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Manual 7 – Marine borer attack on timber structures

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MANUAL NO. 7

Marine Borer Attack on Timber Structures

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EXECUTIVE SUMMARY

Service life is one of the most important considerations in the use of timber in construction. About 10 years ago, the Forestry and Wood Products Research and Development Corporation (FWPRDC), now Forest & Wood Products Australia (FWPA), initiated a major national project on the design for service life of timber structures. The intention was to develop procedures for predicting the service life of all types of timber construction located anywhere in Australia. A major part of this project was to develop prediction models for the attack of timber by decay fungi, termites, corrosion (for fasteners) and marine borers.

This Manual describes the development of the model to predict the strength and service life of timber piles in marine structures subjected to marine borer attack. The model was primarily developed based on expert opinions and data obtained from extensive tests of nearly 700 small clear specimens of 25 hardwood species and CCA treated pine with 2 levels of preservative. The model was then fully developed so that it can be applied to all coastal zones in Australia, to numerous timber species used in practice, and also to other kinds of treated timber. Reality checks and calibration of the model were then carried out with in-service assessment data of some 4500 marine piles in Australia.

From the predicted attack depths, the residual cross-sections of timber piles can be estimated. The strength predictions for the residual cross-sections can then be made. The strength predictions are in quantified form, and hence the model can be used for risk managements, cost-optimised design, engineering design, application to timber engineering standard, and manuals for good practice. For the major outputs of the project, the model is being used to develop a major part of an education software, a durability design guide, and a draft engineering code for timber durability design.

1. Raw Data

1.1 Clear Specimen Trial Tests

This section provides basic descriptions of the clear specimen trial tests at 3 sites, including Port Stephens in NSW, Williamstown, and Geelong in VIC. Refer to Cookson and Scown (2003) for more detailed descriptions of the tests.

Specimens

Timber samples from 25 different species of hardwood were obtained from various suppliers in New South Wales, Victoria and Western Australia. Samples consisted of outer heartwood and were generally from at least three different trees. Blocks 50 x 50 x 300 mm with longest dimension in the grain direction were cut from these samples. At least two blocks from each tree were allocated to each of the three test sites. Blocks with excessive checking, knots or sapwood corners were discarded from test wherever possible. CCA treated *P. radiata* samples with 2 levels of retention, 12 or 36 kg/m³, was also incorporated in this test. Six blocks of both retentions were allocated to each test site.

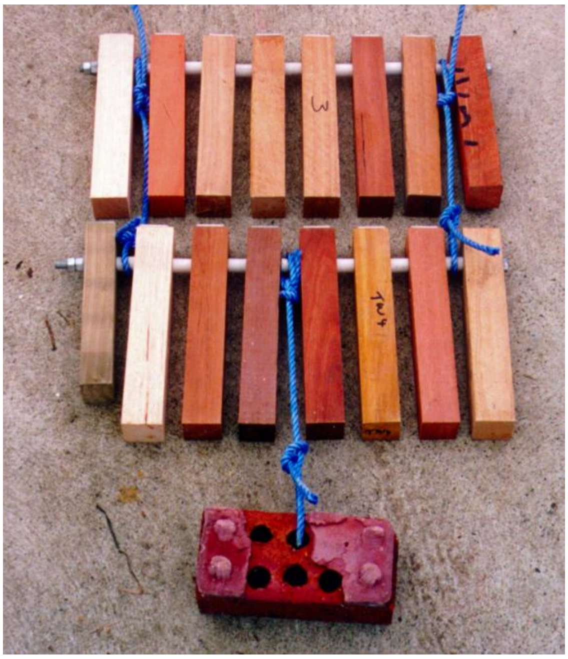


Figure 1.1.1 Frame number 3 prior to installation at Port Stephens in July 1996.

The timber specimens allocated to each test site were divided into two groups, so that the two blocks from each tree were separated. One group of blocks was attached to a lower row in the test frames, while the other group was attached to an upper row in the test frames (Figure 1.1.1). Frames were suspended from the supporting structures at the appropriate depth. A brick or similar was attached to the lower section of the frame to prevent the specimens from floating.

Test Sites

The test sites were selected on the basis of security, and to represent a wide range of borer hazards applicable to the southern coast conditions in which these untreated timbers are likely to be employed.

Port Stephens is a test site north of Newcastle in NSW. The specimens were placed under the jetty at the Brackish Water Fish Culture Research Station, Taylors Beach. The mean monthly salinity ranges seasonally between 17 and 35 ‰, and the mean winter and summer surface water temperatures are about 17ºC and 23ºC. This site has a high *Sphaeroma* hazard (see Cookson, 1986). Test frames for Port Stephens were installed on 9 July 1996.

Williamstown is located at the northern end of Port Philip Bay in Victoria. The test frames were suspended from Breakwater Pier. The mean monthly salinity of Port Philip Bay remains relatively constant at around 33.5 ‰ while seasonal temperatures range from 10 to 22ºC. This site has a moderate *Limnoria* hazard (see Cookson, 1986). Test frames were installed at Williamstown on 17 December 1996.

Geelong is situated on the west coast of Port Philip Bay in Victoria. Test frames have been hung from the Refinery Pier (off Shell Wharf), North Shore, Geelong. The mean monthly salinity of Port Philip Bay remains relatively constant at around 33.5 ‰ while seasonal temperatures range from 10 to 22ºC. This site has a moderate *Limnoria* hazard (see Cookson, 1986). Test frames were installed at Geelong on 5 July 1996.

Inspection time and procedure

Test frames were pulled from the water during inspections (Table 1.1.1), and timber specimens scraped of surface fouling. Timber was then examined and probed with a knife to determine the extent and type of marine borer attack. Specimens were given a performance rating of 8-0, as shown in Table 1.1.2.

Table 1.1.1 Inspection times for marine natural durability trial

Activity	Port Stephens	Williamstown	Geelong
Installation	9 Jul 96	17 Dec 96	5 Jul 96
First inspection	24 Apr 97 (0.8 y)	15 Dec 97 (1 y)	22 Jul 97 (1 y)
Second inspection	21 Apr 98 (1.8 y)	14 Dec 98 (2 y)	Aug 98 (2.1 y)
Third inspection	24 Aug 99 (3.1 y)	Dec 99 (3 y)	Jun 99 (3 y)
Fourth inspection	27 Apr 01 (4.8 y)	22 Feb 01 (4.2 y)	17 Apr 01 (4.8 y)

Table 1.1.2 Rating scale used to assess replicates in the tests.

Performance Rating	Description	% cross section lost, and mm^2 left if attack was uniform from surface	Depth of attack from each face, if uniform from surface
8	no attack	None, 2500 = 50 x 50	0 mm
7	light attack	1-15%, 2125 = 46 x 46	2 mm
6	light-mod	15-30%, 1750 = 42 x 42	4 mm
5	mod	30-45%, 1375 = 37 x 37	6.5 mm
4	mod-heavy (failed)	45-60%, 1000 = 32 x 32	9 mm
3	heavy	60-75%, 625 = 25 x 25	12.5 mm
2	severe	75-90%, 250 = 16 x 16	17 mm
1	severe-dest	90-99%, 25 = 5 x 5	22.5 mm
0	destroyed/missing	100%, 0 = 0 x 0	25 mm

1.2 Expert Opinions on Average Life of Timber of Marine Piles

Table 1.2.1 presents the average life of timber in full salinity location. The data was provided by Cookson, (2003-2005) based on his experience on marine piled structures in Australia. The data in bold are evidenced with some backing from in-service data. Others are estimates or guesses.

The average life of timber given in Table 1.2.1 are defined as follows,

- For heartwood: the numbers given in Table 1.2.1 are the time for marine borer attack depth to reach 75mm. This attack depth is estimated from the definition of the end of service life of a 350mm-diameter pile, which is commonly considered to be failed in-service when the remaining diameter of the pile is 200mm. The numbers given in Table 1.2.1 are therefore also the service life of the pile.

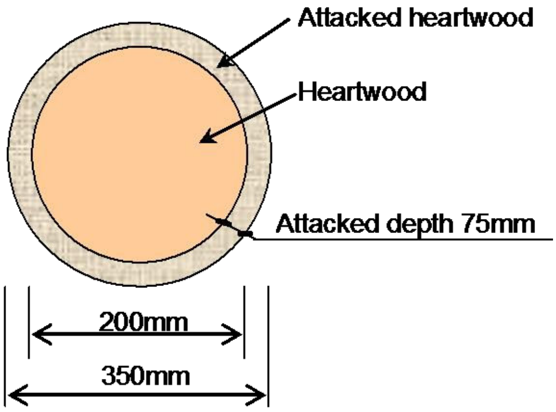


Figure 1.2.1 End of service life definition for a typical pile

- For sapwood: the numbers given in Table 1.2.1 are time for marine borer to attack certain thicknesses of sapwood, which are taken to be 30mm for hardwood piles, and to be 50mm for softwood piles. Note that in treated piles, these sapwoods are assumed to be fully treated.

Table 1.2.1 Average life of timber from Cookson (2003-2005)

Pile	Retn % m/m	A Tas	B Vic	C SA	D WA south	E NSW	F WA north	G Qld
Heartwood 350 mm diameter reduced to 200mm – attack depth = 75mm								
Class 1 heart	-	**100**	**80**	**60**	40?	**32**	25?	**12**
Class 2 heart	-	60?	**50**	37?	12?	**9**	4?	3?
Class 3 heart	-	31?	**25**	19?	**6**	4?	**3**	2?
Class 4 heart	-	**8**	**5**	3?	1?	1?	0.5?	0.5?
Sapwood 30 mm thick for hardwood and 50 mm thick for softwood								
Sapwood	-	2?	**1.5**	1?	0.5?	**0.5**	0.5?	0.5?
CCA hardwood	H4=0.7%	**15**	12?	10?	**8**	**5**	**2**	**2**
	H5=1.2%	23?	18?	17?	**15**	**10**	**4**	**4**
	H6=2.4%	30?	25?	23?	**20**	**15**	10?	**10**
CCA softwood	H4=0.6%	19?	16?	**13**	10?	6?	2?	2?
	H5=1.0%	25?	20?	17?	15?	9?	5?	3?
	H6=2.0%	35?	33?	**30**	**25**	**15**	10?	**5**
	5.0%	45?	45?	40?	40?	25?	30?	**20**
Creosote hardwood	H5= 13%	30?	28?	26?	25?	**25**	23?	**20**
	H6= 22%	50?	45?	40?	35?	**35**	30?	**25**
Creosote softwood	H5= 24%	30?	27?	24?	15?	**15**	15?	15?
	H6= 40%	50?	45?	**40**	25?	**25**	25?	**25**
Double treated hardwood	H6	>50?	>50?	50?	40?	**40**	30?	**25**
Double treated softwood	H6	>50?	>50?	50?	40?	**40**	30?	**25**

Bold = some backing from service data.
? = estimates/guesses

1.3 Expert Opinions / References on Factors Affecting Marine Borer Attack

These notes on factors affecting marine pile life were provided by Cookson (2003-2005).

1.3.1 Maintenance measure

Maintenance measures in Zones E and G (the zones where Sphaeroma is a significant hazard). The old Maritime Services Board that looked after piles in Sydney Harbour used predominantly untreated turpentine piles. They said that the average life of turps piles was 32 years, or if the floating collar maintenance system was used it was about 70 years. So maintenance can double the service life. However, the floating collar method is no longer used in Australia, probably because it relies on floating creosote within the collar, which would cause pollution. The floating collar only protects wood in the tidal zone, where it floats. An alternative is a plastic wrap or physical barrier applied in the TZ, as protection against Sphaeroma. A barrier that is maintained, inspected say every second year, and repaired if needed, should also double the life of turpentine piles. Note that these maintenance systems in zones E and G will only work for CCA softwoods, creosoted softwoods or hardwoods, double treated softwoods and hardwoods, and untreated class 1 timbers. They will not double the life of CCA hardwoods or untreated class 2-4 timbers in zone E and G because teredinids can attack these timbers faster than Sphaeroma, and teredinids also occur below low tide.

For the remaining zones, only full length physical barriers will be effective maintenance systems, and they should reach from about 0.5 m below the mud (mud line can change over time as silt level moves due to currents, boat propellers etc) to high tide mark. These suitable barriers (such as plastic wraps, metal sheathing, concrete jackets) will protect the piles for as long as the barriers remain intact. Therefore, pile life could be 4 times that given for the pile (including in zones E and G, so a full length barrier is better than just a barrier in the tidal zone). But a maintenance schedule is needed, to inspect the barriers to ensure they do not have holes in them. For untreated piles of class 4, the extra life might only be 2 times, as some level of decay may fail the pile earlier above high tide where rain water gets to it. Also, some gradual softening of the wood due to anaerobic bacteria can slowly occur under seawater. For untreated piles of class 3, I guess that the extra life might only be 3x.

So in summary, full length physical barriers that are maintained are very effective ways for prolonging the life of piles.

1.3.2 Presence of surf, strong currents

I see from your model that you calculated that surf would reduce borer activity by about 0.6 factor, based on the comparison of Williamstown and Geelong.

There have been a few old studies on current speed, which would be related to surf or ‘rough water’. This factor you have given is as good a number as any. An old paper by Doochin 1951 suggests that a current of 1.4 to 1.8 knots greatly reduced settlement by borers.

1.3.3 Timber to timber contact

Timber to timber contact in the water zone reduces timber life, especially the amount of attack from Limnoria. Similarly, the presence of knots and scars on a pile can reduce life, as it provides crevices that give shelter to borers, especially Limnoria. We are not sure why crevices are such an advantage to borers. Perhaps the shelter reduces the effects of rough water. Also, to make the join the timber is usually cut or notched, or the bolt is loose, allowing borer entry to untreated parts of the pile. The acceleration of attack would be about 2x, as shown in our paper. It could even be more in some cases, but I cannot give a general rule here. If timber bracing is attached in the upper tidal zone, the effect is less severe. We could say that timber bracing placed at mid tide or below degrades about 2x faster. Timber bracing placed half way between mid and high tide might degrade say 1.5x faster, and timber bracing at high tide might degrade say only 1.1x faster (10% faster). Sometimes, joins cannot be avoided (e.g for steps) in the water zone. If the joins are protected eg with an epoxy or a Denso tape wrap, then the damage from borers can be prevented. But the join will also need to be maintained, to ensure that the epoxy or tape seals are not broken – which is often not done.

1.3.4 Presence of knots

Marine borers will preferably attack knots. This may be due partly because there are more crevices providing shelter from rough water and fish predators, especially for Limnoria and Sphaeroma. Also, knots in treated timber will be less well treated (they usually contain heartwood which does not treat well), so provide an entry point into the pile for all borers but especially teredinids. So a doubled degradation rate if knots are present is probably about right. The protective plate (fill knot with epoxy or durable grease, and cover with a copper or plastic plate) will prevent this damage, although the plate will also need to be inspected periodically (every few years) to check that it is still there and giving a tight seal.

1.3.5 Damage to pile during installation

If care is not taken with piles, and treated piles especially, during pile installation, the damaging effect on the pile's life can be similar to if it had an exposed knot. Examples of some of the damage to avoid, as it could halve pile life, are:

Pile splits or cracks during pile driving (affects treated and untreated piles).
Treated sapwood is shaved off pile to neaten or remove kinks.
Treated sapwood is chiselled away to fit a short bolt, or to fit waling or bracing.
Treated sapwood is abraded or gouged during transportation to site or during installation.

1.3.6 Rubbing strips

Treated fender piles may need rubbing strips attached in the tidal zone and higher, especially with larger boats. Rubbing strips can be made from timber, rubber, plastic etc. Boats moored against fender piles can physically wear away wood from the outer pile face, which is more of a concern for treated piles relying on the treated sapwood, as eventually some or all of the outer treated sapwood can be abraded away. Marine borers can then gain easier access. Rubbing strips are less concern for untreated durable piles such as turpentine, because it does not matter as much if the non-durable sapwood is lost by rubbing, as it reveals the thick band of durable heartwood. Borer development can be halted if the boats continue to rub and so crush the surface borers. But if the jetty is then not used for some time, borers can establish. Or, if a rubbing strip is added later, after the sapwood has been damaged, the borers become protected from the rubbing so continue to damage the abraded area. Rubbing strips are generally beneficial to pile life (fenders only), as they prevent abrasion by boats. This seems contrary to the need to avoid timber to timber contact. Rubbing strips usually extend to just below low tide. If they are fastened to the pile in a way that does not breach or damage the pile timber, then they should have little affect on pile life, especially in relation to the damage that boat abrasion can cause. The attachment of strips to a pile may be with a U-bolt around the pile (so pile is not notched or drilled), or attachment may be made in the upper tidal zone rather than lower tidal zone, or a tight fitting coach screw could be used, as long as it is replaced when it corrodes..

Absence of a rubbing strip may reduce pile life by say 20%. If a rubbing strip is added, but attached in a damaging way that breaches the treated pile sapwood, pile life may be reduced by half (as mentioned for timber to timber contact).

1.3.7 Bark on/off

Bark is always removed from treated piles, before they are treated. So bark only affects untreated piles. Bark has only a minor beneficial effect. I estimate that bark that is at least 4 mm thick will in zones F and G add just 6 months to pile life. In zones E, D and C it will add perhaps 1 year. In zones B and A it might add 2 years. Some timbers have only thin bark, which is probably of no added value. The bark is just an additional bit of padding that the borers have to get through. If the bark is knocked off or a patch torn off during pile installation, or by a boat, the minor protective effect is negated.

1.3.8 Shade from sun

Shade from sun has only a small beneficial effect on borers.

For Sphaeroma in zone G where the sun can overheat this borer at low tide because it lives in the tidal zone, the shaded side of the pile is usually say 20% more damaged than on the sunny side. The effect for Sphaeroma is probably not significant in other zones.

Limnoria, which can bore below the tidal zone, also appears to be more active on internal piles under a wharf than on outer piles, perhaps simply because the water is more sheltered around the inner piles. Limnoria lack pigment (unlike Sphaeroma), which is a general indication that the animal is not used to and avoids sunlight (like termites).

In summary, shade from sun may only reduce pile life by say 20%.

1.3.9 Turbidity

Turbidity can be caused by silt, which marine borers do not like. Excessive silt can clog their ability to filter feed, or reduce the effectiveness of their oxygen absorption from water when it clogs or covers their body. Silt is rarely a problem in the open seawater, but is more likely to come from a flood of fresh water from a river in estuaries, or from construction, or boats stirring up the water. But these effects tend to be short term, perhaps for a few months. Sometimes all borers in a pile are killed, but then a few months later the attack can start again.

Turbidity can also be caused by algal blooms, which reduces the sunlight that can get through the water, so harms bottom dwelling plants and seaweed. But marine borers being animals do not photosynthesise, so this effect is not of concern. However, the algal bloom may indicate pollution, which can reduce oxygen in the water, which would harm the borers.

Therefore, either source of turbidity is probably harmful to borers. Turbidity is most often measured in terms of nephelometric turbidity units (NTU), which measures light scattering by the water. I don't know what level is harmful to borers. So you could just leave it as high or low turbidity. If NTU units are needed, then at a guess I would say that turbidity above 20 NTU might be harmful, and those below OK. But this is just a starting number that would need verification.

As excessive turbidity is usually for short periods, and the life of piles is in terms of 20+ years, the effect of harmful turbidity might be short-lived. So perhaps say that several occasions of high turbidity reduces borer activity by 10-20%.

1.3.10 Pollution of water

There are many chemicals that can pollute water, so it would be difficult to quantify and put a value for every one. Also, the EPAs in Australia have been working to reduce pollution in waterways, so that it would be less of a factor against borers now. Turbidity measures some pollution, if it is caused by excessive nutrients that then cause algal blooms.

Because there are so many variables on which pollutants might affect borers, and for how long the pollution might occur, I think that we should put a factor on the conservative side into the equation, where activity is reduced by just 5%. There would also be many ways to define pollution, depending on which pollutant is being examined. Perhaps the measure for our purposes should simply be 'water that the local EPA considers polluted'.

1.3.11 Depth of water

I am not sure if depth of water is a real affect. It may just be that in deep water, longer piles installed narrow end down have smaller diameter at mud line simply because of pile taper. The narrower section may be less naturally durable, and have proportionately more sapwood. I think it is best to leave this factor out.

1.3.12 Notes on marine borer species' activities

Not all timbers have the same comparative rates of attack between zones, due mainly to the different marine borer types and where they are most active.

- Untreated heartwood class 1 is attacked mostly by Sphaeroma in zones E and G, and Limnoria and Martesia in the other zones.
- Untreated heartwood classes 2-4, and CCA-treated hardwoods, are attacked most by teredinids.
- CCA-treated softwood is attacked most by Sphaeroma in zones E and G, and by teredinids and Limnoria in the other zones.
- Creosote-treated hardwood is attacked most by Sphaeroma in zones E and G, and by teredinids and Limnoria in the other zones.
- Creosote-treated softwood is attacked most by Limnoria tripunctata (which is most active in zones D and E).
- Double treated piles are attacked most by Sphaeroma in zones E and G, and by Limnoria in the other zones.

1.3.13 Notes on Salinity effects

For zones E, F, G, the rate of attack should be the same in each. This is demonstrated in comparisons between our test sites at Sydney (26-35 ppt) and Port Stephens (11-25 ppt), where the rate of attack was similar for a variety of timbers (see the paper you took last week, giving 20 year results). Also, the main example we have for the 1-10 ppt is from the Brisbane River, where Nausitora (low salinity teredinid) is at least as hazardous as the other marine borer species. We could say that in zones E-G, the rate of attack in various salinities is similar due to the presence of the low salinity teredinid Nausitora, and the euryhaline species (tolerate a wide range of salinities, i.e. Sphaeroma in zones E and G). For the other zones A-D, I think the salinity kwood values you are using are about right.

The only data point that I cannot explain, or that is the odd point in all performance results, is that red gum piles (class 2) failed in 8 years to Nausitora in the Mitchell River near Bairnsdale, which is a low salinity 1-10 ppt site in zone B. I don't know if this was a unique occurrence, or a common problem in the rivers leading into the Gippsland lakes.

1.3.14 Miscellaneous Communications with Dr. Cookson

Port Stephens is at a brackish water site, where the mean monthly salinity ranges between 17 and 35 ppt, but I place it in the 11-25ppt salinity category.
Mean winter temperature is about 17oC and mean summer temp about 23oC.

I class it as a sheltered location – not as sheltered as for Williamstown, but still with light wave action. I recall in another test we had test frames at both Port Stephens and Goat Island in Sydney Harbour. The timber blocks were threaded onto long half inch thick galvanised steel bolts. The bolts at Sydney had to be replaced within 10 years as they wore where a metal shackle rubbed against the bolt due to wave action, whereas those at Port Stephens were virtually unaffected after 14 years.

At Williamstown, the test specimens are placed directly behind a breakwater, so the water is quite calm – almost like a bath - compared to Geelong, which is more exposed to waves and turbulence. Also, the water is shallow at our site in Williamstown, only 1.5-2.5 m depth. Water is much deeper at Geelong (4-6m? – but we havnt checked), so there would be more mixing of surface water with cooler deeper water. The combination of shallow water and slow mixing of water at Williamstown probably means it is a bit warmer than at Geelong. Small differences in mean water temperature can have a large effect on borer activity.

There are some papers that suggest that Limnoria is deterred by water current – they do tend to be more active in crevices or behind cross braces on piles, which are more sheltered.

So we think that timber structures placed in sheltered locations, particularly behind a breakwater, will be higher hazard areas than those exposed to an open coastline. In Victoria, ports along the great ocean road would probably be in this exposed category. Geelong is within a bay, but the bay is large enough to generate wave action. The Williamstown site is behind a breakwater within a bay, so is sheltered. It is possible that specimens placed on another more exposed jetty at Williamstown would give more similar results to Geelong.

2. Processed Data

2.1 Data Processing for Clear Specimen Trial Tests

The test results in terms of typical (average) and worst 10%-tile (90%-tile) values of marine borer attacks to the samples of the test specimens are presented in Tables C.1a, C.2a, and C.3a in Appendix C, respectively for the 3 sites: Port Stephens, Williamstown, and Geelong. Each Table includes the results of the 4 times of inspection as recorded in Table 1.1.1 for each site. It is noted that for some samples at a certain inspection, some specimens had been totally destroyed by the borers. The results for these samples are marked with dark background on the Tables. In other words, a result appear within a dark background cell on the Tables should be read as 'more than or equal' the value provided.

Individual data of the inspection results are in Appendix D. The individual data in terms of attack depths on the specimens were derived from the raw inspection data, which were in terms of 'performance rating', using the conversion rule in Table 1.1.2. Note that an attack depth of 25mm indicates that the specimen has been destroyed by borers at the time of inspection.

2.2 Processing of Expert Opinions

Table 2.2.1 is from Table 1.2.1 with some re-arrangements.

Table 2.2.1 Processed Data from expert opinions

Material		Time (yrs) to attack						
		Zone A	B	C	D	E	F	G
75 mm Heartwood	Heartwood Class 1	**100***	**80**	**60**	40	**32**	25	**12**
	Heartwood Class 2	60	**50**	37	12	**9**	4	3
	Heartwood Class 3	31	**25**	19	**6**	4	**3**	2
	Heartwood Class 4	**8**	**5**	3	1	1	0.5	0.5
50mm sapwood of Softwood	Untreated	2	**1.5**	1	0.5	**0.5**	0.5	0.5
	CCA-treated 0.6%m/m	19	16	**13**	10	6	2	2
	CCA-treated 1%m/m	25	20	17	15	9	5	3
	CCA-treated 2%m/m	35	33	**30**	**25**	**15**	10	**5**
	CCA-treated 5%m/m	45	45	40	40	25	30	**20**
	Creosote-treated 24%m/m	30	27	24	15	**15**	15	15
	Creosote-treated 40%m/m	50	45	**40**	25	**25**	25	**25**
	Double-treated CC2+CR2	>50	>50	50	40	**40**	30	**25**
30mm sapwood of Hardwood	Untreated	2	**1.5**	1	0.5	**0.5**	0.5	0.5
	CCA-treated 0.7%m/m	**15**	12	10	**8**	**5**	**2**	**2**
	CCA-treated 1.2%m/m	23	18	17	**15**	**10**	**4**	**4**
	CCA-treated 2.4%m/m	30	25	23	**20**	**15**	10	**10**
	Creosote-treated 13%m/m	30	28	26	25	**25**	23	**20**
	Creosote-treated 22%m/m	50	45	40	35	**35**	30	**25**
	Double-treated CC2+CR2	-	-	50	40	**40**	30	**25**

* Bold numbers indicates data with some backing from in-service data

** As presented in Section 1.2, the 'Time (yrs) to attack' given in Table 2.2.1 is the time for marine borer to attack:

- 75mm heartwood
- 30mm sapwood of hardwood
- 50mm sapwood of softwood

3. Marine Durability Classification

3.1 Classification Rule for the Timber in the Clear Specimen Trial Tests

Classification of heartwood timber based on the clear specimen tests is shown in Table 3.1.1. The 'average rating for site' values are calculated from the rating of the performance of 4-year trial specimens at 3 sites (Appendix D), including Port Stephens (NSW), Williamstown (VIC) and Geelong (VIC). The rating scale is from 0 to 8, indicating the worst to the best performance, respectively; of the timber species against marine borer attack (see Table 1.1.2). From the results of the trial, the pile life in Victoria can be estimated. Refer to Cookson and Scown (2003) for more details. Based on the rating and the estimated pile life, the species are classified into 4 marine-borer durability classes.

Table 3.1.1 Classification of heartwood

Trade name	Botanical name	Average rating for sites*	Estimated pile life in VI (yrs)	Marine Borer Durability Class
Gum, blue, Southern	E. globulus	0.00	1 to 20	4
Ash, mountain	E. regnans	0.20		
Karri	E. diversicolor	0.20		
Ash, silvertop	E. sieberi	0.40		
Gum, grey, mountain	E. cypellocarpa	0.67		
Marri	C. calophylla	1.33		
Gum, spotted	C. maculata	1.57		
Gum, rose	E. grandis	2.03		
Messmate	E. obliqua	3.07		
Stringybark, white	E. eugenioides	3.33		
Ironbark, grey	E. paniculata	3.40	21 to 40	3
Stringybark, yellow	E. muelleriana	3.50		
Gum, blue, Sydney	E. saligna	3.53		
CCA-Treated pine 1	P. radiata 12 kg/m^{3}CCA	3.67		
Tallowwood	E. microcorys	3.97		
Blackbutt	E. pilularis	4.30		
Jarrah	E. marginata	4.40		
Box, grey	E. moluccana	4.43	41 to 60	2
Box, brush	L. confertus	4.53		
Ironbark, red	E. sideroxylon	4.83		
Blackbutt, New England	E. andrewsii	5.13		
Mahogany, white	E. acmenoides	5.60		
Gum, red, river	E. camaldulensis	6.13		
Gum, grey	E. propinqua	6.23		
Turpentine	S. glomulifera	6.53	61 to 100	1
CCA-treated pine 2	P. radiata 36 kg/m^{3}CCA	7.40		
Iroko	Chlorophora excelsa	7.50		

* Definition of Rating is given in Table 1.1.2. The average are computed from data in Appendix D.

3.2 Extended Classification

Classification of heartwood timber is shown in Table 3.2.1. The species are classified into 4 marine-borer durability classes. Compared to previous version, many new species are added. Performances of these species against marine borer attack are collected from various sources, which are coded as in the following and also used in the Table 3.2.1. The classification was introduced to AS 5604–2005. This extended classification table is provided by Dr. Cookson (2002-2005)

Code for information sources used in table:

A = Marine natural durability test at 3 sites (Melbourne, Geelong, Port Stephens), i.e. the clear specimen tests

B = Calibration report and personal observations

C = Cookson (1996). An aquaria test of the natural resistance against marine borers of some commercial timber available in Australia. IRG/WP/96-10145.

D = Watson, C.J.J, McNeill, F.A., Johnson, R.A., Iredale, T. (1936). Destruction of timber by marine organisms in the Port of Brisbane. Queensland Forest Service, Bulletin No. 12.

E = Johnson, R.A. and Moore, D.D. (1950). The natural resistance of timber to marine borer attack. Western Australian timbers. Port of Sydney Journal 3 (2): 55-57.

F = Shillinglaw, A.W. and Moore, D.D. (1947). Report of marine borer survey in New Guinea waters. CSIR Bulletin No. 223.

G = Table provided by the Maritime Services Board, Sydney.

H = Assume all timbers with in-ground natural durability of 3 or 4 will be 4 for marine.

J = Choon, L.W. and Cookson, L.J. (1996). Laboratory study on the natural durability of Sarawak timbers against marine borers. TRTTC Technical Report No. TR/18 (bioassay conducted at same time as C above).

Table 3.2.1 Classification of heartwood

Trade name	Botanical name	Marine Borer Durability Class	Source (see text)
Alder, blush	Sloanea australis	4	H
Alder, brown	Caldcluvia paniculosa	4	H
Alder, pink	Gillbeea adenopetala	4	H
Alder, rose	Caldcluvia australiensis	4	H
Amberoi	Pterocymbium spp.	4	H
Apple, rough-barked	Angophora floribunda	4	H
Apple, smooth-barked	Angophora costata	4	G
Ash, alpine	Eucalyptus delegatensis	4	G
Ash, Blue Mountains	Eucalyptus oreades	4	G
Ash, Crow's	Flindersia australis	4	G
Ash, mountain	Eucalyptus regnans	4	A
Ash, pink	Alphitonia petriei	4	H
Ash, silver	Flindersia bourjotiana, Flindersia schottiana	4	H
Ash, silvertop	Eucalyptus sieberi	4	A
Ash, white	Eucalyptus fraxinoides	4	H
Baltic, red (pine, Scots)	Pinus sylvestris	4	H
Baltic, white (spruce, Norway)	Picea abies	4	H
Beech, myrtle	Nothofagus cunninghamii	4	H
Beech, negrohead	Nothofagus moorei	4	H

Beech, silver	Nothofagus menziesii	4	H
Belian	Eusideroxylon zwageri	1	J
Birch, white, Australia	Schizomeria ovata	4	H
Blackbutt	Eucalyptus pilularis	3	A
Blackbutt, New England	Eucalyptus andrewsii, Eucalyptus campanulata	2	A
Blackbutt, Western Australian	Eucalyptus patens	3	E
Blackwood	Acacia melanoxylon	4	C
Bloodwood, red	Corymbia gummifera, Eucalyptus intermedia Eucalyptus polycarpa	3	D
Bollywood	Cinnamomum baileyanum, Litsea spp.	4	H
Box, brush	Lophostemon confertus	2	A,D
Box, grey	Eucalyptus macrocarpa, Eucalyptus moluccana Eucalyptus woollsiana	2	A
Box, grey, coast	Eucalyptus bosistoana	3	B
Box, ironwood	Choricarpia leptopetala Choricarpia subargentea	4	H
Box, kanuka	Tristania exiliflora, Tristania laurina	4	H
Box, long-leaved	Eucalyptus goniocalyx	4	H
Box, swamp	Lophostemon suaveolens	2	D
Brownbarrel	Eucalyptus fastigata	4	G
Bullich	Eucalyptus megacarpa	4	H
Calophyllum	Calophyllum spp.	4	H
Candlebark	Eucalyptus rubida	4	H
Carabeen, yellow	Sloanea woolsii	4	H
Cedar, red	Toona australis	4	G
Cedar, western red	Thuja plicata	4	H
Cheesewood, white	Alstonia scholaris	4	H
Coachwood	Ceratopetalum apetalum	4	H
Cypress, black	Callitris endlicheri	3	C,G
Cypress, white	Callitris glaucophylla	2	B,C,D
Fir, amabilis	Abies amabilis	4	H
Fir, Douglas (oregon)	Pseudotsuga menziesii	4	C
Geronggang	Cratoxylon arborescens	4	H
Gum, blue, southern	Eucalyptus globulus	4	A
Gum, blue, Sydney	Eucalyptus saligna	3	A
Gum, grey	Eucalyptus canaliculate, Eucalyptus major Eucalyptus propinqua, Eucalyptus punctata	2	A
Gum, grey, mountain	Eucalyptus cypellocarpa	4	A
Gum, Maiden's	Eucalyptus maidenii	4	H
Gum, manna	Eucalyptus viminalis	4	H
Gum, mountain	Eucalyptus dalrympleana	4	G
Gum, pink	Eucalyptus fasciculosa	4	H
Gum, poplar	Eucalyptus alba	4	H
Gum, red, forest	Eucalyptus blakelyi, Eucalyptus tereticornis	2	D
Gum, red, river	Eucalyptus camaldulensis	2	A
Gum, rose	Eucalyptus grandis	4	A
Gum, round-leaved	Eucalyptus deanei	4	H
Gum, shining	Eucalyptus nitens	4	H
Gum, spotted	Corymbia maculate, Corymbia citriodora	4	A,D

	Eucalyptus henryi		
Gum, swamp	Eucalyptus camphora	4	H
Gum, white, Dunn's	Eucalyptus dunnii	4	H
Gum, yellow	Eucalyptus leucoxylon	4	H
Hardwood, Johnston River	Backhousia bancroftii	4	H
Hemlock, western	Tsuga heterophylla	4	4
Iroko	Chlorophora excelsa	1	A
Ironbark, grey	Eucalyptus drepanophylla, Eucalyptus paniculate, Eucalyptus siderophloia	3	A
Ironbark, red	Eucalyptus sideroxylon	2	A
Jam, raspberry	Acacia acuminata	2	E
Jarrah	Eucalyptus marginata	3	A,B
Jelutong	Dyera costulata	4	H
Kamarere	Eucalyptus deglupta	4	H
Kapur	Dryobalanops spp.	4	H
Karri	Eucalyptus diversicolor	4	A,B
Kauri, New Zealand	Agathis australis	4	G
Kauri, Queensland	Agathis atropurpurea, Agathis microstachya Agathis robusta	4	G
Kempas	Koompassia malaccensis	4	H
Keruing	Dipterocarpus spp.	4	H
Kwila (merbau)	Intsia bijuga	3	C
Lumbayau (mengkulang)	Heritiera spp.	4	H
Mahogany, African	Khaya spp.	4	H
Mahogany, American	Swietenia mahogani	4	H
Mahogany, brush	Geissois benthamii	4	H
Mahogany, red	Eucalyptus pellita, Eucalyptus resinifera	2	C
Mahogany, red, Philippine,	Shorea spp.	4	H
Mahogany, southern	Eucalyptus botryoides	4	H
Mahogany, white	Eucalyptus acmenoides, Eucalyptus tenuipes Eucalyptus umbra subsp. Carnea	2	A,G
Malas	Homalium foetidum	4	H
Mallet, brown	Eucalyptus astringens	4	H
Malletwood	Rhodamnia argentea, Rhodamnia costata	4	H
Malletwood, brown	Rhodamnia rubescens	4	H
Malletwood, silver	Rhodamnia acuminata	4	H
Mangrove, grey	Avicennia marina	4	D
Maple, Queensland	Flindersia brayleyana	4	H
Maple, rose	Cryptocarya erythroxylon	4	H
Maple, scented	Flindersia laevicarpa	4	H
Maple, sugar (rock)	Acer saccharum	4	H
Marri	Corymbia calophylla, Eucalyptus calophylla	4	A
Meranti, bakau	Shorea spp.	4	H
Meranti, dark-red	Shorea spp.	4	H
Meranti, light-red	Shorea spp.	4	H
Meranti, white	Shorea spp.	4	H
Meranti, yellow	Shorea spp.	4	H
Mersawa	Anisoptera spp.	4	H
Messmate	Eucalyptus obliqua	4	A,B

Nyatoh	Palaquium and Payena spp.	4	H
Oak, silky, northern	Cardwellia sublimis	4	H
Oak, tulip, blush	Argyrodendron actinophyllum	4	H
Oak, tulip, brown	Argyrodendron polyandrum Argyrodendron trifoliolatum	4	H
Oak, tulip, red	Argyrodendron peralatum,	4	H
Oak, white, American	Quercus alba	4	H
Paulownia	Paulownia spp.	4	H
Penda, brown	Xanthostemon chrysanthus	2	F
Penda, red	Xanthostemon whitei	2	F
Penda, southern	Xanthostemon, oppositifolius	2	F
Penda, yellow	Ristantia pachysperma	2	D
Peppermint, black	Eucalyptus amygdalina	4	H
Peppermint, broad-leaved	Eucalyptus dives	4	H
Peppermint, narrow-leaved	Eucalyptus Australiana, Eucalyptus radiata Eucalyptus robertsonii	4	H
Peppermint, river	Eucalyptus elata	4	H
Peppermint, white	Eucalyptus pulchella	4	H
Pine, brown	Podocarpus elatus	3	D
Pine, bunya	Araucaria bidwillii	4	H
Pine, Canary Island	Pinus canariensis	4	H
Pine, Caribbean	Pinus caribaea	4	H
Pine, celery-top	Phyllocladus asplenifolius	4	H
Pine, Corsican	Pinus nigra	4	H
Pine, hoop	Araucaria cunninghamii	4	G
Pine, Huon	Lagarostrobos franklinii	4	C,D
Pine, King William	Athrotaxis selaginoides	4	C
Pine, klinki	Araucaria hunsteinii	4	H
Pine, loblolly	Pinus taeda	4	H
Pine, longleaf	Pinus palustris	4	H
Pine, maritime	Pinus pinaster	4	H
Pine, NZ white (kahikatea)	Dacrycarpus dacrydioides	4	H
Pine, patula	Pinus patula	4	H
Pine, ponderosa	Pinus ponderosa	4	H
Pine, radiata	Pinus radiata	4	B,C
Pine, Scots	Pinus sylvestris	4	H
Pine, slash	Pinus elliottii	4	H
Pine, white, western	Pinus monticola	4	H
Planchonella	Planchonella chartacea	4	H
Poplar, balsam	Populus spp.	4	H
Poplar, pink	Euroschinus falcata	4	H
Quandong, silver	Elaeocarpus angustifolius, Elaeocarpus grandis	4	H
Ramin	Gonystylus spp.	4	H
Redwood	Sequoia sempervirens	4	G
Rimu	Dacrydium cupressinum	4	H
Rosewood, New Guinea	Pterocarpus indicus	4	H

Sassafras	Daphnandra dielsii, . Daphnandra micrantha Daphnandra repandula, Doryphora aromatica Doryphora sassafras	4	G
Satinash, grey	Syzygium claviflorum, Syzygium gustavioides	4	H
Satinash, rose	Syzygium crebrinerve, Eugenia francisii	4	H
Satinay	Syncarpia hillii	1	D
Sepetir	Copaifera spp., Pseudosindora spp., Sindora spp.	4	H
Sheoak, beach	Allocasuarina equisetifolia	4	H
Sheoak, black	Allocasuarina littoralis	4	G
Silkwood, maple	Flindersia pimenteliana	4	H
Spruce, Norway	Picea abies	4	H
Spruce, Sitka	Picea sitchensis	4	H
Stringybark, blue-leaved	Eucalyptus agglomerata	4	H
Stringybark, brown	Eucalyptus baxteri, Eucalyptus blaxlandii Eucalyptus capitellata	4	H
Stringybark, diehard	Eucalyptus cameronii	4	H
Stringybark, red	Eucalyptus macrorhyncha	3	C
Stringybark, silvertop	Eucalyptus laevopinea	4	H
Stringybark, white	Eucalyptus eugenioides, Eucalyptus globoidea Eucalyptus phaeotricha	3	A,G
Stringybark, yellow	Eucalyptus muelleriana	3	A
Sycamore, silver	Cryptocarya glaucescens	4	H
Tallowwood	Eucalyptus microcorys	3	A
Taun	Pometia spp.	4	H
Tea-tree, broad-leaved	Melaleuca leucadendron, Melaleuca quinquenervia, Melaleuca viridiflora	3	D
Tea-tree, river	Melaleuca bracteata	4	H
Tingle, red	Eucalyptus jacksonii	4	H
Touriga, red	Calophyllum costatum	4	H
Tuart	Eucalyptus gomphocephala	4	E
Turpentine	Syncarpia glomulifera	1	A,B
Walnut, New South Wales	Endiandra virens	4	H
Walnut, Queensland	Endiandra palmerstonii	4	H
Walnut, yellow	Beilschmiedia bancroftii	4	H
Wandoo	Eucalyptus wandoo	3	E
Yate, swamp	Eucalyptus occidentalis	4	E

4. Base Attack Model Based on Clear Specimen Tests

4.1 Original Hazard Zone Map

The hazard coastal zones of Australia are presented in Figure 4.1.1. This map is adopted from Cookson (1986). There is a modification where Zones 6 and 7 defined for particular estuarine river in the original map are omitted. It is intended that the hazard zone for estuarine rivers in general be the same as the corresponding coastal zone with lower salinity.

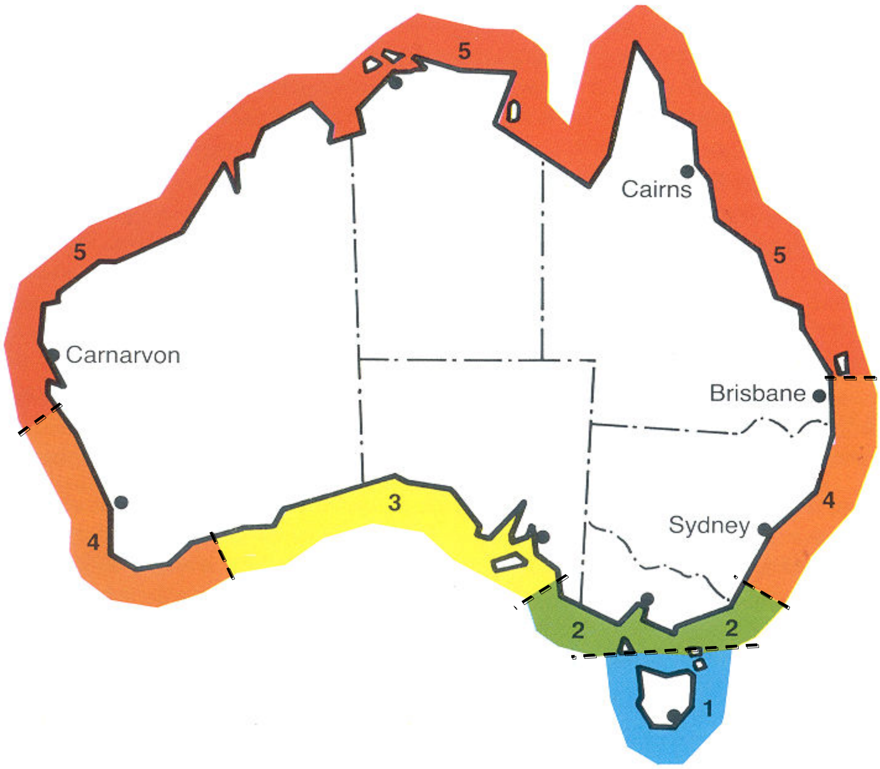


Figure 4.1.1. Marine borer hazard coastal zones. Zone 5 is the most hazardous.

4.2 Basic Model of Marine Borer Attack

A schematic illustration of the progress of marine borer attack assumed in the model is shown in Figure 4.2.1. It comprises of a time-lag (*lag*) followed by a steady attack rate (*r*). The attack depth of timber after *t* years is given as:

$$d_t = \begin{cases} 0 & \text{if } t \le lag \\ (t - lag)r & \text{if } t > lag \end{cases} \tag{4.2.1}$$

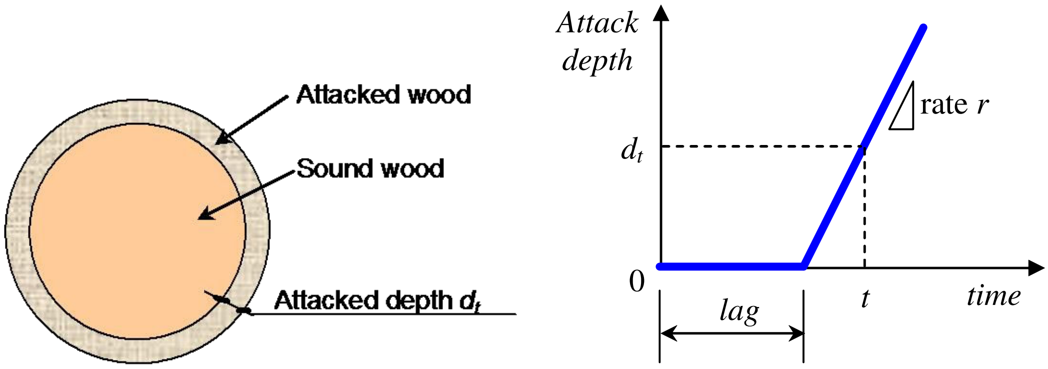


Figure 4.2.1 Basic model of timber attacked by marine borers.

The model developed in this report takes into account the most significant parameters and some secondary factors, i.e.

- coastal zone
- salinity class
- timber class & type of wood (ie. heartwood, sapwood)
- preservative treatment
- maintenance measure
- presence of surf
- timber to timber contact

4.3 Model Equations and Parameters

The marine borer attack rate (r) is determined as

$$r = k_{wood}\, k_{water}\, k_0 \tag{4.3.1}$$

$$k_0 = k_{satl}\, k_{shelter}\, k_{protect}\, k_{contact} \tag{4.3.2}$$

where,

- k_{wood} is given in Table 4.3.2, dependent on types/classes of materials (timber). Classification of heartwood into 4 classes is presented in Section 3.
- k_{water} is climate index in water given in Table 4.3.1, dependent on hazard coastal zones. The hazard coastal zone classification is presented in Section 4.1.
- k_0 is the multiplication of other parameters below.
- k_{salt} is salinity parameter. Depending on salinity, sea water is classified into 3 classes having different salinity parameter, as given in Table 4.3.3.
- $k_{shelter}$ is wave parameter, depending on whether the water is calm and sheltered from wave, or exposed to strong wave and surf, as given in Table 4.3.4.
- $k_{protect}$ is maintenance parameter, depending on the type maintenance measure or not, as given in Table 4.3.5.
- $k_{contact}$ is contact parameter, depending on if there is a contact surface with other timber members, as given in Table 4.3.6.

The time lag is determined as a function of the rate by the following equation,

$$lag = \begin{cases} 0 & \text{if } r \geq 20 \\ 2.0 - 0.1r & \text{if } r < 20 \end{cases} \tag{4.3.3}$$

For double treated wood, an extra lag of 13 years should be added to the calculated lag above. This extra lag is estimated from a reality check in Section 6, and explained in Appendix A. The derivations of the model parameters are presented in Appendix A.

Table 4.3.1 Climate index in water k_{water}.

Hazard Coastal zone*	k_{water}
1	0.7
2	0.9
3	1.3
4	2.0
5	3.8

(*) Hazard zones defined in Section 4.1.

Table 4.3.2 Parameter k_{wood} for different materials

	Material	Notation	k_{wood}
Untreated	Heartwood*		
	Class 1	HW1	1
	Class 2	HW2	2.5
	Class 3	HW3	4.5
	Class 4	HW4	15
	Sapwood	SAP	15
Treated	Creosote-treated		
	100 kg/m3	CR1	4.0
	200 kg/m3	CR2	1.0
	CCA-treated		
	16 kg/m3	CC1	4.0
	32 kg/m3	CC2	1.0
	Double-treated		
	CC2+CR2	DBT	0.2

(*) Heartwood classification is in Section 3.

Table 4.3.3 Parameter k_{sal} and salinity classification

Salinity Class	Salinity (ppt)	k_{sal}
1	1-10	0.7
2	11-25	0.8
3	26-35	1.0

Table 4.3.4 Parameter $k_{shelter}$ for different water zones

Water zone	$k_{shelter}$
Calm or sheltered from wave	1.0
Exposed to strong wave or surf	0.6

Table 4.3.4 Parameter $k_{protect}$for maintenance measures

Maintenance measure	$k_{protect}$
Floating collar	0.5
None	1.0

Table 4.3.5 Parameter $k_{contact}$ for contact with other timber member or not

Contact	k_{conact}
Contact with other timber member (e.g. X-brace)	2.0
None	1.0

4.4 Fitting of the Model to the Clear Specimen Tests

The attack model equations and parameters, as presented in Section 4.3, are developed and calibrated based on, more or less, 'trial and error' technique to the data from clear specimen tests. Some intermediate results and plots of the process to help the calibration are presented in Appendix A.

Using the model in Section 4.3, prediction of attack depth on the test specimen is calculated and listed correspondingly in Tables C.1a, C.2a, and C.3a in Appendix C. Input parameters for the 3 sites are as follows,

- Port Stephen: Coastal zone 4, Salinity class 2, Water zone is calm/sheltered from wave, no maintenance measure, and no contact with any other member.
- Williamstown: Coastal zone 2, Salinity class 3, Water zone is 'calm/sheltered from wave', no maintenance measure, and no contact with any other member.
- Geelong: Coastal zone 2, Salinity class 3, Water zone is 'exposed to wave and surf', no maintenance measure, and no contact with any other member.

Notes: At Williamstown test site, the water is classified as 'calm/sheltered from wave' because the test frames were installed behind a breakwater, so the water was quite calm, almost like a bath. On the contrary, the water at Geelong test site is more exposed to waves and turbulence. This is the main reason why the borers at Williamstown was more active than that in Geelong, as indicated in the test inspection results. At Port Stephens, the water was classified as 'calm and sheltered'. It is because the test frames were installed under a jetty, although the water was actually not as calm as for Williamstown, but with some light wave actions. Port Stephens is a brackish water site, so that the salinity class is set as class 2, although its mean monthly salinity ranges between 17 and 35 ppt. More information and expert opinions for these notes are recorded in Section 1.3.

The prediction model used is the base model in Section 4. Plots of the comparison are in 4.4.1a, 4.4.2a, and 4.4.3a for the 3 sites with data from Tables C.1a, C.2a, and C.3a, respectively. Legend of the data follows service duration. Points with legend of '<' sign before the number of years are plotted from data of the samples containing specimen(s) totally destroyed. In these plots, each point is of a timber species sample.

To provide a better comparison in a more general sense, further grouping the data following their marine borer durability class or type of wood is made. The typical (average) measured and the predicted attack depth for each of the groups are then obtained and presented in Tables C.1b, C.2b, and C.3b, respectively for the 3 sites. The comparison of the measured and the predicted depths are correspondingly plotted in Figures 4.4.1b, 4.4.2b, and 4.4.3b, excluding unreliable data due to destroyed specimen data. It can be seen that the measured and the predicted depths are in quite good agreement, except HW4 specimens at Port Stephens.

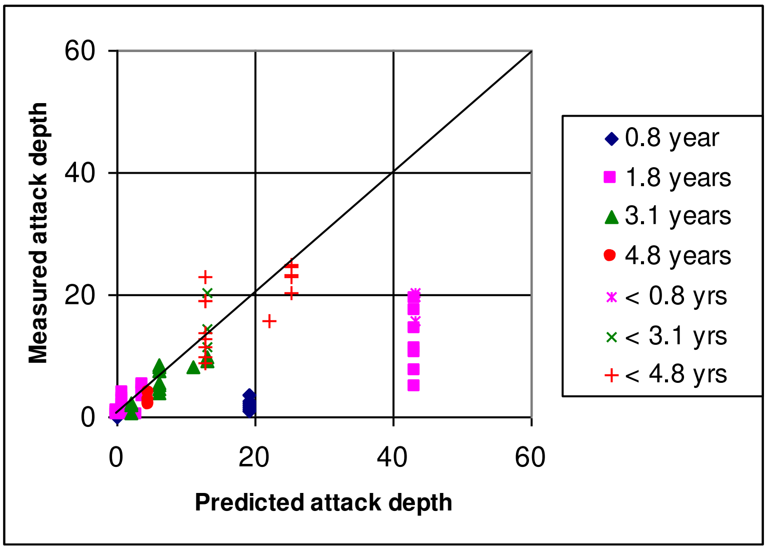


Fig. 4.4.1a Predicted vs measured attack depth on test samples at Port Stephens. Data is from Table C.1a, following *timber species*. The prediction model used is the base model in Section 4.

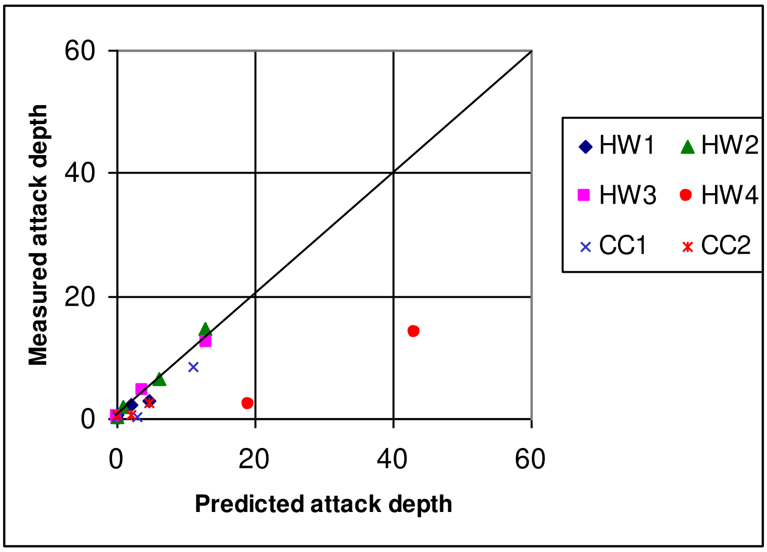


Fig. 4.4.1b Predicted vs measured attack depth on test samples at Port Stephens. Data is from Table C.1b, following *timber class or type of wood*. The prediction model used is the base model in Section 4.

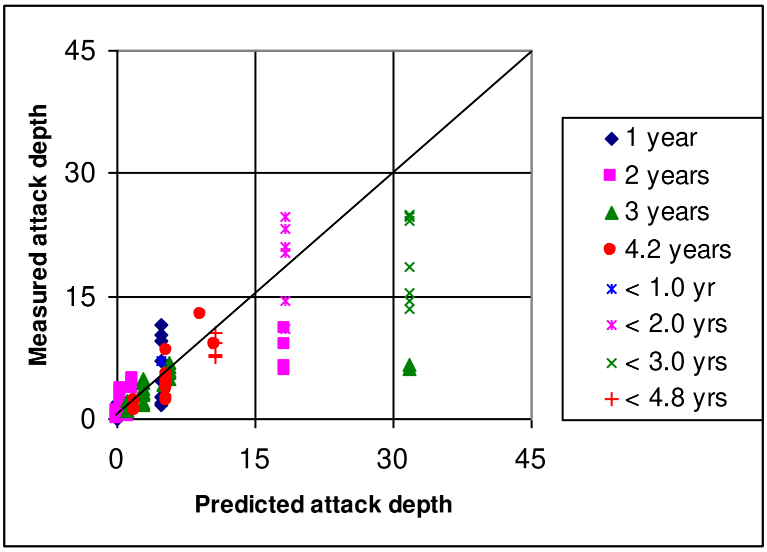


Fig. 4.4.2a Predicted vs measured attack depth on test samples at Williamstown. Data from Table C.2a, following *timber species*. The prediction model used is the base model in Section 4.

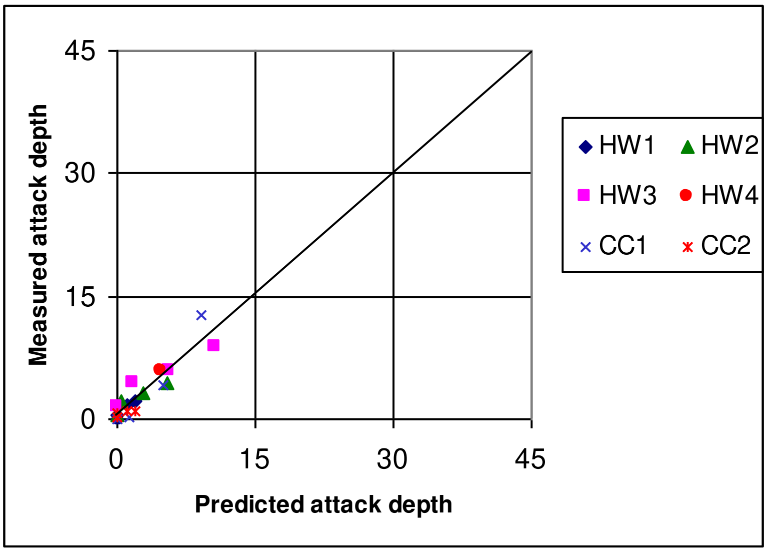


Fig. 4.4.2b Predicted vs measured attack depth on test samples at Williamstown. Data from Table C.2b, following *timber class or type of wood*. The prediction model used is the base model in Section 4.

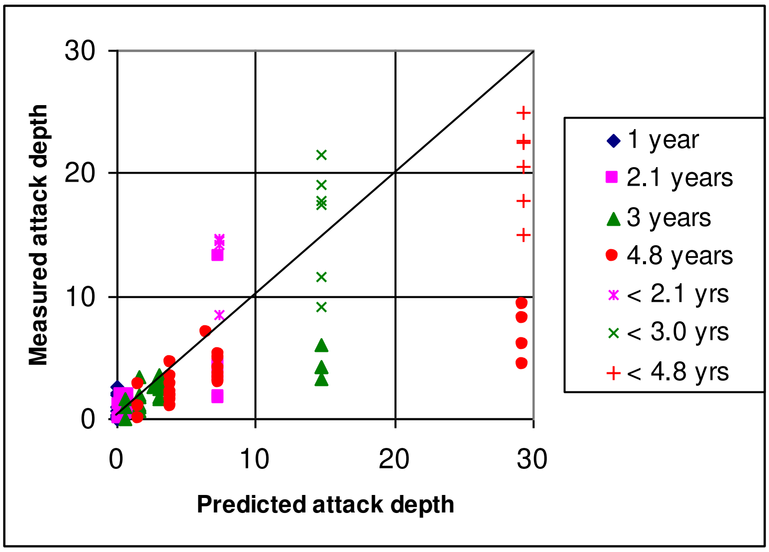


Fig. 4.4.2a Predicted vs measured attack depth on test samples at Geelong. Data from Table C.3a, following *timber species*. The prediction model used is the base model in Section 4.

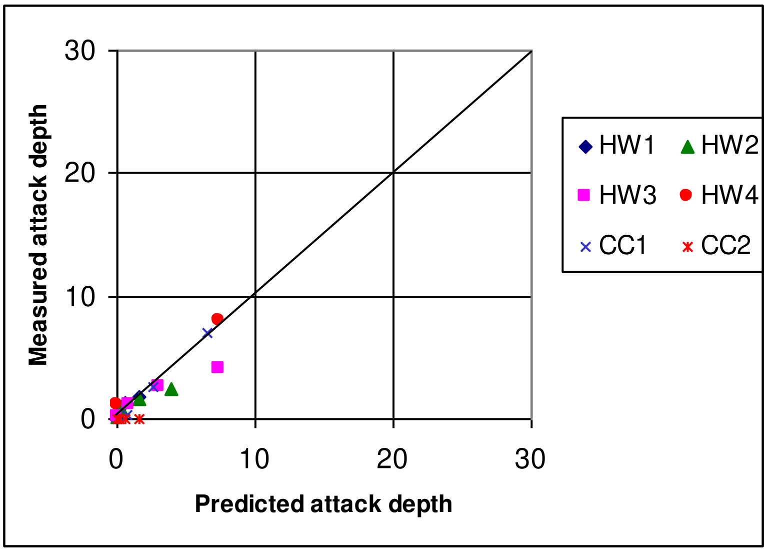


Fig. 4.4.2b Predicted vs measured attack depth on test samples at Geelong. Data from Table C.3b, following *timber class or type of wood*. The prediction model used is the base model in Section 4.

5. Attack Model for Marine Piled Structures

5.1 Upgraded Hazard Zone Map

The upgraded hazard coastal zones of Australia are presented in Figure 5.1.1. The hazard zone for estuarine rivers in general is the same as the corresponding coastal zone with lower salinity. This is an updated version of the hazard map presented in Cookson (1986). This map was based on the mean seawater temperature and information from assessments of marine borer activities as presented in Table 5.1.1. The climate index values, denoted by $k_{water,}$ were first estimated for the hazard coastal zones along the eastern coast, i.e. zone B, E, and G, using expert opinions on the performance of typical piles at different hazard zones, and then calibrated using the data from the small clear specimen tests. The estimated climate index k_{water} was then found depending on the mean summer water temperature of the hazard coastal zones by the following equation:

$$k_{water} = 0.1\, e^{\,0.13\,T} \qquad (5.1.1)$$

where T (in °C) is the mean summer water temperatures of the hazard coastal zones given by Knox, (1963). The climate index values for the other hazard coastal zones can then be estimated by Eq.(5.1.1). The climate index values for all the hazard coastal zones with corresponding mean summer water temperatures are presented in Table 5.1.2. The climate index for zone F, however, was adjusted to 3.0 from the calculated value of 3.8, which is also the value for zone G. This adjustment was based on the risk assessment in Table 5.1.1, where the risk for zone F is less than that for zone G in terms of the Sphaeroma borer, which is actually the most active species attacking timber piles in the tidal zone.

Table 5.1.1 Approximate marine borer hazard levels in each zone:

Marine borer	Zone A	B	C	D	E	F	G
Approx location	Tas	Vic	SA	Perth	NSW	nthWA	Qld
Sphaeroma	none	low	low	low	high	low	high
Limnoria tripunctata	none	low	mod	high	high	mod	mod
Other *Limnoria*	low	low	mod	high	high	mod	mod
Martesia	none	none	none	low	mod	high	high
Teredinids	low	low	mod	high	high	very high	very high

Figure 5.1.1. Marine borer hazard coastal zones. Zone G is the most hazardous.

Table 5.1.2 Climate index in water k_{water}

Hazard coastal zone	Mean summer water temperature for the zone	k_{water}
A	15°C	0.7
B	17°C	0.9
C	19°C	1.2
D	21°C	1.6
E	23°C	2.0
F	28°C	3.0
G	28°C	3.8

5.2 Basic Model of Marine Borer Attack

A schematic illustration of the progress of marine borer attack assumed in the model is shown in Figure 5.2.1. It comprises of a time-lag (*lag*) followed by a steady attack rate (*r*). The attack depth of timber after *t* years is given as:

$$d_t = \begin{cases} 0 & \text{if } t \le lag \\ (t - lag)r & \text{if } t > lag \end{cases} \tag{5.2.1}$$

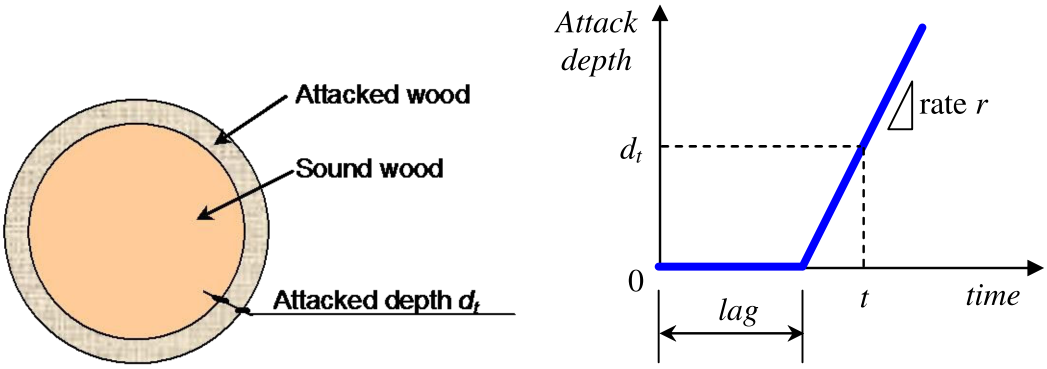


Figure 5.2.1. Basic model of timber attacked by marine borers.

There are a number of marine borer species, and each species has a different habit and extent of attacking timber piles in different coastal regions (Cookson, 1986). However, from observations of marine piled structures in service, the most severely attacked location by marine borers on a pile is often within the tidal zone, as shown in Figure 5.2.2. For engineering design purposes, the model developed herein assumed that the most severe borer attack, regardless of borer species, occurs on a narrow front along the perimeter of the pile's cross-section in the tidal zone, with the un-attacked wood retaining 100 percent of its initial strength.

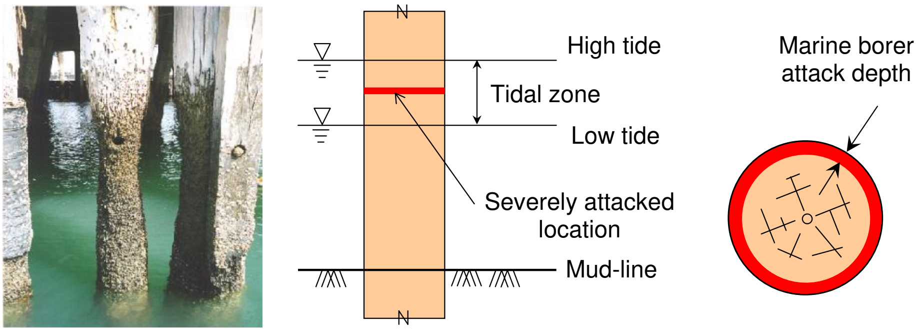


Figure 5.2.2. Assumptions of marine borer attacked location and attacked depth on a pile

The model developed in this report takes into account the following parameters

- coastal zone
- salinity class
- timber class & type of wood (ie. heartwood, sapwood)
- preservative treatment
- protection measure
- shelter/exposure to surf or strong currents
- timber to timber contact
- presence of knots

5.3 Model Equations and Parameters

The marine borer attack rate (*r*) is determined as

$$r = k_{water}\, k_0 \tag{5.3.1}$$

$$k_0 = k_{wood}\, k_{salt}\, k_{shelter}\, k_{protect}\, k_{contact}\, k_{knot} \tag{5.3.2}$$

where,

- k_{wood} is given in Table 5.3.1, dependent on types/classes of materials (timber). Classification of timber (heartwood) into 4 classes is presented in Section 2.2.
- k_{water} is water climate index in water given in Table 5.1.2, dependent on hazard coastal zones. The hazard coastal zone classification is presented in Section 5.1.
- k_{salt} is salinity parameter. Depending on salinity, sea water is classified into 3 classes having different salinity parameter, as given in Table 5.3.2.
- $k_{shelter}$ is shelter parameter, depending on whether the water is exposed to or sheltered from strong current or surf, as given in Table 5.3.3.
- $k_{protect}$ is protection parameter, depending on the type of protection measure, as given in Table 5.3.4.
- $k_{contact}$ is contact parameter, depending on if there is a contact surface with other timber members, as given in Table 5.3.5.
- k_{knot} is knot parameter, depending on if there are big knots with or without protective plates, as given in Table 5.3.6.

The time lag is determined as a function of the rate by the following equation,

$$lag = \begin{cases} 0 & \text{if } r \geq 20 \\ 2.0 - 0.1r & \text{if } r < 20 \end{cases} \tag{5.3.3}$$

This lag equation is the same as that used in the base model in Section 4. For double treated wood, an extra lag of 10 years should be added to the above calculated lag (note that this extra lag was 13 years in the base model). Refer Appendix B for the derivation of wood parameter, and Appendix A for other parameters.

Table 5.3.1 Parameter k_{wood} for different materials

Material		Notation	k_{wood}	
			Zones A to C	**Zones D to G**
Heartwood*	Class 1	HW1	1.1	1.3
	Class 2	HW2	1.7	5.2
	Class 3	HW3	3.4	8.8
	Class 4	HW4	17.0	25
		Notation (treatment level)	**All zones**	
Sapwood of softwood	Untreated	SAPs	40	
	Creosote-treated**			
	24 %kg/kg	CR1s (H5)	1.7	
	40 %kg/kg	CR2s (H6)	1.0	
	CCA-treated**			
	0.6 %kg/kg	CC0s (H4)	4.7	
	1 %kg/kg	CC1s (H5)	3.0	
	2 %kg/kg	CC2s (H6)	1.8	
	5 %kg/kg	CC3s (>H6)	1.0	
	Double-treated CC2s+CR2s	DBTs (H6)	0.9	
Sapwood of hardwood	Untreated	SAPh	25	
	Creosote-treated**			
	13 %kg/kg	CR1h (H5)	0.8	
	22 %kg/kg	CR2h (H6)	0.6	
	CCA-treated**			
	0.7 %kg/kg	CC0h (H4)	3.2	
	1.2 %kg/kg	CC1h (H5)	1.8	
	2.4 %kg/kg	CC2h (H6)	1.1	
	Double-treated CC2h+CR2h	DBTh (H6)	0.5	

(*) Heartwood classification is in Section 3.1

(**) Fitting Equations for k_{wood} with retentions are in Appendix B

Table 5.3.2 Parameter k_{salt} and salinity classification

Salinity Class	**Salinity** (ppt)	k_{salt}	
		Zones A to D	**Zones E to G**
1	1-10	0.7	1.0
2	11-25	0.8	1.0
3	26-35	1.0	1.0

Table 5.3.3 Parameter $k_{shelter}$

Shelter	$k_{shelter}$
Sheltered from strong current or surf (eg. behind breakwaters, harbour, river, etc.)	1.0
Exposed to strong current and/or surf	0.6

Table 5.3.4 Parameter $k_{protect}$ for protection measures

Protection measure	$k_{protect}$
Floating collar or plastic wrap in tidal zone	0.5
None	1.0

Table 5.3.5 Parameter $k_{contact}$ for contact with other timber member or not

Contact	$k_{contact}$
Contact with other timber member (e.g. X-brace) in tidal zone	2.0
None	1.0

Table 5.3.6 Parameter k_{knot} for presence of knots

Knot presence	k_{knot}
Having knots without protective plate	2.0
Having knots with protective plate	1.0
None	1.0

Using the basic model equations, the following attack rates and time lags for timber can be computed and used for predictions of the attack depths

$r_{\mathrm{un,HWi}}$: attack rate on timber of outer heartwood class *i* (mm/year)
$lag_{\mathrm{un,\ HWi}}$: attack time lag on timber of outer heartwood class *i* (years)
$r_{\mathrm{un,sap}}$: attack rate of a clear stake of untreated sapwood (mm/year)
$lag_{\mathrm{un,sap}}$: attack time lag of a clear stake of untreated sapwood (years)
$r_{\mathrm{tr,sap}}$: attack rate of a clear stake of treated sapwood (mm/year)
$lag_{\mathrm{tr,sap}}$: attack time lag of a clear stake of treated sapwood (years)

5.4 Attack Equations for Timber Round Piles

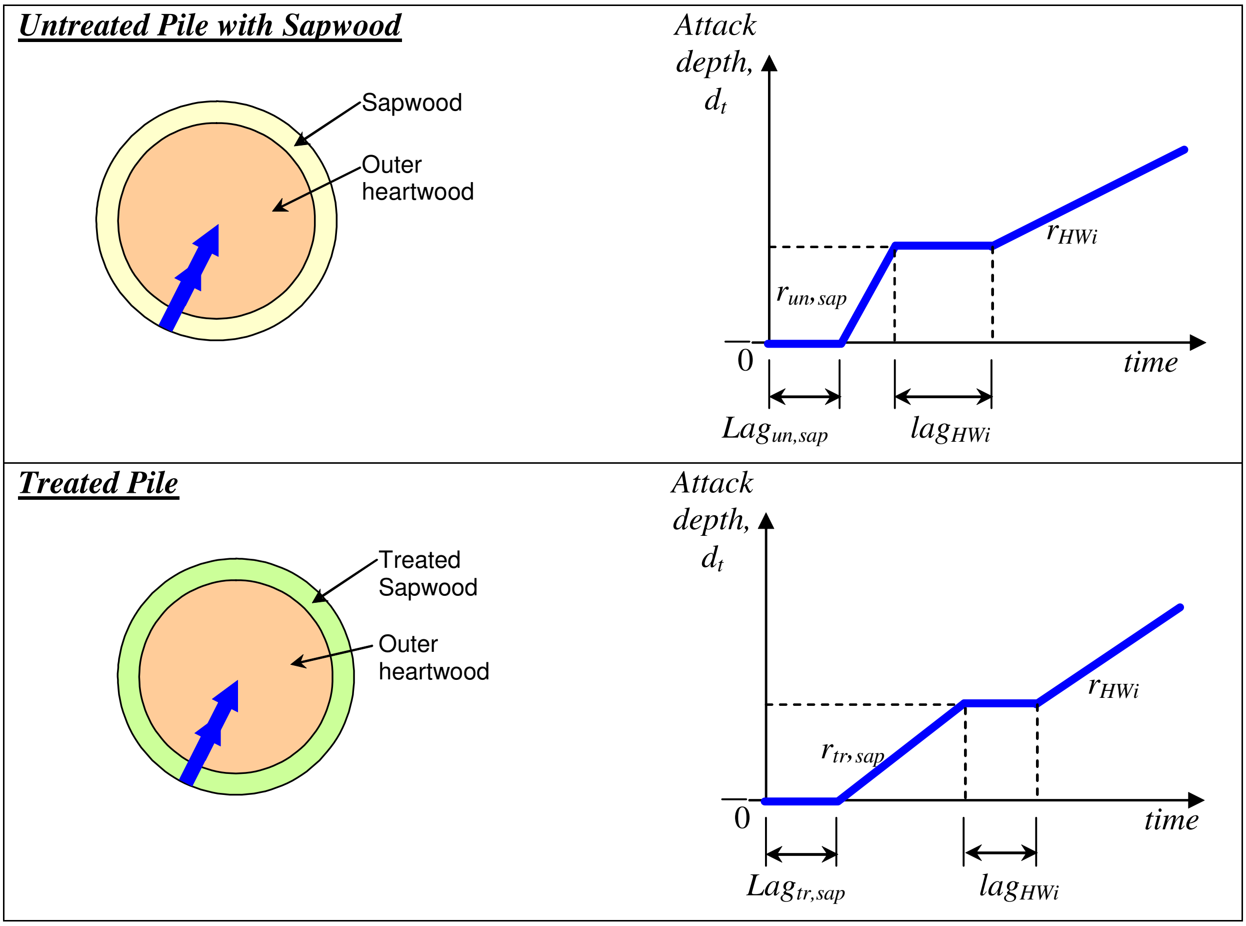


Figure 5.4.1 Attack Equations for Timber Round Piles

5.5 Fitting with Expert Opinions on Average Life of Timber Marine Piles

One of the key parameters of the model developed in this Section 5, i.e. wood parameter, has been derived based on the expert opinion data on life of timber of marine piles, as presented in Appendix B. This Section presents the comparisons between the data and the model prediction in order to check the fitness of the model with the data. The comparisons are carried out in terms of the time (in years) that took marine borers to attack a certain depth on the piles. For untreated heartwood piles (de-sapped), it is defined as the time it takes the borers attack 75 mm heartwood from perimeter. For treated hardwood piles, it is defined as the time it takes the borers attack 30 mm of the sapwood. For treated softwood piles, it is defined as the time it takes the borers attack 50 mm of the sapwood. These definitions are in line with the data provided by expert opinions in Table 2.2.1.

Using the model, the *predicted time of attack* can be calculated and compared with those from expert opinions. Figures 5.5.1, 5.5.2 and 5.5.3 present the comparisons for the heartwood, sapwood of softwood, and sapwood of hardwood, respectively. These comparisons are only for the data with some backing data from in-service structures, as indicated with bold numbers in Table 5.5.1. Figure 5.5.4 shows a full comparison, ie. also with guessed data. Very good agreements are obtained since the model parameter k_{wood} actually calibrated to the expert opinions. Data for these comparisons are in Tables 5.5.1 and 5.5.2. Prediction model used is presented in Section 5.

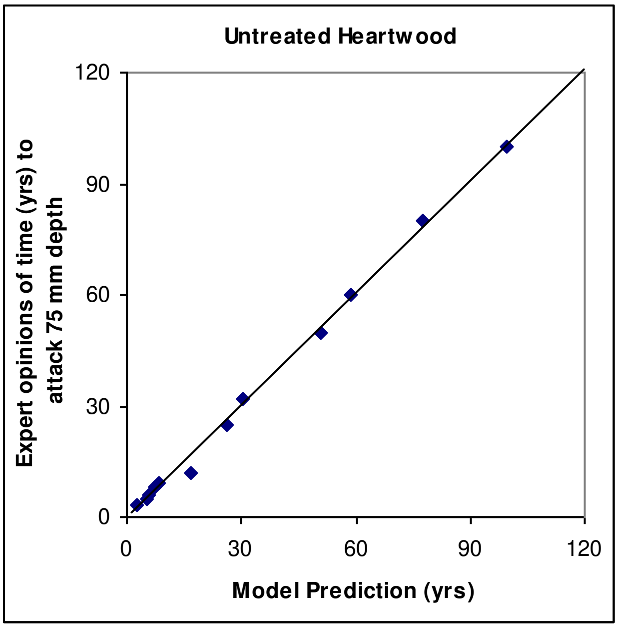


Figure 5.5.1 Comparison for heartwood piles, using data with backing from in-service data. Data is from Tables 5.5.1 and 5.5.2. Prediction model used is presented in Section 5.

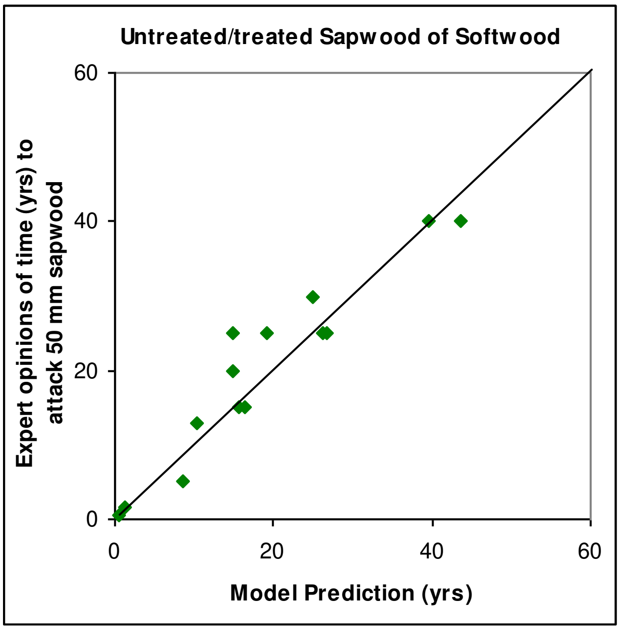


Figure 5.5.2 Comparison for softwood piles, using data with backing from in-service data. Data is from Tables 5.5.1 and 5.5.2. Prediction model used is presented in Section 5.

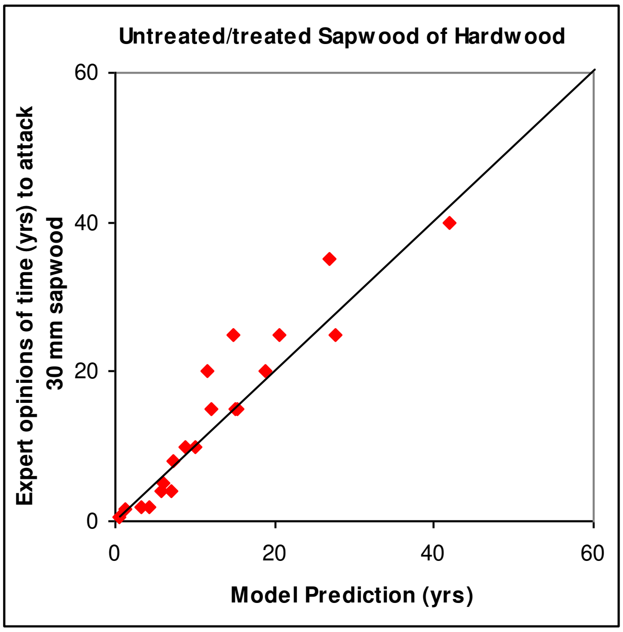


Figure 5.5.3 Comparison for hardwood piles, using data with backing from in-service data. Data is from Tables 5.5.1 and 5.5.2. Prediction model used is presented in Section 5.

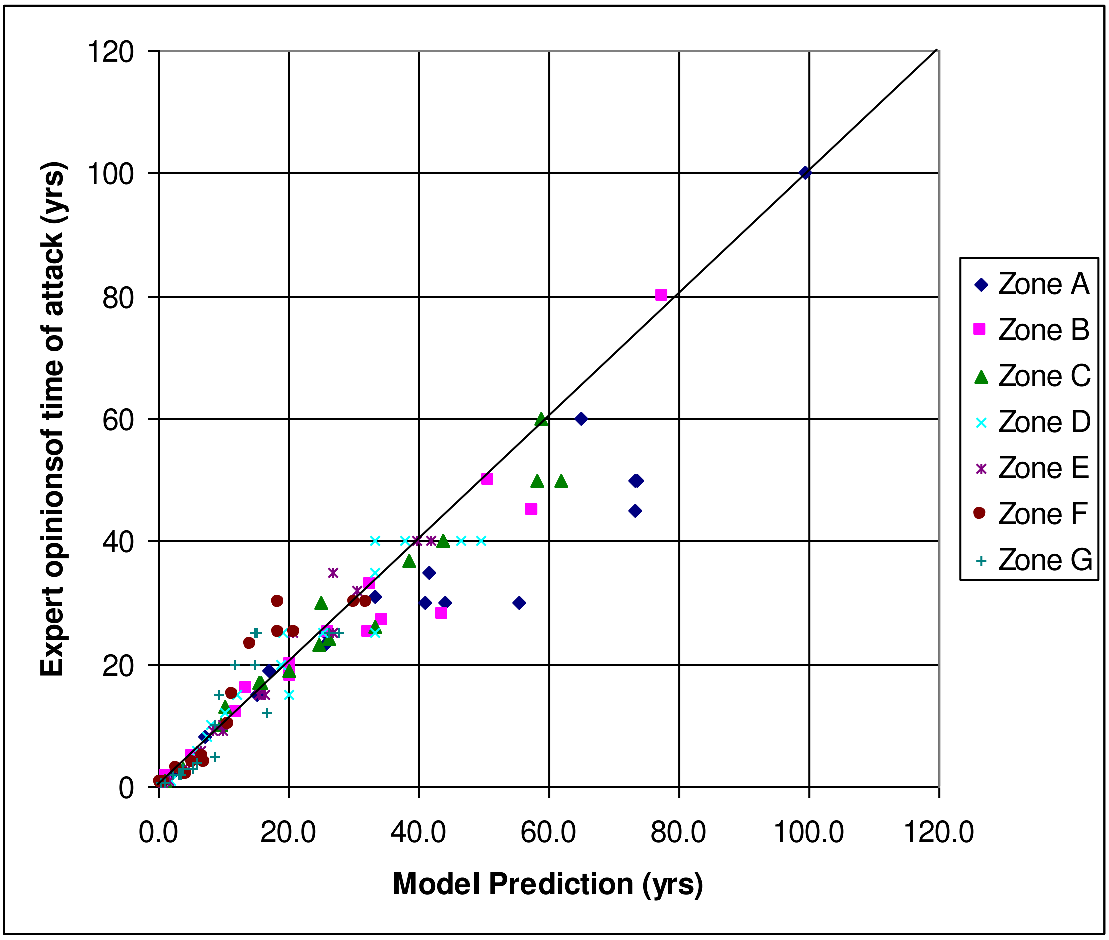


Figure 5.5.3 Comparison for all piles. Data is from Tables 5.5.1 and 5.5.2. Prediction model used is presented in Section 5.

Table 5.5.1 Expert opinion of average life of timber in marine piles (see also Table 2.2.1)

Material		Average life (yrs) of timber in marine piles**						
		Zone A	B	C	D	E	F	G
75 mm Heartwood	Heartwood Class 1	**100***	**80**	**60**	40	**32**	25	**12**
	Heartwood Class 2	60	**50**	37	12	**9**	4	3
	Heartwood Class 3	31	**25**	19	**6**	4	**3**	2
	Heartwood Class 4	**8**	**5**	3	1	1	0.5	0.5
50mm sapwood of Softwood	Untreated	2	**1.5**	1	0.5	**0.5**	0.5	0.5
	CCA-treated 0.6%m/m	19	16	**13**	10	6	2	2
	CCA-treated 1%m/m	25	20	17	15	9	5	3
	CCA-treated 2%m/m	35	33	**30**	**25**	**15**	10	**5**
	CCA-treated 5%m/m	45	45	40	40	25	30	**20**
	Creosote-treated 24%m/m	30	27	24	15	**15**	15	15
	Creosote-treated 40%m/m	50	45	**40**	25	**25**	25	**25**
	Double-treated CC2+CR2	>50	>50	50	40	**40**	30	**25**
30mm sapwood of Hardwood	Untreated	2	**1.5**	1	0.5	**0.5**	0.5	0.5
	CCA-treated 0.7%m/m	**15**	12	10	**8**	**5**	**2**	**2**
	CCA-treated 1.2%m/m	23	18	17	**15**	**10**	**4**	**4**
	CCA-treated 2.4%m/m	30	25	23	**20**	**15**	10	**10**
	Creosote-treated 13%m/m	30	28	26	25	**25**	23	**20**
	Creosote-treated 22%m/m	50	45	40	35	**35**	30	**25**
	Double-treated CC2+CR2	-1	-1	50	40	**40**	30	**25**

* Bold numbers indicates data with some backing from in-service data

** As presented in Section 1.2, the 'Average life (yrs) of timber in marine piles' is the time for marine borer to attack:

- 75mm heartwood
- 30mm sapwood of hardwood
- 50mm sapwood of softwood

Table 5.5.2 Model prediction of the average life (yrs) of timber in marine piles. Prediction model used is presented in Section 5.

Material		Predicted average life (yrs) of timber in marine piles**						
		Zone A	B	C	D	E	F	G
75mm Heartwood	Heartwood Class 1	99.3	77.7	58.7	37.8	30.6	20.8	16.7
	Heartwood Class 2	64.9	50.9	38.6	10.2	8.2	5.2	3.8
	Heartwood Class 3	33.3	26.2	20.0	5.9	4.5	2.8	2.2
	Heartwood Class 4	7.1	5.4	3.7	1.1	0.9	0.6	0.5
50mm Sapwood of Softwood	Sapwood	1.7	1.4	1.0	0.8	0.6	0.4	0.3
	CCA-treated 0.6%m/m	16.9	13.4	10.3	7.9	6.4	4.1	3.0
	CCA-treated 1%m/m	25.6	20.2	15.5	11.9	9.7	6.7	5.2
	CCA-treated 2%m/m	41.6	32.7	24.9	19.1	15.5	10.7	8.6
	CCA-treated 5%m/m	73.4	57.5	43.5	33.1	26.8	18.4	14.8
	Creosote-treated 24%m/m	43.9	34.5	26.3	20.1	16.4	11.3	9.1
	Creosote-treated 40%m/m	73.4	57.5	43.5	33.1	26.8	18.4	14.8
	Double-treated CC2+CR2	91.3	73.6	58.2	46.6	39.6	30.2	26.3
30mm Sapwood of Hardwood	Sapwood	2.0	1.3	1.0	0.8	0.6	0.4	0.3
	CCA-treated 0.7%m/m	15.2	12.1	9.4	7.3	6.0	4.2	3.3
	CCA-treated 1.2%m/m	25.7	20.4	15.7	12.1	10.0	7.0	5.7
	CCA-treated 2.4%m/m	40.9	32.2	24.6	18.9	15.4	10.8	8.8
	Creosote-treated 13%m/m	55.5	43.6	33.2	25.3	20.6	14.3	11.6
	Creosote-treated 22%m/m	73.4	57.5	43.6	33.2	26.9	18.5	14.9
	Double-treated CC2+CR2	97.7	78.6	61.9	49.4	41.9	31.9	27.6

** As presented in Section 1.2, the 'Average life (yrs) of timber in marine piles' is the time for marine borer to attack:

- 75mm heartwood
- 30mm sapwood of hardwood
- 50mm sapwood of softwood

6. Calibration Data & Reality Checks

6.1 Data from Field Assessments of In-service Marine Piles

More than 4500 in-service (or end of service) marine piles/posts of 20 species located at 45 sites have been assessed for extents of marine borer attack in terms of attack depths, with various parameters necessary for the modelling, as presented in Appendix E. The data were provided by Dr Cookson.

6.2 Reality Checks

Progress of marine borer attack on a pile is assumed as in Figure 5.4.1. Reality checks for the model is made using the field assessement data of marine piles. The results are plotted in Figures 6.2.1 to 6.2.10 for various types of piles. The reality check results show the model predictions agree with the collected data in average. Data for the checks are given in Tables E2 to E11, Appendix E, where the measured attack depths given in column [17] with the model predicted attack depths given in column [27] of those Tables.

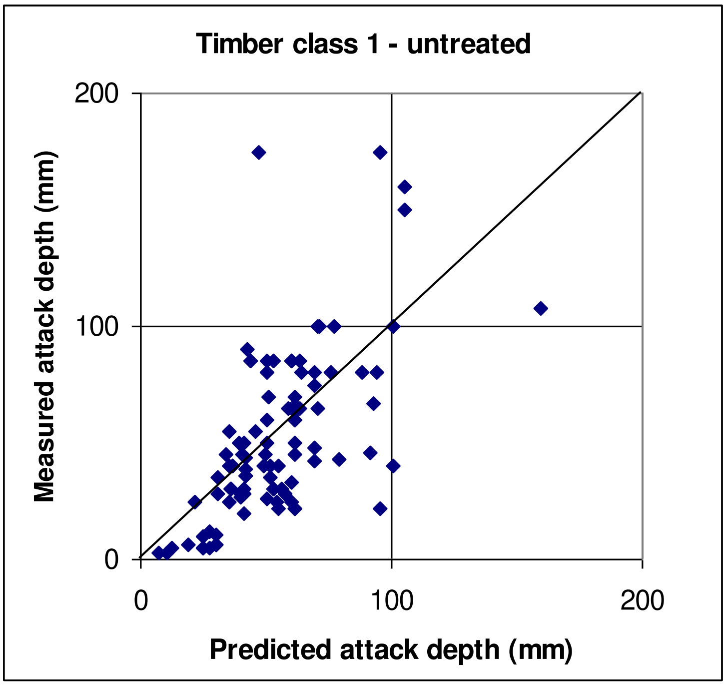


Figure 6.2.1 Reality Checks with marine piles of untreated timber class 1. Data is in Table E2, Appendix E. Prediction model used is presented in Section 5.

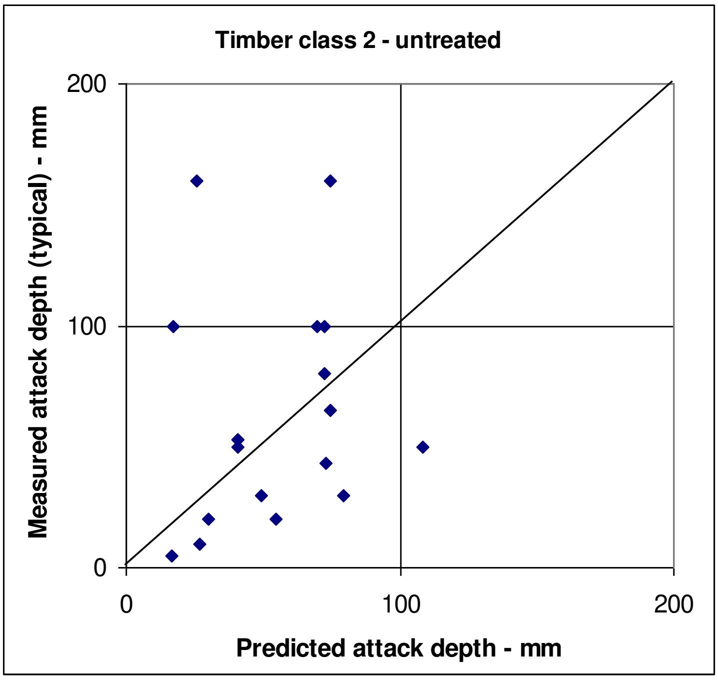


Figure 6.2.2 Reality Checks with marine piles of untreated timber class 2. Data is in Table E3, Appendix E. Prediction model used is presented in Section 5.

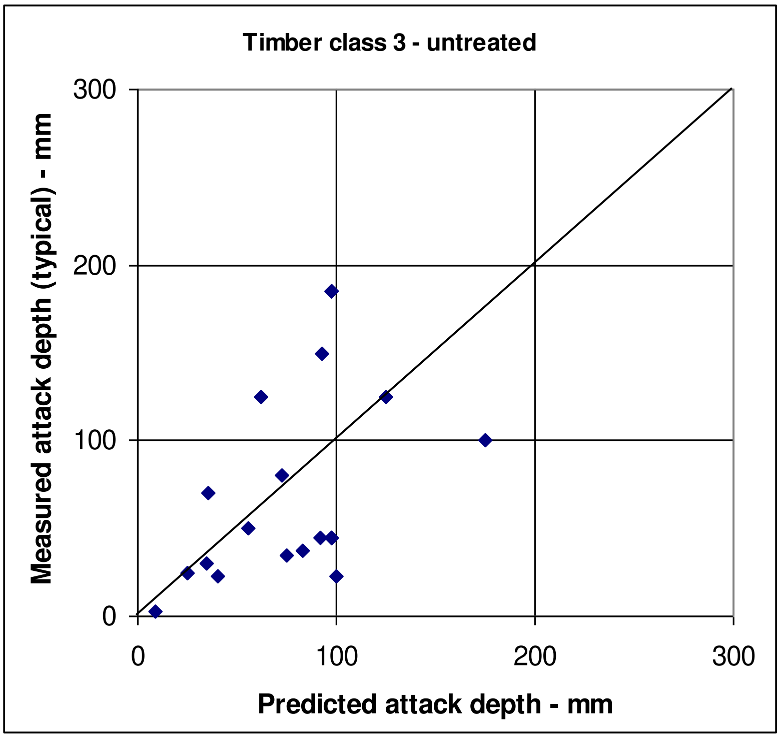


Figure 6.2.3 Reality Checks with marine piles of untreated timber class 3. Data is in Table E4, Appendix E. Prediction model used is presented in Section 5.

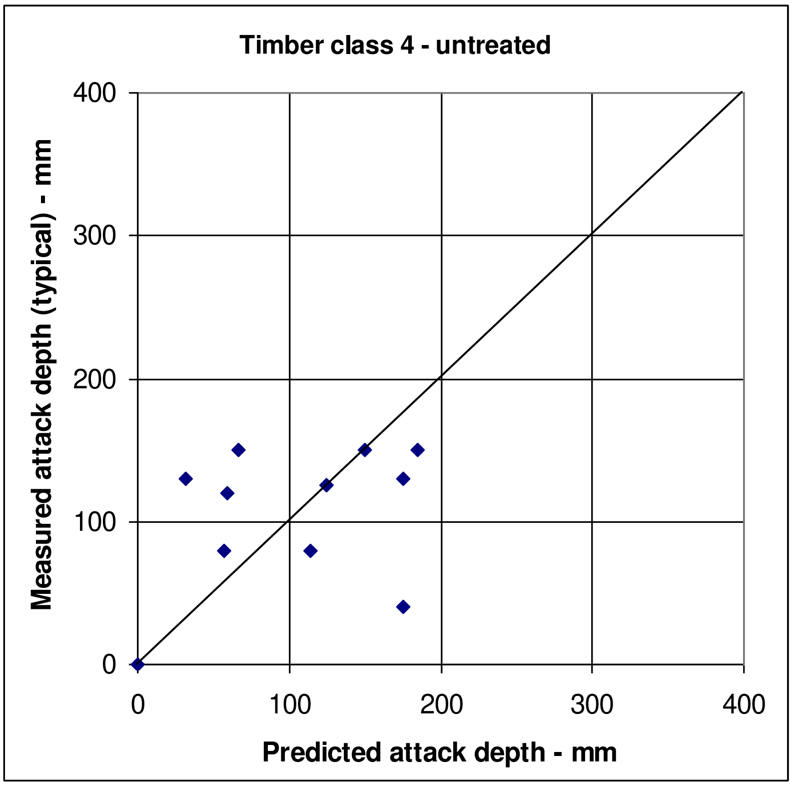


Figure 6.2.4 Reality Checks with marine piles of untreated timber class 4 Data is in Table E5, Appendix E. Prediction model used is presented in Section 5.

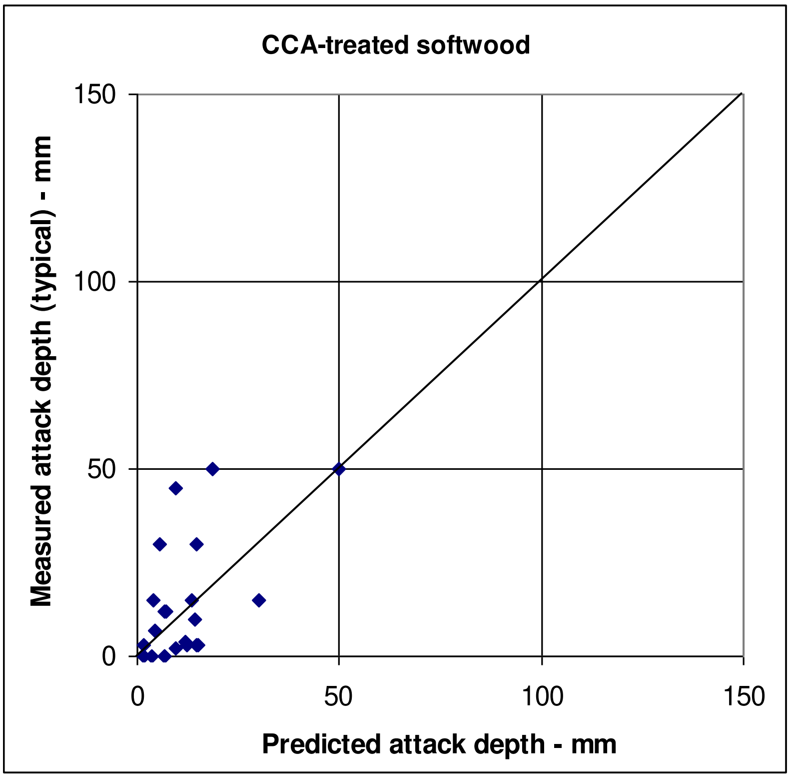


Figure 6.2.5 Reality Checks with marine piles of CCA-treated softwood. Data is in Table E6, Appendix E. Prediction model used is presented in Section 5.

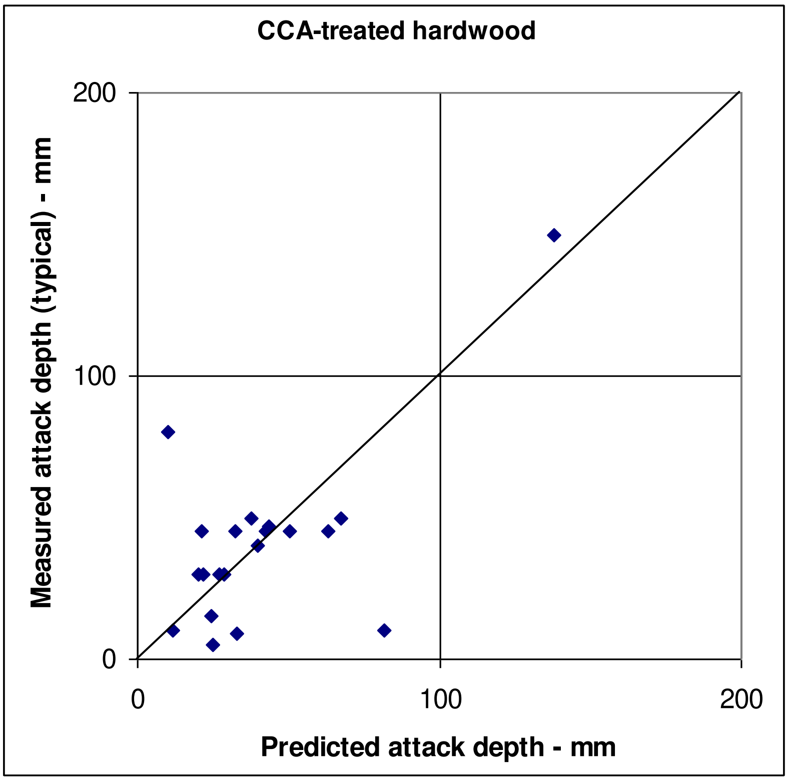


Figure 6.2.6 Reality Checks with marine piles of CCA-treated hardwood. Data is in Table E7, Appendix E. Prediction model used is presented in Section 5.

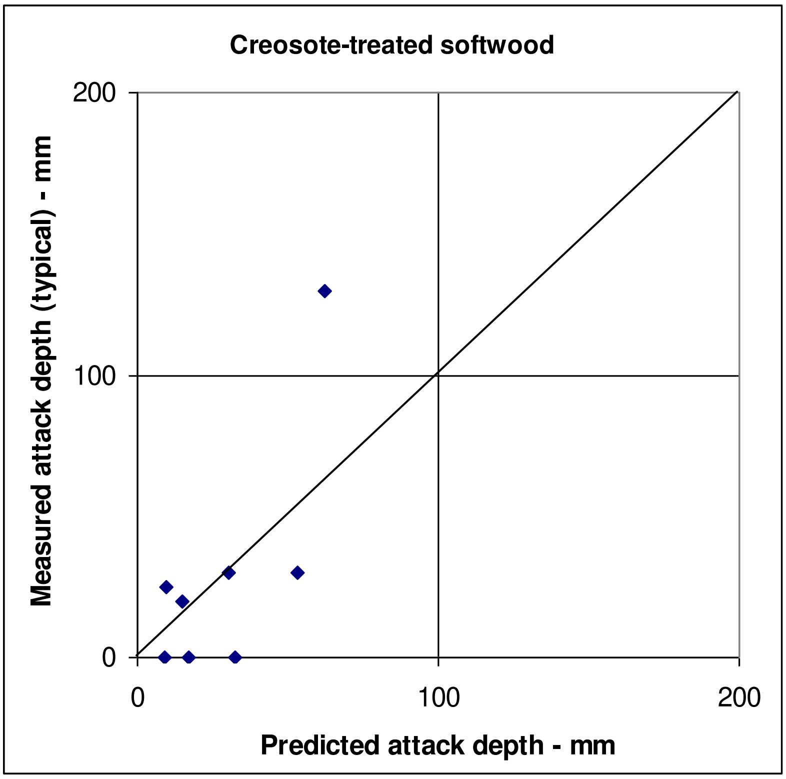


Figure 6.2.7 Reality Checks with marine piles of Creosote-treated softwood. Data is in Table E8, Appendix E. Prediction model used is presented in Section 5.

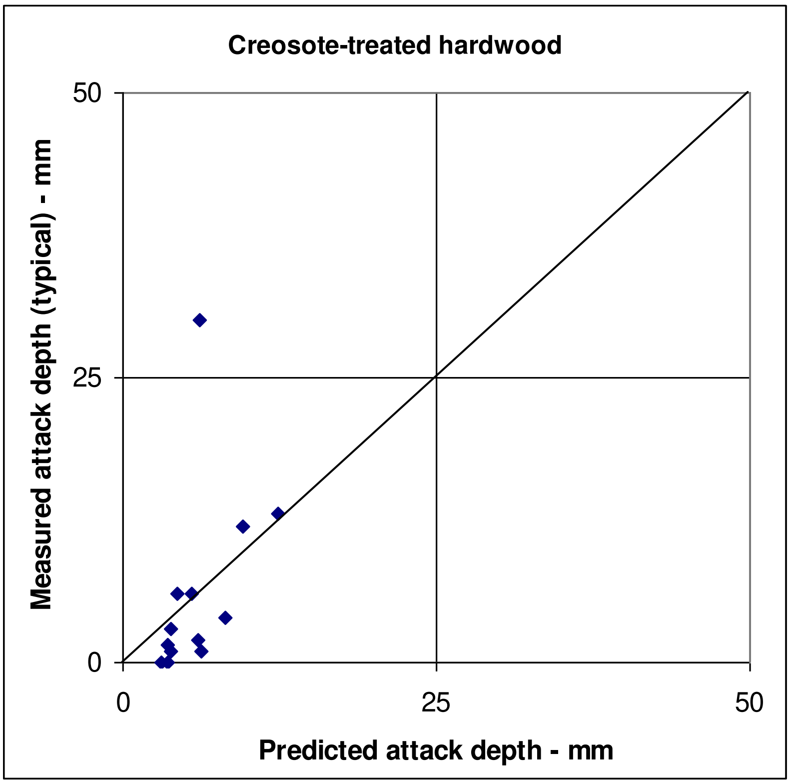


Figure 6.2.8 Reality Checks with marine piles of Creosote-treated hardwood. Data is in Table E9, Appendix E. Prediction model used is presented in Section 5.

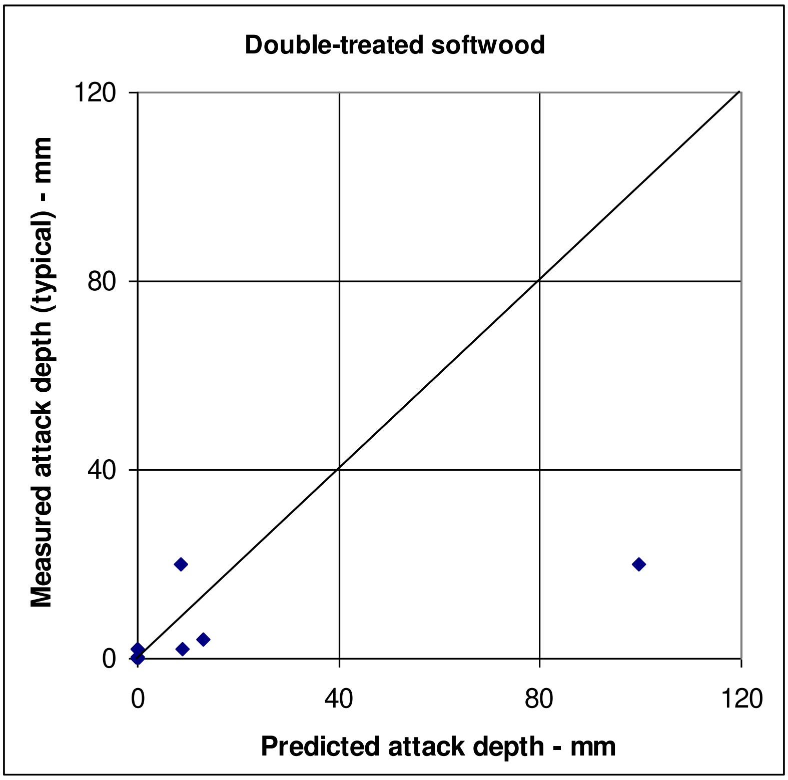


Figure 6.2.9 Reality Checks with marine piles of double-treated softwood. Data is in Table E10, Appendix E. Prediction model used is presented in Section 5.

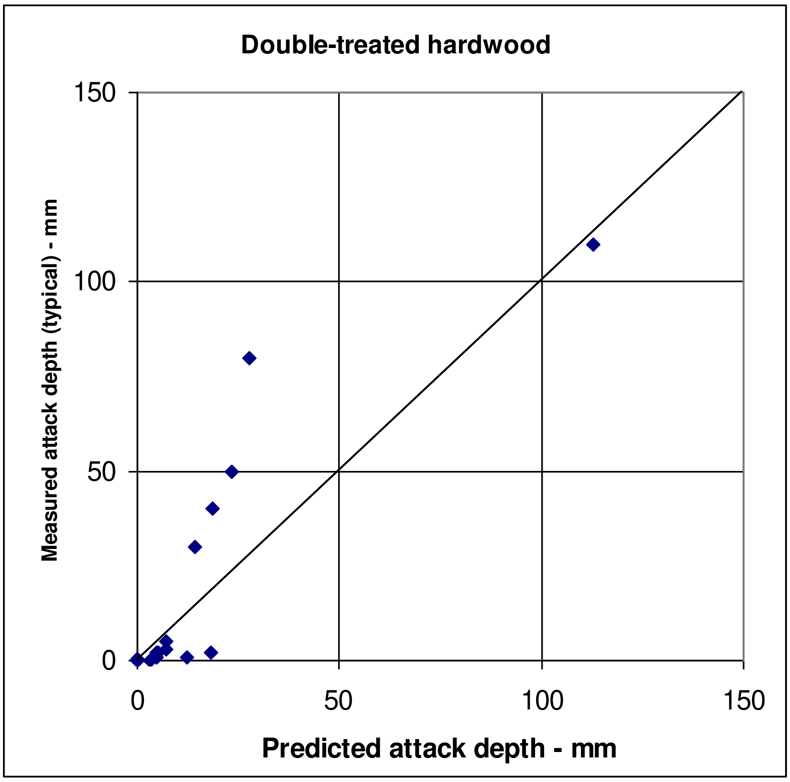


Figure 6.2.10 Reality Checks with marine piles of double-treated hardwood. Data is in Table E11, Appendix E. Prediction model used is presented in Section 5.

7. Design Attack Depth

7.1 Coefficient of variation

The model presented in the Section 5 predicts the mean value of attack depth on piles. To be used for the design procedure, it is essential to evaluate the uncertainty or variability of the attack depths.

There are different ways to assess this variation of attack depths, depending on the availability of data types. Herein, the variability of the marine borer attack prediction model is evaluated using the most direct way, i.e. via direct comparison of the model-predicted attack depths and measured depths from field measurements of in-service marine piles, as presented in the reality checks in Section 6. From the comparision of the attack depths that resulted from the measurement (d_m) with the model-prediction attack depths (d_p), log-normal distributions are assumed for the uncertainties of the predicted and measured attack depths over time. This leads to the coefficient of variation of the attacked depth, denoted by V_d, evaluated as follows (Ang & Tang, 2006),

$$V_d = \sqrt{e^{\sigma^2} - 1} \quad (7.1.1)$$

in which

$$\sigma^2 = \frac{1}{n-2} \sum \left(\ln d_m - \ln d_p \right)^2 \quad (7.1.2)$$

where c_m is the measured attacked depth, c_p is the predicted attacked depth, and n is the number of data points.

Using the data in Appendix E, which were used for the reality check in Section 6, the values of V_d obtained for all classes/types of wood are computed and listed in Table 7.1.1.

Table 7.1.1. Coefficient V_c for marine borer attack model (data in Appendix E)

Timber class / type	V_c
Heartwood class 1	0.7
Heartwood class 2	1.1
Heartwood class 3	0.8
Heartwood class 4	0.9
CCA-treated sapwood of softwood	1.9
CCA-treated sapwood of hardwood	1.1
Creosote-treated sapwood of softwood	0.9
Creosote -treated sapwood of hardwood	1.5
Double-treated sapwood of softwood	1.0
Double-treated sapwood of hardwood	1.6
All Untreated	0.8
All Treated	1.5
All data	1.1

For the Engineering Code, the coefficient V_d for the whole model is set to be 1.5.

7.2 Design Attacked Depths

The design depth of marine borer attack, d_{design} will be given by

$$d_{design} = d\left(1 + \alpha V_d\right) \tag{7.2.1}$$

where

- d is the mean depth of the loss in cross-section due to marine borer attack, computed by equation in Section 5 for a chosen design life time.
- V_d is the coefficient of variation of d, presented in Section 7.1.
- α is specified parameter related to the target reliability level.
  - $\alpha = 0.8$ for normal consequence of failure elements.
  - $\alpha = 0.4$ for low consequence of failure elements.

From the design depth of marine borer attack, the residual cross-section is estimated; from which engineers compute the acceptable design load capacity by normal AS1720.1 procedure.

Refer Manual No.2 (Leicester et.al. 2008) for the derivation of the design depth.

8. Equations for Project Products

Service Life design Guide, Draft Engineering Code, and TimberLife

8.1 Scope and Applications

This Section provides the calculation procedure of the design attacked depths of timber sections attacked by marine borers, which can be used to estimate the attack of marine borers for any timber construction located anywhere in Australia. The attack patterns are depicted in Figure 8.4.1.

To evaluate the design attacked depths, the timber durability class is obtained from Section 8.2, and the hazard coastal zone of the structure location is determined from Section 8.3. The mean attacked depth is then estimated using the model presented in Section 8.5 with the attack progress defined in Section 8.6. The design decay depths are then determined in Section 8.7.

For work examples and application tables, see Appendix C *of the Draft Engineering Code* (Nguyen et.al. 2008).

Notations:

d: attack depth (mm)
d_{design}: design attack depth (mm)
$k_{contact}$: contact parameter
k_{knot} : knot parameter
$k_{protection}$: protection parameter
k_{satl} : salinity parameter
$k_{shelter}$: shelter parameter
k_{water} : water climate factor for marine borer attack
k_{wood} : wood parameter
lag: attack lag (years)
$lag_{\text{tr,sap}}$: attack time lag of a clear stake of treated sapwood (years)
$lag_{\text{un, HW}i}$: attack time lag on timber of outer heartwood class i (years)
$lag_{\text{un,sap}}$: attack time lag of a clear stake of untreated sapwood (years)
r: attack rate (mm/year)
$r_{\text{tr,sap}}$: attack rate of a clear stake of treated sapwood (mm/year)
$r_{\text{un,HW}i}$: attack rate on timber of outer heartwood class i (mm/year)
$r_{\text{un,sap}}$: attack rate of a clear stake of untreated sapwood (mm/year)
t : time (years)
V_d : coefficient of variation of decay depth

8.2 Timber Classification for outer heartwood

Durability classification of timber is listed in Table 8.2.1.

Table 8.2.1 Marine Durability classification of timber

Trade name	Botanical name	Marine Durability Class
Alder, blush	Sloanea australis	4
Alder, brown	Caldcluvia paniculosa	4
Alder, pink	Gillbeea adenopetala	4
Alder, rose	Caldcluvia australiensis	4
Amberoi	Pterocymbium spp.	4
Apple, rough-barked	Angophora floribunda	4
Apple, smooth-barked	Angophora costata	4
Ash, alpine	Eucalyptus delegatensis	4
Ash, Blue Mountains	Eucalyptus oreades	4
Ash, Crow's	Flindersia australis	4
Ash, mountain	Eucalyptus regnans	4
Ash, pink	Alphitonia petriei	4
Ash, silver	Flindersia bourjotiana, Flindersia schottiana	4
Ash, silvertop	Eucalyptus sieberi	4
Ash, white	Eucalyptus fraxinoides	4
Baltic, red (pine, Scots)	Pinus sylvestris	4
Baltic, white (spruce, Norway)	Picea abies	4
Beech, myrtle	Nothofagus cunninghamii	4
Beech, negrohead	Nothofagus moorei	4
Beech, silver	Nothofagus menziesii	4
Belian	Eusideroxylon zwageri	1
Birch, white, Australia	Schizomeria ovata	4
Blackbutt	Eucalyptus pilularis	3
Blackbutt, New England	Eucalyptus andrewsii, Eucalyptus campanulata	2
Blackbutt, Western Australian	Eucalyptus patens	3
Blackwood	Acacia melanoxylon	4
Bloodwood, red	Corymbia gummifera, Eucalyptus intermedia Eucalyptus polycarpa	3
Bollywood	Cinnamomum baileyanum, Litsea spp.	4
Box, brush	Lophostemon confertus	2
Box, grey	Eucalyptus macrocarpa, Eucalyptus moluccana Eucalyptus woollsiana	2
Box, grey, coast	Eucalyptus bosistoana	3
Box, ironwood	Choricarpia leptopetala Choricarpia subargentea	4
Box, kanuka	Tristania exiliflora, Tristania laurina	4
Box, long-leaved	Eucalyptus goniocalyx	4
Box, swamp	Lophostemon suaveolens	2
Brownbarrel	Eucalyptus fastigata	4
Bullich	Eucalyptus megacarpa	4
Calophyllum	Calophyllum spp.	4
Candlebark	Eucalyptus rubida	4
Carabeen, yellow	Sloanea woolsii	4
Cedar, red	Toona australis	4
Cedar, western red	Thuja plicata	4
Cheesewood, white	Alstonia scholaris	4
Coachwood	Ceratopetalum apetalum	4
Cypress, black	Callitris endlicheri	3
Cypress, white	Callitris glaucophylla	2

Fir, amabilis	Abies amabilis	4
Fir, Douglas (oregon)	Pseudotsuga menziesii	4
Geronggang	Cratoxylon arborescens	4
Gum, blue, southern	Eucalyptus globulus	4
Gum, blue, Sydney	Eucalyptus saligna	3
Gum, grey	Eucalyptus canaliculate, Eucalyptus major Eucalyptus propinqua, Eucalyptus punctata	2
Gum, grey, mountain	Eucalyptus cypellocarpa	4
Gum, Maiden's	Eucalyptus maidenii	4
Gum, manna	Eucalyptus viminalis	4
Gum, mountain	Eucalyptus dalrympleana	4
Gum, pink	Eucalyptus fasciculosa	4
Gum, poplar	Eucalyptus alba	4
Gum, red, forest	Eucalyptus blakelyi, Eucalyptus tereticornis	2
Gum, red, river	Eucalyptus camaldulensis	2
Gum, rose	Eucalyptus grandis	4
Gum, round-leaved	Eucalyptus deanei	4
Gum, shining	Eucalyptus nitens	4
Gum, spotted	Corymbia maculate, Corymbia citriodora Eucalyptus henryi	4
Gum, swamp	Eucalyptus camphora	4
Gum, white, Dunn's	Eucalyptus dunnii	4
Gum, yellow	Eucalyptus leucoxylon	4
Hardwood, Johnston River	Backhousia bancroftii	4
Hemlock, western	Tsuga heterophylla	4
Iroko	Chlorophora excelsa	1
Ironbark, grey	Eucalyptus drepanophylla, Eucalyptus paniculate, Eucalyptus siderophloia	3
Ironbark, red	Eucalyptus sideroxylon	2
Jam, raspberry	Acacia acuminata	2
Jarrah	Eucalyptus marginata	3
Jelutong	Dyera costulata	4
Kamarere	Eucalyptus deglupta	4
Kapur	Dryobalanops spp.	4
Karri	Eucalyptus diversicolor	4
Kauri, New Zealand	Agathis australis	4
Kauri, Queensland	Agathis atropurpurea, Agathis microstachya Agathis robusta	4
Kempas	Koompassia malaccensis	4
Keruing	Dipterocarpus spp.	4
Kwila (merbau)	Intsia bijuga	3
Lumbayau (mengkulang)	Heritiera spp.	4
Mahogany, African	Khaya spp.	4
Mahogany, American	Swietenia mahogani	4
Mahogany, brush	Geissois benthamii	4
Mahogany, red	Eucalyptus pellita, Eucalyptus resinifera	2
Mahogany, red, Philippine,	Shorea spp.	4
Mahogany, southern	Eucalyptus botryoides	4
Mahogany, white	Eucalyptus acmenoides, Eucalyptus tenuipes Eucalyptus umbra subsp. Carnea	2
Malas	Homalium foetidum	4
Mallet, brown	Eucalyptus astringens	4
Malletwood	Rhodamnia argentea, Rhodamnia costata	4

Malletwood, brown	Rhodamnia rubescens	4
Malletwood, silver	Rhodamnia acuminata	4
Mangrove, grey	Avicennia marina	4
Maple, Queensland	Flindersia brayleyana	4
Maple, rose	Cryptocarya erythroxylon	4
Maple, scented	Flindersia laevicarpa	4
Maple, sugar (rock)	Acer saccharum	4
Marri	Corymbia calophylla, Eucalyptus calophylla	4
Meranti, bakau	Shorea spp.	4
Meranti, dark-red	Shorea spp.	4
Meranti, light-red	Shorea spp.	4
Meranti, white	Shorea spp.	4
Meranti, yellow	Shorea spp.	4
Mersawa	Anisoptera spp.	4
Messmate	Eucalyptus obliqua	4
Nyatoh	Palaquium and Payena spp.	4
Oak, silky, northern	Cardwellia sublimis	4
Oak, tulip, blush	Argyrodendron actinophyllum	4
Oak, tulip, brown	Argyrodendron polyandrum Argyrodendron trifoliolatum	4
Oak, tulip, red	Argyrodendron peralatum,	4
Oak, white, American	Quercus alba	4
Paulownia	Paulownia spp.	4
Penda, brown	Xanthostemon chrysanthus	2
Penda, red	Xanthostemon whitei	2
Penda, southern	Xanthostemon, oppositifolius	2
Penda, yellow	Ristantia pachysperma	2
Peppermint, black	Eucalyptus amygdalina	4
Peppermint, broad-leaved	Eucalyptus dives	4
Peppermint, narrow-leaved	Eucalyptus Australiana, Eucalyptus radiata Eucalyptus robertsonii	4
Peppermint, river	Eucalyptus elata	4
Peppermint, white	Eucalyptus pulchella	4
Pine, brown	Podocarpus elatus	3
Pine, bunya	Araucaria bidwillii	4
Pine, Canary Island	Pinus canariensis	4
Pine, Caribbean	Pinus caribaea	4
Pine, celery-top	Phyllocladus asplenifolius	4
Pine, Corsican	Pinus nigra	4
Pine, hoop	Araucaria cunninghamii	4
Pine, Huon	Lagarostrobos franklinii	4
Pine, King William	Athrotaxis selaginoides	4
Pine, klinki	Araucaria hunsteinii	4
Pine, loblolly	Pinus taeda	4
Pine, longleaf	Pinus palustris	4
Pine, maritime	Pinus pinaster	4
Pine, NZ white (kahikatea)	Dacrycarpus dacrydioides	4
Pine, patula	Pinus patula	4
Pine, ponderosa	Pinus ponderosa	4
Pine, radiata	Pinus radiata	4
Pine, Scots	Pinus sylvestris	4

Pine, slash	Pinus elliottii	4
Pine, white, western	Pinus monticola	4
Planchonella	Planchonella chartacea	4
Poplar, balsam	Populus spp.	4
Poplar, pink	Euroschinus falcata	4
Quandong, silver	Elaeocarpus angustifolius, Elaeocarpus grandis	4
Ramin	Gonystylus spp.	4
Redwood	Sequoia sempervirens	4
Rimu	Dacrydium cupressinum	4
Rosewood, New Guinea	Pterocarpus indicus	4
Sassafras	Daphnandra dielsii, Daphnandra micrantha Daphnandra repandula, Doryphora aromatica Doryphora sassafras	4
Satinash, grey	Syzygium claviflorum,, Syzygium gustavioides	4
Satinash, rose	Syzygium crebrinerve, Eugenia francisii	4
Satinay	Syncarpia hillii	1
Sepetir	Copaifera spp., Pseudosindora spp., Sindora spp.	4
Sheoak, beach	Allocasuarina equisetifolia	4
Sheoak, black	Allocasuarina littoralis	4
Silkwood, maple	Flindersia pimenteliana	4
Spruce, Norway	Picea abies	4
Spruce, Sitka	Picea sitchensis	4
Stringybark, blue-leaved	Eucalyptus agglomerata	4
Stringybark, brown	Eucalyptus baxteri, Eucalyptus blaxlandii Eucalyptus capitellata	4
Stringybark, diehard	Eucalyptus cameronii	4
Stringybark, red	Eucalyptus macrorhyncha	3
Stringybark, silvertop	Eucalyptus laevopinea	4
Stringybark, white	Eucalyptus eugenioides, Eucalyptus globoidea Eucalyptus phaeotricha	3
Stringybark, yellow	Eucalyptus muelleriana	3
Sycamore, silver	Cryptocarya glaucescens	4
Tallowwood	Eucalyptus microcorys	3
Taun	Pometia spp.	4
Tea-tree, broad-leaved	Melaleuca leucadendron, Melaleuca quinquenervia, Melaleuca viridiflora	3
Tea-tree, river	Melaleuca bracteata	4
Tingle, red	Eucalyptus jacksonii	4
Touriga, red	Calophyllum costatum	4
Tuart	Eucalyptus gomphocephala	4
Turpentine	Syncarpia glomulifera	1
Walnut, New South Wales	Endiandra virens	4
Walnut, Queensland	Endiandra palmerstonii	4
Walnut, yellow	Beilschmiedia bancroftii	4
Wandoo	Eucalyptus wandoo	3
Yate, swamp	Eucalyptus occidentalis	4

8.3 Hazard Zones

The marine borer attack hazard map produced for Australia is shown in Figure 8.3.1. Values of the representative water climate factor k_{water} for the seven zones are given in Table 8.3.1. These values have been modified to calibrate to field data and expert opinions

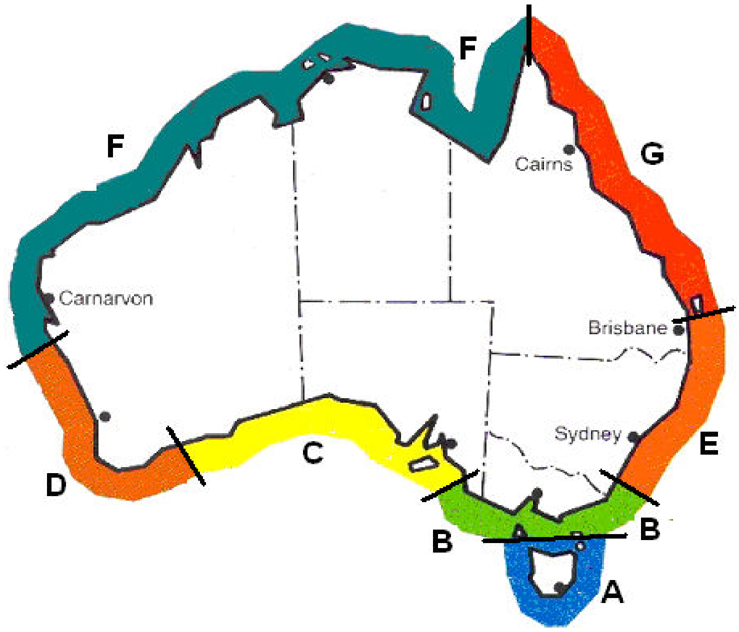


Figure 8.3.1. Marine borer hazard zones. Zone G is the most hazardous.

Table 8.3.1 Definition of hazard coastal zones and water climate index

Hazard Coastal zone	Approximate coastline range		k_{water}
	from (longitude, latitude)	to (longitude, latitude)	
A	Latitude < -40°	Latitude < -40°	0.7
B	(140°, -37°)	(150°, -37°)	0.9
C	(120°, -34°)	(140°, -37°)	1.2
D	(120°, -34°)	(114°, -27°)	1.6
E	(150°, -37°)	(153°, -27°)	2.0
F	(114°, -27°)	(143°, -11°)	3.0
G	(143°, -11°)	(153°, -27°)	3.8

8.4 Attack Patterns

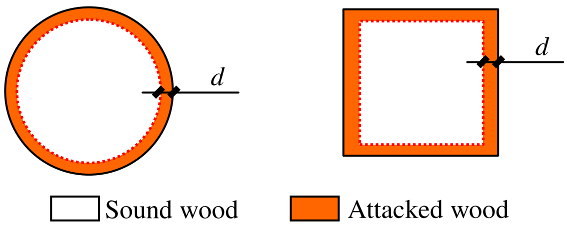


Figure 8.4.1. Attack patterns

8.5 Base Attack Equations

A schematic illustration of the progress of marine borer attack assumed in the model is shown in Figure 8.5.1. It comprises of a time-lag (*lag*) followed by a steady attack rate (*r*). The attack depth of timber, denoted by *d*, after *t* years is given as:

$$d = \begin{cases} 0 & \text{if } t \le lag \\ (t - lag)r & \text{if } t > lag \end{cases} \tag{8.5.1}$$

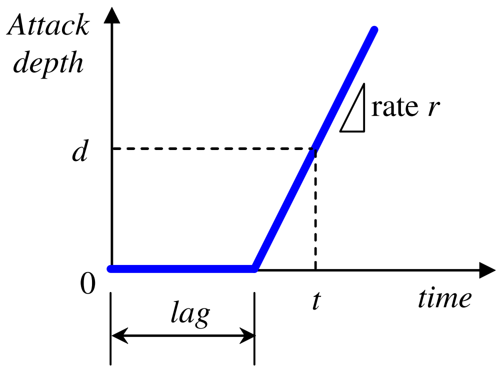


Figure 8.5.1. Basic model of timber attacked by marine borers.

The marine borer attack rate (r) is determined as

$$r = k_0 \, k_{water} \tag{8.5.2}$$

$$k_0 = k_{wood} \, k_{salt} \, k_{shelter} \, k_{protect} \, k_{contact} \, k_{knot} \tag{8.5.3}$$

where,

- k_{water} is climate index in water given in Table 8.3.1, dependent on hazard coastal zones.
- k_{wood} is wood parameter given in Table 8.5.2, dependent on types/classes of materials (timber).
- k_{salt} is salinity parameter. Depending on salinity, sea water is classified into 3 classes having different salinity parameter, as given in Table 8.5.3.
- $k_{shelter}$ is shelter parameter, depending on whether the water is exposed to or sheltered from strong current or surf, as given in Table 8.5.4.
- $k_{protection}$ is protection parameter, depending on the type protection measures, as given in Table 8.5.5.
- $k_{contact}$ is contact parameter, depending on if there is a contact surface with other timber members, as given in Table 8.5.6.
- k_{knot} is knot parameter, depending on if there are big knots with or without protective plates, as given in Table 8.5.7.

The time lag is determined as a function of the rate by the following equation,

$$lag = \begin{cases} 0 & \text{if } r \geq 20 \\ 2.0 - 0.1r & \text{if } r < 20 \end{cases} \tag{8.5.4}$$

For double treated wood, an extra lag of 10 years is added to the above calculated lag.

Table 8.5.2 Wood Parameter k_{wood}

Material		Notation	k_{wood} Zones A to C	k_{wood} Zones D to G
Heartwood*	Class 1	HW1	1.1	1.3
	Class 2	HW2	1.7	5.2
	Class 3	HW3	3.4	8.8
	Class 4	HW4	17.0	25.0
		Notation (treatment level)	**All zones**	
Sapwood of softwood	Untreated	SAPs	40	
	Creosote-treated			
	24 %kg/kg	CR1s (H5)	1.7	
	40 %kg/kg	CR2s (H6)	1.0	
	CCA-treated			
	0.6 %kg/kg	CC0s (H4)	4.7	
	1 %kg/kg	CC1s (H5)	3.0	
	2 %kg/kg	CC2s (H6)	1.8	
	5 %kg/kg	CC3s (>H6)	1.0	
	Double-treated			
	CC2s+CR2s	DBTs (H6)	0.9	
Sapwood of hardwood	Untreated	SAPh	25	
	Creosote-treated			
	13 %kg/kg	CR1h (H5)	0.8	
	22 %kg/kg	CR2h (H6)	0.6	
	CCA-treated			
	0.7 %kg/kg	CC0h (H4)	3.2	
	1.2 %kg/kg	CC1h (H5)	1.8	
	2.4 %kg/kg	CC2h (H6)	1.1	
	Double-treated			
	CC2h+CR2h	DBTh (H6)	0.5	

(*) Heartwood classification is in Section 8.2

Table 8.5.3 Parameter k_{salt} and salinity classification

Salinity Class	Salinity (ppt)	k_{salt} Zones A to D	k_{salt} Zones E to G
1	1-10	0.7	1.0
2	11-25	0.8	1.0
3	26-35	1.0	1.0

Table 8.5.4 Parameter k_{wav} for different water zones

Shelter	$k_{shelter}$
Sheltered from strong current or surf (eg. behind breakwaters, harbour, river, etc.)	1.0
Exposed to strong current and/or surf	0.6

Table 8.5.5 Parameter $k_{protect}$ for maintenance measures

Protection measure	$k_{protect}$
Floating collar or plastic wrap in tidal zone	0.5
None	1.0

Table 8.5.6 Parameter $k_{contact}$ for contact with other timber members

Contact	$k_{contact}$
Contact with other timber member (e.g. X-brace) in tidal zone	2.0
None	1.0

Table 8.5.7 Parameter k_{knot} for presence of knots

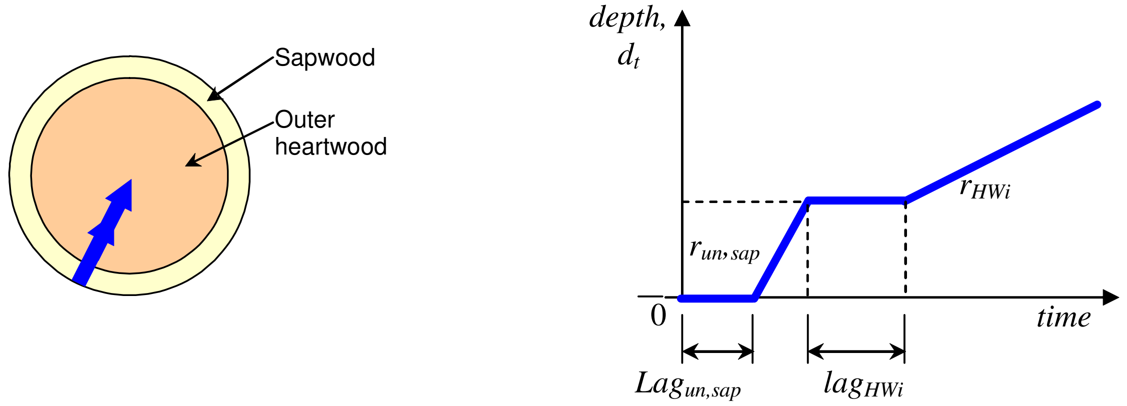
Knot presence	k_{knot}
Having knots without protective plate	2.0
Having knots with protective plate	1.0
None	1.0

Using the base model equations, the following attack rates and time lags for timber can be computed and used for predictions of the attack depths

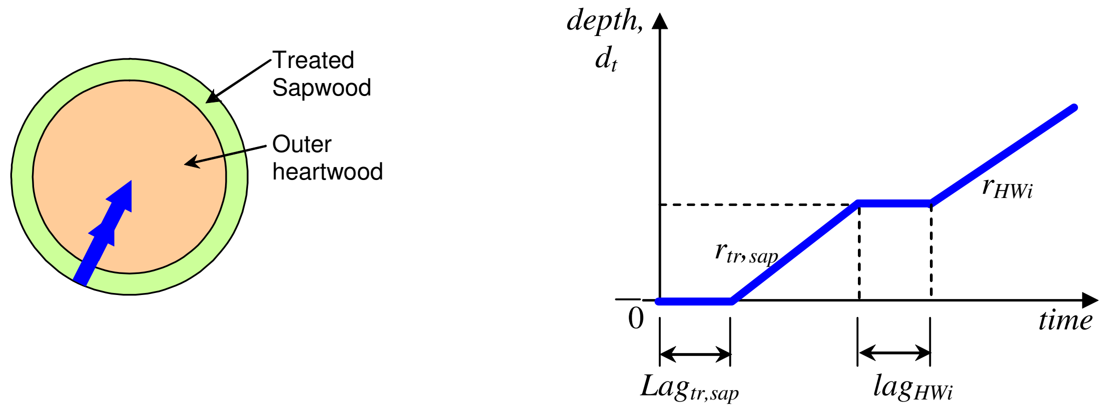
$r_{\mathrm{un,HWi}}$: attack rate on timber of outer heartwood class *i* (mm/year)
$lag_{\mathrm{un,\,HWi}}$: attack time lag on timber of outer heartwood class *i* (years)
$r_{\mathrm{un,sap}}$: attack rate of a clear stake of untreated sapwood (mm/year)
$lag_{\mathrm{un,sap}}$: attack time lag of a clear stake of untreated sapwood (years)
$r_{\mathrm{tr,sap}}$: attack rate of a clear stake of treated sapwood (mm/year)
$lag_{\mathrm{tr,sap}}$: attack time lag of a clear stake of treated sapwood (years)

8.6 Attack Progress for Timber Round Piles

Untreated Pile with Sapwood



Treated Pile



8.7 Design Depth of Marine Borer Attack

The design depth of marine borer attack, d_{design} will be given by

$$d_{design} = d\left(1 + \alpha V_d\right) \tag{8.7.1}$$

where

- d is the mean depth of the loss in cross-section due to marine borer attack, computed by Eq.(8.5.1) for a chosen design life L_{design} time.
- V_d is the coefficient of variation of d. From available data, it is recommended that V_d = 1.5.
- α is specified parameter related to the target reliability level.
  - α = 0.8 for normal consequence of failure elements.
  - α = 0.4 for low consequence of failure elements.

From the design depth of marine borer attack, the residual cross-section is estimated; from which engineers compute the acceptable design load capacity by normal AS1720.1 procedure.

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APPENDIX A

Derivation of the Base Model Equations & Parameters from Clear Specimen Tests

***Parameter k_{wood}* (for the base model in Section 4)**

Parameter k_{wood} is estimated from clear specimen test data using the calibration data in Table C.1b, C.2b, and C.3b. The summary of these data for all 3 sites are in Table A.1. Plots of the typical measured depths vs time are in Figs. A.1, A.2, and A.3 for the 3 test sites, respectively. Note that data in black background in Table A.1 are not reliable because of containing destroyed specimens' data, and hence are not plotted in the Figures.

In each column, normalising the data to the value for HW1 wood type, we get Table A.2. Taking average of all data for each wood type, we get the estimates of k_{wood} for the types of wood as listed in the last column of the Table.

The choice of parameter k_{wood} for each of wood types as presented in Table 4.3.2 are made by referring to both sets of k_{wood}, including that from expert opinions and that in Table A.2 (using clear specimen test data). A summary is in Table A.3.

The value of 0.2 for double treated wood are estimated from a calibration data from field assessment of marine piled structures (see Section 4.2), where the average attack depth on a group of double treated piles was only 4.3 mm after 15 years in service. Moreover, a long lag in the order of more than 10 years was also observed for these piles. An 'extra lag' of 13 years is therefore provisionally introduced to the model.

Climate Index in water k_{water}

By checking the base model with expert opinion data, the climate index is set as presented in Table 4.3.1.

Salinity parameter k_{salt}

The salinity parameter has not been determined properly in the base model. In general, more salty water should have higher value of salinity parameter, indicating more active marine borers attack.

Using the difference of attack between 'brackish site' Port Stephens and 'salty site' Williamstown (both has calm water), the parameter can be estimate for class 2 and class 3. However, since the sites were not in the same coastal zone, the determination of this parameter by the difference is not easy and straightforward. 'Trial and error' technique is used here for best fit of prediction with measurement. The parameter is set as in Table 4.3.3.

Shelter parameter $k_{shelter}$

In general, a calm or sheltered from wave action water zone facilitates more activity of marine borers, whilst a water zone exposed to wave or surf suppresses borers' activity. This is the main reason why the result of borer attack to clear specimens in Williamstown was more severe than that in Geelong, although both sites were located at the same coastal zone (zone 2) with the same salinity class. The specimen test frames at Williamstown were placed behind a breakwater, so that the water was very calm. On the contrary, the test frames at Geelong were placed exposed to wave actions (see Section 1.3).

The shelter parameter are therefore can be estimated by the difference of clear test results between the 2 sites. In Table A.2, average of all attack depths at Williamstown is 4.7 mm, and that of Geelong is 2.6. Set the wave parameter at Williamstown (calm water) as 1, we get the estimate of the parameter at Geelong (exposed to wave) is (2.6/4.7) = 0.6. The values are listed in Table 4.3.4.

Protection parameter $k_{protect}$

In the field assessment calibration data of marine piles as used for reality check in Section 6, there was an expert opinion on the effect of floating collar measure on the service life of marine piles used at Sydney Harbour. In general, the floating collar could double the pile service life. The maintenance parameter therefore can be provisionally set based on this experience. The parameter for piles without any maintenance measure is set as 1.0, and then the parameter for pile with floating collar is 0.5, as listed in Table 4.3.5. This parameter will half the attack rate, and approximately double the predicted service life of piles with floating collar. More information and expert opinions for these notes are recorded in Section 1.3.

Contact parameter $k_{contact}$

As a general observation, and also reflected in the field assessment calibration data of marine piles (Reality checks in Section 6), piles having contact with other timber members, e.g. X-brace will suffer more severe attack from marine borers. The contact locations appear to form a good environment for the borers' activity because it sheltered them from wave and surf actions. More information and expert opinions for these notes are recorded in Section 1.3.
There were records of turpentine piles with 70 years in service in Melbourne, where the typical attack depth of 11 piles without X-brace is 44 mm, and that of 7 piles with X-brace is 102 mm. The parameter is then provisionally set as 1.0 and 2.0 for piles without and with X-brace, respectively, as listed in Table 4.3.6.

Basic lag

The lag equation Eq.(4.3.3) uses a simple linear function. Figure A.4 presents the lag equation curve in comparison with lag values from expert opinions, given in Table A.4.
Moreover, a long lag in the order of more than 10 years was also observed for double treated piles (Section 6), where a group of 18 double treated piles at Port Stephens virtually was not attacked by the borers after 15 years in service. An 'extra lag' of 13 years is therefore introduced to the model.

Table A.1 Average typical values of attack on different wood types at the 3 test sites. Data in dark background are unreliable. Individual data is in Appendix D.

Wood type	Pt. Stephens				Williamstown				Geelong			
	0.8 year	**1.8 years**	**3.1 years**	**4.8 years**	**1 year**	**2 years**	**3 years**	**4.2 years**	**1 year**	**2.1 years**	**3 years**	**4.8 years**
CC1	0.3	0.3	8.3	15.7	0	0.3	4.2	12.8	0	0.3	2.7	7
CC2	0.7	0.7	0.7	2.7	0.3	0.7	1.1	1.1	0	0	0	0
HW1	0.1	0.7	2.2	3	0	0.5	1.6	2.1	0.1	0.6	1.3	1.9
HW2	0.4	1.9	6.4	14.7	0.5	2.3	3.3	4.4	0.2	0.8	1.6	2.4
HW3	0.4	4.5	12.4	23.6	1.5	4.5	5.9	8.9	0.2	1.1	2.6	4
HW4	2.2	14.1	22.2	24.9	5.9	14.7	17.3	20.5	1.2	8	11.4	15.1

Table A.2 Normalised values of Table A.1, and estimates of k_{wood}

Wood type	Pt. Stephens				Williamstown				Geelong				Average (k_{wood})
	0.8 year	**1.8 years**	**3.1 years**	**4.8 years**	**1 year**	**2 years**	**3 years**	**4.2 years**	**1 year**	**2.1 years**	**3 years**	**4.8 years**	
CC1	3.0	0.4	3.8		-	0.6	2.6	6.1	0.0	0.5	2.1	3.7	**2.3**
CC2	7.0	1.0	0.3	0.9	-	1.4	0.7	0.5	0.0	0.0	0.0	0.0	**1.1**
HW1	1.0	1.0	1.0	1.0	-	1.0	1.0	1.0	1.0	1.0	1.0	1.0	**1.0**
HW2	4.0	2.7	2.9	4.9	-	4.6	2.1	2.1	2.0	1.3	1.2	1.3	**2.6**
HW3	4.0	6.4	5.6		-	9.0	3.7	4.2	2.0	1.8	2.0	2.1	**4.1**
HW4	22.0	20.1			-				12.0	13.3			**19.4**

Table A.3 Choice of parameter k_{wood} for different materials and its references

	Material	Notation	Parameter k_{wood}		
			Chosen	Clear specimen test (Table A.2)	Expert opinion**
Untreated	Heartwood*				
	Class 1	HW1	1.0	1.0	1
	Class 2	HW2	2.5	2.6	2
	Class 3	HW3	4.5	4.4	4
	Class 4	HW4	15	19.4	8
	Sapwood	SAP	15		12
Treated	Creosote-treated				
	100 kg/m3	CR1	4		4
	200 kg/m3	CR2	1.0		1.3
	CCA-treated				
	16 kg/m3	CC1	4	2.3	4
	32 kg/m3	CC2	1.0	1.1	1.3
	Double-treated				
	CC2+CR2	DBT	0.2		0.5

(*) Heartwood classification is in Section 3
(**) Expert opinion by L. Cookson at the early stage of the project

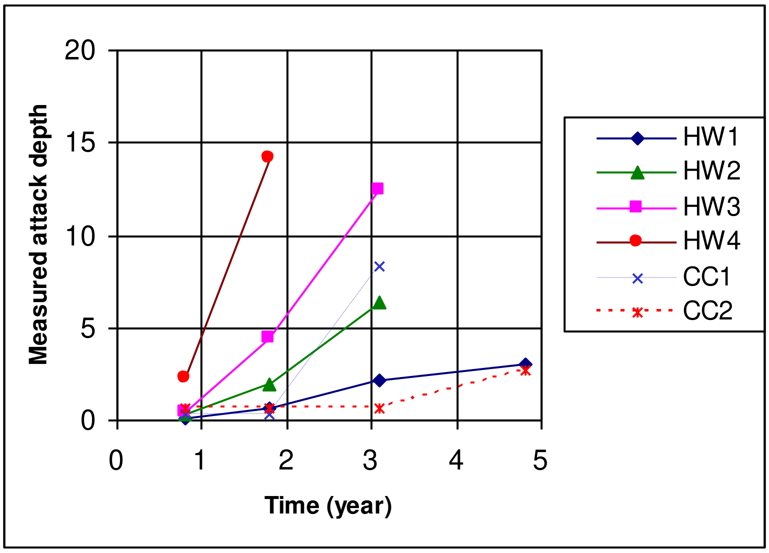

Figure A.1 Average typical values of attack on different wood types vs time at Port Stephens. Data from Table A.1.

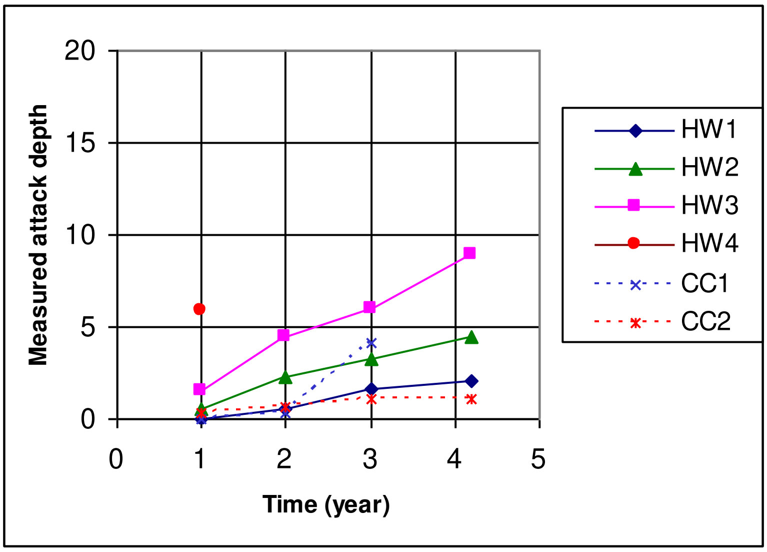

Figure A.2 Average typical values of attack on different wood types vs time at Williamstown. Data from Table A.1.

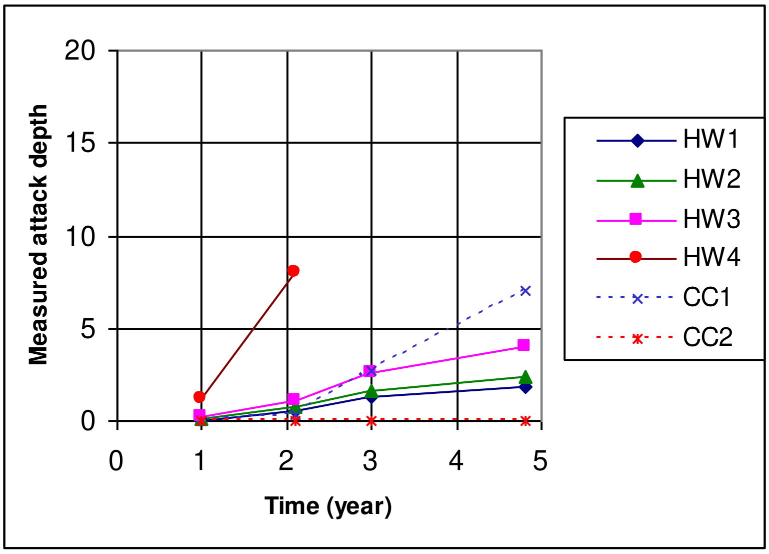

Figure A.3 Average typical values of attack on different wood types vs time at Geelong. Data from Table A.1.

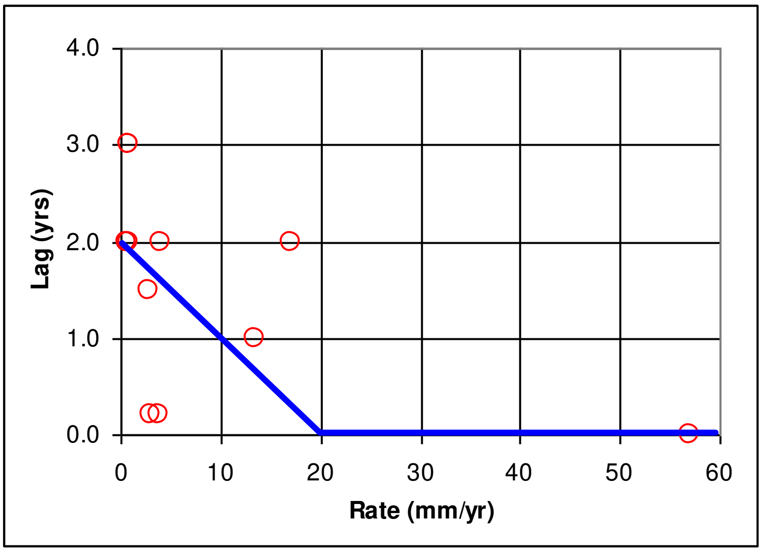

Figure A.4 Lag vs rate from expert opinions (Table A.4) and Eq.(4.3.3).

Table A.4 Summary of data of lag and rate from expert opinions (Cookson, *private communication*)

Material	Coastal Zone	Salinity class	Rate	Lag
CC2	2	1	1.7	2
CC2	2	2	1.3	2
CC2	2	3	1.2	2
CC2	5	1	4.3	1
CC2	5	2	4.3	1
CC2	5	3	4.3	1
HW1	2	1	1.0	2
HW1	2	2	0.6	4
HW1	2	3	0.7	3
HW1	2	3	0.7	2
HW1	5	1	5.6	1
HW1	5	2	5.6	1
HW1	5	3	5.6	1
HW3	2	1	5.6	1
HW3	2	2	3.7	1.5
HW3	2	3	3.8	2
HW3	5	1	12.5	1
HW3	5	2	12.5	1
HW3	5	3	12.5	2
SAP	2	3	10.0	1
SAP	2	3	10.0	1
SAP	5	3	60.0	0.5

APPENDIX B

Derivations of Model Parameters based on Expert Opinions

For the attack model of marine piled structures presented in Section 5, the material parameter k_{wood} was calibrated to the expert opinions provided in Section 2.2. These expert opinions were provided for piles at the following conditions of service

- at full salinity water (salinity class 3)
- at location sheltered from surf / strong current, as at most place where the piles commonly installed
- no protection measure applied, no knot presence, and non contact with other members

Then from the 'service lives' and attack depths provided in Table 2.2.1, the attack rates can be estimated, neglecting the lags. It is for simplifying the procedure since the lags depend on the unknown rates. The next step is to normalise the rates with the corresponding k_{water} of the zones (Table 5.1.2) to estimate the 'primary' parameter k_{wood} for a type of wood in a zone, as shown in Table B1. The parameter k_{wood} for a type of wood is then determined by averaging the 'primary' parameter k_{wood} over the zones, resulting in the Table 5.3.1 of parameter k_{wood} for the model. Note that for sapwood, the parameter k_{wood} was determined for all zones. For heartwood, parameter k_{wood} was determined for 2 groups of zones, including 'A to C' and 'D to G'. The difference of k_{wood} in 2 groups of zones can be noted clearly from the 'primary' k_{wood} in Table A1. This also agrees with expert opinions on the different scales of attacks between the south zones (A to C) and the north zones (D to G) due to different types of active borers (see Section 1.3.12).

An adjustment was made for heartwood class 4 in zones D to G, where the average of primary parameter k_{wood} was 43.5. It is adjusted to 25 as shown in Table 5.3.1, due to the fact that heartwood class four should perform at least as good as untreated sapwood.

A modification was also made for the effect of salinity class in Table 5.3.2. According to expert opinions, the effect of salinity only happens in the south zones, ie. zones A to D, and virtually no effect would be seen in the north zones (see Section 1.3.13).

The knot parameter was set based on expert opinions in Section 1.3.4. Other parameters are the same as in Section 4 with derivation in Appendix A.

To facilitate the calculation for different level of treatment, material parameter k_{wood} for treated wood are fitted with the corresponding data in Table 5.3.1 by the following equations,

* For CCA-treated sapwood of softwood:

$$A = 3.1\ CCA_{retention}^{-0.72};\ A \leq 40 \quad \text{(A1)}$$

* For CCA-treated sapwood of hardwood:

$$A = 2.3\ CCA_{retention}^{-0.86};\ A \leq 25 \quad \text{(A2)}$$

* For Creosote-treated sapwood of softwood:

$$A = 46.1\ Creosote_{retention}^{-1.04};\ A \leq 40 \quad \text{(A3)}$$

* For Creosote-treated sapwood of hardwood:

$$A = 3.3\ Creosote_{retention}^{-0.55};\ A \leq 25 \quad \text{(A4)}$$

Table A1: 'Primary' parameter k_{wood} for each type of wood at each hazard zone

Wood type	Hazard Zone	A	B	C	D	E	F	G
	k_{water}	**0.7**	**0.9**	**1.2**	**1.6**	**2**	**3**	**3.8**
Class 1 heart	-	**1.07**	**1.04**	**1.04**	1.17	**1.17**	1.00	**1.64**
Class 2 heart	-	1.79	**1.67**	1.69	3.91	**4.17**	6.25	6.58
Class 3 heart	-	3.46	**3.33**	3.29	**7.81**	9.38	**8.33**	9.87
Class 4 heart	-	**13.39**	**16.67**	20.83	46.88	37.50	50.00	39.47
Sapwood	Hardwood	21.43	**22.22**	25.00	37.50	**30.00**	20.00	15.79
Sapwood	Softwood	35.71	**37.04**	41.67	62.50	**50.00**	33.33	26.32
CCA hardwood	H4=0.7%	**2.86**	2.78	2.50	**2.34**	**3.00**	**5.00**	**3.95**
	H5=1.2%	1.86	1.85	1.47	**1.25**	**1.50**	**2.50**	**1.97**
	H6=2.4%	1.43	1.33	1.09	**0.94**	**1.00**	1.00	**0.79**
CCA softwood	H4=0.6%	3.76	3.47	**3.21**	3.13	4.17	8.33	6.58
	H5=1.0%	2.86	2.78	2.45	2.08	2.78	3.33	4.39
	H6=2.0%	2.04	1.68	**1.39**	**1.25**	**1.67**	1.67	**2.63**
	5.00%	1.59	1.23	1.04	0.78	1.00	0.56	**0.66**
Creosote hardwood	H5= 13%	1.43	1.19	0.96	0.75	**0.60**	0.43	**0.39**
	H6= 22%	0.86	0.74	0.63	0.54	**0.43**	0.33	**0.32**
Creosote softwood	H5= 24%	2.38	2.06	1.74	2.08	**1.67**	1.11	0.88
	H6= 40%	1.43	1.23	**1.04**	1.25	**1.00**	0.67	0.53
Double treated hardwood	H6	-	-	0.63	0.63	**0.50**	0.50	**0.53**
Double treated softwood	H6	-	-	1.04	1.04	**0.83**	0.83	**0.88**

Bold numbers are data with some backing from in service assessments

APPENDIX C

Processed Data from Clear Specimen Test

This Appendix presents the Calibration data derived from the clear specimen test results. Tables in this Appendix are used for comparative plots in Section 4.4. The individual data of the clear specimen test are presented in Appendix D.

The test results in terms of typical (average) and worst 10%-tile (90%-tile) values of marine borer attacks to the samples of the test specimens of the same species are presented in Tables C.1a, C.2a, and C.3a, respectively for the 3 sites: Port Stephens, Williamstown, and Geelong. Each Table includes the results of the 4 times of inspection at each site. The predicted attack depths on the test specimen using the model in Section 4 are also presented. It is noted that for some samples at a certain inspection, some specimens had been totally destroyed by the borers. The results for these samples are marked with dark background on the Tables. In other words, a result appear within a dark background cell on the Tables should read as ‘more than or equal’ the value provided.

Further grouping the data following their marine borer durability class or type of wood is made for a more general comparison. The typical (average) measured and the predicted attack depth for each of the groups are then obtained and presented in Tables C.1b, C.2b, and C.3b, respectively for the 3 sites. Corresponding predicted attack depths are also provided.

Table C.1a Port Stephens site: Test results and predicted attack depth, following timber species.

No.	Common names	Botanical names	Wood	Sample	0.8 years		1.8 years		3.1 years		4.8 years		Predicted depth			
					Typical	90%-tile	Typical	90%-tile	Typical	90%-tile	Typical	90%-tile	0.8 yr	1.8 yrs	3.1 yrs	4.8 yrs
1	Iroko (African timber)	Chlorophora excelsa	HW1	2	0.0	0.0	1.0	1.8	2.0	2.0	2.0	2.0	0.0	0.0	2.0	4.7
3	Turpentine	Syncarpia glomulifera	HW1	11	0.2	0.0	0.4	2.0	2.4	4.0	4.0	4.0	0.0	0.0	2.0	4.7
2	CCA treated pine 36 kg/m³	P. radiata	CC2	6	0.7	2.0	0.7	2.0	0.7	2.0	2.7	4.0	0.0	0.0	2.0	4.7
4	Grey Gum	E. propinqua	HW2	8	0.5	2.0	1.3	2.0	4.8	9.0	9.9	25.0	0.0	0.8	6.0	12.8
5	River Red Gum	E. camaldulensis	HW2	10	0.2	0.2	0.2	0.2	3.9	4.3	9.0	17.8	0.0	0.8	6.0	12.8
6	White Mahogony	E. acmenoides	HW2	10	0.4	2.0	1.2	2.2	5.5	6.5	11.4	17.8	0.0	0.8	6.0	12.8
7	New England Blackbutt	E. andrewsii	HW2	6	0.7	2.0	4.1	5.3	7.7	12.5	12.7	25.0	0.0	0.8	6.0	12.8
8	Red Ironbark	E. sideroxylon	HW2	10	0.4	2.0	1.0	2.2	7.5	9.0	19.0	25.0	0.0	0.8	6.0	12.8
9	Brush Box	Lophostemon confertus	HW2	6	0.0	0.0	2.8	5.3	5.3	6.5	13.7	23.8	0.0	0.8	6.0	12.8
10	Grey Box	E. moluccana	HW2	10	0.4	2.0	3.1	4.3	8.3	12.5	22.9	25.0	0.0	0.8	6.0	12.8
11	Jarrah	E. marginata	HW2	8	0.3	0.6	2.1	4.8	8.4	12.5	19.0	25.0	0.0	0.8	6.0	12.8
14	CCA treated pine 12 kg/m³	Pinus radiata	CC1	6	0.3	1.0	0.3	1.0	8.3	19.8	15.7	25.0	0.0	2.8	11.1	22.0
13	Tallowwood	E. microcorys	HW3	11	0.5	2.0	3.2	6.5	9.3	12.5	22.9	25.0	0.0	3.7	13.1	25.3
16	Yellow Stringybark (Vic.)	E. muelleriana	HW3	6	0.3	1.0	4.8	6.5	9.2	10.8	25.0	25.0	0.0	3.7	13.1	25.3
17	Grey Ironbark	E. paniculata	HW3	11	0.2	0.0	4.0	6.5	9.8	12.5	23.3	25.0	0.0	3.7	13.1	25.3
12	Blackbutt	E. pilularis	HW3	4	1.0	2.0	4.3	6.5	11.4	21.3	20.4	25.0	0.0	3.7	13.1	25.3
15	Sydney Blue Gum	E. saligna	HW3	6	0.0	0.0	5.3	6.5	20.3	25.0	25.0	25.0	0.0	3.7	13.1	25.3
16	Yellow Stringybark (WA)	E. muelleriana	HW3	10	0.6	2.2	5.1	9.4	14.4	22.8	24.8	25.0	0.0	3.7	13.1	25.3
18	White Stringybark	E. eugenioides	HW4	8	1.0	2.6	5.1	7.3	11.4	19.4	24.4	25.0	19.2	43.2	74.4	115.2
19	Messmate	E. obliqua	HW4	10	1.2	2.2	7.7	13.0	15.9	25.0	25.0	25.0	19.2	43.2	74.4	115.2
20	Flooded Gum	E. grandis	HW4	6	2.0	3.0	14.5	17.0	23.3	25.0	25.0	25.0	19.2	43.2	74.4	115.2
21	Spotted Gum	C. maculata	HW4	6	1.7	3.0	10.3	12.5	23.6	25.0	25.0	25.0	19.2	43.2	74.4	115.2
22	Marri	C. calophylla	HW4	10	1.0	2.2	11.1	17.0	23.4	25.0	25.0	25.0	19.2	43.2	74.4	115.2
23	Mountain Grey Gum	E. cypellocarpa	HW4	8	3.6	4.8	17.3	22.5	25.0	25.0	25.0	25.0	19.2	43.2	74.4	115.2
25	Karri	E. diversicolor	HW4	7	2.3	4.0	19.4	22.5	25.0	25.0	25.0	25.0	19.2	43.2	74.4	115.2
24	Silvertop Ash	E. sieberi	HW4	12	2.5	4.0	15.7	25.0	24.6	25.0	25.0	25.0	19.2	43.2	74.4	115.2
26	Mountain Ash	E. regnans	HW4	10	3.5	4.3	20.5	25.0	25.0	25.0	25.0	25.0	19.2	43.2	74.4	115.2
27	Tasmanian Blue Gum	E. globulus	HW4	10	3.8	6.5	19.8	22.8	25.0	25.0	25.0	25.0	19.2	43.2	74.4	115.2

A dark background value indicates at least one specimen in the sample had been totally destroyed by the borers
Input parameters: Coastal zone 4, Salinity class 2, Water zone is calm/sheltered from wave, no maintenance measure, and no timber contact.
Wood type notations defined in Table 4.3.2.
Predicted depth computed with the base model in Section 4

Table C.1b Port Stephens site: Test results and predicted attack depth, following timber marine borer durability class or type of wood.

Wood type	**Typical measured depth (mm)**				**Predicted depth (mm)**			
	0.8 year	**1.8 years**	**3.1 years**	**4.8 years**	**0.8 year**	**1.8 years**	**3.1 years**	**4.8 years**
CC1	0.3	0.3	8.3	15.7	0.0	2.8	11.1	22.0
CC2	0.7	0.7	0.7	2.7	0.0	0.0	2.0	4.7
HW1	0.1	0.7	2.2	3	0.0	0.0	2.0	4.7
HW2	0.4	1.9	6.4	14.7	0.0	0.8	6.0	12.8
HW3	0.4	4.5	12.4	23.6	0.0	3.7	13.1	25.3
HW4	2.2	14.1	22.2	24.9	19.2	43.2	74.4	115.2

Wood type notations defined in Table 4.3.2.
Shading numbers indicate unreliable values due to many destroyed-specimen data included
Predicted depth computed with the base model in Section 4

Table C.2a Williamstown: Test results and predicted attack depth, following timber species.

No.	Common names	Botanical names	Wood	Sample	1 years		2 years		3 years		4.2 years		Predicted depth			
					Typical	90%-tile	Typical	90%-tile	Typical	90%-tile	Typical	90%-tile	1.0 yr	2.0 yrs	3.0 yrs	4.2 yrs
1	Iroko (African timber)	Chlorophora excelsa	HW1	2	0.0	0.0	0.0	0.0	1.0	1.8	2.0	2.0	0.0	0.1	1.0	2.1
3	Turpentine	Syncarpia glomulifera	HW1	10	0.0	0.0	1.0	2.0	2.2	2.2	2.2	2.2	0.0	0.1	1.0	2.1
2	CCA treated pine 36 kg/m^3	P. radiata	CC2	6	0.3	1.0	0.7	2.0	1.1	3.3	1.1	3.3	0.0	0.1	1.0	2.1
4	Grey Gum	E. propinqua	HW2	9	0.2	0.4	1.1	2.4	2.0	2.9	2.4	4.5	0.0	0.5	2.8	5.5
5	River Red Gum	E. camaldulensis	HW2	10	0.0	0.0	0.4	2.0	1.8	2.2	2.2	4.0	0.0	0.5	2.8	5.5
6	White Mahogony	E. acmenoides	HW2	10	0.4	2.0	2.2	4.0	3.1	4.3	3.7	6.5	0.0	0.5	2.8	5.5
7	New England Blackbutt	E. andrewsii	HW2	6	0.7	2.0	3.3	5.3	3.7	5.3	4.3	7.8	0.0	0.5	2.8	5.5
8	Red Ironbark	E. sideroxylon	HW2	10	0.6	2.0	1.6	4.0	3.3	6.5	4.9	6.8	0.0	0.5	2.8	5.5
9	Brush Box	Lophostemon confertus	HW2	6	1.3	3.0	3.4	6.5	4.9	6.5	8.3	13.0	0.0	0.5	2.8	5.5
10	Grey Box	E. moluccana	HW2	10	0.6	2.0	3.7	6.5	4.4	6.5	5.4	9.0	0.0	0.5	2.8	5.5
11	Jarrah	E. marginata	HW2	8	0.3	0.6	2.6	4.8	3.1	4.8	4.5	7.3	0.0	0.5	2.8	5.5
14	CCA treated pine 12 kg/m^3	Pinus radiata	CC1	6	0.0	0.0	0.3	1.0	4.2	6.5	12.8	25.0	0.0	1.3	4.9	9.2
15	Sydney Blue Gum	E. saligna	HW3	6	1.7	2.0	5.0	9.0	6.9	9.0	9.1	13.0	0.0	1.6	5.7	10.6
16	Yellow Stringybark (WA)	E. muelleriana	HW3	10	1.0	2.0	4.1	6.8	5.9	12.5	9.1	13.8	0.0	1.6	5.7	10.6
12	Blackbutt	E. pilularis	HW3	4	2.0	2.0	4.8	6.5	5.9	8.3	10.5	20.2	0.0	1.6	5.7	10.6
13	Tallowwood	E. microcorys	HW3	11	1.1	2.0	3.7	4.0	5.7	6.5	7.5	9.0	0.0	1.6	5.7	10.6
16	Yellow Stringybark (Vic.)	E. muelleriana	HW3	6	1.7	2.0	4.6	6.5	4.9	7.8	7.9	10.8	0.0	1.6	5.7	10.6
17	Grey Ironbark	E. paniculata	HW3	12	1.5	3.8	4.9	6.5	6.3	6.5	9.3	16.2	0.0	1.6	5.7	10.6
18	White Stringybark	E. eugenioides	HW4	8	2.0	2.6	5.8	8.3	6.1	10.1	9.9	16.3	4.7	18.2	31.7	47.9
19	Messmate	E. obliqua	HW4	10	1.8	2.2	6.4	7.1	6.6	9.4	9.9	17.8	4.7	18.2	31.7	47.9
20	Flooded Gum	E. grandis	HW4	6	2.8	5.3	11.0	17.5	13.5	23.8	18.2	25.0	4.7	18.2	31.7	47.9
21	Spotted Gum	C. maculata	HW4	6	2.7	4.0	9.1	13.0	15.4	23.8	23.7	25.0	4.7	18.2	31.7	47.9
22	Marri	C. calophylla	HW4	11	4.7	12.5	11.0	17.0	14.3	25.0	19.5	25.0	4.7	18.2	31.7	47.9
23	Mountain Grey Gum	E. cypellocarpa	HW4	8	7.0	12.5	14.5	25.0	18.6	25.0	24.4	25.0	4.7	18.2	31.7	47.9
25	Karri	E. diversicolor	HW4	7	9.4	14.3	24.6	25.0	25.0	25.0	25.0	25.0	4.7	18.2	31.7	47.9
26	Mountain Ash	E. regnans	HW4	10	10.3	17.0	20.3	25.0	24.2	25.0	25.0	25.0	4.7	18.2	31.7	47.9
27	Tasmanian Blue Gum	E. globulus	HW4	10	11.6	17.0	23.2	25.0	25.0	25.0	25.0	25.0	4.7	18.2	31.7	47.9
24	Silvertop Ash	E. sieberi	HW4	11	7.0	9.0	21.0	25.0	24.8	25.0	25.0	25.0	4.7	18.2	31.7	47.9

A dark background value indicates at least one specimen in the sample had been totally destroyed by the borers
Input parameters: Coastal zone 2, Salinity class 3, Water zone is 'calm/sheltered from wave', no maintenance measure, and no timber contact.
Wood type notations defined in Table 4.3.2.
Predicted depth computed with the base model in Section 4

Table C.2b Williamstown site: Test results and predicted attack depth, following timber marine borer durability class or type of wood.

Wood type	Typical measured depth (mm)				Predicted depth (mm)			
	1 year	2 years	3 years	4.2 years	1 year	2 years	3 years	4.2 years
CC1	0	0.3	4.2	12.8	0.0	1.3	4.9	9.2
CC2	0.3	0.7	1.1	1.1	0.0	0.1	1.0	2.1
HW1	0	0.5	1.6	2.1	0.0	0.1	1.0	2.1
HW2	0.5	2.3	3.3	4.4	0.0	0.5	2.8	5.5
HW3	1.5	4.5	5.9	8.9	0.0	1.6	5.7	10.6
HW4	5.9	14.7	17.3	20.5	4.7	18.2	31.7	47.9

Wood type notations defined in Table 4.3.2.
Shading numbers indicate unreliable values due to many destroyed-specimen data included
Predicted depth computed with the base model in Section 4

Table C.3a Geelong: Test results and predicted attack depth, following timber species.

No.	Common names	Botanical names	Wood	Sample	1 years		2.1 years		3 years		4.8 years		Predicted depth			
					Typical	90%-tile	Typical	90%-tile	Typical	90%-tile	Typical	90%-tile	1.0 yr	2.1 yrs	3.0 yrs	4.8 yrs
1	Iroko (African timber)	Chlorophora excelsa	HW1	2	0.0	0.0	0.0	0.0	1.0	1.8	1.0	1.8	0.0	0.1	0.6	1.5
3	Turpentine	Syncarpia glomulifera	HW1	9	0.1	0.1	1.1	2.1	1.6	4.0	2.7	6.1	0.0	0.1	0.6	1.5
2	CCA treated pine 36 kg/m³	Pinus radiata	CC2	6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.6	1.5
4	Grey Gum	E. propinqua	HW2	9	0.2	0.4	0.2	0.4	0.7	2.4	1.0	2.6	0.0	0.3	1.5	4.0
5	River Red Gum	E. camaldulensis	HW2	10	0.0	0.0	0.2	0.2	1.0	2.0	1.8	2.0	0.0	0.3	1.5	4.0
6	White Mahogony	E. acmenoides	HW2	10	0.0	0.0	0.8	2.0	1.8	2.2	2.2	4.0	0.0	0.3	1.5	4.0
7	New England Blackbutt	E. andrewsii	HW2	6	0.3	1.0	1.3	2.0	2.0	3.0	3.5	4.0	0.0	0.3	1.5	4.0
8	Red Ironbark	E. sideroxylon	HW2	10	0.0	0.0	0.4	2.0	1.0	2.0	1.5	2.6	0.0	0.3	1.5	4.0
9	Brush Box	Lophostemon confertus	HW2	6	0.7	2.0	2.0	4.0	3.4	5.3	4.5	6.5	0.0	0.3	1.5	4.0
10	Grey Box	E. moluccana	HW2	10	0.0	0.0	0.4	2.0	1.2	2.2	1.8	2.6	0.0	0.3	1.5	4.0
11	Jarrah	E. marginata	HW2	8	0.0	0.0	1.0	2.0	1.8	2.6	2.8	4.0	0.0	0.3	1.5	4.0
14	CCA treated pine 12 kg/m³	Pinus radiata	CC1	6	0.0	0.0	0.3	1.0	2.7	4.0	7.0	9.0	0.0	0.7	2.6	6.5
12	Blackbutt	E. pilularis	HW3	4	1.0	2.0	2.0	3.4	3.0	4.0	5.3	6.5	0.0	0.8	3.0	7.4
13	Tallowwood	E. microcorys	HW3	11	0.0	0.0	0.5	2.0	1.9	4.0	3.0	6.5	0.0	0.8	3.0	7.4
15	Sydney Blue Gum	E. saligna	HW3	6	0.0	0.0	0.7	2.0	1.7	3.0	3.2	5.5	0.0	0.8	3.0	7.4
16	Yellow Stringybark (Vic.)	E. muelleriana	HW3	6	0.0	0.0	1.3	2.0	3.7	4.0	3.7	4.0	0.0	0.8	3.0	7.4
16	Yellow Stringybark (WA)	E. muelleriana	HW3	10	0.2	0.2	1.2	2.0	2.4	4.3	4.1	6.5	0.0	0.8	3.0	7.4
17	Grey Ironbark	E. paniculata	HW3	12	0.0	0.0	0.7	2.0	3.1	6.3	4.9	6.5	0.0	0.8	3.0	7.4
18	White Stringybark	E. eugenioides	HW4	8	0.3	0.6	1.8	2.6	3.3	4.0	4.4	5.3	0.0	7.4	14.7	29.2
19	Messmate	E. obliqua	HW4	10	0.2	0.2	3.4	4.0	4.3	6.5	6.0	6.8	0.0	7.4	14.7	29.2
20	Flooded Gum	E. grandis	HW4	6	1.0	2.0	4.2	7.8	6.1	9.0	9.3	17.5	0.0	7.4	14.7	29.2
21	Spotted Gum	C. maculata	HW4	6	0.3	1.0	1.7	3.0	4.3	6.5	8.2	9.0	0.0	7.4	14.7	29.2
22	Marri	C. calophylla	HW4	10	0.6	2.0	4.4	9.8	9.2	17.8	15.0	25.0	0.0	7.4	14.7	29.2
26	Mountain Ash	E. regnans	HW4	10	2.2	2.2	13.2	22.5	19.0	25.0	22.7	25.0	0.0	7.4	14.7	29.2
23	Mountain Grey Gum	E. cypellocarpa	HW4	8	1.0	2.0	8.5	16.3	11.5	19.4	17.8	25.0	0.0	7.4	14.7	29.2
24	Silvertop Ash	E. sieberi	HW4	12	2.5	4.0	14.3	24.8	17.8	25.0	20.5	25.0	0.0	7.4	14.7	29.2
25	Karri	E. diversicolor	HW4	6	2.0	2.0	14.7	23.8	21.6	25.0	22.5	25.0	0.0	7.4	14.7	29.2
27	Tasmanian Blue Gum	E. globulus	HW4	10	2.0	4.0	14.5	22.8	17.5	25.0	25.0	25.0	0.0	7.4	14.7	29.2

A dark background value indicates at least one specimen in the sample had been totally destroyed by the borers

Input parameters: Coastal zone 2, Salinity class 3, Water zone is 'exposed to wave and surf', no maintenance measure, and no timber contact.

Wood type notations defined in Table 4.3.2.

Predicted depth computed with the base model in Section 4

Table C.3b Geelong site: Test results and predicted attack depth, following timber marine borer durability class or type of wood.

Wood type	**Typical measured depth (mm)**				**Predicted depth (mm)**			
	1 year	**2.1 years**	**3 years**	**4.8 years**	**1 year**	**2.1 years**	**3 years**	**4.8 years**
CC1	0.0	0.3	2.7	7.0	0.0	0.7	2.6	6.5
CC2	0.0	0.0	0.0	0.0	0.0	0.1	0.6	1.5
HW1	0.1	0.6	1.3	1.9	0.0	0.1	0.6	1.5
HW2	0.2	0.8	1.6	2.4	0.0	0.3	1.5	4.0
HW3	0.2	1.1	2.6	4.0	0.0	0.8	3.0	7.4
HW4	1.2	8.0	11.4	15.1	0.0	7.4	14.7	29.2

Wood type notations defined in Table 4.3.2.
Shading numbers indicate unreliable values due to many destroyed-specimen data included
Predicted depth computed with the base model in Section 4

APPENDIX D

Individual Data of Clear Specimen Test

This Appendix contains 3 Tables D.1, D.2, and D.3 of individual data of the clear specimen test at 3 test sites: Port Stephens, Williamstown, and Geelong, respectively. Refer Section 1.1 for details of the test. The individual data here are expressed in terms of attack depths on the specimens assessed at 4 times of inspection. The data were derived from the original inspection data, which were in terms of 'performance rating', using Table 1.1.2 as the conversion rule to the attack depths. Note that an attack depth of 25mm indicates that the specimen has been destroyed by borers at the time of inspection. The original data for the 4th inspection was reported in Cookson & Scown (2003). The original data for the other (earlier) inspections were provided by Dr Cookson (private communication).

In each table, the results of attack depths due to 3 main borers on the specimen (indicated by Block No.) are given at the 4 times of inspection and grouped by timber species. The abbreviations of the timber species are defined in Table D.4. For each sample of a species, number of specimens is counted; and average and 90%-tile values are evaluated for each type of borers. These values are written in the 2 rows in bold font under each group of timber species specimens. In the 1st row, the number at column 'Block' is the number of specimens in the sample; the others are average values of attack depths to the borers and times of inspection of the corresponding column. The 2nd row presents the corresponding 90%-tile values. The maximum values of attack among 3 types of borers are taken as the attack depth for a timber species sample, presented in Tables C.1a, C.2a, and C.3a in Appendix C.

Table D.1: Individual data from Port Stephens test site in terms of average attack depths (mm)

Port Stephens		0.8 year			1.8 years			3.1 years			4.8 years		
Block	**Species**	**Limnoria**	**Teredinid**	**Sphaeroma**	**Limnoria**	**Teredinid**	**Sphaeroma**	**Limnoria**	**Teredinid**	**Sphaeroma**	**Limnoria**	**Teredinid**	**Sphaeroma**
860	BB	0	0	0	0	6.5	0	0	25	0	25	25	25
854	BB	0	0	0	0	2	0	2	4	4	25	25	25
859	BB	0	2	0	0	6.5	0	0	12.5	4	0	22.5	6.5
853	BB	0	2	0	0	2	0	0	4	6.5	2	9	6.5
4		**0.0**	**1.0**	**0.0**	**0.0**	**4.3**	**0.0**	**0.5**	**11.4**	**3.6**	**13.0**	**20.4**	**15.8**
		0.0	**2.0**	**0.0**	**0.0**	**6.5**	**0.0**	**1.4**	**21.3**	**5.8**	**25.0**	**25.0**	**25.0**
573	BG	0	0	0	0	6.5	0	0	25	0	0	25	0
566	BG	0	0	0	0	4	0	0	9	4	0	25	0
580	BG	0	0	0	0	6.5	0	0	25	0	25	25	25
569	BG	0	0	0	0	2	0	0	12.5	4	25	25	25
564	BG	0	0	0	0	6.5	0	0	25	0	25	25	25

579	BG	0	0	0	0	6.5	0	0	25	0	25	25	25
6		**0.0**	**0.0**	**0.0**	**0.0**	**5.3**	**0.0**	**0.0**	**20.3**	**1.3**	**16.7**	**25.0**	**16.7**
		0.0	**0.0**	**0.0**	**0.0**	**6.5**	**0.0**	**0.0**	**25.0**	**4.0**	**25.0**	**25.0**	**25.0**
742	BX	0	0	0	0	0	0	2	4	2	4	6.5	4
735	BX	0	0	0	0	4	0	4	6.5	4	2	12.5	4
729	BX	0	0	0	0	4	0	0	6.5	4	2	22.5	6.5
732	BX	0	0	0	2	2	0	0	4	4	0	25	4
726	BX	0	0	0	0	0	0	4	4	2	4	9	4
741	BX	0	0	0	0	6.5	0	4	6.5	4	9	6.5	9
6		**0.0**	**0.0**	**0.0**	**0.3**	**2.8**	**0.0**	**2.3**	**5.3**	**3.3**	**3.5**	**13.7**	**5.3**
		0.0	**0.0**	**0.0**	**1.0**	**5.3**	**0.0**	**4.0**	**6.5**	**4.0**	**6.5**	**23.8**	**7.8**
878	CCA 12	0	0	0	0	0	0	0	0	0	25	25	25
892	CCA 12	0	0	0	0	0	2	0	0	2	2	0	4
884	CCA 12	0	0	2	0	0	0	4	4	0	25	25	25
874	CCA 12	0	0	0	0	0	0	4	17	4	0	0	4
882	CCA 12	0	0	0	0	0	0	2	22.5	0	17	4	0
885	CCA 12	0	0	0	0	0	0	4	6.5	2	25	0	4
6		**0.0**	**0.0**	**0.3**	**0.0**	**0.0**	**0.3**	**2.3**	**8.3**	**1.3**	**15.7**	**9.0**	**10.3**
		0.0	**0.0**	**1.0**	**0.0**	**0.0**	**1.0**	**4.0**	**19.8**	**3.0**	**25.0**	**25.0**	**25.0**
904	CCA 36	0	0	2	0	0	0	0	0	0	0	0	2
896	CCA 36	0	0	0	0	0	0	0	0	0	0	0	2
914	CCA 36	0	0	0	0	0	2	0	0	2	0	0	2
894	CCA 36	0	0	0	0	0	0	0	0	2	0	0	2
899	CCA 36	0	0	0	0	0	0	0	0	0	0	0	4
910	CCA 36	0	0	2	0	0	2	0	0	0	0	0	4
6		**0.0**	**0.0**	**0.7**	**0.0**	**0.0**	**0.7**	**0.0**	**0.0**	**0.7**	**0.0**	**0.0**	**2.7**
		0.0	**0.0**	**2.0**	**0.0**	**0.0**	**2.0**	**0.0**	**0.0**	**2.0**	**0.0**	**0.0**	**4.0**
554	FG	2	2	0	0	12.5	0	0	25	0	25	25	25
542	FG	0	2	2	2	17	2	2	25	2	25	25	25
547	FG	0	0	0	4	17	0	4	25	0	25	25	25
538	FG	0	2	2	0	6.5	0	0	17	6.5	25	25	25
552	FG	0	4	0	2	17	0	2	25	0	25	25	25
546	FG	0	2	0	0	17	0	0	22.5	0	25	25	25
6		**0.3**	**2.0**	**0.7**	**1.3**	**14.5**	**0.3**	**1.3**	**23.3**	**1.4**	**25.0**	**25.0**	**25.0**
		1.0	**3.0**	**2.0**	**3.0**	**17.0**	**1.0**	**3.0**	**25.0**	**4.3**	**25.0**	**25.0**	**25.0**
126	GB	0	0	0	0	4	0	0	6.5	4	25	25	25
103	GB	0	2	0	0	0	0	4	2	2	0	25	4
129	GB	0	0	0	0	0	0	0	9	4	0	22.5	4
107	GB	0	0	0	0	6.5	0	4	12.5	4	4	9	4
118	GB	0	0	0	0	2	0	2	6.5	4	25	25	25
122	GB	0	2	0	0	4	0	2	9	4	2	22.5	6.5
111	GB	0	0	0	0	4	2	0	6.5	4	25	25	25
128	GB	0	0	0	0	2	0	4	9	4	0	25	0
106	GB	0	0	2	0	4	0	0	9	6.5	25	25	25
102	GB	0	0	0	0	4	0	0	12.5	2	0	25	0

10		**0.0**	**0.4**	**0.2**	**0.0**	**3.1**	**0.2**	**1.6**	**8.3**	**3.9**	**10.6**	**22.9**	**11.9**
		0.0	**2.0**	**0.2**	**0.0**	**4.3**	**0.2**	**4.0**	**12.5**	**4.3**	**25.0**	**25.0**	**25.0**
353	GG	0	0	0	0	2	0	0	9	2	2	6.5	4
372	GG	0	2	0	0	2	0	0	2	2	25	25	25
362	GG	0	0	2	0	0	2	0	4	4	2	9	4
352	GG	0	0	0	0	0	0	2	4	2	0	25	0
357	GG	0	0	0	0	2	0	0	4	2	0	4	4
363	GG	0	0	0	0	2	0	2	9	6.5	0	4	2
344	GG	0	0	0	0	0	0	0	2	2	0	2	2
376	GG	0	2	0	0	2	0	2	4	2	0	4	4
8		**0.0**	**0.5**	**0.3**	**0.0**	**1.3**	**0.3**	**0.8**	**4.8**	**2.8**	**3.6**	**9.9**	**5.6**
		0.0	**2.0**	**0.6**	**0.0**	**2.0**	**0.6**	**2.0**	**9.0**	**4.8**	**8.9**	**25.0**	**10.3**
246	GI	0	0	0	0	4	0	0	9	2	25	25	25
250	GI	0	0	0	0	6.5	0	0	12.5	4	25	25	25
260	GI	0	0	0	0	2	0	4	6.5	2	25	25	25
269	GI	0	0	0	0	2	0	2	6.5	4	0	25	0
240	GI	0	0	0	0	9	0	0	6.5	12.5	0	25	0
257	GI	0	2	0	0	6.5	0	2	17	4	2	22.5	4
259	GI	0	0	0	0	0	0	0	9	2	25	25	25
235	GI	0	0	0	0	2	0	4	6.5	0	25	25	25
267	GI	0	0	0	0	4	0	0	9	4	0	9	2
242	GI	0	0	0	0	2	0	0	12.5	4	25	25	25
247	GI	0	0	0	0	6.5	0	0	12.5	2	0	25	2
11		**0.0**	**0.2**	**0.0**	**0.0**	**4.0**	**0.0**	**1.1**	**9.8**	**3.7**	**13.8**	**23.3**	**14.4**
		0.0	**0.0**	**0.0**	**0.0**	**6.5**	**0.0**	**4.0**	**12.5**	**4.0**	**25.0**	**25.0**	**25.0**
864	IR	0	0	0	0	0	2	0	0	2	0	0	2
863	IR	0	0	0	0	0	0	0	0	2	0	0	2
2		**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**1.0**	**0.0**	**0.0**	**2.0**	**0.0**	**0.0**	**2.0**
		0.0	**0.0**	**0.0**	**0.0**	**0.0**	**1.8**	**0.0**	**0.0**	**2.0**	**0.0**	**0.0**	**2.0**
385	J	0	0	0	0	2	0	4	12.5	2	0	9	6.5
407	J	0	2	0	2	6.5	0	2	12.5	6.5	2	25	4
390	J	0	0	0	0	0	0	2	4	4	0	25	6.5
398	J	0	0	0	0	2	0	0	6.5	4	2	9	6.5
386	J	0	0	0	0	2	0	0	9	4	0	9	6.5
401	J	0	0	0	0	0	2	2	6.5	2	0	25	4
394	J	0	0	2	2	4	0	4	12.5	4	0	25	4
410	J	2	0	0	0	0	2	2	4	6.5	0	25	4
8		**0.3**	**0.3**	**0.3**	**0.5**	**2.1**	**0.5**	**2.0**	**8.4**	**4.1**	**0.5**	**19.0**	**5.3**
		0.6	**0.6**	**0.6**	**2.0**	**4.8**	**2.0**	**4.0**	**12.5**	**6.5**	**2.0**	**25.0**	**6.5**
469	K	0	4	0	6.5	17	0	6.5	25	0	25	25	25
461	K	0	4	0	6.5	22.5	0	6.5	25	0	25	25	25
465	K	0	0	0	4	17	0	4	25	0	25	25	25
452	K	0	4	0	6.5	22.5	0	6.5	25	0	25	25	25
466	K	4	4	0	12.5	17	0	12.5	25	0	25	25	25
462	K	0	0	2	6.5	17	0	6.5	25	0	25	25	25

457	K	2	0	0	9	22.5	0	9	25	0	25	25	25
7		**0.9**	**2.3**	**0.3**	**7.4**	**19.4**	**0.0**	**7.4**	**25.0**	**0.0**	**25.0**	**25.0**	**25.0**
		2.8	**4.0**	**0.8**	**10.4**	**22.5**	**0.0**	**10.4**	**25.0**	**0.0**	**25.0**	**25.0**	**25.0**
429	M	0	0	0	0	4	2	0	25	2	25	25	25
421	M	0	0	0	0	6.5	2	0	17	4	25	25	25
435	M	0	0	2	0	17	0	0	25	0	25	25	25
413	M	0	0	0	2	12.5	0	2	25	0	25	25	25
443	M	0	0	2	0	12.5	0	0	25	0	25	25	25
417	M	0	2	0	0	12.5	0	0	25	0	25	25	25
425	M	0	2	0	0	4	0	4	17	4	25	25	25
434	M	0	4	0	0	12.5	0	0	25	0	25	25	25
442	M	0	2	0	0	17	0	0	25	0	25	25	25
449	M	0	0	2	0	12.5	2	0	25	2	25	25	25
10		**0.0**	**1.0**	**0.6**	**0.2**	**11.1**	**0.6**	**0.6**	**23.4**	**1.2**	**25.0**	**25.0**	**25.0**
		0.0	**2.2**	**2.0**	**0.2**	**17.0**	**2.0**	**2.2**	**25.0**	**4.0**	**25.0**	**25.0**	**25.0**
678	MA	0	4	2	2	22.5	2	2	25	2	25	25	25
649	MA	0	4	2	0	25	2	25	25	25	25	25	25
664	MA	2	4	2	4	22.5	0	4	25	0	25	25	25
657	MA	0	0	4	2	12.5	2	2	25	2	25	25	25
673	MA	0	0	0	2	12.5	4	2	25	4	25	25	25
676	MA	2	4	0	4	17	0	4	25	0	25	25	25
651	MA	2	4	0	6.5	22.5	2	6.5	25	2	25	25	25
662	MA	2	4	2	9	22.5	0	9	25	0	25	25	25
646	MA	2	6.5	2	4	22.5	0	4	25	0	25	25	25
667	MA	2	4	0	4	25	0	25	25	25	25	25	25
10		**1.2**	**3.5**	**1.4**	**3.8**	**20.5**	**1.2**	**8.4**	**25.0**	**6.0**	**25.0**	**25.0**	**25.0**
		2.0	**4.3**	**2.2**	**6.8**	**25.0**	**2.2**	**25.0**	**25.0**	**25.0**	**25.0**	**25.0**	**25.0**
336	MGG	0	6.5	4	2	17	4	2	25	4	25	25	25
317	MGG	0	4	2	0	12.5	2	0	25	2	25	25	25
334	MGG	0	4	6.5	0	22.5	6.5	0	25	6.5	25	25	25
325	MGG	0	0	2	2	12.5	2	2	25	2	25	25	25
321	MGG	0	4	2	2	17	0	2	25	0	25	25	25
328	MGG	0	4	4	4	22.5	0	4	25	0	25	25	25
315	MGG	0	2	0	0	17	4	0	25	4	25	25	25
338	MGG	0	4	2	0	17	0	0	25	0	25	25	25
8		**0.0**	**3.6**	**2.8**	**1.3**	**17.3**	**2.3**	**1.3**	**25.0**	**2.3**	**25.0**	**25.0**	**25.0**
		0.0	**4.8**	**4.8**	**2.6**	**22.5**	**4.8**	**2.6**	**25.0**	**4.8**	**25.0**	**25.0**	**25.0**
501	MS	0	0	0	0	9	0	0	25	0	0	25	12.5
494	MS	0	0	0	0	4	0	2	12.5	6.5	2	25	12.5
506	MS	0	0	4	0	4	0	4	6.5	6.5	25	25	25
474	MS	0	0	0	2	17	0	2	25	0	25	25	25
482	MS	0	4	0	0	6.5	0	0	12.5	4	25	25	25
479	MS	0	2	2	0	9	2	0	25	2	25	25	25
491	MS	0	0	0	0	4	2	0	6.5	6.5	0	25	0
473	MS	0	2	2	0	6.5	0	0	12.5	4	0	25	0
504	MS	0	2	0	0	12.5	0	0	25	0	25	25	25

498	MS	0	2	0	0	4	0	4	9	4	25	25	25
10		**0.0**	**1.2**	**0.8**	**0.2**	**7.7**	**0.4**	**1.2**	**16.0**	**3.4**	**15.2**	**25.0**	**17.5**
		0.0	**2.2**	**2.2**	**0.2**	**13.0**	**2.0**	**4.0**	**25.0**	**6.5**	**25.0**	**25.0**	**25.0**
518	NEB	0	0	0	0	6.5	0	4	12.5	4	2	6.5	6.5
533	NEB	0	0	0	0	4	0	0	4	6.5	0	6.5	9
526	NEB	0	0	2	0	4	0	0	4	2	0	25	0
513	NEB	0	4	0	0	4	0	0	12.5	6.5	25	25	25
525	NEB	0	0	2	0	2	0	0	6.5	2	2	9	4
532	NEB	0	0	0	0	4	0	4	6.5	4	0	4	6.5
6		**0.0**	**0.7**	**0.7**	**0.0**	**4.1**	**0.0**	**1.3**	**7.7**	**4.2**	**4.8**	**12.7**	**8.5**
		0.0	**2.0**	**2.0**	**0.0**	**5.3**	**0.0**	**4.0**	**12.5**	**6.5**	**13.5**	**25.0**	**17.0**
163	RI	0	0	0	0	0	0	2	4	2	2	17	4
139	RI	0	0	0	0	2	0	2	9	0	2	9	4
152	RI	0	0	0	0	0	0	4	6.5	4	25	25	25
157	RI	0	0	0	0	0	0	4	6.5	2	2	12.5	4
145	RI	0	0	0	0	0	0	4	9	4	0	17	2
159	RI	0	0	0	0	0	0	0	6.5	2	0	25	0
147	RI	0	0	0	0	2	0	0	6.5	2	25	25	25
154	RI	0	2	0	0	0	0	4	9	2	2	9	2
141	RI	0	2	0	0	4	0	0	9	6.5	0	25	0
137	RI	0	0	0	0	2	0	0	9	4	0	25	4
10		**0.0**	**0.4**	**0.0**	**0.0**	**1.0**	**0.0**	**2.0**	**7.5**	**2.9**	**5.8**	**19.0**	**7.0**
		0.0	**2.0**	**0.0**	**0.0**	**2.2**	**0.0**	**4.0**	**9.0**	**4.3**	**25.0**	**25.0**	**25.0**
613	RRG	0	0	0	0	0	0	2	4	4	2	6.5	6.5
624	RRG	0	0	0	0	0	0	2	2	4	0	25	17
635	RRG	0	0	0	0	0	0	2	0	6.5	0	17	4
641	RRG	0	0	0	0	0	0	0	2	4	0	4	6.5
629	RRG	0	0	0	0	0	0	0	4	4	2	4	4
630	RRG	0	0	0	0	0	0	2	4	2	0	2	6.5
609	RRG	0	0	0	0	2	0	0	6.5	4	2	9	4
625	RRG	0	0	0	0	0	2	2	4	4	0	9	6.5
617	RRG	0	2	0	0	0	0	0	2	2	2	6.5	6.5
640	RRG	0	0	0	0	0	0	2	4	4	0	6.5	6.5
10		**0.0**	**0.2**	**0.0**	**0.0**	**0.2**	**0.2**	**1.2**	**3.3**	**3.9**	**0.8**	**9.0**	**6.8**
		0.0	**0.2**	**0.0**	**0.0**	**0.2**	**0.2**	**2.0**	**4.3**	**4.3**	**2.0**	**17.8**	**7.6**
3806	SA	0	4	2	4	9	0	4	25	0	25	25	25
3836	SA	0	4	2	2	12.5	0	2	25	0	25	25	25
3824	SA	0	2	0	2	6.5	0	2	22.5	4	25	25	25
3812	SA	2	0	2	4	12.5	0	4	25	0	25	25	25
3830	SA	0	0	0	2	25	2	25	25	25	25	25	25
3818	SA	0	0	0	0	4	0	0	22.5	22.5	25	25	25
3815	SA	2	4	0	4	12.5	0	4	25	0	25	25	25
3827	SA	0	4	0	4	25	0	25	25	25	25	25	25
3821	SA	4	4	0	4	17	0	4	25	0	25	25	25
3833	SA	2	4	0	4	17	0	4	25	0	25	25	25
3809	SA	2	4	0	4	25	0	25	25	25	25	25	25

3803	SA	0	0	0	4	22.5	0	4	25	0	25	25	25
12		**1.0**	**2.5**	**0.5**	**3.2**	**15.7**	**0.2**	**8.6**	**24.6**	**8.5**	**25.0**	**25.0**	**25.0**
		2.0	**4.0**	**2.0**	**4.0**	**25.0**	**0.0**	**25.0**	**25.0**	**25.0**	**25.0**	**25.0**	**25.0**
769	SG	0	0	0	0	6.5	0	4	17	6.5	25	25	25
753	SG	0	2	0	0	9	0	0	25	0	25	25	25
759	SG	0	0	0	2	9	0	2	25	0	25	25	25
768	SG	0	4	2	0	12.5	0	0	25	0	25	25	25
749	SG	0	2	0	0	12.5	0	0	25	0	25	25	25
758	SG	0	2	0	0	12.5	0	0	25	0	25	25	25
6		**0.0**	**1.7**	**0.3**	**0.3**	**10.3**	**0.0**	**1.0**	**23.7**	**1.1**	**25.0**	**25.0**	**25.0**
		0.0	**3.0**	**1.0**	**1.0**	**12.5**	**0.0**	**3.0**	**25.0**	**3.3**	**25.0**	**25.0**	**25.0**
706	T	0	0	0	0	0	0	0	2	2	2	2	4
685	T	0	0	0	0	0	0	0	2	2	0	2	4
696	T	0	0	0	0	0	0	0	2	2	2	2	4
720	T	0	0	0	0	0	2	2	0	4	0	2	4
712	T	0	0	0	0	0	0	0	0	4	0	0	6.5
718	T	0	0	0	0	0	0	2	2	0	2	0	4
683	T	0	2	0	0	0	0	2	4	2	0	0	4
701	T	0	0	0	0	0	0	0	2	2	0	2	4
687	T	0	0	0	0	0	0	0	4	2	0	0	4
691	T	0	0	0	0	0	0	2	2	2	0	0	4
708	T	0	0	0	0	0	2	0	2	4	0	0	2
11		**0.0**	**0.2**	**0.0**	**0.0**	**0.0**	**0.4**	**0.7**	**2.0**	**2.4**	**0.5**	**0.9**	**4.0**
		0.0	**0.0**	**0.0**	**0.0**	**0.0**	**2.0**	**2.0**	**4.0**	**4.0**	**2.0**	**2.0**	**4.0**
800	TBG	0	4	0	2	22.5	0	2	25	0	25	25	25
781	TBG	0	2	0	4	17	0	4	25	0	25	25	25
775	TBG	2	4	0	4	22.5	0	4	25	0	25	25	25
809	TBG	0	0	0	4	22.5	0	4	25	0	25	25	25
790	TBG	0	0	0	2	9	0	2	25	0	25	25	25
805	TBG	0	4	0	4	17	0	4	25	0	25	25	25
789	TBG	4	4	0	4	17	0	4	25	0	25	25	25
780	TBG	4	6.5	0	4	22.5	0	4	25	0	25	25	25
798	TBG	0	6.5	0	4	22.5	0	4	25	0	25	25	25
772	TBG	4	6.5	0	4	25	0	25	25	25	25	25	25
10		**1.4**	**3.8**	**0.0**	**3.6**	**19.8**	**0.0**	**5.7**	**25.0**	**2.5**	**25.0**	**25.0**	**25.0**
		4.0	**6.5**	**0.0**	**4.0**	**22.8**	**0.0**	**6.1**	**25.0**	**2.5**	**25.0**	**25.0**	**25.0**
303	TW	0	0	0	0	0	0	4	6.5	4	2	17	0
310	TW	0	0	0	0	2	0	0	9	6.5	0	25	4
277	TW	0	0	0	0	4	0	2	6.5	4	25	25	25
297	TW	0	0	0	0	4	0	0	6.5	4	25	25	25
288	TW	0	2	0	0	6.5	0	0	12.5	6.5	0	25	0
279	TW	0	0	0	0	2	0	0	4	4	25	25	25
282	TW	0	0	0	0	2	0	4	12.5	4	0	25	4
307	TW	0	0	0	0	2	0	2	6.5	0	0	25	4
275	TW	0	0	0	0	2	0	0	9	6.5	0	25	6.5
295	TW	0	0	0	0	6.5	0	0	17	4	0	22.5	4

299	TW	0	4	0	0	4	0	0	12.5	6.5	0	12.5	4
11		**0.0**	**0.5**	**0.0**	**0.0**	**3.2**	**0.0**	**1.1**	**9.3**	**4.5**	**7.0**	**22.9**	**9.2**
		0.0	**2.0**	**0.0**	**0.0**	**6.5**	**0.0**	**4.0**	**12.5**	**6.5**	**25.0**	**25.0**	**25.0**
183	WM	0	0	0	0	2	0	0	4	4	0	6.5	4
177	WM	0	0	0	0	2	0	0	6.5	6.5	0	6.5	6.5
170	WM	0	0	0	0	0	2	2	4	2	2	12.5	4
187	WM	0	0	2	0	2	0	2	6.5	4	0	25	4
198	WM	0	0	0	0	0	0	0	4	2	0	4	4
166	WM	0	0	0	0	0	2	4	6.5	4	0	4	4
192	WM	0	0	0	0	2	0	4	6.5	4	2	17	4
184	WM	0	0	2	0	0	0	0	6.5	0	2	4	4
179	WM	0	0	0	0	0	0	0	4	4	0	17	4
175	WM	0	0	0	0	4	0	2	6.5	4	0	17	4
10		**0.0**	**0.0**	**0.4**	**0.0**	**1.2**	**0.4**	**1.4**	**5.5**	**3.5**	**0.6**	**11.4**	**4.3**
		0.0	**0.0**	**2.0**	**0.0**	**2.2**	**2.0**	**4.0**	**6.5**	**4.3**	**2.0**	**17.8**	**4.3**
220	WS	0	0	0	0	4	0	2	6.5	4	25	25	25
222	WS	0	0	0	0	2	0	0	6.5	6.5	25	25	25
201	WS	0	0	2	0	4	2	0	17	6.5	2	22.5	6.5
217	WS	0	0	2	0	6.5	0	0	9	6.5	2	22.5	6.5
234	WS	0	0	0	0	2	0	0	4	4	0	25	6.5
200	WS	0	2	0	0	6.5	0	0	6.5	6.5	25	25	25
212	WS	0	2	0	0	9	0	0	25	0	25	25	25
228	WS	0	4	0	0	6.5	0	0	17	6.5	25	25	25
8		**0.0**	**1.0**	**0.5**	**0.0**	**5.1**	**0.3**	**0.3**	**11.4**	**5.1**	**16.1**	**24.4**	**18.1**
		0.0	**2.6**	**2.0**	**0.0**	**7.3**	**0.6**	**0.6**	**19.4**	**6.5**	**25.0**	**25.0**	**25.0**
836	YS	0	0	0	0	4	0	0	17	6.5	25	25	25
844	YS	0	0	0	0	2	0	4	6.5	4	0	25	4
823	YS	0	0	0	0	6.5	0	2	12.5	0	0	22.5	4
816	YS	0	0	0	0	0	0	2	12.5	4	2	25	4
833	YS	0	0	0	0	2	0	4	9	2	25	25	25
830	YS	0	0	0	0	9	0	0	25	0	0	25	0
841	YS	0	0	0	0	6.5	0	0	17	0	25	25	25
822	YS	0	0	0	0	2	0	0	9	4	25	25	25
835	YS	0	4	0	0	12.5	0	0	22.5	4	0	25	4
813	YS	0	2	0	0	6.5	0	2	12.5	4	25	25	25
10		**0.0**	**0.6**	**0.0**	**0.0**	**5.1**	**0.0**	**1.4**	**14.4**	**2.9**	**12.7**	**24.8**	**14.1**
		0.0	**2.2**	**0.0**	**0.0**	**9.4**	**0.0**	**4.0**	**22.8**	**4.3**	**25.0**	**25.0**	**25.0**
598	YSB	0	0	0	0	6.5	0	0	9	6.5	0	25	0
603	YSB	0	0	0	0	4	0	4	9	4	25	25	25
587	YSB	0	0	0	0	6.5	0	2	6.5	4	0	25	4
586	YSB	0	2	0	0	4	0	0	12.5	9	25	25	25
602	YSB	0	0	0	0	4	0	0	9	6.5	25	25	25
592	YSB	0	0	0	0	4	2	4	9	6.5	0	25	0
6		**0.0**	**0.3**	**0.0**	**0.0**	**4.8**	**0.3**	**1.7**	**9.2**	**6.1**	**12.5**	**25.0**	**13.2**
		0.0	**1.0**	**0.0**	**0.0**	**6.5**	**1.0**	**4.0**	**10.8**	**7.8**	**25.0**	**25.0**	**25.0**

Table D.2 Individual data from Williamstown test site in terms of average attack depths (mm)

Williamstown		1 year			2 years			3 years			4.2 years		
Block	**Species**	**Limnoria**	**Teredinid**	**Sphaeroma**	**Limnoria**	**Teredinid**	**Sphaeroma**	**Limnoria**	**Teredinid**	**Sphaeroma**	**Limnoria**	**Teredinid**	**Sphaeroma**
861	BB	2.0	0.0	0.0	4.0	2.0	0.0	4.0	4.0	0.0	4.0	4.0	0.0
850	BB	2.0	0.0	0.0	6.5	6.5	0.0	6.5	6.5	0.0	6.5	9.0	0.0
852	BB	2.0	0.0	0.0	4.0	6.5	0.0	4.0	4.0	0.0	6.5	25.0	0.0
855	BB	2.0	0.0	0.0	4.0	4.0	0.0	6.5	9.0	0.0	4.0	4.0	0.0
4		**2.0**	**0.0**	**0.0**	**4.6**	**4.8**	**0.0**	**5.3**	**5.9**	**0.0**	**5.3**	**10.5**	**0.0**
		2.0	**0.0**	**0.0**	**5.8**	**6.5**	**0.0**	**6.5**	**8.3**	**0.0**	**6.5**	**20.2**	**0.0**
578	BG	2.0	2.0	0.0	4.0	9.0	0.0	4.0	9.0	0.0	4.0	17.0	0.0
560	BG	0.0	0.0	0.0	2.0	4.0	0.0	4.0	6.5	0.0	4.0	6.5	0.0
572	BG	2.0	2.0	0.0	4.0	9.0	0.0	4.0	9.0	0.0	4.0	9.0	0.0
565	BG	0.0	2.0	0.0	2.0	2.0	0.0	4.0	4.0	0.0	4.0	4.0	0.0
568	BG	2.0	2.0	0.0	4.0	4.0	0.0	4.0	9.0	0.0	4.0	9.0	0.0
582	BG	0.0	2.0	0.0	2.0	2.0	0.0	4.0	4.0	0.0	4.0	9.0	0.0
6		**1.0**	**1.7**	**0.0**	**3.0**	**5.0**	**0.0**	**4.0**	**6.9**	**0.0**	**4.0**	**9.1**	**0.0**
		2.0	**2.0**	**0.0**	**4.0**	**9.0**	**0.0**	**4.0**	**9.0**	**0.0**	**4.0**	**13.0**	**0.0**
736	BX	2.0	2.0	0.0	4.0	6.5	0.0	2.0	6.5	0.0	6.5	6.5	0.0
725	BX	0.0	2.0	0.0	4.0	2.0	0.0	4.0	2.0	0.0	6.5	2.0	0.0
743	BX	0.0	0.0	0.0	2.0	0.0	0.0	6.5	0.0	0.0	6.5	4.0	0.0
744	BX	2.0	0.0	0.0	2.0	4.0	0.0	6.5	4.0	0.0	9.0	4.0	0.0
730	BX	0.0	0.0	0.0	2.0	0.0	0.0	4.0	0.0	0.0	4.0	0.0	0.0
734	BX	2.0	4.0	0.0	6.5	6.5	0.0	6.5	6.5	0.0	17.0	12.5	0.0
6		**1.0**	**1.3**	**0.0**	**3.4**	**3.2**	**0.0**	**4.9**	**3.2**	**0.0**	**8.3**	**4.8**	**0.0**
		2.0	**3.0**	**0.0**	**5.3**	**6.5**	**0.0**	**6.5**	**6.5**	**0.0**	**13.0**	**9.5**	**0.0**
883	CCA 12	0.0	0.0	0.0	0.0	0.0	0.0	4.0	4.0	0.0	9.0	4.0	0.0
881	CCA 12	0.0	0.0	0.0	2.0	0.0	0.0	4.0	0.0	0.0	25.0	25.0	0.0
875	CCA 12	0.0	0.0	0.0	0.0	0.0	0.0	6.5	4.0	0.0	9.0	4.0	0.0
891	CCA 12	0.0	0.0	0.0	0.0	0.0	0.0	6.5	4.0	0.0	9.0	4.0	0.0
895	CCA 12	0.0	0.0	0.0	0.0	0.0	0.0	4.0	4.0	0.0	0.0	0.0	0.0
879	CCA 12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	25.0	25.0	0.0
6		**0.0**	**0.0**	**0.0**	**0.3**	**0.0**	**0.0**	**4.2**	**2.7**	**0.0**	**12.8**	**10.3**	**0.0**
		0.0	**0.0**	**0.0**	**1.0**	**0.0**	**0.0**	**6.5**	**4.0**	**0.0**	**25.0**	**25.0**	**0.0**
898	CCA 36	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
901	CCA 36	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
915	CCA 36	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
908	CCA 36	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
905	CCA 36	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3805	CCA 36	0.0	2.0	0.0	4.0	4.0	0.0	4.0	6.5	0.0	4.0	6.5	0.0
6		**0.0**	**0.3**	**0.0**	**0.7**	**0.7**	**0.0**	**0.7**	**1.1**	**0.0**	**0.7**	**1.1**	**0.0**

		0.0	**1.0**	**0.0**	**2.0**	**2.0**	**0.0**	**2.0**	**3.3**	**0.0**	**2.0**	**3.3**	**0.0**
555	FG	2.0	2.0	0.0	6.5	12.5	0.0	6.5	9.0	0.0	25.0	25.0	0.0
543	FG	2.0	0.0	0.0	4.0	6.5	0.0	6.5	22.5	0.0	6.5	25.0	0.0
537	FG	2.0	2.0	0.0	4.0	9.0	0.0	4.0	9.0	0.0	2.0	12.5	0.0
550	FG	2.0	2.0	0.0	4.0	6.5	0.0	25.0	25.0	0.0	6.5	12.5	0.0
551	FG	2.0	4.0	0.0	6.5	22.5	0.0	2.0	9.0	0.0	25.0	25.0	0.0
539	FG	2.0	6.5	0.0	6.5	9.0	0.0	9.0	6.5	0.0	6.5	9.0	0.0
6		**2.0**	**2.8**	**0.0**	**5.3**	**11.0**	**0.0**	**8.8**	**13.5**	**0.0**	**11.9**	**18.2**	**0.0**
		2.0	**5.3**	**0.0**	**6.5**	**17.5**	**0.0**	**17.0**	**23.8**	**0.0**	**25.0**	**25.0**	**0.0**
101	GB	0.0	2.0	0.0	0.0	2.0	0.0	0.0	6.5	0.0	4.0	4.0	0.0
131	GB	0.0	0.0	0.0	2.0	4.0	0.0	4.0	4.0	0.0	4.0	4.0	0.0
117	GB	2.0	0.0	0.0	4.0	6.5	0.0	6.5	6.5	0.0	6.5	9.0	0.0
105	GB	0.0	0.0	0.0	2.0	2.0	0.0	2.0	2.0	0.0	2.0	2.0	0.0
123	GB	0.0	0.0	0.0	0.0	4.0	0.0	4.0	4.0	0.0	4.0	6.5	0.0
132	GB	0.0	2.0	0.0	2.0	4.0	0.0	4.0	4.0	0.0	4.0	9.0	0.0
124	GB	0.0	0.0	0.0	2.0	2.0	0.0	4.0	6.5	0.0	4.0	4.0	0.0
113	GB	2.0	2.0	0.0	0.0	6.5	0.0	2.0	2.0	0.0	2.0	6.5	0.0
108	GB	0.0	0.0	0.0	2.0	2.0	0.0	2.0	6.5	0.0	4.0	2.0	0.0
120	GB	2.0	0.0	0.0	4.0	4.0	0.0	2.0	2.0	0.0	4.0	6.5	0.0
10		**0.6**	**0.6**	**0.0**	**1.8**	**3.7**	**0.0**	**3.1**	**4.4**	**0.0**	**3.9**	**5.4**	**0.0**
		2.0	**2.0**	**0.0**	**4.0**	**6.5**	**0.0**	**4.3**	**6.5**	**0.0**	**4.3**	**9.0**	**0.0**
365	GG	0.0	0.0	0.0	2.0	0.0	0.0	2.0	0.0	0.0	4.0	4.0	0.0
377	GG	0.0	0.0	0.0	2.0	0.0	0.0	4.0	6.5	0.0	2.0	0.0	0.0
355	GG	0.0	2.0	0.0	2.0	4.0	0.0	2.0	2.0	0.0	4.0	6.5	0.0
349	GG	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	2.0	0.0	0.0
342	GG	0.0	0.0	0.0	2.0	2.0	0.0	2.0	2.0	0.0	2.0	2.0	0.0
358	GG	0.0	0.0	0.0	2.0	0.0	0.0	2.0	0.0	0.0	2.0	4.0	0.0
361	GG	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	2.0	0.0	0.0
347	GG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0
373	GG	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	2.0	2.0	0.0
9		**0.0**	**0.2**	**0.0**	**1.1**	**0.7**	**0.0**	**2.0**	**1.2**	**0.0**	**2.4**	**2.1**	**0.0**
		0.0	**0.4**	**0.0**	**2.0**	**2.4**	**0.0**	**2.4**	**2.9**	**0.0**	**4.0**	**4.5**	**0.0**
236	GI	0.0	2.0	0.0	4.0	4.0	0.0	4.0	9.0	0.0	4.0	6.5	0.0
245	GI	2.0	2.0	0.0	4.0	6.5	0.0	4.0	6.5	0.0	4.0	6.5	0.0
268	GI	0.0	4.0	0.0	2.0	6.5	0.0	4.0	6.5	0.0	4.0	17.0	0.0
251	GI	0.0	2.0	0.0	2.0	4.0	0.0	4.0	6.5	0.0	4.0	6.5	0.0
261	GI	0.0	4.0	0.0	2.0	6.5	0.0	4.0	6.5	0.0	4.0	6.5	0.0
237	GI	0.0	0.0	0.0	2.0	4.0	0.0	2.0	4.0	0.0	4.0	6.5	0.0
263	GI	0.0	0.0	0.0	2.0	4.0	0.0	4.0	6.5	0.0	2.0	9.0	0.0
241	GI	0.0	0.0	0.0	0.0	0.0	0.0	4.0	6.5	0.0	25.0	25.0	0.0
270	GI	0.0	2.0	0.0	4.0	9.0	0.0	4.0	6.5	0.0	4.0	9.0	0.0
254	GI	0.0	0.0	0.0	2.0	4.0	0.0	2.0	6.5	0.0	6.5	6.5	0.0
252	GI	0.0	0.0	0.0	4.0	6.5	0.0	2.0	6.5	0.0	6.5	6.5	0.0
256	GI	0.0	2.0	0.0	0.0	4.0	0.0	4.0	4.0	0.0	4.0	6.5	0.0
12		**0.2**	**1.5**	**0.0**	**2.3**	**4.9**	**0.0**	**3.5**	**6.3**	**0.0**	**6.0**	**9.3**	**0.0**
		0.0	**3.8**	**0.0**	**4.0**	**6.5**	**0.0**	**4.0**	**6.5**	**0.0**	**6.5**	**16.2**	**0.0**

865	IR	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	2.0	0.0	0.0
866	IR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0
2		**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**1.0**	**0.0**	**0.0**	**2.0**	**0.0**	**0.0**
		0.0	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**1.8**	**0.0**	**0.0**	**2.0**	**0.0**	**0.0**
393	J	0.0	0.0	0.0	2.0	4.0	0.0	2.0	4.0	0.0	4.0	4.0	0.0
396	J	2.0	0.0	0.0	2.0	4.0	0.0	6.5	6.5	0.0	6.5	4.0	0.0
404	J	0.0	2.0	0.0	2.0	6.5	0.0	4.0	4.0	0.0	9.0	9.0	0.0
381	J	0.0	0.0	0.0	2.0	0.0	0.0	2.0	0.0	0.0	4.0	0.0	0.0
389	J	0.0	0.0	0.0	2.0	2.0	0.0	2.0	4.0	0.0	2.0	2.0	0.0
400	J	0.0	0.0	0.0	2.0	0.0	0.0	2.0	4.0	0.0	4.0	6.5	0.0
382	J	0.0	0.0	0.0	2.0	4.0	0.0	4.0	0.0	0.0	2.0	6.5	0.0
403	J	0.0	0.0	0.0	2.0	0.0	0.0	2.0	2.0	0.0	4.0	4.0	0.0
8		**0.3**	**0.3**	**0.0**	**2.0**	**2.6**	**0.0**	**3.1**	**3.1**	**0.0**	**4.4**	**4.5**	**0.0**
		0.6	**0.6**	**0.0**	**2.0**	**4.8**	**0.0**	**4.8**	**4.8**	**0.0**	**7.3**	**7.3**	**0.0**
468	K	4.0	4.0	0.0	4.0	25.0	0.0	25.0	25.0	0.0	25.0	25.0	0.0
463	K	4.0	9.0	0.0	25.0	25.0	0.0	25.0	25.0	0.0	25.0	25.0	0.0
453	K	0.0	2.0	0.0	4.0	25.0	0.0	25.0	25.0	0.0	25.0	25.0	0.0
451	K	2.0	12.5	0.0	25.0	25.0	0.0	25.0	25.0	0.0	25.0	25.0	0.0
467	K	4.0	9.0	0.0	6.5	22.5	0.0	25.0	25.0	0.0	25.0	25.0	0.0
455	K	2.0	17.0	0.0	25.0	25.0	0.0	25.0	25.0	0.0	25.0	25.0	0.0
459	K	4.0	12.5	0.0	25.0	25.0	0.0	25.0	25.0	0.0	25.0	25.0	0.0
7		**2.9**	**9.4**	**0.0**	**16.4**	**24.6**	**0.0**	**25.0**	**25.0**	**0.0**	**25.0**	**25.0**	**0.0**
		4.0	**14.3**	**0.0**	**25.0**	**25.0**	**0.0**	**25.0**	**25.0**	**0.0**	**25.0**	**25.0**	**0.0**
431	M	2.0	2.0	0.0	4.0	12.5	0.0	4.0	6.5	0.0	4.0	17.0	0.0
424	M	0.0	4.0	0.0	4.0	6.5	0.0	4.0	9.0	0.0	4.0	25.0	0.0
447	M	0.0	12.5	0.0	6.5	17.0	0.0	6.5	17.0	0.0	25.0	25.0	0.0
416	M	2.0	4.0	0.0	4.0	2.0	0.0	4.0	12.5	0.0	4.0	9.0	0.0
440	M	2.0	4.0	0.0	4.0	9.0	0.0	6.5	17.0	0.0	25.0	25.0	0.0
420	M	2.0	4.0	0.0	6.5	12.5	0.0	6.5	6.5	0.0	25.0	25.0	0.0
437	M	2.0	2.0	0.0	4.0	9.0	0.0	25.0	25.0	0.0	25.0	25.0	0.0
412	M	0.0	0.0	0.0	0.0	4.0	0.0	25.0	25.0	0.0	6.5	4.0	0.0
444	M	0.0	0.0	0.0	4.0	6.5	0.0	6.5	22.5	0.0	6.5	9.0	0.0
412	M	4.0	6.5	0.0	6.5	17.0	0.0	6.5	12.5	0.0	25.0	25.0	0.0
428	M	2.0	12.5	0.0	6.5	25.0	0.0	4.0	4.0	0.0	25.0	25.0	0.0
11		**1.5**	**4.7**	**0.0**	**4.5**	**11.0**	**0.0**	**9.0**	**14.3**	**0.0**	**15.9**	**19.5**	**0.0**
		2.0	**12.5**	**0.0**	**6.5**	**17.0**	**0.0**	**25.0**	**25.0**	**0.0**	**25.0**	**25.0**	**0.0**
653	MA	4.0	6.5	0.0	4.0	22.5	0.0	25.0	25.0	0.0	25.0	25.0	0.0
672	MA	4.0	12.5	0.0	4.0	25.0	0.0	25.0	25.0	0.0	25.0	25.0	0.0
665	MA	4.0	17.0	0.0	25.0	6.5	0.0	25.0	25.0	0.0	25.0	25.0	0.0
643	MA	4.0	17.0	0.0	25.0	25.0	0.0	25.0	25.0	0.0	25.0	25.0	0.0
659	MA	4.0	6.5	0.0	25.0	25.0	0.0	25.0	25.0	0.0	25.0	25.0	0.0
679	MA	2.0	6.5	0.0	4.0	25.0	0.0	25.0	25.0	0.0	25.0	25.0	0.0
658	MA	2.0	4.0	0.0	6.5	9.0	0.0	25.0	25.0	0.0	25.0	25.0	0.0
675	MA	2.0	17.0	0.0	6.5	25.0	0.0	25.0	25.0	0.0	25.0	25.0	0.0
671	MA	4.0	9.0	0.0	6.5	22.5	0.0	6.5	17.0	0.0	25.0	25.0	0.0

647	MA	2.0	6.5	0.0	6.5	17.0	0.0	25.0	25.0	0.0	25.0	25.0	0.0
10		**3.2**	**10.3**	**0.0**	**11.3**	**20.3**	**0.0**	**23.2**	**24.2**	**0.0**	**25.0**	**25.0**	**0.0**
		4.0	**17.0**	**0.0**	**25.0**	**25.0**	**0.0**	**25.0**	**25.0**	**0.0**	**25.0**	**25.0**	**0.0**
337	MGG	2.0	0.0	0.0	4.0	12.5	0.0	4.0	17.0	0.0	4.0	22.5	0.0
311	MGG	2.0	9.0	0.0	4.0	9.0	0.0	25.0	25.0	0.0	25.0	25.0	0.0
333	MGG	2.0	9.0	0.0	25.0	25.0	0.0	25.0	25.0	0.0	25.0	25.0	0.0
323	MGG	2.0	2.0	0.0	6.5	6.5	0.0	6.5	12.5	0.0	25.0	25.0	0.0
330	MGG	4.0	12.5	0.0	4.0	17.0	0.0	25.0	25.0	0.0	25.0	25.0	0.0
339	MGG	2.0	2.0	0.0	4.0	4.0	0.0	4.0	12.5	0.0	4.0	22.5	0.0
322	MGG	4.0	12.5	0.0	4.0	25.0	0.0	25.0	25.0	0.0	25.0	25.0	0.0
314	MGG	2.0	9.0	0.0	4.0	17.0	0.0	4.0	6.5	0.0	25.0	25.0	0.0
8		**2.5**	**7.0**	**0.0**	**6.9**	**14.5**	**0.0**	**14.8**	**18.6**	**0.0**	**19.8**	**24.4**	**0.0**
		4.0	**12.5**	**0.0**	**12.1**	**25.0**	**0.0**	**25.0**	**25.0**	**0.0**	**25.0**	**25.0**	**0.0**
505	MS	2.0	0.0	0.0	4.0	4.0	0.0	6.5	6.5	0.0	4.0	9.0	0.0
475	MS	2.0	0.0	0.0	4.0	6.5	0.0	4.0	6.5	0.0	9.0	6.5	0.0
500	MS	2.0	2.0	0.0	4.0	6.5	0.0	6.5	6.5	0.0	6.5	6.5	0.0
488	MS	0.0	0.0	0.0	4.0	6.5	0.0	6.5	9.0	0.0	4.0	9.0	0.0
481	MS	2.0	2.0	0.0	6.5	6.5	0.0	4.0	4.0	0.0	9.0	17.0	0.0
510	MS	2.0	0.0	2.0	4.0	4.0	0.0	6.5	6.5	0.0	6.5	6.5	0.0
486	MS	2.0	4.0	0.0	4.0	12.5	0.0	6.5	4.0	0.0	6.5	25.0	0.0
496	MS	2.0	2.0	0.0	4.0	6.5	0.0	4.0	4.0	0.0	4.0	9.0	0.0
490	MS	2.0	2.0	0.0	6.5	6.5	0.0	6.5	12.5	0.0	6.5	6.5	0.0
477	MS	2.0	0.0	0.0	4.0	4.0	0.0	4.0	6.5	0.0	6.5	4.0	0.0
10		**1.8**	**1.2**	**0.2**	**4.5**	**6.4**	**0.0**	**5.5**	**6.6**	**0.0**	**6.3**	**9.9**	**0.0**
		2.0	**2.2**	**0.2**	**6.5**	**7.1**	**0.0**	**6.5**	**9.4**	**0.0**	**9.0**	**17.8**	**0.0**
531	NEB	0.0	0.0	0.0	2.0	0.0	0.0	4.0	4.0	0.0	4.0	4.0	0.0
521	NEB	2.0	0.0	0.0	4.0	6.5	0.0	4.0	6.5	0.0	4.0	9.0	0.0
516	NEB	0.0	0.0	0.0	4.0	4.0	0.0	4.0	0.0	0.0	4.0	4.0	0.0
522	NEB	2.0	2.0	0.0	4.0	4.0	0.0	4.0	2.0	0.0	4.0	6.5	0.0
512	NEB	0.0	0.0	0.0	2.0	0.0	0.0	2.0	0.0	0.0	2.0	0.0	0.0
534	NEB	0.0	0.0	0.0	4.0	2.0	0.0	4.0	4.0	0.0	4.0	2.0	0.0
6		**0.7**	**0.3**	**0.0**	**3.3**	**2.8**	**0.0**	**3.7**	**2.8**	**0.0**	**3.7**	**4.3**	**0.0**
		2.0	**1.0**	**0.0**	**4.0**	**5.3**	**0.0**	**4.0**	**5.3**	**0.0**	**4.0**	**7.8**	**0.0**
155	RI	0.0	0.0	0.0	0.0	2.0	0.0	4.0	6.5	0.0	2.0	4.0	0.0
143	RI	2.0	2.0	0.0	4.0	4.0	0.0	2.0	2.0	0.0	6.5	4.0	0.0
150	RI	0.0	0.0	0.0	0.0	0.0	0.0	2.0	2.0	0.0	2.0	2.0	0.0
136	RI	0.0	0.0	0.0	2.0	4.0	0.0	2.0	4.0	0.0	2.0	4.0	0.0
160	RI	2.0	0.0	0.0	2.0	2.0	0.0	6.5	4.0	0.0	4.0	9.0	0.0
138	RI	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	2.0	2.0	0.0
148	RI	0.0	0.0	0.0	2.0	0.0	0.0	4.0	6.5	0.0	2.0	4.0	0.0
158	RI	0.0	0.0	0.0	2.0	4.0	0.0	2.0	4.0	0.0	4.0	6.5	0.0
146	RI	0.0	0.0	0.0	2.0	0.0	0.0	2.0	2.0	0.0	6.5	6.5	0.0
164	RI	2.0	0.0	0.0	2.0	0.0	0.0	2.0	2.0	0.0	4.0	6.5	0.0
10		**0.6**	**0.2**	**0.0**	**1.6**	**1.6**	**0.0**	**2.9**	**3.3**	**0.0**	**3.5**	**4.9**	**0.0**
		2.0	**0.2**	**0.0**	**2.2**	**4.0**	**0.0**	**4.3**	**6.5**	**0.0**	**6.5**	**6.8**	**0.0**

632	RRG	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	2.0	0.0	0.0
610	RRG	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	2.0	0.0	0.0
638	RRG	0.0	0.0	0.0	2.0	0.0	0.0	2.0	0.0	0.0	2.0	0.0	0.0
623	RRG	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	2.0	2.0	0.0
616	RRG	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	4.0	0.0	0.0
634	RRG	0.0	0.0	0.0	0.0	0.0	0.0	2.0	2.0	0.0	2.0	0.0	0.0
642	RRG	0.0	0.0	0.0	0.0	0.0	0.0	2.0	4.0	0.0	2.0	4.0	0.0
622	RRG	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	2.0	2.0	0.0
631	RRG	0.0	0.0	0.0	0.0	2.0	0.0	2.0	0.0	0.0	2.0	0.0	0.0
608	RRG	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	2.0	4.0	0.0
10		**0.0**	**0.0**	**0.0**	**0.4**	**0.2**	**0.0**	**1.8**	**0.6**	**0.0**	**2.2**	**1.2**	**0.0**
		0.0	**0.0**	**0.0**	**2.0**	**0.2**	**0.0**	**2.0**	**2.2**	**0.0**	**2.2**	**4.0**	**0.0**
3832	SA	2.0	6.5	0.0	25.0	25.0	0.0	25.0	25.0	0.0	25.0	25.0	0.0
3808	SA	2.0	2.0	0.0	4.0	17.0	0.0	25.0	25.0	0.0	25.0	25.0	0.0
3814	SA	4.0	9.0	0.0	4.0	25.0	0.0	25.0	25.0	0.0	25.0	25.0	0.0
3802	SA	4.0	6.5	0.0	25.0	25.0	0.0	25.0	25.0	0.0	25.0	25.0	0.0
3826	SA	2.0	4.0	0.0	9.0	25.0	0.0	25.0	25.0	0.0	25.0	25.0	0.0
3820	SA	4.0	9.0	0.0	25.0	25.0	0.0	25.0	25.0	0.0	25.0	25.0	0.0
3811	SA	4.0	25.0	0.0	25.0	25.0	0.0	25.0	25.0	0.0	25.0	25.0	0.0
3835	SA	2.0	2.0	0.0	4.0	12.5	0.0	25.0	25.0	0.0	25.0	25.0	0.0
3829	SA	4.0	4.0	0.0	6.5	12.5	0.0	25.0	25.0	0.0	25.0	25.0	0.0
3823	SA	2.0	0.0	0.0	6.5	22.5	0.0	4.0	22.5	0.0	25.0	25.0	0.0
3817	SA	2.0	9.0	0.0	6.5	17.0	0.0	25.0	25.0	0.0	25.0	25.0	0.0
11		**2.9**	**7.0**	**0.0**	**12.8**	**21.0**	**0.0**	**23.1**	**24.8**	**0.0**	**25.0**	**25.0**	**0.0**
		4.0	**9.0**	**0.0**	**25.0**	**25.0**	**0.0**	**25.0**	**25.0**	**0.0**	**25.0**	**25.0**	**0.0**
757	SG	0.0	4.0	0.0	2.0	9.0	0.0	4.0	17.0	0.0	4.0	25.0	0.0
754	SG	0.0	2.0	0.0	4.0	9.0	0.0	25.0	25.0	0.0	25.0	25.0	0.0
767	SG	0.0	4.0	0.0	6.5	17.0	0.0	4.0	12.5	0.0	25.0	25.0	0.0
760	SG	0.0	2.0	0.0	2.0	4.0	0.0	4.0	6.5	0.0	6.5	17.0	0.0
748	SG	0.0	2.0	0.0	4.0	6.5	0.0	4.0	22.5	0.0	6.5	25.0	0.0
763	SG	2.0	2.0	0.0	4.0	9.0	0.0	6.5	9.0	0.0	25.0	25.0	0.0
6		**0.3**	**2.7**	**0.0**	**3.8**	**9.1**	**0.0**	**7.9**	**15.4**	**0.0**	**15.3**	**23.7**	**0.0**
		1.0	**4.0**	**0.0**	**5.3**	**13.0**	**0.0**	**15.8**	**23.8**	**0.0**	**25.0**	**25.0**	**0.0**
705	T	0.0	0.0	0.0	2.0	0.0	0.0	2.0	0.0	0.0	2.0	0.0	0.0
697	T	0.0	0.0	0.0	2.0	0.0	0.0	2.0	0.0	0.0	4.0	0.0	0.0
686	T	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	2.0	0.0	0.0
711	T	0.0	0.0	0.0	2.0	0.0	0.0	4.0	0.0	0.0	2.0	0.0	0.0
717	T	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	2.0	0.0	0.0
693	T	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	2.0	0.0	0.0
713	T	0.0	0.0	0.0	2.0	0.0	0.0	2.0	0.0	0.0	2.0	0.0	0.0
716	T	0.0	0.0	0.0	2.0	0.0	0.0	2.0	0.0	0.0	2.0	0.0	0.0
684	T	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	2.0	0.0	0.0
699	T	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	2.0	0.0	0.0
10		**0.0**	**0.0**	**0.0**	**1.0**	**0.0**	**0.0**	**2.2**	**0.0**	**0.0**	**2.2**	**0.0**	**0.0**
		0.0	**0.0**	**0.0**	**2.0**	**0.0**	**0.0**	**2.2**	**0.0**	**0.0**	**2.2**	**0.0**	**0.0**
771	TBG	4.0	12.5	0.0	25.0	25.0	0.0	25.0	25.0	0.0	25.0	25.0	0.0

782	TBG	2.0	4.0	0.0	25.0	25.0	0.0	25.0	25.0	0.0	25.0	25.0	0.0
788	TBG	4.0	17.0	0.0	4.0	22.5	0.0	25.0	25.0	0.0	25.0	25.0	0.0
802	TBG	2.0	12.5	0.0	25.0	25.0	0.0	25.0	25.0	0.0	25.0	25.0	0.0
810	TBG	2.0	4.0	0.0	6.5	22.5	0.0	25.0	25.0	0.0	25.0	25.0	0.0
779	TBG	2.0	12.5	0.0	25.0	25.0	0.0	25.0	25.0	0.0	25.0	25.0	0.0
776	TBG	4.0	17.0	0.0	25.0	25.0	0.0	25.0	25.0	0.0	25.0	25.0	0.0
793	TBG	2.0	6.5	0.0	4.0	22.5	0.0	25.0	25.0	0.0	25.0	25.0	0.0
797	TBG	4.0	17.0	0.0	4.0	22.5	0.0	25.0	25.0	0.0	25.0	25.0	0.0
803	TBG	2.0	12.5	0.0	4.0	17.0	0.0	25.0	25.0	0.0	25.0	25.0	0.0
10		**2.8**	**11.6**	**0.0**	**14.8**	**23.2**	**0.0**	**25.0**	**25.0**	**0.0**	**25.0**	**25.0**	**0.0**
		4.0	**17.0**	**0.0**	**25.0**	**25.0**	**0.0**	**25.0**	**25.0**	**0.0**	**25.0**	**25.0**	**0.0**
309	TW	0.0	2.0	0.0	4.0	4.0	0.0	4.0	6.5	0.0	4.0	9.0	0.0
296	TW	0.0	2.0	0.0	2.0	2.0	0.0	4.0	17.0	0.0	4.0	6.5	0.0
301	TW	2.0	0.0	0.0	4.0	4.0	0.0	4.0	6.5	0.0	4.0	9.0	0.0
274	TW	0.0	0.0	0.0	2.0	0.0	0.0	4.0	4.0	0.0	4.0	2.0	0.0
283	TW	2.0	2.0	0.0	4.0	4.0	0.0	4.0	2.0	0.0	4.0	6.5	0.0
287	TW	0.0	2.0	0.0	4.0	12.5	0.0	4.0	4.0	0.0	4.0	25.0	0.0
308	TW	0.0	2.0	0.0	2.0	4.0	0.0	4.0	4.0	0.0	4.0	4.0	0.0
302	TW	0.0	2.0	0.0	4.0	2.0	0.0	4.0	6.5	0.0	4.0	4.0	0.0
276	TW	0.0	0.0	0.0	2.0	0.0	0.0	4.0	4.0	0.0	2.0	4.0	0.0
281	TW	2.0	0.0	0.0	2.0	4.0	0.0	4.0	4.0	0.0	4.0	6.5	0.0
293	TW	0.0	0.0	0.0	2.0	4.0	0.0	2.0	4.0	0.0	4.0	6.5	0.0
11		**0.5**	**1.1**	**0.0**	**2.9**	**3.7**	**0.0**	**3.8**	**5.7**	**0.0**	**3.8**	**7.5**	**0.0**
		2.0	**2.0**	**0.0**	**4.0**	**4.0**	**0.0**	**4.0**	**6.5**	**0.0**	**4.0**	**9.0**	**0.0**
196	WM	0.0	2.0	0.0	2.0	0.0	0.0	4.0	2.0	0.0	4.0	4.0	0.0
181	WM	0.0	0.0	0.0	2.0	0.0	0.0	4.0	4.0	0.0	6.5	4.0	0.0
172	WM	0.0	0.0	0.0	4.0	0.0	0.0	2.0	2.0	0.0	4.0	4.0	0.0
169	WM	0.0	0.0	0.0	2.0	2.0	0.0	4.0	2.0	0.0	4.0	2.0	0.0
185	WM	2.0	2.0	0.0	4.0	2.0	0.0	2.0	4.0	0.0	4.0	4.0	0.0
178	WM	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	2.0	0.0	0.0
190	WM	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	2.0	0.0	0.0
173	WM	2.0	0.0	0.0	4.0	2.0	0.0	2.0	2.0	0.0	6.5	4.0	0.0
194	WM	0.0	0.0	0.0	2.0	0.0	0.0	2.0	0.0	0.0	2.0	2.0	0.0
165	WM	0.0	0.0	0.0	2.0	0.0	0.0	6.5	2.0	0.0	2.0	6.5	0.0
10		**0.4**	**0.4**	**0.0**	**2.2**	**0.6**	**0.0**	**3.1**	**1.8**	**0.0**	**3.7**	**3.1**	**0.0**
		2.0	**2.0**	**0.0**	**4.0**	**2.0**	**0.0**	**4.3**	**4.0**	**0.0**	**6.5**	**4.3**	**0.0**
233	WS	2.0	0.0	0.0	4.0	6.5	0.0	4.0	4.0	0.0	6.5	9.0	0.0
216	WS	2.0	2.0	0.0	4.0	6.5	0.0	6.5	12.5	0.0	4.0	6.5	0.0
202	WS	2.0	4.0	0.0	6.5	12.5	0.0	4.0	6.5	0.0	25.0	25.0	0.0
223	WS	2.0	0.0	0.0	4.0	4.0	0.0	6.5	6.5	0.0	4.0	6.5	0.0
209	WS	2.0	0.0	0.0	4.0	2.0	0.0	4.0	2.0	0.0	4.0	4.0	0.0
225	WS	2.0	0.0	0.0	4.0	4.0	0.0	6.5	9.0	0.0	4.0	6.5	0.0
204	WS	2.0	2.0	0.0	4.0	6.5	0.0	4.0	4.0	0.0	6.5	12.5	0.0
231	WS	2.0	0.0	0.0	6.5	4.0	0.0	6.5	4.0	0.0	9.0	9.0	0.0
8		**2.0**	**1.0**	**0.0**	**4.6**	**5.8**	**0.0**	**5.3**	**6.1**	**0.0**	**7.9**	**9.9**	**0.0**
		2.0	**2.6**	**0.0**	**6.5**	**8.3**	**0.0**	**6.5**	**10.1**	**0.0**	**13.8**	**16.3**	**0.0**

842	YS	2.0	0.0	0.0	4.0	4.0	0.0	6.5	12.5	0.0	4.0	6.5	0.0
824	YS	0.0	0.0	0.0	2.0	0.0	0.0	4.0	4.0	0.0	2.0	4.0	0.0
811	YS	2.0	2.0	0.0	6.5	6.5	0.0	2.0	0.0	0.0	25.0	25.0	0.0
827	YS	2.0	2.0	0.0	2.0	9.0	0.0	4.0	4.0	0.0	2.0	12.5	0.0
838	YS	0.0	0.0	0.0	4.0	4.0	0.0	2.0	12.5	0.0	4.0	6.5	0.0
845	YS	0.0	2.0	0.0	2.0	6.5	0.0	2.0	0.0	0.0	4.0	9.0	0.0
834	YS	2.0	0.0	0.0	2.0	4.0	0.0	2.0	4.0	0.0	2.0	6.5	0.0
820	YS	0.0	0.0	0.0	0.0	0.0	0.0	4.0	6.5	0.0	2.0	2.0	0.0
837	YS	0.0	0.0	0.0	2.0	0.0	0.0	4.0	6.5	0.0	4.0	6.5	0.0
818	YS	2.0	2.0	0.0	4.0	6.5	0.0	4.0	9.0	0.0	4.0	12.5	0.0
10		**1.0**	**0.8**	**0.0**	**2.9**	**4.1**	**0.0**	**3.5**	**5.9**	**0.0**	**5.3**	**9.1**	**0.0**
		2.0	**2.0**	**0.0**	**4.3**	**6.8**	**0.0**	**4.3**	**12.5**	**0.0**	**6.1**	**13.8**	**0.0**
601	YSB	2.0	2.0	0.0	4.0	6.5	0.0	4.0	2.0	0.0	6.5	9.0	0.0
588	YSB	2.0	0.0	0.0	4.0	6.5	0.0	4.0	4.0	0.0	6.5	12.5	0.0
595	YSB	2.0	2.0	0.0	4.0	2.0	0.0	4.0	6.5	0.0	4.0	6.5	0.0
605	YSB	0.0	0.0	0.0	4.0	4.0	0.0	4.0	4.0	0.0	4.0	6.5	0.0
590	YSB	2.0	2.0	0.0	4.0	6.5	0.0	4.0	4.0	0.0	4.0	9.0	0.0
596	YSB	2.0	0.0	0.0	4.0	2.0	0.0	4.0	9.0	0.0	4.0	4.0	0.0
6		**1.7**	**1.0**	**0.0**	**4.0**	**4.6**	**0.0**	**4.0**	**4.9**	**0.0**	**4.8**	**7.9**	**0.0**
		2.0	**2.0**	**0.0**	**4.0**	**6.5**	**0.0**	**4.0**	**7.8**	**0.0**	**6.5**	**10.8**	**0.0**

Table D.3 Individual data from Geelong test site in terms of average attack depths (mm)

Geelong		**1 year**			**2.1 years**			**3 years**			**4.8 years**		
Block	**Species**	**Limnoria**	**Teredinid**	**Sphaeroma**	**Limnoria**	**Teredinid**	**Sphaeroma**	**Limnoria**	**Teredinid**	**Sphaeroma**	**Limnoria**	**Teredinid**	**Sphaeroma**
848	BB	2	0	0	4	2	0	4	4	0	6.5	6.5	0
851	BB	2	0	0	2	0	0	4	4	0	6.5	4	0
857	BB	0	0	0	2	0	0	2	0	0	4	0	0
856	BB	0	0	0	0	0	0	2	0	0	4	2	0
4		**1.0**	**0.0**	**0.0**	**2.0**	**0.5**	**0.0**	**3.0**	**2.0**	**0.0**	**5.3**	**3.1**	**0.0**
		2.0	**0.0**	**0.0**	**3.4**	**1.4**	**0.0**	**4.0**	**4.0**	**0.0**	**6.5**	**5.8**	**0.0**
576	BG	0	0	0	2	0	0	2	0	0	2	0	0
563	BG	0	0	0	0	0	0	2	0	0	4	0	0
577	BG	0	0	0	0	0	0	2	2	0	4	4	0
570	BG	0	0	0	0	0	0	0	0	0	4	6.5	0
567	BG	0	0	0	2	0	0	2	4	0	2	4	0
559	BG	0	0	0	0	0	0	2	0	0			
6		**0.0**	**0.0**	**0.0**	**0.7**	**0.0**	**0.0**	**1.7**	**1.0**	**0.0**	**3.2**	**2.9**	**0.0**
		0.0	**0.0**	**0.0**	**2.0**	**0.0**	**0.0**	**2.0**	**3.0**	**0.0**	**4.0**	**5.5**	**0.0**
724	BX	0	0	0	0	0	0	2	0	0	2	0	0
728	BX	0	0	0	2	0	0	2	0	0	4	0	0
745	BX	0	0	0	2	0	0	4	0	0	4	0	0
731	BX	0	0	0	0	0	0	2	2	0	4	2	0

746	BX	2	0	0	4	0	0	4	0	0	6.5	0	0
737	BX	2	0	0	4	0	0	6.5	4	0	6.5	4	0
6		**0.7**	**0.0**	**0.0**	**2.0**	**0.0**	**0.0**	**3.4**	**1.0**	**0.0**	**4.5**	**1.0**	**0.0**
		2.0	**0.0**	**0.0**	**4.0**	**0.0**	**0.0**	**5.3**	**3.0**	**0.0**	**6.5**	**3.0**	**0.0**
880	CCA 12	0	0	0	0	0	0	4	0	0	6.5	0	0
871	CCA 12	0	0	0	0	0	0	2	0	0	4	0	0
869	CCA 12	0	0	0	0	0	0	4	0	0	9	4	0
887	CCA 12	0	0	0	0	0	0	0	0	0	6.5	4	0
870	CCA 12	0	0	0	0	0	0	2	0	0	9	9	0
873	CCA 12	0	0	0	2	0	0	4	0	0			
6		**0.0**	**0.0**	**0.0**	**0.3**	**0.0**	**0.0**	**2.7**	**0.0**	**0.0**	**7.0**	**3.4**	**0.0**
		0.0	**0.0**	**0.0**	**1.0**	**0.0**	**0.0**	**4.0**	**0.0**	**0.0**	**9.0**	**7.0**	**0.0**
917	CCA 36	0	0	0	0	0	0	0	0	0	0	0	0
893	CCA 36	0	0	0	0	0	0	0	0	0	0	0	0
906	CCA 36	0	0	0	0	0	0	0	0	0	0	0	0
907	CCA 36	0	0	0	0	0	0	0	0	0	0	0	0
911	CCA 36	0	0	0	0	0	0	0	0	0	0	0	0
916	CCA 36	0	0	0	0	0	0	0	0	0			
6		**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
		0.0	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
549	FG	0	0	0	2	0	0	4	6.5	0	4	6.5	0
540	FG	0	0	0	4	9	0	4	9	0	4	12.5	0
557	FG	2	4	0	4	6.5	0	6.5	9	0	9	22.5	0
541	FG	2	0	0	6.5	4	0	6.5	4	0	2	4	0
553	FG	2	0	0	6.5	2	0	6.5	4	0	6.5	6.5	0
544	FG	0	0	0	2	2	0	4	4	0	6.5	4	0
6		**1.0**	**0.7**	**0.0**	**4.2**	**3.9**	**0.0**	**5.3**	**6.1**	**0.0**	**5.3**	**9.3**	**0.0**
		2.0	**2.0**	**0.0**	**6.5**	**7.8**	**0.0**	**6.5**	**9.0**	**0.0**	**7.8**	**17.5**	**0.0**
130	GB	0	0	0	0	0	0	0	0	0	0	2	0
119	GB	0	0	0	2	0	0	2	0	0	4	0	0
125	GB	0	0	0	0	0	0	0	2	0	2	2	0
121	GB	0	0	0	2	0	0	4	0	0	2	0	0
110	GB	0	0	0	0	0	0	0	2	0	2	2	0
116	GB	0	0	0	0	0	0	0	0	0	2	2	0
109	GB	0	0	0	0	0	0	2	0	0	0	2	0
134	GB	0	0	0	0	0	0	2	2	0	2	4	0
104	GB	0	0	0	0	0	0	0	2	0			
114	GB	0	0	0	0	0	0	2	2	0			
10		**0.0**	**0.0**	**0.0**	**0.4**	**0.0**	**0.0**	**1.2**	**1.0**	**0.0**	**1.8**	**1.8**	**0.0**
		0.0	**0.0**	**0.0**	**2.0**	**0.0**	**0.0**	**2.2**	**2.0**	**0.0**	**2.6**	**2.6**	**0.0**
366	GG	2	0	0	2	0	0	2	0	0	2	2	0
348	GG	0	0	0	0	0	0	2	0	0	0	0	0
375	GG	0	0	0	0	0	0	0	0	0	0	2	0
354	GG	0	0	0	0	0	0	0	2	0	0	0	0
369	GG	0	0	0	0	0	0	0	0	0	2	0	0

346	GG	0	0	0	0	0	0	0	0	0	2	4	0
343	GG	0	0	0	0	0	0	2	4	0	0	0	0
356	GG	0	0	0	0	0	0	0	0	0	0	0	0
378	GG	0	0	0	0	0	0	0	0	0			
9		**0.2**	**0.0**	**0.0**	**0.2**	**0.0**	**0.0**	**0.7**	**0.7**	**0.0**	**0.8**	**1.0**	**0.0**
		0.4	**0.0**	**0.0**	**0.4**	**0.0**	**0.0**	**2.0**	**2.4**	**0.0**	**2.0**	**2.6**	**0.0**
272	GI	0	0	0	0	0	0	2	4	0	2	4	0
271	GI	0	0	0	2	2	0	2	4	0	2	4	0
248	GI	0	0	0	2	0	0	2	0	0	4	6.5	0
249	GI	0	0	0	0	2	0	2	2	0	4	4	0
239	GI	0	0	0	2	0	0	2	4	0	0	4	0
244	GI	0	0	0	0	0	0	0	0	0	2	4	0
262	GI	0	0	0	0	2	0	2	4	0	4	9	0
255	GI	0	0	0	2	0	0	2	6.5	0	2	6.5	0
258	GI	0	0	0	0	0	0	2	4	0	2	4	0
264	GI	0	0	0	0	0	0	4	2	0	2	4	0
243	GI	0	0	0	0	2	0	2	6.5	0	0	4	0
238	GI	0	0	0	0	0	0	0	0	0			
12		**0.0**	**0.0**	**0.0**	**0.7**	**0.7**	**0.0**	**1.8**	**3.1**	**0.0**	**2.2**	**4.9**	**0.0**
		0.0	**0.0**	**0.0**	**2.0**	**2.0**	**0.0**	**2.0**	**6.3**	**0.0**	**4.0**	**6.5**	**0.0**
867	IR	0	0	0	0	0	0	0	0	0	0	0	0
868	IR	0	0	0	0	0	0	2	0	0	2	0	0
2		**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**1.0**	**0.0**	**0.0**	**1.0**	**0.0**	**0.0**
		0.0	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**1.8**	**0.0**	**0.0**	**1.8**	**0.0**	**0.0**
402	J	0	0	0	2	0	0	2	0	0	2	0	0
399	J	0	0	0	0	0	0	0	0	0	2	0	0
391	J	0	0	0	2	0	0	4	0	0	2	2	0
383	J	0	0	0	0	0	0	2	0	0	4	0	0
408	J	0	0	0	2	0	0	2	2	0	4	0	0
409	J	0	0	0	2	0	0	2	0	0			
388	J	0	0	0	0	0	0	0	0	0			
380	J	0	0	0	0	0	0	2	0	0			
8		**0.0**	**0.0**	**0.0**	**1.0**	**0.0**	**0.0**	**1.8**	**0.3**	**0.0**	**2.8**	**0.4**	**0.0**
		0.0	**0.0**	**0.0**	**2.0**	**0.0**	**0.0**	**2.6**	**0.6**	**0.0**	**4.0**	**1.2**	**0.0**
458	K	2	2	0	4	22.5	0	25	25	0	25	25	0
454	K	2	0	0	9	6.5	0	9	12.5	0	9	12.5	0
470	K	2	0	0	9	9	0	9	17	0	25	25	0
456	K	2	0	0	9	12.5	0	9	25	0	25	25	0
464	K	2	0	0	22.5	12.5	0	25	25	0	25	25	0
460	K	2	0	0	6.5	25	0	25	25	0			
6		**2.0**	**0.3**	**0.0**	**10.0**	**14.7**	**0.0**	**17.0**	**21.6**	**0.0**	**21.8**	**22.5**	**0.0**
		2.0	**1.0**	**0.0**	**15.8**	**23.8**	**0.0**	**25.0**	**25.0**	**0.0**	**25.0**	**25.0**	**0.0**
411	M	2	0	0	4	9	0	6.5	17	0	25	25	0
445	M	2	0	0	2	2	0	4	6.5	0	6.5	12.5	0
448	M	0	0	0	2	4	0	4	6.5	0	4	25	0

419	M	2	0	0	4	4	0	6.5	9	0	25	25	0
427	M	0	0	0	6.5	17	0	25	25	0	25	25	0
439	M	0	0	0	2	0	0	2	4	0	4	6.5	0
436	M	0	0	0	2	4	0	4	6.5	0	6.5	9	0
423	M	0	0	0	0	4	0	2	4	0	4	6.5	0
415	M	0	0	0	2	0	0	2	6.5	0	4	6.5	0
432	M	0	0	0	4	0	0	6.5	6.5	0	6.5	9	0
10		**0.6**	**0.0**	**0.0**	**2.9**	**4.4**	**0.0**	**6.3**	**9.2**	**0.0**	**11.1**	**15.0**	**0.0**
		2.0	**0.0**	**0.0**	**4.3**	**9.8**	**0.0**	**8.3**	**17.8**	**0.0**	**25.0**	**25.0**	**0.0**
648	MA	2	0	0	12.5	22.5	0	25	25	0	25	25	0
644	MA	2	0	0	6.5	22.5	0	25	25	0	9	17	0
652	MA	2	0	0	2	6.5	0	9	17	0	25	25	0
660	MA	4	0	0	12.5	17	0	12.5	22.5	0	25	25	0
669	MA	2	0	0	6.5	6.5	0	6.5	12.5	0	9	12.5	0
654	MA	2	0	0	4	4	0	6.5	6.5	0	25	25	0
677	MA	2	0	0	9	9	0	9	22.5	0	25	25	0
661	MA	2	0	0	9	22.5	0	9	25	0	25	25	0
670	MA	2	0	0	12.5	12.5	0	12.5	17	0	25	25	0
680	MA	2	0	0	6.5	9	0	2	17	0			
10		**2.2**	**0.0**	**0.0**	**8.1**	**13.2**	**0.0**	**11.7**	**19.0**	**0.0**	**21.4**	**22.7**	**0.0**
		2.2	**0.0**	**0.0**	**12.5**	**22.5**	**0.0**	**25.0**	**25.0**	**0.0**	**25.0**	**25.0**	**0.0**
327	MGG	2	0	0	6.5	12.5	0	9	17	0	25	25	0
340	MGG	0	0	0	4	0	0	4	6.5	0	9	9	0
319	MGG	0	0	0	4	4	0	6.5	6.5	0	9	22.5	0
312	MGG	0	0	0	6.5	9	0	6.5	12.5	0	9	12.5	0
313	MGG	2	0	0	6.5	9	0	6.5	9	0	25	25	0
332	MGG	2	0	0	4	25	0	25	25	0	4	12.5	0
320	MGG	2	0	0	6.5	6.5	0	6.5	9	0			
335	MGG	0	0	0	2	2	0	2	6.5	0			
8		**1.0**	**0.0**	**0.0**	**5.0**	**8.5**	**0.0**	**8.3**	**11.5**	**0.0**	**13.5**	**17.8**	**0.0**
		2.0	**0.0**	**0.0**	**6.5**	**16.3**	**0.0**	**13.8**	**19.4**	**0.0**	**25.0**	**25.0**	**0.0**
480	MS	0	0	0	4	4	0	6.5	4	0	6.5	6.5	0
485	MS	0	0	0	4	4	0	4	6.5	0	6.5	6.5	0
476	MS	0	0	0	4	0	0	4	4	0	6.5	6.5	0
472	MS	2	0	0	4	0	0	4	4	0	6.5	4	0
507	MS	0	0	0	4	0	0	4	0	0	4	0	0
495	MS	0	0	0	4	0	0	4	0	0	6.5	4	0
487	MS	0	0	0	2	0	0	4	0	0	4	2	0
497	MS	0	0	0	2	0	0	4	4	0	6.5	6.5	0
509	MS	0	0	0	2	0	0	4	6.5	0	6.5	9	0
489	MS	0	0	0	4	0	0	4	4	0	6.5	4	0
10		**0.2**	**0.0**	**0.0**	**3.4**	**0.8**	**0.0**	**4.3**	**3.3**	**0.0**	**6.0**	**4.9**	**0.0**
		0.2	**0.0**	**0.0**	**4.0**	**4.0**	**0.0**	**4.3**	**6.5**	**0.0**	**6.5**	**6.8**	**0.0**
515	NEB	0	0	0	2	0	0	2	0	0	2	0	0
529	NEB	0	0	0	0	0	0	2	0	0	4	2	0
528	NEB	0	0	0	2	0	0	2	0	0	4	4	0

511	NEB	0	0	0	2	0	0	2	2	0	4	0	0
524	NEB	2	0	0	2	0	0	2	4	0			
520	NEB	0	0	0	0	0	0	2	0	0			
6		**0.3**	**0.0**	**0.0**	**1.3**	**0.0**	**0.0**	**2.0**	**1.0**	**0.0**	**3.5**	**1.5**	**0.0**
		1.0	**0.0**	**0.0**	**2.0**	**0.0**	**0.0**	**2.0**	**3.0**	**0.0**	**4.0**	**3.4**	**0.0**
142	RI	0	0	0	0	0	0	0	0	0	2	0	0
151	RI	0	0	0	0	0	0	2	0	0	0	0	0
140	RI	0	0	0	0	0	0	0	0	0	2	2	0
161	RI	0	0	0	0	0	0	2	2	0	2	4	0
153	RI	0	0	0	0	0	0	0	2	0	0	0	0
156	RI	0	0	0	0	0	0	0	2	0	2	2	0
149	RI	0	0	0	0	0	0	0	0	0	0	0	0
162	RI	0	0	0	2	0	0	2	2	0	4	2	0
135	RI	0	0	0	0	0	0	0	0	0			
144	RI	0	0	0	2	0	0	2	2	0			
10		**0.0**	**0.0**	**0.0**	**0.4**	**0.0**	**0.0**	**0.8**	**1.0**	**0.0**	**1.5**	**1.3**	**0.0**
		0.0	**0.0**	**0.0**	**2.0**	**0.0**	**0.0**	**2.0**	**2.0**	**0.0**	**2.6**	**2.6**	**0.0**
619	RRG	0	0	0	0	0	0	2	0	0	2	0	0
607	RRG	0	0	0	0	0	0	0	0	0	0	4	0
637	RRG	0	0	0	0	0	0	0	0	0	2	0	0
627	RRG	0	0	0	0	0	0	2	0	0	2	0	0
615	RRG	0	0	0	0	0	0	2	0	0	2	0	0
626	RRG	0	0	0	0	0	0	0	0	0	2	0	0
628	RRG	0	0	0	0	0	0	0	0	0	2	0	0
611	RRG	0	0	0	2	0	0	2	0	0	2	0	0
639	RRG	0	0	0	0	0	0	2	0	0			
612	RRG	0	0	0	0	0	0	0	0	0			
10		**0.0**	**0.0**	**0.0**	**0.2**	**0.0**	**0.0**	**1.0**	**0.0**	**0.0**	**1.8**	**0.5**	**0.0**
		0.0	**0.0**	**0.0**	**0.2**	**0.0**	**0.0**	**2.0**	**0.0**	**0.0**	**2.0**	**1.2**	**0.0**
3822	SA	2	0	0	12.5	17	0	25	25	0	25	25	0
3825	SA	2	0	0	9	6.5	0	9	17	0	25	25	0
3804	SA	0	0	0	2	0	0	4	6.5	0	25	25	0
3831	SA	4	0	0	12.5	25	0	25	25	0	6.5	6.5	0
3816	SA	0	0	0	4	2	0	6.5	6.5	0	25	25	0
3807	SA	2	0	0	9	17	0	9	17	0	17	17	0
3828	SA	2	2	0	9	12.5	0	9	12.5	0	6.5	4	0
3834	SA	0	0	0	4	4	0	6.5	4	0	25	25	0
3813	SA	4	0	0	22.5	22.5	0	25	25	0	25	25	0
3819	SA	4	0	0	22.5	17	0	12.5	25	0	25	25	0
3810	SA	6.5	0	0	12.5	25	0	25	25	0			
3801	SA	4	0	0	22.5	22.5	0	25	25	0			
12		**2.5**	**0.2**	**0.0**	**11.8**	**14.3**	**0.0**	**15.1**	**17.8**	**0.0**	**20.5**	**20.3**	**0.0**
		4.0	**0.0**	**0.0**	**22.5**	**24.8**	**0.0**	**25.0**	**25.0**	**0.0**	**25.0**	**25.0**	**0.0**
755	SG	0	0	0	2	0	0	2	6.5	0	4	6.5	0
750	SG	0	0	0	2	0	0	2	2	0	6.5	9	0
765	SG	2	0	0	4	0	0	4	4	0	2	9	0

761	SG	0	0	0	0	0	0	2	0	0			
766	SG	0	0	0	2	0	0	4	6.5	0			
747	SG	0	0	0	0	4	0	2	6.5	0			
6		**0.3**	**0.0**	**0.0**	**1.7**	**0.7**	**0.0**	**2.7**	**4.3**	**0.0**	**4.2**	**8.2**	**0.0**
		1.0	**0.0**	**0.0**	**3.0**	**2.0**	**0.0**	**4.0**	**6.5**	**0.0**	**6.0**	**9.0**	**0.0**
690	T	0	0	0	0	0	0	0	0	0	2	0	0
710	T	0	0	0	2	0	0	2	0	0	2	0	0
694	T	0	0	0	2	0	0	4	0	0	6.5	0	0
721	T	0	0	0	0	0	0	0	0	0	0	0	0
700	T	0	0	0	2	0	0	2	0	0	2	0	0
698	T	0	0	0	0	0	0	0	0	0	0	0	0
722	T	0	0	0	0	0	0	0	0	0	2	0	0
714	T	0	0	0	0	0	0	2	0	0	4	0	0
702	T	0	0	0	2	0	0	2	0	0			
9		**0.1**	**0.0**	**0.0**	**1.1**	**0.2**	**0.0**	**1.6**	**0.7**	**0.0**	**2.7**	**1.0**	**0.0**
		0.1	**0.0**	**0.0**	**2.1**	**0.2**	**0.0**	**4.0**	**0.6**	**0.0**	**6.1**	**1.8**	**0.0**
778	TBG	4	0	0	12.5	22.5	0	25	25	0	25	25	0
796	TBG	2	0	0	6.5	9	0	9	9	0	25	25	0
804	TBG	0	0	0	4	9	0	6.5	9	0	25	25	0
774	TBG	4	0	0	4	25	0	25	25	0	25	25	0
786	TBG	2	0	0	6.5	17	0	25	25	0	25	25	0
792	TBG	2	0	0	6.5	12.5	0	6.5	12.5	0	25	25	0
791	TBG	2	0	0	6.5	9	0	6.5	12.5	0	25	25	0
783	TBG	0	0	0	6.5	17	0	25	25	0	25	25	0
795	TBG	2	0	0	6.5	17	0	9	25	0	25	25	0
806	TBG	2	0	0	9	6.5	0	9	6.5	0			
10		**2.0**	**0.0**	**0.0**	**6.9**	**14.5**	**0.0**	**14.7**	**17.5**	**0.0**	**25.0**	**25.0**	**0.0**
		4.0	**0.0**	**0.0**	**9.4**	**22.8**	**0.0**	**25.0**	**25.0**	**0.0**	**25.0**	**25.0**	**0.0**
273	TW	0	0	0	2	0	0	2	6.5	0	4	6.5	0
278	TW	0	0	0	0	0	0	0	0	0	2	0	0
305	TW	0	0	0	0	2	0	0	4	0	0	4	0
306	TW	0	0	0	0	0	0	2	0	0	2	2	0
298	TW	0	0	0	0	0	0	2	2	0	4	2	0
292	TW	0	0	0	0	0	0	0	0	0	4	6.5	0
289	TW	0	0	0	0	0	0	2	0	0	2	4	0
300	TW	0	0	0	2	2	0	2	4	0	4	2	0
294	TW	0	0	0	0	0	0	2	2	0	4	0	0
280	TW	0	0	0	0	2	0	2	2	0			
284	TW	0	0	0	2	0	0	2	0	0			
11		**0.0**	**0.0**	**0.0**	**0.5**	**0.5**	**0.0**	**1.5**	**1.9**	**0.0**	**2.9**	**3.0**	**0.0**
		0.0	**0.0**	**0.0**	**2.0**	**2.0**	**0.0**	**2.0**	**4.0**	**0.0**	**4.0**	**6.5**	**0.0**
188	WM	0	0	0	2	0	0	4	0	0	4	0	0
182	WM	0	0	0	0	0	0	2	0	0	2	0	0
180	WM	0	0	0	2	0	0	2	0	0	2	0	0
171	WM	0	0	0	0	0	0	2	0	0	2	0	0
167	WM	0	0	0	0	0	0	0	0	0	2	0	0

197	WM	0	0	0	0	0	0	2	0	0	2	0	0
174	WM	0	0	0	2	0	0	2	0	0	4	0	0
189	WM	0	0	0	2	0	0	2	0	0	2	0	0
168	WM	0	0	0	0	0	0	2	0	0	2	2	0
199	WM	0	0	0	0	0	0	0	0	0	0	0	0
10		**0.0**	**0.0**	**0.0**	**0.8**	**0.0**	**0.0**	**1.8**	**0.0**	**0.0**	**2.2**	**0.2**	**0.0**
		0.0	**0.0**	**0.0**	**2.0**	**0.0**	**0.0**	**2.2**	**0.0**	**0.0**	**4.0**	**0.2**	**0.0**
224	WS	0	0	0	2	0	0	2	0	0	4	4	0
230	WS	0	0	0	2	0	0	4	4	0	6.5	6.5	0
229	WS	0	0	0	2	0	0	4	4	0	4	4	0
206	WS	0	0	0	2	0	0	4	4	0	4	4	0
211	WS	0	0	0	0	0	0	4	2	0	4	4	0
208	WS	2	0	0	4	0	0	4	0	0	4	4	0
214	WS	0	0	0	2	0	0	2	0	0			
226	WS	0	0	0	0	0	0	2	0	0			
8		**0.3**	**0.0**	**0.0**	**1.8**	**0.0**	**0.0**	**3.3**	**1.8**	**0.0**	**4.4**	**4.4**	**0.0**
		0.6	**0.0**	**0.0**	**2.6**	**0.0**	**0.0**	**4.0**	**4.0**	**0.0**	**5.3**	**5.3**	**0.0**
821	YS	0	0	0	2	0	0	4	0	0	4	4	0
840	YS	2	0	0	2	2	0	4	2	0	4	4	0
839	YS	0	0	0	2	0	0	2	0	0	2	6.5	0
829	YS	0	0	0	2	0	0	2	0	0	2	2	0
831	YS	0	0	0	0	0	0	2	0	0	4	2	0
814	YS	0	0	0	0	0	0	2	0	0	4	6.5	0
846	YS	0	0	0	2	0	0	2	6.5	0	4	4	0
815	YS	0	0	0	0	0	0	2	0	0	2	4	0
843	YS	0	0	0	0	0	0	2	4	0	2	4	0
826	YS	0	0	0	2	0	0	2	4	0			
10		**0.2**	**0.0**	**0.0**	**1.2**	**0.2**	**0.0**	**2.4**	**1.7**	**0.0**	**3.1**	**4.1**	**0.0**
		0.2	**0.0**	**0.0**	**2.0**	**0.2**	**0.0**	**4.0**	**4.3**	**0.0**	**4.0**	**6.5**	**0.0**
594	YSB	0	0	0	2	0	0	2	4	0	4	4	0
583	YSB	0	0	0	2	0	0	2	4	0	2	2	0
600	YSB	0	0	0	2	0	0	4	4	0	4	4	0
604	YSB	0	0	0	0	0	0	2	4	0	4	4	0
584	YSB	0	0	0	0	0	0	2	4	0	4	4	0
597	YSB	0	0	0	2	2	0	2	2	0	4	4	0
6		**0.0**	**0.0**	**0.0**	**1.3**	**0.3**	**0.0**	**2.3**	**3.7**	**0.0**	**3.7**	**3.7**	**0.0**
		0.0	**0.0**	**0.0**	**2.0**	**1.0**	**0.0**	**3.0**	**4.0**	**0.0**	**4.0**	**4.0**	**0.0**

Table D.4 Abbreviation of timber species

Code	Common name	Species
BB	Blackbutt	*E. pilularis*
BG	Sydney Blue Gum	*E. saligna*
BX	Brush Box	*Lophostemon confertus*
CCA 12	CCA treated pine 12 kg/m^3	*Pinus radiata*
CCA 36	CCA treated pine 36 kg/m^3	*P. radiata*
FG	Flooded Gum	*E. grandis*
GB	Grey Box	*E. moluccana*
GG	Grey Gum	*E. propinqua*
GI	Grey Ironbark	*E. paniculata*
IR	Iroko (African timber)	*Chlorophora excelsa*
J	Jarrah	*E. marginata*
K	Karri	*E. diversicolor*
M	Marri	*C. calophylla*
MA	Mountain Ash	*E. regnans*
MGG	Mountain Grey Gum	*E. cypellocarpa*
MS	Messmate	*E. obliqua*
NEB	New England Blackbutt	*E. andrewsii*
RI	Red Ironbark	*E. sideroxylon*
RRG	River Red Gum	*E. camaldulensis*
SA	Silvertop Ash	*E. sieberi*
SG	Spotted Gum	*C. maculata*
T	Turpentine	*Syncarpia glomulifera*
TBG	Tasmanian Blue Gum	*E. globulus*
TW	Tallowwood	*E. microcorys*
WM	White Mahogony	*E. acmenoides*
WS	White Stringybark	*E. eugenioides*
YS	Yellow Stringybark (WA)	*E. muelleriana*
YSB	Yellow Stringybark (Vic.)	*E. muelleriana*

APPENDIX E

Field Assessment Data of Marine Piles, Posts, or Stakes

During the course of the project, field assessments of in-service (or end of service) marine piles have been extensively carried out at various coastal locations. A summary of the field assessment data is provided in Table E1. The data were used to make reality checks for the model as presented in Section 6.

There are totally 4583 data records, which are divided into 10 tables, i.e. Tables E2 to E11. Each Table contains the data of a different type of pile, including Untreated Class 1, 2, 3, 4, CCA-treated softwood and hardwood, Creosote-treated softwood and hardwood, Double-treated softwood and hardwood. Each Table provides information in the following columns. The reality checks in Section 6 are comparisons between the measured attack depths given in column [17] with the model predicted attack depths given in column [27].

[1] Pile number (s)
[2] Location
[3] In-service duration
[4] Coastal zone of the structure location
[5] Salinity (ppt) / salinity class
[6] Timber species
[7] Durability class of heartwood
[8] Preservative treatment (CCA, Creosote, or Double treated)
[9] Level of the treatment (ie. retention of the preservative) in % m/m
[10] Original diameter of the pile in tidal zone
[11] Original thickness of sapwood
[12] Maintenance measure (if any)
[13] Exposed to surf & waves, or sheltered in calm water
[14] Is there any timber element contacted (e.g. X-brace) at the assessed cross-section?
[15] Worst attacked zone on pile (TZ: tidal zone, ML: mudline, LT: low tide, LLT: below low tide, MMT: mud to mid tide, AW: above water)
[16] If a group of piles was assessed, how many piles were there in the group?
[17] Average of total depths of marine borer attack from perimeter of the pile(s) in mm (ie radius depth not diameter) at last inspection
[18] Worst 10 percentile service life in years
[19] Worst 10 percentile of total depths of marine borer attack from perimeter of the pile(s) at last inspection, mm
[20] Estimate service life years (average), eg when 50% section lost or remaining diameter being 200mm
[21] Main borer species which attacked the pile (T: Teredinid, M: Matersia, L: Limnoria, S: Sphaeroma)
[22] Bark on pile or not (Note: all treated piles have Bark removed)
[23] Presence and size of knot at marine attacked zone
[24] Pile site is sheltered from sun or not (Note: this influences Sphaeroma attack only)
[25] Depth of sea water to mean low tide at pile site in metre
[26] Turbid water or not
[27] Model-predicted attack depth (mm)

Table E1 Summary of field assessment of in-service marine piles/posts/stakes

Type of pile	No. of Piles	Timber species	Location
CCA treated hardwood piles	368	Corymbia maculata, Euc obliqua, E. pilularis, E. macrorhyncha, E. marginata, Syncarpia glomulifera (turpentine)	Port Douglas, Townsville, Ross River (Towsville), Port Stephens, Sydney, Bowen, Mouth of Tamar River (Tasmania), Kwinana, Port Hedland, Brisbane River, Fremantle
CCA treated softwood piles	218	P. elliottii, A. cunninghamii (hoop pine), P. radiata	Port Douglas, Townsville, Port Stephens, Sydney, Cairn, Bowen, Daydream Island, Bundaberg, Lakes Entrance, Batemans bay, Kwinana, Port Augusta, Coffin Bay.
Creosote treated hardwood piles	44	Corymbia maculata, E. pilularis, E. macrorhyncha	Port Stephens, Sydney, Bowen, Bundaberg, Townsville, Kwinana.
Creosote treated softwood piles	77	P. radiata	Port Stephens, Sydney, Cairn, Port Wakefield, Frankin Harbour, Tumby Bay
Double-treated hardwood piles	193	Corymbia maculata, E. pilularis	Port Stephens, Sydney, Bundaberg, Townsville, Brighton Baths.
Double-treated softwood piles	66	P. radiata, P. elliottii	Bowen, Port Douglas, Townsville, Cairn, Bundaberg, Port Stephens, Sydney.
Untreated durability class 1 piles	3210	S. glomulifera, Turpentine	Port Douglas, Townsville, Port Stephens, Sydney Harbour, Sydney, Brisbane River, Kwinana, Port Hedland, Melbourne, Geelong, Coffin Bay, Port Pirie, Gippsland Lakes, Larg Bay.
Untreated durability class 2 piles	124	E. moluccana (grey box), E. sideroxylon, E. paniculata (ironbark), E. camaldulensis (river red gum), Callitris glaucophylla, Ironbark	Melbourne, Geelong, Port Phillip Bay, Ballina, Gippsland Lakes, Larg Bay, Bairnsdale, Port Arlington, Brighton.
Untreated durability class 3 piles	214	E. marginata (jarrah), E. muelleriana (yellow stringybark), E. bosistoana (coast grey box)	Barrow Island, Near Bunbury, Kwinana, Port Hedland, Melbourne, Gippsland Lakes, Queenscliff, Fremantle, Exmouth, Broome, Port Pirie, Geelong, Port Phillip Bay.
Untreated durability class 4 piles	69	E. obliqua (messmate), E. globulus, E. regnans, E. diversicolor (karri)	Melbourne, Gippsland Lakes, San Remo, Hobart, Phillip Island, Wilsons Prom, Southern NSW, Port Albert, Fremantle, Exmouth.
Total	**4583**	**20**	**45**

Table E2 Field assessment data of **untreated class 1** piles

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]	[16]	[17]	[18]	[19]	[20]	[21]	[22]	[23]	[24]	[25]	[26]	[27]
Pile 5	Port Douglas	16	7	3	S. glomulifera	HW1	none	none	420	20	no	Exposed	no	TZ	1	60		60	19	S	yes	no	no	2.5	no	62
Pile 6	Port Douglas	16	7	3	S. glomulifera	HW1	none	none	410	20	no	Exposed	no	TZ	1	70		70	18	S	yes	no	no	2.5	no	62
Fender 73	Townsville	3.3	7	3	S. glomulifera	HW1	none	none	400	25	no	Exposed	yes	TZ	1	40		80	11	S	yes	no	half	3.5	no	35
Fender 73	Townsville	5.7	7	3	S. glomulifera	HW1	none	none	400	25	no	Exposed	yes	TZ	1	45		80	11	S	yes	no	half	3.5	no	50
Fender 73	Townsville	9.2	7	3	S. glomulifera	HW1	none	none	400	25	no	Exposed	yes	TZ	1	65		80	11	S	yes	no	half	3.5	no	70
Fender 73	Townsville	12.2	7	3	S. glomulifera	HW1	none	none	400	25	no	Exposed	yes	TZ	1	80		80	11	S	yes	no	half	3.5	no	88
Fender 73	Townsville	13.2	7	3	S. glomulifera	HW1	none	none	400	25	no	Exposed	yes	TZ	1	80		80	11	S	yes	no	half	3.5	no	94
Fender 16	Townsville	5.6	7	3	S. glomulifera	HW1	none	none	400	25	no	Exposed	yes	TZ	1	40		40	?	S	yes	no	half	3.5	no	49
Fender 87	Townsville	3.9	7	3	S. glomulifera	HW1	none	none	400	25	no	Exposed	yes	TZ	1	50		100	8	S	yes	no	half	3.5	no	39
Fender 87	Townsville	6.3	7	3	S. glomulifera	HW1	none	none	400	25	no	Exposed	yes	TZ	1	85		100	8	S	yes	no	half	3.5	no	53
Fender 87	Townsville	9.2	7	3	S. glomulifera	HW1	none	none	400	25	no	Exposed	yes	TZ	1	100		100	8	S	yes	no	half	3.5	no	70
Mooring T9	Townsville, Ross River	2	7	3	S. glomulifera	HW1	none	none	400	25	no	Exposed	no	TZ	1	5		40	11	S	yes	no	no	2	no	25
Mooring T9	Townsville, Ross River	4	7	3	S. glomulifera	HW1	none	none	400	25	no	Exposed	no	TZ	1	35		40	11	S	yes	no	no	2	no	31
Mooring T9	Townsville, Ross River	6	7	3	S. glomulifera	HW1	none	none	400	25	no	Exposed	no	TZ	1	40		40	11	S	yes	no	no	2	no	37
Mooring T10	Townsville, Ross River	2	7	3	S. glomulifera	HW1	none	none	400	25	no	Exposed	no	TZ	1	5		80	12	S	yes	yes	no	2	no	28
Mooring T10	Townsville, Ross River	4	7	3	S. glomulifera	HW1	none	none	400	25	no	Exposed	no	TZ	1	28		80	12	S	yes	yes	no	2	no	40
Mooring T10	Townsville, Ross River	6	7	3	S. glomulifera	HW1	none	none	400	25	no	Exposed	no	TZ	1	35		80	12	S	yes	yes	no	2	no	51
Mooring T10	Townsville, Ross River	9	7	3	S. glomulifera	HW1	none	none	400	25	no	Exposed	no	TZ	1	80		80	12	S	yes	yes	no	2	no	69
Mooring T11	Townsville, Ross River	2	7	3	S. glomulifera	HW1	none	none	400	25	no	Exposed	no	TZ	1	5		55	14	S	yes	no	no	2	no	25
Mooring T11	Townsville, Ross River	4	7	3	S. glomulifera	HW1	none	none	400	25	no	Exposed	no	TZ	1	28		55	14	S	yes	no	no	2	no	31
Mooring T11	Townsville, Ross River	6	7	3	S. glomulifera	HW1	none	none	400	25	no	Exposed	no	TZ	1	40		55	14	S	yes	no	no	2	no	37
Mooring T11	Townsville, Ross River	9	7	3	S. glomulifera	HW1	none	none	400	25	no	Exposed	no	TZ	1	55		55	14	S	yes	no	no	2	no	46
Mooring T12	Townsville, Ross River	2	7	3	S. glomulifera	HW1	none	none	400	25	no	Exposed	no	TZ	1	12		75	12	S	yes	yes	no	2	no	28
Mooring T12	Townsville, Ross River	4	7	3	S. glomulifera	HW1	none	none	400	25	no	Exposed	no	TZ	1	27		75	12	S	yes	yes	no	2	no	40
Mooring T12	Townsville, Ross River	6	7	3	S. glomulifera	HW1	none	none	400	25	no	Exposed	no	TZ	1	40		75	12	S	yes	yes	no	2	no	51
Mooring T12	Townsville, Ross River	9	7	3	S. glomulifera	HW1	none	none	400	25	no	Exposed	no	TZ	1	75		75	12	S	yes	yes	no	2	no	69
Walkway	Port Stephens	17	5	2	S. glomulifera	HW1	none	none	400	25	no	Calm	no	TZ	6	80	16	90	19	S	yes	no	no	0.3	yes	64
Moore 1961	Sydney Harbour	32	5	3	S. glomulifera	HW1	none	none	400	25	no	Exposed	no	TZ	1000	100			32	S	yes	no	no		no	71
Moore 1961	Sydney Harbour	70	5	3	S. glomulifera	HW1	none	none	400	25	yes	Exposed	no	TZ	1000	100			70	L/T	yes	no	no		no	77
Goat Island	Sydney	35	5	3	S. glomulifera	HW1	none	none	400	25	no	Exposed	no	TZ	30	80	25	120	32	S	yes	no	no	2	no	76
Goat Island	Sydney	9	5	3	S. glomulifera	HW1	none	none	400	25	no	Exposed	no	TZ	6	25		28	25+	T/L/S	yes	no	no	2	no	35

Table E2 (cont) Field assessment data of **untreated class 1** piles

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]	[16]	[17]	[18]	[19]	[20]	[21]	[22]	[23]	[24]	[25]	[26]	[27]
CSIRO P5-7 test	Sydney	24	5	3	S. glomulifera	HW1	none	none	76x50	0	no	Exposed	no	LT	4	10	20	20	24+	L	no, sawn	no	no	1	no	25
CSIRO P5-7 test	Kwinana	22	4	3	S. glomuliferra	HW1	none	none	76x50	0	no	Exposed	no	LT	4	5	12	20	22+	L	no, sawn	no	no	1	no	25
CSIRO P5-7 test	Sydney	10	5	3	S. glomulifera	HW1	none	none	76x50	0	no	Exposed	no	LT	4	5		8	24+	L	no, sawn	no	no	1	no	13
CSIRO P5-7 test	Kwinana	10	4	3	S. glomuliferra	HW1	none	none	76x50	0	no	Exposed	no	LT	4	3		6	22+	L/T	no, sawn	no	no	1	no	10
CSIRO P5-7 test	Brisbane River	10	5	1	S. glomuliferra	HW1	none	none	76x50	0	no	Calm	no	LT	4		1.5		2.5	T	no, sawn	no	no	1	yes	21
CSIRO P5-7 test	Port Hedland	10	6	3	S. glomuliferra	HW1	none	none	76x50	0	no	Exposed	no	LT	4	6		10	15	L/T		no				19
Shell Wharf piles 1 to 10	Geelong	30	2	3	S. glomulifera	HW1	none	none	400	25	no	Exposed	no	LT	10	28	60	31	70+	L	yes	no	no	4	no	41
Shell Wharf pile 11	Geelong	30	2	3	S. glomulifera	HW1	none	none	400	25	no	Exposed	no	LT	1	28			50+	L	yes	yes	no	4	no	58
Shell Wharf pile 12	Geelong	30	2	3	S. glomulifera	HW1	none	none	400	25	no	Exposed	no	LT	1	28			40	L	yes	yes	no	4	no	58
Swimming Enclosure	Geelong	50	2	3	S. glomulifera	HW1	none	none	400	25	no	Exposed	no	LT	1	30			80+	L	yes	no	no	2	no	53
Station Pier	Melbourne	70	2	3	S. glomulifera	HW1	none	none	450	25	no	Calm	no	LT	12	46	75	90	100+	L	yes	no	Yes	2.5	no	92
Station Pier	Melbourne	70	2	3	S. glomulifera	HW1	none	none	450	25	no	Calm	yes	LT	7	108	40	225	57	L	yes	no	Yes	2.5	no	159
Fuel Jetty	Gippsland Lakes	23	2	2	S. glomulifera	HW1	none	none	400	25	no	Calm	no	LT	1	20		20	70+	L	yes	no	no	2	no	41
Largs jetty	Largs bay, SA	46	3	3	S. glomulifera	HW1	none	none	300	20	no	Exposed	no	LT	5	25		30	50+	T	yes	no	no	0.5	no	54
Berth 3 piles	Port Pirie	42	3	3	S. glomulifera	HW1	none	none	350	25	no	Exposed	no	LT	10	30		40	60+	L	yes	no	no	1.5	no	56
Oyster sawn stakes	Coffin Bay	11	3	3	S. glomulifera	HW1	none	none	48x48	0	no	Exposed	no	LT	1000	3	11	12	12+	T	none	no	no	2	no	7
Bridge pile	Lake Tyers	35	2	1	S. glomulifera	HW1	none	none	350	25	no	Calm	no	LT	1	175			<35	T	?	no	no	1	yes	47
Mooring Pile 5	Port Douglas	16	7	2	Turpentine	HW1	none	none	450	20	no	Exposed	no	LT	1	22				L		no				62
Mooring Pile 6	Port Douglas	16	7	2	Turpentine	HW1	none	none	430	20	no	Exposed	no	LT	1	22				L		no				62
Mooring Pile 5	Port Douglas	16	7	3	Turpentine	HW1	none	none	450	20	no	Exposed	no	LT	1	45				M		no				62
Mooring Pile 6	Port Douglas	16	7	3	Turpentine	HW1	none	none	430	20	no	Exposed	no	LT	1	50				M		no				62
Mooring Pile 5	Port Douglas	16	7	3	Turpentine	HW1	none	none	450	20	no	Exposed	no	TZ	1	60				S		no				62
Mooring Pile 6	Port Douglas	16	7	3	Turpentine	HW1	none	none	430	20	no	Exposed	no	TZ	1	60				S		no				62
Fender pile 73	Townsvile	3.3	7	3	Turpentine	HW1	none	none	350	30	no	Exposed	no	TZ	1	45				S		no				34
Fender pile 87	Townsvile	3.9	7	3	Turpentine	HW1	none	none	350	30	no	Exposed	no	TZ	1	55				S		no				36
Fender pile 16	Townsvile	5.6	7	3	Turpentine	HW1	none	none	350	30	no	Exposed	no	TZ	1	45				S		no				41
Fender pile 73	Townsvile	5.7	7	3	Turpentine	HW1	none	none	350	30	no	Exposed	no	TZ	1	50				S		no				41
Fender pile 87	Townsvile	6.3	7	3	Turpentine	HW1	none	none	350	30	no	Exposed	no	TZ	1	90				S		no				43
Fender pile 73	Townsvile	9.2	7	3	Turpentine	HW1	none	none	350	30	no	Exposed	no	TZ	1	70				S		no				51
Fender pile 73	Townsvile	12.2	7	3	Turpentine	HW1	none	none	350	30	no	Exposed	no	TZ	1	85				S		no				60
Fender pile 73	Townsvile	13.2	7	3	Turpentine	HW1	none	none	350	30	no	Exposed	no	TZ	1	85				S		no				63
Mooring Pile T9	Townsvile	2	7	1	Turpentine	HW1	none	none	350	30	no	Exposed	no	TZ	1	6				S/M		no				30
Mooring Pile T10	Townsvile	2	7	1	Turpentine	HW1	none	none	350	30	no	Exposed	no	TZ	1	6				S/M		no				30
Mooring Pile T11	Townsvile	2	7	1	Turpentine	HW1	none	none	350	30	no	Exposed	no	TZ	1	6				S/M		no				30
Mooring Pile T12	Townsvile	2	7	1	Turpentine	HW1	none	none	350	30	no	Exposed	no	TZ	1	10.5				S/M		no				30

Table E2 (cont) Field assessment data of **untreated class 1** piles

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]	[16]	[17]	[18]	[19]	[20]	[21]	[22]	[23]	[24]	[25]	[26]	[27]
Mooring Pile T9	Townsvile	4	7	1	Turpentine	HW1	none	none	350	30	no	Exposed	no	TZ	1	30.5				S/M		no				36
Mooring Pile T10	Townsvile	4	7	1	Turpentine	HW1	none	none	350	30	no	Exposed	no	TZ	1	30.5				S/M		no				36
Mooring Pile T11	Townsvile	4	7	1	Turpentine	HW1	none	none	350	30	no	Exposed	no	TZ	1	30.5				S/M		no				36
Mooring Pile T12	Townsvile	4	7	1	Turpentine	HW1	none	none	350	30	no	Exposed	no	TZ	1	30.5				S/M		no				36
Mooring Pile T9	Townsvile	6	7	1	Turpentine	HW1	none	none	350	30	no	Exposed	no	TZ	1	36				S/M		no				42
Mooring Pile T10	Townsvile	6	7	1	Turpentine	HW1	none	none	350	30	no	Exposed	no	TZ	1	36				S/M		no				42
Mooring Pile T11	Townsvile	6	7	1	Turpentine	HW1	none	none	350	30	no	Exposed	no	TZ	1	39				S/M		no				42
Mooring Pile T12	Townsvile	6	7	1	Turpentine	HW1	none	none	350	30	no	Exposed	no	TZ	1	44				S/M		no				42
Mooring Pile T10	Townsvile	9	7	1	Turpentine	HW1	none	none	350	30	no	Exposed	no	TZ	1	85				S/M		no				51
Mooring Pile T11	Townsvile	9	7	1	Turpentine	HW1	none	none	350	30	no	Exposed	no	TZ	1	60				S/M		no				51
Mooring Pile T12	Townsvile	9	7	1	Turpentine	HW1	none	none	350	30	no	Exposed	no	TZ	1	80				S/M		no				51
Walkway piles 1-6	Port Stephens	17	4	2	Turpentine	HW1	none	none	350	30	no	Exposed	no	TZ	6	85				S		no				44
Piles (Moore, 1961)	Sydney Harbour	32	4	2	Turpentine	HW1	none	none	350	30	no	Exposed	no	TZ	ex	65				S		no				59
Piles (Moore, 1961)	Sydney Harbour	70	4	2	Turpentine	HW1	none	none	350	30	yes	Exposed	no	TZ	ex	65				S		no				63
Piles AE	Melbourne	70	2	3	Turpentine	HW1	none	none	350	20	no	Exposed	no	TZ	1	25				L		no				60
Piles CE	Melbourne	70	2	3	Turpentine	HW1	none	none	350	40	no	Exposed	no	TZ	1	43				L		no				79
Piles HE	Melbourne	70	2	3	Turpentine	HW1	none	none	350	10	no	Exposed	no	TZ	1	50				L		no				50
Piles RW	Melbourne	70	2	3	Turpentine	HW1	none	none	350	15	no	Exposed	no	TZ	1	22				L		no				55
Piles QW	Melbourne	70	2	3	Turpentine	HW1	none	none	350	30	no	Exposed	no	TZ	1	42				L		no				70
Piles HW	Melbourne	70	2	3	Turpentine	HW1	none	none	350	10	no	Exposed	no	TZ	1	26				L		no				50
Piles SW	Melbourne	70	2	3	Turpentine	HW1	none	none	350	30	no	Exposed	no	TZ	1	48				L		no				70
Piles PE	Melbourne	70	2	3	Turpentine	HW1	none	none	350	20	no	Exposed	no	TZ	1	85				L		no				60
Piles RE137	Melbourne	70	2	3	Turpentine	HW1	none	none	350	15	no	Exposed	no	TZ	1	40				L		no				55
Piles QE127	Melbourne	70	2	3	Turpentine	HW1	none	none	350	20	no	Exposed	no	TZ	1	33				L		no				60
Piles RE98	Melbourne	70	2	3	Turpentine	HW1	none	none	350	20	no	Exposed	no	TZ	1	65				L		no				60
Piles RE	Melbourne	70	2	3	Turpentine	HW1	none	none	350	15	no	Exposed	yes	TZ	1	175				L		no				96
Piles PW	Melbourne	70	2	3	Turpentine	HW1	none	none	350	12	no	Exposed	yes	TZ	1	67				L		no				93
Piles FW	Melbourne	70	2	3	Turpentine	HW1	none	none	350	20	no	Exposed	yes	TZ	1	40				L		no				100
Piles KW	Melbourne	70	2	3	Turpentine	HW1	none	none	350	15	no	Exposed	yes	TZ	1	22				L		no				96
Piles RE	Melbourne	70	2	3	Turpentine	HW1	none	none	350	25	no	Exposed	yes	TZ	1	160				L		no				105
Piles QE	Melbourne	70	2	3	Turpentine	HW1	none	none	350	20	no	Exposed	yes	TZ	1	100				L		no				100
Piles RE87	Melbourne	70	2	3	Turpentine	HW1	none	none	350	25	no	Exposed	yes	TZ	1	150				L		no				105
Piles	Melbourne	60	2	3	Turpentine	HW1	none	none	350	30	no	Exposed	no	TZ	1	65				-		no				64
Enclosure pile1	Geelong	50	2	3	Turpentine	HW1	none	none	350	25	no	Exposed	no	TZ	1	30				L		no				53
Piles 1-10	Geelong	30	2	3	Turpentine	HW1	none	none	350	25	no	Exposed	no	TZ	10	28				L		no				41
Piles 11	Geelong	30	2	3	Turpentine	HW1	none	none	350	25	no	Exposed	no	TZ	1	30				L		no				41
Piles 12	Geelong	30	2	3	Turpentine	HW1	none	none	350	25	no	Exposed	no	TZ	1	28				L		no				41

Table E3 Field assessment data of **untreated class 2** piles

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]	[16]	[17]	[18]	[19]	[20]	[21]	[22]	[23]	[24]	[25]	[26]	[27]
Station Pier	Melbourne	60	2	3	E. moluccana	HW2	none	none	350	20	no	Exposed	no	MMT	20	80	50	150	60	T/L	yes	no	no	2.5	no	72
Shell Wharf	Geelong	20	2	3	E. sideroxylon/paniculata	HW2	none	none	350	25	no	Exposed	no	TZ	11	50	25	80	27+	T/L	no	no	no	4	no	41
Channel light	Port Phillip Bay	52	2	3	E. sideroxylon/paniculata	HW2	none	none	320	25	no	Exposed	no	ML	1	100			45	T/L	yes	no	no	10	no	70
Missingham bridge	Ballina	0.5	5	3	E. sideroxylon/paniculata	HW2	none	none	250	25	no	Calm	no	MMT	5	100			0.5	T	no	no	no	2	no	17
Victoria Dock, Yarra river	Melbourne	30	2	1	E. camaldulensis	HW2	none	none	350	20	no	Calm	no	MMT	7	30	35		40+	T	no	no	yes	3	yes	49
Victoria Dock, Yarra river	Melbourne	30	2	1	E. camaldulensis	HW2	none	none	350	20	no	Calm	yes	MMT	1	30			35+	T	no	no	yes	3	yes	80
Victoria Dock	Melbourne	30	2	1	E. camaldulensis	HW2	none	none	200x75	0	no	Calm	no	MMT	10	20	20		30+	T	no	no	yes	1	yes	30
Dolphin piles	Gippsland lake	8	2	2	E. camaldulensis	HW2	none	none	350	20	no	Calm	no	MMT	4	10	12		30+	T	no	no	no	3	no	27
Mitchell River	Bairnsdale	8	2	1	E. camaldulensis	HW2	none	none	365	20	no	Calm	no	MMT	10	160	4		5	T	no	no	no	1.5	yes	26
Jetty	Port Arlington	60	2	3	E. camaldulensis	HW2	none	none	350	20	no	Calm	no	MMT	10	50	45	60	50	T/L	no	no	no	2	no	108
Hovel light	Port Phillip Bay	46	2	3	E. camaldulensis	HW2	none	none	360	15	no	Exposed	no	MMT	4	20		30	50+	T/L	no	no	no	6	no	55
Brighton pier	Brighton	60	2	3	E. camaldulensis	HW2	none	none	360	20	no	Exposed	no	MMT	30	100	45		55	T/L	no	no	no	2	no	72
Largs jetty	Largs bay, SA	46	3	3	E. camaldulensis	HW2	none	none	300	20	no	Exposed	no	LT	3	43	35	70	50	T/L	no	no	no	0.5	no	73
Sawn walers	Brighton Baths	11	2	3	Callitris glaucophylla	HW2	none	none	150x150	0	no	Exposed	yes	none	4	5			20+	none	no	no	no	0	no	17
Piles 1-10	Geelong (Shell wharf)	20	2	3	Ironbark	HW2	none	none	350	25	no	Exposed	no	TZ	1	53				T/L	no	no	no			41
Pile 11	Geelong (Shell wharf)	20	2	3	Ironbark	HW2	none	none	350	25	no	Exposed	no	TZ	1	53				T/L	no	no	no			41
Pile	Geelong (Channel light)	52	2	3	Ironbark	HW2	none	none	320	30	no	Exposed	no	ML	1	160				T	no	no	no			75
Pile	Geelong (Channel light)	52	2	3	Ironbark	HW2	none	none	310	30	no	Exposed	no	LLT	1	65				T	no	no	no			75

Table E4 Field assessment data of **untreated class 3** piles

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]	[16]	[17]	[18]	[19]	[20]	[21]	[22]	[23]	[24]	[25]	[26]	[27]
Sawn pile	Barrow Island	5	6	3	E. marginata	HW3	none	none	300x200	0	no	Exposed	no	MMT	17	80	3		3.5	T/L	no	no	no	2	no	73
Collie river bridge	Near Bunbury	21	4	2	E. marginata	HW3	none	none	350	20	no	Calm	no	MMT	56	100	15		20	T/S	no	no	no	2 to 3	yes	175
CSIRO P5-7 test	Kwinana	22	4	3	E. marginata	HW3	none	none	76x50	0	no	Exposed	no	LLT	4	riddled	2		6	T/L		no	no	1	no	25
CSIRO P5-7 test	Port Hedland	10	6	3	E. marginata	HW3	none	none	76x50	0	no	Exposed	no	LLT	4	riddled	2		4	T/L		no	no	1	no	25
Victoria Dock	Melbourne	30	2	1	E. muelleriana	HW3	none	none	350	25	no	Calm	no	MMT	4	37		40	35+	T	no	no	no	3	yes	83
Post office jetty	Gippsland lakes	16	2	2	E. muelleriana	HW3	none	none	200x75	0	no	Calm	no	MMT	10	30	10		12	T	no	no	no	2	no	35
Ellwood boat ramp	Melbourne	4	2	3	E. muelleriana	HW3	none	none	100x50	0	no	Exposed	yes	MMT	5	3		4	8+	T/L	no	no	no	0	no	9
Sawn sheet piles	Queenscliff	32	2	3	E. muelleriana	HW3	none	none	200 x 200	0	no	Exposed	no	MMT	10	50	25	80	30	T/L		no	no	2	no	55
Sawn rubbing strips	Fremantle	5	4	3	E. marginata	HW3	none	none	280x250	0	no	Calm	no	LT	7	125	3.5		4	T		no	no	3	no	62
Sawn beams	Exmouth	5	6	3	E. marginata	HW3	none	none	280x250	0	no	Exposed	yes	LT	10	125	3.5		4	T		no	no	2	no	125
Sawn chafers	Broome	3	6	3	E. marginata	HW3	none	none	250 x 150	0	no	Exposed	yes	LT	5	35	2		4	T		no	no	2	no	75
Berth 3 sawn bearers	Port Pirie	42	3	3	E. marginata	HW3	none	none	400x200	0	no	Exposed	yes	LT	9	23	30	50	40	L	yes	pith	no	1.5	no	100
Berth 3 sawn decking	Port Pirie	42	3	3	E. marginata	HW3	none	none	220x80	0	no	Exposed	yes	LT	50	23	25	40	30	L	yes	pith	no	1.5	no	40
Channel light	Port Phillip Bay	40	2	3	E. bosistoana	HW3	none	none	390	25	no	Exposed	no	ML	4	150	35	170	35	T	no	no	no	7	no	93
Kalimna West	Gippsland lakes	5	2	2	E. bosistoana	HW3	none	none	200	30	no	Calm	no	MMT	10	70	3		4	T	no	no	no	2	no	35
Pile 1	Near Geelong	40	2	3	Coast Grey Box	HW3	none	none	260	30	no	Exposed	no	ML	1	185		155	35	T	no	no	no			98
Pile 2	Near Geelong	40	2	3	Coast Grey Box	HW3	none	none	330	30	no	Exposed	no	ML	1	185		45		T	no	no	no			98
Pile 3	Near Geelong	40	2	3	Coast Grey Box	HW3	none	none	350	30	no	Exposed	no	ML	1	185				T	no	no	no			98
Pile 4	Near Geelong	40	2	3	Coast Grey Box	HW3	none	none	300	30	no	Exposed	no	ML	1	185				T	no	no	no			98
Hopetuon light 3	Near Geelong	37	2	3	Coast Grey Box	HW3	none	none	470	30	no	Exposed	no	TZ	1	45				T/L	no	no	no			92
Pile 1	Near Geelong	40	2	3	Coast Grey Box	HW3	none	none	380	30	no	Exposed	no	TZ	1	45				T/L	no	no	no			98
Pile 2	Near Geelong	40	2	3	Coast Grey Box	HW3	none	none	410	30	no	Exposed	no	TZ	1	45				T/L	no	no	no			98
Pile 3	Near Geelong	40	2	3	Coast Grey Box	HW3	none	none	410	30	no	Exposed	no	TZ	1	45				T/L	no	no	no			98
Pile 4	Near Geelong	40	2	3	Coast Grey Box	HW3	none	none	365	30	no	Exposed	no	TZ	1	45				T/L	no	no	no			98

Table E5 Field assessment data of **untreated class 4** piles

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]	[16]	[17]	[18]	[19]	[20]	[21]	[22]	[23]	[24]	[25]	[26]	[27]
Victoria Dock	Melbourne	30	2	1	E. obliqua	HW4	none	none	350	30	no	Calm	no	MMT	3	40		50	35+	T	no	no	yes	3	yes	175
Hopkins Bight	Gippsland Lakes	4	2	2	E. obliqua	HW4	none	none	200	30	no	Calm	no	MMT	10	80	100	2.5	3	T	no	no	no	2	no	57
San Remo jetty	San Remo	7	2	3	E. obliqua	HW4	none	none	300	25	no	Calm	no	MMT	10	80	3.5	100	5	T/L	no	no	no	2	no	114
Rhyll jetty	Phillip Island	37	2	3	E. obliqua	HW4	none	none	370	20	no	Exposed	no	MMT	1	150			<20	T/L	no	no	no	3	no	185
Port Albert jetty	near Wilsons Prom	6	2	3	E. obliqua	HW4	none	none	350	25	no	Exposed	no	MMT	5	120	3.5		4	T/L	no	no	no	3	no	60
Ellwood ramp	Melbourne	4	2	3	E. obliqua	HW4	none	none	100x50	0	no	Exposed	yes	MMT	5	riddled	1.5		2.5	T/L	no	no	no	0	no	0
Ulladulla	southern NSW	5	5	3	E. obliqua	HW4	none	none	300	25	no	Exposed	no	MMT	5	150	1.5		2.5	T/L	no	no	no	2	no	150
Piles	Hobart	35	1	3	E. globulus	HW4	none	none	350	25	no	Exposed	no	MMT	10	130	20		25	T/L	no	no	no	2	no	175
Metung Marina	Gippsland lakes	5	2	2	E. regnans	HW4	none	none	350	25	no	Calm	no	MMT	1	150			3	T	no	no	no	2	no	66
Slipway	Port Albert	3	2	3	E. regnans	HW4	none	none	300	25	no	Exposed	no	MMT	2	130	2		2	T	no	no	no	2	no	32
Sawn rubbing strips	Fremantle	5	4	3	E. diversicolor	HW4	none	none	280x250	0	no	Calm	no	LT	7	125	2.5		3	T	no	no	no	3	no	125
Horizontal beams	Exmouth	5	6	3	E. diversicolor	HW4	none	none	280x250	0	no	Exposed	yes	LT	10	125	2		3	T	no	no	no	2	no	125

Table E6 Field assessment data of **CCA-treated softwood** piles

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]	[16]	[17]	[18]	[19]	[20]	[21]	[22]	[23]	[24]	[25]	[26]	[27]
Mooring pile 7	Port Douglas	25.9	7	3	P. elliottii	CC2	CCA	0.02	320	100	no	Calm	no	TZ	1	50			20	S/T	no	no	no	3	yes	50
Mooring piles	Bundaberg	9	7	3	P. elliottii	CC3	CCA	0.03	350	100	no	Exposed	no	none	5	0			15+	None	no	no	no	2	yes	7
Mooring piles	Townsville	9	7	3	P. elliottii	CC3	CCA	0.03	350	100	no	Exposed	no	TZ	6	15		20	15+	S/M	no	yes	no	2	no	13
Mooring piles	Cairns	9	7	3	P. elliottii	CC3	CCA	0.03	350	100	no	Exposed	no	TZ	6	12	12	40	15+	S/T	no	no	no	2	no	7
C19&D17	Bowen	13.9	7	3	P. elliottii	CC2	CCA	0.02	350	100	no	Exposed	no	TZ	2	15		20	17+	S	no	yes	no	2	no	30
Piles	Daydream Island	4	7	3	A. cunninghamii	CC2	CCA	0.02	350	100	no	Exposed	yes	TZ	4	30		30	15+	T	no	no	no	3	no	6
Boat jetty	Lakes Entrance	10	2	3	P. radiata	CC1	CCA	0.01	150	75	no	Calm	no	none	16	0			20+	none	no	no	no	1.5	no	7
Oyster battens	Port Stephens	3	5	2	P. radiata	CC1	CCA	0.012	70x35	all sap	no	Calm	yes	LT	50	15	3		3	S	no	no	no	2	yes	4
Oyster posts	Port Stephens	6	5	2	P. radiata	CC2	CCA	0.02	120	all sap	no	Calm	no	TZ	6	7		10	10	S	no	no	no	2	yes	4
Oyster battens	Batemans bay	8	2	3	P. radiata	CC0	CCA	0.006	70 x 35	all sap	no	Calm	yes	LT	20	3		5	10+	T	no	no	no	2	yes	15
1-4 CSIRO test	Port Stephens	19	5	2	P. radiata	CC2	CCA	0.02	100	all sap	no	Calm	no	TZ	4	50	?		9.4	S	no	no	yes	2	yes	19
1-4 CSIRO test	Sydney	20	5	3	P. radiata	CC2	CCA	0.02	100	all sap	no	Exposed	no	LLT	4	4		5	25+	L	no	no	no	3	no	12
Hanging posts	Townsville	12.5	7	3	P. radiata	CC3	CCA	0.032	90	all sap	no	Exposed	no	TZ	3	45	3		4	S	no	no	yes	2	no	9
Hanging posts	Townsville	12.5	7	3	P. radiata	CC3	CCA	0.032	90	all sap	no	Exposed	no	LLT	3	2		3	15+	T	no	no	yes	2	no	9
CSIRO P5-7 test	Sydney	25	5	3	P. radiata	CC2	CCA	0.02	76x50	all sap	no	Exposed	no	LLT	5	3		5	25+	L/T	no	no	no	1	no	15
CSIRO P5-7 test	Kwinana	25	4	3	P. radiata	CC2	CCA	0.02	76x51	all sap	no	Exposed	no	LLT	5	3		5	25+	L/T	no	no	no	1	no	12
Salt lake	Port Augusta	3	3	3	P. radiata	CC0	CCA	0.0065	120	all sap	no	calm	no	AW	8	3		3	10+	none	no	no	no	1	no	2
Yacht club jetty	Coffin Bay	6	3	3	P. radiata	CC2	CCA	0.02	135	all sap	no	Exposed	no	none	20	0		0	20+	none	no	no	no	1.5	no	2
Yacht club jetty	Coffin Bay	6	3	3	P. radiata	CC0	CCA	0.0063	80x50	all sap	no	Exposed	no	none	5	0		0	10+	none	no	no	no	1.5	no	4
Oyster posts	Coffin Bay	10	3	3	P. radiata	CC0	CCA	0.0063	70	all sap	no	Exposed	yes	ML	15	30	8		9	T/L	no	no	no	2	no	15
Oyster posts	Coffin Bay	10	3	3	P. radiata	CC0	CCA	0.0063	70	all sap	no	Exposed	no	ML	15	12	12		12+	T/L	no	no	no	2	no	7
Oyster posts	Coffin Bay	20	3	3	P. radiata	CC2	CCA	0.02	70	all sap	no	Exposed	yes	ML	15	10	20		20+	T/L	no	no	no	2	no	14

Table E7 Field assessment data of **CCA-treated hardwood** piles

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]	[16]	[17]	[18]	[19]	[20]	[21]	[22]	[23]	[24]	[25]	[26]	[27]
Bowen 1-50	Bowen	3	7	3	Corymbia maculata	HW4	CCA	0.008	350	30	no	Exposed	no	ML	50	80	2.5y	170	4	T	no	no	no	2.5	no	10
Hobart 1-20	Hobart	12	1	3	Euc obliqua	HW4	CCA	0.008	350	25	no	Exposed	no	MMT	20	10		20	20+	T/L	no	no	no	2.5	no	12
Tamar 1-20	Tamar River Mouth	23	1	3	Euc obliqua	HW4	CCA	0.008	350	25	no	Exposed	no	MMT	20	15		25	25+	T/L	no	no	no	3.5	no	24
E3,E4,E9,E11,E13,E18	Townsville, Ross river	9	7	3	C. maculata	HW4	CCA	0.012	350	30	no	Exposed	no	MMT	6	9		15	15	T/M	no	no	no	2	no	54
Posts1-4	Port Stephens	19	5	2	E. pilularis	HW3	CCA	0.022	100	12	no	Calm	no	MMT	4	40	15y	50	16	T/S	no	no	yes	2	yes	85
Posts 1-4	Sydney	20	5	3	E. pilularis	HW3	CCA	0.022	100	12	no	Exposed	no	MMT	4	5	20+	5	20+	T	no	no	no	3	no	44
Post 1	Port Stephens	19	5	2	C. maculata	HW4	CCA	0.012	100	32	no	Calm	no	MMT	1	50	14y		14	T	no	no	yes	2	yes	342
Posts 1-3	Sydney	20	5	3	C. maculata	HW4	CCA	0.012	100	32	no	Exposed	no	MMT	3	45	14y	50	16	T	no	no	no	3	no	122
Posts 1-3	Kwinana	25	4	3	E. macrorhyncha	HW3	CCA	0.01	90	25	no	Exposed	no	MMT	3	45	12		12	T	no	no	no	3	no	58
Posts 1-3	Sydney	25	5	3	E. macrorhyncha	HW3	CCA	0.01	90	25	no	Exposed	no	MMT	3	45	13		14	T	no	no	no	3	no	76
Posts 1-3	Port Hedland	9.5	6	3	E. macrorhyncha	HW3	CCA	0.01	90	25	no	Exposed	no	MMT	3	45	3		3	T	no	no	no	5	no	27
Posts 1-3	Brisbane River	9.5	5	1	E. macrorhyncha	HW3	CCA	0.01	90	25	no	Exposed	no	MMT	3	45	4		8	T	no	no	no	3	yes	21
Posts 1-6	Townsville	10	7	3	E. obliqua	HW4	CCA	0.016	60	26	no	Exposed	no	MMT	6	30	3		3.3	T	no	no	yes	2	no	56
Posts 1-6	Townsville	10	7	3	E. obliqua	HW4	CCA	0.022	60	26	no	Exposed	no	MMT	6	30	3.5		4.5	T	no	no	yes	2	no	22
Posts 1-6	Port Stephens	10.6	5	2	E. obliqua	HW4	CCA	0.016	60	26	no	Calm	no	MMT	6	30	6		8	T	no	no	yes	2	yes	36
Posts 1-6	Port Stephens	10.6	5	2	E. obliqua	HW4	CCA	0.022	60	26	no	Calm	no	MMT	6	30	6.5		8.1	T	no	no	yes	2	yes	20
Jetty 3, piles	Fremantle	32	4	3	E. marginata	HW3	CCA	0.014	360	15	no	Calm	no	MMT	200	10	28	180	40	T/L	no	no	no	2.5	no	142
Fender piles	Broome	24	6	3	E. marginata	HW3	CCA	0.014	450	15	no	Exposed	yes	MMT	20	150	15	225	18	T/L	no	no	no	3	no	252
Mooring piles 1&2	Port Douglas	16	7	3	Turpentine	HW1	CCA	0.012	380	27	no	Exposed	no	MMT	2	47	>20	20	>20	S/M	no	no	no	2.5	no	43
C18&D16	Bowen	13.7	7	3	Turpentine	HW1	CCA	0.012	380	27	no	Exposed	no	TZ	2	50		70	18	S/M	no	no	no	2	not	38

Table E8 Field assessment data of **Creosote-treated softwood** piles

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]	[16]	[17]	[18]	[19]	[20]	[21]	[22]	[23]	[24]	[25]	[26]	[27]
1-4 CSIRO test	Port Stephens	19	5	2	P. radiata	4	0.88	0.0158	100	All sap	no	Calm	no	TZ	4	20	18	40	22+	S/L	no	no	yes	2	yes	15
1-4 CSIRO test	Sydney	20	5	3	P. radiata	4	0.88	0.0158	100	All sap	no	Exposed	no	LLT	3	25	17	5	20	L	no	no	no	3	no	9
1-4 CSIRO test	Cairns	11	7	3	P. radiata	4	0.88	0.0158	100	All sap	no	Exposed	no	LLT	3	0		0	20+	none	no	no	no	3	no	9
CSIRO P5-7 test	Sydney	25	5	3	P. radiata	4	0.64	0.0115	76x50	All sap	no	Exposed	no	LLT	5	0	5		6	L	no	no	no	3	no	17
Mooring piles	Port Wakefield	29	3	3	P. radiata	4	0.4	0.0072	450	100	no	Calm	no	none	12	0			40+	none	no	no	no	0	no	32
Cowell jetty piles	Frankin Harbour	18	3	3	P. radiata	4	0.6	0.0108	410	100	no	Exposed	yes	LT	20	30	25	200	30	L	no	yes	no	3	no	30
Cowell jetty piles	Frankin Harbour	35	3	3	P. radiata	4	0.6	0.0108	410	100	no	Exposed	yes	LT	20	130	25	200	30	L	no	yes	no	3	no	62
Jetty piles	Tumby Bay	30	3	3	P. radiata	4	0.6	0.0108	425	100	no	Exposed	yes	LT	10	30	25	50	35+	L	no	yes	no	3	no	53

Table E9 Field assessment data of **Creosote -treated hardwood** piles

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]	[16]	[17]	[18]	[19]	[20]	[21]	[22]	[23]	[24]	[25]	[26]	[27]
Mooring pile C17	Bowen	14	7	3	C. maculata	HW4	0.15	0.0027	350	30	no	Exposed	no	TZ	1	1			30+	S/L	no	no	no	2	no	6
Mooring pile C17	Bowen	26	7	3	C. maculata	HW4	0.15	0.0027	350	30	no	Exposed	no	TZ	1	13			30+	S/L	no	no	no	2	no	12
Mooring piles	Bundaberg	9	7	3	C. maculata	HW4	0.15	0.0027	350	30	no	Exposed	no	none	4	0			15+	None	no	no	no	2	yes	4
Mooring piles Ross River	Townsville	9	7	3	C. maculata	HW4	0.15	0.0027	350	30	no	Exposed	no	ML	5	1.5		2	15+	M/S	no	no	no	2	no	4
Oyster posts	Port Stephens	20	5	2	C. maculata	HW4	0.15	0.0027	120	30	no	Calm	no	TZ	10	4		7	20+	S	no	no	no	2	yes	8
1-4 CSIRO test	Port Stephens	19	5	2	C. maculata	HW4	0.1	0.0018	100	32	no	Calm	no	TZ	4	12	19		19	L	no	no	yes	2	yes	10
1-4 CSIRO test	Sydney	20	5	3	C. maculata	HW4	0.1		100	32	no	Exposed	no	LLT	4	30	14		14	L	no	no	no	3	no	6
1-4 CSIRO test	Port Stephens	19	5	2	E. pilularis	HW3	0.24		100	12	no	Calm	no	TZ	2	2		2	25+	L	no	no	yes	2	yes	6
1-4 CSIRO test	Sydney	20	5	3	E. pilularis	HW3	0.24		100	12	no	Exposed	no	LLT	3	3		4	25+	L	no	no	no	3	no	4
CSIRO P5-7 test	Sydney	25	5	3	E. macrorhyncha	HW3	0.36		90	100	no	Exposed	no	LLT	3	1		2	30+	L	no	no	no	3	no	4
CSIRO P5-7 test	Kwinana	25	4	3	E. macrorhyncha	HW3	0.36		90	100	no	Exposed	no	LLT	2	0		0	30+	none	no	no	no	3	no	3
CSIRO P5-7 test	Sydney	25	5	3	E. macrorhyncha	HW3	0.19		90	100	no	Exposed	no	LLT	3	6	25	10	28+	L	no	no	no	3	no	5
CSIRO P5-7 test	Kwinana	25	4	3	E. macrorhyncha	HW3	0.19		90	100	no	Exposed	no	LLT	2	6	21	10	25+	L	no	no	no	3	no	4

Table E10 Field assessment data of **Double-treated softwood** piles

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]	[16]	[17]	[18]	[19]	[20]	[21]	[22]	[23]	[24]	[25]	[26]	[27]
C21&D19	Bowen	13.7	7	3	P. radiata	4	DBT	std	430	100	no	Exposed	no	TZ	2	20			20+	S	no	yes	no	2	no	9
Mooring pile 3&4	Port Douglas	25.9	7	3	P. radiata	4	DBT	std	420 & 470	100	no	Calm	no	TZ	2	20		25	30+	S/M	no	yes	no	3	yes	100
Burnett River	Bundaberg	9	7	3	P. elliottii	4	DBT	std	350	100	no	Exposed	no		3	0			30+	None	no	no	no	2	yes	0
Burnett River	Bundaberg	5	7	3	P. elliottii	4	DBT	std	350	100	no	Exposed	no		3	0			30+	None	no	no	no	3	yes	0
Mooring piles	Townsville, Ross river	2	7	3	P. elliottii	4	DBT	std	350	100	no	Exposed	no	TZ,ML	6	0		3	30+	S/M	no	no	no	2	no	0
Mooring piles	Townsville, Ross river	4	7	3	P. elliottii	4	DBT	std	350	100	no	Exposed	no	TZ,ML	6	0		3	30+	S/M	no	no	no	2	no	0
Mooring piles	Townsville, Ross river	6	7	3	P. elliottii	4	DBT	std	350	100	no	Exposed	no	TZ,ML	6	0.5		3	30+	S/M	no	no	no	2	no	0
Mooring piles	Townsville, Ross river	9	7	3	P. elliottii	4	DBT	std	350	100	no	Exposed	no	TZ,ML	6	2		3	30+	S/M	no	no	no	2	no	0
Mooring piles	Cairns	2	7	3	P. elliottii	4	DBT	std	350	100	no	Exposed	no	TZ	6	0		3	30+	S	no	no	no	2	no	0
Mooring piles	Cairns	4	7	3	P. elliottii	4	DBT	std	350	100	no	Exposed	no	TZ	6	0		3	30+	S	no	no	no	2	no	0
Mooring piles	Cairns	6	7	3	P. elliottii	4	DBT	std	350	100	no	Exposed	no	TZ	6	0.5		3	30+	S	no	no	no	2	no	0
Mooring piles	Cairns	9	7	3	P. elliottii	4	DBT	std	350	100	no	Exposed	no	TZ	6	2		3	30+	S	no	no	no	2	no	0
1-4 CSIRO test	Port Stephens	19	5	2	P. radiata	4	DBT	std	100	100	no	Calm	no	MMT	4	4		4	23+	S	no	no	yes	2	yes	13
1-4 CSIRO test	Sydney	20	5	3	P. radiata	4	DBT	std	100	100	no	Exposed	no	MMT	4	2		3	25+	L	no	no	no	3	no	9

Table E11 Field assessment data of **Double-treated hardwood** piles

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]	[16]	[17]	[18]	[19]	[20]	[21]	[22]	[23]	[24]	[25]	[26]	[27]
Brackish water jetty	Port Stephens	15	5	2	C. maculata	HW4	DBT	std	330	30	no	Calm	no	TZ	18	0		10	45+	L/S	no	no	no	2	yes	3
Brackish water jetty	Port Stephens	24	5	2	C. maculata	HW4	DBT	std	330	30	no	Calm	no	TZ	18	1		10	45+	L/S	no	no	no	2	yes	12
Brackish water jetty	Port Stephens	30	5	2	C. maculata	HW4	DBT	std	330	30	no	Calm	no	TZ	18	2		10	45+	L/S	no	no	no	2	yes	18
Mooring piles	Bundaberg	9	7	3	C. maculata	HW4	DBT	1.2% +11%	350	30	no	Exposed	no	none	4	0			15+	None	no	no	no	2	yes	0
Mooring piles	Townsville	9	7	3	C. maculata	HW4	DBT	1.2% +11%	350	30	no	Exposed	no	TZ	6	0.5		1	15+	S/M	no	no	no	2	no	0
Mooring piles	Bundaberg	9	7	3	E. pilularis	HW3	DBT	1.4% +15%	350	30	no	Exposed	no	none	4	0			15+	None	no	no	no	2	yes	0
Mooring piles	Townsville	9	7	3	E. pilularis	HW3	DBT	1.4% +15%	350	30	no	Exposed	no	TZ	6	0.2		0.5	15+	S/M	no	no	no	2	no	0
Pittwater piles	Sydney	20	5	3	C. maculata	HW4	DBT	std	350	30	no	Exposed	no	TZ	100	1		2	30+	S	no	no	no	2	no	5
1-4 CSIRO test	Port Stephens	19	5	2	C. maculata	HW4	DBT	1.2% +13%	100	32	no	Calm	no	TZ	3	5		8	25+	S	no	no	yes	2	yes	7
1-4 CSIRO test	Sydney	20	5	3	C. maculata	HW4	DBT	1.2% +13%	100	32	no	Exposed	no	LLT	4	2		3	25+	L	no	no	no	3	no	5
1-4 CSIRO test	Port Stephens	19	5	2	E. pilularis	HW3	DBT	1.7% +14%	100	12	no	Calm	no	TZ	3	3		5	25+	S	no	no	yes	2	yes	7
1-4 CSIRO test	Sydney	20	5	3	E. pilularis	HW3	DBT	1.7% +14%	100	12	no	Exposed	no	LLT	4	1		3	25+	L	no	no	no	3	no	5
Piles	Brighton Baths	18	2	3	C. maculata	HW4	DBT	std	350	30	no	Exposed	yes	none	5	0			30+	none	no	no	no	0.5	no	3
Mooring pile D15	Bowen	14	7	3	C. maculata	HW4	DBT	1.2% +10%	350	30	no	Exposed	yes	TZ	1	2				S/L/T	no	no	no	2	no	5
Mooring pile D15	Bowen	18	7	3	C. maculata	HW4	DBT	1.2% +10%	350	30	no	Exposed	yes	TZ	1	30				S/L/T	no	no	no	2	no	14
Mooring pile D15	Bowen	20	7	3	C. maculata	HW4	DBT	1.2% +10%	350	30	no	Exposed	yes	TZ	1	40				S/L/T	no	no	no	2	no	19
Mooring pile D15	Bowen	22	7	3	C. maculata	HW4	DBT	1.2% +10%	350	30	no	Exposed	yes	TZ	1	50				S/L/T	no	no	no	2	no	23
Mooring pile D15	Bowen	24	7	3	C. maculata	HW4	DBT	1.2% +10%	350	30	no	Exposed	yes	TZ	1	80				S/L/T	no	no	no	2	no	28
Mooring pile D15	Bowen	26	7	3	C. maculata	HW4	DBT	1.2% +10%	350	30	no	Exposed	yes	TZ	1	110			25	S/L/T	no	no	no	2	no	113