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Figure 1. Layfield's headquarters and manufacturing facility in Vancouver, Canada

Layfield Environmental Containment is a vertically integrated business involved in the manufacturing, fabrication, construction and maintenance of high performance geomembranes, floating covers and specialty geosynthetics. The company is active in multiple sectors including Oil & Gas, Water Management, Mining, Agriculture, Food and Construction & Infrastructure. Layfield does business throughout North America with a growing international business focused in Australia, South America and Asia.

SECTION 1 MANUFACTURING CAPABILITIES

Layfield is a leading supplier of extruded, fabricated and installed polymer based products. Layfield was originally established in the mid-1950s as a fabricated plastics business. In 1978, the current owners purchased Layfield and diversified the product line. Layfield has pursued an aggressive course of expansion through acquisitions, in-house developments and diversification.

We provide industry owners with single source accountability through our integration capabilities which combine geomembrane manufacturing, fabrication, construction and maintenance services.

The manufacture of geomembranes at Layfield is governed and controlled by our registered quality management system which meets the requirements of the ISO 9001:2008 standard. Each product is certified to meet published Minimum Average Roll

Value (MARV) specifications. Layfield can provide signed mill certificates for each lot of geomembrane produced, showing actual results for specified properties.

Layfield manufactures and supplies a full range of standard grade and specialty fortified geomembranes. Fortified geomembranes are defined as a product heavily treated with special stabilizers providing enhanced heat, UV stability and chemical resistance. Our Research and Technology Group is constantly developing innovative ways to enhance the quality of our existing products and develop new and more specialized products.

Layfield manufactures some of the industry's most popular brands of geomembranes including our Enviro Liner® and HAZGARD® geomembranes. Layfield is able to produce a variety of wide geomembrane widths and thicknesses designed both for prefabricated liners and field installed liners. Our co-extrusion process provides texturing capabilities and a variety of specialty skin colors

SECTION 2a

Vapor Flex™ Product Overview

VaporFlex™ has been designed to perform as an ultra low permeable vapor barrier that exceeds all ASTM E1745 Class A requirements. VaporFlex™ prevents the infiltration of moisture through concrete slabs and foundations, thus preventing mold formation and growth. Mold formation has become a major liability for both property owners and the construction industry in North America.

The Class A is ASTM's highest performance standard for "Water Vapor Retarders Used in Contact with Soil or Granular Fill Under Concrete Slabs." VaporFLEX™ vapor barriers are available in both a 15 mil and a 10 mil thick variation, each exceeding the physical requirements of ASTM E1745. They are available in easy-to-use rolls, 12' x 150' and 15' x 196' respectively, making them easy to transport and install.

VaporFlex™ is manufactured from a special blend of virgin polyolefin resins and additives. VaporFlex™ products are available in rollstock and are seamed in place using rugged VaporFlex™ polymer tape, providing "quick-stick" bonding. We also offer double-sided VaporFlex™ moldable sealant tape for attaching to foundations and other structures.

VaporFlex™ vapor barriers are placed underneath or around building foundations to prevent unwanted vapors from entering the building.

VaporFlex™ is simply unrolled in place to cover the entire area of the slab to be poured. All joints should be overlapped by six inches and then taped in place using VaporFlex™ polymer tape. If VaporFlex™ is run vertically along the walls of

VaporFlex™ Specifications			
Test	ASTM	VaporFlex™ 10	VaporFlex™ 15
Thickness (Nominal)	D5199	10 mil 0.250mm	15 mil 0.375mm
Baseline Water Vapor Permeance	E154 Section 7	0.044 Perms	0.020 Perms
Permeance After Wetting, Drying and Soaking	E154 Section 8	0.057 Perms	0.050 Perms
Tensile Strength After Soaking	E154 Section 9	62 ppi	64.9 ppi
Resistance to Puncture	E154 Section 10	3500 grams	2968 grams
Resistance to Plastic Flow and Elevated Temperature	E154 Section 11	0.067 Perms	0.026 Perms
Effect of Low Temperature Bending	E154 Section 12	0.068 Perms	0.038 Perms
Resistance to Organisms and Substrates in Contact	E154 Section 13	0.050 Perms	0.044 Perms
Roll Dimensions		15' X 196'	12' X 150'
¹ Properties tested by the CTT Group, not intended as minimum properties ² The Requirements of a Class A vapor retarder according to ASTM E1745 ³ ppi = pounds (force)/inch width			
<i>VaporFlex™ exceeds all Class "A" requirements for underground vapor barriers (ASTM E1745)</i>			

the foundation, tape the barrier in place using double-sided VaporFlex™ moldable sealant tape. Concrete can be poured directly onto the VaporFlex™ barrier if desired.

SECTION 2b
Vapor Flex™ Premium
Product Overview

VaporFlex™ Premium is a 7 layer co-extruded geomembrane barrier with ethylene vinyl alcohol (EVOH) core layer. The EVOH layer is designed to provide excellent barrier to methane, radon and other volatile organic compounds (VOCs) that exist naturally or is a result of an abandoned industrial/commercial facility suspected of polluting the soil due to hazardous waste. VaporFlex™ Premium is tested to a wide range of VOCs including benzene, toluene and xylene and is offered in 30, 40 and 60 mil thickness that permits its use in a broad range of geo-environmental applications.

EVOH is a flexible thermoplastic copolymer with excellent flex-crack resistance, and very high resistance to hydrocarbons, oils and organic solvents. It also has some of the best barrier properties to gases such as oxygen, methane, radon, nitrogen and carbon dioxide. EVOH is very versatile, making it one of the dominant barrier materials for a broad range of applications.

Due to its exceptional chemical resistance properties even a thin layer of EVOH can significantly reduce the transport of gases or liquids across the barrier film. Layfield VaporFlex Premium demonstrates highest level of barrier characteristics. The EVOH film is encapsulated between layers of polyolefin film to protect it from exposed elements.

VaporFlex™ Premium Specifications			
Test	ASTM	VaporFlex™ Premium 30 mil	VaporFlex™ Premium 40 mil
Thickness (Nominal)	D5199	30 mil 0.75 mm	40 mil 1.0 mm
Sheet Density (minimum)	D792	≤ 0.939 g/cc	≤ 0.939 g/cc
Melt Flow Index, G/10min. 190°C	D1238	≤ 1.0	≤ 1.0
Tensile Strength At Break (min. avg)	D638	99 ppi 17 N/mm	128 ppi 22 N/mm
Elongation at Break	D6693	550%	550%
Tear Resistance (min. avg)	D1004	22 lbs 100N	27 lbs 120N
Puncture Resistance (min. avg)	D4833	52 lbs 235 N	90 lbs 400 N
Carbon Black Content	D4218	2-3%	2-3%
Carbon Black Dispersion	D5596	Categories 1-2	Categories 1-2
High Pressure Oxidative Induction Time	D5885	400 mins	400 mins
Oxidative Induction Time	D3895	100 mins	100 mins
¹ Properties tested by the CTT Group, not intended as minimum properties ² The Requirements of a Class A vapor retarder according to ASTM E1745 ³ ppi = pounds (force)/inch width			
VaporFlex™ exceeds all Class "A" requirements for underground vapor barriers (ASTM E1745)			

Layfield believes, to the best of its knowledge, that specifications and recommendations herein are accurate and reliable. However, since site conditions and installations are not within control, Layfield does not guarantee results from use of the information provided and disclaims all liability from any loss or damage. No warranty expressed or implied is given.

What is the difference between VaporFlex™ and VaporFlex™ Premium?

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SECTION 3a Performance Properties VaporFlex™

General Chemical Notes: Radon Diffusion

Radon gas occurs naturally in the soil, a result of decomposing uranium in the ground. It has been detected across North America; some locations have higher concentration of Radon gas than others. It is therefore important to consider a Radon gas barrier that will restrict the movement of Radon gas into a building. Layfield recently tested our vapour barriers to Radon Gas and found that the rate of diffusion is significantly restricted by using our 10 mil and 15 mil VaporFlex. If Radon concentrations are higher, Layfield recommends considering a radon evacuation stack to lower radon gas levels in buildings.

The measurement of Radon gas permeance was performed in accordance with the requirements as stated in K124/02/95, method C of ISO/TS 11665/13.



Figure 3. VaporFlex™ finished installation

SECTION 3b

Performance Properties VaporFlex™ Premium

General Chemical Notes: Permeation Testing

Hydrocarbon Vapor Management often requires the use of a geomembrane to prevent the migration of hazardous vapors from one area to the next. Common vapors that are diverted are methane and other hydrocarbon vapors. The geomembrane can be placed under, or around buildings to prevent vapor infiltration, or along the outside of a property line (in a cut-off trench) to prevent migration of vapors onto (or off) site. In all cases where a geomembrane for vapor management is used, Layfield recommends that a vent be incorporated to provide a path for any accumulated vapors. Geomembranes are easily placed around the perimeter of contaminated sites, buildings, landfills, and other structures. Different geomembranes have characteristic diffusion rates for different chemicals. Layfield can provide chemical compatibility and vapor permeability testing to determine the appropriate vapor barrier material for a specific application. A vapor transmission test is recommended as part of the design process for any vapor management system. This section talks about our performance testing of liquids and gases through a vapor barrier film.

BTEX testing on VaporFlex Premium

BTEX is an acronym for hydrocarbon compounds that include Benzene, Toluene, Ethylbenzene, and Xylenes. BTEX is known to be highly volatile organic compounds and is the main source of ground contamination caused by petroleum related contamination. Because of their small molecular size and high solubility in water and soil, BTEX in their vapor form has the potential to permeate into buildings and other infrastructure that was built on contaminated land that was suspected of polluting due to presence of hazardous chemicals.

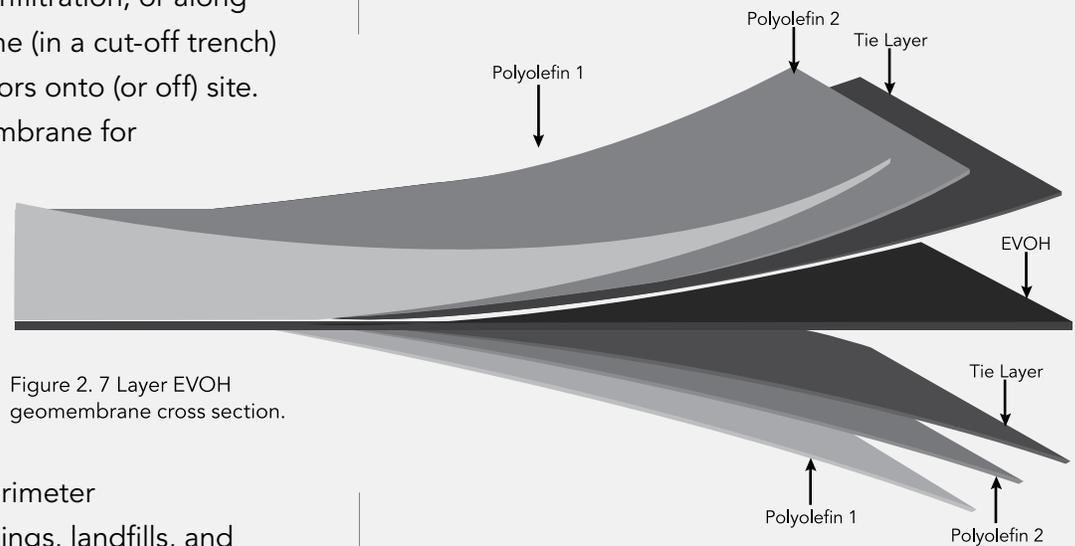


Figure 2.7 Layer EVOH geomembrane cross section.

The vapour transmission test was performed on VaporFlex premium using the ASTM D814 inverted cup method as a guide. The inverted cup method requires good sealing of the liner samples, to ensure good seal special perm cups were utilized that worked well. Table 1 presents the vapor transmission results performed on a 30 mil barrier film. For a 28 day test, the volumetric flow was measured to be less than 0.1 grams/m².hr; the hydraulic conductivity was calculated mathematically using the Darcian laws.

Table 1. BTEX Permeability Coefficients

Solvents	Hydraulic Conductivity
Benzene	5x10-14 m/s
Toluene	5x10-14 m/s
Ethylbenzene	5x10-14 m/s
P-Xylene	5x10-14 m/s
O-Xylene	5x10-14 m/s

Tested on our 30 mil VaporFlex™ Premium Geomembrane

Methane Transmission

Contaminated sites presents hazard in the form of material that has the potential to harm. For example, a landfill site where large quantiles of organic matter decomposes over period of time to form methane can cause both odor and health issues for the nearby community. Methane is also generated naturally and any dwellings build on it needs to be assessed and proper systems needs to be put in place to mitigate the methane from the building envelop. Layfield tested gas transmission tests to measure the volumetric flow of methane across the vapour barrier. The tests

were performed in accordance with ASTM 1434 using 99% methane and test temperature was maintained at 40C. The methane transmission was measured at 2.72x10-4 cm3.mil/cm2.day which is significantly lower than a HDPE geomembrane.

Oxygen Permeation

EVOH is most well-known and most commonly used for its gas barrier properties, particularly as an Oxygen barrier. The oxygen barrier properties of EVOH is orders of magnitude higher than commonly used polyolefin resins and even medium barrier polymers like polyamide (PA) and polyethylene terephthalate (PET). The table summarizes some common gases and their transmission rates through the EVOH barrier film.

Gas	EVOH	HDPE
Nitrogen	0.019	190
Oxygen	0.25	2300
Carbon Dioxide	0.6	17526
Sulfur Dioxide	0.3	21844

Table 2. Volumetric permeation rate in cc.20µ/m2.day.atm; Source: Kuraray



SECTION 4

Major Applications

Brownfields

A brownfield is a property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant. According to US EPA, it is estimated that there are more than 450,000 brownfields in the U.S alone. Cleaning up and reinvesting in these properties increases local tax bases, facilitates job growth, utilizes existing infrastructure, takes development pressures off of undeveloped, open land, and both improves and protects the environment. The U.S EPA has announced Cleanup grants that provide funding for a grant recipient to carry out cleanup activities at brownfield sites.

Landfill Liners and Covers

The type of hazardous waste can pose significant challenges to landfill design and operation. Often in a hazardous waste facility there will be a landfill for solids, and a pond to collect the leachate that may be produced by the landfill. Layfield can provide lining of the highest quality for all of these applications. Our VaporFlex Premium 7 layer EVOH barrier has very good resistance to landfill leachate and can significantly reduce the volumetric flow of chemicals and solvents into the ground.

The decomposition that occurs inside a landfill system can release nasty odors into the nearby environment affecting local communities. Our VaporFlex Premium 7 layer EVOH barrier will not only capture the gages but will restrict its movement across the barrier to reduce or eliminate odors.

Layfield provides geomembrane containment systems for many hazardous waste applications including the containment of liquid or solid hazardous wastes. In hazardous waste applications a double lined system is often needed. Layfield can assist with the design of multiple lined systems including the geomembrane layers, the drainage systems, and the connections to piping and structures.

Odor Control Floating Cover

Floating covers control odors from waste water and manure ponds by preventing the evaporation of volatile ingredients into the atmosphere. By keeping ammonia, hydrogen sulfide and other odor causing chemicals trapped in the water, the VaporFlex Premium is an effective floating cover to prevent odors from leaving the property.

Geofoam Protection

EPS geofoam can be damaged when exposed to certain hydrocarbon chemical and needs to be protected. Some common solvents that can dissolve geofoam include:

- Gasoline
- Diesel
- Other Petroleum Based Fuel
- Organic Fluids





SECTION 7

ASTM E 1745 Class A Vapor Barrier Selection

Why the ASTM Standard

In 1996, ASTM recognized the need for standardizing vapor barriers placed below slab by enacting ASTM E1745. The standard assures specific vapor retarders must meet minimum values to ensure that they meet high performance standards; and that the vapor barrier performs as intended as per the design life of the building or structure. The CLASS A standard provides the best characteristics of low permeability, resistance to puncture, tearing and chemical and / or environmental attack.

VaporFlex® CLASS A Vapor Barrier

VaporFlex® is extremely durable to ensure it withstands the rigors of the installation. The true permeability of a vapor barrier is the laboratory test results minus any installation damage. This is why the VaporFlex® has been designed to have extremely high tensile and more importantly, high puncture resistance. VaporFlex® vapor barriers are produced from the highest quality North American produced polymer resins. Virgin polymer resins also ensure the VaporFlex® is highly resistant to organisms and substrates that will come in contact with the vapor barrier, resistant to cold and high temperatures and offer very low permeability values. There are NO reprocessed or recycled materials in any of the VaporFlex® products.

Selecting and Specifying a CLASS A Vapor Barrier

Specifying and selecting a CLASS A vapor barrier brand is very important. Many of the company's that own a brand name vapor barrier do NOT manufacture their own product. Rather, they subcontract out the manufacturing to various plastic

producers across the country. The brand's owner then surrenders their control over the products QA/QC to the individual manufacturing plant(s). This leaves the quality assurance and quality control testing in the hands of the manufacturer of the product, not the company that owns the brand. This can lead to inconsistent product quality from one production run to another, and from the one manufacturing plant to the other.

Layfield manufactures 100% of all the VaporFlex® vapor barrier produced ensuring the manufacturing of every single roll is completed with strict adherence to a registered quality management system that meets the requirements of the ISO 9001:2008 standard. Layfield can produce a complete audit trail from resin specifications to production run test results, in addition to the accredited third party testing.

Layfield's manufacturing plant is equipped with the most up to date modern technology for the manufacturing of flexible polymer films. Layfield Poly Films has recently upgraded (2005) its manufacturing facility with a new state of the art co-extrusion line to complement the variety of new mono-layer extrusion lines.

SECTION 10

Installation Instructions

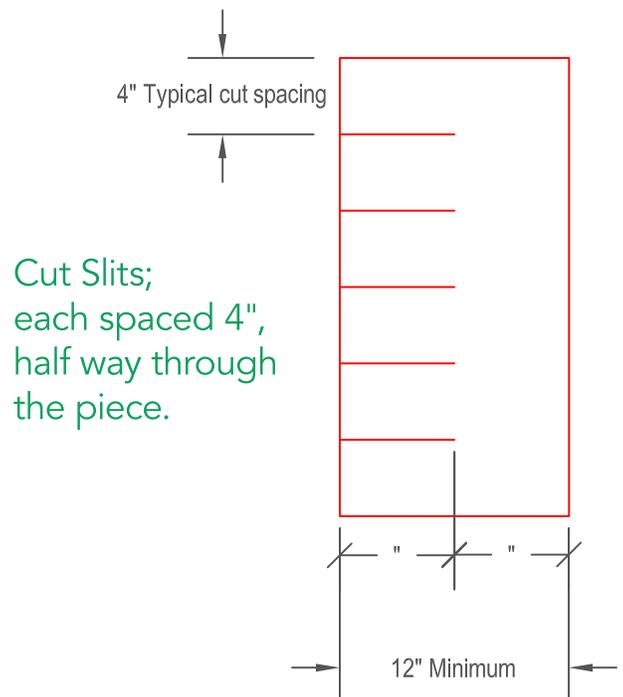
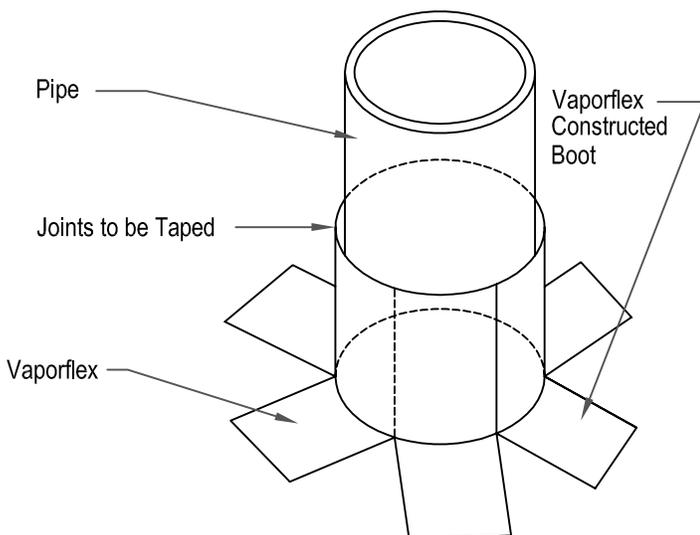
1. Where appropriate, install VaporFlex® vapor barriers in accordance with ASTM E 1643-98 (Standard Practice for Installation of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs)
2. The granular base needs to be compacted and graded in accordance with the projects plans & specifications. The base should be free of all protruding objects and debris.
3. VaporFlex® should be unrolled parallel to the direction that the concrete will be poured. After unrolling, pull out the folds to the full roll width. The vapor barrier should be left deployed in a relaxed state. Overlap all seams a minimum of 6" and continuously seal the overlap with 4" VaporFlex® Tape. The VaporFlex® needs to be lapped over footings or sealed to the foundation wall. All other penetrations like columns and utilities need to also be sealed.
4. Seam surface area should be clean and dry to optimize the integrity of the seam adhesion.

5. Care needs to be taken at all times to protect the VaporFlex® from damage during the installation of the reinforcing steel, utilities and during the concrete pour. It is important not to drive stakes through the VaporFlex®. In the event a repair is required on the VaporFlex® as a result of damage done during one of these processes, ensure the repair patch material is the same VaporFlex® material. All repair patches must have round edges and overlap the repair area by a minimum of 150mm (6"). Seal the patch with VaporFlex® tape.

Sealing VaporFlex® Around Penetrations

Option 1: Constructing Boots from VaporFlex® Material

1. Cut a piece of VaporFlex® at least 12" wide and long enough to wrap around the circumference of the pipe at least 1.5 times
2. Make cuts in the VaporFlex® every 4" along the



length, if the piece is 12" wide cut the slits into the piece 6", or halfway across the material.

3. Wrap the solid section of the VaporFlex® around the pipe, fanning out the 4" slit sections at 90 degrees over the installed vapor barrier.

4. Tape the boot in place to the installed vapor barrier, and to the penetrating pipe, using VaporFlex® tape.

Option 2: Purchase Prefabricated Pipe Boots

Layfield can offer preformed pipe boots made with VaporFlex® polyethylene (black in color), to seal around penetrations of the following diameters:

2"
4" to 6"
6" to 8"
8" to 10"
10" to 12"

Contact your Layfield Representative for more information on prefabricated pipe boots.

