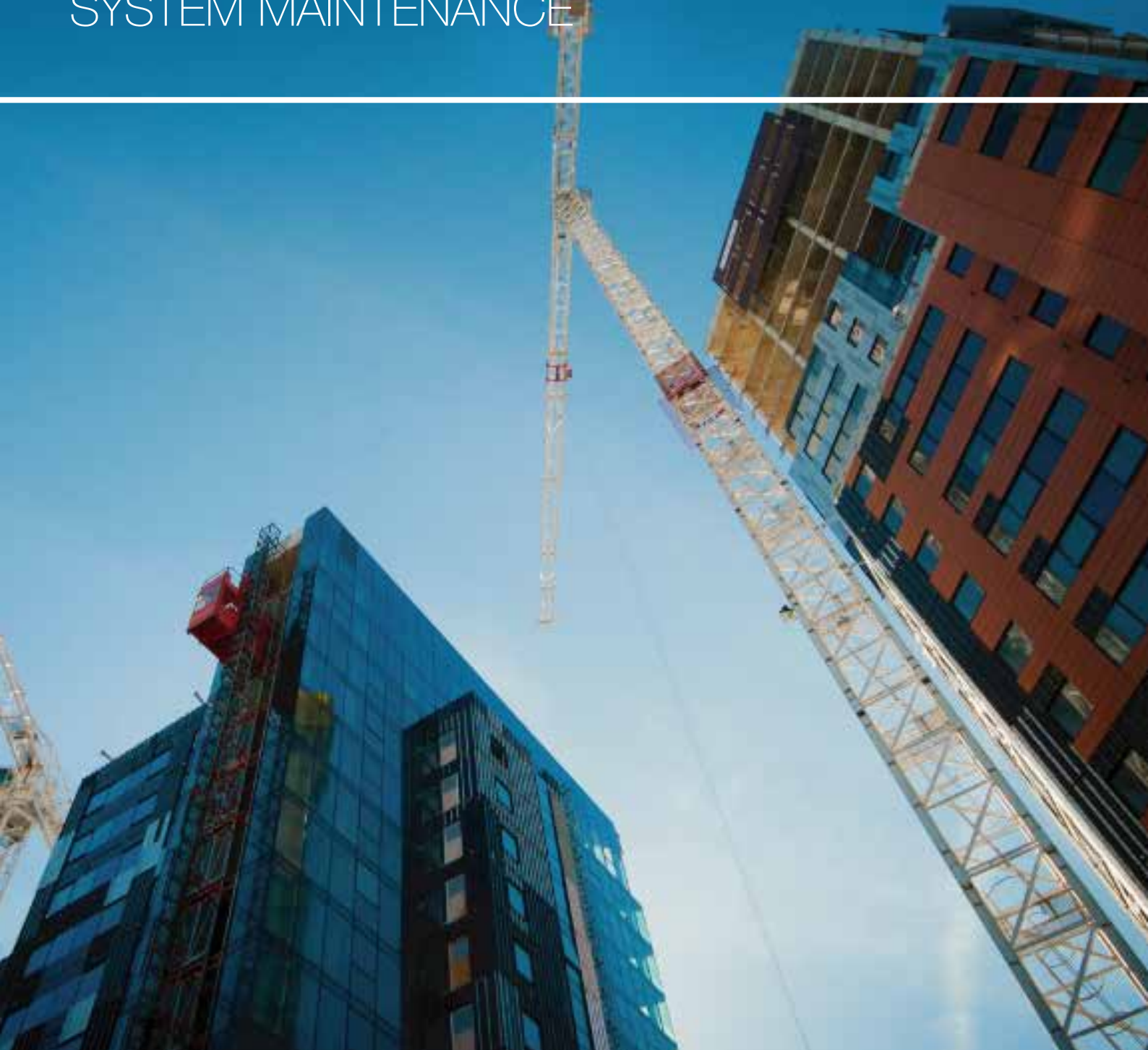


APPENDIX F: ROOF MAINTENANCE

MAINTENANCE GUIDE

A GUIDE TO AXTER WATERPROOFING
SYSTEM MAINTENANCE



FLAT ROOF

Flat roof maintenance

Flat roof guide

Rooflight maintenance guide

Hydome rooflight operation and maintenance

LIVING ROOF

Living roof maintenance

SOLAR PV

Photovoltaic (Solar PV) membrane laminates maintenance guide

CHECK LIST

Flat roof maintenance check list

FLAT ROOF MAINTENANCE

All flat roofs require regular and proper care and maintenance if they are to function reliably over the long term. The maintenance of flat roofs should be well-thought-out during the building design process and a comprehensive maintenance programme and budget should be compiled for the entire building. The provision of regular maintenance is considered to be general good practice, but is also a condition of the waterproofing system guarantee or warranty, and full attention should be paid to the system specific requirements within the building maintenance plan to ensure compliance.

PLANNED MAINTENANCE

The flat roof is considered to be one of the largest depreciating elements of the building fabric and a planned structured maintenance programme completed by qualified personnel is essential to safeguard its maximum service life. Planned maintenance will also give a clear indication of the most economic time to refurbish and/or upgrade the roof to ensure compliance with modern building regulations, such as improved thermal performance in relation to energy conservation.

A well designed, installed and maintained flat roof will exceed anticipated performance-in-use expectations over a building's life and should be undertaken. The implementation of a pro-active (preventative) maintenance plan will likely be more cost effective and cause less long term prolonged disruption to the building owner and/or its occupants than reactive (problem solving) maintenance post occurrence of a defect.

However, there will be occasions during the life of even the most well maintained building when an unexpected problem will arise and reactive maintenance will be required. For this reason, both forms of maintenance should be covered within the building maintenance plan.

MAINTENANCE INSPECTION

The first requirement of a planned maintenance programme is inspection. A flat roof should be routinely inspected every spring and autumn. The spring inspection may detect winter related roof damage. The autumn inspection is to ensure the roof is clear of leaves, debris and dirt before the approach of winter.

Areas of the roof considered to be high-risk locations, those areas subjected to high dust or pollution or in close proximity to trees, should be inspected more frequently. All inspections should include all associated construction, such as brick parapets, rooflights, and rainwater drainage, as well as the building interior, and any defects should be recorded and rectified. A permanent record of inspection and any associated repair works should be held and be available for review at any time.

HEALTH AND SAFETY

The starting point of any maintenance inspection must be the completion of a detailed risk assessment and method statement taking into account site specific requirements. All maintenance inspections must be carried out strictly in accordance with the relevant Health and Safety regulations. Please refer to Health and Safety Executive (HSE) publications, such as Working at Height Regulations (WAHR) and Health and Safety in Roof Work HSG33, for further guidance.

INSPECTION PROCEDURE

Following the completion of risk assessment and method statements, the inspection should commence with the interior of the building, where internal walls and ceilings should be checked for leaks and signs of water staining. A floor plan corresponding to the roof plan should be developed to identify roof level problems manifesting internally.

The exterior walls, rainwater goods (hoppers & downpipes), eaves and soffits should also be included in the inspection procedure, where all signs of defect, such as movement and cracks to exterior walls, blocked hoppers and damaged eaves and soffits, should be noted.

The roof should then be safely accessed and inspected by checking the following roof components:

- » Cap flashings - metal or other rigid or semi-rigid coverings of membrane terminations, including counter flashings, expansion joint covers and copings.
- » Edge details - metal or other rigid or semi-rigid components used to terminate, waterproof and provide wind uplift protection at the perimeter of the roofing system.
- » Membrane flashings - roof membrane termination at walls, water checks, kerbs and gutters.
- » Penetrations and protrusions - pipes, drains, rooflights and all other items that penetrate the roofing membranes.
- » Main waterproofing - the main membrane roofing system.

MAINTENANCE MANUALS

A maintenance manual should be prepared for each building preferably at the time of construction, although this can be completed retrospectively. Maintenance manuals should include the following information:

- » A complete set of 'as built' roof drawings.
- » A dated schedule of roof works covering the life of the building, detailing repairs and any alterations that have taken place.
- » Project specific roofing specifications and design calculations (thermal & drainage).

- » Reference to controlling documentation, such as Building Regulations, British Standards and relevant trade association guidance.
- » Copy records of quality assurance (QA) reports during construction, final QA reports issued upon completion and any supporting test information, such as waterproofing integrity test (WIT) reports.
- » A comprehensive list of manufacturers, designers, suppliers, contractors and accredited installers involved in the roof element of the works.
- » Copies of roof system Guarantees/Warranties combined with specific maintenance requirements and clear guidance of who to contact in the event of a reported defect.
- » Maintenance checklists and timetables of required maintenance tasks, such as clarification of items to be checked bi-annually, annually every 3 years, 5 years and so on.
- » Standard documents that will help keep maintenance record keeping in order, including provision for photographic and video footage record keeping.
- » Records of any reported or discovered defects and any following actions.
- » General building use information and any special requirements and observations.
- » Detailed guidance to assist with all aspects of planned (preventative) and reactive maintenance.
- » Details of any term maintenance contracts and/or repairing lease agreements.

PREVENTATIVE MAINTENANCE GUIDELINES

The following preventative maintenance guidelines should be followed to minimise the effect of disruption to the building owner and/or its occupants.



FLAT ROOF GUIDE

MAINTENANCE GUIDELINES

- » Remove debris such as nails, bottles, cans, balls, boards and bricks.
- » Leaves, paper, dirt etc., which may collect at roof drains, gutters and gullies, should be cleared and removed from the roof.
- » Cut back tree limbs which overhang the roof to give a metre clearance outside the roof edge. This will significantly reduce leaves continually blocking drainage ways.
- » Remove or repair roof mounted equipment which has fallen into disuse or become redundant - it may have the potential to cause damage to the roof membranes.
- » Ensure chippings and other materials designed to protect the roof membranes from UV degradation are in place and evenly spread. Redistribute any surfacing that has been displaced by the action of wind or water flow.
- » Ensure flashings to supporting plinths and cradles of ductwork are checked and maintained in good condition, that they are not penetrating the membranes or restricting drainage.
- » Surface coatings, if applied, will generally require at least one re-application during the life of the waterproofing system to maintain effectiveness against UV degradation. Re-coating is an integral part of the maintenance schedule of any roof system that employs a surface coating material.
- » Regularly ponded surfaces and other areas of self-finished membranes, where there is a build up of moss or algae, should be treated with an appropriate fungicide to reduce the risk of 'mud curling'.
- » Ensure sealants / mastics at counter flashings, termination strips and other locations are in good condition and effective.
- » Ventilation of the roof spaces, if any, and the building or rooms under the roof should be checked. Corrective measures should be taken to improve ventilation of the roof construction in cases of excessive condensation.

INSPECTION - EXCEPTIONAL

An inspection should also be carried out if one or more of the following situations has occurred:

- » Recent construction on or adjacent to the roof
- » New equipment is installed on the roof
- » Unusual weather conditions, such as very high winds or unusually heavy snow
- » Following fire, vandalism or other known damage to an adjacent roof area

TRAFFIC - WARM ROOF CONSTRUCTION WITH SELF PROTECTED MEMBRANE CAP SHEET

Routine foot traffic for inspection purposes is permitted. Concentrated occasional loads such as ladders must not be allowed, except when a load spreading plate is used below the point. Specialist walkway membranes are available if more regular access is required to maintain roof top plant.

In periods of hot weather care must be taken not to disturb the surface of the membrane, which will become soft in the heat. Suitable footwear must be worn and maintenance personnel instructed to minimise their visits to the exposed roof areas. Similarly, in periods of cold weather, it is probable that frost and ice will be present on the roof and all concerned must exercise the utmost care.

PROTECTED MEMBRANE ROOFS

Protected membrane roofs, properly designed and installed, should last for many years without failure. It is often extremely difficult to inspect the waterproofing membranes; in such cases it is only when water enters a building that failure can be detected.

PAVING SLABS

Where paving slabs on proprietary supports cover the waterproofing membrane, then periodic inspection of the membrane, by removing some of the slabs, is recommended. Any debris that has accumulated beneath the paving slabs must be removed.

GREEN ROOFS

It is not practicable to remove the plants and growing medium to inspect the waterproofing, and the system should have been designed to eliminate the risk of mechanical damage. If mechanical damage does occur then it will be necessary to remove the coverings so that inspection and/or repair can take place.

MASTIC ASPHALT, MACADAM ETC.

The membrane in such cases cannot be inspected, but the wearing surface should be periodically inspected for signs of cracks, blisters or other indicators. The underside of the structure should also be inspected for signs of water ingress.



INFORM

If a leak is discovered then inform:

- » The roofing contractor who installed the Axter roofing system that a fault has been discovered.
- » Axter Ltd, if the matter is subject to a warranty claim or if further discussion is required.

RECOMMENDATIONS - SUMMARY

In order to care properly for the roof, the following should be implemented:

- » Maintain historical records
- » Control roof access
- » Conduct 6 monthly inspection and special inspections
- » Report leaks or roof damage immediately
- » Ensure routine maintenance is carried out
- » Use competent persons for major maintenance, emergency repairs and permanent repairs.

GUARANTEE

Failure to follow these guidelines could affect Axter Ltd's and the roofing contractor's liability under the terms of any issued Guarantee or Warranty.

This guide should be read in conjunction with the following:

BS 6229 : 2018 Flat roofs with continuously supported flexible waterproofing coverings - Code of Practice

BS 8217 : 2005 Reinforced bitumen membranes for roofing - Code of Practice

SPRA Single Ply Design Guide 2018 Edition (for PVC-p roofs)



ROOFLIGHT MAINTENANCE GUIDE

MAINTENANCE AND PERIODIC CHECKS

Axter rooflight units are not guaranteed against changes to the characteristics or functions of the unit or any of its constituent parts.

Periodic function checks and maintenance procedures should be carried out in accordance with current regulations. In particular, Axter stipulates a minimum of two tests per year to check the opening/closing in security position of the unit.

Special attention should be paid to the hinges and lock (which must be kept lubricated) and to the struts.

Check that screwed parts are fastened tightly.

Check that the locking system is working properly.

Gas struts should be replaced if they become scratched, distorted or if there is any sign of a leak.

Do not clean the struts with a solvent; this could damage the joints.

Do not paint the struts.

Units should be checked at least once a year.



HYDOME ROOFLIGHT OPERATION AND MAINTENANCE

Hydome rooflights and accessories require no specific maintenance, however the following general guidelines should be followed in strict compliance with relevant Health and Safety regulations.

	OPERATION	MAINTENANCE
HYDOME ROOFLIGHTS	Hydomes are fixed at installation stage to the relevant upstand, and are a means of allowing natural light into the area below.	Wash only with warm soapy water.
	Acrylic rooflights are fragile and should be treated as such.	DO NOT USE strong detergents or abrasives.
	Polycarbonate rooflights are non-fragile, but should not be trafficked.	
HYDOME KERB	Normally manufactured in extruded PVCu, or GRP, Hydome kerbs provide a proprietary upstand detail for Hydome rooflights.	Maintenance free. GRP Hydome kerbs may be decorated internally if required.
PASSIVE VENTILATION	Normally by means of 'Trickle', 'Louvre' or 'Rotating' vents, to provide background ventilation. Trickle vents are adjusted by hand. Louvre and Rotating vents are adjusted by a proprietary operating rod – available in 1.5, 2 or 3m lengths. Louvre vents require a sharp upwards push to fully close.	Maintenance free.
OPENING FRAME	Operated electrically by means of 24V electric actuators. Electric actuators must be connected by a qualified electrician.	Physically check fixing brackets to ensure fixings are secure.
OPENING VENTILATION	Operated manually by spindle and proprietary winding rod, or electrically by means of 24V or 240V electric box motors. Manual operation opens to 300mm. Electric motors must be installed by a qualified electrician.	Test annually by an Approved Electrical Installations Testing Company.
ACCESS UNITS	For means of access onto roof area. Only to be used by authorised personnel. Unit is opened by opening the locking cockspur handle and pushing the unit into the open position. The two frictional struts should be adjusted to ensure unit is safely held in the open position. DO NOT use as a means of ventilation. DO NOT USE in windy conditions. ONLY USE in accordance with relevant Health and Safety Regulations.	Check brackets, struts, locking handle, etc., to ensure operation is correct and fixings are secure.
EXTRACT FANS	These are factory fitted to the relevant rooflight component and connected to an unswitched fused-spur. A switched electrical supply should be connected by a qualified electrician.	Test annually by an Approved Electrical Installations Testing Company.
ELECTRIC ACTUATOR	The actuator drives the opening frame to 160 degrees within 60 seconds.	Test weekly and test at 6 month intervals by an Approved Servicing Company.



LIVING ROOF MAINTENANCE GUIDE

Maintenance, conducted by qualified personnel, will ensure the initial establishment and continued health of the green roof system. It is strongly recommended that the installing contractor remains responsible for the maintenance of the green roof during this establishment stage (between 12 - 15 months) and prior to the assignation of maintenance duties to the building owner's representative. Maintenance contractors with specialist training in green roof care should be used where possible.

All maintenance actions carried out at roof level must be in full compliance with the appropriate Health and Safety regulations, and particularly those specifically dealing with working at height. BS 4428:1989 – Code of practice for general landscape operations (excluding hard surfaces) and BS 7370-4:1993 Grounds maintenance - Part 4: Recommendations for maintenance of soft landscape (other than amenity turf) provide guidelines for maintenance actions.

IRRIGATION

Irrigation will be required for the initial establishment of the green roof. Take care not to over water. Once the plants are established, irrigation on extensive and bio-diverse roofs can be reduced or eliminated altogether.

FERTILISER

On extensive roofs with low nutrient growing medium, regular fertilising will be required to provide additional nutrients to enhance germination, flowering and resistance to extremes of weather.

PLANTING REGIME

Unless the object of the green roof is to replicate the ecology of the site prior to the development, as could be the case with a bio-diverse green roof, undesirable plant species can be avoided by ensuring full coverage of the desired plant species at the outset. Alien plants should be removed before they have an opportunity to take root.

PLANT MANAGEMENT

Dead plant material should be removed to allow greater coverage. This improves the appearance of the roof as well as reducing the spread of fungal diseases. On bio-diverse roofs this material could be left to create habitat for wildlife.

MAINTENANCE PROGRAMME

After installation of vegetation on an Axter extensive or bio-diverse green roof, two visits should be made:

- » The first a month later to ensure that the vegetation is in a good condition and to observe any anomalies,
- » The second three to six months later to verify the root growth and to effect any reinstatement that may be necessary.

After this initial maintenance, it is recommended that at least two maintenance visits are made to the roof each year, the first in early spring and the second in late autumn, to ensure that leaf fall is not adversely affecting drainage performance.

The following table gives an indicative work plan during installation and for each subsequent visit.

GENERAL MAINTENANCE FOR ALL GREEN ROOFS	DURING INSTALLATION	STANDARD MAINTENANCE
Remove all vegetation and debris from rainwater outlets, walkways and on sterile areas. Additional pebbles or gravel should be added to the vegetation barrier if movement or settlement has occurred.	✓	✓
Manually remove any herbaceous material that may be detrimental to waterproofing.	✓	✓
Remove leaves that may stifle vegetation and block rainwater outlets, although some leaf litter may be beneficial to a bio-diverse environment.	✓	✓
Manually remove any aesthetically unpleasing vegetation which may affect waterproofing membranes (e.g. grass).		Optional
Minimum number of maintenance visits per year		2
In addition the following procedures should be followed for specific Axter green roof systems:		
Axter Hydropack pre-planted modular tray extensive green roof (sedum):		
» Dead head the sedum.	Optional	Optional
» Re-plant any missing sedum fragments.	As required	As required
» Use of fertiliser: it is recommended that a slow release fertiliser is applied to the Hydropack at the start of spring (25gm/m ²). A product such as Osmocote Exact (produced by Scotts) with a formula NPK 15-9-9 should be applied by a hand spreader to ensure even coverage.		As required
» Water after installation and during prolonged dry periods or periods of high temperatures. Take care not to over water.		
Axter Sedum Vegetation Blanket:		
» Light hand weeding once or twice a year to keep out wind blown seeds.	As required	As required
» Dead head the sedum.	Optional	Optional
» Re-plant any missing sedum fragments.		As required
» Use of fertiliser: use of fertiliser: It is recommended that a slow release fertiliser is applied to the sedum mat twice a year in March and September (25gm/m ²). A product such as Osmocote Exact (produced by Scotts) with a formula NPK 15-9-9 should be applied by a hand spreader to ensure even coverage.		
» Water after installation and during prolonged dry periods or periods of high temperatures. Take care not to over water.		
Axter Wildflower Blanket:		
» One main cut in late autumn, removing all cuttings.		✓
» A spring cut may be advisable if the grasses become too dominant.		✓
» Water after installation and during prolonged dry periods or periods of high temperatures. Take care not to over water.	✓	✓

	DURING INSTALLATION	STANDARD MAINTENANCE
Axter Bio-diverse Green Roofs:		
» One light cut in late autumn removing all cuttings.		✓
» Bio-diverse roofs usually require minimal maintenance with no fertilisation or artificial watering. However this may be needed if vegetation other than naturally colonising plants is introduced into the roof. Consult Axter for further advice.		✓
Axter Hydroseed:		
» The Axter seed mix for green roofs should be applied evenly onto the prepared Axter brown roof substrate by hand-broadcasting, seed fiddle, or seed/fertilizer distributor. Rake after sowing, particularly in dry weather and with freshly worked loose soil; this will press the seed into contact with the soil and bring moisture to the surface by capillary action. In wet weather a good rain after sowing will wash the seed in and settle the soil surface.	✓	
» Regular light watering is important once seeds are sown, particularly in prolonged dry periods, to provide optimum conditions for seed establishment with sufficient water at the critical time. Weeds should be removed as soon as possible.		✓
» It is important to remember that some seeds are slower to germinate than others and some may not germinate until the following year. In addition, some seeds will not flower in the first year.		
The seed mix may take two growing seasons to become fully established and produce a full floral display. During this time other wind-blown seeds may also establish themselves and should be removed.		

Separate information sheets are available from Axter for the different types of green roof mentioned above. Contact Axter Ltd for further details.

ROOF MAINTENANCE PROCEDURES

- » Ensure safe access can be gained to the roof and that, when working at roof level, safety harness attachment points and man safe systems are used where provided and that Health and Safety Procedures are respected.
- » Rainwater outlets, chutes, gutters and inspection chambers to be kept free from debris and leaves. All downpipes should be kept unblocked so that water can flow freely.
- » Check mastic sealant and mortar pointing for degradation and repair or renew as required.
- » Check that protective metal flashing or termination bars remain securely fixed in place.
- » Paving slab walkways and promenade tiles should remain securely fixed and in good condition.
- » Plant or equipment on the roof should be positioned on suitable supports and fixings not allowed to penetrate the waterproofing. In addition, maintenance to adjoining areas should be carried out without causing damage to the roof waterproofing.
- » Any signs of damage or deterioration to the roof waterproofing should be reported to Axter Ltd immediately.
- » Contact Axter Ltd for advice on works or alterations that may affect the integrity of the waterproofing and the validity of the Axter Guarantee.

**Further information on Axter green roofs is available from Axter, tel: 01473 724056,
email: info@axterltd.co.uk. For more general advice go to www.nfrco.co.uk/green-roof-installations**



PHOTOVOLTAIC (SOLAR PV) MEMBRANE LAMINATES MAINTENANCE GUIDE

The following inspection and routine maintenance instructions are in addition to and must be read in conjunction with Axter's standard maintenance instructions for waterproof membranes.

A grid connected General Solar PV system is a potentially dangerous, high voltage electrical generator and should be inspected at least every six months to ensure that all system components are working correctly.

Appropriate maintenance should occur at least before the onset of both summer and winter. Axter recommend that all General Solar PV systems are fitted with monitoring software as this can give advance warning of potential problems and can provide the opportunity to perform corrective action before a problem becomes serious.

CAUTION

General Solar PV photovoltaic modules produce electrical energy when exposed to the sun, including under cloud, or other light sources. The power of an individual module is not considered dangerous but when connected in series and / or parallel the danger of an electric shock will increase.

The DC voltage produced by General Solar PV modules can reach up to 1000V during the day even if the inverter is not switched on. The module surface can become slippery when wet and operatives must follow appropriate safe working practices when accessing General Solar PV systems.

GENERAL ADVICE

- » Ensure that appropriate safety signs are in place at each access point to the installation.
- » When working on a roof, ensure you are properly tethered and that your safety equipment is in safe operating condition.
- » Avoid walking on photovoltaic modules and utilise access routes where provided.
- » Do not cut or fold the photovoltaic modules for any reason.
- » Do not apply screws, nails etc. and avoid letting pointed or heavy objects fall onto any part of the module. Such action could cause shock, generate flame, and invalidate any warranty.
- » Do not place any device on top of the photovoltaic modules.
- » Do not work on a Solar PV array when it is under standing water.

INSPECTION & MAINTENANCE GUIDANCE

- » Visually check that each laminate is bonded perfectly to the waterproof membrane. If any areas of the laminate are NOT perfectly bonded, mark the product with a permanent marker or crayon. If this de-bonding gets worse over subsequent maintenance visits, carry out the following repair advice:
- » Re-establish the adhesion by a combination of hot air and pressure from a Teflon coated roller or by applying Axter Solar fill glue and pressing the two elements together until they adhere.
- » Check the top surface of each laminate for any scratches or surface damage. Patch any surface damage in accordance with module manufacturer repair guidelines (contact your Axter representative) without delay. If the PTFE top surface becomes damaged and is not repaired quickly, system performance can be degraded and the laminate could fail.

- » Visually inspect cables and cable ducting, verifying that adequate strain relief is provided and the connections are tight, secure and free from corrosion. Ponding water on laminate surface should be avoided, laminates should not be subjected to ponding water and cables should be housed off the membrane surface in an appropriate free-draining cable tray. The most appropriate time to carry out this inspection is just before and/or just after the winter (or rainy) season.
- » Cable trays should be secured to the roof membrane with an Axter approved attachment system. Consult Axter for further information..
- » Clean laminates which are particularly dirty or have localised shading (bird droppings, leaves, etc.).
- » During the pre-summer visit, check the extent of dirt on the module surface and perform cleaning if this is warranted (refer to the Cleaning Procedure for cleaning instructions).

- » Verify that all laminates are located in areas that have no shading, and remove temporary objects that may be shading the array and reducing system performance. For example, prune trees that may be shading the array during the summer months.
- » Ensure that the drainage system is not blocked and that there is no potential for water pooling on the laminates.

SYSTEM COMMISSIONING & TROUBLESHOOTING FOR ELECTRICIANS & MAINTENANCE STAFF

- » The following tests should only be performed by trained and qualified personnel. The best weather conditions that will provide the most accurate system tests are cloudless days with strong sun conditions.



- » Before starting PV system maintenance, check that metal parts (array frames, junction box enclosures, DC disconnect switch enclosures, inverter enclosures) are earthed properly.
- » When working on the PV Laminates, always wear electrical gloves and shoes and use only insulated tools rated for the maximum rated system voltage (i.e. 600 VDC), disconnect all energy source (i.e. battery and/or utility) and short-circuit the output of the PV Laminates.
- » If more than one ground rod is being used, verify that all ground rods are bonded together with appropriately sized conductors.
- » Measure and record the open circuit voltage of each series string, verifying that all strings that are feeding the same inverter have the same polarity and a similar open circuit voltage (within + 5V of each other). If the variation in string voltages is greater than 5V, check the individual connections to that string of laminates.
- » Measure and record the operating current of each series string and verify that all strings with the same number of laminates have a similar operating current (within + 1A of each other). A variation in operating current can indicate areas of the array which are shaded or are particularly dirty and should be investigated further.
- » Check the alarm status of each inverter and also the historical alarm log if this is available (refer to inverter manufacturer's manual). Any alarm which indicates either a low resistance or an earth leakage fault should be investigated as soon as weather conditions permit, by suitably qualified personnel.
- » Record DC and AC power (at the input and output of the inverter) and determine inverter operating efficiency.
- » Perform and record insulation resistance (Riso) on the input to each inverter.
- » Check that system fuses and DC disconnect switches are operational.
- » Check for loose wires or connections at all solar system array controllers (voltage regulators), Combiner Boxes, and/or other Junction Boxes within the system.
- » Perform maintenance on the inverter(s) as stipulated by the manufacturer (clean filters, etc.).
- » Confirm that no new loads have been added to the system and that loads are operating for the specified number of hours per day.



CLEANING PV LAMINATES

Generally, a good rain is sufficient to clean the PV Laminates. However, in dusty arid locations the PV Laminates can be cleaned with water or mild soap and water in accordance with the following procedure. However, avoid cleaning the panels in the middle of the day and do not use abrasive soaps or solvents.

GENERAL RECOMMENDATIONS

- » Wear rubber soled boots and cut resistant gloves when cleaning laminates.
- » Survey the roof for any loose wires, damaged modules and tough stains that will require special attention.
- » While surveying, remove all large debris from the roof surface.
- » Use a leaf blower to remove all small sized debris from the roof surface.
- » Use a garden hose to get the entire PV laminate wet, making sure not to spray water on electrical wires.

WHEN TO CLEAN

The amount of electricity generated by a solar cell is proportional to the amount of light falling on it. A shaded cell will produce less energy. The non-stick PTFE top surface of Axter General Solar PV modules promotes automatic self-cleaning. It is normally NOT necessary to perform an all-encompassing cleaning of dirt from the solar array, provided that the array is installed on more than a 5% slope.

Cleaning should be performed on any modules that are excessively affected by a collection of bird droppings, dirt, or miscellaneous debris, such as fallen leaves. This cleaning should be performed at each maintenance visit. The monetary value of cleaning dirt and debris from the array is a trade-off between the cost of the cleaning, increased energy production as a result of the cleaning, and the inevitable re-soiling of the laminates over time once they have been cleaned.

To help determine the performance benefit of cleaning, perform the following steps to measure the short circuit current of individual laminates before and after cleaning:

- » Measure and record the operating voltage of each series string and verify that all strings feeding the same inverter have a similar operating voltage (within $\pm 5V$ of each other). Any difference greater than 5V between strings requires investigation.
- » Isolate a single string, making sure all the DC isolation switches are open (OFF) and all the string fuses have been removed.
- » Disconnect the laminates that will be used for the test by opening connections via an MC4 disconnect tool.
- » Verify that the current sunlight is effectively constant (clear sky, strong sunshine, no clouds)
- » Connect a DC multimeter across the terminals (10A or greater) to measure and record short circuit current.
- » Clean the laminate as described in the Cleaning Procedure below.
- » Measure and record the current and verify the percentage difference between the two readings. This percentage difference is the potential gain that will be derived from cleaning the product.

CLEANING PROCEDURE

Clothing: anti-slip rubber shoes and gloves.

Tools: soft brush, dry cotton mop or clean broom; low pressure water or portable pressurised water tank; biodegradable, non-abrasive mild detergent; clean water source.

- » Check earth connection of PV modules and inverter.
- » Examine the roof for damaged modules or persistent staining.
- » Remove all waste matter lying on the modules.
- » Wet the area avoiding the electrical cables.
- » Using a soft brush remove excess dirt.
- » Pressurised power washers should NOT be used directly on the laminates. If these devices are being used to clean the roof around a solar array, ensure that the nozzle of the power washer remains at least two feet away from the surface of the laminates at all times while cleaning.
- » When spraying a module, do NOT spray water directly on the electrical connections or at the leading edge of the PV laminate.
- » Use caution when cleaning PV modules, as the combination of water and electricity may present a shock hazard.
- » Use a soft brush to scrub stubborn stains, be careful not to scratch the surface.
- » Rinse with water to remove all traces of detergent.
- » Dry any puddles left on the roof post cleaning.



FLAT ROOF MAINTENANCE CHECK LIST

WATERTIGHTNESS	COMPLETE	ACTION REQUIRED
Visual check of membrane for watertightness		
Repairing identified defects and damages		
Checking the watertightness of distressed areas		
Check existing permanent and emergency repairs		
Cleaning the roof area from incrustation, vegetation and foreign matter		
Check and, if needed, repair laps		
Check mechanical fastening elements		
Movement joints, stresses, deformations to be repaired if required		
FLASHINGS IN ROOF AREA		
Visual check for stress cracks, splits		
Check existing permanent and emergency repairs		
Check and, if needed, repair laps		
Check the mechanical fastening system and flashings, repair if needed		
ROOF PERIMETER		
Visual check for stress cracks, splits		
Check existing permanent and emergency repairs		
Check laps and repair if needed		
Check the mechanical fastening system and flashings, repair if needed		
Check roof edge trims and repair if required		
Check roof edge trims, corrosion, apply protective coating if required		
Check integrity of wall connection profile and repair if required		
Check integrity of fascia boards and repair if required		
DRAINAGE		
Visual check of outlets to be cleaned from obvious debris, if required		
Performance test, check with water if required		
Visual check of water spouts or emergency outlets, to be cleaned if required		
Performance test, check with water if required		
Visual check of gutters and performance test, to be cleaned if required		
Down pipe, check fastening and integrity		
Corrosion, protective coating if applicable		
SURFACE PROTECTION LAYER		
Removal of debris and vegetation growth		
Paving slabs, to be aligned if required		
Inverted roof, checking position stability of thermal insulation		
Inverted roof, condition of thermal insulation		
Other protective layers, status check, to be replaced if needed		
Vegetation layer, removal of unwanted vegetation		
VENT PIPES		
Check vent pipes, to be cleaned if needed		
KERBS AND PENETRATIONS		
Check condition and integrity of rooflights and other kerbs		
Check roof anchor's watertightness		

OTHER	COMPLETE	ACTION REQUIRED



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APPENDIX G: LANDSCAPE MAINTENANCE

GENERAL SOFT LANDSCAPE MAINTENANCE

MAINTENANCE OBJECTIVES

Location: Site – 1 month from point of starting works, 24 months maintenance from point of completion.

- Aims: Maintain landscape visual amenity.
- Restrictions: Check with client with programme of proposed works.
- Results: Adequate establishment of plants and maintained standards of hard landscaping.

NOTICE

- Give notice before:
 - Application of herbicide.
 - Application of fertilizer.
 - Watering.
 - Each site maintenance visit.
- Period of notice: 2 weeks.

REINSTATEMENT

- Damage or disturbance to soil structure, planting, grass, fencing, hard landscaping, structures or buildings: Reinstate to original condition.

WATERING

- Supply: Outside taps on site.
- Quantity: Wet full depth of topsoil.
- Application: Do not damage or loosen plants.
- Compacted soil: Loosen or scoop out, to direct water to rootzone.
- Fill irrigation tubes for trees.
- Frequency: As necessary for the continued thriving of all planting.

DISPOSAL OF ARISING

- General: Unless specified otherwise, dispose of arisings as follows:
 - Biodegradable arisings: Remove to recycling facility.
 - Grass cuttings: Remove to recycling facility.
 - Tree roots and stumps: Remove from site.
 - Shrub and tree pruning's: Remove to recycling facility.
 - Litter and nonbiodegradable arisings: Remove from site.

CHIPPING OR SHREDDING

- General: Not permitted on site.

LITTER

- Extraneous rubbish not arising from the contract work: Collect and remove from site.

PROTECTION OF EXISTING GRASS

- General: Protect areas affected by maintenance operations using boards - tarpaulins. Do not place excavated or imported materials directly on grass.

CLEANLINESS

- Soil and arisings: Remove from hard surfaces.
- General: Leave the works in a clean, tidy condition at completion and after any maintenance operations.

GRASSED AREAS

MAINTENANCE OF GRASSED AREAS

- General: Maintain turf in a manner appropriate to the intended use.
- Soil and grass:
 - Condition: Maintain a healthy vigorous sward, free from disease, fungal growth, discolouration, scorch or wilt.
 - Waterlogging and compaction: Prevent.
 - Damage: Repair trampling, abrasion or scalping.
- Ornamental lawns: Maintain reasonably free from moss, excessive thatch, weeds, frost heave, worm casts and mole hills.
 - Edges: Neat and well defined, in clean straight lines or smooth flowing curves.
- Litter and fallen leaves: Remove regularly to maintain a neat appearance.

MAINTENANCE OF GRASSED AREAS

- Standard: To BS 7370-3. Carry out maintenance appropriate to each category of turf, as follows:
 - Objectives: To BS 7370-3, table 6.
 - Programme: To BS 7370-3, clause 11.
 - Mowing methods: To BS 7370-3, table 3.

GRASS CUTTING GENERALLY

- Before mowing: Remove litter, rubbish and debris.

- Finish: Neat and even, without surface rutting, compaction or damage to grass.
- Edges: Leave neat and well defined. Neatly trim around obstructions.
- Adjoining hard areas: Sweep clear and remove arisings.
- Drought or wet conditions: Obtain instructions.

TREE STEMS

- Precautions: Do not use mowing machinery closer than 100 mm to tree stems. Use nylon
- Precautions: Do not allow nylon filament rotary cutters and other mechanical tools closer than 100 mm to the stem of any tree.

-Operations close to stems: Complete using hand tools.

MOWING STRIPS

- Location: to be confirmed.
- Width (approximate): 150 mm.
- Operations: Maintain by applying a suitable herbicide twice during the growing season.

LEAF REMOVAL

- Operations: Collect fallen leaves.
- Special requirements: Remove by hand raking.
- Disposal: Remove from site for recycling.

FIRST CUT OF ALL GRASSED AREAS

- Height of initial growth: 75 mm.
- Preparation:
 - Debris and litter: Remove.
 - Stones and earth clods larger than 25 mm in any dimension: Remove
- Height of first cut: 40 mm.
- Mower type: Contractor's choice.
- Arisings: Remove.

MOWING GENERAL AREAS

- Grass height: Maintain between 25 and 50 mm.
- Arisings: Remove.

MOWING ROUGH GRASSED AREAS

- Grass height: 300mm max.
- Arisings: Spread evenly over cut areas.

TOP DRESSING

- Location: All lawns.
- Timing: November.
- Material: Compost, sand, loam mix.
- Supplier: Contractor's choice.
 - Product reference: Contractor's choice.
- Declaration of analysis: Submit.
- Additional analyses: Not required.
- Samples: Not required.
- Application rate: to Manufacturer's Spec.

SPIKING

- Location: All lawns.
- Timing: February or March, after first mowing.
- Operations: Aerate the soil and improve surface water penetration.
- Depth (minimum): 100 mm into soil.

EDGES TO SEEDED AREAS

- Location: Planting beds and around newly planted trees.
- Timing: After seeded areas are well established.
- Edges: Cut to clean straight lines or smooth curves. Draw back soil to permit edging.
- Arisings: Remove.

RE-FORMING GRASS EDGES

- Location: All edges and Where damage occurs.
- Edges: Draw back soil and re-form edges to clean straight lines or smooth flowing curves, sloping slightly back from vertical.
- Location: Where damage occurs.
- Standard: To BS 7370-3.
- Finishing: Damaged parts of turned turf replaced with sound turf: Support: Not required.

LEVELLING HOLLOWES AND BUMPS IN TURF

- Standard: To BS 7370-3, clauses 12.4 and 12.5.

RELIEVING SURFACE COMPACTION IN TURF

- Standard: To BS 7370-3.
- Method: Spiking.
- Top dressing: Fine sand.
 - Depth: 2-3 mm.

SPOT WEED KILLING IN ROUGH GRASS AREAS

- Herbicide: Non-selective contact type.
- Operations: Spot treat
 - All broad-leaved weeds;
 - injurious weed species listed in the Weeds Act 1959 and Wildlife and Countryside Act

FERTILIZER - SPRING APPLICATION

- Type: Organic, slow release.
- Application rate: Manufacturer's recommendations.

FERTILIZER - AUTUMN APPLICATION

- Type: Organic, slow release.
- Application rate: Manufacturer's recommendations.

REINSTATEMENT OF DAMAGED LAWNS

- Damaged turf: Remove to a depth of 30 mm.
- Preparation: Cultivate substrate to a fine tilth.
- Reinstatement: Contractor's choice of re turfing or top soiling and reseeding:
 - Re turfing: Quality and appearance to match existing.
 - Reseeding: Fill with fine topsoil to BS 3882 multipurpose class, free from stones, debris and weeds. Re seed with a seed mix to match existing grass in quality and appearance.
- Protection and watering: Provide as necessary to promote successful germination and/ or establishment.

FLOWER BEDS - SEASONAL BEDDINGS

BEDS OF PERENNIALS OR PERENNIALS AND ANNUALS

- Plant supports: Stake and tie plants using flower canes.
 - Length: 600 mm.

- Maintain throughout the growing season.
- Gaps in planting: Refill by replanting.
- Watering:
 - New plants: Before and after planting out.
 - Ongoing: As necessary for the continued thriving of all planting.
- Operations at end of growing season:
 - Trim: Older flowering stems of herbaceous perennials.
 - Remove: Redundant plant supports, litter, debris and arisings.
 - Cultivate: Fork over the soil, taking care not to cause undue disturbance to plants.
 - Top dress: Apply sanitized and stabilized compost top dressing.

FLOWER BEDS GENERALLY

- Operations:
 - Remove: Dead flower heads, fallen leaves, litter and debris.
 - Weeds: Thoroughly hand weed.
 - Cultivate: Lightly hoe.
 - Trim: Clip grass edges.
- Fungicide: Not required.
- Insecticide: Not required.

SHRUBS, TREES, HEDGES

ESTABLISHMENT OF NEW PLANTING

- Duration: One full growing season from the date of planting.
- Weed control:
 - Method: Keep planting beds clear of weeds by maintaining full thickness of mulch to 50 mm depth and hand weeding.
 - Area: Maintain a weed free area around each tree and shrub, minimum diameter the larger of 1m or the surface of the original planting pit.
- Soil condition: Fork over beds to keep soil loose, with gentle cambers and no hollows. Do not reduce depth or effect of mulch.
- Watering: as and when required to maintain healthy establishment of plants.

TREE'S GUYED, STAKED AND TIED

- Inspection, Maintenance times: As scheduled and immediately after strong winds.
- Guyed:

- See attached data sheet.
- Stakes:
 - Replace loose, broken or decayed stakes to original specification.
 - If longer than half of clear tree stem height, cut to this height in spring. Retie to tree firmly but not tightly with a single tie.
- Ties: Adjust, re fix or replace loose or defective ties, allowing for growth and to prevent chafing.
 - Where chafing has occurred, reposition or replace ties to prevent further chafing.
- Removal of stakes and ties: to be agreed with the site, subject to their agreed ongoing site maintenance.
 - Fill stake holes with lightly compacted soil.

REFIRMING OF TREES AND SHRUBS

- Timing: After strong winds, frost heave and other disturbances.
- Re firming: Tread around the base until firmly bedded.
- Collars in soil at base of tree stems, created by tree movement: Break up by fork, avoiding damage to roots. Backfill with topsoil and refirm.

PRUNING GENERALLY

- Pruning: In accordance with good horticultural and arboriculture practice.
 - Removing branches: Do not damage or tear the stem or bark.
 - Wounds: Keep as small as possible and cut cleanly back to sound wood.
 - Cutting: Make cuts above and sloping away from an outward facing healthy bud, angled so that water will not collect on cut area.
 - Larger branches: Prune neither flush nor leaving a stub but using the branch bark ridge or branch collar as a pruning guide.
- Appearance: Thin, trim and shape each specimen appropriately to species, location, season and stage of growth, leaving a well-balanced natural appearance.
- Tools: Use clean sharp secateurs, hand saws or other approved tools. Trim off ragged edges of bark or wood with a sharp knife.
- Disease or infection: Give notice if detected.
- Growth retardants, fungicide or pruning sealant: Do not use unless instructed.

PRUNING OF EXCESSIVE OVERHANG

- Timing: Annually.
- Operations: Remove growth encroaching onto grassed areas, paths, roads, signs, sightlines and road lighting luminaires.
- Special requirements: None.

PRUNING TREES AND SHRUBS

- Standard: To BS 7370-4.
- Special requirements: Growth retardants not permitted.

FORMATIVE PRUNING OF YOUNG TREES

- Standard: Type and timing of pruning operations to suit the plant species.
- Time of year: Do not prune during the late winter/ early spring sap flow period.
- Young trees up to 4 m high:
 - Crown prune by removing dead branches and reducing selected side branches by one third to preserve a well-balanced head and ensure the development of a single strong leader.
 - Remove duplicated branches and potentially weak or tight forks. In each case cut back to live wood.
- Whips or feathered trees: Do not prune.
- Operatives: Member of the Arboriculture Association.

PRUNING ORNAMENTAL SHRUBS

- General: Prune to encourage healthy and bushy growth and desirable ornamental features, e.g. flowers, fruit, autumn colour, stem colour.
- Suckers: Remove by cutting back level with the source stem or root.

PRUNING FLOWERING SPECIES OF SHRUBS AND ROSES

- Time of year:
 - Winter flowering shrubs: Spring.
 - Shrubs flowering between March and July: Immediately after the flowering period.
 - Shrubs flowering between July and October: Back to old wood in winter.
 - Rose bushes: Early spring to encourage basal growths and a balanced, compact habit.

TRIMMING RAPIDLY ESTABLISHING HEDGES

- General: Allow to reach planned height as rapidly as possible. Form: Trim back lateral branches moderately.

TRIMMING SLOWLY ESTABLISHING HEDGES

- Operations:
 - Timing: Cut back hard in June and September to encourage bushy growth down to ground level
 - Form: Allow to reach planned dimensions only by gradual degrees, depending on growth rate and habit.

REMOVAL OF DEAD PLANT MATERIAL

- Operations: At the end of the growing season, check all shrubs and remove all dead foliage, dead wood and broken or damaged branches and stems.

CLIMBING PLANTS

- Pruning: Remove excess growth, to ensure that signs, light fittings, doors and windows are always kept clear.
- Insecure growth: Attach to supporting wires or structures using Stainless steel wire.
- Supporting structures: Check and repair as necessary.

DEAD AND DISEASED PLANTS

- Removal: As soon as possible.
- Replacement: In the next suitable planting season.

REINSTATEMENT OF SHRUB - HERBACEOUS AREAS

- Dead and damaged plants: Remove.
- Mulch - matting materials:
 - Carefully move to one side and dig over the soil, leaving it fit for replanting.
 - Do not disturb roots of adjacent plants.
- Replacement plants:
 - Use pits and plants: To original specification or to match the size of adjacent or nearby plants of the same species, whichever is the greater.
 - Additional requirements: Submit details and cost of plants before ordering.
- Dressing: Slow release fertilizer:
 - Type: Organic.
 - Application rate: As manufacturer's recommendations.

WEED CONTROL GENERALLY

- Weed tolerance: Always, weed cover less than 5% and no weed to exceed 100 mm high.
- Adjacent plants, trees and grass: Do not damage.

HAND WEEDING

- General: Remove weeds entirely, including roots.
- Disturbance: Remove the minimum quantity of soil, and disturb plants, bulbs and mulched surfaces as little as possible.
- Completion: Rake area to a neat, clean condition.

- Mulch: Reinstate to original depth.

WEED CUTTING BY HAND OR MACHINE

- Undesirable grass, brambles and herbaceous growth: Cut down cleanly to a maximum height of 25mm.
- Herbicides: Give notice before use and seek approval from the project landscape architect. Herbicide is to be suitable for application within site grounds.

HERBICIDE TO KILL REGROWTH

- Type: Suitable foliar acting herbicide to kill regrowth.
- Timing: Allow recommended period for herbicide to take effect before clearing dead weeds.

WEED CONTROL WITH WINTER HERBICIDE

- Type: Suitable residual soil acting herbicide.
- Time of year: Unless otherwise agreed, complete before end of March.
- Timing: Allow recommended period for herbicide to take effect before clearing dead weeds.

WEED CONTROL WITH SUMMER HERBICIDE

- Type: Suitable foliar acting herbicide.
- Timing: Allow recommended period for herbicide to take effect before clearing dead weeds.

DIGGING OVER

- General: Dig over beds. Do not damage existing plants, bulbs and roots.
 - Depth of dig (minimum): 100 mm.

SOIL AERATION

- Compacted soil surfaces:
 - Prick up: To aerate the soil of root areas and break surface crust.
 - Size of lumps: Reduce to crumb and level off.
 - Damage: Do not damage plants and their roots.

SOIL LEVEL ADJUSTMENT

- Level of soil/mulch at edges of beds: Reduce to 50 mm below adjacent grass or hard surface.
 - Arisings (if any): Spread evenly over the bed.

MAINTENANCE OF LOOSE MULCH

- Thickness (minimum): 50 mm.
 - Top up: Every three months.
- Mulch spill on adjacent areas: Remove weeds and rubbish and return to planted area.

- Weeding: Remove weeds growing on or in mulch by hand weeding.

SNOW REMOVAL FROM SHRUBS/ TREES

- Standard: To BS 7370-4.
- Plants subject to snow removal: As instructed.
- Timing: When instructed.

APPENDIX H: CONFIRMATION STATEMENT FROM CHARTED ENGINEER

Iesis Special Structures Limited
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IESISSTRUCTURES

Our ref: SE1560-RJ-L-140525

Mike Kemp

Deputy Area Team Leader
Planning and Regeneration
Central Services
Hillingdon Council

14th May 2025

Dear Sir/ Madam,

**RE: Crown Trading Centre, Hayes
Phase 1 (Blocks E & F) SuDS Scheme Verification Report For Condition 12 of
Planning Ref: 3955/App/2020/139**

Please accept this letter as a statement confirming that the approved drainage/SuDS measures have been fully implemented.

We trust that the above is acceptable however, if you have any queries please do not hesitate to contact us.

Yours faithfully,



ROGER JACK
BEng (Hons) CEng MICE
ICE Membership No. 61334943
Associate Civil Engineer



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