

ELCOSEAL[®]

Geosynthetic Clay Liners

Installation Guidelines



QUALITY - SUPPORT - EXPERTISE

 **GEOFABRICS[®]**

ELCOSEAL® Installation Guidelines

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1. INTRODUCTION

ELCOSEAL®¹ is a needle-punched Geosynthetic Clay Liner (or GCL) produced in Australia in accordance with the ISO 9001:2008 Quality Management System.

ELCOSEAL® consists of premium grade sodium bentonite powder, which acts as the swelling and sealing component, embedded and sandwiched between two or more geotextiles. The composite is then needle-punched through all layers and thermally-locked developing high connection strength. Thus, ELCOSEAL® is a shear strength transmitting GCL.

ELCOSEAL® is generally fast and easy to install, however the performance of the GCL is dependent on the quality of its installation. It is the installer's responsibility to follow these guidelines and the project specifications and drawings whenever possible. It is the engineer's and owner's responsibility to provide construction quality assurance (CQA) for the installation to ensure that the installation has been executed properly. Variance from this guideline is at the engineer's discretion.

Recommended further reading:

1. ASTM D 5888 - "Standard Guide for Storage and Handling of GCLs".
2. ASTM D 6102 - "Standard Guide for Installation of GCLs".
3. ASTM D 5889 - "Standard Practice for Quality Control of GCLs".
4. ASTM D 6072 - "Standard Guide for Obtaining Samples of GCLs".

2. PACKAGING, TRANSPORTATION & UNLOADING ON SITE

ELCOSEAL® rolls are packed in moisture tight plastic wrapping. The standard roll dimensions and weights are listed in Table 1. Every ELCOSEAL® roll has a unique roll number on the wrapping label and on the panel itself.

Table 1 - ELCOSEAL® standard grade roll dimensions and weight. Custom roll lengths are available on request to suit project requirements.

Grade	Width (m)	Length (m)	Diameter (m)	Typical Roll Mass (kg)
X800	4.7	45	~0.52	~1,395
X1000	4.7	35	~0.52	~1,050
X2000	4.7	30	~0.52	~960
X3000	4.7	30	~0.55	~950

Note: Up to 15% of rolls may contain a join over the length. These rolls are marked on the outside of the wrapping with a green circular sticker indicating a join and the individual panel lengths.

ELCOSEAL® rolls are usually delivered to site in closed containers or covered trailers on flatbed trucks. At the point of unloading, the rolls need to be accessible either from the top of the trailer or the container opening.

Should any damage to rolls occur in transit it must be immediately brought to the attention of the Supplier, who will advise on the required course of action.

A flat, hard, dry and free draining surface must be provided for unloading and storage. Rolls may be off-loaded using:

- a **Spreader Bar with steel tube insert through the core of the rolls. Refer to Section 8 and the "ELCOSEAL® Spreader Bar Safe Usage Guideline" in the ELCOSEAL® product folder for detailed information.**
- a 'carpet prong' protruding from the front end of a forklift (>3.5 tonne) or other equipment. The prong should be at least 3/4 the length of the core and also must be capable of supporting the full weight of ELCOSEAL® without significant bending.
- the two slings provided by the manufacturer (upon request) wrapped around the ELCOSEAL® roll at third (1/3) points, fixed to an excavator bucket or a front-end loader. Slings should not be used for general lifting and transportation around the site. If excessive deformation or bending of the roll occurs the integrity of the composite may be affected. A steel tube or similar reinforcement can be inserted into the core of the roll to prevent excessive deformation across the roll during off-loading.

Under no circumstances should ELCOSEAL® rolls be dragged, lifted by one end only, pushed to the ground from the delivery vehicle, or otherwise unloaded in a fashion which could damage the roll.

After transportation and unloading the plastic wrapping should be checked. Minor damage should be repaired with weather-resistant adhesive tape. Wrapping should only be removed immediately before use. The maximum storage height is four rolls.

3. STORAGE

ELCOSEAL® rolls should be stored in their original, unopened packaging in a location away from construction traffic but sufficiently close to the active work area to minimise handling.

The designated storage area should be level, dry, well-drained, stable, and should protect the product from:

- Precipitation.
- Chemicals.
- Standing water.
- Excessive heat.
- Ultraviolet radiation.
- Vandalism and animals.

ELCOSEAL® rolls should always be stored lying flat, continuously supported, and should never be stored standing on one end. Enclosed indoor storage such as shipping containers or a warehouse environment is preferred if ELCOSEAL® is to be stored for long periods.

4. INSTALLATION REQUIREMENTS

- Excavator (tracked or wheeled) or front-end loader .
- Spreader Bar/Loading Frame.
- HP Paste.
- Trowel.
- Carpet knife or knife with covered blade (for safety).
- Felt pens or chalk.
- Measuring tape.
- Broom.
- Dusk masks & goggles (optional) - refer to ELCOSEAL® MSDS for recommended dust mask.

5. INSTALLATION TEAM

Before installing ELCOSEAL® this guideline should be read thoroughly by the installation personnel. The installation team should be aware of their individual roles in ensuring a quality installation. Any questions raised by the installation team that cannot be answered by this document should be referred immediately to the Supplier.

6. SUBGRADE PREPARATION

The preparation of the subgrade before placement of any lining material is critical to the system's performance. The surface(s) upon which ELCOSEAL® is to be laid should be suitable for the intended application and function.

ELCOSEAL® will generally be placed on either an earthen (eg. compacted clay) or geosynthetic (eg. geotextile or geocomposite) subgrade.

6.1 Earthen Subgrades

The surface upon which ELCOSEAL® will be deployed should conform to the following:

- The subgrade should be firm and unyielding (typically compacted to >90% density), without abrupt elevation changes, and be proof rolled with a smooth drum roller immediately prior to deployment of the panels. The subgrade should not be disturbed or rutted by the equipment deploying the rolls or other traffic. No foreign matter or stones loose on the surface or penetrating out of the subgrade >10 mm should be allowed. The engineers approval of the subgrade needs to be obtained immediately prior to roll deployment.

- In applications where ELCOSEAL® is the sole or primary barrier, and will be subjected to constant or long-term hydraulic heads exceeding 300 mm (1 foot), subgrade surfaces consisting of gravel or granular soils may not be appropriate due to their large void contents and puncture potential. In these applications, the top 150 mm of the subgrade should possess a particle size distribution where at least 80% of the soil is finer than 0.25 mm (or #60 sieve) - unless the ELCOSEAL® grades X2000 or X3000 are being used (see below).

For X2000 and X3000 grades (with a composite woven/nonwoven carrier geotextile) in high hydraulic head applications:

Subgrade materials **recommended** without further investigation are:

- Clays or clay-based mixes.
- Sandy clays (with > 20% fines).
- Silty or loamy clays (with > 20% fines).
[fine grained soils should be placed at suitable moisture contents for construction operations and roll deployment - that provide adequate bearing capacity to deploy the rolls without disturbance of the subgrade - ie no rutting or large deflections].
- Well graded sands and gravels ($d_{max} < 32$ mm, $d_{60} < 5$ mm, $d_{20} < 0.15$ mm).
[these materials should bind and have good bearing capacity when compacted/rolled].

Subgrade materials **not recommended** without further investigation:

- Single-sized and gap-graded sands and gravels of any size or description.
- Sands or soils that have low bearing capacity at the moisture contents during the construction/deployment operations (ie materials that do not bind when rolled, or will heave or shove under equipment or foot traffic during or after deployment).
- Subgrades that have a bony or porous appearance after compaction and rolling.

6.2 Geosynthetic Subgrades

When deploying ELCOSEAL® over a geosynthetic material such as a geomembrane or geotextile, the surface should be firm and unyielding as per the requirements for earthen subgrades. The equipment used to deploy ELCOSEAL® should be approved for use by the Design Engineer and/or the Supplier of the underlying geosynthetic material. Generally, the underlying geosynthetic and ELCOSEAL® rolls will be deployed consecutively such that each layer is side-cast from equipment tracking over the earthen subgrade - unless specialised light rubber tyred dispensers are available and approved by the Design Engineer that allow direct trafficking over the geosynthetics.

6.3 Anchor Trenches

Anchor trench and slope stability considerations should be assessed by the Design Engineer.

As a general guide:

- An anchor trench should be used at the top of slopes steeper than 7H: 1V. (see Figure 15 for a typical anchor trench detail).
- The anchor trench should be constructed free of sharp edges or corners and maintained in a dry condition. The ELCOSEAL® panels should be placed down the front face and along the base of the anchor trench. The base of the anchor trench should not contain large gravel or loose material and the trench backfill material should be compacted.

7. WEATHER CONDITIONS FOR INSTALLATION

Light rainfall¹ should not affect the installation of ELCOSEAL® provided deployed panels are covered and confined by 300 mm of cover soil (or equivalent) within 2 hours of first exposure to the light rain. Heavy direct raindrop impact should be avoided. The ELCOSEAL® panels can be covered during heavy rainfall events with a tarpaulin or plastic sheet if there is not enough time to complete soil cover placement.

Avoid placing ELCOSEAL® in areas where water is ponding unless panels can be confined immediately (with 300 mm cover soil or equivalent).

1. Light rainfall is defined as < 5mm / hr intensity

8. ELCOSEAL® GCL PLACEMENT

The ELCOSEAL® roll wrapping should only be removed immediately prior to installation. On site, ELCOSEAL® is unrolled along the prepared subgrade using the Spreader Bar assembly as shown in Figures 1 and 2.

ELCOSEAL® should only be trafficked by light, low tyre pressure vehicles (no tracked vehicles).

Rolls must be laid without folds on the subgrade with a standard overlap of 300 mm in both the longitudinal and transverse direction. For longitudinal or edge overlaps, the blue coloured line on the underside of the panels can be used to ensure the correct overlap width. The edge of deployed or previously placed panels needs to coincide or match with the visible blue line on the roll being deployed.

The transverse or end overlaps need to be sealed using bentonite paste. The treatment of end (transverse) overlaps is detailed in Section 9.2.

Rolls can be cut to length with a carpet/stanley knife. When overlapping cut panels bentonite paste will need to be applied as per the requirements for end (transverse) overlaps in Section 9.2.

No trafficking or walking should occur over the overlap region during installation. The overlap must also be free from folds and foreign matter (eg. soil). Any soil particles on the laps must be swept away carefully.

Overlaps should occur in the direction of ground slope in a similar manner to roof tiles.

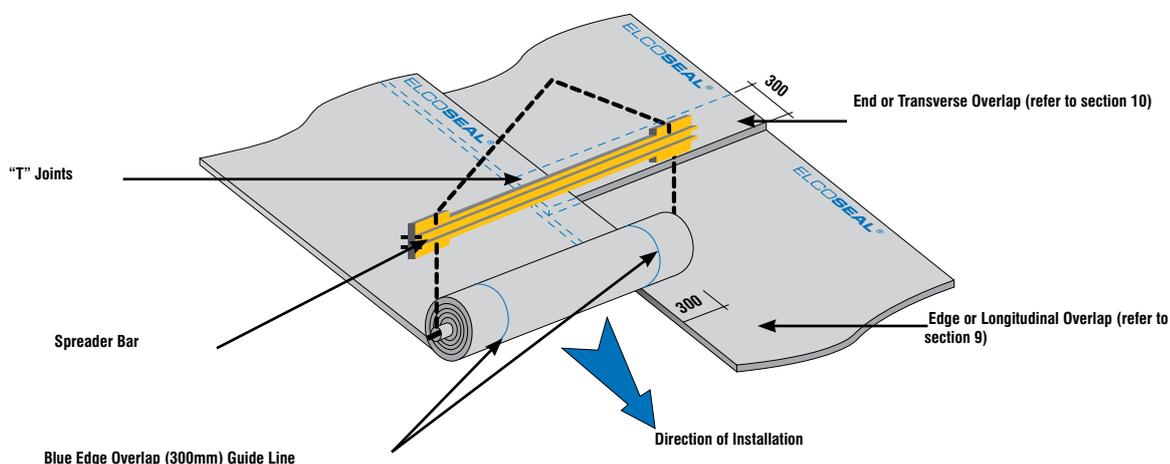


Figure 1. ELCOSEAL® deployment using the standard ELCOSEAL® Spreader Bar.
 [Important: Refer to the “ELCOSEAL® Spreader Bar Safe Usage Guideline” prior to using the lifting equipment and ensure Occupational Health and Safety requirements have been met and potential hazards are eliminated] .

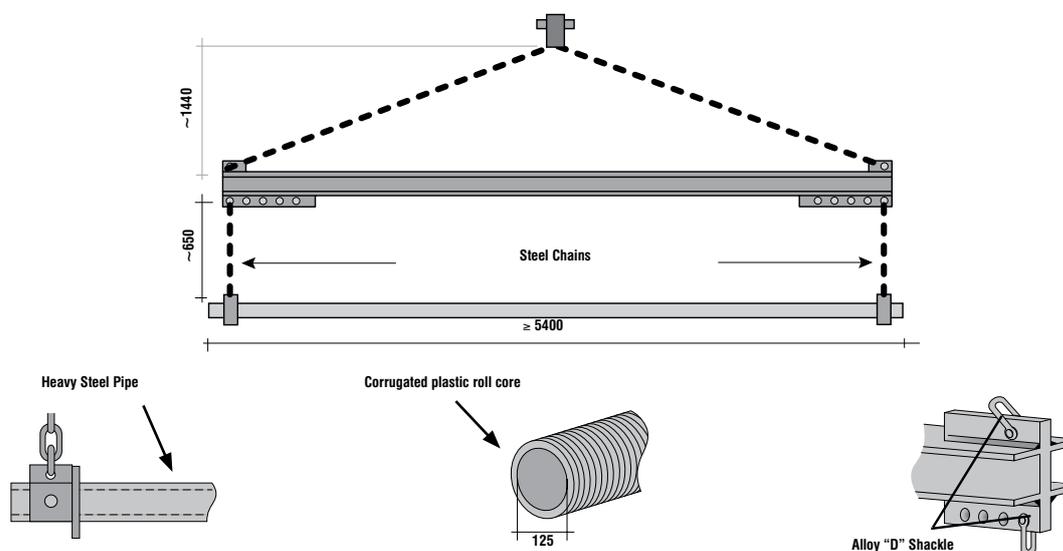


Figure 2. Typical Spreader Bar Assembly - (Available for hire from Geofabrics Australasia.)

9. ELCOSEAL® PANEL OVERLAPS

9.1 Installation of Edge Overlaps (Longitudinal Direction)

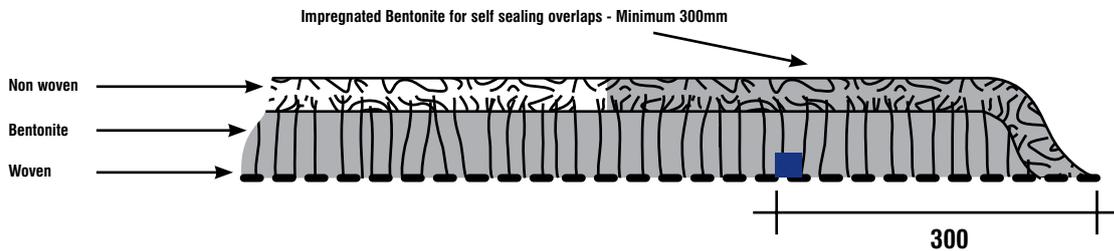


Figure 3: Cross section of GCL roll edges for grades X800 and X1000

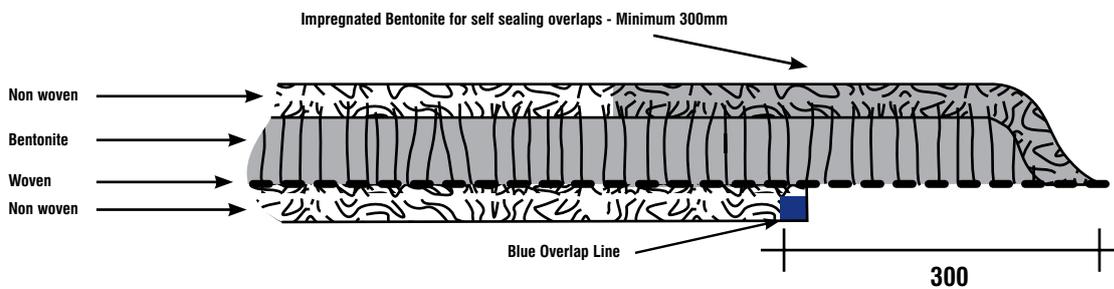


Figure 4: Cross section of GCL roll edges for grades X2000 and X3000

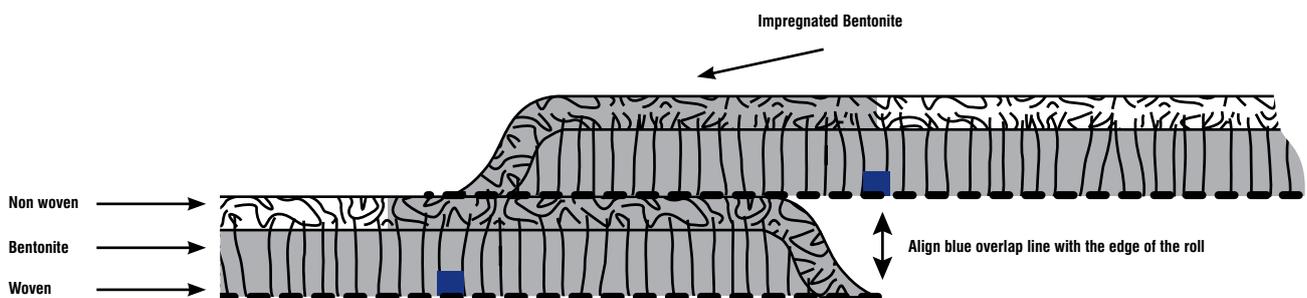


Figure 5: Longitudinal (or edge) overlap with self-sealing impregnated bentonite. (X1000 shown)

The longitudinal overlap is where GCL rolls overlap along their length. The installation of a longitudinal overlap can be seen in Figure 1. The width of this overlap shall be a minimum of 300mm which is indicated by a blue marker line printed on the bottom of the roll. The overlapping area has bentonite powder impregnated into the top nonwoven fibres of the GCL as seen in Figure 3 for grades X800 and X1000 and in Figure 4 for grades X2000 and X3000. When hydrated, the impregnated bentonite will swell into the fibre porespace to provide a sealed hydraulic barrier. An installed cross section can be seen in Figure 5.

9.2 Installation of Edge Overlaps (Transverse Direction)

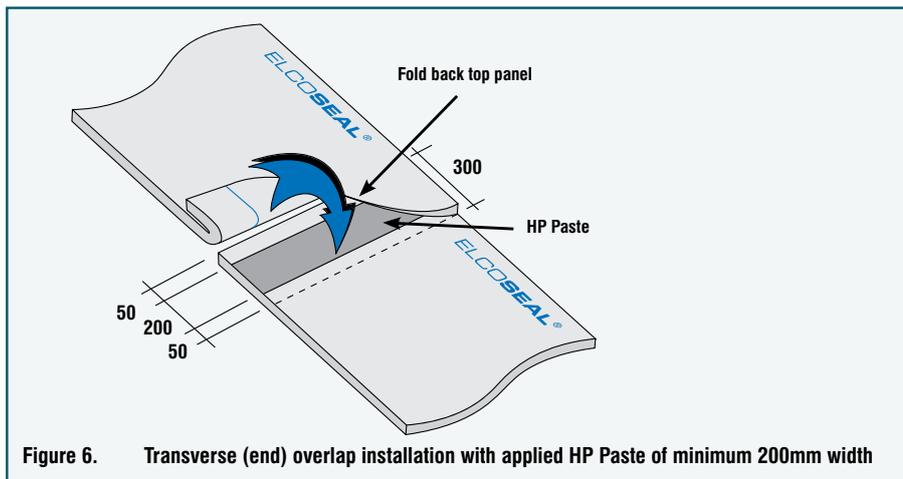


Figure 6. Transverse (end) overlap installation with applied HP Paste of minimum 200mm width

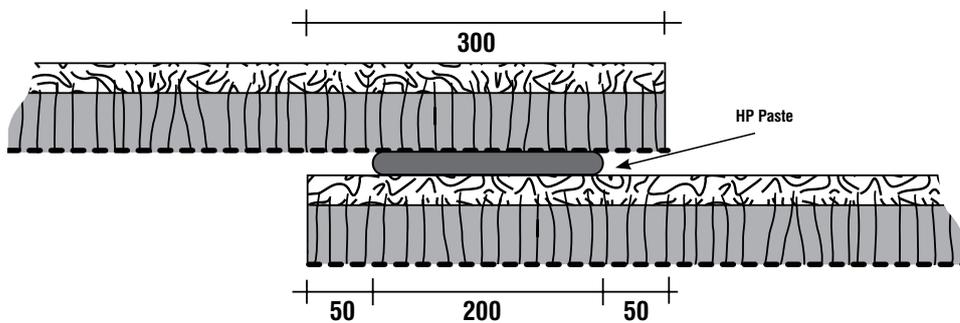


Figure 7. Transverse (end) overlap cross section (X1000 shown)



Figure 8. HP Paste application

Transverse overlaps occur at the end of rolls. The width of the GCL transverse overlap shall be a minimum of 300mm. It is recommended that the topside of the underlying ELCOSEAL® panel be marked as per Figure 6, as a reference point for paste placement. The top ELCOSEAL® panel is then pulled back after marking.

All transverse/roll end overlaps should be sealed with bentonite paste. Geofabrics supplies HP paste which is an extensively tested sealing solution available in 20L containers. As indicated in Figure 6, HP paste should be placed within the 300mm overlap with a minimum width of 200mm and a nominal thickness of 10mm. The paste can be easily poured from the 20L container and spread into place using a trowel or broom. Approximately 10L or ½ of a container is used for each roll width at the transverse overlap. Once the paste is applied, the top panel is then rolled back into place and pressed down (Figure 6). Care should be taken to prevent folds or creases. The end overlap cross section for X1000 is shown in Figure 6. If an alternative method of end of roll overlap sealing is required, please consult your local Geofabrics office.

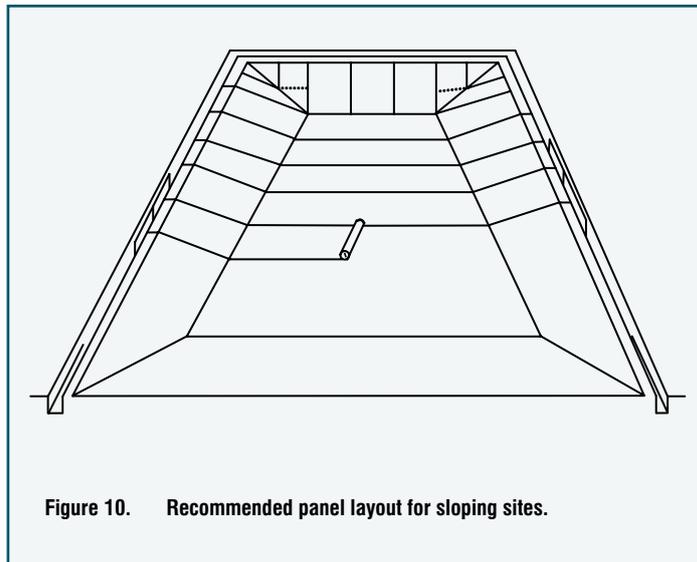
To ensure the integrity of the ELCOSEAL® lining system it is essential that the treatment of end overlaps be carefully supervised. End overlaps in sumps or inverts are to be avoided.

10. INSTALLATION ON SLOPES

The stability of lining system components on slopes should be assessed on a case-by-case basis. The Supplier can assist in this respect upon request.

ELCOSEAL® panels should be deployed in the direction of the slope as per Figure 10 and anchored at the crest of the slope (Figure 11). End (or transverse) overlaps on steep slopes should be avoided. If overlaps on slopes are unavoidable, please consult your local Geofabrics branch for information on custom extra-long GCL rolls.

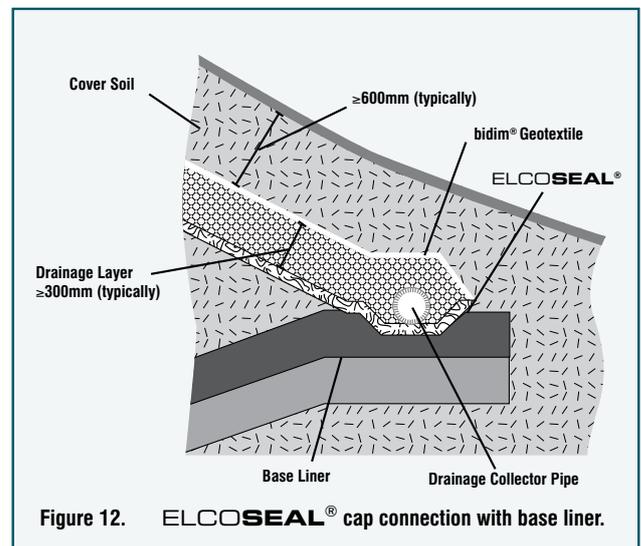
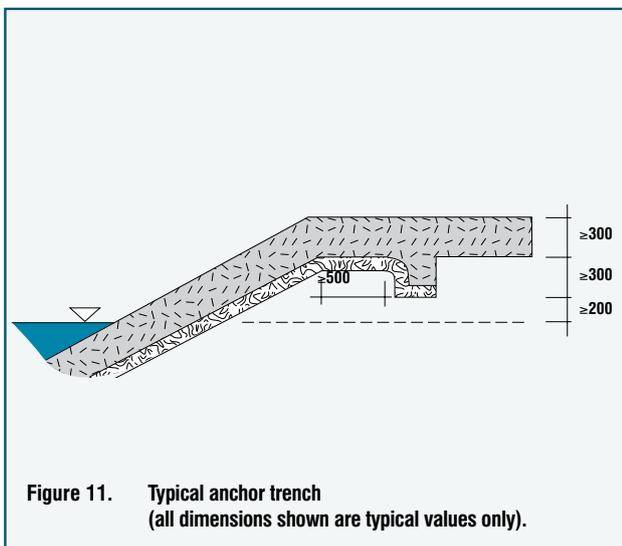
Cover soil should be placed up the slope (starting at the toe). It must not be installed down the slope unless stability for this approach has been carefully investigated.



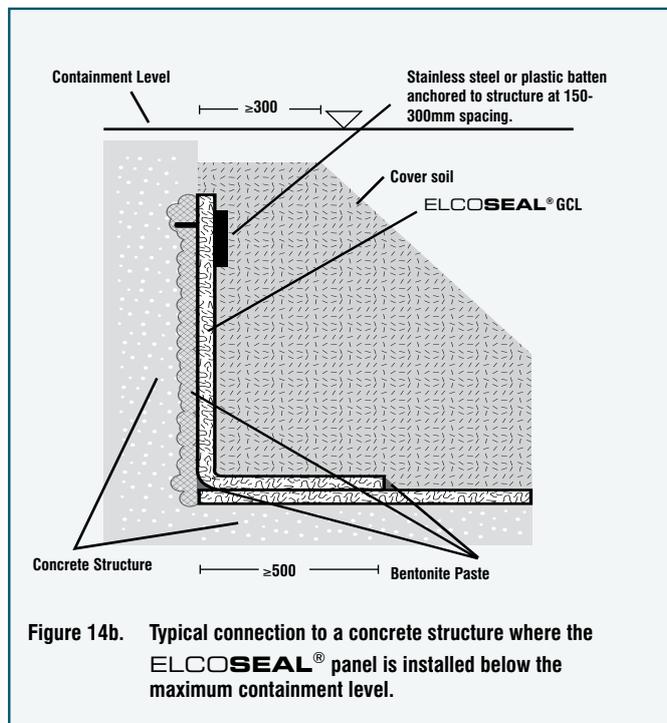
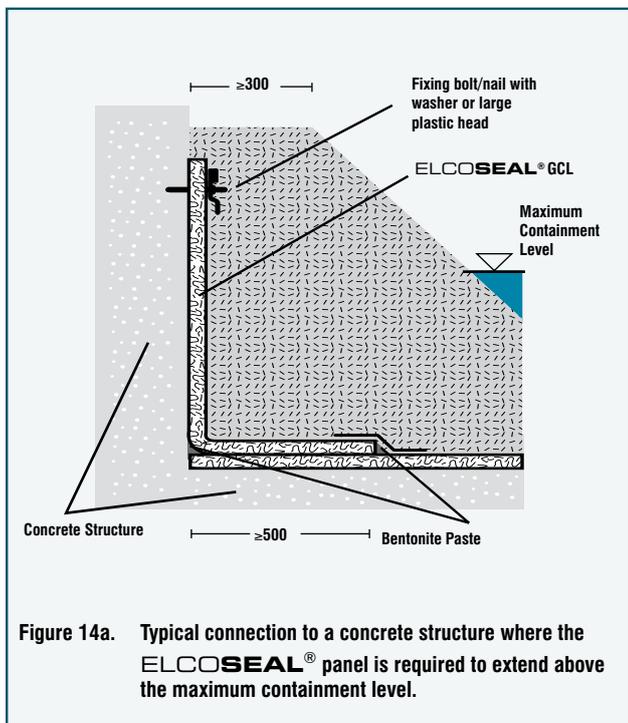
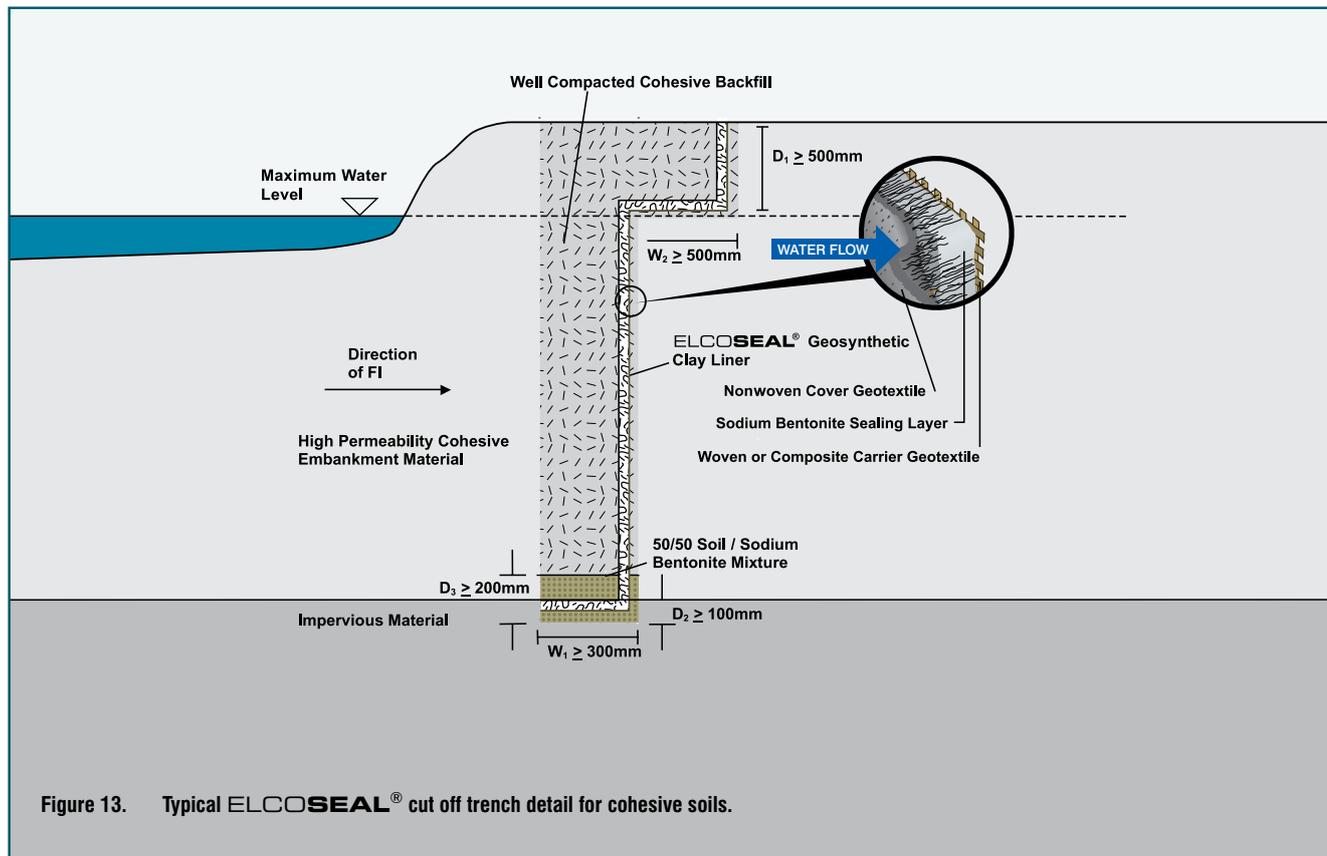
11. CONNECTIONS & PENETRATIONS

Overlaps around connections, penetrations, and where panels have been cut should be carried out according to the principles outlined in Section 9. Most situations require site specific design input, however some commonly used details are shown below:

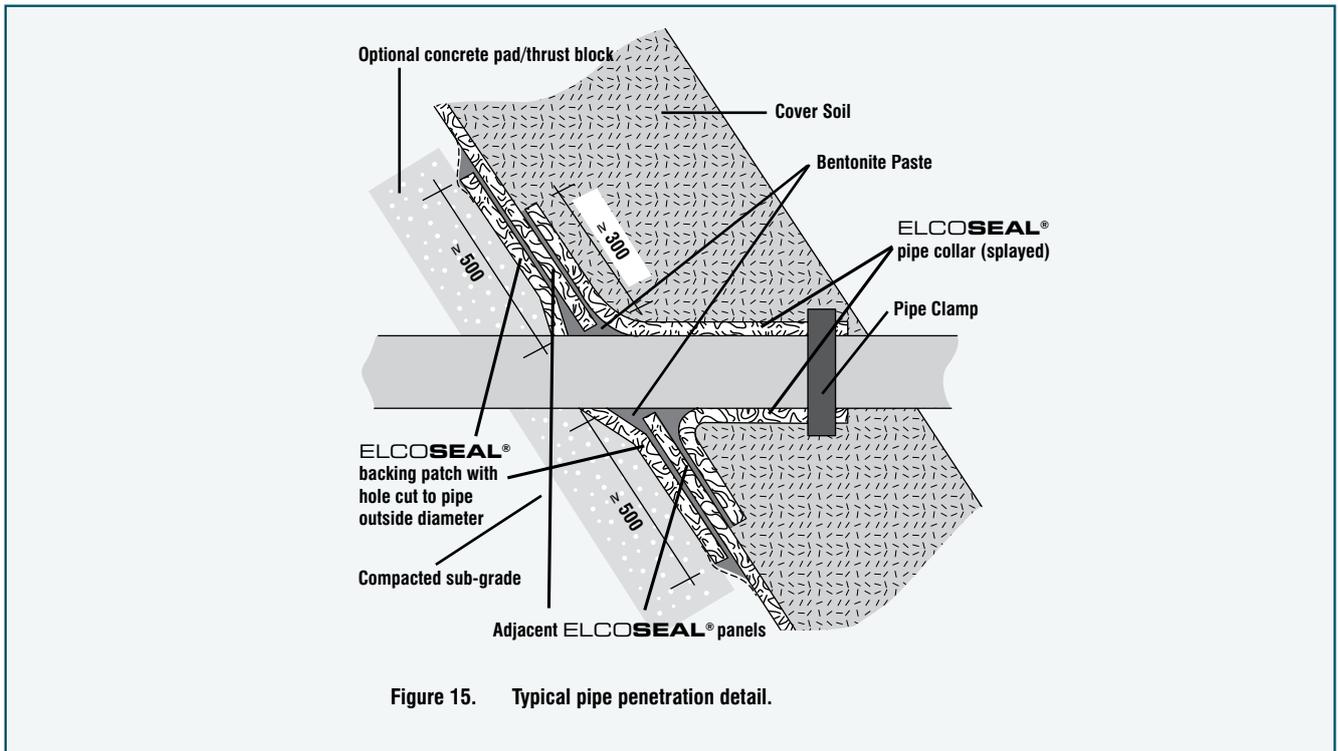
- Integration with thick compacted clay liners is shown in Figure 12.
- Cut-off trenches using ELCOSEAL® GCL in cohesive soil are typically constructed as shown in Figure 13.
- Attachment and sealing against concrete structures, can be achieved according to Figures 14a and 14b. These typical connections are appropriate where the structure needs to be waterproofed to a height above and below the maximum containment level. Temporary fixing of the vertical ELCOSEAL® panel to the structure (as shown) is required to allow the backfill placement.
- Penetrations such as pipe ducts are typically carried out according to Figure 15.
- Further connection methods and penetrations details can be discussed with the Supplier.



11. CONNECTIONS & PENETRATIONS (Cont.)



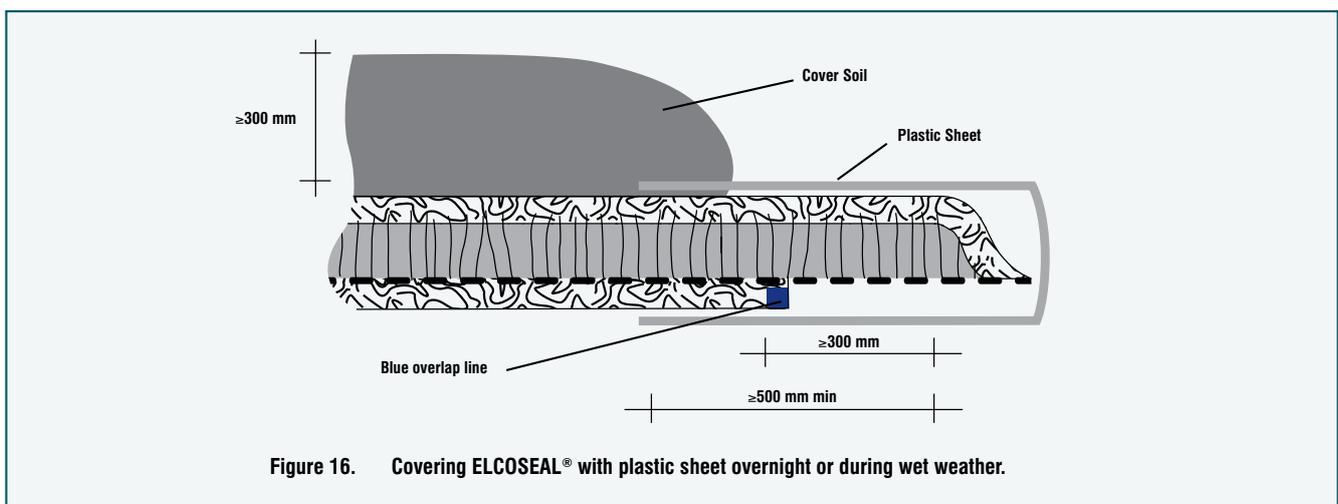
11. CONNECTIONS & PENETRATIONS (Cont.)



12. PREPARATION FOR PLACING SOIL COVER

Where the ELCOSEAL® is not confined by the cover soil the same working day as deployment, a temporary layer of plastic should be laid to protect ELCOSEAL® from prematurely hydrating (Figure 16).

If the deployed ELCOSEAL® panels have hydrated (for example during a rainfall event) without confinement, special operating conditions may need to be imposed during cover soil placement.



- | | | | |
|----|--------------------------------------|---|--|
| ie | If ELCOSEAL® m.c. ¹ < 50% | > | no special considerations. |
| | If ELCOSEAL® 50% < m.c. < 100% | > | avoid direct traffic (including foot traffic) on the panels. |
| | If ELCOSEAL® m.c. > 100% | > | contact the Supplier for further advice. |

ELCOSEAL® Installation Guidelines

13. SOIL COVER PLACEMENT

A cover soil layer at least 300 mm thick (approx. 6 kN/m² confining stress) should be placed and compacted over ELCOSEAL® each working day immediately after the deployed panels have been inspected. In general, fine-grained cohesive material is recommended, although stones up to 32 mm are acceptable if the material is well graded ($C_u > 5$) or stones up to 16 mm if single sized. Silty soils or organic material are not recommended without further stability analysis. Calcareous or limestone based cover soils should be evaluated prior to use.

Disturbance of the overlap area during placement (by means of vehicles spreading cover soil) must be avoided. It may be necessary to place the cover soil in this area manually or carefully using vertical placement by an excavator. The cover should not be pushed or graded in a direction that may cause the overlap to move (Figure 17).

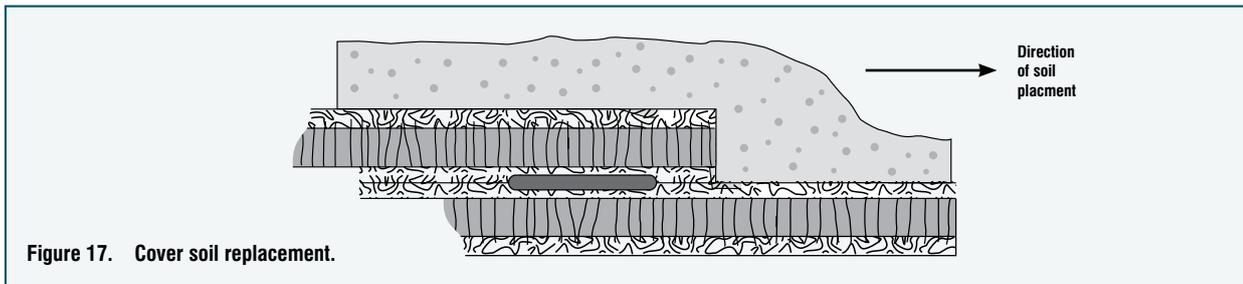


Figure 17. Cover soil replacement.

ELCOSEAL® may not be trafficked directly. The cover material should be pushed in front of the construction equipment thus creating a safe working platform. Overlaps should not be moved or squeezed during this process. In the case of an expected repeated dynamic load on ELCOSEAL®, a sand layer of at least 300 mm should be laid first on the ELCOSEAL®.

Generally, temporary access roads should not go over deployed panels. These areas should be sealed last to minimise traffic volume over deployed material. Where site traffic cannot be avoided (eg. the delivery of cover material by lorries) additional protection measures will be required. For temporary roads, a minimum roadbase thickness over ELCOSEAL® of 600 mm is acceptable without any further analysis. Shallower coverage or alternative cover materials may be allowed after further analysis or field trials to assess the damage potential.

14. REPAIRS

Where ELCOSEAL® has been damaged during installation, covering with an overlapping piece of ELCOSEAL® can repair such areas. The overlap should be at least 500 mm and should be completed in accordance with Section 9.

1. "m.c." - moisture content of the bentonite, % by weight.

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