Design & Installation Specification

Specification for an AgriShield® Based Geosynthetic Lining System in Farm Dairy Effluent (FDE) Ponds

1. Introduction
Viking Containment has produced this specification to provide information and advice about AgriShield® based geosynthetic lining systems for use in Farm Dairy Effluent (FDE) ponds. The information in this document can be used in conjunction with the Dairy NZ Farm Dairy Effluent Design Code of Practice and Farm Dairy Effluent Design Standards, which guide designers through the process of developing an FDE system. Together, these documents will help you to make informed decisions to ensure the best long-term results for your project.

2. Background
Geosynthetics have been used extensively in landfills, mining operations and water applications such as wastewater treatment ponds, canal and reservoir liners for many years. More recently, usage has expanded into the containment of animal waste in various agricultural applications. The containment properties of geomembrane are superior to clay lining systems. AgriShield® HDPE lining systems offer excellent permeability, chemical resistance and durability. There has also been a marked increase in environmental awareness and responsibility in business, and with the increased size of many animal farms, companies are seeking more environmentally friendly options for treating and managing animal waste products. Geosynthetics can prevent environmental concerns such as surface and groundwater contamination, algae blooms and improve the management of FDE.

3. Gathering Information
In the first stage, the following site specific information should be collected:-

1. Environmental Conditions:
   - Site layout, water tables, location of waterways, soils and climatic information

2. Regulatory Requirements:
   - Regional Council requirements
   - Resource Consent Conditions
   - Food Safety requirements
   - Supply Contract requirements

3. Farm Management Information
To calculate the effluent loading the following items need to be considered:
   - Herd size at peak milking
   - Wash water use
   - Milking schedule
   - Feed pad
   - Yard size
   - Rain water diversion
   - Solids separation
   - Future expansion or intensification
   - Labour resources
   - Contingency for breakdown and maintenance

Refer to the Dairy NZ Farm Dairy Effluent Design Code of Practice item 3.0 for detailed information.
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4. Deciding Performance Parameters

In the second stage, the level of performance of the future system is determined.

Design specifications are prepared, listing requirements that the final system must be able to achieve (such as application depth and area, required storage size, etc.) so all regulatory requirements and operational parameters can be met.

Refer to the Dairy NZ Farm Dairy Effluent Design Code of Practice item 4.0 for detailed information.

The remainder of this specification refers directly to the performance parameters required for a fully functional FDE storage pond.

4.1 Deferred Storage Volume

The following formula provides an approximate deferred storage volume.

\[
\text{Capacity required} = \frac{\text{Max no cows in milk}}{\text{litres of effluent/cow/day (50 -100 litres)}} \times \text{days storage required.}
\]

Other considerations should include:

- Pond system: single or multiple ponds
- 25 year rainfall events
- Stormwater diversion
- Solid separation – mechanical or passive
- Is there a stand off pad or feed pad increasing the volume of effluent to be stored
- Green water recycling
- Future expansion

To finalise storage capacity calculations refer to the Massey University Dairy Effluent Storage Calculator.

4.2 Pond site location

Evaluate the FDE pond site location and soil type.

Consider the following:

- Site options and constraints.
- Plans and options for future expansion.
- Ground water and surface water issues.
- Soil type and constraints.

4.3 Soil Type

Table 1.

<table>
<thead>
<tr>
<th>Subgrade Type</th>
<th>Risk</th>
<th>Solution</th>
<th>Slope Angle*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clay</td>
<td>Granule size &gt; 10mm puncture damage</td>
<td>Include TexShield® Geotextile protection layer or sand/silt blinding layer</td>
<td>Max 1:1 pref 2:1</td>
</tr>
<tr>
<td></td>
<td>Desiccation cracking or runnelling</td>
<td>Trim and roll</td>
<td></td>
</tr>
<tr>
<td>Alluvial</td>
<td>Granule size &gt; 10mm puncture damage</td>
<td>Include TexShield® Geotextile protection layer</td>
<td>Max 2:1</td>
</tr>
<tr>
<td>Pumice</td>
<td>Highly erodible</td>
<td>Change sites</td>
<td>Max 1:1 pref 2:1</td>
</tr>
<tr>
<td></td>
<td>Formation of tomos and undermining resulting in structural collapse</td>
<td>Install GeoFlow leak detection and drainage system</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Manage ground and surface water runoff</td>
<td></td>
</tr>
<tr>
<td>Sand</td>
<td>Slope stability can be compromised by erosion</td>
<td>Include GeoFlow drainage system</td>
<td>Max 2:1 pref 3:1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reinforce with TexShield® Geotextile</td>
<td></td>
</tr>
<tr>
<td>Stony</td>
<td>Puncture damage to liner</td>
<td>Include TexShield® Geotextile protection layer</td>
<td>Max 2:1 pref 3:1</td>
</tr>
<tr>
<td>Peat</td>
<td>Methane Gas Generation</td>
<td>Import suitable construction material, GridShield geogrid</td>
<td>Max 2:1</td>
</tr>
<tr>
<td></td>
<td>Differential settlement</td>
<td>Include GeoFlow drainage and gas vent system, Use GeoShield® LLDPE liner to accommodate differential settlement</td>
<td></td>
</tr>
<tr>
<td>Contaminated Subgrade (failed earth lined pond)</td>
<td>Methane Gas Generation</td>
<td>Remove contaminated soil</td>
<td>Refer to base soil type</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Include a GeoFlow drainage and gas vent system</td>
<td></td>
</tr>
</tbody>
</table>

*The Slope Angle values mentioned in the table above may be used as a general guide. These values are recommended according to the nature of the soil. Contact Viking Containment for detailed information.
5. Pond Design

In the third stage, components are selected that will perform to meet the design specification.

Viking Containment can provide assistance with storage volumes, pond design, effluent separation, membrane selection, pumps, stirrers and aerators.

The following design components are essential for the efficient performance of a FDE pond.

5.1 Pond Dimensions.
To calculate the pond dimensions the following information is required.

- Deferred storage volume as calculated in item 4.1.
- Available land area
- Pond depth – the pond base recommendation is 1 metre above the maximum water table level.
- The subgrade type determines the slope angle refer to table 1.
- Grade base to low point
- Subsoil drainage system
- Solid separation method
- Sludge removal
- Access for plant and equipment for operations and servicing

5.2 Avoiding Leakage And Gas Build Up
A leak detection system (LDS) is not compulsory with geosynthetic linings, but is recommended to ensure maximum security and performance.

There have been instances internationally in geomembrane lined waste water ponds where the liner has lifted above the surface of the pond forming “whales” due to:

- Methane gas generated from effluent contaminated subgrade (failed earth lined pond)
- Methane gas generated from effluent leakage caused by damage to the liner system
- Methane gas generated from a peat subgrade
- Water that has not been able to escape from under the geomembrane due to high water table issues.

This is most frequently due to an assumption that liner systems (synthetic or clay lined) will not leak and therefore are not provided with leakage removal, gas venting or drainage systems. These are design-related problems and not material performance problems. This specification for an Agrishield HDPE lining system will provide best practice for geosynthetically lined ponds and ensure that these design issues are considered.

The required characteristics of an FDE pond lining system will comprise of some or all of the following, depending upon site conditions and size of the pond:

1. A sloping floor and a low-point sump for removal of sludge on top of the liner
2. The definition of a maximum allowable (action) leak rate (ALR) that can be handled without damage to the liner and subgrade. FDE design standards specify \(10^{-8}\) m/s.
3. A sloping leakage detection system (LDS) under the geomembrane that will allow monitoring and drainage of any leakage to a secondary sump from which it can be removed.
4. The LDS can also be utilised to remove and monitor ground water caused by a high water table.
5. A gas venting system under the liner that will allow venting counter-current to the direction of drainage.
6. Gas vents at the top of side slopes or crest are aligned with the venting network.
7. Minimal liner penetrations.

5.3 Leakage Detection System (LDS)
A leakage detection, drainage, collection, and removal system that also functions as a gas venting system shall be installed under the Agrishield® geomembrane. This LDS system shall preferably be a combination of French drains and a geocomposite vent-drain. GeoFlow GC 412 or WD 520 (geocomposite) will provide adequate compressive strength to tolerate the hydrostatic head without collapsing and to provide the required leak flow rate (LFR) transmissivity. The GeoFlow shall be placed on the pond base and slopes as per project requirements.
5.4 Alternative LDS Systems

French Drain
An alternative to the geocomposite LDS is a system of French drains in the subgrade that shall be appropriately designed to collect and direct leakage or ground water to the secondary sump and to vent any gases.

The grid drain layout extends up the side slopes to provide a venting path for gas. Viking vents or vents flaps are aligned over the drains at the top of the crest or slope to discharge gas.

Drainage design will vary depending on site conditions:

**Plan Elevations**

- Single Centre Drain
- Toe Drain
- Floor & Toe Drain
- Herringbone Drain

Geotextile
Light non-woven geotextiles that might be used for cushioning between geomembrane and subgrade are typically not sufficient to serve as an LDS and gas venting system and are not recommended. However, if a single nonwoven geotextile is required it shall be a minimum of 500 gsm (TexShield® NW 500). The selected geotextile has adequate transmissivity to manage the maximum LFR under the expected hydrostatic head.

5.5 Leakage Monitoring

The LDS system shall drain to an external sump where water can be sampled or removed and flow rates monitored.

5.6 Geomembrane Material

The liner shall be a minimum 1.5 mm thick HDPE AgriShield® geomembrane with the specifications shown in Table 2. These specifications ensure better than average long term durability.
### Table 2. AgriShield HDPE Specification

<table>
<thead>
<tr>
<th>Properties</th>
<th>ASTM Test Method</th>
<th>Test Value</th>
<th>Testing Frequency (min.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thickness, mm (min. ave.)</td>
<td>D 5199</td>
<td>nom. (mil) -10%</td>
<td>per roll</td>
</tr>
<tr>
<td>• lowest individual of 10 values</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Density (min.)</td>
<td>D 1505/ D 792</td>
<td>0.940g/cc</td>
<td>90,000kg</td>
</tr>
<tr>
<td>Tensile Properties (1) (min. ave.)</td>
<td>D 6693 Type IV</td>
<td>22kN/m</td>
<td>9,000kg</td>
</tr>
<tr>
<td>• Yield Strength</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Break Strength</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Yield Elongation</td>
<td></td>
<td>12%</td>
<td></td>
</tr>
<tr>
<td>• Break Elongation</td>
<td></td>
<td>700%</td>
<td></td>
</tr>
<tr>
<td>Tear Resistance (min. ave.)</td>
<td>D 1004</td>
<td>187N</td>
<td>20,000kg</td>
</tr>
<tr>
<td>Puncture Resistance (min. ave.)</td>
<td>D 4833</td>
<td>480N</td>
<td>20,000kg</td>
</tr>
<tr>
<td>Stress Crack Resistance (min. ave.) (2)</td>
<td>D 5397 (App.)</td>
<td>1000hr.</td>
<td>per GRI GM10</td>
</tr>
<tr>
<td>Carbon Black Content, %</td>
<td>D 1603 (3)</td>
<td>2.0-3.0%</td>
<td></td>
</tr>
<tr>
<td>Carbon Black Dispersion</td>
<td>D 5596 note (4)</td>
<td>note (4)</td>
<td>20,000kg</td>
</tr>
<tr>
<td>Oxidative Induction Time (OIT) (min. ave.) (5)</td>
<td>D 3895</td>
<td>100 min.</td>
<td>90,000kg</td>
</tr>
<tr>
<td>(a) Standard OIT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(b) High Pressure OIT</td>
<td>D 5885</td>
<td>600 min.</td>
<td></td>
</tr>
<tr>
<td>Oven Ageing at 85°C (5), (6)</td>
<td>D 5721</td>
<td>55%</td>
<td>per each formulation</td>
</tr>
<tr>
<td>(a) Standard OIT (min. ave.), % retained after 90 days</td>
<td>D 3895</td>
<td>55%</td>
<td></td>
</tr>
<tr>
<td>(b) High Pressure OIT (min. ave.), % retained after 90 days</td>
<td>D 5885</td>
<td>80%</td>
<td></td>
</tr>
<tr>
<td>UV Resistance (7)</td>
<td>D 3895</td>
<td>N.R. (8)</td>
<td>per each formulation</td>
</tr>
<tr>
<td>(a) Standard OIT (min. ave.)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(b) High Pressure OIT (min. ave.), % retained after 1600hrs (9)</td>
<td>D 5885</td>
<td>75%</td>
<td></td>
</tr>
</tbody>
</table>

1. Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction. Yield elongation is calculated using a gauge length of 33mm. Break elongation is calculated using a gauge length of 50mm.
2. The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer’s mean value via MQC testing.
3. Other methods such as D 4218 (muffle furnace) or microwave methods are acceptable if an appropriate correlation to D 1603 (tube furnace) can be established.
4. Carbon black dispersion (only near spherical agglomerates) for 10 different views: 9 in Categories 1 or 2 and 1 in Category 3.
5. The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.
6. It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.
7. The condition of the test should be 20hr. UV cycle at 75°C followed by 4hr. Condensation at 60°C.
8. Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.
9. UV resistance is based on percent retained value regardless of the original HP-OIT value.

This data is based on GRI GM13 Revision 9: 06/01/09. It is provided for informational purposes only and is not intended as a warranty or guarantee. Viking Containment assumes no responsibility in connection with the use of this data. These values are subject to change without notice. Please contact us for updated information.
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6. Construction and Installation

In the fourth stage the system is constructed to the design parameters.

6.1 Survey and Setout
The earthworks contractor must ensure that all pipe work, drainage, embankment construction and levels meet the project specification and drawings.

6.2 Subgrade Preparation
A smooth, firm, compacted subgrade free of vegetative matter and no ponding water shall be prepared for placement of the AgriShield® liner.

Surfaces to be lined shall be smooth and free of debris, roots, and angular or sharp rocks larger than 10mm in diameter. All fill shall consist of well-graded material free of organics, trash, clayballs or other deleterious material. The subgrade shall be compacted in accordance with design specifications but in no event less than is required to provide a firm unyielding foundation sufficient to permit the movement of vehicles and welding equipment over the subgrade without causing rutting or other deleterious effects. The subgrade shall have no sudden sharp or abrupt changes in grade exceeding 10mm, especially at pipe penetrations and concrete structures.

The subgrade shall be sloped at a gradient between 0.5% and 2% to a leakage collection and removal sump at one end of the pond, for the gravity drainage and removal of any leaked FDE.

6.3 Subgrade Acceptance
Viking shall inspect and accept the condition of the subgrade surface prior to placement of any geosynthetic materials. If the subgrade is not acceptable to Viking it shall be made good by the earthworks contractor.

6.4 Anchor Trench
An anchor trench at least 600mm deep and 500mm wide shall be excavated around the perimeter of the pond with the front edge a minimum of 500mm back from the crest of the pond side slope. The front corner of the trench will be rounded and contain no sharp-edged stones or rocks that might damage the liner. The anchor trench shall contain no loose material and shall not be allowed to be softened by standing water. The earthworks contractor will dewater and re-prepare the trench as required by Viking. Anchor trenches shall be backfilled and carefully compacted in a minimum of two lifts with a soil that will not damage the liner. The final level of the anchor trench shall be sloped to direct water run off away from the trench and pond. Refer to Drawing TAT01

6.5 Project Conditions
Geomembrane should not be installed in the presence of ponding water, during excessive winds or rain, or when material temperatures are outside the welding parameters.

6.6 Personnel
Viking installation personnel are trained to the International Association of Geosynthetic Installers (IAGI) Welder’s Certification Program which also includes quality assurance testing.

The installation supervisor shall have a minimum of 500,000 m² of geomembrane installation experience.

Viking is a member of Site Safe New Zealand Incorporated, and our employees are accredited with the Site Safe Building Construction Passport.

6.7 Liner Deployment
Trained technicians shall deploy the geomembrane using a spreader bar and spindles to lift each roll. The sheets are then pulled out and positioned by hand in accordance with the approved panel layout plan. The installation supervisor ensures bridging or stressed conditions are avoided and allowances have been made to accommodate thermal expansion and contraction of the material. Seaming follows as soon as practical.

There shall be no horizontal seams on slopes or within 2 m of the toe of the slope on the floor. Seams on the floor will be shingled down slope; lower panel down-slope, upper panel up-slope. Care shall be taken when deploying geomembrane not to damage the subgrade surface or other geosynthetic components.

Each geomembrane panel shall be clearly marked and numbered in the order in which it is placed. Roll edges shall be overlapped a minimum 100 mm such that, after welding and sampling, there is enough material to grip for destructive peel and shear testing. Only panels that can be welded the same day will be deployed. Free edges shall be ballasted with sand bags at a frequency that liner uplift will be prevented.
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6.8 Seaming
Seaming shall be performed using automated twin track fusion welding machines or extrusion welders using welding rod made with the same resin as the geomembrane. Welding rod will be clean and dry as it enters the welder.

Seams shall be identified by the numbers of the panels on each side of the seam. Viking will maintain spare welding machines on site in the event of breakdown of production welding machines.

During installation a welding technician with at least 300,000 m² of seaming experience will be on site to supervise the seaming process.

Prior to production welding, trial welds will be made using the same liner material under the same field conditions. Trial welds will be made at the beginning of each welding shift, every five hours or whenever welding machines have been switched off, and whenever liner temperature changes by more than 25°C.

Five 25 mm wide coupons shall be cut from each trial seam. Specimens 1, 3, and 5 shall be tested in peel mode and numbers 2 and 4 in shear mode. Both tracks of double track fusion welds will be tested in peel mode. All five specimens shall meet the specifications in Table 2 Seam Specifications.

If any specifications are not met another sample shall be welded and re-tested. If this sample fails the machine shall be inspected and adjusted until two passing samples have been made. Data from failing samples shall be recorded as well as for passing samples.

No production welding shall be performed until each operator/machine combination has made a passing trial weld. If operator/machine combinations change, a new trial weld shall be made.

Each welded seam shall be labelled with the welding machine number, the operator’s initials/name, and date and time of starting the weld. This information shall be written on the liner.

Surfaces to be welded shall be cleaned to remove dirt and moisture prior to fusion welding.

Surfaces to receive extrusion weld beads shall be uniformly ground no more than 15 minutes prior to welding. Grinding gouges and depth shall not exceed 10% of the thickness of the geomembrane nor extend more than 15 mm from the edge of the top sheet. The top corner along the edge of the top sheet shall be bevelled at approximately 45°. All grinding debris shall be removed prior to welding.

At fish-mouths caused by differential expansion between adjacent panels, the wrinkle shall be cut along its peak, the two parts overlapped and an extrusion weld performed. At the end of the cut, where there is insufficient overlap, a “keyhole” cut will be made and a patch placed over the keyhole.

All grinding marks shall be covered by weld bead, and squeeze-out along the edges of the bead shall be minimised to avoid stress-concentrating geometries along the edge of the bead.

No more than two weld beads will be placed at any one location.

At stop/start locations the end of the first bead will be tapered by grinding and the new weld bead built up steadily to full thickness along the tapered section. Large blobs of extrudate at the start and ends of welds will be avoided.

Welds will continue to the edges of the liner in the anchor trenches.

If AgriShield® liner surface temperature is lower than -5°C or exceeds 80°C additional and frequent trial welds (every 2 hr) will be made to ensure seam shear and peel performance meets specifications.

6.9 Seam Testing

Non Destructive

Air Pressure Testing
All wedge weld seams are non-destructively pressure tested using a nanometer in accordance with ASTM D5820. The twin track seam channel is sealed off at each end and pressurised to 200kpa. It is monitored for leakage over a 5 minute period by our QA technician. This method can identify a pinhole leak. A failed seam is repaired and retested until a pass is achieved.

Vacuum Box
For extrusion welds where air pressure testing is not possible a vacuum box is used to test the geomembrane in accordance with ASTM D5641.

Spark Testing
Detail extrusion welds that cannot be vacuum box tested will be made with a conductive wire inserted and it will be spark tested according to ASTM D6365. The voltage setting on the spark testing unit will be calibrated to ensure that a signal will be generated by the longest expected leak path but without burning a hole in the geomembrane itself. For a given thickness of Agrishield the voltage shall not exceed those shown in Table 3.

Table 3. Maximum spark test voltage (V)

<table>
<thead>
<tr>
<th>Thickness (mm)</th>
<th>Voltage (kV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5</td>
<td>30</td>
</tr>
<tr>
<td>2.0</td>
<td>40</td>
</tr>
<tr>
<td>2.5</td>
<td>50</td>
</tr>
</tbody>
</table>
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Destructive testing
To evaluate seam strength and integrity a destructive test is carried out. This test involves taking coupons from a weld seam and testing its tensile peel and shear strength on a field tensiometer.

The locations of samples will be identified by the design engineer or by Viking’s QC/QA representative. Samples will preferably be taken from the Agrishield above the waterline or in the anchor trench.

The holes left by the sampling will immediately be repaired and samples numbered. Ten 25 mm wide coupons will be cut from each seam sample and tested alternately in peel, shear, peel, shear, etc. Both tracks of fusion seam coupons will be tested at the same time in shear but separately by peeling. The specifications in Table 2 shall be met by all coupons for the sample to be accepted.

If any sample is rejected, two new samples shall be taken approximately 3 m on each side of the failed one, and so on, until the extent of the failing seam is defined. The seam between two passing test samples will be repaired or replaced.

Table 4. Seam Specification

<table>
<thead>
<tr>
<th>Properties</th>
<th>GRI Test Method</th>
<th>1.50mm</th>
<th>2.00mm</th>
<th>2.50mm</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fusion seams</strong></td>
<td>GM-19</td>
<td>&gt;54</td>
<td>&gt;72.6</td>
<td>&gt;90.8</td>
</tr>
<tr>
<td>shear strength (kg/25 mm)</td>
<td></td>
<td>&gt;50</td>
<td>&gt;60</td>
<td>&gt;50</td>
</tr>
<tr>
<td>shear elongation at break (%)</td>
<td></td>
<td>&gt;41.2</td>
<td>&gt;54.9</td>
<td>&gt;68.5</td>
</tr>
<tr>
<td>peel strength (kg/25 mm)</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>peel separation (%) (1)</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Extrusion seams</strong></td>
<td>GM-19</td>
<td>&gt;54</td>
<td>&gt;72.6</td>
<td>&gt;90.8</td>
</tr>
<tr>
<td>shear strength (kg/25 mm)</td>
<td></td>
<td>&gt;50</td>
<td>&gt;50</td>
<td>&gt;50</td>
</tr>
<tr>
<td>shear elongation at break (%)</td>
<td></td>
<td>&gt;35.2</td>
<td>&gt;47.2</td>
<td>&gt;59.1</td>
</tr>
<tr>
<td>peel strength (kg/25 mm)</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>peel separation (%)</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

(1) Omit separation along sides of squeeze-out bead

7. Pipes & Structures

7.1 Sealing to Concrete Structures - Mechanical
AgriShield® is sealed to concrete structures using a stainless steel batten and rubber gasket.

For below water applications. Refer to Drawings EABB101 & EPAB101.
- Battens shall be 316# stainless steel with a minimum dimension of 6mm x 40mm
- A rubber gasket (6mm x 40mm) shall be compressed on both sides of the geomembrane.
- Fasteners shall be M10 stainless steel, spacing shall be no more than 150mm on centre.
- The distance between the end of batten and the first fastener shall not exceed 50mm.
- When installed the batten shall be made uniformly parallel with the concrete surface. It shall not be bowed between fasteners.

For above water applications. Refer to Typical Details EABA101 & EPAA101
- Battens shall have a rubber gasket on the under side of the geomembrane.
- Fastener spacing shall be no more than 300mm on centres.

7.2 Sealing to Concrete Structures - Geolock
AgriShield® is sealed to concrete structures by welding to a Geolock Anchor. Refer Typical Details GLH01 & GLV01
- Geolock will be welded together at butt joints and mitred corners using a mirror welder.
- The Geolock is cast in place or vibrated into newly poured concrete.
- After the removal of the forms the exposed welding surface allows the AgriShield® liner to be extrusion welded to the Geolock.

7.3 Sealing to Pipe Penetrations
Pipe penetrations through the Agrishield liner are sealed using a fabricated pipe penetration seal. Refer Drawings PP01 & PPV01.
7.4 Liner Protection Pad

The AgriShield® liner shall be protected from contact with any equipment such as pumps or mixers floating in the water as the water level are lowered. At such locations, and to maintain liner integrity, the liner shall be covered by a minimum 150 mm thick slab of concrete. To protect the liner two pieces of a minimum of 500 g/m² nonwoven geotextile and a secondary liner of the same size is welded to the primary liner. Refer to Drawing LPP01.

Both protective geomembrane and geotextile shall extend a minimum of 150 mm from the edges of the concrete pad.

The concrete may be cast-in-place using fibre reinforced concrete with rounded corners. Concrete formers will be placed without penetrating the geomembrane liner and in such a way that concrete cannot penetrate between former and the protective geomembrane. If using reinforcing bars or mesh, care must be taken to prevent damage to the liner. Re-bar and tools must not be placed directly on the liner. Alternatively a pre-cast slab of concrete with rounded corners and a smooth underside will carefully be lowered onto the protective layers. Cables anchoring any floating equipment shall be fastened to posts anchored outside the anchor trench in such a way that they do not come into direct contact with the liner at the crests of the slopes. However this can not always be achieved and where the cables are in contact they shall be sleeved to protect the liner.

To protect the primary liner two pieces of a minimum of 500 g/m² nonwoven geotextile and a secondary liner of the same size is positioned beneath the pad. Refer to Drawing LPP01.

8. Repairs

Scratches, gouges, pinholes, and other surface blemishes may be repaired with an extrusion bead using the same resin from which the geomembrane was made. No more than two beads shall be placed together at the same location. All penetrating defects such as punctures, cuts, hot air gun holes, etc., shall be repaired using geomembrane patches with rounded corners overlapping the defect by at least 100 mm in all directions.

If extrusion welds are made on fusion seams the free flap on the fusion seam will be carefully cut back to the edge of the outer weld track. All patch repairs shall be numbered and recorded. All repair welds shall be vacuum box or spark tested and results recorded. Details of test operator, time tested, and test results will be written on the liner adjacent to each patch. The locations of all patches will be recorded.

9. Health & Safety

A health and safety plan for safe operation and maintenance of the pond should be developed by the farm owner and staff, including but not limited to the following items:

- We recommend the Viking Geoladder be installed on side slopes for safer access in and out of the pond.
- Ponds should be fully secured with permanent fencing.
- A floatation device and rescue equipment should be readily available within the secured area.
- Access should be limited to authorised personnel only.
- If vehicle access is required it shall be limited to designated points only.

10. Final Inspection

At the end of liner installation the Viking Installation Supervisor and the owner’s representative will jointly perform a thorough walk-over inspection of the complete liner area to accept the liner.

11. Practical Completion

At completion of the liner installation and all testing requirements, a quality control and assurance report is submitted to the owners’ representative. This report includes liner roll certificates, subgrade acceptance, qualification welds, field seams, non-destructive and destructive test results and an as-built panel layout drawing.

12. Commissioning

Remove sand bag ballast and any debris that may block pipes or pumps.

Do not commence filling the pond if thermal expansion wrinkles are present. The recommended time for filling is early morning or evening when the liner has sufficiently cooled and contracted.

Avoid turbulence during filling that may disrupt the subgrade surface or stress the liner. If pond filling does not commence immediately provision should be made to ballast the liner against wind uplift.
Design & Installation Specification

13. Pond System Maintenance

Preventive maintenance is important for efficient operation and compliance with resource consent conditions. The pond system should be monitored throughout its operational life to identify issues before they become a serious problem.

Note: All maintenance activities should be carried out in accordance with the farm’s Health and Safety Plan.

Table 5.

<table>
<thead>
<tr>
<th>Maintenance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Weekly</strong></td>
</tr>
<tr>
<td>Clean and clear effluent stone trap and gratings</td>
</tr>
<tr>
<td>Check inlet and outlet pipes are not blocked</td>
</tr>
<tr>
<td>Check ancillary equipment in the pond is operating and secured correctly</td>
</tr>
<tr>
<td>Check that fencing is stock proof</td>
</tr>
<tr>
<td>Ensure maximum storage capacity is not exceeded</td>
</tr>
<tr>
<td><strong>Monthly</strong></td>
</tr>
<tr>
<td>Monitor the subsoil drains.</td>
</tr>
<tr>
<td>Visual inspection: check for settlement, slumping, bulging or tight sections of liner.</td>
</tr>
<tr>
<td><strong>6 Monthly</strong></td>
</tr>
<tr>
<td>Check there is no excessive build-up of solids in the pond. Desludge ponds regularly, when the sludge level is over half the normal effluent depth.</td>
</tr>
<tr>
<td>Control weeds around the pond.</td>
</tr>
<tr>
<td><strong>Desludging Effluent Ponds</strong></td>
</tr>
<tr>
<td>Ponds should never be emptied out completely, maintain a depth of 300mm.</td>
</tr>
<tr>
<td>Care must be taken when desludging to ensure the liner is not damaged.</td>
</tr>
<tr>
<td><strong>Emergency Repair</strong></td>
</tr>
<tr>
<td>Early identification of liner damage is important to ensure that it does not escalate to a major failure of the liner system or pond structure.</td>
</tr>
<tr>
<td>Liner damage: Reduce the water level or empty the pond immediately to prevent further ingress of effluent beneath the liner.</td>
</tr>
<tr>
<td>Contact Viking Containment immediately for repairs - Freephone 0800 454 646</td>
</tr>
</tbody>
</table>

14. Warranty

The geomembrane manufacturer will provide a 20 year material warranty to be signed by both the manufacturer and owner. Viking Containment will provide a 5 year warranty on installation workmanship.