MUNICIPAL WASTES WILL NOT BE ACCEPTED IN THE LANDFILL, THE PERCENTAGE OF BIODEGRADABLE MATERIAL PRESENT WILL BE SMALL, USE $FS_{BC} = 1$.

$FS_{SEDIMENT\ CLOGGING}$: SINCE FINE GRAINED SOILS MAY BE PRESENT IN THE PROTECTIVE COVER MATERIAL (SM CLASSIFICATION), USE $FS_{SC} = 1.5$

$$\text{TOTAL } FS = FS_{IN} \times FS_{CR} \times FS_{CC} \times FS_{BC} \times FS_{SC} = 1 \times 1.5 \times 1.5 \times 1 \times 1.5$$

$$= 3.375$$

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ASSUMPTIONS (CONTINUED)

1. GEOCOMPOSITE TRANSMISSIVITY (CONTINUED)

ALLOWABLE GEOCOMPOSITE FLOW RATE(q) = q(MANUF. TEST) × $\frac{1}{FS_{TOTAL}}$

$q_{ALLOW} = \frac{2.2 \times 10^{-4}}{3.375} = 6.52 \times 10^{-5}\ m^2/sec$ SAY $6.5 \times 10^{-5}\ m^2/sec$

CHECK q_{ALLOW} VS EPA MINIMUM (REF 1, p 3468)

$6.5 \times 10^{-5} > 3.0 \times 10^{-5}$ ∴ OK

(NOTE: ALTHOUGH THE ASSUMPTIONS LEADING TO $q_{ALLOW} = 6.5 \times 10^{-5}\ m^2/sec$ ARE CONSERVATIVE, CONFIRMATORY TESTING OF GEOCOMPOSITE TRANSMISSIVITY WILL BE REQUIRED. TESTING WILL BE CONDUCTED ON ACTUAL GEOCOMPOSITE SELECTED AT DESIGN CONDITIONS)

2. MAXIMUM HEAD ON LINER

USE 1.0 ft PER EPA 40 CFR 264.302

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CALCULATION

DETERMINE ALR

$$ALR = Q_{ALLOWABLE} = KD(2h - D) \quad (GPAD)$$

WHERE

$K_{GEOCOMPOSITE} = T/t$ T = TRANSMISSIVITY = 6.5×10^{-5} m^2/s; t = THICKNESS = 5mm

$K_{GEOCOMPOSITE} = \dfrac{6.5\times10^{-5}\ m^2/sec}{.005\ m} = 0.013$ m/sec ✓

$= 1.3$ cm/sec ✓

$= 0.043$ FT/sec ✓

h = 1.0 ft

D = 5mm = 0.0164 FT ✓

$ALR = Q_{ALLOWABLE} = 0.043\ \frac{FT}{SEC} \times 0.0164\ FT \times (2 \times 1.0\ FT - 0.0164\ FT)$

$= 0.00140$ CFT/Ac/SEC ✓

$= 120.9$ CFT/Ac/DAY ✓

$= 904$ GPAD ✓

RECOMMENDED ALR IS 900 GPAD ←

NOTE: THE RECOMMEND ALR VALUE OF 900 GPAD IS ABOVE THE EPA RECOMMENDED VALUE OF 100 GPAD (REF 1, p 3979). THE PRIMARY REASON FOR THIS DIFFERENCE IS THE EPA VALUE IS BASED ON SAND PERMEABILITY (1×10^{-2} cm/sec) COMPARED TO THE GEOCOMPOSITE PERMEABILITY ASSUMED ABOVE (1.3 cm/sec).

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CALCULATION (CONTINUED)

CHECK LDRS FLOOR PIPE CAPACITY

USE FLOOR LAYOUT AND CROSS SECTIONS (REF.

USE ADS N-12 PIPE FLOW CAPACITY CHART FOR 8" DIAM. PIPE (REF. 7B)

FLOW = 2.07 CFT/SEC
= 929 GPM ✓
= 1.337 MGPD ✓

USE EPA FLOW RATE EQN TO DETERMINE FLOW INTO LDRS WITH T = 5×10^{-4} m/SEC (REF. 7A) (most transmissiv value, conserv.)

NOTE: TRANSMISSIVITY VALUE USED HERE IS GREATER THAN THAT USED FOR ALR CALC BECAUSE WE ARE CHECKING MAXIMUM FLOW CAPACITIES FOR THE LDRS PIPE AND SUMP GRAVEL. THE HIGH TRANSMISSIVITY VALUE HERE IS MORE REPRESENTATIVE OF A SCENARIO EARLY IN THE LIFE OF THE LANDFILL WHEN WASTE FILL HEIGHTS ARE RELATIVELY LOW.

$Q = K \cdot D(2h - D)$ (REF 2, P12, EQN 3)

$K = T/t = \frac{5 \times 10^{-4} m^2/sec}{0.005 m} = 0.1$ m/SEC ✓
= 10 CM/SEC ✓
= 0.328 FT/SEC ✓

h = 1.0 ft
D = 5mm = 0.0164 FT ✓

$Q = 0.328 \times 0.0164 \times ((2 \times 1.0) - 0.0164)$
= 0.0106 CFT/AC/SEC ✓
= 922 CFT/AC/DAY ✓
= 6898 GAL/AC/DAY (GAPD) ✓

FLOW INTO PHASE 1 LDRS = 6898 GAPD × 7AC = 48,286 GPD ✓

FLOW INTO PHASE 1 LDRS << PIPE FLOW CAPACITY
48,286 GPD << 1.34 MGPD So PIPE CAPACITY OK ✓

Technical Notes

Technical Note 2.109
Re: Flow Capacity
Date: March 1, 1995

It is the intent of this Technical Note to provide current hydraulic performance data for use by the engineering community. A bibliography is included for the engineer's use if further information or guidance is needed.

Manning's "n" values are offered for design purposes based on the best available data assembled from a variety of sources as indicated. Table 1 presents the Manning's "n" values recommended by the A.D.S. engineering staff for use in design.

REF 7B

Table 1
Manning's "n" Value For Design
(Storm & Sanitary Sewer and Culverts)

Pipe Type	"n"
A.D.S. Corrugated Polyethylene Pipe	
3" - 6" Diameter	0.015
8" Diameter	0.016
10" Diameter	0.017
12" - 15" Diameter	0.018
18" - 36" Diameter	0.020
A.D.S. N-12	0.012 ←
Concrete Pipe	0.013
Corrugated Metal Pipe (2 2/3" x 1/2" corrugation)	
Annular	
Plain	0.024
Paved Invert	0.020
Fully Paved (smooth lined)	0.013
Helical	
Plain 15" Diameter	0.013
Plain 18" Diameter	0.015
Plain 24" Diameter	0.018
Plain 36" Diameter	0.021
Spiral-Rib	0.012
Plastic Pipe (SDR, S&D, Etc.)	0.011
Vitrified Clay	0.013

3300 RIVERSIDE DRIVE COLUMBUS, OH 43221 (614) 457-3051 http://www.ADS-pipe.com

REF. 7B

TABLE 4

PIPE SLOPE : 2.5%

CIRCULAR PIPE FLOW CAPACITY
Full Flow (cubic feet per second)

Mannings "n"= 0.012

Dia. (in.)	*Conv. Factor	0.02	0.05	0.10	0.20	0.35	0.50	0.75	1.00	1.25	1.50	1.75	2.0	2.5	5.0	10.0	20.0
		% Slope (feet per 100 feet) (c.f.s.)															
3	0.957	0.014	0.021	0.030	0.043	0.057	0.068	0.083	0.096	0.107	0.12	0.13	0.14	0.15	0.21	0.30	0.43
4	2.062	0.029	0.046	0.065	0.092	0.122	0.146	0.179	0.206	0.231	0.25	0.27	0.29	0.33	0.46	0.66	0.92
5	3.738	0.053	0.084	0.118	0.167	0.221	0.264	0.324	0.374	0.418	0.46	0.49	0.53	0.59	0.84	1.18	1.67
6	6.079	0.086	0.136	0.192	0.272	0.360	0.430	0.526	0.608	0.680	0.74	0.80	0.86	0.96	1.36	1.92	2.72
8	13.091	0.185	0.293	0.414	0.585	0.774	0.926	1.134	1.309	1.464	1.60	1.73	1.85	2.07	2.93	4.14	5.85
10	23.74	0.34	0.53	0.75	1.06	1.40	1.68	2.06	2.37	2.65	2.91	3.14	3.36	3.75	5.31	7.51	10.61
12	38.60	0.55	0.86	1.22	1.73	2.28	2.73	3.34	3.86	4.32	4.73	5.11	5.46	6.10	8.63	12.21	17.26
15	69.98	0.99	1.56	2.21	3.13	4.14	4.95	6.06	7.00	7.82	8.57	9.26	9.90	11.06	15.65	22.13	31.30
18	113.80	1.61	2.54	3.60	5.09	6.73	8.05	9.86	11.38	12.72	13.94	15.05	16.09	17.99	25.45	35.99	50.89
21	171.65	2.43	3.84	5.43	7.68	10.16	12.14	14.87	17.17	19.19	21.02	22.71	24.28	27.14	38.38	54.28	76.77
24	245.08	3.47	5.48	7.75	10.96	14.50	17.33	21.22	24.51	27.40	30.02	32.42	34.66	38.75	54.80	77.50	109.60
27	335.51	4.74	7.50	10.61	15.00	19.85	23.72	29.06	33.55	37.51	41.09	44.38	47.45	53.05	75.0	106.1	150.0
30	444.35	6.28	9.94	14.05	19.87	26.29	31.42	38.48	44.44	49.68	54.42	58.78	62.84	70.26	99.4	140.5	198.7
36	722.57	10.22	16.16	22.85	32.31	42.75	51.09	62.58	72.26	80.79	88.50	95.59	102.19	114.25	161.6	228.5	323.1
42	1089.9	15.41	24.37	34.47	48.74	64.5	77.1	94.4	109.0	121.9	133.5	144.2	154.1	172.3	243.7	344.7	487.4
48	1556.1	22.01	34.80	49.21	69.59	92.1	110.0	134.8	155.6	174.0	190.6	205.9	220.1	246.0	348.0	492.1	695.9

* Conveyance Factor = (1.486 x R2/3 x A) / n

602-020 JK 10/6/97 12/4.

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CALCULATION (CONTINUED)

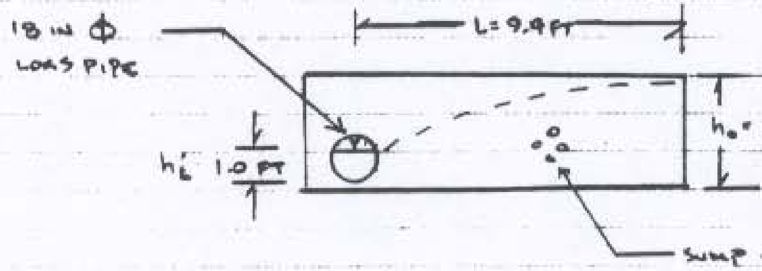
CHECK LDRS SUMP PUMPING CAPACITY

USE LDRS CROSS-SECTIONS (REF
USE METHOD DESCRIBED IN "HYDRAULICS OF GROUNDWATER" (REF 4)

USE DUPUIT-FORCHHEIMER EQN

$$Q = K/2L\,(h_0^2 - h_L^2)$$

WHERE: Q = FLOW RATE PER FT OF PIPE LENGTH
L = DISTANCE TO MAXIMUM FLUID ELEVATION
h_0 = MAXIMUM FLUID ELEVATION
h_L = FLUID ELEVATION IN PIPE
K = PERMEABILITY OF LDRS SUMP GRAVEL



(REF
= 1.969 FT/MIN ✓

$$Q = \frac{1.969\ \text{FT/MIN}}{2 \times 9.4\ \text{FT}} \times (3^2\ \text{FT} - 1^2\ \text{FT})$$

= 0.837 CFT/MIN/FT PIPE LENGTH ✓

PIPE LENGTH = 15 FT (REF.

Q_{TOTAL} = 0.837 CFT/MIN/FT PIPE LENGTH × 15 FT = 12.57 CFT/MIN
= 135,403 GPD

FLOW INTO LDRS < FLOW CAPACITY OF SUMP

40,286 GPD < 135,403 GPD ∴ SUMP CAPACITY OK

APPENDIX G-2

EVAPORATION POND ALR CALCULATION

TERRAMATRIX INC.

Calculation Cover Sheet

Sheet 1 of 1

Project Title: Triassic Park

Project No. 602-0200

Calculation Title: Evaporation Pond Action Leakage Rate

	Name	Date
Prepared By:	J. Kendall	10/7/97
Checked By:	J. Pellicer	14-Nov-97
Reviewed By:	P. Corser	14 Nov 97
QA Review:		

Revisions	Date	By	Checked By	Reviewed By	QA Review

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TITLE: TRIASSIC PARK EVAPORATION POND ACTION LEAKAGE RATE

OBJECTIVE: DETERMINE ACTION LEAKAGE RATE (ALR) FOR THE TRIASSIC PARK HAZARDOUS WASTE FACILITY EVAPORATION POND

REFERENCES:

1. USEPA, FEDERAL REGISTER, VOL 57 NO. 19, WEDNESDAY JANUARY 29, 1992, RULES AND REGULATIONS, PP. 3462-3477
2. USEPA, "ACTION LEAKAGE RATES FOR LEAK DETECTION SYSTEMS", EPA/530-R-92004, JANUARY 1992.
3. CODE OF FEDERAL REGULATIONS, TITLE 40, PART 264.222
4. BEAR, JACOB, "HYDRAULICS OF GROUNDWATER", McGRAW-HILL, 1979. PP 74-89
5. TERRAMATRIX/MONTGOMERY WATSON, TRIASSIC PARK HAZARDOUS WASTE FACILITY DRAWINGS AS FOLLOWS:

DRAWING NO.	DRAWING TITLE	DATE
29	EVAP. POND CAP LINER CONTOURS	Nov 97
32	EVAP POND LDRS PLAN AND DETAILS	Nov 97
		Nov 97
		Nov 97
		Nov 97
		Nov 97

6. TERRAMATRIX/MONTGOMERY WATSON, TRIASSIC PARK HAZARDOUS WASTE FACILITY SPECIFICATIONS AS FOLLOWS:

SPEC NO.	SPEC TITLE	DATE
02224	DRAINAGE GRAVEL	Nov 97
02710	GEOCOMPOSITE	Nov 97

7. MANUFACTURER'S PRODUCT SPECIFICATIONS AND TEST DATA AS FOLLOWS

A. NSC, "POLY-NET® TRANSMISSIVITY CHARTS, PN 3000, HDPE/POLY-NET/HDPE @ 2,000 PSF AND i = 1.

8. MINIMUM EPA REQUIREMENTS FOR GEOSYNTHETIC DRAINAGE LAYERS IN SURFACE IMPOUNDMENTS: 5×10^{-4} m^2/SEC (REF 1 p. 3468)

9. KOERNER, ROBERT M., "DESIGNING WITH GEOSYNTHETICS" 3RD ED, PRENTICE HALL, ENGLEWOOD CLIFFS, NJ, 1994.

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METHOD:

1. ALR IS DEFINED BY FEDERAL LAW AS

^U264.222 Action leakage rate.

(a) The Regional Administrator shall approve an action leakage rate for surface impoundment units subject to ^U264.221(c) or (d). The action leakage rate is the maximum design flow rate that the leak detection system (LDS) can remove without the fluid head on the bottom liner exceeding 1 foot. The action leakage rate must include an adequate safety margin to allow for uncertainties in the design (e.g., slope, hydraulic conductivity, thickness of drainage material), construction, operation, and location of the LDS, waste and leachate characteristics, likelihood and amounts of other sources of liquids in the LDS, and proposed response actions (e.g., the action leakage rate must consider decreases in the flow capacity of the system over time resulting from siltation and clogging, rib layover and creep of synthetic components of the system, overburden pressures, etc.).

(b) To determine if the action leakage rate has been exceeded, the owner or operator must convert the weekly or monthly flow rate from the monitoring data obtained under ^U264.226(d) to an average daily flow rate (gallons per acre per day) for each sump. Unless the Regional Administrator approves a different calculation, the average daily flow rate for each sump must be calculated weekly during the active life and closure period, and if the unit is closed in accordance with ^U264.228(b), monthly during the post-closure care period when monthly monitoring is required under ^U264.226(d). [^U264.222 added at 57 FR 3486, Jan. 29, 1992]

2. FLOW RATE INTO LEAK DETECTION SYSTEM CAN BE DETERMINED FROM THE FOLLOWING EQUATION CITED IN REF 1. P 3474 AND DEVELOPED FOR GEONET DRAINAGE LAYERS CITED IN REF. 2, P.2, (EQN 3)

$Q = K \cdot D(2h - D)$ WHERE

Q = FLOW RATE IN LEAK DETECTION SYSTEM RESULTING FROM 1 HOLE PER ACRE (GAPD)

K = HYDRAULIC CONDUCTIVITY OF DRAINAGE LAYER (FT/SEC)

FOR GEONET: $K = T/t$

WHERE T = TRANSMISSIVITY OF GEONET

t = THICKNESS (FT)

h = HEAD ON LINER (FT)

D = LEAK DETECTION LAYER THICKNESS

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METHOD (CONTINUED)

3. GEONET TRANSMISSIVITY CORRECTIONS FOR INTRUSION OF ADJACENT MATERIALS (REF 9, pp 402-4?

GEONET MANUFACTURERS TYPICALLY REPORT TRANSMISSIVITY (OR FLOW RATE) DATA BASED ON ASTM 4716-87 TEST PROCEDURES CONDUCTED AT VARIOUS RANGES OF OVERBURDEN PRESSURES (NORMAL LOADS), HYDRAULIC GRADIENTS, AND MATERIAL LAYER ARRANGEMENTS. FOR THIS DATA TO BE APPLICABLE, THE TEST CONDITIONS MUST BE REPRESENTATIVE OF ACTUAL DESIGN AND OPERATING CONDITIONS. FURTHER, HYDRAULIC TESTING OF THE SELECTED GEOCOMPOSITE SHOULD BE CONDUCTED UNDER ACTUAL DESIGN AND OPERATING CONDITIONS TO CONFIRM THAT THE FACTORS OF SAFETY APPLIED TO THE MANUFACTURER'S DATA ARE ADEQUATE.

4. CHECK LDRS SUMP FLOW CAPACITY VS LDRS INFLOW

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ASSUMPTIONS

1. GEONET TRANSMISSIVITY

FROM REF 7a. HDPE / POLY-NET / HDPE (PN 3000) (ASTM 4716-87) MINIMUM GEONET TRANSMISSIVITY IS 5.0×10^{-3} m²/sec @ NORMAL LOAD OF 2000 PSF AND HYDRAULIC GRADIENT OF 1. TEST RAN FOR 1 HOUR. (15 ft H_2O × 62.4 lb/cft = 936 PSF)

ADJUST TRANSMISSIVITY VALUE CITED ABOVE FOR DIFFERENCES BETWEEN MANUFACTURER'S TEST CONDITIONS AND ACTUAL DESIGN CONDITIONS. APPLY FS IN A MANNER SIMILAR TO THE APPROACH SUGGESTED BY KOERNER (REF 9. PP 413-414)

$FS_{INTRUSION}$: FACTOR OF SAFETY FOR ELASTIC DEFORMATION, OR INTRUSION, OF ADJACENT MATERIALS INTO GEONET CORE. SINCE TESTS WERE RUN WITH STEEL PLATES ABOVE AND BELOW THE HDPE WITHOUT SOIL INFLUENCES, USE $FS_{IN} = 1.5$.

FS_{CREEP}: FACTOR OF SAFETY FOR CREEP DEFORMATION OF GEONET. SINCE NORMAL LOADS IN THE TEST ARE HIGHER THAN EXPECTED LOADS IN THE POND DESIGN (20 FT × 62.4#/CFT = 1250 PSF VS 2000 PSF), USE $FS_{CR} = 1$

$FS_{CHEMICAL\ CLOGGING}$: FACTOR OF SAFETY FOR CHEMICAL CLOGGING AND OR PRECIPITATION OF CHEMICALS IN THE GEONET CORE. SINCE CHEMICAL WASTES OF A WIDE VARIETY MAY BE PRESENT, USE $FS_{CC} = 1.5$

$FS_{BIOLOGICAL\ CLOGGING}$: FACTOR OF SAFETY FOR BIOLOGICAL CLOGGING IN THE GEONET CORE. HIGH CONCENTRATIONS OF BIODEGRADEABLE FLUIDS ARE NOT EXPECTED IN THE POND, HOWEVER, SINCE THIS IS AN AQUEOUS SOLUTION, USE $FS_{BC} = 1.5$.

$FS_{SEDIMENT\ CLOGGING}$: FACTOR OF SAFETY FOR CLOGGING DUE TO FINE GRAINED SEDIMENT BUILD UP IN THE GEONET. USE $FS_{SC} = 1.5$.

$$TOTAL\ FS = FS_{IN} \times FS_{CR} \times FS_{CC} \times FS_{BC} \times FS_{SC} = 1.5 \times 1 \times 1.5 \times 1.5 \times 1.5 = 5.1$$

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ASSUMPTIONS (CONTINUED)

1. GEONET TRANSMISSIVITY (CONTINUED)

ALLOWABLE GEONET FLOW RATE $(g) = g_{(MANUF. TEST)} \times \frac{1}{FS_{TOTAL}}$

$$g_{ALLOW} = \frac{5.0 \times 10^{-3}\ m^2/sec}{5.1} = 9.8 \times 10^{-4}\ m^2/sec$$

CHECK g_{ALLOW} VS. EPA MINIMUM (REF 1, P 3468)

$9.8 \times 10^{-4}\ m^2/sec > 3 \times 10^{-4}\ m^2/sec$ so OK

(NOTE: ALTHOUGH THE ASSUMPTIONS LEADING TO $g_{ALLOW} = 9.8 \times 10^{-4}\ m^2/s$ ARE CONSERVATIVE, CONFIRMATORY TESTING OF GEONET TRANSMISSIVITY WILL BE REQUIRED. TESTING WILL BE CONDUCTED ON THE ACTUAL GEOCOMPOSITE SELECTED AT DESIGN CONDITIONS)

2. MAXIMUM HEAD ON LINER

USE 1.0 ft PER EPA 40 CFR 264.222

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CALCULATION

ALR = $Q_{ALLOWABLE} = KD(2h - D)$ (GAPD)

WHERE

$K_{GEONET} = T/t$ T = TRANSMISSIVITY = 9.8×10^{-4} m²/sec
t = THICKNESS = 5mm

$K_{GEONET} = \frac{9.8 \times 10^{-4}\ m^2/sec}{.005\ m} = 0.1961$ m/sec ✓
= 19.61 cm/sec ✓
= 0.64 FT/sec ✓

h = 1.0 ft

D = 5mm = 0.0164 ft

ALR = $Q_{ALLOWABLE} = 0.64 \frac{ft}{sec} \times 0.0164\ ft \times (2 \times 1.0\ ft - 0.0164\ ft)$
= 0.0208 CFT/Ac/sec ✓
= 1,798 CFT/Ac/DAY ✓
= 13,456 GAL/AC/DAY ✓

NOTE: THE ALR CALCULATED ABOVE IS MANY TIMES GREATER THAN THE MAXIMUM ALR VALUE OF 1000 GPAD RECOMMENDED BY EPA (REF 1. p3474). THE PRIMARY REASON FOR THIS IS THE EPA VALUE IS BASED ON SAND PERMEABILITY (1×10^{-2} cm/sec) COMPARED TO THE GEONET PERMEABILITY ASSUMED ABOVE (19.61 cm/sec).

ALTHOUGH, BASED ON THIS APPROACH, AN ALR VALUE FOR THE EVAPORATION POND MUCH LARGER THAN THE EPA MAXIMUM VALUE OF 1000 GPAD COULD BE RECOMMENDED, HOWEVER, WE RECOMMEND THE MAXIMUM ALR VALUE OF 1000 GPAD BE ADOPTED. GIVEN THE RELATIVE SMALL SIZE OF THE EVAPORATION POND, A LEAKAGE RATE OF 1000 GPAD WOULD ADEQUATELY REPRESENT A LARGE AND RAPID LEAK. ←

NSC
tional Seal Company

912-2230
10/2.92

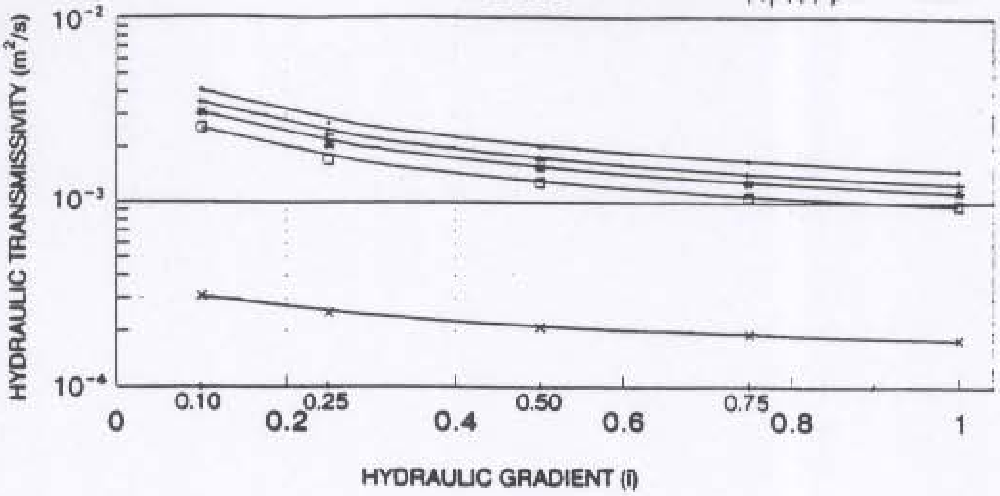
7/11

POLY-NET® TRANSMISSIVITY CHARTS

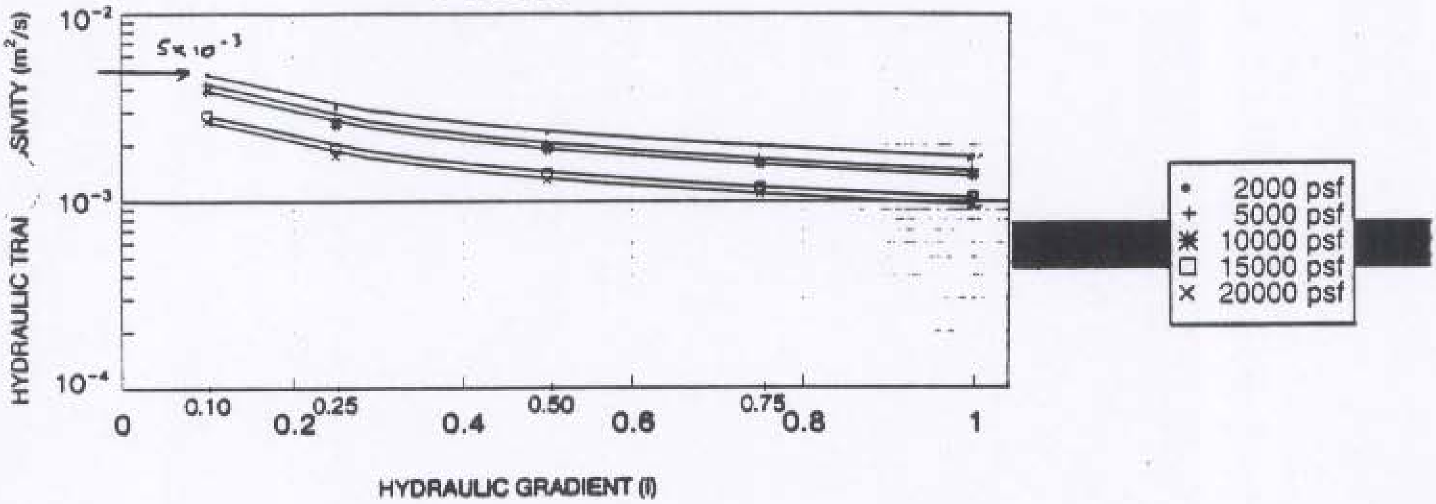
The results listed are nominal values based on limited testing.
Minimum values and minimum average roll values may vary.

602-0200
K
10/7/97
3/1

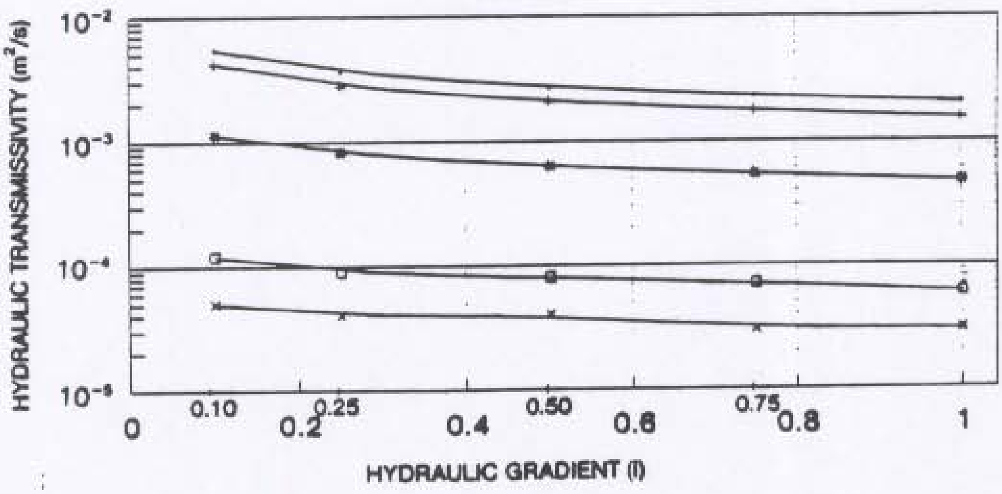
PN2000



PN3000



PN3000CN



602-0200
K
10/7/97

0/1

SPECIFICATION – Minimum Average Roll Values

Raw material	PN2000 polyethylene	PN3000 polyethylene	PN3000CN polyethylene
Weight (lbs/ft²) ASTM D5261	0.100	0.162	0.140
Thickness (inches) ASTM D5199	0.160	0.200	0.200
Density (g/cm³) ASTM D1505	0.940	0.940	0.940
Tensile strength (lb/in) ASTM D5035	30	45	32
Carbon black (%) ASTM D4218	2	2	2
Porosity (%), Nom.	83	80	76
Roll with (feet), Nom.	7.54 & 14.5	7.54 & 14.5	7.54 & 14.5
Standard roll length (feet), Nom.	300	300	300
Area per roll (ft²), Nom.	2262 & 4350	2262 & 4350	2262 & 4350

The transmissivity results listed on the preceding pages were determined in compliance with ASTM D4716-87 test procedure. The transmissivity was measured using water @ 20°C (68°F) with a seat time of one hour. Values may vary, based on dimensions of the transmissivity specimen and specific laboratory.

CONVERSION FACTORS FOR TRANSMISSIVITY UNITS

$1 m^2/s$ = 1 cubic meter/second/meter width/unit gradient
$1 m^2/s$ = 10^3 liters/second/meter width/unit gradient
$1 m^2/s$ = 6×10^4 liters/minute/meter width/unit gradient
$1 m^2/s$ = 10.76 ft^2/second
$1 m^2/s$ = 646 ft^2/minute
$1 m^2/s$ = 4830 gallons/minute/foot width/unit gradient

1 ft^2/second = 1 cubic foot/second/foot width/unit gradient
1 ft^2/second = $9.3 \times 10^{-2} m^2/s$
1 ft^2/minute = 1 cubic foot/minute/foot width/unit gradient
1 ft^2/minute = $1.55 \times 10^{-3} m^2/s$
1 gpm/foot width/unit gradient = $2.07 \times 10^{-4} m^2/s$
1 liter/minute/meter width/unit gradient = $1.66 \times 10^{-5} m^2/s$
100 liters/minute/meter width/unit gradient = 1.07 ft^2/min.

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CALCULATION (CONTINUED)

CHECK LDRS SUMP PUMPING CAPACITY

USE EPA FLOW RATE EQN TO DETERMINE FLOW INTO LDRS WITH $T = 5.0 \times 10^{-3}$ m²/SEC

NOTE: TRANSMISSIVITY VALUE USED HERE IS GREATER THAN THAT USED FOR ALR CALC BECAUSE WE ARE CHECKING MAXIMUM FLOW CAPACITIES FOR THE LDRS SUMP GRAVEL.

$Q = K \cdot D\,(2h - D)$ (REF. 2, p.12, EQN 3)

$K = T/t = \dfrac{5.0 \times 10^{-3}\ m^2/SEC}{0.005\ m} = 1.0$ m/SEC ✓

= 100 cm/SEC ✓

= 3.28 FT/SEC ✓

$h = 1.0$ ft

$D = 5$ mm = 0.0164 FT

$Q = 3.28 \times 0.0164 \times ((2 \times 1.0) - 0.0164)$

= 0.1067 CFT/AC/SEC ✓

= 9,219 CFT/AC/DAY ✓

= 68,963 GAL/AC/DAY (GAPD) ✓

FLOW INTO POND PHASE 1A = 68,963 GAPD × .71 Ac = 48,963 GPD ✓

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Project Name: TRIASSIC PARK HW FACILITY - SUMP POND
Project Number: 602-0200
Prepared By: K
Checked By: J. Pellicer

Date: 10/7/97
Date: 14-Nov-97

CALCULATION (CONTINUED)

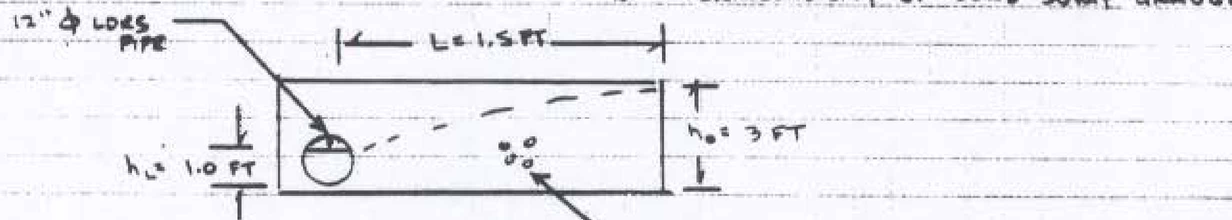
CHECK LDRS SUMP PUMPING CAPACITY (CONTINUED)

USE LDRS CROSS-SECTIONS (REF.
USE METHOD DESCRIBED IN "HYDRAULICS OF GROUNDWATER" (REF. 4)

USE DUPUIT-FORCHHEIMER EQN

$$Q = K/2L\,(h_o^2 - h_L^2)$$

WHERE: Q = FLOW RATE PER FT OF PIPE LENGTH
L = DISTANCE TO MAXIMUM FLUID ELEVATION
h_o = MAXIMUM FLUID ELEVATION
h_L = FLUID ELEVATION IN PIPE
K = PERMEABILITY OF LDRS SUMP GRAVEL



$$Q = \frac{1.969 \text{ FT/MIN}}{2 \times 1.5 \text{ FT}} \times (3^2 \text{ FT} - 1^2 \text{ FT})$$

= 5.25 CFT/MIN / FT PIPE LENGTH

PIPE LENGTH = 10 FT (REF.

Q_{TOTAL} = 5.25 CFT/MIN/FT PIPE LENGTH x 10 FT = 52.5 CFT/MIN
= 75,600 GPD

FLOW INTO LDRS < FLOW CAPACITY OF SUMP

48,963 GPD < 75,600 GPD ∴ SUMP CAPACITY OK