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Ref: 21st Feb. 2019 Rev 27th May 2020 - BJU/mmi

To: Mr & Mrs Wright
 Church Villa,
 High Street, Ruardean,
 Gloucestershire GL17 9US
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Dear Mr & Mrs Wright,

Land at Church Villa, High Street, Ruardean, GL17 9US, - BS5837 Tree Constraints, Tree Impacts and Tree Protection Method Statement for REVISED residential development.

Contents:

<p>Fig 1: BS5837 Design & construction process & tree care.</p>	<p>1. Instruction.</p>
<p>2. Inspection.</p>	<p>3. The Site.</p>
<p>4. The Trees. 4.1 Trees on site: 4.2 Off-site trees:- 4.3 Amenity: 4.4 Photos: 4.5 Detailed Tree Descriptions & Tree Table.</p>	<p>5. Proposed Development & Tree Impacts. 5.1 The proposal. 5.2 Tree Constraints and Impacts (considered below). 5.3 Physical contact of above-ground parts of trees. 5.4 Below-ground root spread. 5.5 Light Interception & Shading. 5.6 Over-bearing and Falling material. 5.7 Subsidence/heave & root growth. 5.8 Amenity impact.</p>
<p>6. Arboricultural Method Statement in sequential order for proposed development. 6.1 Supervision 6.2 Tree Management 6.3 Tree Protection 6.4 Construction Access. 6.5 Demolition / Excavation within RPAs:- 6.6 Foundations within RPAs:- 6.7 Drainage. 6.8 Service Trenches within RPAs. 6.9 Minimal-dig construction for new access Drives, parking & paths 6.10 Tree work following construction. 6.11 New Planting.</p>	<p>7. Conclusions.</p> <p>Appendices 1 to VIII:- I Location & Google Earth aerial. II Vertical Tree Protection Fencing, from BS5837 III Horizontal Ground Protection x 2 examples IV Shallow trays for strengthening gravelled or grassed areas. Slightly deeper (50mm or 80mm trays for strengthening gravelled or grassed areas. Deeper Cellweb 3-D grid for strengthening tracks. V Example of Air-spade. VI B J UNWIN FORESTRY CONSULTANCY CV. VII Constraints plan:- Tree Crowns Root, Protection Areas, Theoretical Shading. VIII Tree retention and Tree Protection Plan.</p>

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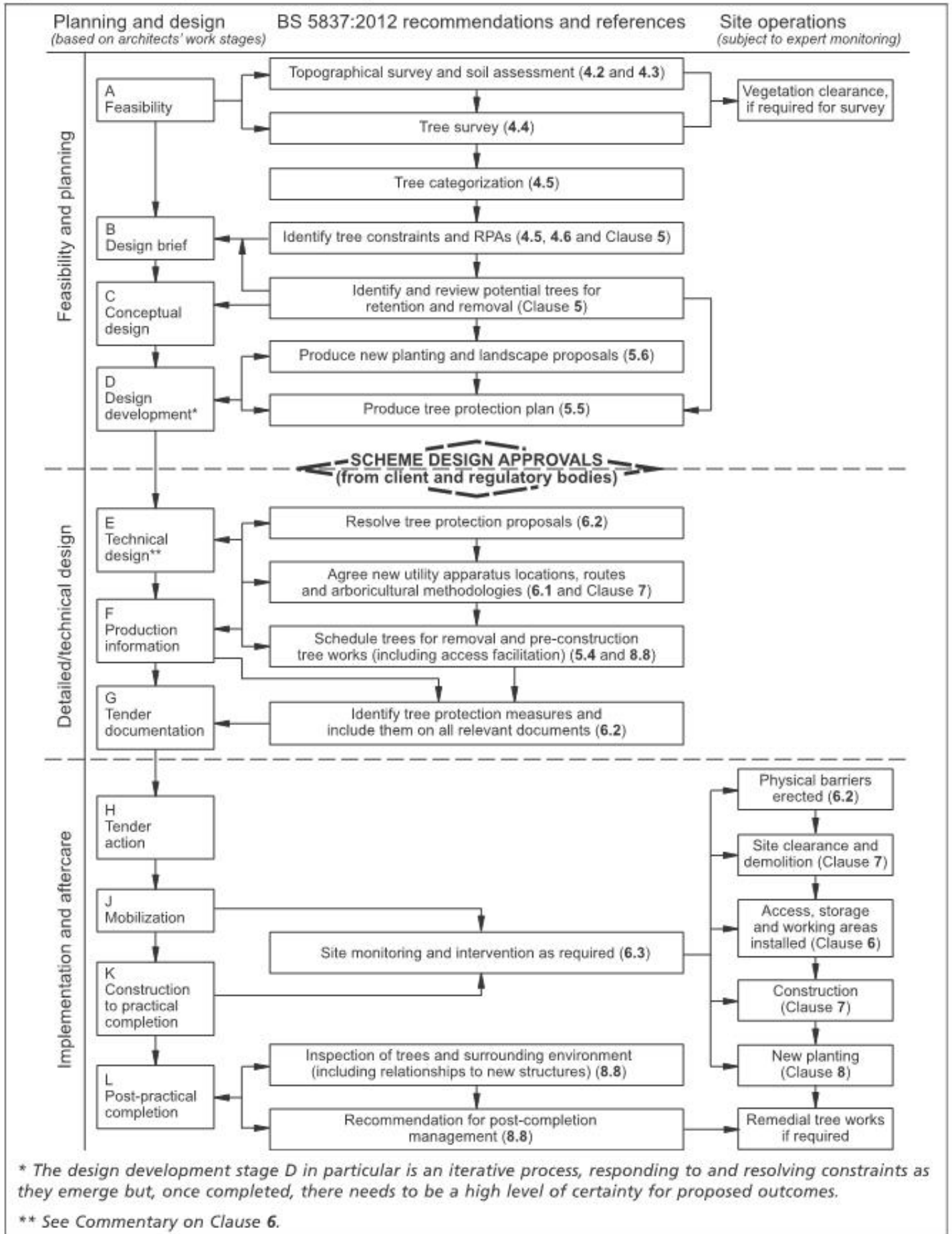
Limitation of Report:-The statements made in this Report do not take account of the effects of extremes of climate, vandalism or accident, whether physical, chemical or fire. BJUFC cannot therefore accept any liability in connection with these factors, nor where prescribed work is not carried out in a correct and professional manner in accordance with current good practice. The authority of this Report ceases at any stated time limit within it, or if none stated after two years from the date of the survey or when any site conditions change, or pruning or other works unspecified in the Report are carried out to, or affecting, the Subject Tree(s), whichever is the sooner.

Tree and Woodland Consultancy
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Figure 1 The design and construction process and tree care



1. Instruction.

- 1.1 Mr and Mrs Wright wish to construct a new residential dwelling on land to the north of Church Villa, Ruardean. Therefore, they have asked B J Unwin Forestry Consultancy to advise on trees for planning application purposes, subject to quote.
- 1.2 The local authority (Forest of Dean District Council) refused a previous application, but require a tree impact assessment and tree protection method statement for any proposal. The local authority may require mitigation by new planting for any trees lost as part of any development.
- 1.3 We have used a **topo survey by Monument Geomatics MG1744/S1 of March 2020** for constraints plans. **Proposed New Dwelling MSP of April 2020 20WR1/1202/PL/04/20/SK/D**, extract in section 5, shows the proposal, and guides our tree impact and tree protection sections 5 & 6 of this report.
- 1.4 Therefore methodology of the report below follows *BS5837:2012 Trees in Relation to Design, Demolition & Construction*.
- 1.5 BS5837 flowchart previous page. Appendices follow signature page.

2. Inspection.

- 2.1 Owen Hutchison visited the property on 19th February 2019, met the occupier, and made an un-accompanied inspection.
- 2.2 The survey was from ground level, involving visual observation (Visual Tree Assessment: Mattheck and Breloer, 1994 and Lonsdale, 1999). We measured dbh, (estimated for off-site trees) and measured or estimated crown spread and height.
- 2.3 The survey and report for this project are by Owen Hutchison, who has >10 years' experience working with trees, and has been checked by Jim Unwin (professional-CV attached).

3. The Site.

- 3.1 The site inspected is a domestic plot about 75m north to south and 28m east to west. Church Villa is located at the southern end of the plot, adjacent to the High Street. The site's western boundary is marked by an access track, with the church and graveyard beyond. Little Vale, residential dwelling is located to the east, while open farmland borders the site's northern and north-eastern boundaries.
- 3.2 The site slopes gently from south to north, between 205m and 200m aod. The site is relatively sheltered from prevailing south-westerly winds by the surrounding village of Ruardean.

Bedrock geology from BGS website is the boundary between:- Trenchard Formation - Mudstone And Sandstone. Sedimentary Bedrock formed approximately 308 to 310 million years ago in the Carboniferous Period. Local environment previously dominated by rivers.

Superficial deposit: None recorded.

Therefore, subsoils may contain fine-textured material, with shrink-swell potential.

- 3.3 The access road, located to the west of the site is a public footpath.

4. The Trees.

- 4.1 Trees on site:-

- The northern end of the surveyed site contains predominantly fruit trees of poor quality.
- The north-western and eastern boundaries are defined by hedges H12 and H4. These are low-level hedges, comprising a mix of native species, dominated by ivy.
- Golden Lawson cypress T7 is located in the centre of the site. The tree could potentially become much larger and may dominate the site.
- Walnut tree T14 has the highest amenity value of the on-site trees.

- Numerous low-level shrub beds exist throughout the site.

4.2 Off-site trees:-

- Hedge H2 is located within the grounds of Little Vale. This is a tall hedge, comprising predominantly cypress, laurels and privet.
- Purple plum T3 is located at the northern end of H2. It has suffered storm damage, leaving a large wound on the northern stem.
- Tree T19 is located just north of the surveyed site. This is a poor quality, ivy clad plum.
- Ash T11 grows within hedge H12. This is a triple-stemmed tree, which is prominent in its surroundings.
- Trees T28 to T33 grow within the grounds of the churchyard, to the west of the surveyed site. These are large trees, which dominate their immediate surroundings.

4.3 Amenity: This could describe an attractive tree, a screening function, habitat potential, or historic/veteran tree.

- All trees and hedges on site have wildlife value.
- Hedge H2 provides excellent screening between Church Villa and Little Vale.
- Walnut T14 has visual amenity for uses of the site and can be viewed from the High Street and public footpath to the west.
- Off-site trees T28 to T33 provide excellent screening from the churchyard, and are visible from the High Street.
- We have not checked for the presence of TPOs.

4.4 Photos below:



4.4.1 View north from existing parking area. Walnut T14 to the right. Brick-built shed and T13 ahead. Hedge H12 to the left.



4.4.2 View north along hedge H12. Plum T9 ahead, with off-site Trees T32 and T33 to the left.



4.4.3 View south east from G8. Golden cypress T7 ahead, with apple T5 to the right. Hedge H2 beyond.



4.4.4 View north of trees T17 to T27 ahead. Walnut T14 to the left, with hedge H4 to the right.



4.4.5 View north along access road, along the site's western boundary. Off-site trees T28 to T33 to the left.

4.5 Detailed Tree Descriptions

4.5.1 Trees **on, or potentially influencing** the site, are individually described in the table below, and shown on the plans in Appendices.

Age class is described as:-

- Sap: Very young tree, or sapling, one-five years old.
- Y: Young tree less than fifteen years old and <1/3 fully grown.
- Sm: Semi-mature tree having attained 1/3 to 2/3 full stature and 1/3 to 1/2 estimated lifespan.
- Em: Early mature: tree at 2/3 to virtually full size, and halfway through its safe life.
- M: Mature: fully-grown tree with useful life expectancy.
- Lm: Late-mature: fully grown, of declining vigour, but still healthy.
- Om: Overmature tree: fully grown and starting to decline in health (but may still have many years of safe life).
- Vet: Veteran: usually very old; of significant historic, habitat or cultural value.

Health & Structural condition:- Self-explanatory:- **Good, Fair, Poor or Dead.**

Remaining Safe Useful Life

Prediction of safe life in its location, estimated as:-
<5 years, <10 years, 10-20 years, 20-40 years, >40 years.

Retention categories, based on BS 5837 Section 4.5, are:-

Retain:

- A =** High quality or value >40yrs safe life:
- B =** Moderate quality or value >20yrs safe life:
- C =** Low quality or value >10yrs safe life
or young trees <150mm stem diameter.

Light Green*

Mid Blue*

Grey*

Remove:

- U =** <10yrs safe life or should be removed for
sound arboricultural reasons:

Dark Red*

(*Colour marking on relevant Tree plan)

Sub-category for retention:-

- 1 = Arboricultural Value
- 2 = Landscape Value
- 3 = Cultural and/or Habitat Conservation Value

BS 5837:2012 Root Protection Area:

The estimated volume of soil 1m deep required to sustain the tree, usually expressed as a disc 1m deep, centred on the tree's trunk.

**THE RPA CAN BE A VARIED SHAPE ENCLOSING THE CORRECT ROOTABLE AREA:
but SHOWN AS A CIRCLE FOR CONVENIENCE.**

Calculated as:-

Single-stem tree, radial distance = $12 \times$ stem diameter at 1.5m ht.

Multi-stem trees 1-5 stems = Square root of (sum of individual stem diameters squared).
> 5 stems = Square root of (average dbh squared x number of stems).

4.4.2

Land at Church Villa, Ruardean, GL17 9US – BJUFC BS5837 inspection – 19th February 2019

No. T=tree S=shrub H=hedge G=group	Species	Dbh (stem diam @ 1.5m ht) mm.	Total height. Ht to base of crown. Est Ht in 10 yrs. m.		Crown radii m.				Age class	Health	Structural Condition	SULE	Comment (All are in average to good health and condition, unless stated otherwise.)	Retention category A (best) to C. U = (remove) Sub-category 1, 2 or 3	BS 5837 Root Protection Area radius. m.	Recommended WORK excluding development.	
					N	E	S	W									
H1	Mixed species	50	1.8	0	1.8	0.5	0.5	0.5	0.5	Em	F/P	F/P	20-40	Mixed species boundary hedge, comprising box, holly and privet. Ivy throughout.	C2	0.6	Trim annually to maintain size and shape.
H2	Mixed species	300 Ave.	8-16	0	10-18	3	3	3	3	Em	F	F	20-40	Off-site, mixed species hedge. Comprising Leyland cypress, lawson cypress, laurel and privet. Estimated position and dimensions.	B2	3.6	
T3	Purple plum	250, 250	5	1.5	6	3	2	1	4	M	F	F/P	10-20	Off-site tree with estimated position and dimensions. Large tear-out wound on northern stem.	C2	3.5	
H4	Mixed species	60	2	0	2	0.75	0.75	0.75	0.75	M	F	F/P	20-40	Boundary hedge comprising ash, holly, hawthorn and privet. Bramble and ivy throughout.	C2	0.7	

T5	Apple	380	8	2	9	2.5	3	1.5	3	M	F	F/P	20-40	Twin stems from 1.8m. Crude historic pruning stubs.	C2	4.6	Target prune old stubs.
T6	Holly	200	9	2	11	2	2	2	2	Sm	F	F	>40	Slightly suppressed by T5. Growing in shrub bed.	C2	2.4	
T7	Golden lawson cypress	350	12	0	14	3	2	2.5	2	Sm	F	F	20-40	Poor position for species and could become much larger. Compost heap to the north.	C2	4.2	Consider removal.
G8	Silver birch	20	2	1	6	0.5	0.5	0.5	0.5	S	F	F	>40	Eight close-planted silver birch saplings.	C2	0.2	
T9	Plum	220, 300	5	2	7	1	2.5	2.5	0.5	Om	F/P	P	<10	Twin stems at 1.5m. Western stem is almost dead. <i>Ganoderma</i> bracket at base to the south.	U	3.7	Fell.
T10	Plum	270, 290	8	5	9	5	2.5	1	0.5	Lm	F/P	F/P	10-20	Twin stems at 1.2m. Heavy lean north.	C2	4.0	
T11	Ash	350, 370, 410	12	5	14	6	7	5	2	Sm	F	F/P	20-40	Boundary tree and possibly off-site. Thee stems from base. Ivy up main stems.	B2	6.5	Sever ivy at base.

H12	Mixed species	50	1.5	0	1.5	0.5	0.5	0.5	0.5	0.5	M	F	F/P	>40	Old boundary hedge. Comprising ash, elder, and hawthorn, with ivy throughout.	C2	0.6	Trim annually to maintain size and shape.
T13	Apple	180, 190	6	2	7	3	3	3	3	2	Em	F	F/P	>40	Crude historic pruning stubs throughout.	C2	2.6	Target prune old stubs.
T14	Walnut	300, 340, 340	11	3	13	4	5.5	6	6	6	Em	F	F/P	>40	Three stems from base. Crude pruning of lower branches.	B2	5.7	Target prune stubs.
T15	Apple	70	2.5	1.5	4	1	1	1	1	1	Y	F	F	20-40	Mower damage at base.	C2	0.8	
T16	Apple	100 at 1.2m	2	1.2	4	1.5	2	0	0.5	0.5	Y	F	F/P	20-40	Heavy lean north west.	C2	1.2	
T17	Lilac	50, 100, 100, 100, 180	5	2	7	1.5	2.5	3	1.5	1.5	Em	F	F/P	10-20	Multi-stemmed from base.	C2	2.5	
T18	Weeping willow	230, 290	6	3	8	6	2	6	3.5	3.5	Sm	F	F/P	20-40	Twin stems from base.	C2	3.7	

T19	Plum	220	5	2	7	1.5	1.5	2	3	Sm	F/P	F/P	10-20	Off-site tree with estimated position and dimensions. Ivy up main stem.	C2	2.6	Sever ivy at base.
T20	Holly	210	6	3	8	1.5	1.5	1.5	1.5	Sm	F	F	20-40	Boundary tree. Dead ivy on stem.	C2	2.5	
T21	Grey polar	180, 250	7	3	9	2.5	2.5	2.5	2.5	Sm	F	F/P	20-40	Boundary tree with estimated position and dimensions. Twin ivy clad stems.	C2	3.1	Sever ivy at base.
T22	Plum	160	5	2	6	1.5	1	1	1.5	Sm	F	F/P	10-20	Growing in compost heap.	C2	1.9	
T23	Plum	260	4	2	4	0.5	0.5	0.5	0.5	Om	P	P	<10	Pollard in poor condition with decay in stem.	U	3.1	Fell.
T24	Plum	230, 270	6	2	6	1	1	1	1	Om	P	P	<10	Pollard in poor condition with advanced decay in main stems.	U	3.5	Fell.
T25	Plum	260	6	2	6	1	1	1	1	Om	P	P	<10	Pollard in poor condition with advanced decay in main stems.	U	3.1	Fell.
T26	Plum	180, 180, 250	5	2	5	1	2	2	1	Om	F/P	F/P	10	Old pollard with decay in stems. Poor.	C2	3.6	

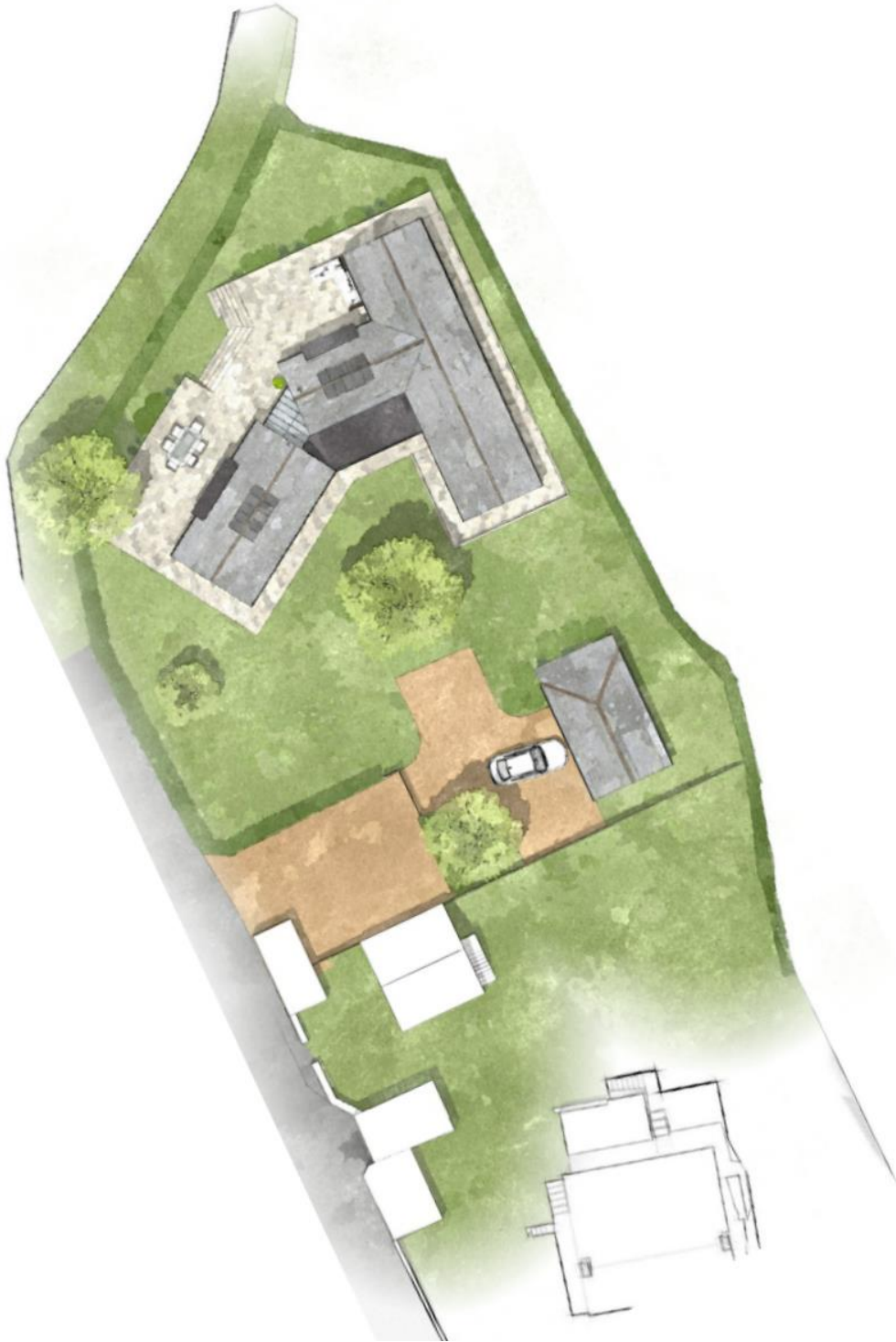
T27	Hawthorn	200	5	2.5	7	1.5	1.5	1.5	1.5	1.5	Sm	F	F	>40	Boundary tree with ivy throughout.	C2	2.4	Sever ivy at base.
T28	Western red cedar	750	20	3	22	4	3.5	3.5	3	3	M	F	F	20-40	Off-site tree with estimated position and dimensions.	A2	9.0	
T29	Silver fir	400	13	6	14	2	2	1	3	3	Em	F	F/P	20-40	Suppressed off-site tree, with estimated position and dimensions.	C2	4.8	
T30	Western hemlock	700	20	3	22	1	5	6	5	5	M	F	F	20-40	Off-site tree with estimated position and dimensions. Two stems at 4m. Ivy up main stems.	B2	8.4	Sever ivy at base.
T31	Holly	380	7	2	7	1	3	3	2	2	Em	F/P	F/P	10-20	Off-site tree with estimated position and dimensions. Suppressed by trees 30 and 32.	C2	4.6	
T32	Black pine	750	20	3	22	5	4	4	5	5	M	F	F	>40	Off-site tree with estimated position and dimensions. Two stems at 5m. Ivy up main stem.	B2	9.0	Sever ivy at base.
T33	Yew	200, 200	7	3	9	5	5	5	5	5	Em	F	F/P	>40	Off-site tree with estimated position and dimensions. Two stems at base. Ivy up main stems.	B2	2.9	Sever ivy at base.

End of table.

5. Proposed Development & Tree Impacts.

5.1 The proposal.

- 5.1.1 The proposal, **Proposed New Dwelling MSP WR1/1202/PL/04/20/SK/D of April 20**, extract below, shows the proposal. Tree retention is indicative.
- 5.1.2 A new house and garage are built in the northern half of the plot.
- 5.1.3 Access is via the existing access and parking area. The existing parking area will be extended east, to the proposed eastern double garage.



5.2 Tree Constraints and Impacts (considered below).

5.2.1 There are six potential arboricultural constraints to the development of the site:

- **physical contact of above-ground** parts of the tree,
- **below-ground** parts,
- **shading,**
- **over-bearing, and falling material,**
- **subsidence/heave, and root growth,**
- **impact on amenity value.**

5.2.2 Trees are listed in table, and coloured on the Tree Plans, to indicate their retention categories A,B,C,U: with the colours explained in the keys of the table & plan (**A = best** to **U = remove**). This allows the site designer to plan around important trees, and ignore lesser trees.

5.3 Physical contact of above-ground parts of trees.

5.3.1 General:-

Tree Plans in Appendices shows tree locations and crown spreads. Crown dimensions: spread in four directions, base of crown and tree height, are given in Table 4.5.2.

5.3.2 Specific above-ground impacts:-

- Small fruit trees T10, T13, T15, T16, T17, T18, T23, T24, T25, T26 are either within or too close to new house and its patios.
- Golden cypress T7 is shown retained on plans: as screening between new and old houses. Pruning back on the northern side may be needed to allow easy vehicle access to new garage.
- H4 northeast of new house will have to be trimmed back hard to allow construction access.

5.4 Below-ground root spread.

5.4.1 General:-

BS5837 defines a tree's Root Protection Area as a disc of soil 1m deep required to maintain long-term health a full-canopied tree, of a given stem size, usually 12 x stem diameter. We show it as an idealised circle. Rooting areas are never symmetrical, but ideally there should be no ground disturbance within the RPA zone. At the discretion of an arboriculturalist, the RPA can be offset if work is proposed on one side only, and the tree can root in the opposite direction. It is not appropriate to rely on the reduced RPA where potential disturbance extends halfway or more around the tree.

Typically the structural root plate of a tree to resist windthrow is much smaller than the RPA. Therefore tree stability should not be affected by some disturbance within the RPA.

5.4.2 Specific Rootzone Impacts:-

- Walnut T14 has minor rootzone intrusion on its southern side. Provided temporary ground protection is used on other sides, it will be tolerant. See 6.3.3 below.
- Cypress T7 is edged by new drive / parking to west and north. This can be accommodated by minimal-dig and porous drive construction. See 6.9 below.

5.5 Light Interception & Shading.

5.5.1 General:-

The sun rises to 60° at mid-day in mid-Summer when trees are in leaf (ratio of 16m vertical height to 10m horizontal distance).

The sun only rises to 12° in mid-Winter. However, in winter deciduous trees are leafless, so shading is reduced.

Theoretical shadows of arcs equal to estimated tree height in ten-years' time is recommended in BS5837. *This is the shadow pattern for a period from May to September inclusive, from 10.00hrs to 18.00hrs daily.*

5.5.2 Specific Shading Impacts:-

- Trees T14 and T11 will cause shading of the new dwelling. But both have open canopies when in leaf. Shading is not a problem.

5.6 Over-bearing and Falling material.

5.6.1 General:-

All trees drop flower parts, leaves, twigs and fruits throughout the year. These can create a mulch layer on roads. Bird droppings and honeydew can spoil car paintwork. Big trees make adjacent dwellers nervous.

5.6.2 Specific Impacts:-

- Leaves from walnut T14 are likely to fall into the gutters of the new dwelling and over the new drive.
- Leaves and needles from off-site trees T11 and T28 to T33 may be blown across the site by prevailing south-westerly winds.
- We note here that the site owners propose to inhabit the new house: so they are well aware of tree proximity.

5.7 Subsidence/heave & root growth.

5.7.1 To be assessed by an engineer referring to NHBC 4.2:2017.

BGS data suggests a possible presence of fine-textured material, with shrink-swell potential.

5.7.2 Foundations should be designed by an engineer accordingly.

5.8 Amenity impact.

5.8.1 Amenity can be *visual landscape, habitat or heritage/historic.*

- All trees to be removed are small, of low amenity value, and cannot be viewed from the High Street.

6. Arboricultural Method Statement in sequential order for proposed development at Church Villa.

6.1 Supervision

- 6.1.1 We would recommend a pre-start site meeting between architect, building/groundwork contractor, Council Tree/Landscape Officer, and retained arboriculturalist to agree feasibility of tree retention, tree protection and working methods.
- 6.1.2 **Further** arboriculturalist inspections to supervise/check:
- **Installation of protection fencing.**
 - **Hand excavation for the installation of the foul drainage pipe if within tree RPAs.**
 - **Supervision of ground works around cypress T7.**
- 6.1.3 All inspections to be followed within three working days with emailed supervision log with action points and photos, copied to client and tree/landscape officer.

6.2 Tree Management

6.2.1 Tree Work prior to ground work:-

No	Species	RPA radius m.	Work for landscape / tree health.	<i><u>ADDITIONAL WORK FOR DEVELOPMENT</u></i>
H1	Mixed species	0.6	Trim annually to maintain size and shape.	
H2	Mixed species	3.6		
T3	Purple plum	3.5		
H4	Mixed species	0.7	Trim annually to maintain size and shape.	<i><u>PRUNE HARD BEHIND HOUSE TO ALLOW CONSTRUCTION ACCESS.</u></i>
T5	Apple	4.6	Target prune old stubs.	
T6	Holly	2.4		
T7	Golden lawson cypress	4.2	Consider removal.	
G8	Silver birch	0.2		
T9	Plum	3.7	Fell.	
T10	Plum	4.0		<i><u>REMOVE.</u></i>
T11	Ash	6.5	Sever ivy at base.	
H12	Mixed species	0.6	Trim annually to maintain size and shape.	
T13	Apple	2.6	Target prune old stubs.	
T14	Walnut	5.7	Target prune stubs.	

T15	Apple	0.8		<u>REMOVE.</u>
T16	Apple	1.2		<u>REMOVE.</u>
T17	Lilac	2.5		<u>REMOVE.</u>
T18	Weeping willow	3.7		<u>REMOVE.</u>
T19	Plum	2.6	Sever ivy at base.	
T20	Holly	2.5		
T21	Grey polar	3.1	Sever ivy at base.	
T22	Plum	1.9		
T23	Plum	3.1	Fell.	<u>REMOVE.</u>
T24	Plum	3.5	Fell.	<u>REMOVE.</u>
T25	Plum	3.1	Fell.	<u>REMOVE.</u>
T26	Plum	3.6		<u>REMOVE.</u>
T27	Hawthorn	2.4	Sever ivy at base.	
T28	Western red cedar	9.0		<u>CROWN RAISE IF DELIVERY VEHICLES EXCEED 3M IN HEIGHT.</u>
T29	Silver fir	4.8		<u>CROWN RAISE IF DELIVERY VEHICLES EXCEED 3M IN HEIGHT.</u>
T30	Western hemlock	8.4	Sever ivy at base.	<u>CROWN RAISE IF DELIVERY VEHICLES EXCEED 3M IN HEIGHT.</u>
T31	Holly	4.6		
T32	Black pine	9.0	Sever ivy at base.	
T33	Yew	2.9	Sever ivy at base.	

End of table.

(Treework following development see 6.10 below)

6.2.2 Treework informatives, included for general information:-

6.2.2.1 Disturbance to wildlife.

It is essential to check for nesting birds, bat roosts, badgers and hibernating animals such as hedgehogs under trees, before pruning or removing trees, as negligent disturbance is an offence under the EC Habitats Directive 92/43/EEC, Countryside and Rights of Way Act 2000, Protection of Badgers Act 1992. The Conservation (Natural Habitats, & C) (Amendment) Regulations 2007 make **any** damage or destruction of a breeding site or resting place of a European Protected species (mainly bats in a tree context) an offence.

In general, autumn tree work: **September, October and November** is least disruptive to bats and birds. Work on very ivy-clad trees may need a formal pre-start bat assessment by a trained bat worker.

6.2.2.2 Permission

Trees may be protected by a TPO, or could lie within a Conservation Area. Trees may be owned by third-parties.

Trees may be protected by planning conditions.

Therefore, a contractor must satisfy himself that all necessary permissions from the local planning authority or tree owners are in place before touching trees.

A Felling Licence may be needed to clear non-domestic areas.

6.2.2.3 Quality of Tree Work

All off-ground tree work should be done by insured tree surgeon with certificates in aerial chainsaw use (new designations:- NPTC 020-04, 0020-05, 0020-07, 0021-01, 0021-07; LANTRA 600/5703/8, 600/5717/8, 600/5715/5, 600/5704/X, 600/5714/2), and working to BS3998:2010 and working to BS3998:2010, and “*Treework at Height*”, the Arboricultural Association’s ICoP.

(Stumps can be left to shoot again, ground out, or grubbed out, or poisoned, depending on location.)

6.3 Tree Protection

6.3.1 Requirement

The most important tree-protection measure is effective protective fencing, erected as close as possible to the Root Protection Area (RPA) boundary before any other work starts on site including demolition in the vicinity of trees. It must be maintained until all work is completed, except final soft landscaping. Here tree protection is proposed for retained trees, and for areas of possible new planting where this is feasible: called **landscape protection zones**.

6.3.2 Vertical Tree Protection

6.3.2.1 Tree Protection fencing **locations** are shown on Tree Protection Plan in Appendices.

6.3.2.2 Two **specifications** for suitable protective fencing are given in Appendix II. **Lightweight fencing will suffice here.**

6.3.2.3 Within the fenced off **CEZ** Construction Exclusion Zone: there must be:-

- no construction access,
- no storage of materials, including soil,
- no ground disturbance.

6.3.2.4 Fencing to remain until all demolition, construction and hard landscaping work is completed, and removed only for final soft landscaping.

6.3.3 Temporary Ground Protection (TGP) within RPAs:-

6.3.3.1 IF work is required to be closer than the all-round protection zone, then the fenced off zone can be made smaller on that side, or entered temporarily, subject to permission from retained arboriculturalist.

Within such zones, temporary horizontal ground protection plus temporary fencing would be essential.

TGP is needed here to allow construction access by T14 and by T7.

6.3.3.2 Obvious options for temporary ground protection would be:-

- Temporary ground protection plates such as aluminium “Eve Trakway” or plastic interlocking-plate ground protection, both on 150mm depth of woodchip or bark, shown in Appendix III.
- A layer of woven geo-textile under minimum 250mm depth of graded aggregate which is lifted after work.
- Butted scaffold boards or 22mm plyboard laid on bearers on 150mm depth woodchip or bark mulch (pedestrian access only).

6.4 Construction Access.

6.4.1 General points:-

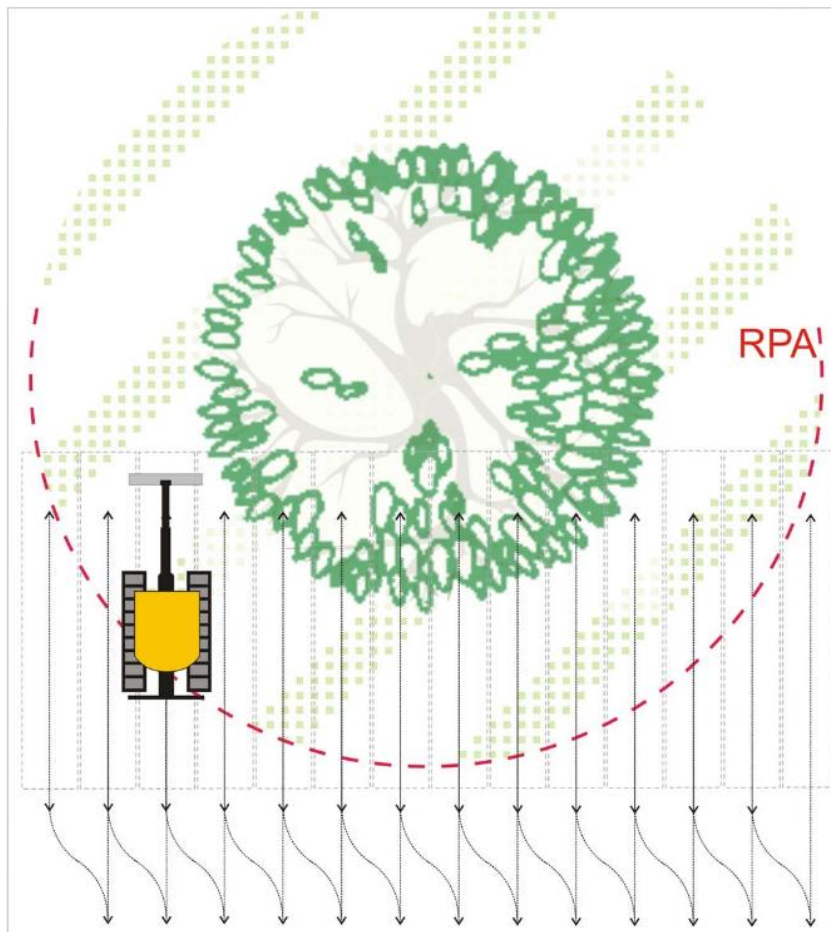
- Access will be via the existing access track and existing parking area.
- All nearby trees and hedges need protection.
- No pedestrian, vehicle, plant or machinery to enter RPAs without temporary ground protection as detailed in para 6.3.3 above.

6.4.2 Site huts could be placed within RPA of trees and hedges; provided they stand elevated on stilt feet, no excavation is required for temporary services, and pedestrian and vehicle access is ground protected as detailed in 6.3.3 above.

6.5 Demolition / Excavation within RPAs:-

6.5.1 General specification FOR EXCAVATION, may be applicable here for T7:-

- Parallel tracking with slewing outside the RPA:-.
- 1.5-tonne rubber-tracked mini-digger with toothless grading bucket.
- Scrape off only turf or top layer to 100mm depth.
- Slew outside RPA.
- Heap spoil outside RPA, for dumper to collect and run outside RPA.
- Process shown below



6.6 Foundations within RPAs:-

6.6.1 House & garage: No special measures needed.

6.7 Drainage.

- 6.7.1 Storm-water drainage: Any soak-away system must be designed to avoid significant increase and no decrease of ground water in trees' rooting zones. Divert into soakaways outside RPAs, or store for greywater recycling.
- 6.7.2 Foul Drainage: **keep out of RPAs.**
- 6.7.3 Sustainable Urban Drainage System: Any SUDS scheme, to reduce the load on local mains drainage, must not significantly add to, or reduce, the soil water in trees' root zones. Store for greywater re-use or allow percolation into parking areas.

6.8 Service Trenches within RPAs.

- 6.8.1 Service trenches (electric lights, utilities, telecoms, drains etc) must be **designed** to run as far from trees as possible. **Use existing runs.**
- 6.8.2 Trenches **within RPAs must be avoided.**
- 6.8.3 Otherwise use this onerous, generalised, work method:-
- Hand digging* or trench-less systems must be used.
*Use an air-spade to reveal roots (Appendix V).
 - Retain roots >15mm diameter within service trenches. Thread service pipe underneath.

 - No roots >25mm diameter must be exposed or severed without express written permission of local authority tree officer or retained arboriculturalist.
 - Any excavation within the RPA of a tree must be covered immediately after digging with damp hessian, topped by tarpaulin & plyboard, to prevent root desiccation.
 - Hole must be backfilled within five days of opening.
 - Wrap exposed roots >20mm with hessian, and surround by 50mm depth sand, as part of backfill medium.
 - Tamp backfill material by hand thumper or whacker plate only.

6.9 Minimal-dig construction for new access drives, parking & paths

- 6.9.1 If roads, footpaths, cycle-ways, yards or parking are required near trees, they can be constructed in two ways:-
Conventional construction:- If outside a tree's RPA.
Minimal-dig construction:- If within a tree's RPA.
- 6.9.2 Appendix IV gives materials for minimal-dig, porous, build-up, as needed with current proposal.
- 6.9.3 **Minimal-dig construction is required for the proposed new drive and footpath, within the RPA of cypress T7.**
- Remove max 100mm depth soft material.
 - Build up with 300g/m² treetex geotextile, then 75mm cellweb filled with porous gravel 20-4mm in size, topped by geotextile, sand layer, then 40mm ground guards (GOLPLA) filled with porous gravel.
 - Kerbing to be timber edging or baulks pinned to the ground by re-bar rod, set no deeper than initial 100mm depth excavation.

6.10 Tree work following construction.

6.10.1 Trees should be re-inspected. This inspection would reveal the need for remedial tree work for the following reasons:-

- to rectify damage occurring during construction (regrettable but possible),
- to allow additional clearance.
- or complete tree removal if trees were considered too close for safe retention.

6.10.2 All additional work subject to further local authority agreement if trees are protected by TPO or planning conditions, or stand within a Conservation Area.

6.11 New Planting.

6.11.1 The proposal is edged by trees and hedges.

6.11.2 Any planting and maintenance to comply with: **BS 8545 “Trees: from nursery to independence in the landscape – Recommendations”**. BSI 2014.

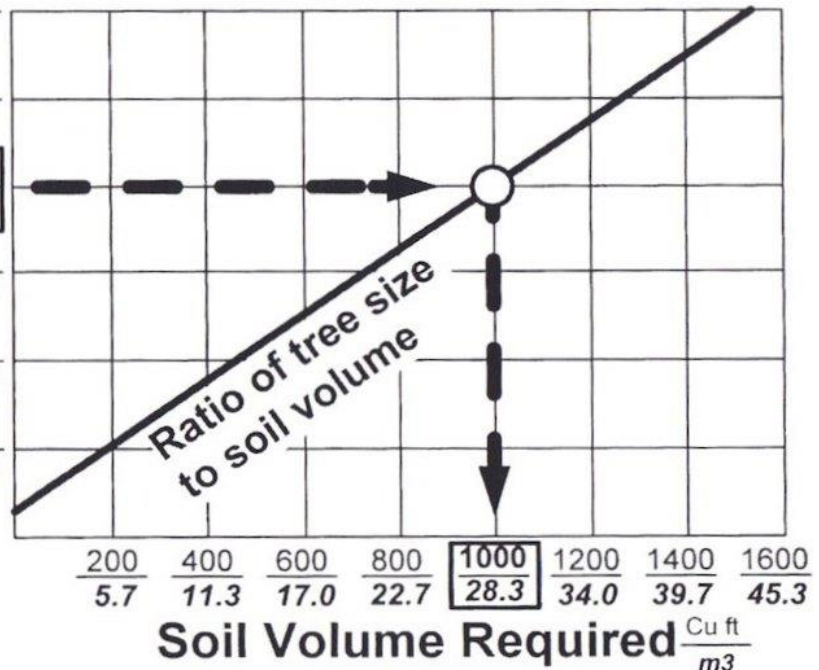
6.11.3 Any new planting must be provides with adequate long-term soil-moisture availability: graph below from James Urban shows rootable area related to tree size (Up by Roots, ISA, 2008), to remind designers:

Table 2.4.1. Tree size to soil volume relationships (Urban 1992).

Ultimate tree size

Crown Spread Sq Ft <i>m²</i>	DBH-Trunk Diameter Inch <i>mm</i>
1200	24
111	610
1000	20
92	508
800	16
74	406
550	12
51	305
350	8
32	203
150	4
14	102

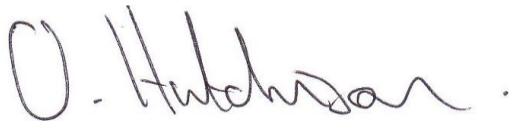
Example: A 16 inch/406 mm diameter tree requires 1000 cu ft/28.3 m³ of soil.



7.0 Conclusions

- 7.1 The proposed dwelling has been re-designed from a previous proposal to better fit the site.
- 7.2 Some small trees are lost. Section 6 provides working methods to protect cypress T7 & walnut T14.
- 7.3 The trees, hedge and shrubs requiring removal, represent only a small loss of amenity. New planting is not required as part of this proposal.

Please contact us for further information.
Yours sincerely,



B J Unwin Forestry Consultancy.

References:

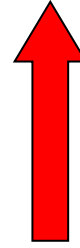
- "The Body Language of Trees"*. Claus Mattheck and Helge Breloer. HMSO 1994.
- "Principles of Tree Hazard Assessment and Management"*. David Lonsdale. HMSO 1999.
- BS 3998: 2010 *"British Standard Recommendations for Treework"*.
- BS 5837: 2012 *"Trees in Relation to Design, Demolition & Construction"*.
- BS 8545 *"Trees: from nursery to independence in the landscape – Recommendations"*. BSI 2014.
- NJUG Volume 4 2007 *"Guidelines for the Planning, Installation and Maintenance of Utility Services in Proximity to Trees"*. NJUG, 30 Millbank, London, SW1P 4RD.
- "Trees and Development"*. Nelda Matheny and James R Clark. ISA. 1998.
- BS 8206:1992 *"Lighting for buildings"*.
- BRE guide 209 (2002) *"Site Layout planning for daylight and sunlight"*.
- NHBC Chapter 4.2, *Building Near Trees*. National House Building Council, 2013.
- "Tree Roots in the Built Environment"*. J Roberts, N Jackson & M Smith. R.A.T.8, TSO (The Stationary Office), London, 2006.
- "Treework at Height"* Industry Code of Practice. Arboricultural Association. 2014.

Appendix I

Location



Google Earth aerial.
Taken 27/06/18.



Appendix II

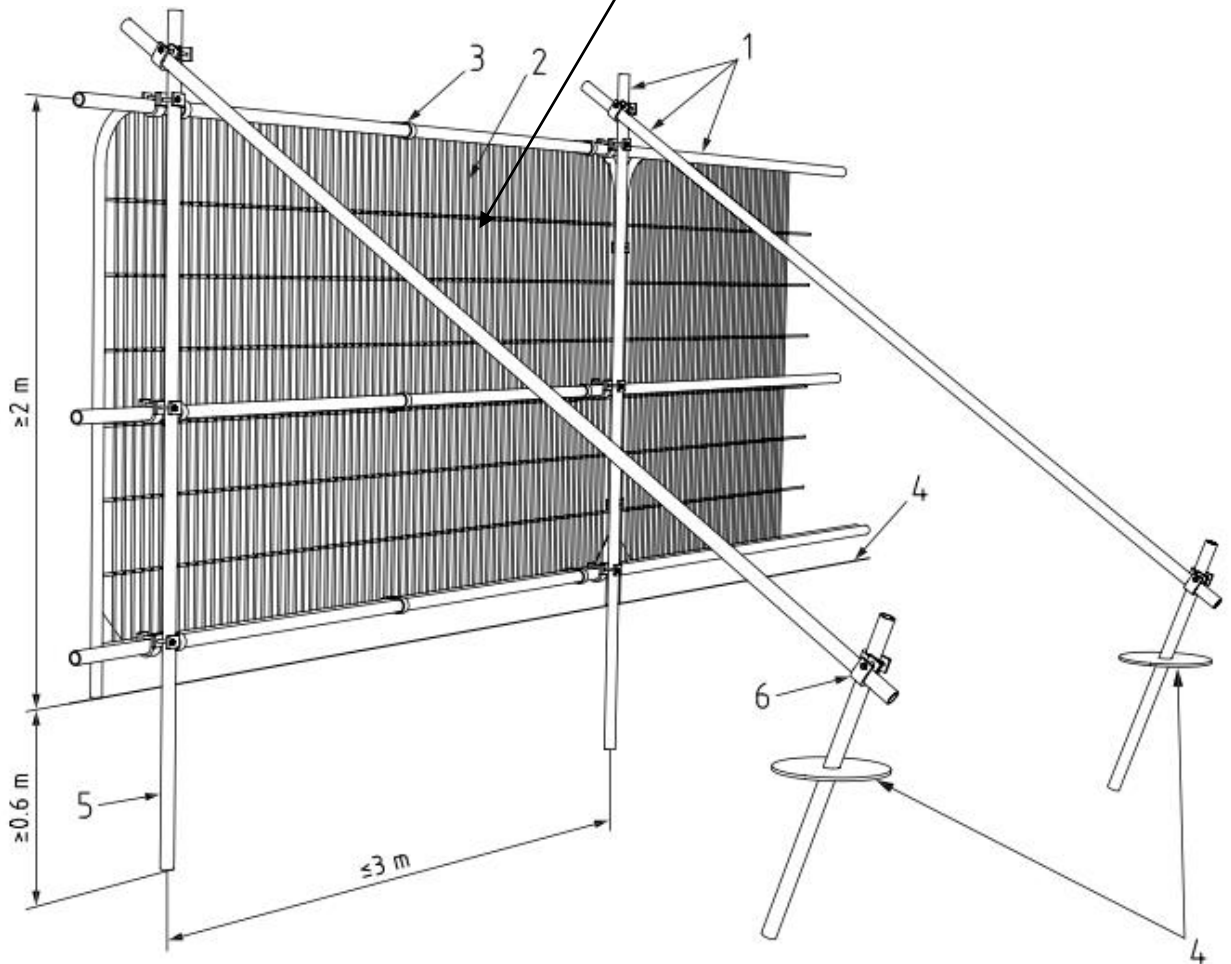
**Vertical Tree Protection Fencing, from BS5837.
Heras panels on rubber feet, pinned braces.**

Vertical protective fence: location on plan:

Default in situ > 3 months:-

Apply signs at MAX 10m spacing:

**TREE PROTECTION -
Construction Exclusion
Zone.
NO ACCESS**



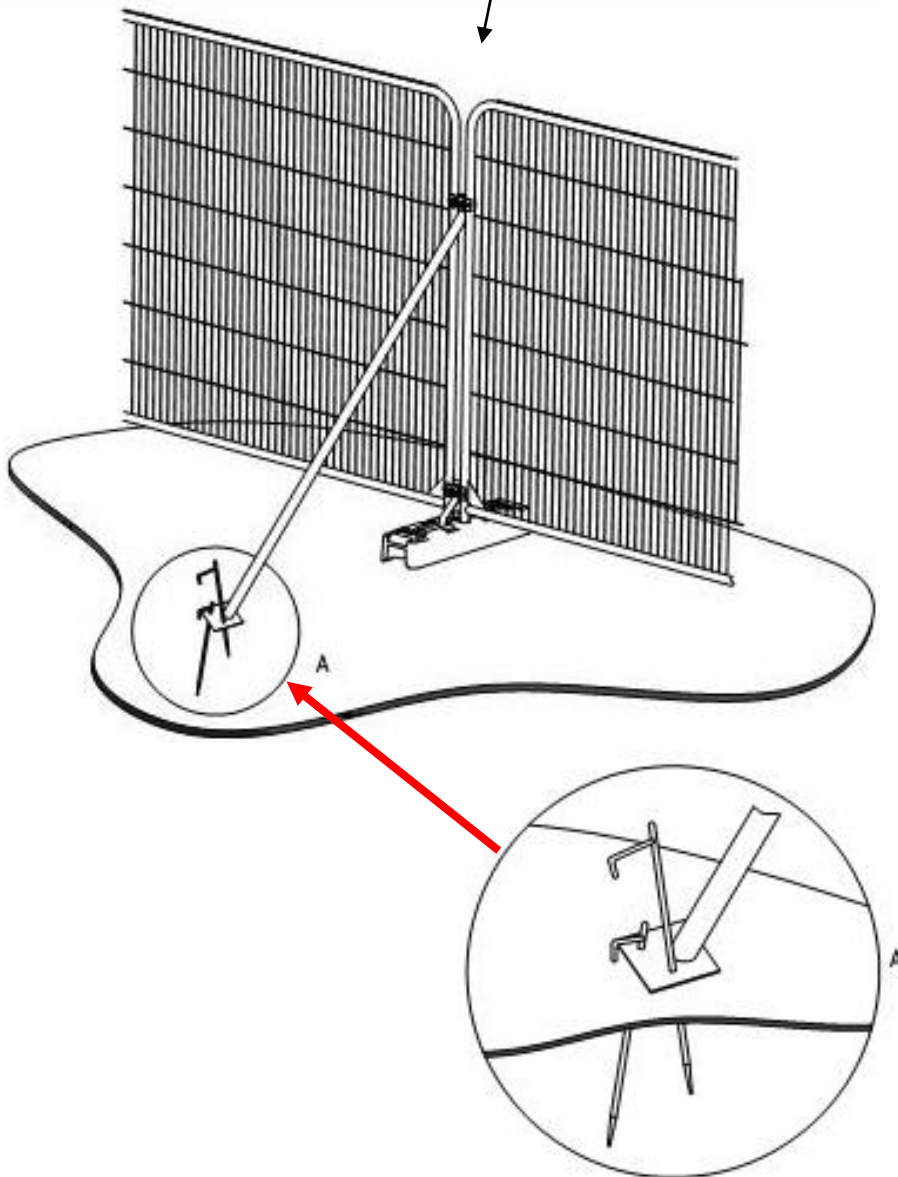
Key

- 1 Standard scaffold poles
- 2 Heavy gauge 2 m tall galvanized tube and welded mesh infill panels
- 3 Panels secured to uprights and cross-members with wire ties
- 4 Ground level
- 5 Uprights driven into the ground until secure (minimum depth 0.6 m)
- 6 Standard scaffold clamps

Lightweight: in situ for < 3 months-

Apply signs at maxm 20m spacing:

**TREE PROTECTION -
Construction Exclusion
Zone.
NO ACCESS**



Appendix III

Horizontal Ground Protection x 2 examples

Example of aluminium temporary ground protection.

EVE TRAKWAY



Roadways - Medium Duty Trakpanel

The Medium Duty Trakpanel, or 'Box' panel, is ideal for where both pedestrian and vehicle access is required. This versatile panel can be laid with either a smooth or corrugated surface uppermost. The smoother surface finish provides excellent support underfoot, whilst the construction of the panel maintains a high load bearing capacity. Due to the way these panels fit together, a smooth joint is created therefore reducing trip hazards.

The Benefits:-

Pedestrian friendly upper surface

Suitable for heavy vehicles Ideal for where both pedestrians and vehicles require safe passage.

Technical Specifications

Dimensions	2.5 x 3m (when installed 2.44m x 3m due to overlap)
Weight	274.7 kg
Carrying Capacity	A more pedestrian friendly roadway, this system is capable of taking any road going loads.

The following Roadways are available.

Please select an item to view more information:

Other Roadways products:-

Heavy Duty Trakpanel-

LD20-

Roadway Ramps-

Multi-Directional Trakpanel

Example of plastic temporary ground protection.

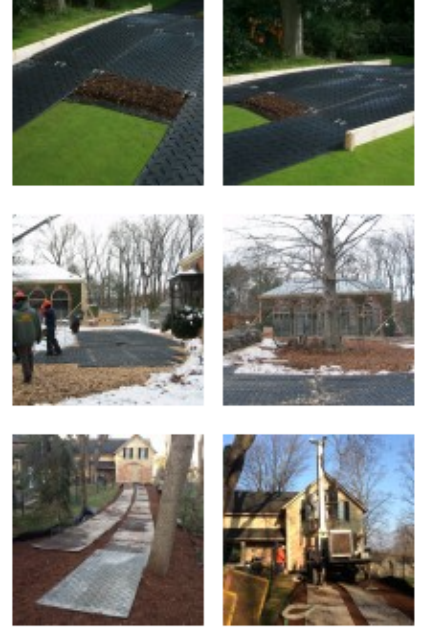
Ground-Guards Tree Root Protection

Tree root protection for construction projects

Planning Departments may often need to stipulate that site access roads will not involve any excavation because of the proximity of tree roots on the site. Furthermore, that they will also provide additional ground cushioning when passing over the immediate areas where there are tree roots beneath. This is very important to prevent compaction of the ground, and long-term damage to the soil structure, the tree roots, and ultimately, to the health of the trees themselves.

An effective means of protecting tree roots is to use a double layer of Ground-Guards. Panels with 150mm of wood chips sandwiched in-between which creates a suitably cushioned roadway for this purpose.

The Ground-Guards system is so durable and versatile that whatever your need, the team will be delighted to work with you to provide an effective solution. Please just call our team on 0113 267 6000 for friendly advice on any difficult site conditions that you need assistance with.



Appendix IV

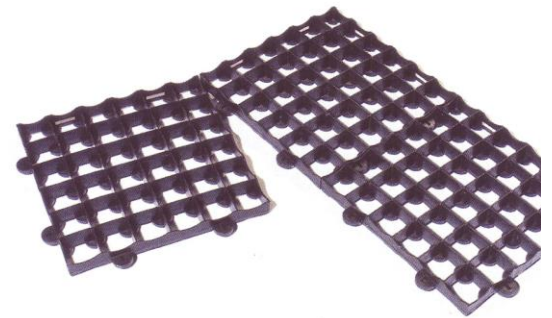
Trays for strengthening gravelled or grassed areas. (50mm or 80mm trays for strengthening gravelled or grassed areas.

DuoBlock

Grass Protection System



Using grass or gravel infill, DuoBlock 750 and 500 give architects, consulting engineers, landscape contractors and developers the ultimate in load-bearing performance combined with aesthetic appearance.



Porous paving systems have been available since the early 1990's and provide a durable yet aesthetically pleasing alternative to traditional surfacing solutions. Increased awareness of the need to manage storm water runoff in new developments and the advent of Sustainable Urban Drainage Systems (SUDS) has led to an increase in popularity.

DuoBlock is a permanent grass protection / gravel retention porous paving system. It is extremely versatile and may be used in a wide range of applications including:

Applications:

- Overspill car parking
- Emergency access and service roads
- Caravan hardstanding
- Verge hardening
- Service Roads
- Pedestrian walkways and towpaths
- Bridle ways
- Helipads
- Golf course pathways / Tee reinforcement

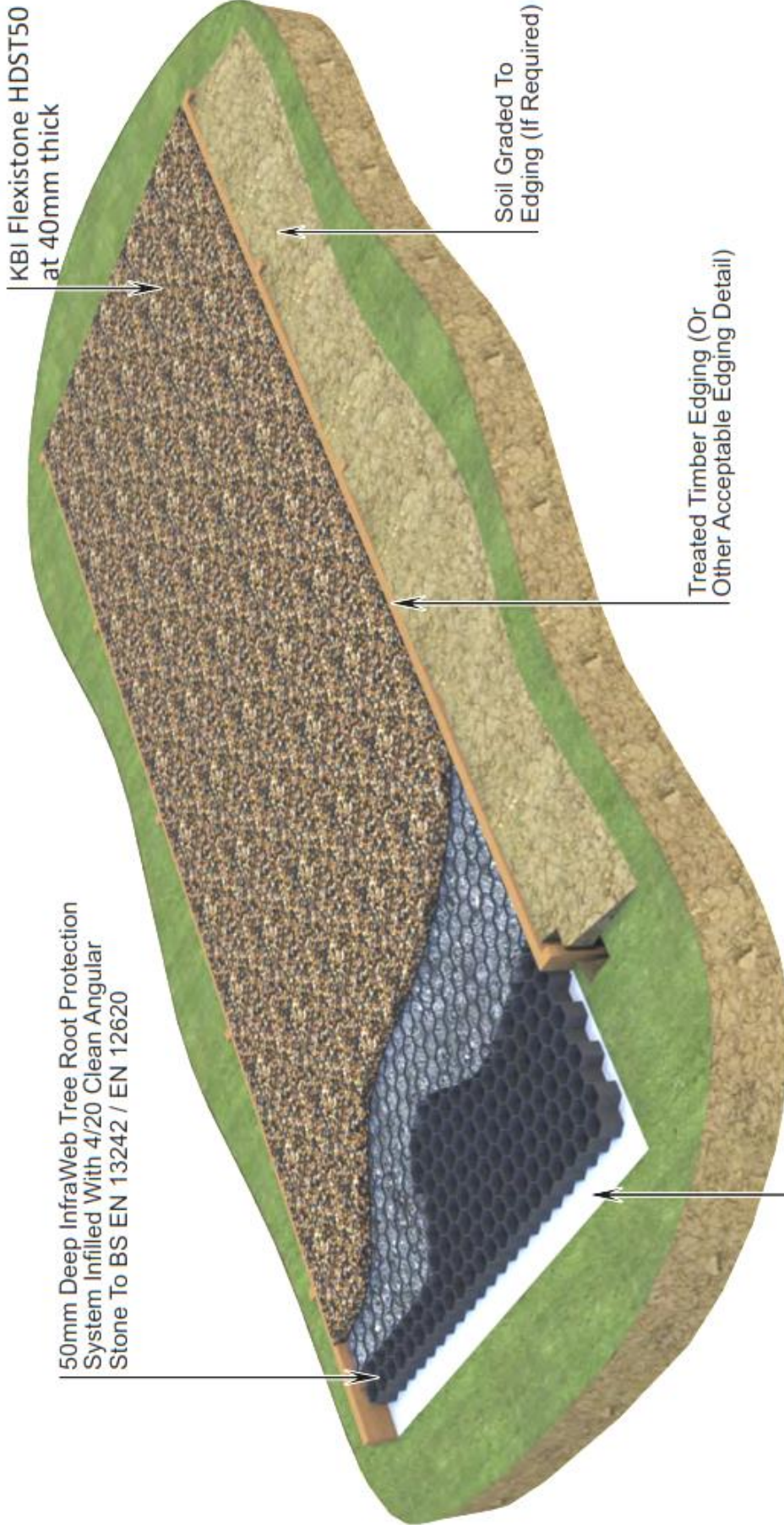
DuoBlock systems are uniquely designed to ensure the ultimate in load bearing performance and aesthetic appearance and have numerous benefits over traditional and first generation plastic systems such as:

Benefits:

- 90% surface area available for infill
- Reduces surface water runoff
- Increases water Filtration
- Interconnecting cell walls
- High Load Performance
- Unique surface design for greater aesthetic appeal
- Positive interlock System

**NEXT DAY
DELIVERY**
from stock

InfraWeb TRP 50 Section - Tree Root Protection c/w Flexistone HDST50 at 40mm thick for pedestrian and cycleway use only



 <p>Sustainable Porous Paving Solutions</p>	<p>KBI Longfields Court Middlewoods Way Wharmcliffe Business Park Barnsley South Yorkshire S71 3GN +44 (0) 1422 242880 http://www.kbiuk.co.uk</p>	<p>InfraWeb TRP 50 Section - Tree Root Protection c/w Flexistone HDST50 at 40mm thick for pedestrian and cycleway use only</p>	<p>Date: 29/12/2016 Drawn By: NLG Design Revision: A Drawing Number: TRP50HDST50</p>
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Deeper Cellweb 3-D grid for strengthening tracks.

Cellweb® TRP is a 3D cellular confinement tree root protection system. The system provides a 'no dig' solution for the construction of new hard surfaces within root protection areas (RPAs). Cellweb® TRP has been designed and independently tested to comply with recommendations made in Arboricultural Practice Note 12 and BS 5837 2012 – Trees in relation to design, demolition and construction.



Cellweb® TRP Key Functions

Cellweb® is a 'no dig' solution which is constructed directly on the existing ground surface. This eliminates the requirement for excavation, preventing root severance.

Cellweb® is a completely porous system allowing continued water permeation and gas exchange between the rooting environment and atmosphere.

Cellweb® spreads point loads, minimising increases in soil compaction within the rooting environment. This maintains an open graded soil structure allowing continued root growth, water, gas and nutrient migration.

The Cellweb® TRP system comprises the following three components

Treetex™ Geotextile. Following minimal ground preparation the Treetex™ is laid onto the existing ground and top soil. This acts as a separation layer, separating the system above from the soil and rooting environment below. Treetex™ performs as a hydrocarbon pollution control measure in accordance with BS5837, holding 1.7lt of oil per square meter.

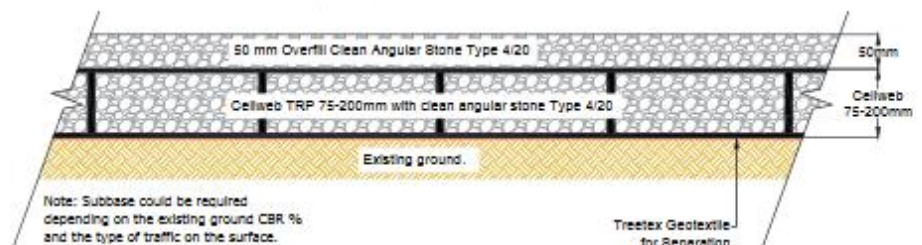
Cellweb® 3D Cellular Confinement. The Cellweb® is installed on top of the Treetex™ layer. This is fixed to the ground using ten steel J pins per panel. The panels can be cut to the required shape and adjoining panels can be connected using heavy duty staples or cell ties.

4-20mm Clean Angular Stone. The expanded Cellweb® is infilled with a 4-20mm clean angular stone. The confined angular stone locks together to produce a rigid stone mattress, while maintaining air pockets for continued water permeation and gas exchange. The low fines content of the stone prevents the Treetex™ layer from becoming blocked over time.

Which depth of Cellweb® TRP?

The Cellweb® System is provided in four different depths; 200mm, 150mm, 100mm and 75mm. The depth required is determined by the proposed traffic loadings and the site ground conditions. Geosynthetics in house engineering department can provide a free site specific technical recommendation. For free technical and engineering support please contact Geosynthetics Ltd 01455 617139 or the full installation guide can be found on our website www.geosyn.co.uk.

Indicative Cellweb with overfill



Web: www.geosyn.co.uk | Tel: 01455 617139
Fax: 01455 617140 | Email: Sales@geosyn.co.uk



Geosynthetics
Engineered Solutions

Appendix V

Example of Air-spade.

HANDLE VIBRATION TEST

Product type – MBW Soil Pick SP125

Manufacturer of testing apparatus – Castle

Accelerometer was affixed to the rear of the handle on the Soil Pick and all three axes were tested.

Accelerometer position:

X axis = 0.0M/S²

Y axis = 0.0M/S²

Z axis = 0.0M/S²

Hand/arm vibration = 0.0M/S²

TREE CARE

MBW's Soil Pick provides a multi-functional air tool for a variety of applications in the tree care industry including:

Radial Trenching

Radial trenching is a process which involves aerating the soils around a tree root in a pattern resembling a wagon wheel. The Soil Pick provides a safe and damage free means of utilizing a high air pressure to loosen tightly compacted soils.

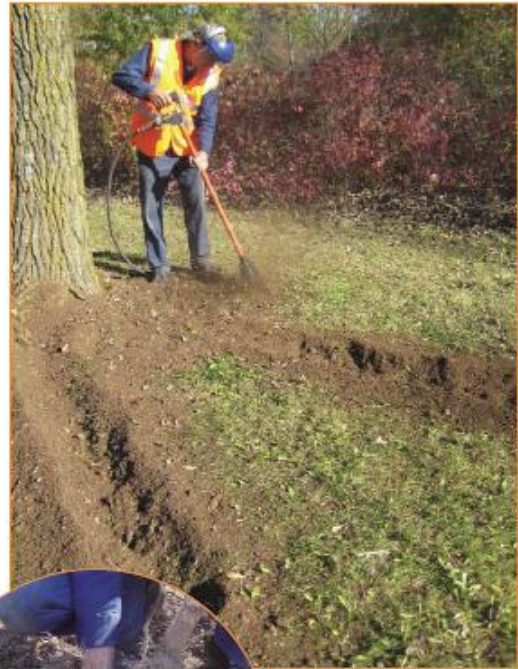
Aeration & Excavation

Root Locating for Utility Line Installation or Pruning

Investigating Root Structure and Damage

Transplanting or Bare Rooting

Reducing Soil Compaction



- Non-Conducting Barrel**
Independently certified safe for 100,000 Volts/12" Barrel
- Large Deflector**
protects operator from scatter of dirt and debris
- Non-Sparking Nozzle**
allows safe use around leaking gas lines
- Polymer Trigger**
reduces operator fatigue
- Unlike the Competition,**
the Soil Pick maintains a cool temperature
- Pressure Gauges**
ensure maximum performance

MBW UK Ltd.
Units 2 & 3 Cochrane Street • Bolton BL3 6BN • England UK
Ph: 44 (0) 1204 387784 • Fax: 44 (0) 1204 387797
E-mail: mbwuk@btinternet.com • Website: www.mbw.com

 1-800-878-5287

Appendix VI

- B J UNWIN FORESTRY CONSULTANCY -

Head office: **Parsonage Farm, Longdon, Tewkesbury, Gloucestershire. GL20 6BD.**

Tel / Fax: 01684 833538. Home Tel: 01684 833795. Mob: 07860376527. E-mail: Jim@bjunwin.co.uk

Satellite Offices: - Haley Ridge, Highcliffe, **Nr. Wadebridge, Cornwall**, PL27 6TN.

-105 Charfield Court, 2 Shirland Road, **London**, W9 2JR.

Associate office: - 1 Market Place Mews, **Henley-on-Thames, Oxfordshire**, RG9 2AH.

Principal: **Jim Unwin BScFor, MICFor, FArborA, RCarborA, CEnv.**

Chartered Forester - ICF Registered Consultant - Fellow of the Arboricultural Association -

Arboricultural Association Registered Consultant - Chartered Environmentalist.

From:	Jim Unwin	To:	Prospective Client
Date:	Sept2019	No. of pages:	2
Subject:	Professional CV		

Below are set out **B J Unwin Forestry Consultancy's** competences and experience.

Insurance:-

£5m Public Liability & £2m Professional Indemnity (renewed June).

Personnel:-

B J Unwin (born 1956) started his forestry career as a tree surgeon and landscape contractor in 1975. He studied forestry at Aberdeen University from 1977 to 1981, worked for Unilever as a Forestry Manager in the Solomon Islands from 1981 to 1983. Since then he has been based in Gloucestershire assisting clients to manage their woodland, trees and vegetation throughout Southern Britain, and occasionally in northern England, Scotland and Northern Ireland.

In the mid-1980s to mid-1990s for a period of about ten years he taught chainsaw, tree felling and tree surgery courses at Worcestershire Agricultural College on a part-time basis. He was assessed and passed as a LANTRA assessor in these skills, and held NPTC certificates of competence in chainsaw use on the ground and up trees.

He now works as a tree consultant / manager / contract manager to a range of clients listed below.

For tree decay testing we have a **PICUS II ULTRASOUND** tomograph with electronic callipers and **RESISTOGRAPH-R400** drill.

He works with two self-employed arboriculturalists of >20 years' combined experience:-

Jasper Fulford-Dobson Arboricultural Association Registered Consultant - Associate Member of the Institute of Chartered Foresters - Professional member of the International Society of Arboriculture - Technicians Certificate (ArborA) 2005, now regarded as NQF "level 4" - Professional Tree Inspection Certificate (LANTRA) 2013,

Owen Hutchison BSc(Hons) Agriculture & Estate Management, Level 4 Diploma Arboriculture, LANTRA Professional Tree Inspection & working with trees since 2007, &

Alex Collier who achieved in July 2018 Level 5 Arboriculture Foundation Degree with a Distinction. In June 2016 achieved Pershore College Level 3 Extended Diploma in Forestry and Arboriculture, completing the course with a Distinction grade (+SC30).

Plus a secretary/ plan technician; calling in extra help as required (eg ecologist or arboricultural assistant). On bigger projects he regularly works as a part of a multi-disciplinary team.

Current BJUFC qualifications are:-

BSc Forestry Hons 1st Class, Aberdeen 1981.

Chartered Forester No. 0330064, 1986.

Fellow of the Arboricultural Association, 1995.

Licensed Subsidence Risk Assessor, 1997-2001 (scheme closed in 2001).

Completed Training in September 2002 to Prepare Native Woodland Plans for CCW and FC in Wales.

Arboricultural Association Registered Consultant No. 42, 2004.

LANTRA certificate for Arboriculture and Bats, BJU in 2005.

Examined and approved to submit Welsh WGS as Management Planner and PAWS Assessor, 2006.

Joined Utilities Vendor DataBase, Supplier No: 88101 in Feb 2006 (left 2010).

Training and Certification in basic CAD operation 2006.

Chartered Environmentalist April 2008.

Woodfuel Production and Supply : LANTRA Certificate of Training Dec 2008.

Training in CAVAT amenity tree asset valuation October 2010.

Company Safety Policy:- We have been successfully assessed by Safety Management Advisory Services (SMAS) as meeting CDM Regs 2015 Core Criteria Stage 1, as a **Worksafe Consultant No. 90180.** expiry 27/09/2020.

CITB *Health, Safety & Environment Test for Managers & Professionals* passed 22/01/2015.

First-aid at work June 2013.

Current clients and typical work include:-

English Heritage	Tree safety inspection contract 2007-2013 for East Midlands, East Anglia, London and SE England. Tree safety inspection contract for West of England & Midlands 2013-2019.
Planning Inspectorate (PINS) & Dept for Communities and Local Government. 2000-2017.	Arboricultural Inspecting Officer in South-West England, South East England, West Midlands and East Midlands; advising the First Secretary of State on TPO appeals since 2000. Contract with DCLG expired April 2008 when transferred to PINS. Contract continued with PINS, as Non-Salaried Arboricultural Inspector, determining TPO appeals and High Hedge appeals. All non-salaried inspectors released in 2017.
Architects / Developers / Planning Appeals	Complete Tree Constraints, Impact Assessment & Tree Protection advice for planning, working with other professionals to input arboriculture into more complex development schemes. Recent assignments in Liverpool to Dorset, Kent, Norfolk & London. All using BS5837:2012. FULL CAD CAPABILITY.
Amey Mouchel Ltd	Overseeing Amey Tree Officer on motorway and trunkroad tree inspections throughout Midlands and Marches to 2012. Amey Mouchel are agents for Highways Agency.
CRH Tarmac Ltd, + Midland Quarry Products + Quarryplan (in Northern Ireland).	Since 1990 working with Estates staff, quarry managers and Landscape / ecological consultancies organising and managing contracts for tree and woodland planting both pre- and post- quarrying. Also preparing landscape restoration schemes for straightforward sites plus landscape management on sites throughout southern England, East Anglia and south and south-west Wales. (Commendations for Land Restoration and Environmental improvements from Spelthorne Borough Council 2003.) Also in England & Northern Ireland ongoing tree consultancy for Quarryplan.
Land Agents	Assisting Bruton Knowles clients' with woodland management and other tree issues since 1984. We also assist clients of Fisher German and Savills on a regular basis.
Tarmac Central now CRH Tarmac Ltd.	Since 1988 woodland management of Hopwas Hays Wood, Tamworth.
Rural estates in Herefordshire, Worcestershire and Gloucestershire, plus private woodland owners in southern England and Wales.	Since 1983 woodland management, tree management, hedgerow management. Many are Ancient woodlands and SSSI's requiring detailed ecological management plans produced in consultation with ecologists. About forty Farm Woodland Premium Schemes and about twenty Native Woodland Plans prepared to date in England and Wales. On-going EWGS grant applications. Input into Tir Gofal (and its successor) and Stewardship schemes. Better Woods for Wales (BWW) applications.
British Waterways	Ten-year Tree and Vegetation Management Plans along canals and around reservoirs in London, Hertfordshire, Berkshire, Birmingham, Staffordshire, Worcestershire, Gloucestershire, Shropshire, Llangollen Canal, etc: plus help in dispute with riparian owners. This work ceased around 2011.
Stroud District Council	Management of 49Ha woodland since 1989 on FC schemes plus grassland on DEFRA Stewardship Schemes, including HLS. Retired Nov07.
One-off clients	Since 1983 assisting tree owners, developers, lawyers etc throughout southern or midland Britain, including Wales, on a wide range of tree-related issues including planning, planning appeals, subsidence, health & safety, disputes, vegetation control, expert witness, valuation of woodlands, standing and felled timber, Christmas trees etc, and tree and landscape planting schemes. Recently High Hedge issues and BS5837 are hot topics.
Malvern Hills District Council. South Oxfordshire District Council	BJU Stand-in part-time Consultant Tree Officer Summer 2003. JF-D stand in Consultant Tree Officer summer 2009 to spring 2010.
Golf course & leisure facilities	Assistance with development of Carden Park golf course in Cheshire. Management advice for trees on other golf courses: Eg Ross Golf Club, Swindon Golf Club .
Farm management	Management of own 95Ha farmland since 1985.

Please do not hesitate to ask for further information. B J Unwin END.

Appendix VII

Constraints plans :-

- **Tree Plan**

Retention categories. based on BS 5837 Table 1:-

A = *High quality & Value (>40yrs life):* Green.

B = *Moderate quality & Value (>20yrs life):* Blue.

**C = *Low quality & Value (>10yrs life):* Grey.

U = *Trees to be removed (<10yrs life):* Red.

**PLEASE NOTE. FOR CLARITY, C-CATEGORY TREES MAY NOT BE COLOURED.

and

- **Root Protection Areas Plan**

RPA = circles.

See Tree Table for dimensions.

and

- **Theoretical Shading Plan**

= quadrant of tree height in ten years' time from north west (mid-morning) to due east (evening). This is a shadow pattern for 1 x tree height from 10.00-18.00hrs from May to September.

Plans are not included in pdf format of report.

Insert plans here in paper copy of report:-

Appendix VIII

Tree retention and Tree Protection Plan

Plans are not included in pdf format of report.

Insert plans here in paper copy of report:-

END.