Golder Associates Inc.
CONSULTING ENGINEERS

Industri-Plex
6.4
0 0 I

FINAL REPORT

INTERIM CAP MATERIALS REPORT
INDUSTRI-PLEX SITE
WOBURN, MASSACHUSETTS

Submitted to:

Monsanto Chemical Company
800 North Linbergh Boulevard
St. Louis, Missouri

DISTRIBUTION:

6 Copies - M. Wade, U.S. Environmental Protection Agency
1 Copy - J. Naparstek, Massachusetts Department of Environment Protection
2 Copies - A. Ostrofsky, NUS Corporation
8 Copies - Industri-Plex Site Remedial Trust
3 Copies - Golder Associates Inc.
1 Copy - Roux Associates
1 Copy - STV Engineers
1 Copy - Normandeau Associates
1 Copy - H2M Group
1 Copy - Sasaki Associates

March 1990 Project No.: 893-6255

GOLDER ASSOCIATES INC. • 20000 HORIZON WAY, SUITE 500, MT. LAUREL, NEW JERSEY 08054 • TELEPHONE (609) 273-1110 • FACSIMILE (609) 273-0778

OFFICES IN UNITED STATES • CANADA • UNITED KINGDOM • SWEDEN • AUSTRALIA

Golder Associates Inc.
CONSULTING ENGINEERS

March 27, 1990 Project No.: 893-6255

Monsanto Chemical Company
800 North Linbergh Blvd.
Bldg. #F3WB
St. Louis, MO 63167

Attn: Mr. Ken Winkler
Project Manager

RE: INTERIM CAP MATERIALS REPORT
INDUSTRI-PLEX SITE
WOBURN, MASSACHUSETTS

Gentlemen:

This interim report presents potential material sources for the permeable and impermeable covers for the Industri-Plex site in Woburn, Massachusetts.

BACKGROUND

The Consent Decree entered between the Industri-Plex Site Remedial Trust (ISRT), the United States Environmental Protection Agency (USEPA), and the Massachusetts Department of Environmental Protection (MDEP) on April 24, 1989 incorporates the Remedial Design/Action Plan (RDAP). The RDAP requires the execution of a Pre-Design Investigation which includes the identification of potential cap material sources as defined in the Pre-Design Work Plan (Task S-3). This interim report discusses actions taken, to date, to identify these potential sources.

As stated in the Record of Decision (ROD), page 27,

> **"...the objective of the remedial alternatives addressing contaminated soils and sludges is to prevent the public from coming into direct contact with these materials..."**

Further, as stated in the Remedial Design/Action Plan (RD/AP), Appendix I of the Consent Decree,

(p.1) **"The remedial action for soils, sediments, and sludges contaminated with Hazardous Substances, other than those emitting odors (the East Hide Pile), shall include site grading, capping with a permeable soil cover, excavation, dredging, and/or consolidation for all areas containing Hazardous Substances at concentrations above established action levels (300 ppm = arsenic, 600 ppm = lead, 1000 ppm = chromium...)"**

(p.7) **"The remedial action shall consist of stabilizing the side slopes of the East Hide Pile, installing a gas collection layer, capping with a synthetic membrane liner to establish impermeability, and soil cover in accordance with Attachment A..."**

The construction of both the permeable and impermeable caps require importation of soil and synthetic materials. Golder Associates Alternate Cover Design Report, dated May 1989, discussed in detail a cost effective permeable cover. This alternate cover design was subsequently approved by EPA/MDEP. Specifically, the permeable cap components are (from bottom to top):

- a geotextile
- a minimum thickness of 16 inches of imported borrow.

The geotextile will function as a separator between the contaminated soils and the imported borrow, a visual definition of the top of the contaminated soils, and an inhibitor of migration of stones from the existing soils resulting from freeze/thaw action.

The imported borrow will function as the physical barrier to prevent direct contact with the public.

Golder's alternate cover design estimated the volume of the imported borrow (general fill) cover to be on the order of 75,000 cubic yards with 208,000 square yards (43 acres) of geotextile.

The impermeable cap, to encompass the East Hide Pile, will include (from bottom to top):

- a gas collection layer
- a bedding layer
- an impermeable synthetic geomembrane
- a drainage layer
- a vegetated layer

The gas collection layer will consist of a uniformly graded, coarse grained borrow (gravel) to allow extraction of gases from the hide pile for collection and subsequent treatment. The bedding layer will provide a stable base for overlying layers. The impermeable synthetic geomembrane will function as a hydraulic barrier to surface infiltration and percolation, and as a vapor barrier to gas migration out of the hide pile. The drainage layer will allow flow of infiltrated water off of the synthetic geomembrane, and the vegetated layer will support ground cover to minimize erosion.

The estimated volume of borrow (from the alternate cover design report) for the impermeable cover was on the order of 15,000 cubic yards, which includes 6,000 cubic yards each of topsoil and gas collection gravel, and 3,000 cubic yards of drainage layer sand.

POTENTIAL BORROW SOURCES

Golder contacted 15 local suppliers and inquired about the availability of borrow soils. The suppliers were asked to potentially supply the following volumes of borrow:

75,000 cubic yards fill
6,000 cubic yards topsoil
6,000 cubic yards gravel
3,000 cubic yards sand

Four of the fifteen suppliers indicated that they were interested in providing the required borrow quantities. They include:

Reddish Hauling, Inc.
North Plymouth, Massachusetts

Joseph Roberto, Inc.
Burlington, Massachusetts

E.H. Perkins Construction
Wayland, Massachusetts

Townsend Sand and Gravel
Townsend, Massachusetts

The suppliers were asked to identify borrow source locations. These included Plymouth, Canton, Middleboro, Sterling, Gardner, Taunton, Berkley, Townsend, Burlington, Winchendon, Hubbardstown, and Ashburnham, Massachusetts.

Golder visited borrow pits in Townsend, Ashburnham, Winchendon, and Hubbardstown. Photographs for each of these four locations are shown in Appendix A. All of these borrow pits have been permitted by MDEP as an acceptable source of borrow soils, and are currently capable of providing required borrow volumes for cap construction. It is understood that MDEP permitting addresses the environmental sensitivity of the borrow pit; hence, these permitted borrow sources should not be environmentally sensitive areas. Additional sources may be determined prior to actual cap construction. These additional sources will be investigated to assure that the design specifications are met and will be submitted for approval to EPA and MDEP prior to use.

POTENTIAL GEOSYNTHETIC SOURCES

Golder visited the Geosynthetics Research Institute (GRI) at Drexel University and developed a list of major geotextile and geomembrane manufactures. The major geotextile manufacturers include:

Hoechst Fibers Industries
Spartansburg, South Carolina

Mirafi Inc.
Charlotte, North Carolina

Amoco Fabrics and Fibers Company
Atlanta, Georgia

Reemay, Inc. (formerly DuPont)
Old Hickory, Tennessee

Phillips 66 Company
Pasadena, Texas

The major geomembrane manufacturers include:

Gundle Lining Systems, Inc.
Houston, Texas

Poly-America Inc.
Grand Prairie, Texas

National Seal Company
Palatine, Illinois

It is estimated that approximately 43 acres of geotextile will be required for the permeable cap, and approximately 4 acres of geomembrane will be required for the impermeable cap over the East Hide Pile.

Geosynthetic product information is presented in Appendix B.

We appreciate the opportunity to provide this information to the Industri-Plex Site Remedial Trust (ISRT). If you have any questions, or are in need of additional information, please contact us at (609) 273-1110.

Very truly yours,

GOLDER ASSOCIATES INC.

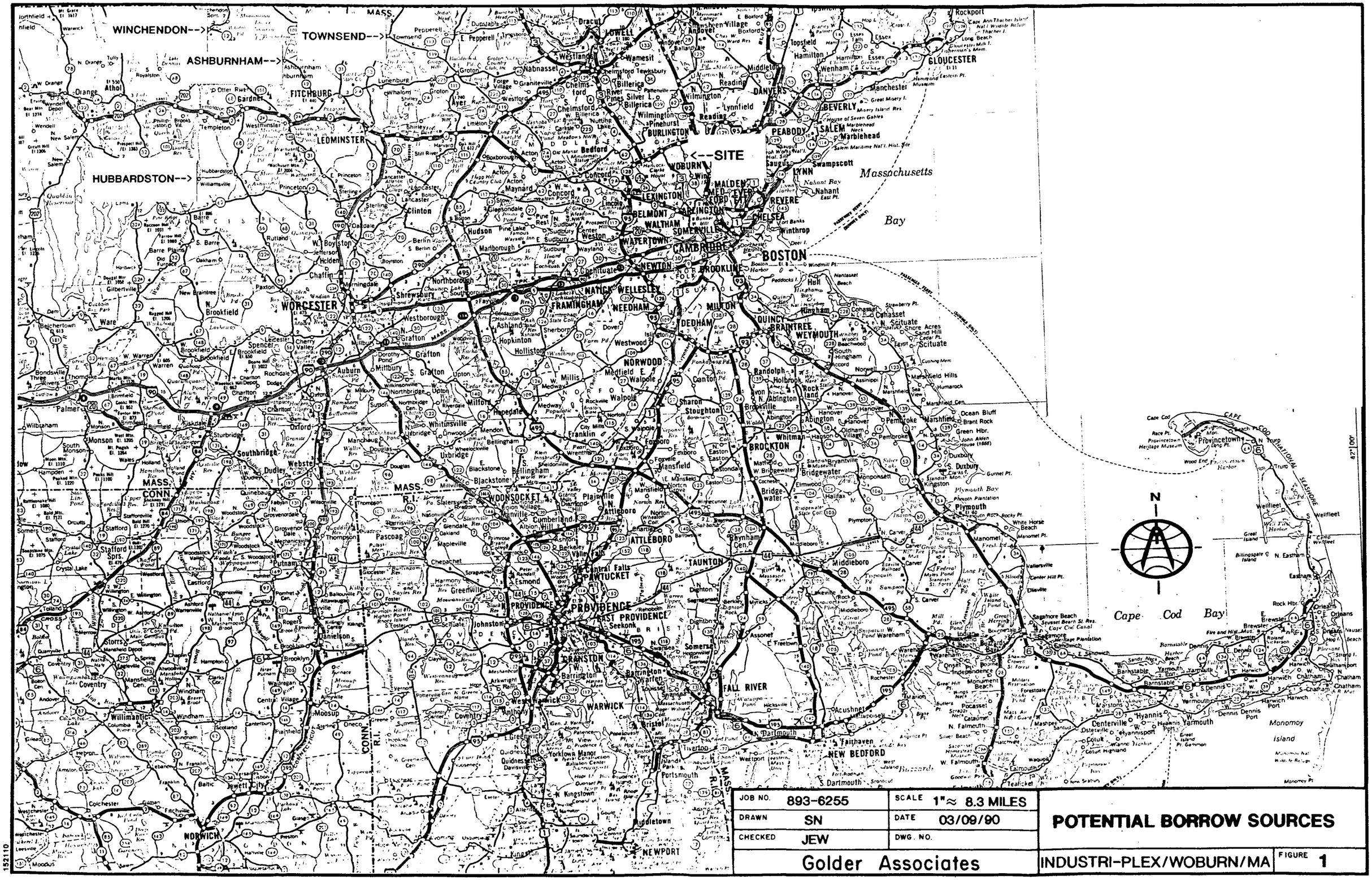
James E. Whitty, P.E.
Project Engineer

J. Edmund Baker, P.E.
Principal

JEW/JEB/bjt
C:6255327

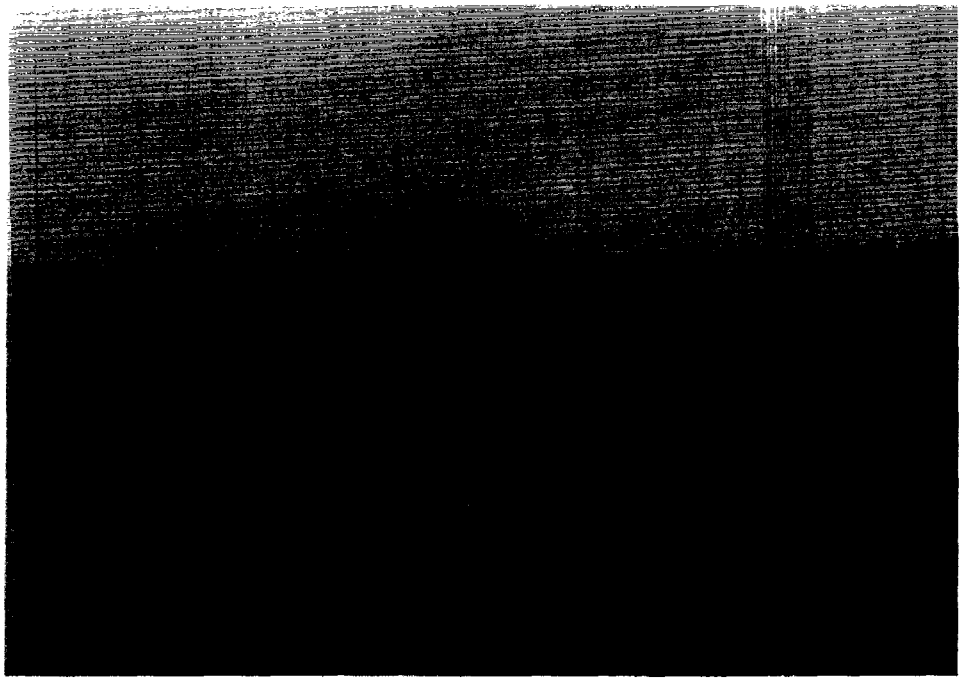
APPENDIX A

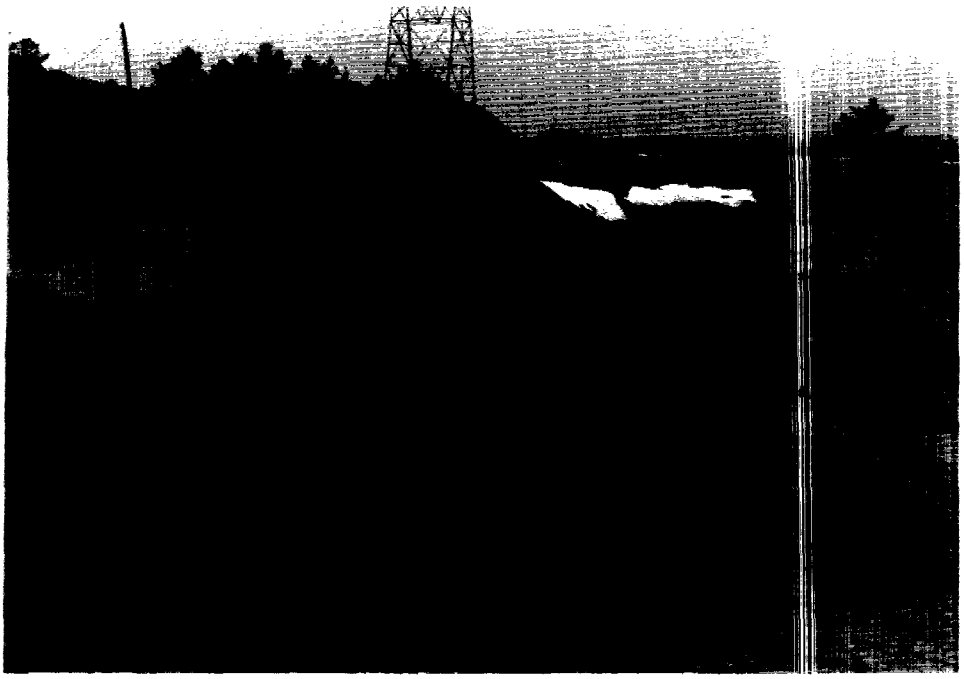
Locations of Potential Borrow Sources



JOB NO. 893-6255	SCALE 1"≈ 8.3 MILES	**POTENTIAL BORROW SOURCES**	
DRAWN SN	DATE 03/09/90		
CHECKED JEW	DWG. NO.		
Golder Associates		INDUSTRI-PLEX/WOBURN/MA	FIGURE 1

152110

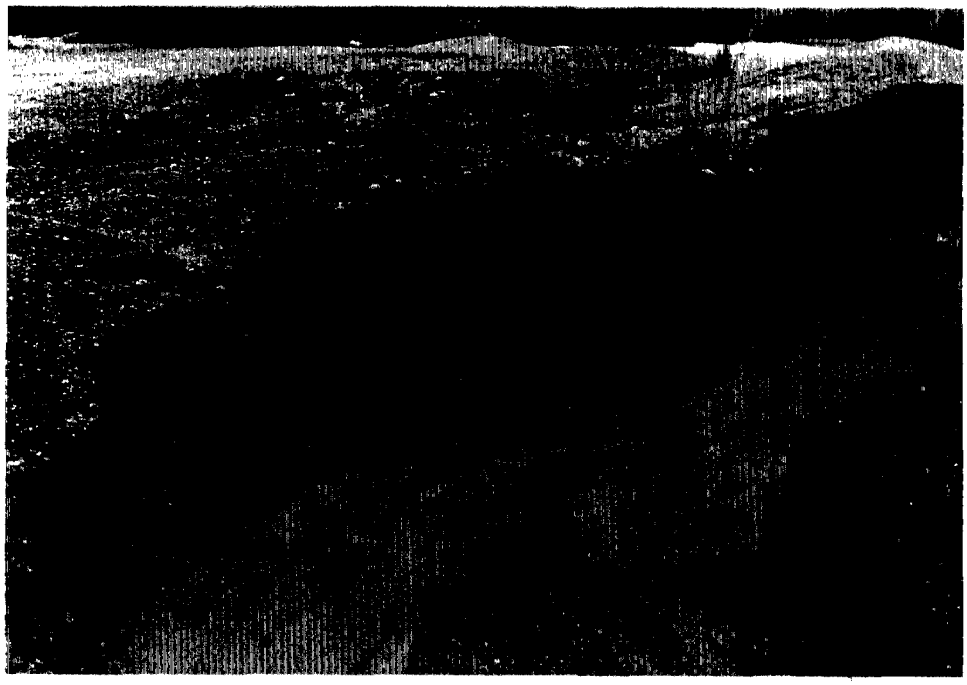




Originals in color.

JOB NO. 893-6255.10	SCALE N/A	**ASHBURNHAM BORROW PIT ROUTE 12 ASHBURNHAM, MASSACHUSETTS**	
DRAWN SN	DATE 03/14/90		
CHECKED JEW	DWG. NO.		
Golder Associates		ISRT/WOBURN/MA	FIGURE 2

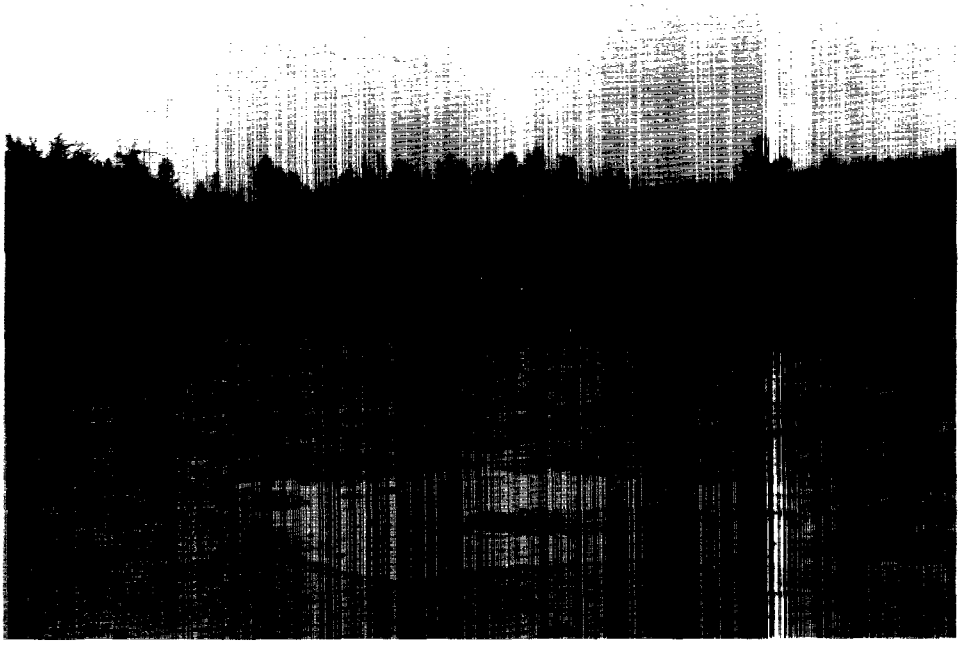
152978

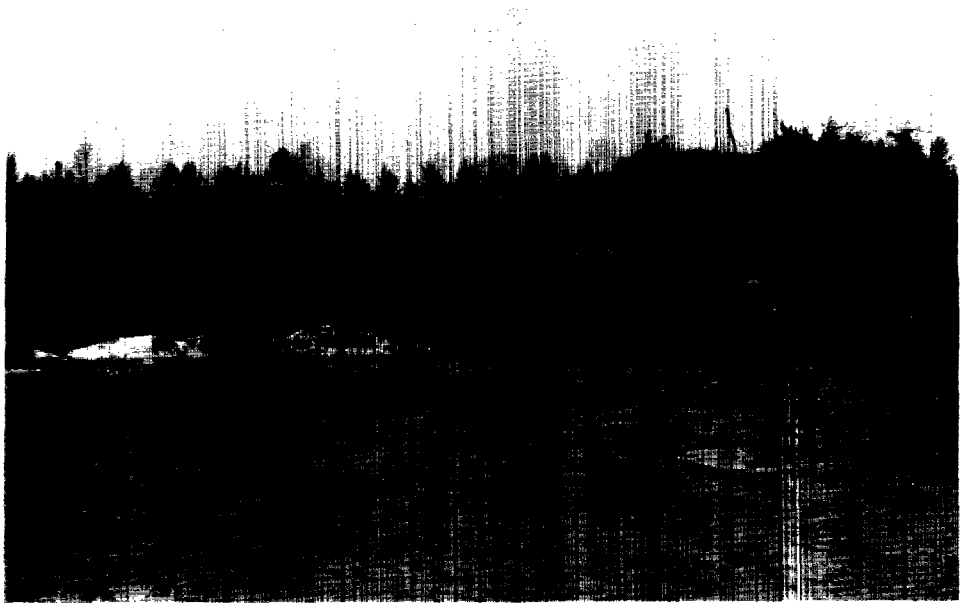


Originals in color.

JOB NO. 893-6255.10	SCALE N/A	**TOWNSEND BORROW PIT MASON ROAD TOWNSEND, MASSACHUSETTS**
DRAWN SN	DATE 03/14/90	
CHECKED JEW	DWG. NO	
Golder Associates	ISRT/WOBURN/MA	FIGURE 3

152978

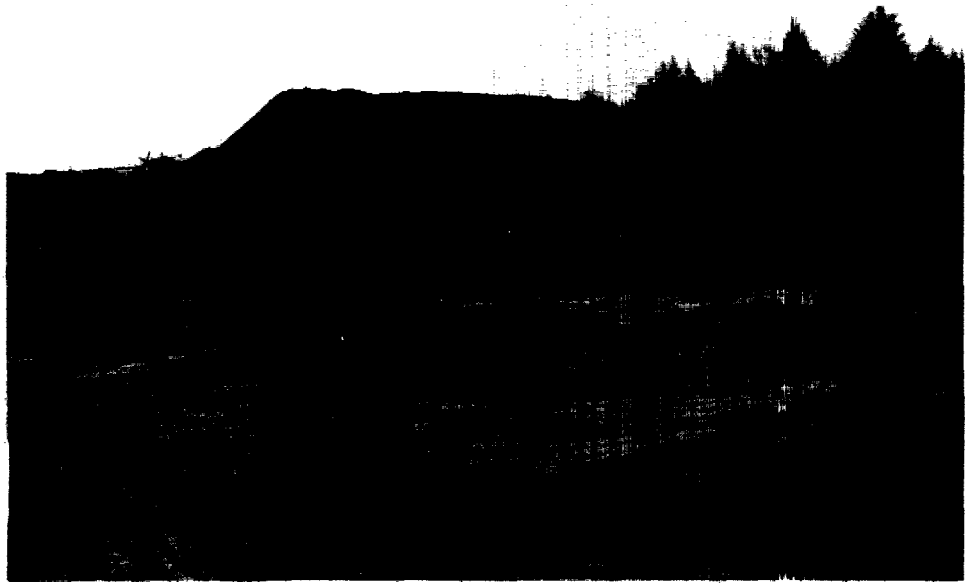




Originals in color.

JOB NO. 893-6255.10	SCALE N/A	**WINCHENDON BORROW PIT MILL GLEN ROAD WINCHENDON, MASSACHUSETTS**	
DRAWN SN	DATE 03/14/90		
CHECKED	DWG NO.		
Golder Associates		ISRT/WOBURN/MA	FIGURE 4

152978



Originals in color.

JOB NO. 893-6255.10	SCALE N/A	HUBBARDSTOWN BORROW PIT PITCHERVILLE ROAD HUBBARDSTOWN, MASSACHUSETTS
DRAWN SN	DATE 03/14/90	
CHECKED JEW	DWG. NO.	
Golder Associates	ISRT/WOBURN/MA	FIGURE 5

152976

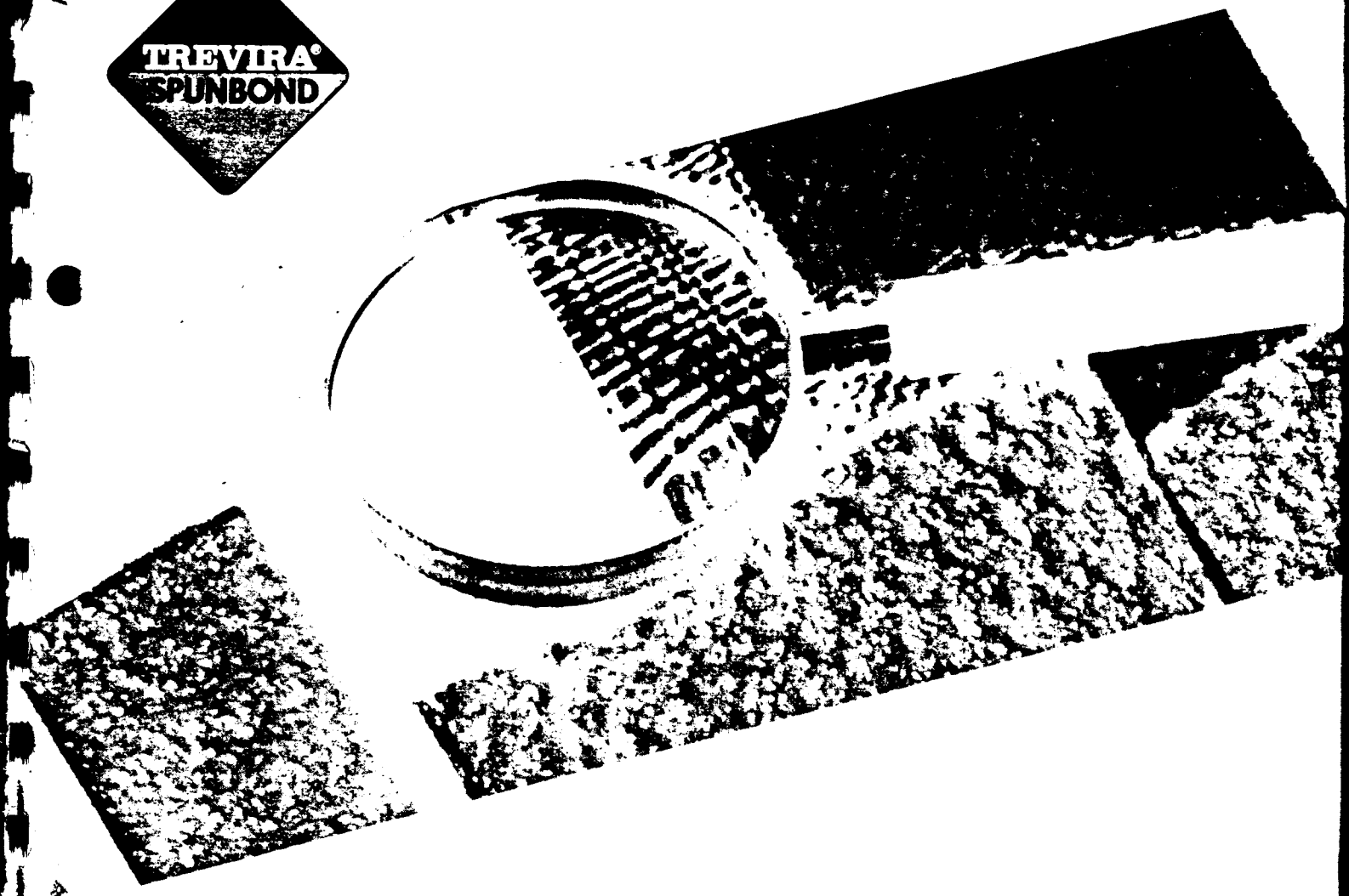
APPENDIX B

Geosynthetic Product Information

Geotextile Product Information

TREVIRA SPUNBOND ENGINEERING FABRIC

THE PLAIN FACTS



Hoechst

HOECHST

• Registered Trademark of Hoechst AG

The Plain Facts

The Plain Facts of engineering fabrics:

- **Engineering Fabrics: Close-Up!**
- **Product Uniformity**
- **Effect of Restraint**
- **Effect of Puncture**
- **Soil Retention**
- **Resistance to Heat**
- **Resistance to Creep**

All too often, the comparison of properties, such as physical strength, etc., of engineering fabrics is based upon published literature.

The need to understand the true nature and function of engineering fabrics in installations requires more information than just typical (average) physical values.

This literature provides, in a simple format, information to better understand the differences between nonwoven and woven fabrics and between polyester and polypropylene fabrics.

The information provided will establish:

- Needlepunched Nonwovens are multi-directional
- Wovens are bi-directional
- Needlepunched Nonwovens outperform Wovens in:
  - Permeability
  - Soil retention
  - Conformability
  - Lateral restraint
- For any given installation, strength requirements for wovens are significantly higher than for Nonwovens (interface friction, 360° performance).
- Needlepunched Nonwovens have the necessary high aggregate/fabric friction to provide lateral restraint.
- Wovens fail to provide lateral restraint due to low aggregate/fabric friction and accumulation of moisture at the soil/fabric interface.
- Needlepunched Continuous Filament Nonwovens are virtually uneffected by punctures based upon strength.
- Wovens significantly weaken, elongate and tear after a puncturing.
- Needlepunched Nonwovens are unsurpassed in retaining soil and maintaining water flow.
- Polyester is unsurpassed in resistance to heat.
- Polyester is unsurpassed in resistance to creep.
- Polyester is unsurpassed in resistance to hydrocarbons.

WOVEN and NONWOVEN

Woven engineering fabrics are constructed by meshing fiber strands in a perpendicular fashion.

Since the *woven* fiber strands are oriented in only two directions, fabric strength and elongation characteristics are directionally dependent. Furthermore, significant directional strength differences exist for many woven fabrics (up to 40%).

Actual field loads are applied in multi-directional patterns. Thus the true measure of a woven or nonwoven fabric is determined by examining the physical properties in a 360 degree analysis as provided in this literature.

Nonwoven fabrics like TREVIRA® are constructed of fibers oriented in a random pattern.

The controlled, random orientation provides *multi-directional* strength and elongation properties.

Nonwoven fabrics' thickness and fiber orientation insure superior soil retention while allowing ample water permeation. Thicker *nonwovens* provide a plane for pore water pressure dissipation and water flow within the fabric itself.

Nonwovens are pliable and conform far more readily to subgrade and ballast irregularities, thus providing more intimate contact with the soil, and higher aggregate/fabric restraint.

HEATBONDED and NEEDLEPUNCHED

Heatbonding and needlepunching are manufacturing techniques to fashion fibers into nonwoven fabrics.

Heatbonding fibers into a nonwoven fabric is accomplished by pressing the fibers together under heat, partially melting the fibers together at the fiber overlaps.

Heatbonding fibers causes indentations in the fiber, causing stress concentrations, resulting in lower tear and puncture strengths, as well as causing the fabric to be board-like, thus reducing the fabric's conformability significantly.

Heatbonding severely inhibits the fabric's ability to conduct water within the plane of the fabric. *Heatbonding* significantly reduces the lateral restraint of aggregate in contact with the fabric due to low aggregate/fabric friction.

Needlepunching is a *mechanical* interlocking of the fibers without heat, pressure, or resins.

Needlepunching produces a superior pliable, thick, multi-directional strength fabric with no stress concentrations or directional weaknesses as wovens or heatbonded nonwovens.

Needlepunching allows the fabric to conform to the subgrade, while allowing for controlled soil retention and superior water flow characteristics over all other types of nonwoven bonding.

PRODUCT DESCRIPTION

TREVIRA® Spunbond products are 100% polyester (poly-ethylene terephthalate), continuous filament fabrics mechanically bonded by needling.

TREVIRA Spunbond Type 11 fabrics are produced in weights from 4.5 through 16 oz/yd² and in a light grey color.

TYPICAL PHYSICAL PROPERTIES OF TYPE 11 PRODUCTS

Fabric Type	1115	1120	1127	1135	1145	1155
Fabric Weight (oz/yd²)	4.5	6	8	10	13	16
Thickness (Mils) (ASTM D-1777)	85	100	125	150	175	210
Grab Strength (LB, MD/CD*) (ASTM D-1682)	130/110	175/155	260/225	340/300	430/390	525/485
Grab Elongation (%, MD/CD) (ASTM D-1682)	85/95	85/95	85/90	90/95	90/95	90/95
Trapezoid Tear Strength (LB, MD/CD) (ASTM D-1117)	50/45	65/60	100/95	130/130	185/180	205/200
Puncture Strength — 5/16" (LB) (ASTM D-751)	60	90	125	155	200	260
Mullen Burst Strength (PSI) (ASTM D-3786)	220	300	380	500	600	800
Vertical Water Flow (GAL/MIN/FT²) (HFI Test)	325	300	280	265	240	220
EOS (CW-02215)	70 +	50-70	70-100	70 + -100 +	100-120	120 +
Std. Roll Widths (FT)	← 12.5, 14.5, & 16.0 →					
Std. Roll Length (FT)	← 300 & 1000 →				← 300 & 600 →	

*MD = Machine Direction, CD = Cross Machine Direction. Special width and length rolls are available upon request.

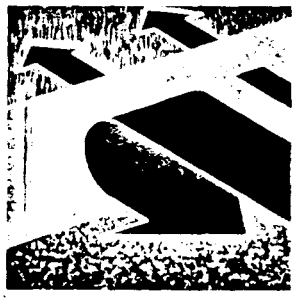
NOTE: Typical Physical Properties of Type 11 Products represent typical average values as opposed to specification values. For recommended end use specifications and physical propeties, contact your TREVIRA Spunbond Distributor.

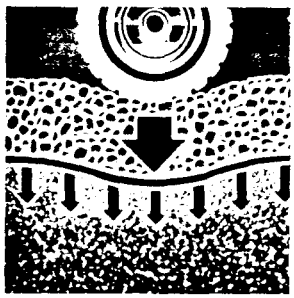
Hoechst

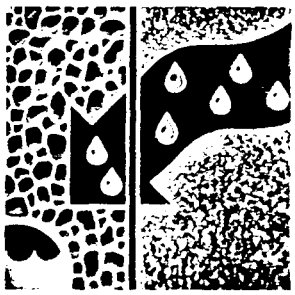
Hoechst Fibers Industries
Spunbond Business Unit
P. O. Box 5887
Spartanburg, SC 29304
Telephone 1-800-845-7597

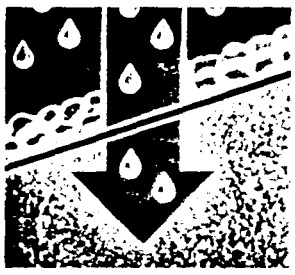
MIRAFI® INC

PRODUCTS FOR CONSTRUCTION APPLICATIONS









The leader in geotechnical innovation

AN IMPORTANT MESSAGE FROM MIRAFI INC

At Mirafi, we believe concise, accurate information is essential for effective decision making. The purpose of this brochure is to provide you with the geotextile/geotechnical product information that will aid your decision-making process. Mirafi Inc, a wholly-owned subsidiary of Dominion Textile (USA) Inc., is the only company in North America totally qualified to meet all your geotextile/geotechnical product information needs.

OUR QUALIFICATIONS

In 1969, the first square yard of Mirafi's geotextile product was installed in a field trial. Since that modest beginning, Mirafi Inc has emerged as the North American pioneer in new construction products and technologies.

In the following years, Mirafi has continued to focus totally on geotechnical products. As a result, Mirafi is now the acknowledged leader in the field and is uniquely qualified to confidently assist the geotechnical decision maker. Geotechnical products are Mirafi's only business and we are the only producer and marketer of our kind in North America. Our qualifications, however, center not just on our technical achievements; but on the character of our company itself. This character is best described by Mirafi Inc's corporate capabilities.

OUR CAPABILITIES

Technology

First and foremost, Mirafi products are technologically based. Years of application development in the field, in laboratories, through Mirafi funded university programs, and with leading geotechnical consultants have kept Mirafi ahead of the competition. Our extensive product base is backed by technical service devoted to making our new technologies easy to understand and use.

Manufacturing

Mirafi products are produced by Mirafi Inc as well as other manufacturers recognized for quality. In addition, our custom fabrication capabilities and special order manufacturing give Mirafi flexibility unmatched in the industry.

Research And Development

Geotextiles and related products have grown dramatically, largely as a result of Mirafi's innovative applications, ideas and products. When additional development expertise is needed, Mirafi responds. For example, we have recently established long-term product development and marketing agreements with Burlington Industrial Fabrics Co., a division of Burlington Industries, and 3M. Products developed as a result of these associations are presented in this brochure.

Marketing

Bringing the technology, service, manufacturing capability and experience to engineers and contractors is the responsibility of the largest geotextile marketing organization of its kind in North America. Our experienced, well-informed Manufacturer's Representatives and Distributors cover the continent. Mirafi's products and product information are available through a network of warehouses that support the wide array of stocking distributors. Clearly, Mirafi Inc is well-qualified to inform.

This brochure gives you an overview of the numerous Mirafi geotechnical products and their applications. Detailed design guidelines, extensive product testing results, case histories and research reports are available to support all the facts in this brochure.

OUR PRODUCTS

Since Mirafi always begins by first defining application needs, this brochure is organized by application categories. For the application problem you face, turn to the appropriate section for your solutions. In each section, product applications, recommended products, typical installations and installation guidelines are described.

For more information about our products or specific product applications, please contact Mirafi Inc or your local Mirafi Representative.

SPECIFICATIONS

Mirafi Construction Products: Typical Property Values

The product specifications are average values. For minimum certifiable values contact your local Mirafi Representative or the Mirafi Technical Department at 1-800-438-1855.

SR=SOIL REINFORCEMENT **SC**=SEDIMENTATION CONTROL **AO**=ASPHALT OVERLAY
D=DRAINAGE **L**=LANDSCAPING **PU**=POND UNDERLINING
EC=EROSION CONTROL

Property	Unit	Test Method	140N (D,EC)	140S (D,EC)	Miradrain (D)	700X (D,EC)	Miramat (EC)	Easy Fencin' (EC)
Weight	oz/sy	ASTM D-3776-79	4.5	4.0		6.5	24	5.0
Grab Strength	lbs	ASTM D-1682-64[1]	120	125		400 x 250	18 x 6[7]	370 x 210
Grab Elongation	%	ASTM D-1682-64[1]	55	50		35 (max)		20
Modulus (10% Elongation)	lbs	ASTM D-1682-64[1]						
Trapezoid Tear Strength	lbs	ASTM D-1117-80	50	65		110 x 55		
Mullen Burst Strength	psi	ASTM D-3786-80[2]	210	125		490		525
Puncture Strength	lbs	ASTM D-3787-80[3]	70	55		130		
Abrasion Resistance	lbs	ASTM D-3884-80[4] & D-1682-64				155		
Thickness	mils	ASTM D-1777-64	60			19	250	
Coef. of Permeability, k	cm/sec	CFMC GET-2	0.2	0.1		0.015		
Water Flow Rate	gal/min/sf	CFMC GET-2	285	300		60		
Air Flow Rate	cf/min/sf	ASTM D-737-75	225			115		
Equivalent Opening Size (EOS)	U.S. Std. Sieve	COE CW-02215-77	100+	70-100		70-100		
Open Area	%	COE Method				4		50
Sediment Retention Efficiency	%	Virginia DOH VTM-51						
Slurry Flow Rate	gal/min/sf	Virginia DOH VTM-51						
Ultraviolet Stability	%	ASTM G-26[5] & D-1682-64				90		90
Asphalt Retention	gal/sy	Measured						
Shrinkage from Asphalt	%	Measured						
Porosity	%	Calculated					85-90	
Flexibility	mg-cm	ASTM D-1388-64					2000	
Core Compressive Strength	psf	ASTM-D-1621 (modified)			4320			
Lateral Flow Rate	gpm/ft width/side	PDS Flow Test[6]			5			
Core Amplitude	in	Measured			0.75			
Core Wave Length	in	Measured			1.25±.25			

1. Constant rate of extension of 12 in/min.
2. Diaphragm Bursting Tester.
3. Tension Testing Machine with ring clamp; steel ball replaced with a ⅝inch diameter solid steel cylinder centered within the ring clamp.
4. ASTM D-1682 as above after abrasion as required by ASTM D-3884 Rotary Platform, Double Head Method using CS-17 "Calibrase" wheels, 1 kg. load per wheel, 1000 revolutions.
5. ASTM D-1682 as above after 250 cycles in a Xenon-Arc Weatherometer (Type BH or Type C). One cycle consists of 102 minutes of light followed by 18 minutes of light with water spray.
6. Flow Rate measured in Mirafi Flow Tester ($\Delta h/L=0.5$ at 1440 psf confining soil pressure).
7. Two inch Strip Method.

	500X (SR)	600X (EC,SR)	1000HP (EC,SR)	1200HP (EC, SR)	1500HP (SR)	1600HP (SR)	2100HP (SR)	2300HP (SR)	Envirofence 100X (SC)	900N (AO)	180N (PU)	Mirascape II (L)
	4.0	6.0	10.0	12.0	15.0	16.0	21.0	23.0	2.5	4.0	9.0	1.5
	200	300	400	550	750	1150 x 250	1150 x 550	1000	100	115	210	
	30 (max)	35 (max)	15-35	15-35	15-35	15-35	15-35	15-35	30 (max)	60	140	
	115	140										
	115	120	120						65		75	
	400	>600	700	1500+	1500+	1200	1500+	1500+	210		350	
	85	130	125								125	
	50	100										
	23	30	30	40	60	70	75	80	17	50	90	
	0.002	0.01	0.01	0.01	0.01	0.01	0.1	0.03	0.0009		0.3	0.15
	35	50	30	30	30	30	75	50	40		320	200
										290		230
	20-45	20-45	30-50	30-120	30-120	50+	50+	30-120	20		80-100	
									75			
									0.5			
		90							90			
										0.20		
										<6		

Information on

Amoco Fabrics & Fibers Company
900 Circle 75 Parkway
Suite 500
Atlanta, Georgia
30339

Amoco Fabrics and Fibers Company

Amoco Fabrics and Fibers Company is the only producer of both woven and nonwoven geotextile fabrics worldwide with manufacturing facilities in the U.S., Canada, Brazil, Scotland, England, Germany, and Australia. With U.S. manufacturing facilities in Roanoke, AL, Andalusia, AL, Bainbridge, GA, Nashville, GA, and Hazlehurst, GA, Amoco makes products ranging from carpet backing, carpet face yarns, industrial bags to nonwovens for hazardous waste landfill filtering and cushioning applications. These are just a few of the many varying applications in which Amoco is a leading supplier.

A.W. Olson is President of Amoco Fabrics and Fibers Company's North America operations located at:

900 Circle 75 Pkwy.
Suite 550
Atlanta, GA 30339

Amoco's nonwoven fabric manufacturing facility is located on Alma Highway in Hazlehurst, Georgia, 31539. The Plant Manager is Duke Campbell and Wesley Morrison is the Quality Control Manager. A complete history of Amoco Fabrics and Fibers is enclosed.

Amoco's nonwoven manufacturing process is a needle punched process which utilizes staple polypropylene fibers. The weight range of fabrics produced is 2.1 ounces per square yard to 20 ounces per square yard. The maximum continuous width for each product is 15 feet.

AMOCO WOVEN CONSTRUCTION FABRICS

Grab Tensile	ASTM-D-4632	lbs.	WARP 300 FILL 200	WARP 350 FILL 230	90	140	200	300	WARP 175	WARP 110 FILL 100
Grab Elongation	ASTM-D-4632	%	WARP 30 FILL 23	WARP 34 FILL 32	15	15	15	15	25	15
Mullen Burst	ASTM 3786	psi	450	510	200	350	400	600	300	275
Puncture	ASTM-D-4833	lbs.	120	140	30	70	90	120	80	60
Trapezoidal Tear	ASTM-D-4533	lbs.	WARP 75 FILL 65	WARP 75 FILL 65	30	45	75	120	50	50
UV Resistance	ASTM-D-4355*	%**	90	90	70 (200 hrs)	70	70	70	70	70
Abrasion Resistance (Strength retained)	ASTM-D-3884(1000 cycles-CS17 wheel)	lbs.	55	55	n/a	n/a	n/a	n/a	n/a	n/a
Apparent Opening Size (AOS)	ASTM-D-4751	US Sieve Number	30/50	70/100	30/70	30/70	30/70	30/70	30/50	20/30
Permittivity	ASTM 4491	gal/min/ft^2 sec^{-1}	50 .5	5 .04	2 .02	4 .04	4 .04	2 .02	30 .4	15 .2

*Fabric conditioned as per ASTM-D-4355.
**Percent of minimum grab tensile after conditioning.
Minimum roll average values.
Nonfunctional properties such as color, weight, and thickness are not shown.

Roll Width (ft.)	6	6	12.5	12.5	18	12.5	14.5	18	14.5	3.5	2.5	2	3
Roll Length (ft.)	450	450	720	504	350	504	435	350	310	150	150	1500	1500
Roll Diameter (in.)	12	12	13	11	10	13	12	11	12	8	8	8	8
Gross Weight (lbs.)	140	140	160	140	140	220	220	220	220	25	18	60	90
Area (sq.yd.)	300	300	1000	700	700	700	700	700	500	58	42	333	500

AMOCO FABRICS AND FIBERS COMPANY
900 Circle 75 Parkway, Suite 300
Atlanta, Georgia 30339
Telephone 404-984-4444

AMOCO
CONSTRUCTION
FABRICS

AMOCO NONWOVEN CONSTRUCTION FABRICS

Grab Tensile	ASTM-D-4632	lbs.	90	150	200	275	325	90	120
Grab Elongation	ASTM-D-4632	%	50	50	50	50	50	55	50
Mullen Burst	ASTM 3786	psi	250	350	450	>750	>750	215	300
Puncture	ASTM-D-4833	lbs.	65	90	130	200	250	60	90
Trapezoidal Tear	ASTM-D-4533	lbs.	45	65	80	115	130	35	45
UV Resistance	ASTM-D-4355*	%**	70	70	70	70	70	70	70
Apparent Opening Size (AOS)	ASTM-D-4751	US Sieve Number	70 min	70 min	70 min	70 min	70 min	n/a	n/a
Permittivity	ASTM-D-4491	gal/min/ft² sec⁻¹	100 .7	90 .7	80 .7	60 .7	50 .7	n/a	n/a
Permeability	ASTM-D-4491	cm/sec	.2	.2	.25	.15	.2	n/a	n/a
Asphalt Retention	TX DOT 3099	gal/yd² oz/ft²	n/a	n/a	n/a	n/a	n/a	.25 3.5	.35 4.5

*Fabric conditioned as per ASTM-D-4355.
**Percent of minimum grab tensile after conditioning.

Minimum Roll Average values.
Nonfunctional properties such as color, weight, and thickness are not shown.

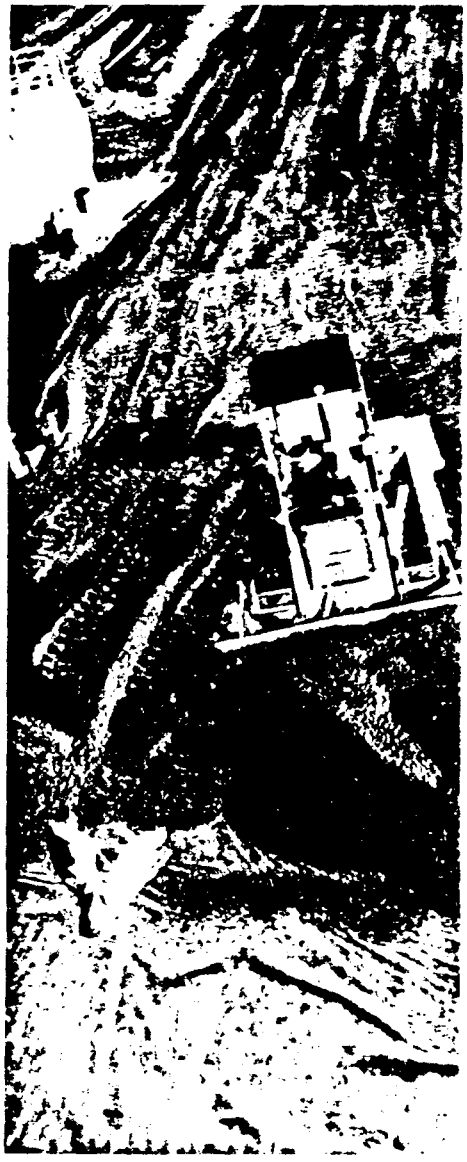
Roll Width (ft.)	15	15	15	15	15	12.5	12.5
Roll Length (ft.)	420	300	240	165	120	360	300
Roll Diameter (in.)	17	19	19	19	20	13	14
Gross Weight (lbs.)	210	200	215	220	220	155	170
Area (sq.yd.)	700	500	400	275	200	500	416

AMOCO FABRICS AND FIBERS COMPANY
900 Circle 75 Parkway, Suite 300
Atlanta, Georgia 30339
Telephone 404-984-4444

IND-WH1035 7/89 10,000

DU PONT

GEOTEXTILES FOR THE CONSTRUCTION INDUSTRY



SUPPORT

DRAINAGE

EROSION CONTROL

THE ADVANTAGES O

SUPPORT

STRUCTURAL

REINFORCEMENT

Increases the load-bearing capacity of the subsoil significantly.

Increases the load-spreading capability of the aggregate base; reduces rutting.

SEPARATION

Prevents contamination of the aggregate base by the subsoil, improves compaction.

DRAINAGE

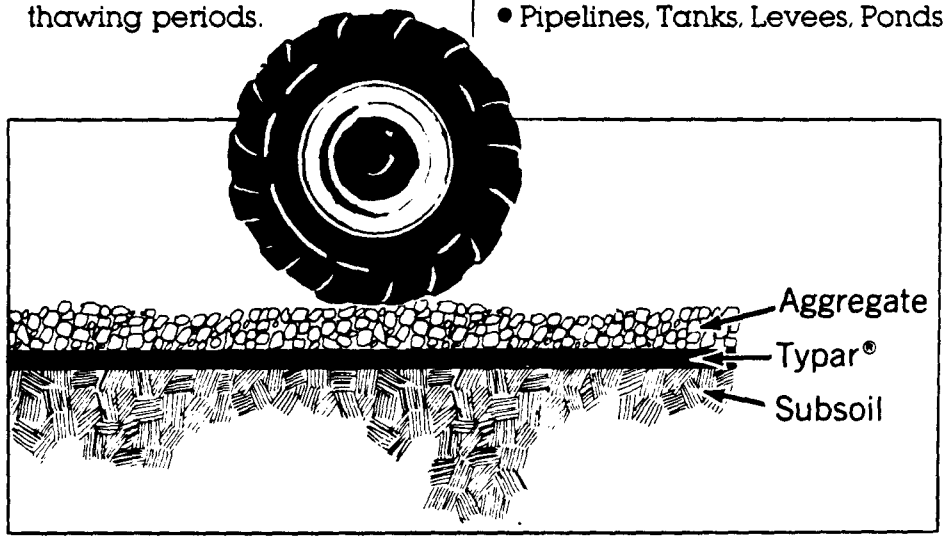
Permits lateral and vertical drainage of subsoil and aggregate base but retains solids.

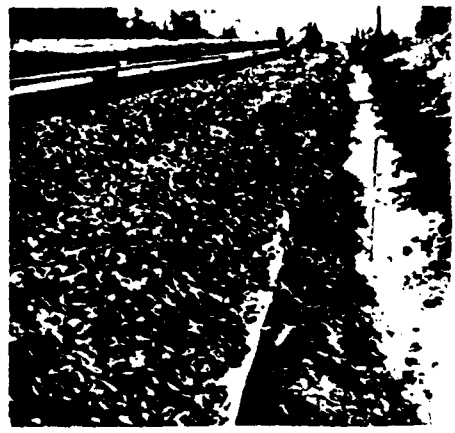
COST SAVINGS

- Permits significant savings in design depth of aggregate base and surface materials.
- Reduces maintenance costs of material, labor and equipment.
- Allows more efficient operation of equipment.
- Allows construction during inclement weather and thawing periods.

APPLICATIONS

- Roadways — Access, Haul, Permanent
- Parking Lots
- Storage Yards & Staging Areas
- Airport Runways & Taxiways
- Railroads
- Sports Facilities
- Pipelines, Tanks, Levees, Ponds





DU PONT TYPAR* GEOTEXTIL

DRAINAGE

STRUCTURAL

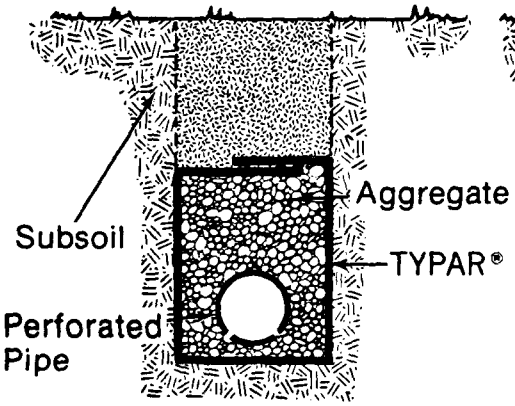
- Improves separation of subsoil and drainage aggregate preventing contamination.
- Allows free passage of water while retaining solids.
- Improves stabilization of drainage system and more quickly allows subsoil to become filter medium.
- Is more consistent in quality and more permeable than graded aggregate systems and sands.

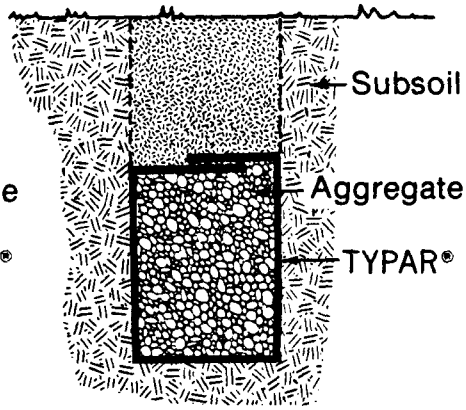
COST SAVINGS

- Eliminates need for costly sand filters and graded aggregate filters.
- Eliminates need for perforated pipes in certain situations.
- Permits faster and simpler construction methods by eliminating need for slant wall ditches and shoring.
- Increases life of drainage system significantly.
- Is more readily available than graded aggregate filters.

APPLICATIONS

- Highway Shoulder & Blanket Drains
- Railroad Shoulder & Blanket Drains
- Airport Drains
- Construction Site Drains
- Farm Field Drains
- Earth Dam Toe & Blanket Drains
- Building Foundation Drains
- Landscape Drains





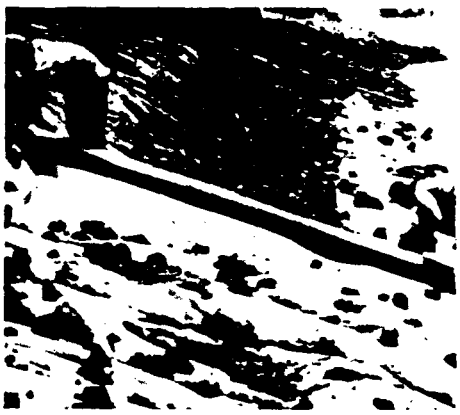
*Du Pont registered trademark. Only Du Pont makes TYPAR.

‹S FOR CONSTRUCTION

EROSION CONTROL

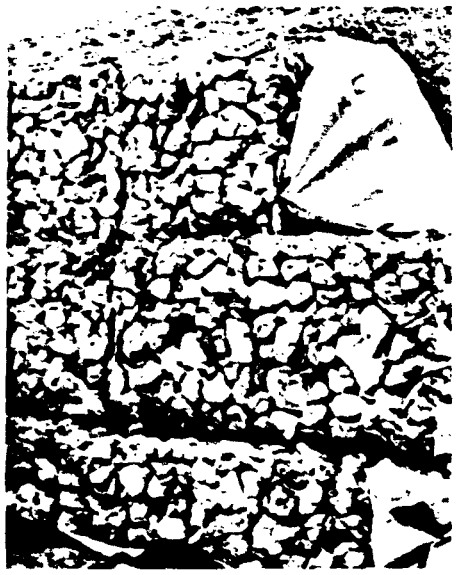
STRUCTURAL

- Is more consistent in quality than graded aggregate filters.
- Eliminates undermining of erosion control structures by better preventing piping and scouring of soils.
- Is more permeable than conventional drainage mediums thus eliminating hydrostatic pressure buildups that cause slides.
- More effectively absorbs and dissipates frontal water forces because of its excellent strength.
- Is a better filter in sediment control thus improving water quality.



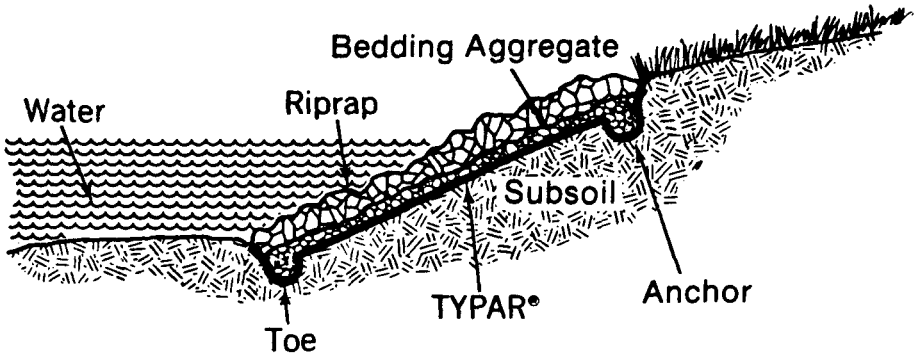
COST SAVINGS

- Easier to handle and more quickly installed than graded aggregate filters.
- Eliminates the need for costly graded aggregate filters.
- Offers more design flexibility than conventional filters; thus opportunities to reduce costs.
- Increases life and reduces maintenance of erosion control systems. Reduces loss of land.
- Is a less costly sediment control system than hay bales.



APPLICATIONS

- River, Lake & Pond Banks
- Levee Banks
- Highway & Railroad Cuts
- Ocean & Bay Shores
- Earth Dam Slopes
- Wall Construction
- Strip Mining Sites
- Construction Sites



TYPAR®

Physical Properties — Style 3401
Road Support, Soil Stabilization & Filter Fabric Applications

PROPERTIES & CHARACTERISTICS

-
-
-
-
-
-
-
-
-

Weight	4.0 oz./yd.^{2}	ASTM D1910-64 (1975)*
Thickness	15 mils	ASTM D1777-64 (1975)
Grab Tensile	150 lbs.	ASTM D1682-64 (1975)
Elongation at Break	78%	ASTM D1682-64 (1975)
Modulus	1200 lbs.	ASTM D1682-64 (1975)
Trapezoidal Tear	77 lbs.	ASTM D1117-80
Puncture Strength	43 lbs.	CW02215 (Nov. '77)
Mullen Burst	200 psi	ASTM D774-67 (1971)
Abrasion Resistance	44 lbs.	ASTM D1175-71
Specific Gravity	0.95	
Equivalent Opening Size (EOS)	70 to 100 U.S. Std. Sieve	Corps of Engineers/ CW02215 (Nov. '77)
Flux	270 gal./ft.^{2}/min.	EURM-100**
Coefficient of H_2O Permeability (K)	3 x 10^{-2} cm./sec.	EURM-100**

Shrinkage

270°F	1%
300°F	3%
340°F	Melts

NON-PROPRIETARY DESCRIPTION:

A sheet structure composed entirely of preferentially oriented isotactic polypropylene continuous filaments thermally bonded mostly at the crossover points and weighing 4.0 ± 0.3 oz./yd.^{2}.

PRODUCT RANGE — STYLE 3401

Width* (in.)	Roll Length** (yds.)	Roll Diameter (in.)	Roll Weight** (lbs.)	Roll Sq. Yds.**
151	100	9	115	420
197	100	9	145	547

TYPAR® support/filter fabric is made at a convenient mid-America manufacturing facility with worldwide stocking points and over 90 distribution locations in the United States. Call this toll-free number 800-441-7515, or Telex DUPEX 83-5420 for the name of your local distributor or for technical assistance to help you with a specific application.

TYPAR® Sales
Du Pont Company
Wilmington, DE 19898

Supac®

Phillips Fibers engineered geotextiles.

PHILLIPS 66 ENGINEERED GEOTEXTILES

Supac® saves you money now. And down the road.

Supac®

Supac geotextiles — engineered, proven money-savers.

Supac is the registered trademark for a broad range of needlepunched nonwoven and woven geotextiles manufactured and marketed by Phillips Fibers Corporation. Needlepunched nonwoven geotextiles are available in a wide range of weights up to sixteen (16) ounces per square yard. Woven geotextiles, both slit-film and monofilament, are also offered.

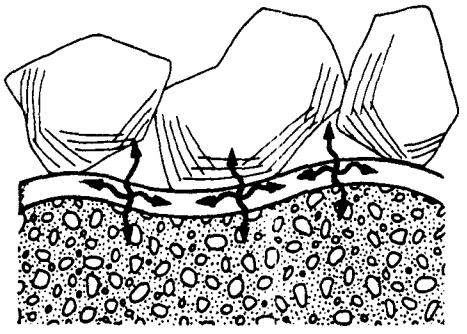
Nonwoven Geotextiles.

Supac N is manufactured with 100% man-made fibers which are mechanically interlocked by needlepunching and heat bonding. This proprietary process produces three dimensional geotextiles which are highly permeable, compact and extremely puncture resistant. Nonwoven Supac is made from polypropylene, a petrochemical based polymer that is essentially chemically and biologically inert. Supac will not decompose in soil due to bacterial or fungal action. In normal use it is unaffected by acids, alkalis, oils and most chemical solvents. Ultraviolet-light (UV) stabilized grades of Supac N are also available.

Needlepunched Nonwoven Geotextile (100 x)

Because Supac N has excellent drapability, puncture and abrasion resistance, it is an excellent geotextile for the drainage, embankment stabilization, protective liner and railroad trackbed stabilization end uses.

Supac N has the capability of passing water through the geotextile both normally and within the plane. The ability for water to pass through the geotextile normally is usually expressed as coefficient of permeability (cm/sec.) or flow rate (gal/sq. ft./min.).



Supac

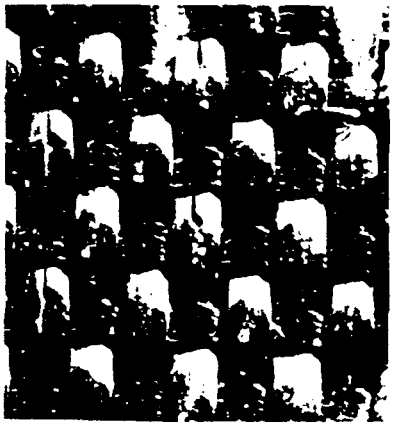
The geotextile's coefficient of permeability should always be greater than the coefficient of permeability of the soil being drained or separated; for critical drainage applications the geotextile's coefficient of permeability should be ten times the permeability of the soil medium.

Passage of water within the plane of Supac N is defined as lateral permeability or transmissivity and is expressed in units of cm/sec. Field evaluations indicate that transmissivity is an important attribute when a geotextile is used as a protective geomembrane liner and in the stabilization of railroad trackbeds.

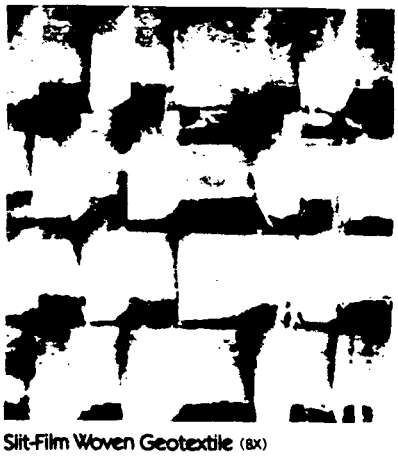
Typical properties of Supac N are shown on the technical data sheet contained in the inside back cover.

Woven Geotextiles.

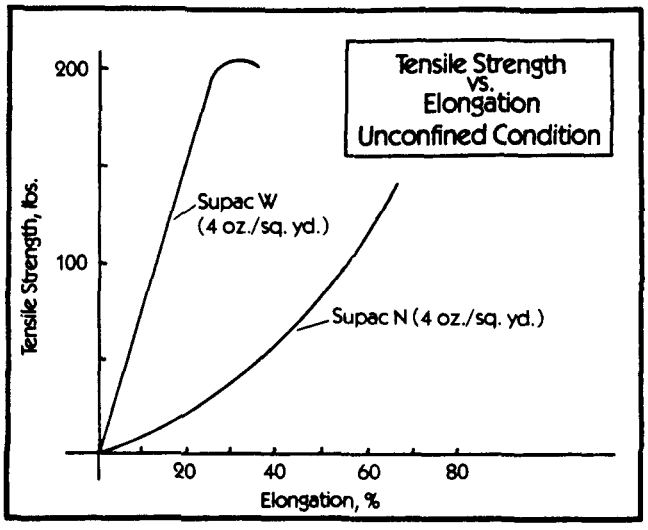
Supac W woven geotextiles are also manufactured from polypropylene. They are two-dimensional; this type of fabric is advantageous for soil reinforcement applications where tensile modulus is important. The two styles supplied are of slit-film and monofilament construction. The monofilament style geotextile is the more permeable of the two. All Supac W geotextiles are ultraviolet light (UV) stabilized.



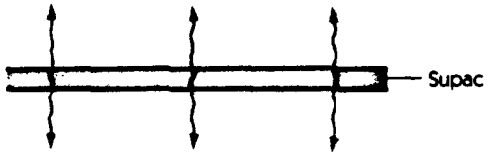
Monofilament Woven Geotextile (8x)



Slit-Film Woven Geotextile (8x)



This graph represents the typical stress-strain (tensile strength vs. elongation) curve for nominal 4.0 oz./sq. yd. slit-film woven (Supac 4WS (UV)) and needlepunched nonwoven (Supac 4NP) geotextiles. This graph was developed using values measured in the unconfined condition. Preliminary results from research currently being conducted indicate that the shape of the needlepunched nonwoven geotextile curve approaches that of the slit-film woven geotextile curve when the values are measured in the confined (surrounded by soil) condition.



Supac W being a two-dimensional geotextile, exhibits flow rate and coefficient of permeability properties, but does not pass water within its plane (transmissivity).

Typical properties of the Supac W product line are presented on the technical data sheet contained in the inside of this brochure's back cover.

SUPAC N

Typical Properties

PROPERTY	TEST PROCEDURE	4NP	4½NP	5NP	8NP	10NP	12NP	16NP	4½ NP (UV)	8NP (UV)	12NP (UV)
Weight, oz./sq. yd. (#)	ASTM D-3776	4.1	4.5	5.3	8.0	10.0	12.0	16.0	4.5	8.0	12.0
Thickness, mils.	ASTM D-1777	40	45	50	80	100	120	160	45	80	120
Tensile Strength, lbs.	ASTM D-1682	140	155	185	260	330	390	500	130	255	350
Elongation, %	ASTM D-1682	65	65	65	65	80	80	90	65	65	65
Puncture Strength, lbs.	ASTM D-751**	85	90	105	150	180	210	280	80	140	210
Mullen Burst Strength, psi	ASTM D-3786	275	285	335	450	575	700	850	260	450	700
Coefficient of Water Permeability, cm/sec.	Constant Head (50mm)	0.10	0.10	0.10	0.22	0.30	0.30	0.30	0.20	0.25	.030
Permittivity, $sec.^{-1}$	Coefficient of Permeability / Thickness	0.98	0.87	0.78	0.96	1.18	0.98	0.74	1.75	1.23	0.98
EOS*	Corps of Engineers CW-02215	70-100	70-100	70-100	70-100	70-100	80-140	80-120	70-100	70-100	70-100
Trapezoidal Tear Strength, lbs.	Proposed ASTM	75	90	100	140	170	210	270	70	140	200
Abrasion Resistance, lbs.	ASTM D-3884 Taber Test (1000 cycles, 1 kg. load/wheel)	35	35	65	150	200	235	370	35	135	200
Flow Rate, $gal./ft.^2/min.$	Constant Head (50mm)	105			125						
	Falling Head (200 to 100mm)	380			360						
Transmissivity, cm/sec.	@ 2 psi confining pressure	4.0×10^{-2}			1.3×10^{-1}						

SUPAC W

PROPERTY	TEST PROCEDURE	3WS (UV)	4WS (UV)	5WS (UV)	6WS (UV)	6WM (UV)	6WM(UV) Calendered
Weight, oz./sq. yd. (#)	ASTM D-3776	3.0	4.0	5.1	6.5	6.5	6.3
Thickness, mils.	ASTM D-1777	10	20	20	25	25	15
Tensile Strength, lbs.	ASTM D-1682	125	200	290	320	325	320
Elongation, %	ASTM D-1682	25	25	25	25	25	22
Puncture Strength, lbs.	ASTM D-751**	40	120	135	150	115	145
Mullen Burst Strength, psi	ASTM D-3786	230	400	500	650	375	500
Coefficient of Water Permeability, cm/sec.	Constant Head (50mm)	0.010	0.008	0.010	0.015	0.11	0.024
	Falling Head (200 to 100mm)	0.014	0.013	0.016	0.027	0.13	0.025
Flow Rate, $gal./ft.^2/min.$	Constant Head (50mm)	20	10	10	20	130	45
	Falling Head (200 to 100 mm)	50	45	50	75	365	130
EOS	Corps of Engineers CW-02215	40	40	70	45	35	50-80
Trapezoidal Tear Strength, lbs.	Proposed ASTM	60	105	110	130	110	90
Abrasion Resistance, lbs.	ASTM D-1175 Taber Test (1000 cycles, 1 kg. load/wheel)	–	–	80	110	150	135
Modulus (Tensile Strength at 10% Elongation) lbs.	ASTM D-1682	80	120	130	165	155	125
Open Area, %	Corps of Engineers Procedure AD-745-085	<1	<1	<1	<1	7-8	4-10

Notes: Typical is the average value for the warp and fill directions for the typical fabric weight.

* Samples are washed and allowed to dry before testing.

** Tension testing machine with ring clamp; steel ball replaced with a 5/16" diameter solid steel cylinder centered within the ring clamp.

Nominal weight of Supac; N-Nonwoven; P-Polypropylene; W-Woven; S-Slit-film; M-Monofilament.

Consult your sales engineer/representative or distributor if a minimum value is required or if clarification is needed relative to a SUPAC physical property or test procedure.

Printed September, 1985.

Product and packaging information

Availability: Supac is available from Regional Warehouses and Distributors located throughout the United States.

Packaging: Supac, except for some sewn fabric, is wound on a 4" (I.D.) disposable paper tube, and the fabric is wrapped with polyethylene film for protection.

Storage: For best results, protect rolls against sunlight and moisture by storing inside or placing on dunnage and covering with tarpaulin or other suitable material.

SUPAC N

STANDARD ROLL DIMENSIONS

	4NP	4½NP	5NP	8NP	10NP	12NP	16NP	4½NP (UV)	8NP (UV)	12NP (UV)
*Width, ft.	15	15	15	15	15	15	15	15	15	15
Length, ft.	300	300	300	150	150	150	99	300	150	150
Typical Gross Weight, lbs.	145	160	185	150	175	210	185	160	150	205
Square Yards	500	500	500	250	250	250	167	500	250	250

* Roll widths of Supac N (nonwoven geotextiles) less than 15' available upon request.

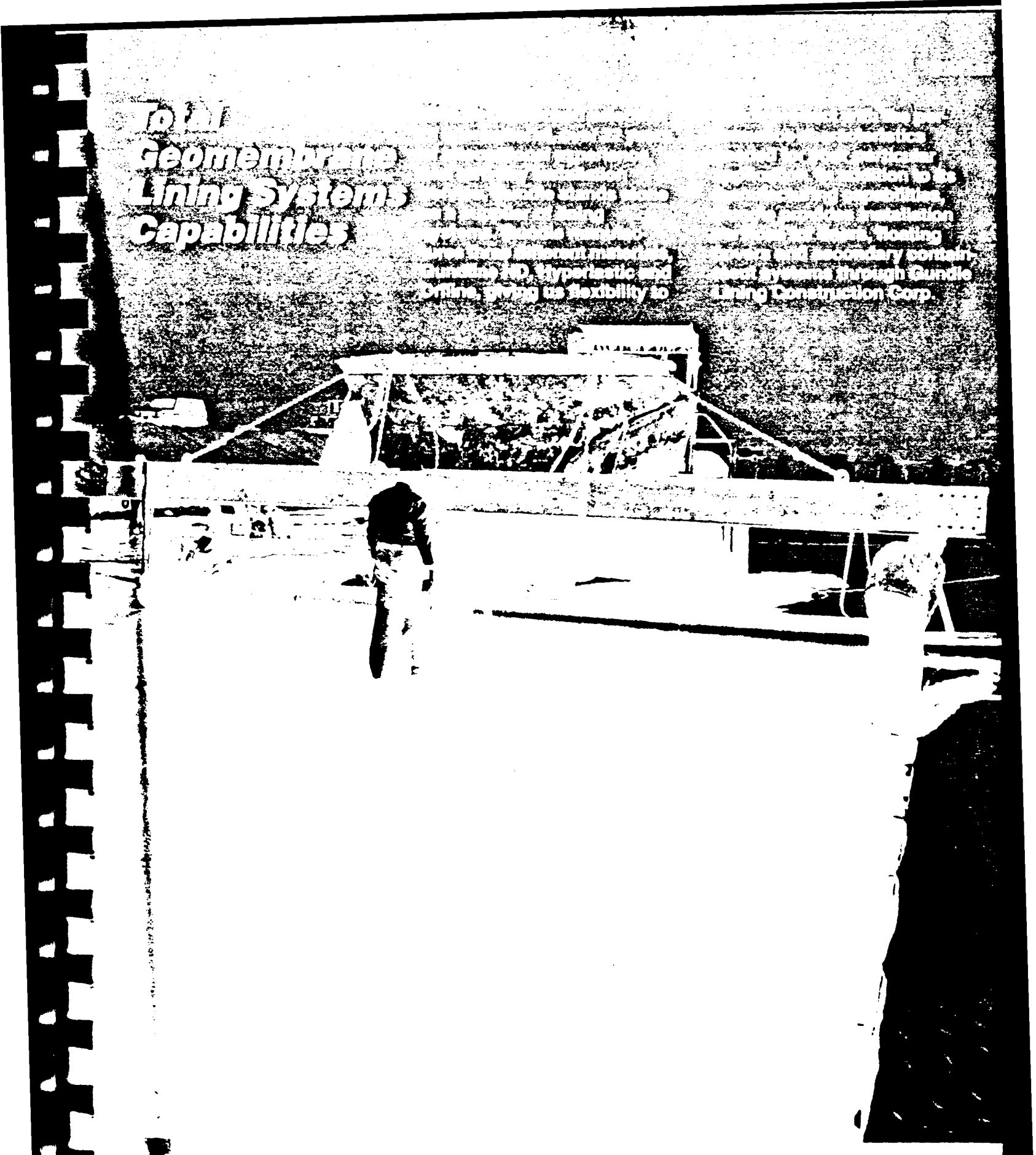
SUPAC W

	3WS (UV)	4WS (UV)	5WS (UV)	6WS (UV)	6WM (UV)	6WM(UV) Calendered
Width, ft.	3	15**	12½***	12½***	12½***	6***
Length, ft.	300	300	300	300	300	900
Typical Gross Weight, lbs.	20	145	175	220	190	245
Square Yards	100	500	500	500	417	600

** Roll widths up to 44' can be fabricated (sewn) prior to shipment.
*** Roll widths up to 49' can be fabricated (sewn) prior to shipment.

PHILLIPS 66
PHILLIPS FIBERS CORPORATION
A SUBSIDIARY OF PHILLIPS PETROLEUM COMPANY
ENGINEERED PRODUCTS MARKETING
P.O. BOX 66 GREENVILLE, SC 29602 (803) 242-6600

Geomembrane Product Information



Geomembrane Lining Systems Capabilities

Gundle Lining Systems Inc

Gundle®

Gundle Road
1340 E. Richey Rd.
Houston, Texas 77073
U.S.A.

Phone: (713) 443-8564
Toll Free: (800) 435-2008
Telex: 4620281 Gundle Hou
FAX: (713) 875-6010

A CLIFCOR... Company

In order to provide a guide for engineers seeking suitable plastic membranes for lining applications, this resistance guide has been tabulated from information both obtained from our own laboratories, as well as from a variety of other sources.

Our range of plastics are primarily inert, particularly stable, and contain no plasticizers. They exhibit a resistance to a wide range of chemicals. Chemical resistance refers to the liners' ability to withstand two main kinds of attack by chemicals. The one is their resistance to chemical attack and the other relates to their resistance to absorption and swelling and consequent weakening.

It is important to note that mixtures of chemicals do not necessarily have the same effect or lack of effect on a plastic than do each of the individual components. Chemical attack can be influenced by temperature, contact time, concentration and composition. **It is recommended that immersion tests be carried out at the design stage of the project in order to confirm the suitability of the type of membrane selected.**

GUNDLINE ® HD

CHEMICAL RESISTANCE RATING GUIDE – DATA BASED ON IMMERSION AT 25°C (77°F)

O — No effect
M — Moderate effect
S — Severe effect

	HD	DRI	HYP
WATER			
Distilled Water	O	O	O
Sea Water — Atlantic	O	O	O
Sea Water — Pacific	O	O	O
INORGANIC ACIDS			
Boric Acid (10%)	O	O	O
Chlorosulphonic Acid (10%)	S	S	S
Chromic Acid (10%)	O	S	S
Chromic Acids (Conc.)	M	S	S
Hydrochloric Acid (10%)	O	O	O
Hydrochloric Acid (Conc.)	O	M	M
Hydrofluoric Acid (Conc.)	O	M	M
Nitric Acid (10%)	O	O	O
Phosphoric Acid (Conc.)	O	O	M
Sulphuric Acid (10%)	O	O	O
Sulphuric Acid (Conc.)	M	M	M
INORGANIC BASES			
Ammonium Hydroxide (10%)	O	O	O
Ammonium Hydroxide (Conc.)	O	O	O
Barium Hydroxide (Conc.)	O	O	O
Calcium Hydroxide (10%)	O	O	O
Potassium Hydroxide (10%)	O	O	O
Sodium Hydroxide (10%)	O	O	O
Sodium Hydroxide (Conc.)	O	O	O
INORGANIC SALTS (25% Solution)			
Aluminum Chloride	O	O	O
Aluminum Sulphate	O	O	O
Ammonium Chloride	O	O	O
Ammonium Nitrate	O	O	O
Ammonium Phosphate	O	O	O
Barium Chloride	O	O	O
Barium Sulphide	O	O	O
Calcium Chloride	O	O	O
Calcium Hypochlorite	O	O	O
Cupric Chloride	O	O	O
Cupric Sulphate	O	O	O
Ferric Chloride	O	O	M
Ferric Nitrate	O	O	M
Ferrous Sulphate	O	O	O
Magnesium Chloride	O	O	O
Magnesium Sulphate	O	O	O
Nickel Sulphate	O	O	O
Potassium Chloride	O	O	O
Potassium Permangenate	O	O	S
Potassium Bisulphite	O	O	O
Potassium Dichromate	O	O	O
Sodium Borate (Borax)	O	O	O
Sodium Bicarbonate	O	O	O
Sodium Chloride	O	O	O
Zinc Chloride	O	O	O
Zinc Nitrate	O	O	O
Sodium Chloride – Saturated	O	O	O
ORGANIC ACIDS			
Acetic Acid (10%)	O	O	O
Acetic Acid (Glacial)	O	M	O
Chloracetic Acid (10%)	O	O	O
Citric Acid (10%)	O	O	O
Formic Acid (10%)	O	O	O
Lactic Acid (10%)	O	O	O
Oleic Acid (100%)	O	S	S
Oxalic Acid (10%)	O	O	O
Phenol (10%)	O	M	M
Phenol (100%)	O	S	S
Picric Acid (10%)	O	S	O
Stearic Acid (100%)	O	O	O
Tannic Acid (10%)	O	O	O
Tartaric Acid (10%)	O	O	O
ALCOHOLS			
Benzyl Alcohol	O	S	S
Ethyl Alcohol	O	M	O
Isopropyl Alcohol	O	M	O
Methyl Alcohol	O	M	O
Ethylene Glycol	O	O	O
Methyl Ethyl Ketone	O	M	S
Methyl Isobutyl Ketone	O	S	S
Glycerol	O	O	O
I-Hexanol	O	O	O
Resorcinol	O	O	O
ALDEHYDES			
Benzaldehyde	O	S	S
Butraldehyde	O	S	S
Furfural	O	S	S
AMINES			
Aniline	O	S	S
Triethanolamine	O	M	S
ESTERS			
Amyl Acetate	O	S	S
Dibutyl Sebacate	O	M	S
Dioctyl Phthalate	O	M	S
Ethyl Acetate	O	M	S
Tricresyl Phosphate	O	M	S
ETHERS			
Dibenzyl Ether	M	S	S
Diethylene Glycol Monobutyl Ether	M	S	S
Ethyl Ether	M	S	S
Ethylene Glycol Monoethyl Ether	M	S	S
HYDROCARBONS			
Benzene	M	S	S
Cyclohexane	M	S	S
Ethylbenzene	M	S	S
Heptane	M	S	S
Hexane	M	S	S
Napthalene	M	S	S
Toluene	M	S	S
Xylene	M	S	S
HALOGENATED HYDROCARBONS			
Benzyl Chloride	M	S	S
Bromobenzene	M	S	S
Carbon Tetrachloride	M	S	S
Chloroform	S	S	S
Ethylene Dichloride	S	S	S
Perchloroethylene	S	S	S
OTHER SUBSTITUTED HYDROCARBONS			
Carbon Disulphide	M	S	S
Nitrobenzene	O	S	S
KETONES			
Acetone	O	S	S
DETERGENTS & OTHER CLEANING PRODUCTS			
Calgonite (1%)	O	O	O
Chlorox (1%)	O	O	O
Chlorox (Conc.)	O	O	O
Joy (1%)	O	O	O
Joy (Conc.)	O	O	O
Lestoil (1%)	O	O	O
Lux Flakes (1%)	O	O	O
Rinse Dry (1%)	O	O	O
Rinse Dry (Conc.)	O	O	O
Tide (1%)	O	O	O
NATURAL FATS & OILS			
Butter	O	O	S
Castor Oil	O	O	S
Cottonseed Oil	O	O	S
Lard	O	O	S
Oleomargarine	O	O	S
Olive Oil	O	O	S
White Mineral Oil	O	O	S
OILS & FUELS			
A.S.T.M. No. 1 Oil	O	S	S
A.S.T.M. No. 2 Oil	O	S	S
A.S.T.M. No. 3 Oil	O	S	S
A.S.T.M. Fuel A	O	S	S
A.S.T.M. Fuel B	O	S	S
A.S.T.M. Fuel C	O	S	S
Heating Fuel Oil	O	S	S
Jet Aircraft Engine Oil	O	S	S
HYDRAULIC FLUIDS			
Oronite 8200	M	S	S
Pydraul F.9	M	S	S
Pydraul 60	M	S	S
Skydrol	M	S	S
Skydrol 500	M	S	S
MISCELLANEOUS			
Gelatine (sat. sol'n)	O	O	O
Glucose (sat. sol'n)	O	O	O
Tincture of Iodine	O	S	M
Prestone antifreeze	O	O	O
Dowgard antifreeze	O	O	O

The information and recommendations contained in this bulletin are based on data which we believe are reliable but all such information and recommendations are given without guarantee or warranty.

LITHO IN U.S.A. 8/85

Gundle Lining Systems Inc

Gundle

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

GUNDLINE® HD SPECIFICATIONS

PROPERTY	TEST METHOD	GAUGE (NOMINAL)					
		20 mil (0.5 mm)	30 mil (0.75 mm)	40 mil (1.0 mm)	60 mil (1.5 mm)	80 mil (2.0 mm)	100 mil (2.5 mm)
Density (g/cc) (Minimum)	ASTM D1505	0.94	0.94	0.94	0.94	0.94	0.94
Melt Flow Index (g/10 min.)	ASTM D 1238 Condition E (190°C, 2.16 kg.)	0.3	0.3	0.3	0.3	0.3	0.3
Minimum Tensile Properties (Each direction)	ASTM D638 Type IV Dumb-bell at 2 ipm.						
1. Tensile Strength at Break (Pounds/inch width)		80	120	160	240	320	400
2. Tensile Strength at Yield (Pounds/inch width)		50	70	95	140	190	240
3. Elongation at Break (Percent)		700	700	700	700	700	700
4. Elongation at Yield (Percent)		13	13	13	13	13	13
5. Modulus of Elasticity (Pounds/square inch)	ASTM D882	110,000	110,000	110,000	110,000	110,000	110,000
Tear Resistance Initiation (lbs Min.)	ASTM D1004 Die C	15	22	30	45	60	75
Low Temperature/ Brittleness	ASTM D746 Procedure B	−112°F	−112°F	−112°F	−112°F	−112°F	−112°F
Dimensional Stability (Each direction, % change max.)	ASTM D1204 212°F 1 hr.	±2	±2	±2	±2	±2	±2
Volatile Loss (Max. %)	ASTM D1203 Method A	0.1	0.1	0.1	0.1	0.1	0.1
Resistance to Soil Burial (Maximum percent change in original value)	ASTM D3083 using ASTM D638 Type IV Dumb-bell at 2 ipm.						
Tensile Strength at Break and Yield	% Change	±5	±5	±5	±5	±5	±5
Elongation at Break and Yield	% Change	±10	±10	±10	±10	±10	±10
Ozone Resistance	ASTM D1149 7 days 100 pphm, 104°F Magnification	No cracks 7 ×	No cracks 7 ×	No cracks 7 ×	No cracks 7 ×	No cracks 7 ×	No cracks 7 ×
Environmental Stress Crack (Minimum hours)	ASTM D1693 Condition C (100°C)	1500	1500	1500	1500	1500	1500
Puncture Resistance (Pounds)	FTMS 101B Method 2031	85	135	175	270	350	440
Water Absorption (Max. % Wt. change)	ASTM D570	0.1	0.1	0.1	0.1	0.1	0.1
Hydrostatic Resistance (Pounds/square inch)	ASTM D751 Method A Procedure I	160	240	315	490	650	810
Coefficient of Linear Thermal Expansion ($\times 10^{-4} \frac{cm}{cm \cdot °C}$) Nominal	ASTM D696	1.2	1.2	1.2	1.2	1.2	1.2
Moisture Vapor Transmission ($g/m^2 \cdot day$)	ASTM E96	0.06	0.05	0.04	0.03	0.02	0.01

PRODUCT DESCRIPTION

JOINING SYSTEMS

Critical to the success of any flexible membrane liner is the joining system. Gundle's patented Extrusion Welding System is used to join individual panels of GUNDLINE HD. Request your copy of the Gundle Extrusion Welding bulletin for complete details.

CHEMICAL RESISTANCE

GUNDLINE HD is resistant to a wide range of chemicals including acids, alkalis, salts, alcohols, amines, oils, and hydrocarbons. Since combinations of chemicals of different concentrations and temperatures have different characteristics, consult Gundle for specific application details. Write for Gundle's chemical compatibility information.

SUPPLY SPECIFICATIONS

The following describes standard roll dimensions for GUNDLINE HD.

THICKNESS		WIDTH		LENGTH		AREA		ROLL WEIGHT	
mil	mm	ft	m	ft	m	ft^2	m^2	lb	kg
20	0.5	22.5	6.86	1250	381	28,125	2613	2800	1272
30	0.75	22.5	6.86	840	256	18,900	1756	2800	1272
40	1.0	22.5	6.86	650	198	14,625	1359	2800	1272
60	1.5	22.5	6.86	420	128	9,450	878	2800	1272
80	2.0	22.5	6.86	320	98	7,200	670	2800	1272
100	2.5	22.5	6.86	250	76	5,625	522	2800	1272

GUNDLINE HD is rolled on 6" I.D. hollow cores.
Each roll is provided with 2 slings to aid handling on site.
Dimensions and weights are approximate. Custom lengths available on request.

Gundle Lining Systems Inc

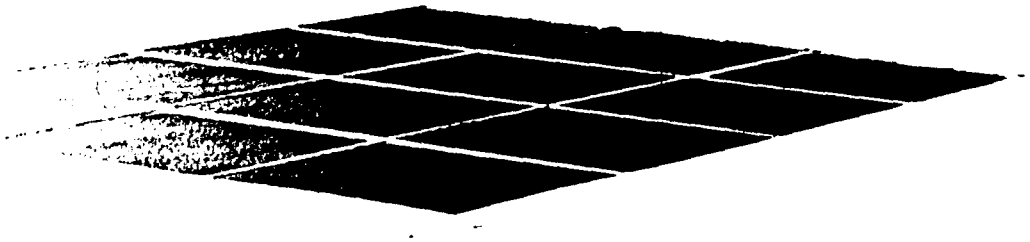
Gundle

Gundle Road
1340 E. Richey Road
Houston, Texas 77073
U.S.A.

Phone: (713) 443-8564
Toll Free: (800) 435-2008
Telex: 4620281 Gundle Hou
Fax: (713) 875-6010

POLY-FLEX™

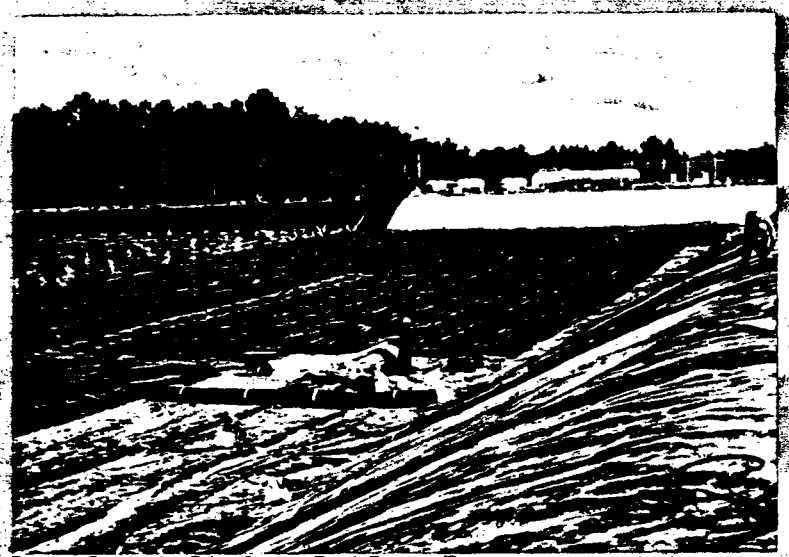
Polyethylene geomembranes
pollution abatement and water conservation.



Reservoirs
Man-made Lakes
Hazardous Waste Containment
Industrial Waste Lagoons
Evaporation Ponds
Irrigation Canals

POLY-FLEX™

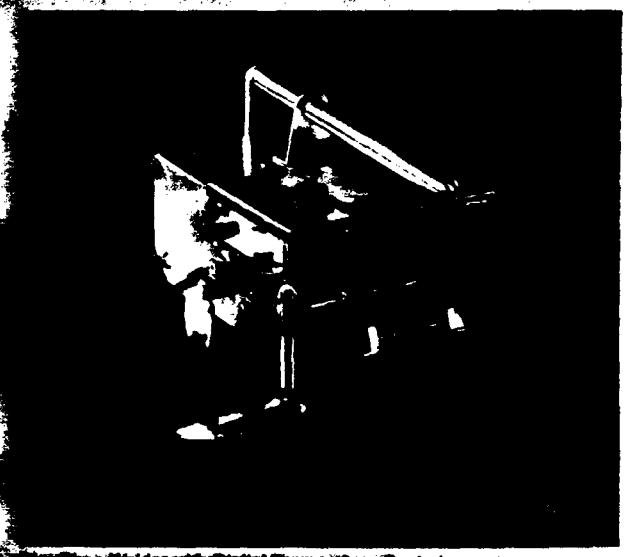
Polyethylene Geomembranes



Chevron Corporation Brine Storage Pond, Fannett, Texas

Eden Valley Stabilization Pond, Eden Valley, Minnesota / Engineer: Meyer, Borgman, Johnson

Eden Valley Stabilization Pond, Eden Valley, Minnesota / Engineer: Meyer, Borgman, Johnson



Hot Wedge Welder with Digital Temperature Control

An optimum combination of properties has established POLY-FLEX Geomembranes as an excellent liner with broad utility in the Hazardous Waste Containment Industry.

POLY-FLEX Geomembranes . . .
offer a cost effective method for lining environmental control and water conservation facilities.

POLY-FLEX Geomembranes . . .
prevent leachate and waste liquid components from leaking from impoundments, and subsequently entering and polluting ground water.

POLY-FLEX Geomembranes . . .
are compounded of special polymers providing the best protection to the site. A combination of good chemical resistance, high tensile strength, high environmental stress crack resistance, low permeability and high puncture resistance makes **POLY-FLEX** Geomembranes ecologically suitable for civil engineering applications.

POLY-FLEX Geomembranes . . .
are manufactured of materials that resist sunlight and leachate degradation. They are of sufficient strength and thickness to prevent failure due to physical stresses.

Proper installation is critical to the success of a liner. The **POLY-FLEX** process of seaming results in seams as strong as the geomembrane. This proprietary heat fusion seaming method assures long term, leak free containment.

POLY-FLEX™

Polyethylene Geomembranes

LINER-INDUSTRIAL WASTE COMPATIBILITIES

The table below indicates that **POLY-FLEX** Geomembranes are resistant to most acids, alkalies and hydrocarbons. In addition, **POLY-FLEX** does not contain plasticizers which tend to leach out and cause membrane failure.

	POLY-FLEX™	CSPE	PVC
ACIDS	■		
BASES	■		
HEAVY METALS	■		
ALIPHATIC HYDROCARBONS			
AROMATIC HYDROCARBONS			
CRUDE PETROLEUM			
ALCOHOLS	■		
SALTS	■		
ULTRAVIOLET	■		

■ = good □ = poor

		20 mil.	30 mil.	40 mil.	60 mil.	80 mil.	100 mil.
Density (g/cm³)	ASTM D1505	.940	.940	.940	.940	.940	.940
Tensile Strength at Break (Pounds/Inch Width)	ASTM D638	80	120	160	240	320	400
Tensile Strength at Yield (Pounds/Inch Width)	ASTM D638	50	75	100	150	200	250
Elongation at Break (%)	ASTM D638	750	750	750	750	750	750
Tear Resistance (Pounds Force)	ASTM D1004	30	45	60	90	120	150
Puncture Resistance (Pounds Force)	FTMS101B	100	150	200	300	400	500
ESCR (Hours to Failure)	ASTM D1693	1000 +	1000 +	1000 +	1000 +	1000 +	1000 +
Secant Modulus (Pounds/Inch²)	ASTM D638	80,000	80,000	80,000	80,000	80,000	80,000

Polyethylene Geomembranes

Poly-America was founded in 1975, offering plastic film products at competitive prices with personal service and on-time deliveries from our own fleet of trucks. We have one of the most modern film extrusion facilities in the U.S. with an annual capacity in excess of 200,000,000 pounds. Poly-America ships worldwide.

We are growing because our representatives are knowledgeable and their personal goals are to understand your environmental needs and to be supportive by ensuring technological input. Poly-America is still expanding and recently completed the addition of the world's largest blown film line.

The blown film line was designed to produce one of the widest seamless geomembranes in the United States: 24 feet by 80 mils thick.

SPECIFICALLY, THE EPA RECOMMENDS A MINIMUM OF 60 MIL SYNTHETIC LININGS FOR POLLUTION CONTROL.

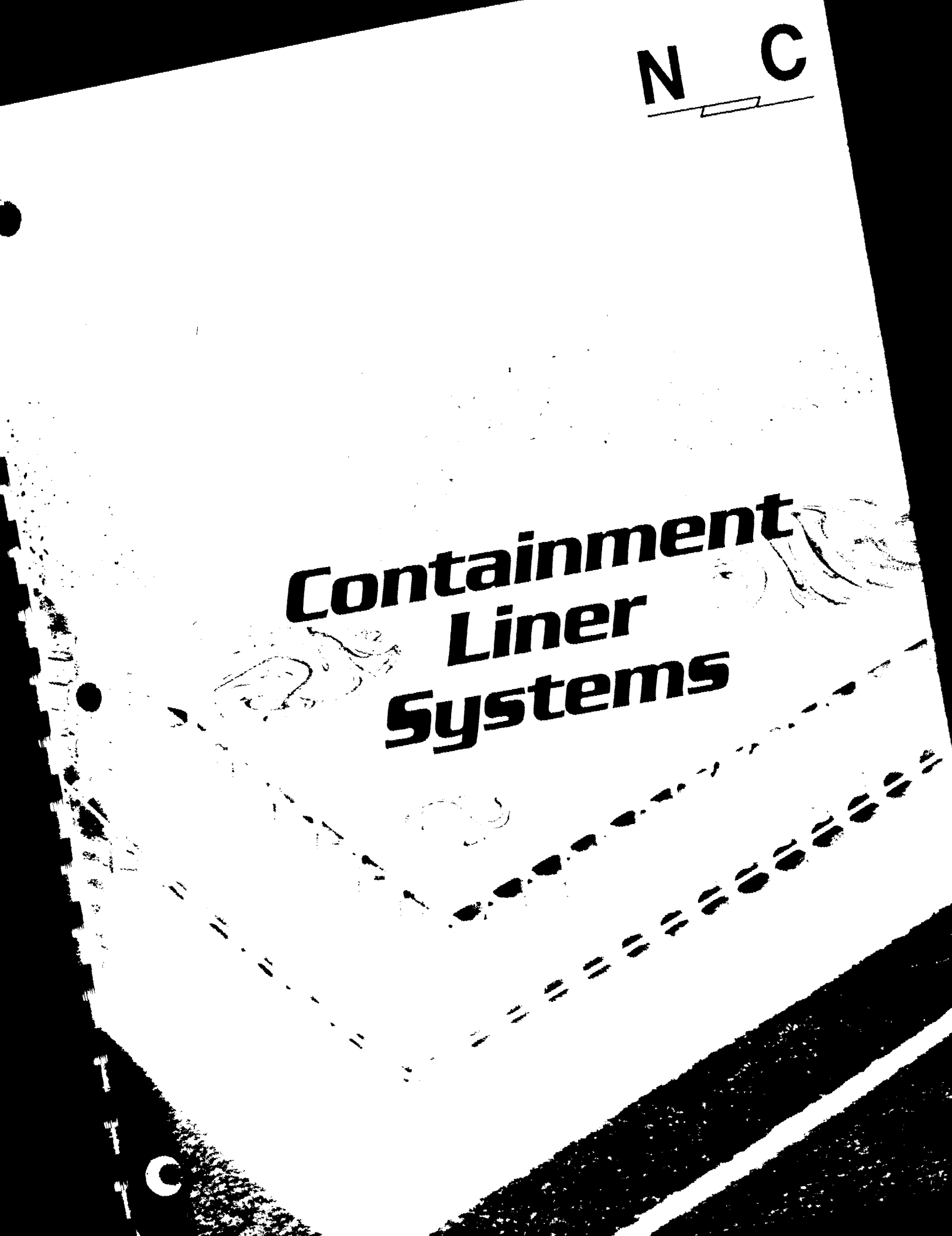
Poly-America provides all physical tests required to meet government and ASTM standards for ... membranes. Each ... material and tested to ... quality.

POLY-AMERICA Inc.

2000 W. Marshall Dr. • Grand Prairie, TX 75051 • (214) 647-4374 • 800-527-3322 • Telex 79-2851

N C

Containment Liner Systems



National Seal Company

Americans generate 160 million tons of solid waste material each year. That figure is on the rise. Disposal of solid waste material in a competent, responsible manner is one of the most important issues of our times. We do not want 20th century solid waste disposal to become our 21st century groundwater pollution problem.

National Seal Company is acutely aware of the importance of providing an effective barrier between solid waste material and the surrounding soil and groundwater. Whenever this country relies on land based waste disposal sites to contain our solid waste material, we must make a maximum effort to assure that the material is, in fact, contained. NSC has designed all of its products and installation services with that thought in mind.

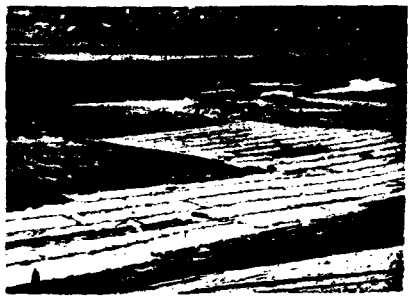
National Seal Company has installed flexible membrane liners, drainage nets and geotextiles at waste disposal sites throughout the United States and abroad. Because of our extensive experience, we know the issues that can arise and the obstacles that can occur when designing and constructing a waste disposal cell. We also know how to resolve those issues and overcome those obstacles. In fact, we have been doing it for more than 10 years for some of the leading waste management companies in the world. Over the years we have established a reputation for providing the highest quality products and the best installation service in the industry.

Applications

National Seal Company has broad experience in areas other than solid waste disposal sites. For example, National Seal Company has installed containment systems for:

- **Retention ponds and waste piles at superfund sites.**
- **Hazardous waste disposal sites.**
- **Specialized storage sites for industrial waste.**
- **Leach pads and retention ponds for mining applications.**
- **Potable water reservoirs.**
- **Wastewater treatment facilities.**

Whenever your application calls for containment, you should call for National Seal Company. We will be happy to assist you in any way we can, from the design stage all the way through turn-key installation by our highly qualified and experienced Construction Department. Chances are that we have encountered, and solved, whatever problem you are experiencing, or will experience, as you design and construct your site. And that includes the special problems associated with geomembrane installation at superfund sites under stringent HEALTH AND SAFETY PROTECTIVE PROVISIONS, installation at sites inaccessible by road and cold weather installation.



National Seal Company offers a full line of flexible membrane liners, drainage netting and geotextiles.

National Seal Company recently installed the world's largest flat sheet extruder for making HDPE geomembranes. On our sophisticated, computer monitored and controlled extrusion line we are able to produce geomembranes up to 15 feet wide in any thickness between 40 and 100 mils. And, our ± 3% typical variation on thickness is far superior to the industry standard 10% tolerance.

Our geomembranes are made of the highest quality, virgin resin. From this resin we produce an extremely strong, durable and chemically resistant liner. As a testament to its durability, HDPE geomembrane is the material of choice for use in hazardous waste disposal sites.

National Seal Company also manufactures Poly Net™, a drainage netting made of the same durable resin as our flexible membrane liner. Because of the identity of the resins used for the geomembrane and the drainage netting, you will always be assured that the geomembrane and netting supplied by National Seal Company are chemically compatible.

We make Poly Net by extruding strands of polyethylene into a diamond shaped net. This three dimensional structure has great strength and very high transmissivity even under high compressive loads.

It often happens that a layer of geotextile is added to a design to act as a filter for drainage netting or to act as a protective cushion underneath or above a geomembrane. Geotextile can effectively increase the puncture resistance of the liner system and can reduce the potential for geomembrane abrasion. The geotextile can also act as a pathway for escaping gas. Whenever your application calls for the use of a geotextile, we can supply you with materials manufactured to the same high standard of quality applicable to all NSC products.

HIGH DENSITY POLYETHYLENE | HDPE-40 MIL

PHYSICAL PROPERTIES

ALL PROPERTIES MEET OR EXCEED NSF STANDARD 54 SPECIFICATIONS FOR HDPE

PROPERTY	UNITS	TEST METHOD	VALUE
GAUGE OF MATERIAL	MILS	ASTM D 1593	40 (± 5%)
SPECIFIC GRAVITY, MINIMUM		ASTM D 792 A	0.94
MINIMUM TENSILE PROPERTIES		ASTM D 638	
TENSILE STRENGTH AT YIELD	PSI		2200
TENSILE STRENGTH AT BREAK	PSI		3800
ELONGATION AT YIELD	%		13
ELONGATION AT BREAK	%		600
MODULUS OF ELASTICITY	PSI		80,000
TEAR RESISTANCE, MINIMUM	PPI	ASTM D 1004	700
LOW TEMP. BRITTLENESS	DEG C.	ASTM D 746 B	−75° C.
SOIL BURIAL RESISTANCE MAX. CHANGE	%	ASTM D 3083[1]	
TENSILE STRENGTH AT YIELD			10
TENSILE STRENGTH AT BREAK			10
ELONGATION AT YIELD			10
ELONGATION AT BREAK			10
MODULUS OF ELASTICITY			10
ENVIRONMENTAL STRESS CRACK RES.	HRS.	ASTM D 1693[1]	1500
CARBON BLACK CONTENT	%	ASTM D 1603	2-3
CARBON BLACK DISPERSION	RATING	ASTM D 3015	A-2
MELT INDEX, CONDITION E, MAXIMUM	g/10m	ASTM D 1238	1.0
PUNCTURE RESISTANCE	LBS	FTMS 101, 2065	60
WATER VAPOR TRANSMISSION	g/M² hr.	ASTM E 96	0.008
HYDROSTATIC RESISTANCE	PSI	ASTM D 751 A	300

NATIONAL SEAL SEAMING PROPERTIES

BONDED SEAM STRENGTH, MINIMUM	PPI	ASTM D 3083[1]	80 & FTB[2]
SEAM PEEL ADHESION, MINIMUM	PPI	ASTM D 413[1]	60 & FTB[2]
SOIL BURIAL RESISTANCE		ASTM D 3083[1]	
BONDED SEAM STRENGTH, MAX. CHANGE	%		−10
SEAM PEEL ADHESION			FTB[2]

1. AS MODIFIED IN NSF STANDARD NUMBER 54.
2. FILM TEARING BOND.

NSC NATIONAL SEAL COMPANY

1255 MONMOUTH BLVD..
GALESBURG, IL 61401
800/323-3820
309/343-3418
309/343-1536 FAX