



ARK Agriculture general maintenance notes

Silage clamps require consistent monitoring and maintenance to ensure their longevity (see below).

Alongside maintenance there are several key points that must be considered in their design and operation. These points are outlined in the construction notes for the ARK clamps.

Design and operation

- Fundamental to the long life of a silage clamp is ensuring the panels are not exposed to acidic leachate.
 - o Plastic sidewall films must always be used against the panels with 1m under and 1m over the top of the silage.
 - o The base of the clamps **must** slope away from the bottom of the panels to stop leachate puddling against the walls.
 - o Silages which produce large volume of leachate e.g Sugar/ Energy Beet will corrode any surface quicker and should be stored with even more care. We recommend you get in touch with ARK should you be considering this.

Repair and maintenance

- Silage clamps must be visually inspected annually with enough time to make any remedial work required – this maintenance plan should be recorded, photos can help in this process.
- We would recommend in the long term you paint the silage clamp walls using the ARK wall paints. ARK wall paints are a simple, low cost, nontoxic product that can be applied (layered) as often as annually which will build up protection for the walls.
- Joints should be inspected as part of the repair schedule and any areas that are corroding over time removed and replaced with the ARK silage clamp joint bitumen.
- Mechanical damage can happen to the clamp in which case we recommend you get in touch with ARK for a solution.
- Drains should also be inspected to ensure where necessary they are free running. Joints around drains are particularly vulnerable – especially in the base and where two materials meet (e.g. a concrete base meeting an asphalt base).

For any further information please call ARK on 01206585090 or visit us at

www.arkagriculture.com



General Construction Notes for the Patented
ARK Agriculture Silage Clamp System
Not for general distribution



ARK Clamps in use, Suffolk, 2017

January 2018

ARK agriculture are a supply only company of the patented sloping walled silage clamp system.

Before you work on the construction of the ARK Silage clamp we request you make contact with the team at ARK so we can talk you through the process to ensure the quick and safe construction of ARK clamps.

Please call us on

01787220560

Standard construction industry health and safety measures need to be incorporated when installing these units

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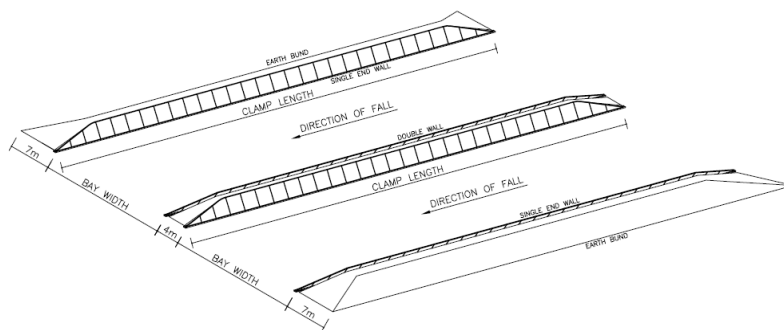
Typical clamp design

ARK Agriculture offer two simple silage clamp designs: -Parallel walls with an opening at both ends ('Open ended' or 'Drive through' clamps) being the most common design, or three walls with an opening at one end ('U shaped clamps').

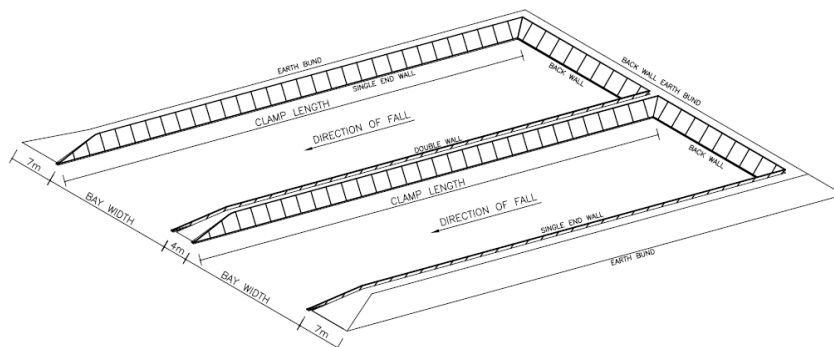
ARK strongly recommends the open ended layout as this offers more flexibility, ease of operation and better silage quality. 'U shaped' clamps should only be considered where site limitations make it impossible to position an open ended clamp.

ARK will advise on the best design for your requirements.

For further design advice please contact ARK sales@ARKagriculture.com



Open ended (Drive through) Clamp



U-shaped Clamp



Environmental Considerations

These Construction Notes have been produced by ARK Agriculture following consultation with the Environment Agency to ensure that silos constructed in this manner should comply with the SSAFO Regulations 2010.

SSAFO Regulations

The proposed development will have to meet the requirements of The Water Resources (Control of Pollution) (Silage, Slurry and Agricultural Fuel Oil) Regulations 2010. These are commonly referred to as **SSAFO**.

These SSAFO regulations govern all methods of making and storing of silage crops and set out minimum standards of design and construction, which must be met whenever a relevant system is used.

Requirements for silos:-

- The system must be impermeable, resistant to corrosion and constructed to meet BS 5502: Part 22 1993. It must have a life expectancy of at least 20 years (with maintenance).
- No part of the system can be within 10 metres of inland freshwaters or coastal waters that silage Leachate could enter.
- The base must have drainage collection channels around the outside. Where there are walls, the base of the silo must extend beyond them and be designed to collect any Leachate at the perimeter.
- The walls must also be able to withstand any likely load placed upon them in accordance with BS 5502 Part 22 1993;
- Collected Leachate should be conveyed to a purpose-built Leachate tank that should have a life expectancy of 20 years without maintenance;
- All parts of the system must comply with the regulations whenever it is used. Proper maintenance is therefore essential.

A copy of the regulations can be viewed at:

<http://archive.defra.gov.uk/environment/quality/water/waterquality/diffuse/nitrate/documents/201009ssafo-england.pdf> or Google 'SSAFO 2010 Environment Agency'

Environment Agency

The revised SSAFO regulations came into effect on 15th June 2013.

“(1) this regulation applies to any silo, slurry or fuel oil storage system whose construction is to be begun on or after 15th June 2013 (“a new or improved store”).

(2) A person who proposes to have custody or control of silage, slurry or fuel oil that is to be kept in a new or improved store must give the Agency notice specifying the type of silo or storage system and its location, at least 14 days before work constructing the new or improved store is to begin.

(3) In this regulation, “construction” includes substantial enlargement and reconstruction.”



The SSAFO regulations do not place requirements on the EA to undertake specific actions when notifications are received, or require them to inspect premises.

Upon receipt of the proposals the EA will assess the proposals and may visit the site they may also ask you to fill in notification form WQE3.

The EA can serve a Notice where there is a significant risk of pollution to controlled waters. They will assess compliance using all appropriate evidence - mainly a visual inspection.

The Notice will outline steps to be taken, or for improvements to be made to an existing or to a new installation in order to reduce to a minimum any significant risk of pollution of controlled waters.

Normally they will have dialogue with a farmer / operator before serving a Notice.

If pollution occurs the farmer / operator may be liable, even if the EA has agreed to the system installed.

Leachate

Leachate, (fermentation juice or silage liquor) may occur when preparing, storing or extracting silage. Leachate normally develops during the fermentation process, with dry matter content less than 30%.

The majority of leachate will be produced in the first three weeks after the clamp has been filled.

Maize silage leachate is highly acidic, pH 4 and has a Biochemical Oxygen Demand BOD of 12,600-90,000mg/litre.

The Leachate must be collected, drained off into an impermeable container and disposed of in a safe manner.

Collection tanks must be incorporated within the silo system. The drainage system components should be connected with corrosion resistant pipes, of sufficient diameter, located beneath the frost level.

The tanks must be monitored and emptied regularly during the drainage period in the first 4 – 6 weeks.

Leachate collection tanks buried in the ground must be constructed to meet BS 5502: Part 22 1993, be impermeable and resistant to attack by the highly acidic silage Leachate and must have a life expectancy of at least for 20 years without maintenance. (CIRIA Report 126 provides guidance on tank construction.)



The tank size depends upon the Silo System Capacity as indicated in the table below (information taken from the SSAFO regulations).

Silo Capacity	Less than 1,500 m³	Greater than 1,500 m³
Leachate Tank Capacity	20 Litres per m ³ Capacity	30m ³ + 6.7 Litres for every m ³ Capacity over 1,500m ³

If material with a low dry substance content is ensilaged (e.g. silage maize for biogas,) accumulation of larger amounts of Leachate must be allowed for and **daily control of leakage of Leachate during ensilaging is essential.**

Outlet or overflows from the Leachate tanks must be within the silo system. The tanks must be emptied regularly such that they are never more than $\frac{2}{3}$ full.

If regular emptying of the Leachate collection tank cannot be guaranteed, the tank's capacity must be increased as required.

Where a Leachate tank is constructed in situ, below ground or partially below ground, the designer/installer will need to complete the relevant part of EA Form WQE3.

Uncontaminated surface water should be drained off outside the silo system to soakaways.

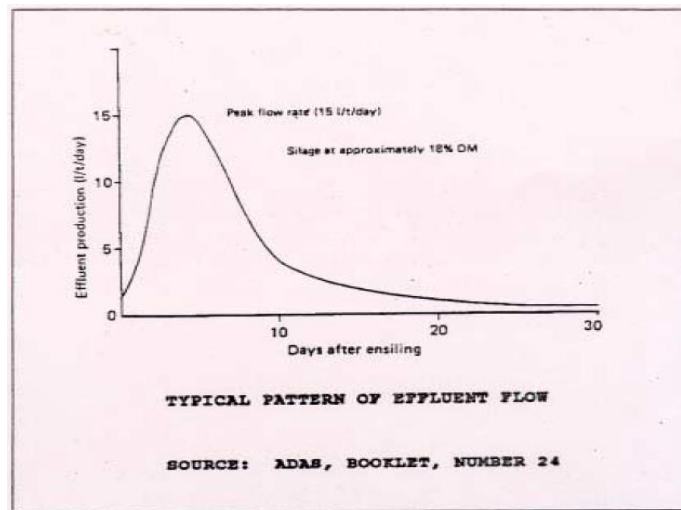
Leachate Tank Testing

Before the Leachate tank is backfilled and buried, it must be tested for water tightness.

Drainage

During the fermentation process, at least 50% of the silage leachate is generated within the first week and in the next two weeks an additional 25% is produced; thus 75% of the silage leachate can be generated within three weeks after ensiling.

Silage leachate can continue to be generated for a period up to eight weeks after ensiling. The graph below shows the pattern of silage leachate generation over time.



Typical leachate production

It is therefore important to cover the clamps effectively because in cases where rainfall, groundwater or storm water is not excluded, Silage leachate generation can continue for the entire biological life of the silage pile.

The Leachate must be drained off quickly to prevent acidic attack at the joint between the silo wall and floor, so in addition to a 2% fall along the axis of the silo, it is recommended that a longitudinal “gully” is created by sloping the silo floor with a 2% fall away from the side walls. Note that there should be no joints in this gully.

A drainage system is needed for each silo bay which should where possible enable the Leachate and surface water to be drained off separately. This system should be designed by a drainage consultant taking into account the nature of each silage clamp site.

Silage residues should be prevented from accumulating on the floor by regular cleaning.

The farmer / operator is responsible for the design and operation of the silage system and they should ensure that pollution of surface or ground waters is prevented.

Durability of Materials

Insitu Concrete

Silage Leachate is acidic and attacks all types of concrete, leading to degradation over time. For selection of appropriate concrete mixes for extreme exposure conditions refer to BS8007: 1987, BS 8500-1:2006 and BS8110-1:1997

Laying the concrete

Insitu concrete must be ordered to the correct specification and laid with due care. The concrete



requires compacting depending on its consistency - compaction may be manual or through mechanical vibration.

Concrete Curing

Correct curing ensures that the concrete will achieve maximum strength; have good wear resistance, be durable in terms of resistance to weathering and resistance to chemical corrosion, reduces shrinkage cracking and ensures good adhesion for subsequent silo coatings.

Curing involves retention of moisture in the concrete and the maintenance of a favourable temperature to prolong the hydration process. The curing regime should prevent the development of high temperature gradients within the concrete.

Commonly used curing methods include covering the concrete with cover sheets which should be in place for at least 7 days or the application of suitable liquid curing membranes.

Surface Treatments

Surface treatments, either as surface coatings or penetrating sealants, should be applied to concrete exposed to strong chemical corrosion ($\text{pH} < 5.5$). ARK Agriculture has products for just this purpose; please contact us for more information.

Coating thickness and wear

The durability and resistance of surface coatings is largely determined by the strength and quality of the subsurface which is dependent upon proper curing of the concrete.

A sufficient coating thickness (2 or 3 coats) must be achieved; if the coating layers are too thin, acid penetration may occur, which usually causes even greater damage to the concrete surfaces than if they had been left untreated. The coating manufacturer's instructions should be followed.

Please contact ARK Agriculture for more information on the products we are able to supply to coat panels.

Precast Concrete Panels

The concrete used in the Wall Panels is designated C40/50, complying with BS8500 exposure classifications XC4, XF4 and XA3; using 20mm flint aggregate.

Exposure Class	Class Description	Nominal cover to reinforcement $35 + \Delta C_{dev}$	Min Compressive Strength Class	Min Water/Cement ratio	Minimum Cement content kg/m^3
XC4	Moderate humidity or cyclical wet and dry	40mm	C25/30	0.65	320
XF4	High water saturation	40mm	C40/50	0.45	360
XA3	Chemical attack: Acid water $\text{PH} \leq 4.0$		C35/45	0.45	360



Surface treatments, either as surface coatings or penetrating sealants, should be applied to the wall units after 1 year to give protection against silage Leachate attack.

ARK Agriculture are adamant that protective membranes (side wall sheets) must be used.

Hot Rolled Asphalt (HRA)

Floors of bunker silos are constantly exposed to aggressive silage Leachate and mechanical stress due to the use of machinery such as silage cutters, mixing vehicles etc.

Asphalt is well suited for the construction of silo floors **provided that Limestone materials are excluded.**

Asphalt is acid-proof, sufficiently resistant to abrasion and withstands mechanical stress. Because of the bitumen's chemical stability against many acids and Leachates (even in high concentrations,) asphalt achieves a very long useful life provided that the aggregates are added with due care and to the correct formulation.

The higher the density of the asphalt laid, the greater its resistance to aggressive fluids; proven construction methods include tightly roller-compacted asphalt or mastic.

Bitumen has not been found to contain any harmful or soluble substances that can be expected to have negative effects on food or forage.

Asphalt is also used for hygienically demanding circumstances, such as for making drinking water pools, water reservoirs, pipelines etc. watertight.

A floor constructed with HRA surfacing will comprise a series of layers formed over the sub-grade (natural ground). The thickness and type of these layers depends upon the stability of the subgrade. If site conditions are satisfactory and traffic is limited (self-feed systems) then the construction could comprise a sub-base (compacted crushed stone), a binder course of HRA and a top surface course of HRA. Where vehicles regularly use the floor, a base of dense regular concrete mix may also be required. Specialist advice should be obtained for the design of the floor.

The life of the laid asphalt can be enhanced by ensuring:

- That the area is not used for storage or parking of vehicles, machinery etc. when the clamps are empty.
- Oil, mud and waste silage is removed from the surface as soon as possible.
- Any damage to the surface is repaired using a suitable impermeable bitumen product.
- All joints between the floor and wall panels and drains are inspected regularly for signs of wear.



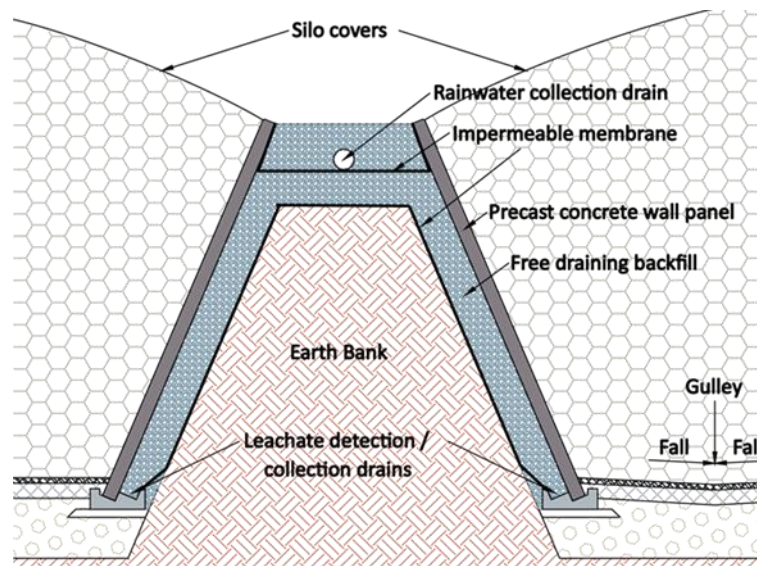
References:

CIRIA C759 : 2015	"Livestock manure and silage storage infrastructure for agriculture- <i>Part 2 Design and construction</i> "
BS5502-2: 1990	"Buildings and structures for agriculture - Code of practice for selection and use of construction materials"
BS8077: 1987	"Design of concrete structures for retaining aqueous liquids"
BS8110-1: 1997	"Structural use of Concrete- code of practice for design and construction"
BS8500-1: 2006	"Concrete – Method of specifying and guidance for the specifier"
ADAS CGN 012: 2002	"The use of hot rolled asphalt (HRA) surfacing for agricultural forage silos"
BS EN 13108-4: 2016	"Bituminous mixtures - Material Specifications - Part 4: Hot Rolled Asphalt"

Silo Construction:

For health and safety reasons it is recommended to construct the Silo in the following sequence:

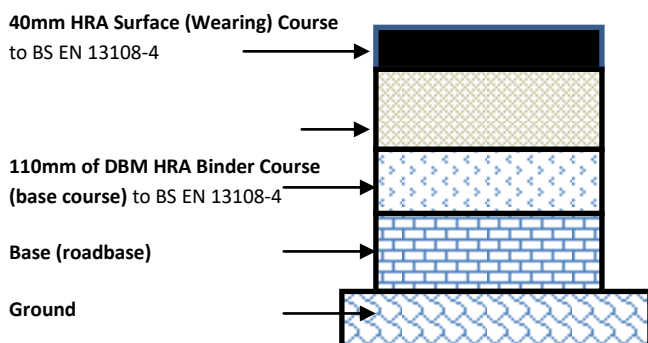
1. Frost Protection Layer (clamp base)
2. Earth Bank Construction
3. Laying the seating channel
4. Drainage installed
5. Placing the wall panels and fitting tension anchors (supplied)
6. Back-filling the wall panels
7. Laying the silo floor area with asphalt



Section through internal bank

1. Frost protection layer

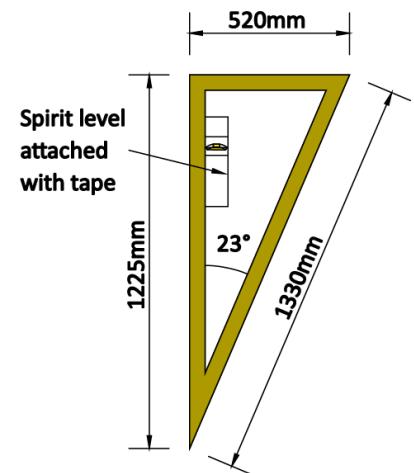
Frost sensitive soils such as clay or silt can heave when subjected to long periods of sub-zero temperatures.



Therefore it may be necessary to replace the frost susceptible soil with a frost-proof base, (e.g. finely graded gravel, sands or other frost-proof soil material,) which can be easily compacted to provide a strong foundation layer.

In the case of non-load bearing soil, soil-improvement work will have to be carried out.

2. Earth bank construction



A profile frame can be made up as above to achieve the correct bank slope

It is recommended to first construct a generously dimensioned preliminary earth bank and to then cut it off to match the 23° incline of the wall panel using a digger.

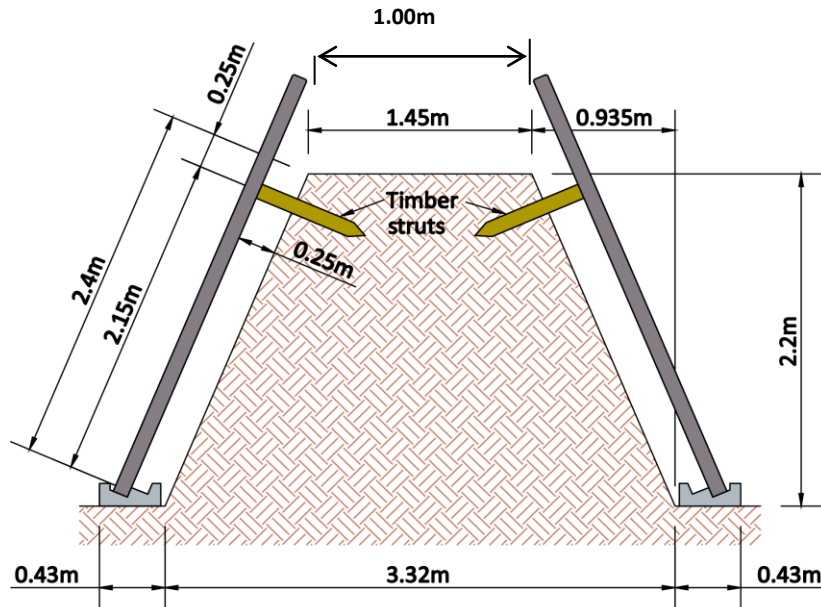
The earth bank should be at least 1.45m wide at the top, (1.00m between the tops of the precast wall units) – **Heavier silage compactors will require wider banks – consult your structural engineer.**

The bank should be built up in compacted layers – the depth of the layers will depend on the soil, type of machinery being used and local conditions.

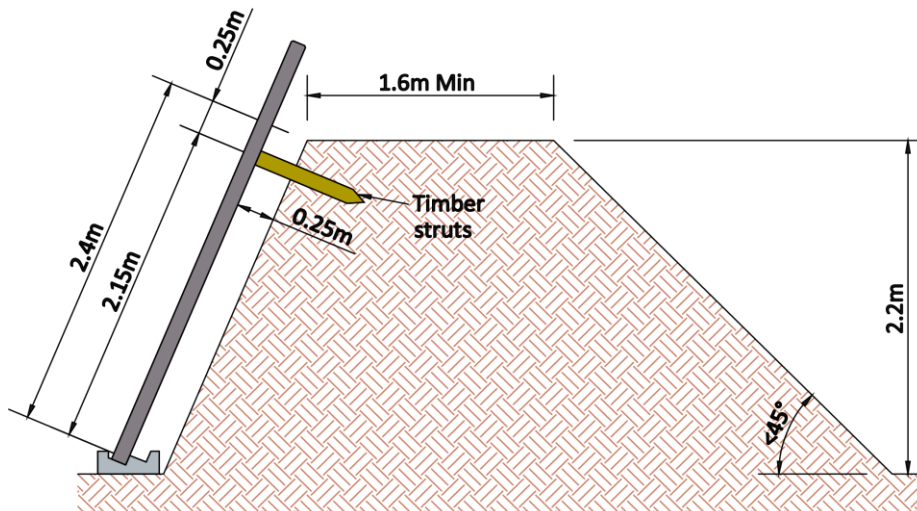
Allowance must be made for the 200 – 300mm thickness of backfill between the bank and the precast wall units.



Earth banks being built up or 'dug in' prior to panel installation



TYP. SECTION THROUGH DOUBLE WALL EARTH BUND



TYP. SECTION THROUGH SINGLE WALL EARTH BUND

The outer slope of external bank should be less than 45° for safety reasons; this bank should be planted to prevent soil erosion.

A geotextile liner (e.g. Terram T1000) should be placed over the bank, to ensure that the gravel infill does not migrate into the bank.


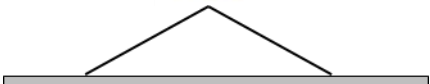

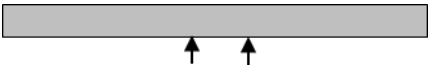
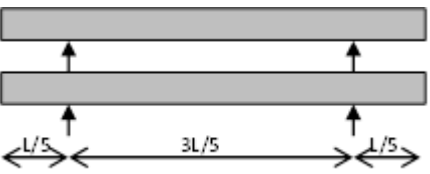
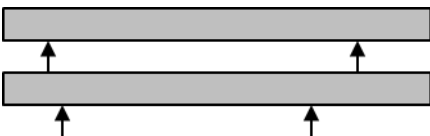
3. Seating channels

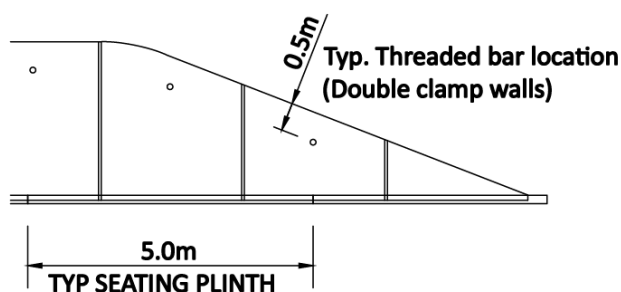
3.1 Offloading and stacking

5m long Seating channels weigh 0.53 T. The seating channels are to be lifted with chains using 2No. M12 lifting loops (supplied) inserted into sockets cast into the top of the units.

Extreme care should be taken when moving and stacking the seating channels to avoid damage. Stacking should be on firm level ground.

Lifting of channels should only be carried out with the appropriate machinery – Telehandlers (due to their swaying motion on rough ground) are not advised.

<p>Lifting</p>	  <p>A set of M12 wire lifting loops (SWL 500kg) will be supplied with the first delivery of seating channels. These loops screw into the open sockets on the seating channels for easy handling with lifting chains.</p>	  <p>Seating channels should not be lifted in the middle with forks.</p>
<p>Stacking</p>	 <p>Stacking should be on level ground with bearers placed at $\frac{1}{5}$th points</p>	 <p>Bearers should line up vertically above one another</p>



3.2 Installation- General

The seating channel has 2 recesses, the upper (front) recess supports the wall panels, and the lower (back) recess acts as a drain should leachate penetrate the wall. The seating channels are set below the surface of the silo floor so that the flooring material covers the top of the channel.

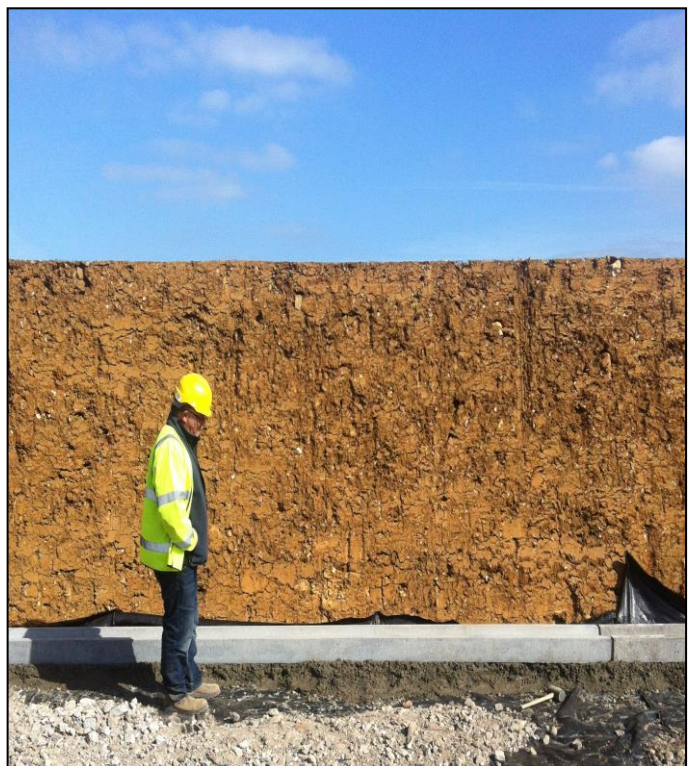
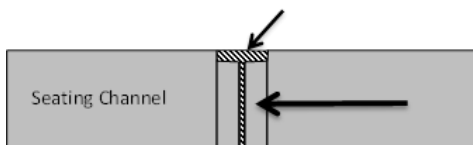
The seating channel must be positioned at a constant offset from the base of the bank to allow placement of the gravel backfill.

The seating channels are placed on concrete blinding and anchored against sideways displacement by 2No. H25 bars 600mm long embedded in the lean-mix concrete blinding; (these bars will be supplied with the first plinth delivery.)

The technical drawings that are supplied with the clamps will explain the positioning of the seating channels on site. The channel with the down pipe built in must sit at the lowest point on the clamps.

You can choose to apply a bead of the bitumen paste in the recessed sections of the channels once installed.

Bitumen bead sealing joint between seating channels

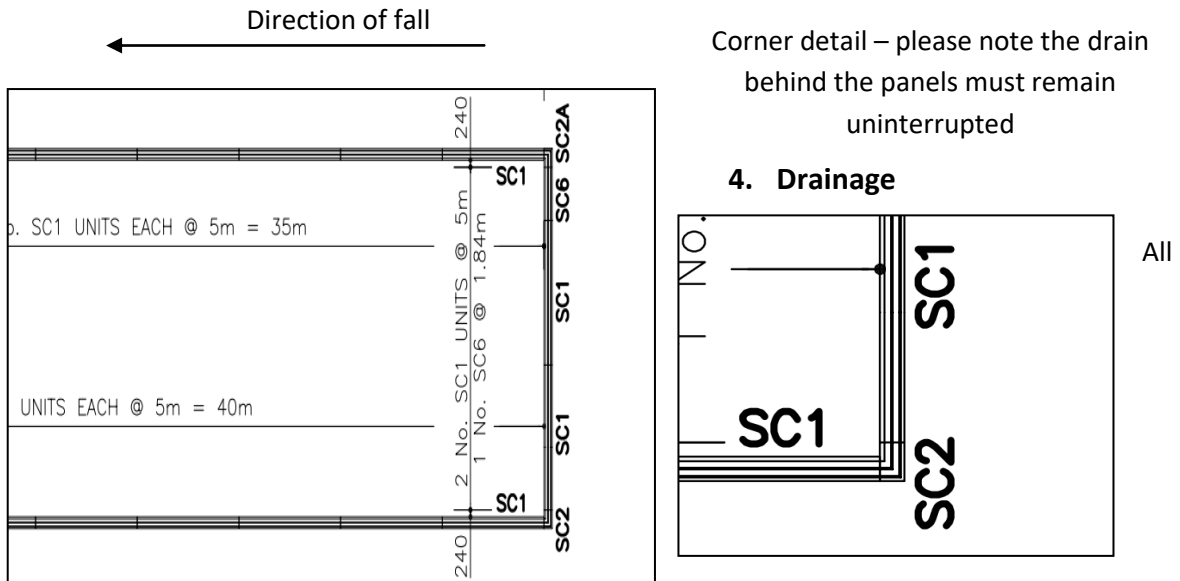


Typical install of seating channels

3.3 Installation - U shaped clamps

When constructing a 'U shaped clamp', separate corner pieces (marked on the drawings) will be supplied.

The seating channels should be laid, working away from the top left corner, please see example below.

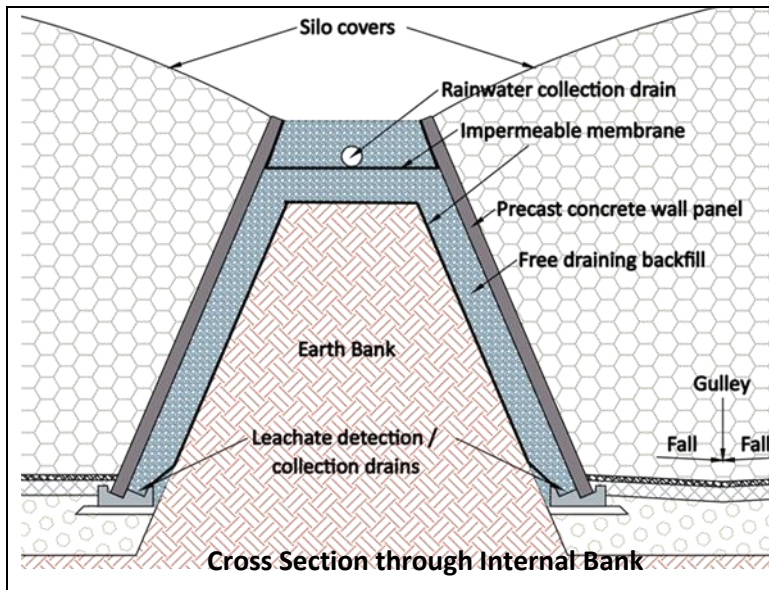


drainage arrangements are site specific and must adhere to the SSAFO regulations- professional advice from a drainage engineer should be obtained before work commences.

ARK UK does not accept any responsibility for the specific drainage design of the silage clamp, however it is good practice to slope the floor away from the base of the walls and to have a 2% longitudinal fall along the axis of the silo.

In the unlikely event of leakage occurring through the vertical joints in the concrete panels, the leachate will percolate down the back of the walls and be intercepted by the Leachate leakage collection drains incorporated in the seating channels. These channels should be connected to an inspection chamber prior to entering the main leachate drainage system.

When the highly nutritious silage effluent is used to feed Micro-organisms present in AD plants and suitable control mechanisms must be incorporated by the drainage designer.



Laying impermeable membrane

Surface water collection drains can be located on top of the earth bank, separated from the free draining backfill by an impermeable membrane to convey rainwater run off from the silo covers to the surface water drains.

Although there is little likelihood of Leachate leakage through the wall panel joints, the concrete seating channel incorporates a collection drain, thus complying with the SSAFO regulations which require Leachate drains behind the walls. These channels are connected to collection drains which pass through an inspection chamber that is regularly inspected for signs of Leachate contamination.



Seating Channel with Drain outlet

All drainage pipes should be of sufficient diameter to cater for the volumes generated. These pipes must be surrounded by a jacket of filter gravel which must be separated from the surrounding soil by a geotextile.

The percolation performance of the soakaways should be verified by percolation tests.

Note:

The farmer / operator is responsible for the design and operation of the Silage system and they should ensure that pollution of surface or ground waters is prevented.

If pollution occurs the farmer / operator may be prosecuted by the Environment Agency.

5. Erection of Precast Walls

Offloading wall panels from Lorries – not the panels are reversible for use both ways.

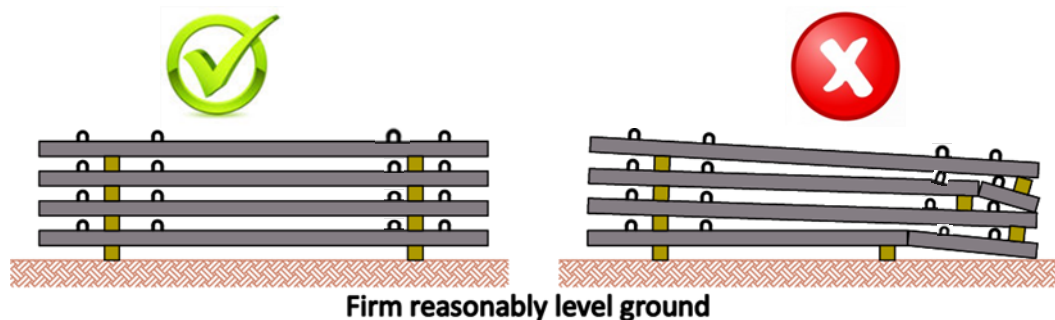
For off-loading wall panels, attach chains to 3 outer loops



The client is to provide appropriately trained labour and machinery to offload the precast units. Suitable control measures should be provided to protect operatives from falls from height.

3m x 2.5m x 0.1m Wall panels weigh ~ 1.8T. For offloading the wall panels, lifting chains should be attached to the 3 or 4 outer loops as illustrated on opposite page.

The length of chains or slings should be sufficient so that the included angle is not greater than 90°
Stacking wall panels



If the wall panels are to be placed in stacks, they should be placed on timber bearers, located just in from the sides of the panel, with the bearers lined up vertically above one another. Similar sized panels should be stacked together.

Care should be taken in the stacking and general handling of the units, taking into account the weight of the products and the load carrying capacity of the ground.

5.1 Timber struts.

Suitable wooden posts (e.g. 75mm x 75mm x 1.2m long,) provided by the client, are driven into the bank, one post per wall panel. (These timbers will remain in position after the panels have been backfilled.)

The purpose of the posts is to act as temporary support to the wall panels, ensuring that they are correctly aligned at 23° to the vertical and positioned off the bank, before the backfill is placed.

Using the profiling gauge, the posts are marked and cut to the correct length to support the wall panels.



5.2 Vertical joints

The joints between the wall panels should not be exposed to leachate if the appropriate side wall film is used - if not they will only be subjected to short term exposure to dilute Leachate when the silage is wet. The “halving joints” on each vertical edge need to be treated with the specialist primer (Hahne – Imberal Aquarol 10D) and then the 2 component bitumen sealant (Hahne – Imberal Aquarol 90B) (approx. 0.7 litres / metre run) in accordance with the manufacturer’s instructions on the tub and within the order confirmation pack.



Correct application: Applying plenty of bitumen over entire face ensures the joint is filled

Incorrect application: Insufficient bitumen (note the unsealed gaps between panels)



Placing wall Panels



The 1.8T wall panels are lifted from the stack using the two outer loops cast into the back of the unit. The length of chains or slings should be sufficient so that the included angle is not greater than 90°



It is suggested that pieces of wood are used as wedges to keep the bottom of the panel tight against the back of the precast seating channel.

The wall panels are lowered into the upper groove in the seating channel and leant against the wooden strut.

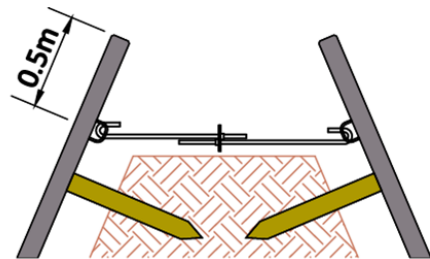


An 800mm long tube (supplied) is placed through the top loops at the sides of the wall unit and secured with an oak wedge (supplied) to ensure that there is a tight joint between the units.

ARK UK will provide you with drawings outlining the correct layout of the wall panels and channels for the clamp design.

5.3 Fixing of ties

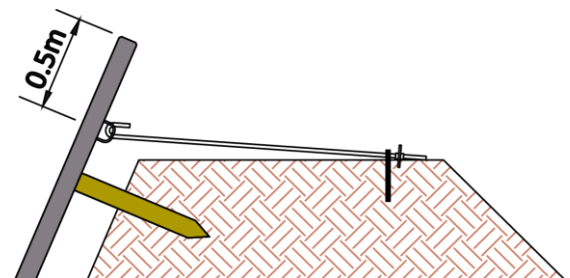
The tension ties are designed to restrain the wall panels from being displaced when the gravel backfill is placed.



2 No. 16mm threaded ties pass through plate and secured with nuts

For **internal banks**, the wall panels are tied to one another by hooking the ends of the 1.2m threaded tie bars through the centre loop cast in the back of the wall panel, (500mm from the top,) and fixing them together with a drilled plate and nuts. (Tension ties can be omitted for joining lower sloping panels PC3,PC4, PC6 and PC7.)

For **external wall panels**, the hooked end of the 1.20m long tie bar is inserted through the centre loop cast into the back of the panel and the anchor plate is fixed to the other end and laid on the top of the bank. A U bar, placed tight against the anchor plate is driven vertically into the bank to restrain the assembly.



1 No. hooked threaded bar, 1 No. plate, 2 No. nuts and washers; plate restrained by 1No. U bar driven vertically into bank

5.4 Treatment of horizontal joints



The gap between the top of the plinth and the precast walls is filled with non-shrink grout (supplied) and the wooden wedges removed. This joint will be covered by the asphalt support layer.

5.5 Backfilling the wall units

Free draining backfilling material (8–32mm) should be **carefully trickled** into the 250 – 300mm gap behind the precast walls in 150mm layers.

Recycled concrete as produced at state-of-the-art reprocessing plants is also suitable; to assess the material the constructor must consult a specialist (e.g. a civil engineer or a road

construction specialist).

The drainage material should not be mechanically compacted or washed in.



6. Silo Floor

Hot Rolled Asphalt (HRA) specified for use on silage clamps should be laid in two layers with the void content limited to a maximum of 3.0% vol. Careful compacting is therefore required, especially towards the margins.

The mineral products used (e.g. grit, sand and filler) must be resistant to acids, e.g. basalt, granite etc. - **Limestone fillers must not be used.**



The recommendations made in this document only apply to the use of roller-compacted asphalt.

Large areas of asphalt are laid by machine, smaller areas by hand. It is particularly important to avoid unevenness which leads to puddle formation, and ensure careful compaction to avoid subsequent Leachate infiltration through the asphalt layer. It is normal practice to offset joints in different layers.

Careful planning of this operation is essential as the asphalt should be laid in a continuous operation. (Cold asphalt is difficult to compact and does not produce a smooth surface.)

The gap between the top of the silo floor and the precast walls is to be filled with an acid resistant, permanently elastic bitumen material or epoxy sealant.

Newly laid HRA should not be trafficked until it has cooled to ambient temperatures - normally about 24 hours. Certain machinery oils soften HRA and sustained point loadings can damage the surface. HRA surfaces should not be used as permanent parking or for pallet/feed trough storage areas.

7. Silo Wall Leachate protection:

Leachate is acidic and attacks all types of concrete, leading to degradation over time.

Surface treatments, either as surface coatings or penetrating sealants, should be applied to the wall units after 1 year to give protection against Leachate attack.



Protective membranes such as ARK polyethylene Side Wall Film should be used to ensure that air is kept out of the silage and to protect the concrete walls.

Silo Inspection and Maintenance:

Element	Symptom	Cause	Remedy
Walls	Cracked or spalled concrete	Machinery impact damage causing corrosion of reinforcement due to insufficient concrete cover	Remove damaged concrete and make good with R+M products (contact ARK)
	Erosion of concrete	Leachate dissolving cement matrix	Repair damaged area with R+M products (contact ARK). ARK Protective Silo Paint can be applied to the bottom of the wall panels. Protective membranes such as ARK polyethylene Silo Wall Film must be used.

Wall Joints	Leachate detected in inspection chamber. Sealant between concrete wall panels damaged or degraded	Inappropriate sealant or simply worn out	Remove old jointing material. Clean out joint and reseal vertical joints between the precast wall panels with ARK Bitumen filler.
Floor	Floor eroded	Leachate dissolving cement matrix	If only slight erosion, slow down further deterioration by coating with penetrating sealer. If severe erosion, resurface
Floor Joints	Leachate detected in inspection chamber. Sealant between Floor / Wall panels damaged or degraded	Inappropriate sealant, or simply worn out	Remove old jointing material. Reform groove. Reseal with permanently elastic, acid-proof bitumen grouting compound.

Wall panels

Before the silo is filled the wall panels, joints and asphalt should be inspected for damage and repairs carried out as necessary.

Wall panels should be thoroughly cleaned to remove old silage residue. Repairs can be made with the appropriate R+M materials (contact ARK for more information).

ARK Silo wall paints can be sprayed onto the concrete and ARK Protective Silo Paint can be applied to the bottom of the wall panels.

Vertical joints between the precast wall panels should be repaired with ARK Bitumen filler.

The horizontal joint between the wall panel and silo base should also be inspected and repaired as necessary with permanently elastic, acid-proof bitumen grouting compound.

Silo Floor

Silage residues should be prevented from accumulating on the floor by regular cleaning.

Repair: Where small areas of the surface are damaged repair products are available; these should be checked for their permeability characteristics. They must be used strictly in accordance with the manufacturer's instructions and be inert after curing. For major repairs consult an experienced contractor.

Resurfacing: A detailed survey of the existing floor slab should be carried out to confirm that



a new surface could be laid without causing any structural damage.

Once the base is approved as structurally sound the old floor should be prepared in the following manner:

- a. Power wash apron to create a clean surface.
- b. Thoroughly clean all existing cracks or open joints and fill with a sealant.
- c. Repair potholes and failed edges.
- d. Form chases in floor at the front of clamp to key the new surface.
- e. Apply tack coat.
- f. Lay and compact HRA surface course and caulk joints with sealants or water bars.

Drains

The Leachate inspection chamber should be inspected regularly to ensure that there is no leakage through the concrete walls / joints. If Leachate leakage is detected the wall panels and joints will need to be inspected and repaired.

Leachate Tank

Tanks must be monitored and emptied regularly during the drainage period in the first 4 – 6 weeks.

The tanks must be emptied regularly such that they are never more than $\frac{2}{3}$ full.

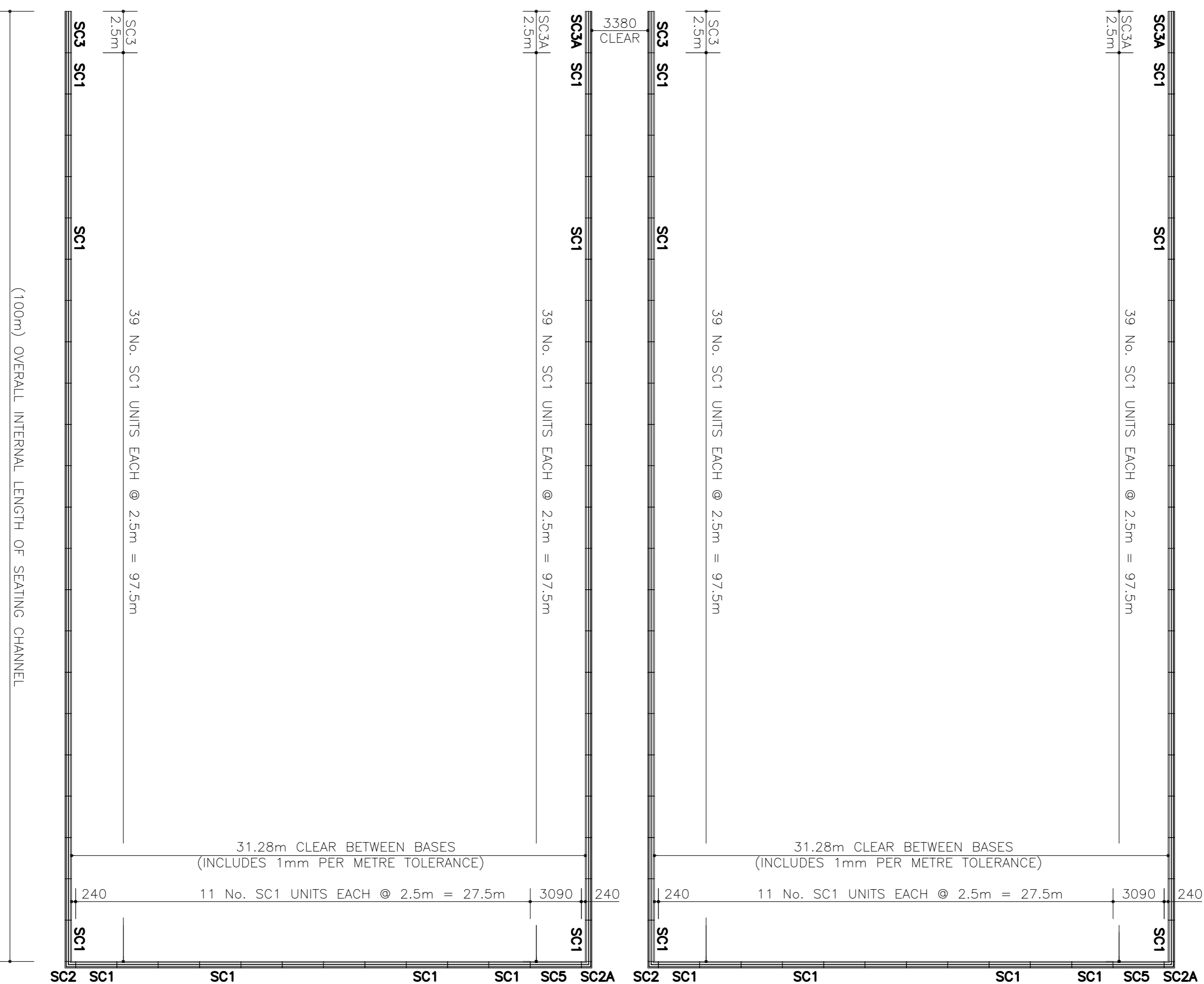
Disclaimer

ARK Agriculture Limited assumes no liability for damages caused by incorrect construction of the silo. The work described must be performed by qualified specialist firm. - The selection of such specialist firms is at the sole discretion of the client.

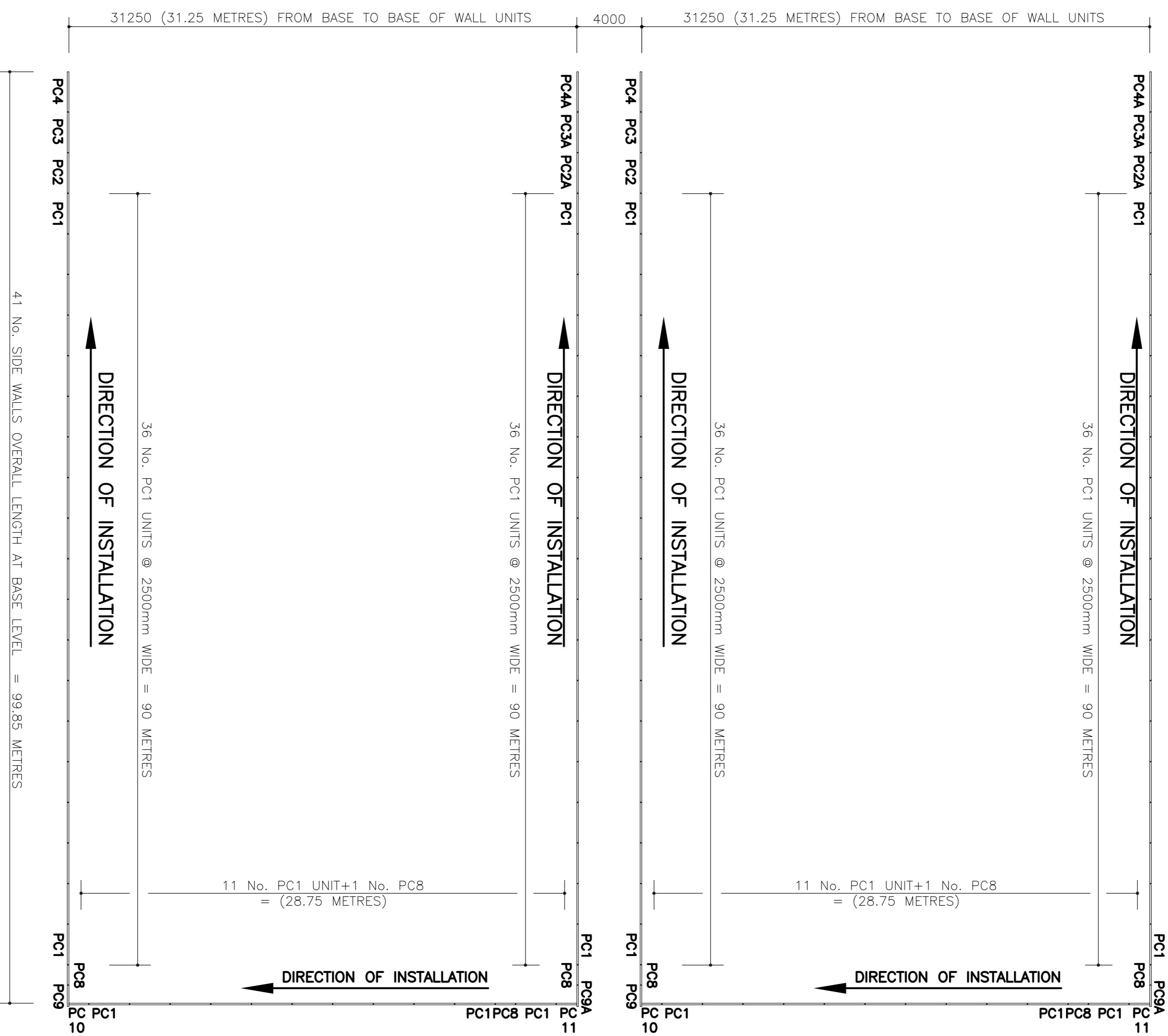
ARK Agriculture Ltd
Milbank House
Earls Colne Business Park
Colchester, Essex. CO6 2NS

Note: These construction specifications are not to be disclosed to third parties!

NOTE:
 ALL SC3/3A CHANNELS TO BE LAID AT LOWEST POINT AS PIPE PROVIDED FOR LEACHATE DRAINAGE



PLAN ON SEATING CHANNELS



PLAN ON WALL UNITS

NOTES

1. Design Information.
 Loadings, Self weight as noted on drawing
 Finishes – KNV/m²
 Imposed – KNV/m²
 Concrete: 50 N/mm² @ 28 days
 Exposure: XA3/ XF4/ XC4
 Fire resistance: ONE Hours
 Min cover to reinforcement: 40 mm
2. Dimensions.
 The Main Contractor (M.C.) shall check and approve all setting out dimensions and return a copy of this drawing signed as approved before manufacture can commence.
 Dimensions checked and approved
 Signed:
 For:
 Date:

3. Installation.
 Access and hoisting shall be provided by the M.C. for a mobile crane and transport as stated in the Bill of Materials.
 The M.C. shall remove and/or remove and reinstate any overhead obstructions that may hinder the installation of the precast units.
 All bearing surfaces must be constructed to the correct levels, be true and mature at the time of installing the precast units.
4. Finish of Precast units.
 Exposed wall face will have a steel mould finish.
 Wall sides face will have a timber mould finish.
 Back wall face will have steel trowel finish.
 Concrete or mortar infill at lifting sockets, tolerance joints, and other joints in concrete make up by the M.C., unless noted otherwise.

C	12/05/21	BACK WALL LENGTH REDUCED TO 31.25m LONG	DK
B	26/04/21	SIDE WALL LENGTHS REDUCED TO 100m LONG	DK
A	16/04/21	BACK WALLS ADDED	DK
			BY
	NO. DATE	REVISION	
	WORKS ORDER No.	DATE	
	45440		

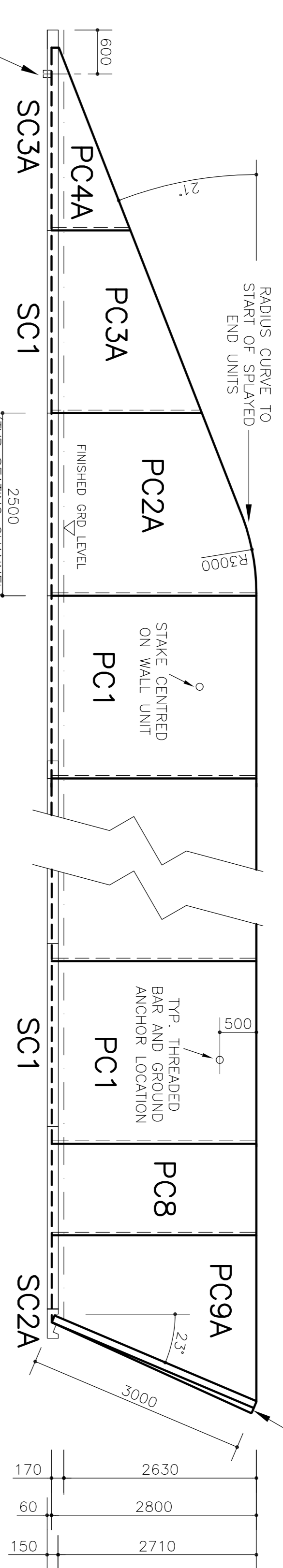
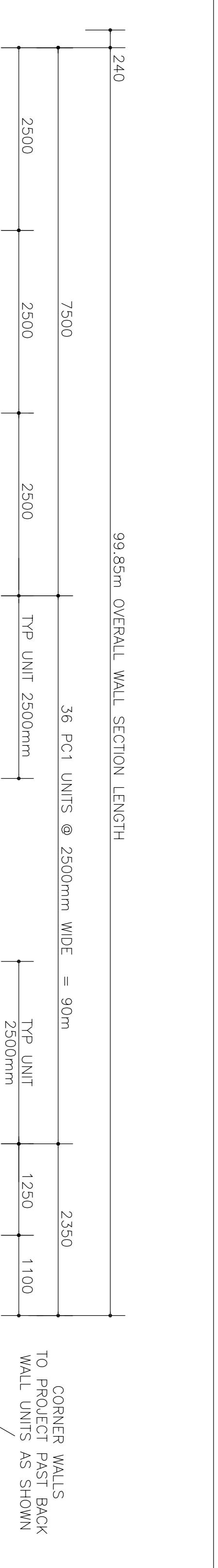
CONTRACTOR: CHARLTON PARK AD PLANT

TITLE
 PRECAST CONCRETE SILAGE CLAMP
 PLAN SETTING OUT
 OPEN END CLAMP



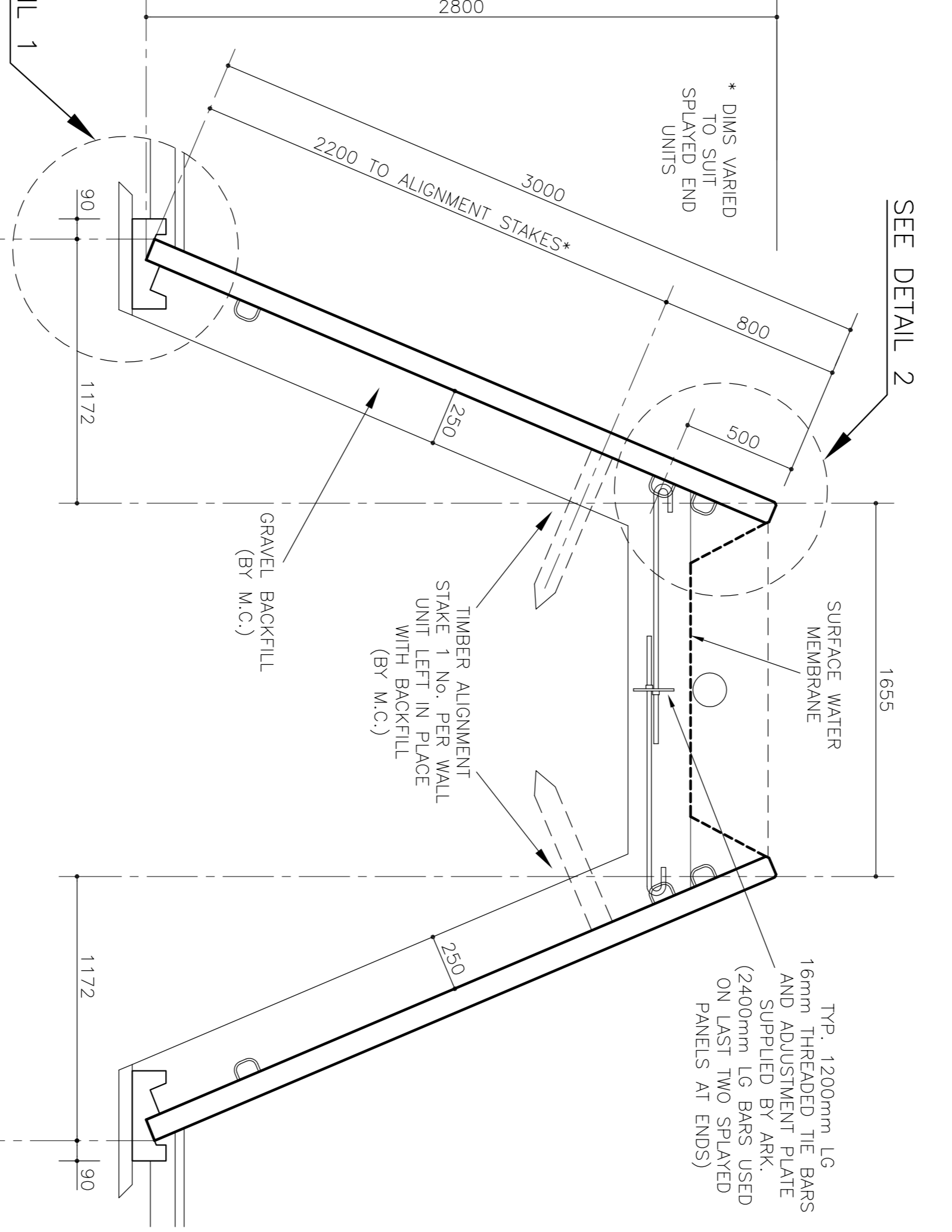
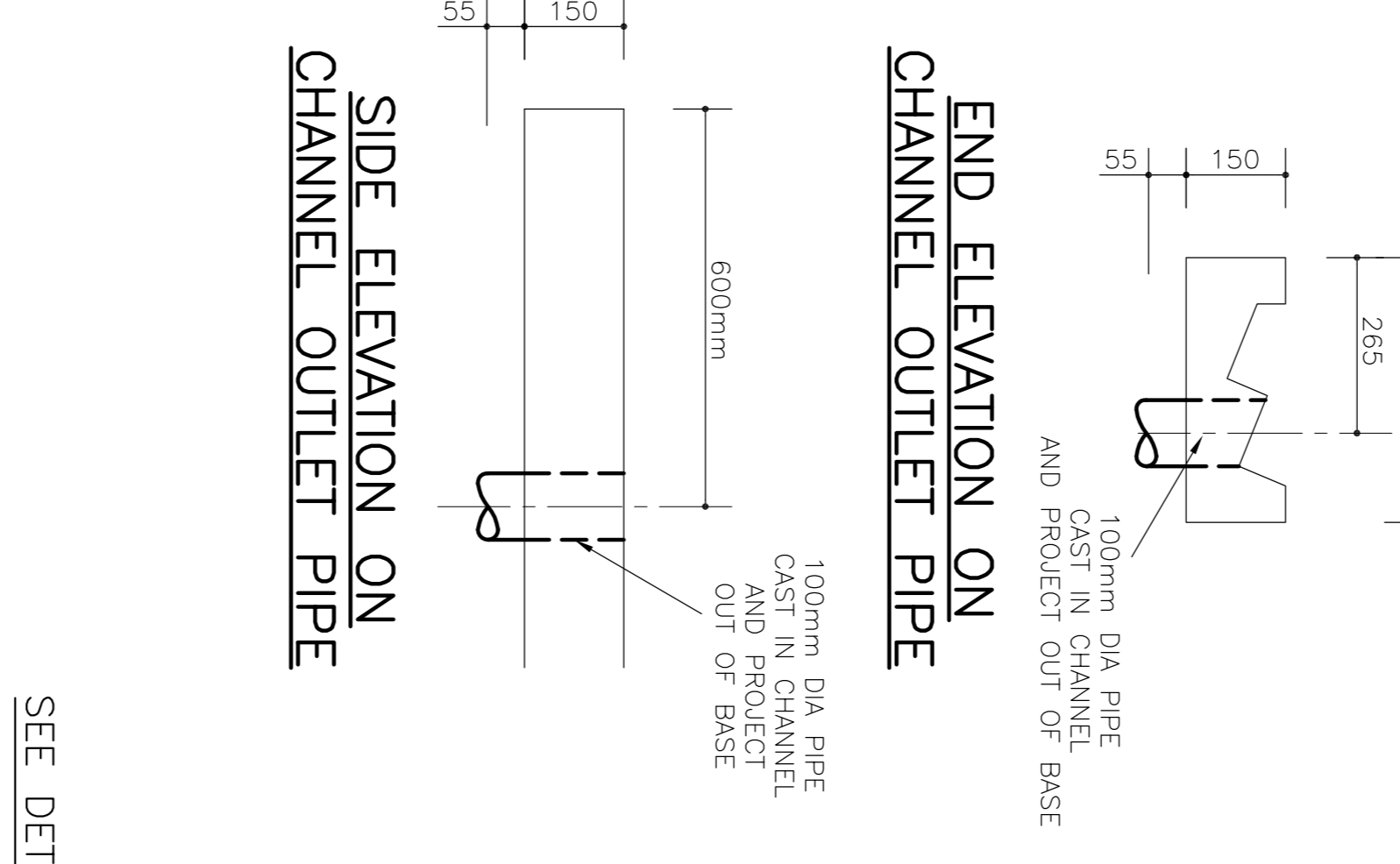
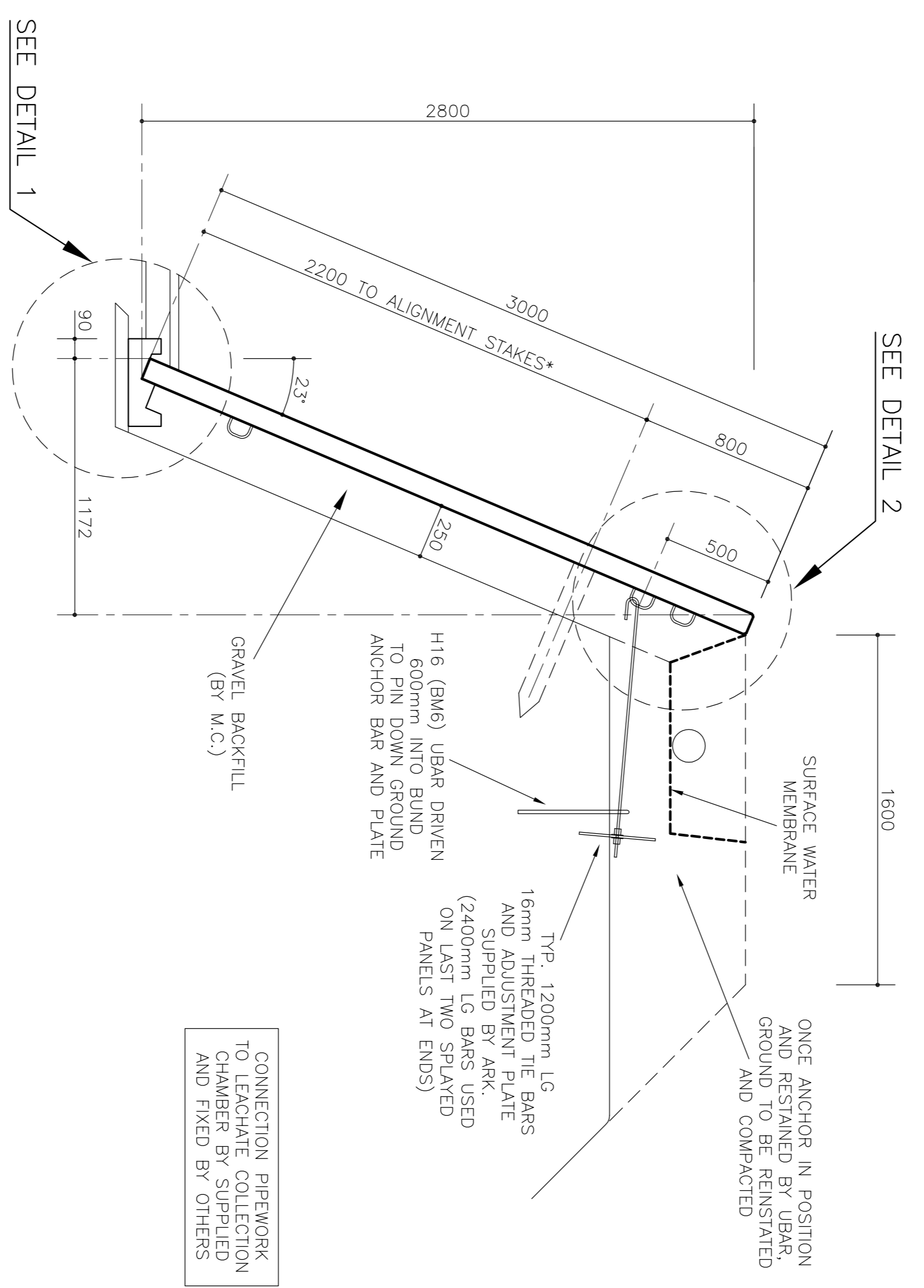
Ernis Colne Business Park, Ernis Colne,
 Colchester, Essex, CO6 2NS
 Tel: 01787 220560

CLIENT	RAW ENERGY	L/D	CHK
SCALE	1:200 = A1	DATE	09/04/21
		DRWN	DK
		CHK	DK
SCHEME No.	W153916	Rev	C



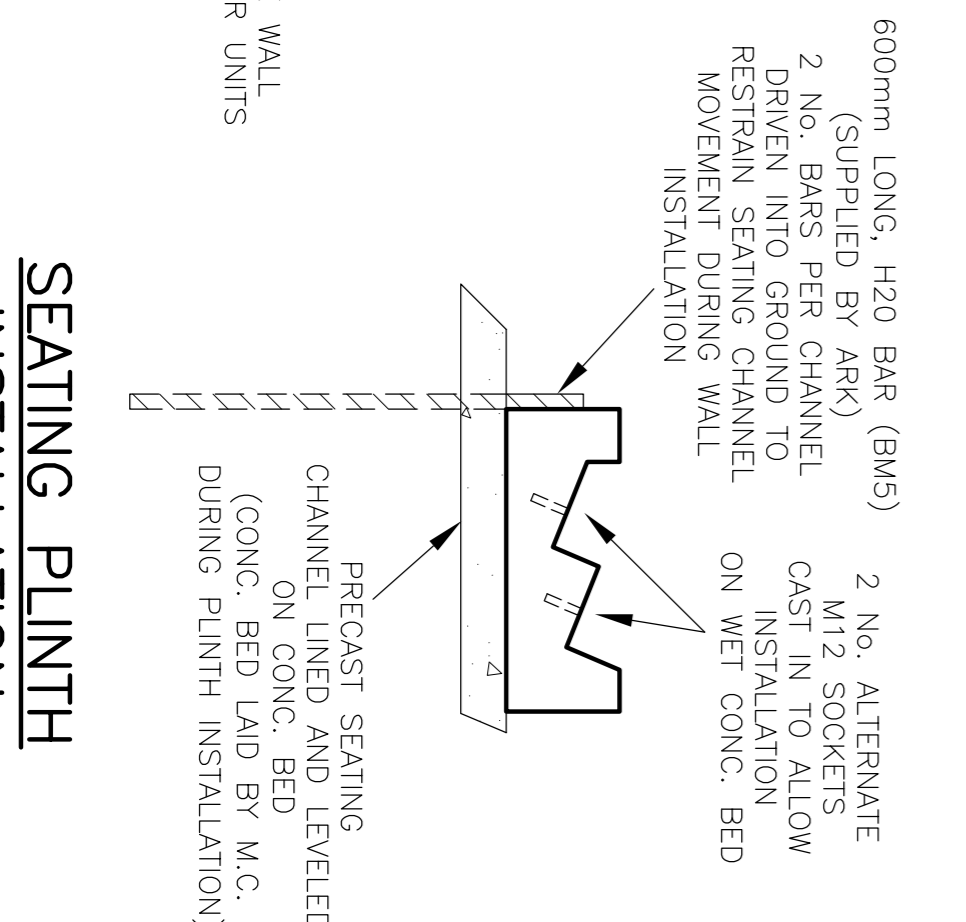
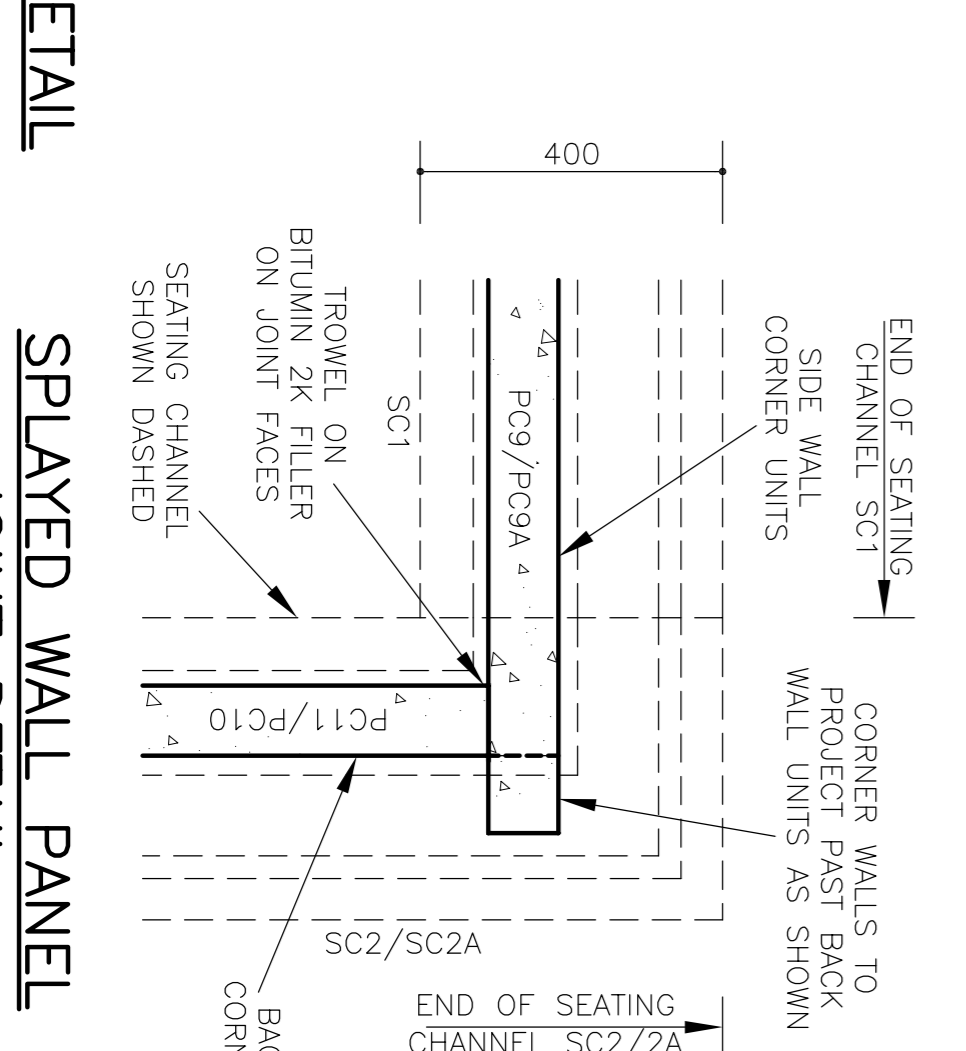
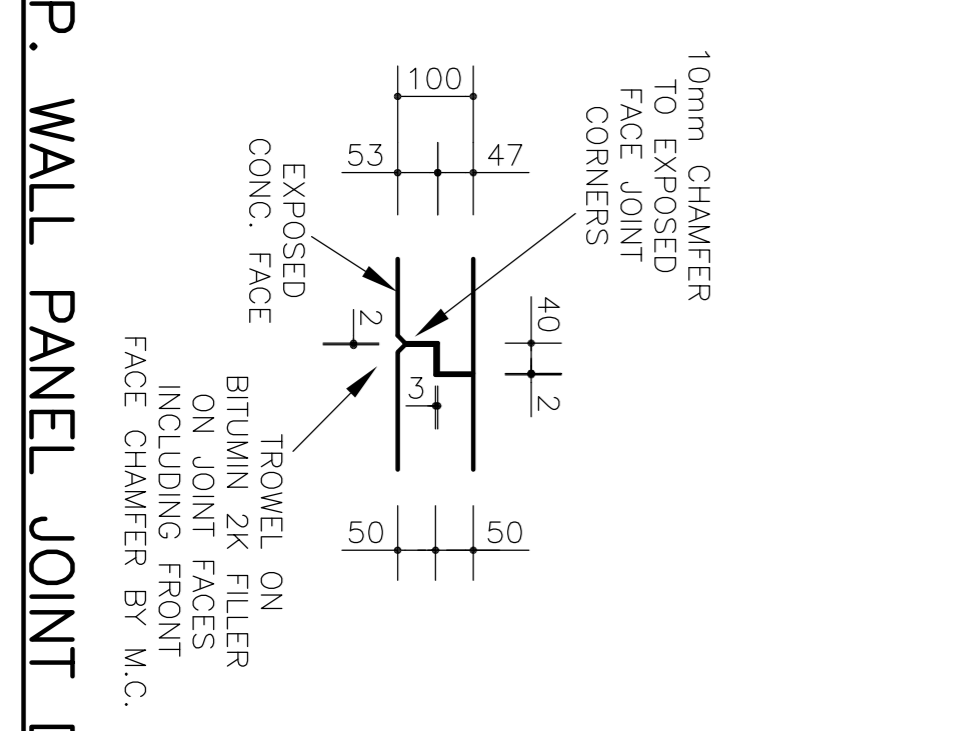
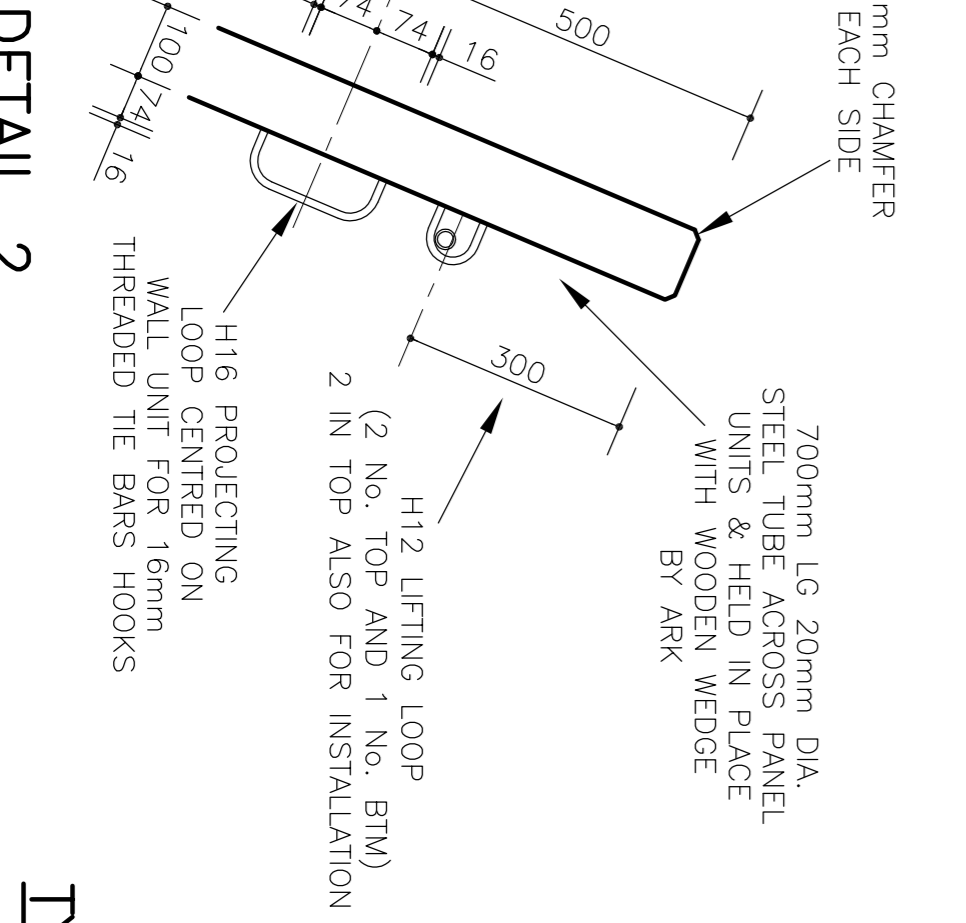
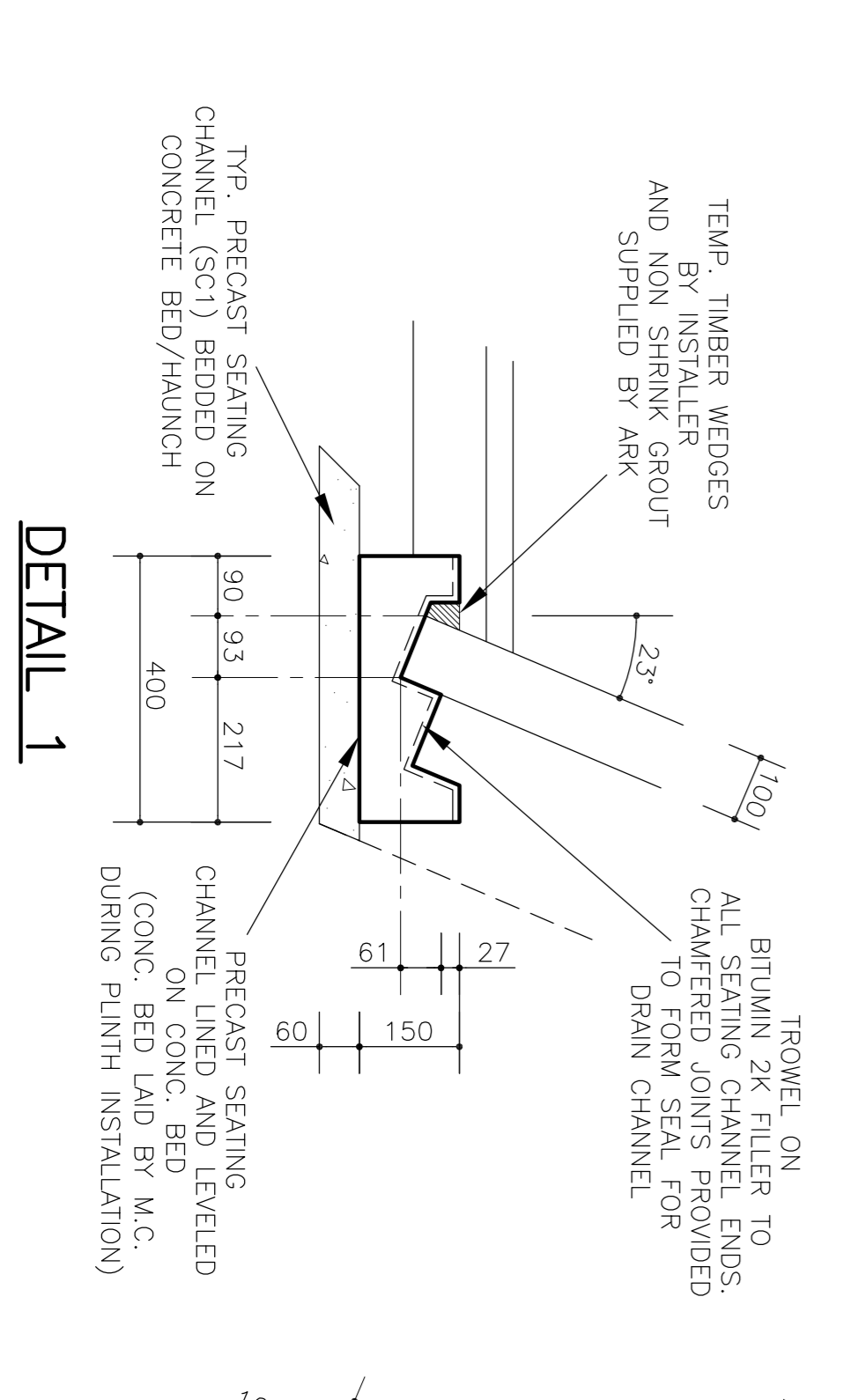
TYP. ELEVATION ON SILAGE CLAMP SIDE WALL
(4 No. 99.85m WALL LENGTHS REQUIRED)

TYP. ELEVATION ON SILAGE CLAMP BACK WALL
(2 No. 31.25m WALL LENGTHS REQUIRED)



TYP. SECTION THROUGH SINGLE CLAMP WALL
(SEE DRG. 02 FOR EARTH BUND SETTING OUT)

TYP. SECTION THROUGH DOUBLE CLAMP WALL
(SEE DRG. 02 FOR EARTH BUND SETTING OUT)



NOTES

- Design Information. Loadings, Self weight as noted on drawing. Finishes = KN/m². Imposed = KN/m². Concrete: 50 N/mm² @ 28 days. Exposure: XA3/XF4/XC4. Fire resistance: ONE Hour. Min cover to reinforcement: 40 mm.
- Dimensions. The Main Contractor (M.C.) shall check and approve all setting out dimensions and return a copy of this drawing signed as approved before manufacture can commence. Dimensions checked and approved. Signed: For: Date:
- Installation. Access and handstanding shall be provided by the M.C. for a Mobile Crane and Transport as stated in the Method Statement. The M.C. shall remove and/or remove and reinstale any overhead obstructions that may hinder the installation of the precast units. All bearing surfaces must be constructed to the correct levels, be true and mature at the time of installing the precast units.
- Finish of Precast units. Exposed wall face will have a steel mould finish. Wall sides face will have a timber mould finish. Back wall face will have steel trowel finish. Concrete or mortar infill at lifting sockets, tolerance joints, and other instlu concrete make up by the M.C., unless noted otherwise.

UNIT	QUANTITY
PC1	166
PC2	2
PC3	2
PC4	2
PC2A	2
PC3A	2
PC4A	2
PC8	6
PC9	2
PC9A	2
PC10	2
PC11	2
SC1	178
SC2	2
SC2A	2
SC3	2
SC3A	2
SC5	2

No. DATE	REVISION	DATE	BY
A	16/04/21	BACK WALLS ADDED	DK
B	26/04/21	SIDE WALL LENGTHS REDUCED TO 31.25m LONG	DK
C	12/05/21	BACK WALL LENGTH REDUCED TO 31.25m LONG	DK

CONTRACTOR: CHARLTON PARK AD PLANT
 TITLE: PRECAST CONCRETE SILAGE CLAMP TYPICAL ELEVATIONS & SECTIONS
 OPEN END CLAMP



Edis Colne Business Park, Edis Colne, Colchester, Essex, CO3 2NS
 Tel: 01787 220560

CLIENT	RAW ENERGY	L/D CHK
SCALE	1:30/25/10 = A1	DATE 09/04/21
DWG. No.	03	Rev C

Solvent-free, polystyrene-filled, crack-bridging, two-component thick bitumen-rubber coating for the reliable waterproofing of buildings

With general building inspection certificate



Characteristics

IMBERAL® S100 90B is a pasty, environmentally-friendly, polystyrene-filled thick waterproofing sealant made of bitumen and rubber and containing a hydraulically setting powder. It is resistant to aggressive substances normally occurring in the ground and is not harmful if it enters the groundwater.

In its hardened state it is resistant to frost and gritting salt.

- Easy to apply and work
- Becomes rainproof quickly
- Even consistency when applying
- Highly flexible
- Low shrinkage
- Complies with DIN 15814

Use

DIN 18533

IMBERAL® S100 90B is used to seal building parts which come into contact with the soil against ground moisture and non-pressing water (W1.1-E - W1.2-E - Situations 1 und 2), against pressing water from outside, medium loadings (W2.1-E), against non-pressing water on soil-covered surfaces (e.g. ceilings and roofs) (W3-E), against splash water on wall bases and capillary water in and under walls in contact with the soil (W4-E). On walls, wall bases and floor tiles (slabs) and panels coming into contact with water, on soil-covered floor tiles or slabs.

For sealing wall joints and connections on WU (waterproof) concrete and for concrete construction joints and butted joints with a high resistance to water penetration.

It can also be used as an adhesive for insulating boards, protection boards and drain tiles.

On unplastered masonry, concrete, plaster (mortar), MG P II and P III plaster and on pre-cleaned old bitumen coatings.

DIN 18195

IMBERAL® S100 90B is used to seal building parts which are in contact with the soil against ground moisture and non-standing seepage water, non-pressing water (on floors and in wet areas), accumulated seepage water and pressing water, on vertical and horizontal external and internal surfaces. For sealing wall connections on wu-concrete floor tiles (floor slabs) and concrete construction and butted joints with a high water penetration resistance.

It can also be used as an adhesive for insulating boards, protection boards and drain tiles.

On unplastered masonry, concrete, plaster (mortar) MG P II and P III plaster and on pre-cleaned old bitumen coatings.

Areas of Application:

- Cellars in residential and commercial buildings
- Underground car parks
- Balconies, terraces, patios
- Washrooms, shower cubicles, showers etc.
- Retaining walls

Specifications

Packaging	PE bucket/paper sack
Dual container (powder/liquid)	30 l
Delivery Quantity	17 containers/pallet
Density, ready for processing	approx. 0.75 kg/l
Working temperature	+5 °C to +35 °C
Working time	> 1 hour
Softening point (ring and ball)	> 100 °C
Elongation at break	approx. 130 %
Max. tensile strength	approx. 0.25 N/mm ²
Crack bridging	
- without reinforcing fabric	> 2 mm at +4 °C
Imperviousness	
- test according to AIB	> 0.5 bar / 8 hours
- test according to DIN 1048	> 5.0 bar / 3 days
Slot pressure test according to DIN EN 15814	> 0.75 bar
Fully hardened and load-bearing after	2 days
Storage	frost-free and cool, 9 months

¹⁾ At +20 °C and 60 % relative humidity.

Quantity required

according to DIN 18533

Scratch coat 1 - 2 l/m²

DIN 18533-3 W1.1-E

Floor slabs in contact with soil
Ground moisture on floor slabs 3.3 l/m²

DIN 18533-3 W1.2-E W4-E

Floor slabs in contact with soil
Ground moisture on walls and wall bases
and non-pressing water
Situations 1 and 2 3.3 l/m²

DIN 18533 W3-E

Floor slabs covered with soil 3.3 l/m²

DIN 18533 W2.1-E

Floor slabs in contact with soil
Walls and wall bases against pressing water
from outside
medium exposure 4.4 l/m²

In accordance with DIN 18195

Scratch coating 1 - 2 l/m²

DIN 18195 Part 4

Ground water and
non-standing seepage water 3.3 l/m²

DIN 18195 Part 5

Non-pressing water
(on floor surfaces
and in wet areas/wet rooms) 3.3 l/m²

DIN 18195 Part 6

Standing seepage water²⁾ 4.4 l/m²

Pressing water²⁾ 4.4 l/m²

Fillets (coved skirtings) 1 l/per meter.

- Depending on the individual construction site, the material amounts indicated above can increase by about 1 - 1.5 l/m² (due to uneven substrate or uneven material application). Leveling and scratch coats must be considered separately.
- Waterproofing measures against pressing water do not comply with DIN 18 195 and must be approved separately with the customer before waterproofing works start.

¹⁾ given +20 °C and 60 % relative humidity.

²⁾ as a rule, a reinforcement fabric must be embedded in the entire area.

Preparation of the surface

Substrates must be firm, sound and free of dust, dirt, and residual mortar.

Brush or spray on **IMBERAL® Aquarol 10D** as an undercoat on all absorbent mineral surfaces. Amount required approx. 0.2 kg/m².

The substrate can be slightly damp. During the building phase no water must be allowed to enter between substrate and sealant. Use **INTRASIT® DS2 54Z**, **INTRASIT® Poly-C1 54Z-C2 55Z** or **IMBERAL® RSB 55Z** as an intermediate seal as required.

Thoroughly clean all projections on the floor slabs.

Remove any sintered layers and impurities (dirt).

Before starting the sealing work, apply **IMBERAL® S100 90B**, **INTRASIT® SM 54Z** or the quick-setting universal filler **INTRASIT® RZ1 55HSP** on all fillets (coved skirtings). Use a tongue-shaped trowel.

Old, firmly adhering bitumen coatings can be overcoated after cleaning.

Seal open joints up to 5 mm with **IMBERAL® S100 90B** as a scratch coat or use a thin-layer plaster.

Use mortar to close joints which are wider than 5 mm, mortar pockets, holes and unsealed butt joints.

Apply a scratch coating to prevent or reduce blistering caused by deep pores or hollows in the concrete.

Scratch coats and must have completely hardened off before beginning the waterproofing work.

Application

DIN 18195 – Waterproofing of buildings

DIN 1053 – Masonry

Please observe the guideline for planning and treating structures in contact with the soil using polymer-modified thick bitumen coatings.

1. Stir **IMBERAL® S100 90B** by using an agitator with a stirring paddle revolving at a slow speed (400 to 600 rpm). First stir the component liquid well, then add all the powder component at once and stir the mixture well. Mixing will take about 1 minute and is complete when the mixture is homogenous and without lumps.
2. Apply the product with a float, trowel or **Peristaltikpumpe PP 99** as thickly as necessary.
3. If the substrate has expansion joints, use **IMBERAL® S100 90B** to insert **IMBERAL® FAB 89ZH**.
4. Clean tools with water immediately after use.

Apply vertical wall sealing as far as the foundation sides and approx. 30 cm above ground level (splashproofing). If this region is plastered, the perimeter strip can be sealed beforehand with a sealing slurry, **INTRASIT® DS2 54Z**, **INTRASIT® Poly-C1 54Z** or **-C2 55Z**. For clinker brickwork, the sealing should be extended over the clinker layer to prevent water penetration during the building phase.

As a rule, two waterproofing layers must be applied. If waterproofing is done according to DIN 18195 Parts 4 and 5, then waterproofing layers can be applied "wet on wet". If waterproofing is against outside pressing water (load case Part 6 of the above standard), the first layer must be allowed to dry adequately.

Coves must be provided in all inner edges. Outer edges of the construction must be beveled.

Cover settlement joints using **IMBERAL® FAB 89ZH** in a loop shape. Fix the tape at the edges with **IMBERAL® S100 90B** and embed it into the surface sealing.

Precautions

Drainage in compliance with DIN 4095 is admissible before sealing. Any water from the cellar floor or other water which has collected on the intermediate floors or from downpipes which have not yet been connected must be prevented from running behind the sealing layer. No cohesive soils (i.e. containing clay) must be allowed to come into contact with the sealing coating. The seal must be protected from damage (protective layers/wearing surfaces according to DIN 4095).

Use **IMBERAL® Multidrain 89V**, hahne's drainage and protection product, as a protective and drain layer.

Drain tiles or thermal insulation tiles can be fixed (stuck) on the completely hardened seal with **IMBERAL® S100 90B** or a soft bituminous paste such as **IMBERAL® BEP-F 20B**. Corrugated or bobble boards are not suitable.

hahne system products

IMBERAL® Aquarol 10D

IMBERAL® BEP-F 20B

INTRASIT® DS2 54Z

INTRASIT® Poly-C1 54Z

INTRASIT® Poly-C2 55Z

INTRASIT® FZ1 55HSP

INTRASIT® SM 54Z

IMBERAL® FAB 89V

IMBERAL® VE 89V

IMBERAL® Multidrain 89V

IMBERAL® RSB 55Z

Important notes

- Keep to a working temperature of +5 °C to +35 °C.
- Do not apply the product in direct sunlight.
- Pipe passages etc. through the sealing should, where possible, be made in the area of ground moisture, non-accumulating seepage water. Connect the sealing to the pipe passage like a coving.
- Use bonded flanges or loose and fixed flanges for openings in the area of non-pressing water. Openings in the area of accumulating seepage water or pressing water must always be made with loose and fixed flange screw connections.
- Gullies must be reinforced with a plate edge or clamped sheeting, integrating a woven tape.
- Apply protective layers and protective means according to DIN 18195 Part 10.
- As a rule, any deviations from DIN 18195 must be approved separately.

Ingredients

Bitumen, polymers, emulsifiers, functional fillers, fibers, hydraulic binders

Safety provisions/recommendations

Powder component contains cement and causes alkaline reaction when coming into contact with moisture or water. For further information on safety when transporting, storing and handling, please refer to the current safety data sheets.

Disposal

The local waste removal regulations must be observed.

Manufacturer

Heinrich Hahne GmbH & Co KG

Heinrich-Hahne-Weg 11

D-45711 Datteln

IMBERAL® S100 90B



This information is based on extensive tests and practical experience. However, it cannot be applied to every type of application. If in doubt, we recommend that you test the product before using it. Due to continuous product improvement, this information is subject to change without notice. Our General Terms and Conditions apply. Version as of 7.2016