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Standard Guide for Selecting Test Methods for Experimental Evaluation of Geosynthetic Durability[1]

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1. Scope

1.1 This guide covers a designer/specifier through a systematic determination of those factors of the appropriate application environment that may affect the post-construction service life of a geosynthetic. Subsequently, test methods are recommended to facilitate an experimental evaluation of the durability of geosynthetics in a specified environment so that the durability can be considered in the design process.

1.2 This guide is not intended to address durability issues associated with the manufacturing, handling, transportation, or installation environments.

1.3 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D1204 Test Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature

D1987 Test Method for Biological Clogging of Geotextile or Soil/Geotextile Filters

D2990 Test Methods for Tensile, Compressive, and Flexural Creep and Creep-Rupture of Plastics

D3083 Specification for Flexible Poly(Vinyl Chloride) Plastic Sheeting for Pond, Canal, and Reservoir Lining (Withdrawn 1998)[3]

D4355/D4355M Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus

D4439 Terminology for Geosynthetics

D4594/D4594M Test Method for Effects of Temperature on Stability of Geotextiles

D4716/D4716M Test Method for Determining the (In-plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head

D4833/D4833M Test Method for Index Puncture Resistance of Geomembranes and Related Products

D4886 Test Method for Abrasion Resistance of Geotextiles (Sand Paper/Sliding Block Method)

D5101 Test Method for Measuring the Filtration Compatibility of Soil-Geotextile Systems

D5262 Test Method for Evaluating the Unconfined Tension Creep and Creep Rupture Behavior of Geosynthetics

D5322 Practice for Laboratory Immersion Procedures for Evaluating the Chemical Resistance of Geosynthetics to Liquids

D5397 Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test

D5496 Practice for In Field Immersion Testing of Geosynthetics

D5567 Test Method for Hydraulic Conductivity Ratio (HCR) Testing of Soil/Geotextile Systems

D5721 Practice for Air-Oven Aging of Polyolefin Geomembranes

D5970/D5970M Test Method for Deterioration of Geotextiles from Outdoor Exposure

D6992 Test Method for Accelerated Tensile Creep and Creep-Rupture of Geosynthetic Materials Based on Time-Temperature Superposition Using the Stepped Isothermal Method

D7238 Test Method for Effect of Exposure of Unreinforced Polyolefin Geomembrane Using Fluorescent UV Condensation Apparatus

D7361 Test Method for Accelerated Compressive Creep of Geosynthetic Materials Based on Time-Temperature Superposition Using the Stepped Isothermal Method

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] The last approved version of this historical standard is referenced on www.astm.org.

TABLE 1 Functions^{A} and Other Performance Characteristics^{B}

Containment^{B} (C)—A geosynthetic provides containment when it encapsulates or surrounds materials such as sand, rocks, and fresh concrete.^{C}

Filtration^{A} (F)—A geosynthetic performs the filtration function when the equilibrium geotextile-to-soil system allows for adequate liquid flow with limited soil loss across the plane of the geotextile over a service lifetime compatible with the application under consideration.

Fluid Barrier^{A} (FB)—A geosynthetic performs the fluid barrier function when it essentially eliminates the migration of fluids through it.

Fluid Transmission^{A} (*a.k.a. drainage*)—A geosynthetic performs the fluid transmission function when the equilibrium geotextile-to-soil system allows for adequate flow with limited soil loss within the plane of the geotextile over a service lifetime compatible with the application under consideration.

Insulation^{B} (I)—A geosynthetic provides insulation when it reduces the passage of heat, electricity, or sound.

Protection^{A} (P)—A geosynthetic, placed between two materials, performs the protection function when it alleviates or distributes stresses and strains transmitted to the material to be protected.

Reinforcement^{A} (R)—A geosynthetic performs the reinforcement function when it provides often synergistic improvement of a total system's strength created by the introduction of a tensile force into a soil (good in compression but poor in tension) or other disjointed and separated material.

Screening^{B} (Scr)—A geosynthetic, placed across the path of a flowing fluid (ground water, surface water, wind) carrying particles in suspension, provides screening when it retains some or all soil fine particles while allowing the fluid to pass through. After some period of time, particles accumulate against the screen which requires that the screen be able to withstand pressures generated by the accumulated particles and the increasing fluid pressure.

Separation^{A} (S)—A geosynthetic placed between dissimilar materials so that the integrity and functioning of both materials can remain intact or be improved performs the separation function.

Surface Stabilization^{B} (SS)—A geosynthetic, placed on a soil surface, provides surface stabilization when it restricts movement and prevents dispersion of surface soil particles subjected to erosion actions (rain, wind), often while allowing or promoting vegetative growth.

Vegetative Reinforcement^{B} (VR)—A geosynthetic provides vegetative reinforcement when it extends the erosion control limits and performance of vegetation.

^{A} Functions are used in the context of this guide as terms that can be quantitatively described by standard tests or design techniques, or both.
^{B} Other performance characteristics are qualitative descriptions that are not yet supported by standard tests or generally accepted design techniques.
Note—during the placement of fresh concrete in a geotextile flexible form, the geosynthetic functions temporarily as a filter to allow excess water to escape.

D7406 Test Method for Time-Dependent (Creep) Deformation Under Constant Pressure for Geosynthetic Drainage Products
G160 Practice for Evaluating Microbial Susceptibility of Nonmetallic Materials By Laboratory Soil Burial

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions relating to geosynthetics used in this standard, refer to Terminology D4439.

4. Summary of Guide

4.1 The effects of a given application environment on the durability of a geosynthetic must be determined through appropriate testing. Selection of appropriate tests requires a systematic determination of the primary function(s) to be performed and the associated degradation processes that should be considered. This guide provides a suitable systematic approach.

4.2 Primary functions of geosynthetics are listed and defined in Table 1. With knowledge of the specific geosynthetic application area and end use, the corresponding primary function(s) is (are) identified. Table 2 gives degradation concerns as they relate to geosynthetic functions. Table 3 gives the environmental elements that relate to the various degradation processes and the currently available ASTM Committee D35 test method for the experimental evaluation of specific types of geosynthetic degradation. The following appendixes are included to provide background information:

X1. Terminology
X2. Application/End Use/Primary Function Tables
X3. Example of Test Method Selection Procedure
X4. Design-by-Function Discussion
X5. Commentary on Geosynthetic Durability
X6. Bibliography

5. Significance and Use

5.1 Designers/specifiers of geosynthetics should evaluate geosynthetic durability as an integral part of the geosynthetic specification/selection process. This guide is intended to guide a designer/specifier through a systematic determination of degradation concerns based on the intended geosynthetic function or performance characteristic. This guide then provides a guide to select available test methods for experimentally evaluating geosynthetic durability and to identify areas where no suitable test exists.

5.2 This guide does not address the evaluation of degradation resulting from manufacturing, handling, transporting, or installing the geosynthetic.

6. Suggested Procedure

6.1 To utilize a structured procedure for selecting appropriate test methods, the geosynthetic designer/specifier must have knowledge of:

6.1.1 The intended geosynthetic application,

6.1.2 The end use of the geosynthetic via its primary function(s) or performance characteristic(s), or both,

6.1.3 The specific environment to which the geosynthetic will be exposed,

6.1.4 The types of geosynthetics that may or will be used, and

6.1.5 The duration or time of use (that is, service life).

6.2 With this knowledge, the designer/specifier follows the following procedure:

6.2.1 Identify the primary function(s) or performance characteristic(s), or both, to be performed by the geosynthetic in the specific application and end use intended. Functions and performance characteristics are defined in Table 1. (Tables for guidance in identifying primary function(s) and performance characteristics are given in Appendix X2.)

6.2.2 Using Table 2, identify the potential degradation process(es) that will almost always (denoted as "A") or sometimes (denoted as "S") be of concern when a geosynthetic performs the primary function(s) or provides the performance characteristic(s), or both, which were identified in 6.2.1. Appendix X1 contains associated notes to Table 2 that help to identify the process(es) that is (are) sometimes a concern in the specific expected application environment.

TABLE 2 Geosynthetic Function/Durability Assessment[A]

Function	Abbreviation	Potential Degradation Process[B]: Biological Degradation	Chemical Degradation	Chemical Dissolution	Clogging/Piping	Creep	Environmental Stress Cracking	Hydrolysis	Mechanical Damage	Photo-Degradation	Plasticization	Stress Relaxation	Temperature Instability	Thermal-Degradation	Explanations of Primary Long-Term Concerns
Containment	C	P[C,D]	S[E]	S[E]	S[F]	S[G]	N	S[H]	S[I]	S[J]	N	S[G]	N	S[K]	Remain intact and maintain filtration performance
Filtration	F	P[C,D]	S[E]	S[E]	A[L]	S[M]	N	S[H]	S[I]	S[J]	N	S[M]	N	S[K]	Maintain design filtration and resist deformation and intrusion
Fluid Barrier	FB	S[C]	S[E]	S[E]	N	S[G]	A[N,O]	S[H]	S[I]	S[J]	N	S[G]	S[P]	S[K]	Maintain intended level of essential impermeability
Fluid Transmission	FT	P[C,D]	S[E]	S[E]	A[Q]	A[R]	A[O]	S[H]	S[I]	S[J]	N	A[R]	N	S[K]	Maintain flow under compressive loads
Insulation	I	P[C,D]	S[E]	S[E]	N	N	N	N	N	N	N	N	N	N	Minimize temperature losses and gains across geosyn
Protection	P	P[C,D]	S[E]	S[E]	N	S[S]	N	S[H]	N	S[J]	N	S[S]	N	S[K]	Maintain protective performance
Reinforcement	R	P[C,D]	S[E]	S[E], P[T]	N	A[U]	P[O]	S[H]	P[T]	S[J]	P[V]	S[U]	S[U]	S[K]	Provide necessary strength, stiffness and soil interaction
Screening	Scr	P[C,D]	S[E]	S[E]	S[W]	N	N	S[H]	S[I]	S[J]	N	N	N	S[K]	Maintain filtration performance and resist deformation
Separation	S	P[C,D]	S[E]	S[E]	N	N	N	S[H]	P[X]	S[J]	N	N	N	S[K]	Remain intact
Surface Stabilization	SS	P[C,D]	S[E]	S[E]	N	N	N	S[H]	A[Y]	A[Y]	N	N	N	S[K]	Remain intact to resist erosive forces until vegetation is established
Vegetative Reinforcement	VR	P[C,D]	S[E]	S[E]	N	N	N	S[H]	A[Y]	A[Y]	N	N	N	S[K]	Remain intact throughout vegetation

[A] Refer to Appendix X1 for terminology relating to Table 2.
[B] M = Not a generally recognized concern; S = Sometimes a concern; A = Almost always a concern; P = Potential concern being researched.
[C] Microorganisms have been known to attack and digest additives (plasticizers, lubricants, emulsifiers) used to plasticize some base polymers. This attack will change physical and mechanical properties. Study is needed to determine relevance to polymers incorporated into geosynthetic products. Embrittlement of geosynthetic surfaces may influence interaction properties.
[D] Microbial enzymes have been known to initiate and propagate reactions deteriorative to some base polymers. Study is needed to determine relevance to polymers used in geosynthetic products.
[E] Chemical degradation or dissolution, or both, including the leaching of plasticizers or additives from the polymer structure, may be a concern for some geosynthetics exposed to liquids containing unusually high concentrations of metals, salts, or chemicals, especially at elevated temperatures.
[F] If select fill is not available, then a clogging resistance test should be performed with the job-specific soil.
[G] Geosynthetics in containment structures which require long-term strength characteristics should be designed using appropriate creep and stress relaxation criteria.
[H] Hydrolysis may be a concern for polyester (PET) and polyamide (PA) geosynthetics exposed to extreme pH conditions, especially at elevated temperatures.
[I] When subject to rocking (abrasion), puncture (floating or airborne debris), or cutting (equipment or vandalism).
[J] When permanently exposed or in extended construction phases (>2–4 weeks) and in "wrap-around" construction, photo degradation may be a concern for the exposed geosynthetic.
[K] Geosynthetics in applications such as dam facings and floating covers which results in exposure to temperatures at or above ambient must be stabilized to resist thermal oxidation.
[L] Clogging resistance of geotextiles can only be assessed by testing with site-specific soil and (sometimes) liquid.
[M] If a filter geotextile is used with a geonet, it is important to assess short-term extrusion and long-term intrusion into the net.
[N] Residual stresses and surface damage may produce synergistic effects with other degradation processes.
[O] Polyethylene geosynthetics may experience slow crack growth under long-term loading conditions in certain environmental conditions.
[P] Excessive expansion and contraction resulting from temperature changes may be a concern for geosynthetics without fabric reinforcement.
[Q] Composite drains must resist clogging due to soil retention problems and intrusion of filter medium.
[R] Geosynthetics relying on a 3D structure to facilitate flow must demonstrate resistance to compression creep.
[S] Sufficient thickness must be maintained by a protective layer over an extended period of time.
[T] Chemical dissolution of, or mechanical damage to geosynthetic surfaces or coatings may affect their interaction properties, that is, lead to surface or joint slippage.
[U] Geosynthetics creep and stress relax at different rates depending primarily on manufacturing process, polymer type, load levels, temperature, and application.
[V] Plasticization may be a concern for polyester (PET) geosynthetics exposed to humid conditions or polypropylene and polyethylene geosynthetics exposed to hydrocarbons while under stress.
[W] If the screen is expected to operate indefinitely, then clogging should be assessed often. Commonly, screens are considered temporary.
[X] Holes resulting from mechanical damage may alter the effectiveness of separators.
[Y] Always exposed, therefore resistance to photo oxidation and mechanical damage must be determined.

6.2.3 Using Table 3, select the test method(s) that applies to the potential degradation process(es) identified in 6.2.2 as a concern(s) in the specific application environment expected.

NOTE 1—Guidance is given in Table 3 to identify the most important elements or variables relating to each degradation process.

TABLE 3 Environmental Factors of Degradation

NOTE 1—This table provides the standard test methods current at the time of the writing of this guide. ASTM standards are in constant development, review, revision, and replacement. It is the responsibility of the geosynthetic specifier to identify the most current applicable standard test method. Refer to Appendix X1 for terminology relating to Table 3.

Potential Degradation Process	Environmental Elements Relating to Degradation											Test Methods Relating to Geosynthetics	
	Air Chemistry	Fluid Content	Geometry of Exposure	Liquid Chemistry	Macro-Organisms	Micro-Organisms	Radiation	Soil Chemistry	Stress	Temperature of Exposure	Time of Exposure		
Biological degradation	X	X			X	X		X		X	X	G160	Microbiological attack (in soil)
Chemical degradation				X				X		X	X	D5322	Chemical immersion
												D5496	*In-situ* immersion
Chemical dissolution				X				X		X	X	None	Effect of solvents
Clogging/piping		X		X		X		X		X	X	D5567	
												D5101	Gradient ratio
												D1987	Biological clogging
												None	Precipitate clogging
Creep			X						X	X	X	D5262	Tension
												D2990	Time-temperature superposition
												D6992	Accelerated tensile creep
												D7406	Compressive creep
												D7361	Accelerated compressive creep
Environmental stress cracking	X			X				X	X	X	X	D5397	Stress cracking and appendix
Hydrolysis		X		X				X		X	X	None	Effect of water
Mechanical damage			X						X		X	D4886	Abrasion
												None	Fatigue
												D4833/D4833M	Puncture
Photo-degradation	X						X			X	X	D4355/D4355M	Xenon arc
												D5970/D5970M	Outdoor exposure
												D7238	Fluorescent UV
Plasticization		X		X						X	X	None	Effect of liquids
Stress relaxation			X						X	X	X	None	
Temperature instability										X	X	D4594/D4594M	Temperature instability
												D1204	Temperature instability
Thermal degradation	X						X			X	X	D5721	Effect of heat

7. Keywords

7.1 aging; degradation; durability; environment; exposure; geosynthetic; long-term performance

APPENDIXES

(Nonmandatory Information)

X1. TERMINOLOGY

X1.1 The *application environment* in which a geosynthetic is placed can be characterized by the following environmental elements:

Air Chemistry
Fluid Content
Geometry of Exposure
Liquid Chemistry
Organisms (micro- and macro-)
Radiation
Soil Chemistry
Stress
Temperature of Exposure
Time of Exposure

X1.1.1 *Air chemistry* shall include the identification of the following characteristics of the gases expected to be present or created, or both:

Oxygen content
Gaseous pollution (for example, NO_x, SO_2)
Ozone

Organics (for example, methane)

X1.1.2 *Fluid content* is a measure of the amount of liquid or vapor, or both, which is in the environment immediately surrounding the geosynthetic.

X1.1.3 *Geometry of exposure* may be described by:
Angle of exposure
Degree of exposure (surface versus complete)

X1.1.4 *Liquid chemistry* shall include the identification of the following characteristics of the ground water or leachate:
pH
Electrolytic conditions
Dissolved/suspended minerals
Chemicals
B.O.D., C.O.D.
D.O.

X1.1.5 *Macroorganisms*—Those which are or could be present in the environment shall be identified. Macroorganisms such as insects, rodents and other higher life forms shall be considered.

X1.1.6 *Microorganisms*—Those which are or could be present in the environment shall be identified. Possible microorganisms included:
Bacteria
Fungi
Algae
Yeast

X1.1.7 *Radiation* shall be considered as including:
Ultraviolet Radiation
Ionizing Radiation
Infrared and Visible Radiation

X1.1.8 *Soil chemistry* shall include the identification of the following characteristics of the soil or waste:
Transition Metals
Soluble Minerals
Polarizability
Clay Mineralogy

X1.1.9 *Stress* shall be focused upon mechanical forces applied externally to the geosynthetic/soil system, resulting in tensile compressive or shear stresses, or both, on the geosynthetic. Stresses on the geosynthetic shall be described by:
Normal stresses
Planar stresses
Surface stresses
Intensity of stresses
How stresses vary with time (static, dynamic, periodic)
How stresses are distributed over the geosynthetic

X1.1.10 *Time of exposure* shall be defined by the duration of exposure to any specific set of environmental elements.

X1.1.11 *Temperature of exposure* shall be defined as the temperature of the geosynthetic, which is not necessarily that of the surrounding medium.

X1.2 The *effects* of the application environment are characterized by the following degradation processes:

Biological Macro- and Micro-Degradation	Mechanical Damage
Chemical Degradation	Oxidative Degradation
Chemical Dissolution	Photo Degradation
Clogging	Plasticization
Creep	Stress Relaxation
Environmental Stress Cracking	Temperature Instability
Hydrolysis	Thermal Degradation

X1.2.1 *Chemical degradation* is the reaction between a chemical(s) and a specific chemical structure within a polymer resulting in chain scission, and a reduction in molecular weight and physical properties.

X1.2.2 *Chemical dissolution* is the physical interaction between a solvent and polymer whereby the polymer absorbs the solvent, swells, and eventually dissolves.

X1.2.3 *Clogging* is the collection of soil particles, microbiological growth, precipitates, or combinations thereof on or within the geosynthetic, altering its initial hydraulic properties.

X1.2.4 *Creep* is the time-dependent part of a strain resulting from an applied stress.

X1.2.5 *Environmental stress cracking* is the deterioration of a polymer's mechanical properties that occurs when cracks created by high stress concentrations are exposed to certain environmental conditions.

X1.2.6 *Hydrolysis* is the degradative chemical reaction between a specific chemical group within a polymer and absorbed water causing chain scission and reduction in molecular weight.

X1.2.7 *Macrobiological degradation* is the attack and physical destruction of a geosynthetic by macroorganisms leading to a reduction in physical properties.

X1.2.8 *Microbiological degradation* is the chemical attack of a polymer by enzymes or other chemicals excreted by microorganisms resulting in a reduction of molecular weight and changes in physical properties.

X1.2.9 *Mechanical damage* is the localized degradation of the in-service geosynthetic as a result of externally applied load—abrasion, fatigue, and puncture are examples.

X1.2.9.1 Discussion—*Construction damage* is excluded, but is an important consideration in geosynthetic selection.

X1.2.10 *Oxidation* is the chemical reaction between oxygen and a specific chemical group within a polymer converting the group into a radical complex which ultimately leads to molecular chain scission or crosslinking, thus changing the chemical structure, physical properties, and sometimes appearance of the polymer. Oxidation can occur during photo or thermal degradation, or both.

X1.2.11 *Photo degradation* is the change in chemical structure resulting in deleterious changes to physical properties and sometimes appearance of the polymer as a result of the irradiation of the polymer by exposure and light.

X1.2.12 *Plasticization* is the physical process of increasing the molecular mobility of a polymer by absorption or incorporation of material(s) of lower molecular weight. The effects are usually reversible when the material(s) are removed.

X1.2.13 *Stress relaxation* is the decrease in stress, at constant strain, with time.

X1.2.14 *Thermal degradation* is the change in chemical structure resulting in changes in physical properties, and sometimes appearance of a polymer caused by exposure to heat alone.

X1.2.15 *Temperature instability* is the change in appearance, weight, dimension, or other property of the geosynthetic as a result of low, high, or cyclic temperature exposure.

X1.3 *Aging* is the alteration of physical, chemical, and mechanical properties caused by the combined effects of environmental conditions over time. The following tests have been utilized or considered to simulate some of these conditions.

Accelerated Soil Burial Testing (Specification D3083)
Environmental Stress Rupture (Withdrawn)
Environmental Stress Cracking (Test Method D5397)
Radiation, Moisture, and Heat Exposure (Test Method D4355/D4355M)
Xenon Arc

X1.3.1 Aging can manifest itself in numerous ways, including:

Blistering
Chalking
Changes in Chemical Resistance
Changes in Puncture, Burst, or Tear Resistance, or other index properties
Crack Propagation
Delamination
Dimension Changes
Discoloration
Embrittlement
Loss of Gloss
Permeability Changes
Stiffness Changes
Surface Cracking
Surface Crazing
Tensile or Compressive Elongation Changes
Tensile or Compressive Modulus Changes
Tensile or Compressive Strength Changes

X1.4 *Geosynthetic Polymers*—The following polymeric materials are the most widely used in the manufacture of currently available geosynthetics.

Acrylics—latex geogrid coatings
Bitumen—geogrid coatings
Chlorinated Polyethylene (CPE)
Chlorosulfonated Polyethyelene (CSPE)
Polyamide (PA)—principally polycaprolactam (nylon 6).
Polyester (PET)—principally polyethylene terephthalate
Polyethylene (PE)—including a range of densities.
Polypropylene (PP)
Polystyrene (PS)
Poly (vinyl chloride) (PVC)—both plasticized (geomembranes and geogrid coatings) and rigid (geopipe).
Polyurethane (PUR)
Ethylene Interpolymer Alloy (EIA)

X2. APPLICATION/END USE/PRIMARY FUNCTION

X2.1 See Tables X2.1-X2.5.

X3. TEST METHOD SELECTION PROCEDURE – EXAMPLE

X3.1 *Problem*—Select the appropriate standard test methods to assess the durability characteristics of a geotextile to be used as a filter over a geonet in the leachate collection layer of a 30-acre double-lined landfill.

X3.1.1 The landfill will be filled in two years. During filling, the geotextile will be fully exposed above the level of filling.

X3.1.2 The design life of the facility is 30 years.

X3.2 *Selection Procedure:*

X3.2.1 *Application:* Landfill (See Table X2.3)
End Use: Filter for Leachate drain
Primary Function(s): Filtration, Separation

X3.2.2 *Function:* Filtration (See Table X2.3)
Potential Degradation Processes:

Mechanical Damage (Sometimes)[4]
Thermal-Oxidation (Sometimes)[5]
Photo-Oxidation (Sometimes)[6]
Hydrolysis (Sometimes)[7]
Chemical Degradation (Sometimes)[8]
Biological Degradation (Potential being Researched)[9,10]
Creep (Sometimes)[11]
Clogging (Always)

Function: Separation

[4] No rocking, puncture, or cutting is expected because of a thick operational cover layer. Therefore mechanical damage is not a concern.
[5] Extended exposure is expected. Therefore, a test is required.
[6] Extended ultraviolet exposure is expected. Therefore a test is required.
[7] Extreme pH conditions are not expected. Therefore hydrolysis is not a concern.
[8] Unknown, complex leachate is expected. Therefore a test is required.
[9] Research topics. Not a documented concern at this time.
[10] Research topics. Not a documented concern at this time.
[11] Since the geotextile will be used over a geonet, extrusion and intrusion should be investigated.