Report

FWPA R&D Program Evaluation

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Prepared for

Forest and Wood Products Australia

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Introduction

Forest and Wood Products Australia (FWPA) directs investment into research and development (R&D) projects that aim to increase the competitiveness and profitability of the forest and wood product-based industries. Since January 1996, FWPA has invested in 423 projects within 14 investment priority areas.

According to the protocol developed by the Council of Rural Research and Development Corporations Chairs (CRRDCC) has committed to regularly undertaking an evaluation of its investment program by considering a representative sample of projects and scaling this up to reflect the overall benefits of FWPA's R&D investment program.

This report contains the results from the evaluation of nine of FWPA's research projects.

Methodology

Six projects from each of FWPA's major investment categories (growing, processing and marketing) were randomly selected. These were then shortlisted to three projects, which represented high, low and average cost projects, all of which commenced after April 2002 and which were completed and delivered before July 2009. The short-list was discussed with FWPA to help refine the selection. The final selection of nine projects is contained in Table 1. Note that some projects have been combined and reviewed as a single project because the project benefits could not be readily attributed to a single project.

Table 1 Projects that have been included in the review

Major Grouping	Project Number	Project Title
Growing - high	PN03.1915	An advanced genetic evaluation system for forest tree improvement (TREEPLAN)
	PN07.4025	Genetic gain optimisation in tree breeding (MATEPLAN) and deployment (SEEDPLAN)
Growing - medium	PN04.3003	Genetic variation in wood properties of *E. dunnii* relevant to solid wood products
	PN06.3017	Improving dimensional stability in plantation-grown *E. pilularis* and *E. dunnii*
Growing - low	PRC072-0708	Fertiliser usage in forestry: current status and prospects for increasing its efficiency and profitability
Processing - high	PN04.2004	Wood quality initiative
Processing - medium	PNC053-0708	Standing tree measurement of acoustic velocity as a predictor of kraft pulp yield in *E. nitens* across 2 sites
Processing - low	PN04.2002	Treatment correction factors for capacitance meters with radiata pine and slash pine
	PN07.2045	Moisture meter corrections for ACQ treated pine
Marketing - high	PN03.1213	A risk based approach to enhancing the perception of timber as a suitable construction material in termite prone areas
Marketing - medium	PNA020-0809	Strategy for large span second storey timber and wood products
Marketing - low	PNA014-0708	Assessing the ability of a large-scale fire test to predict the performance of wood poles exposed to bushfires and the ability of fire protective formulations to reduce loss of wood poles exposed to severe bushfires

URS

Benefit cost analysis (BCA) has been used to undertake the evaluation of each project. The BCA framework involves defining a base case (or counterfactual) against which the project impacts can be assessed in terms of the projects' Net Present Value (NPV), Benefit Cost Ratio (BCR) and the Internal Rate of Return (IRR).

The BCAs consider the total funds invested in a given project relative to the total benefits that the projects have conferred to Australian society, rather than just those costs (and benefits) incurred by FWPA. In addition to FWPA's funding, most of the projects have also obtained additional funding through either in-kind contributions or third-party investment. Environmental outcomes from the projects have been identified and quantified where possible. None of the projects were considered to have any quantifiable social value.

Project leaders and key industry contacts were consulted to inform the evaluation, with supporting information and data obtained through desktop research.

The project level evaluations have been 'scaled up' using the estimated benefit cost ratios to estimate the program level benefits.

Results

Project level results

Table 2 contains the summary results for the projects. For each project, results are evaluated through to 50 years after the project was completed, using a five percent discount rate. A 50 year timeframe was considered appropriate for forestry projects where the benefits often accrue only after trees are grown and harvested. Monetary values are reported in 2009 dollars. It was not possible to estimate the benefits of the medium value growing and processing projects and the high value marketing project in quantitative terms. Further details about the assessment of these projects are contained in Appendices A - I.

Table 2 Results of project analysis

	Project value		
Project	**Low**	**Medium**	**High**
Growing			
BCR	1.4	NA	15.4
IRR	3%	NA	21%
Processing			
NPV ($ 000)	$346	NA	$14,717
BCR	3.1	NA	5.5
IRR	16%	NA	26%
Marketing			
NPV ($ 000)	$702	$821	NA
BCR	4.9	6.4	NA
IRR	42%	48%	NA

* Note that all BCRs are evaluated over 50 years, using a 5% discount rate. Values are reported in 2009 dollars.
Source: URS estimates.

All projects for which the benefits were quantified provided a positive NPV. There is significant variation in the NPVs associated with the projects and the BCR's ranging from 1.4 to 15.4.

Program level results

The results obtained for each category have not been aggregated to obtain a measure of the overall benefits achieved from FWPA's entire investment portfolio. This was based on the assessment that such aggregation would not be reflective of the potential benefits. Rather, aggregation has been undertaken at the category level (i.e. growing, marketing, and processing). Table 3 contains the estimated benefit and weighted average BCR, aggregated for each investment category.

Table 3 Evaluation: category level aggregation

	Number	Total value invested ($ 000)	Value of sample projects ($ 000)	Sample projects as % of total	Weighted average BCR	Estimated benefits from total investment ($ 000)
Growing category	33	$16,694	$2,626	16%	14.8	$247,894
Processing category	58	$35,150	$3,004	9%	5.4	$189,550
Marketing category	47	$18,924	$594	3%	2.4	$45,061

Note that all BCRs are evaluated over 50 years, using a 5% discount rate. Values are reported in 2009 dollars.
Source: URS estimates.

The BCRs across the categories are all positive, ranging from 2.4 to 14.8, with the growing category projects providing higher weighted average BCRs than processing or marketing projects Applying these BCRs to the total value invested provides an indication of the benefits that may be expected in each category. However, the aggregation required to calculate these potential benefits means that the estimates should be treated with a significant degree of circumspection. Not every project within these categories can be expected to achieve the estimated BCR.

Sensitivity analysis results

Table 4 contains the results from the sensitivity analysis, reflecting both high and low estimates. The results continue to be positive for all but the low-value growing project. Further information about the assumptions that underpin the sensitivity analyses are contained in the relevant appendices.

Table 4 Sensitivity analysis - project results

	Benefit Cost Ratio*	
Project	Low estimate	High estimate
Growing - low	0.7	4.8
Growing - high	6.8	32.8
Processing - low	2.0	7.1
Processing - high	4.4	7.3
Marketing - low	2.8	15.2
Marketing - medium	2.9	12.2

* Note that all BCRs are evaluated at over 50 years, using a 5% discount rate.
Source: URS estimates.

Discussion

The results suggest that the "growing" research provides the greatest return on investment, despite the long time horizons before some benefits are accrued. The primary reason for this is that projects resulting in genetic gains will increase yields from a given area of land without any substantial change in the costs of managing that land during the rotation. Benefits are therefore transferred straight to the bottom line of growers at the time of harvesting. This contrasts to the processing projects where the potential to increase revenue from quality improvements is limited by the commodity nature of the product and volume based costs associated with production.

The research projects associated with the growing sector also produced information with the potential to be readily applied across both the softwood and hardwood plantation industries. In addition, adoption of research outcomes in the growing sector is expected to be rapid as the beneficiaries of the research are a relatively small group.

The marketing research appears to provide the lowest estimated return on investment. However, this does not necessarily mean that this area of research is not worthwhile for the forest industry. Rather, it is likely that this result reflects a conflict between the methodology for assessing the benefits in this analysis and the charter of the FWPA in funding marketing projects. While the FWPA will fund projects to maximise the value of returns to the timber industry at the expense of other competitive industries (e.g. steel), the Cost Benefit Analysis assesses the benefits to society as a whole. As such, any increase in the market share of timber is valued only in terms of the net cost saving to society, not the increase in revenue to the timber industry. In marketing projects the 'technology' transfer (i.e. extension and marketing activity) also needs to be directed at a much broader audience than for the other research categories, which makes it particularly difficult to maximise the impact of a given marketing project.

Environmental and social impacts

Environmental and social impacts were considered for all projects; however, environmental benefits could be estimated quantitatively for only one of the projects. This was the 'Assessing the ability of a large-scale fire test to predict the performance of wood poles exposed to bushfires and the ability of fire protective formulations to reduce loss of wood poles exposed to severe bushfires' project (PNA014-0708), which was assumed to result in the substitution of wooden poles for steel or concrete equivalents. In this case there was technical information available to assess the differences in embodied energy between the alternative products and some early signals on carbon prices (although this market has not yet been established. For other projects, the environmental and social impacts of the research (relative to the base case) could not be accurately quantified. There are a number of reasons for this:

- Of the projects selected for evaluation, many were considered to have no, or very limited, direct environmental or social impacts.
- For some projects that could potentially have environmental or social impacts, quantifying the impacts with any confidence was not possible because of the lack of technical or market price information.
- For other projects, many of the environmental and social benefits are already captured in the benefits derived from improved efficiency. In these cases, estimating the environmental and social benefits would result in double-counting of the project benefits.

Although direct environmental and social impacts have not been identified or estimated for a number of the projects, it is important to recognise that there may be secondary environmental and social benefits associated with projects that result in productivity improvements. Through such improvement, fewer resources are required to produce the same volume of output, potentially resulting in a smaller ecological footprint and, hence, in environmental benefits. Society also benefits through the improved living standards that result from productivity improvements.

It is also important to recognise that there is a broader benefit to society from maintaining research capacity that is capable of tackling future research needs. Research capacity, particularly in terms of scientists, engineers and technicians, cannot be established quickly. Reduction in research capacity could mean that potential productivity improvements are foregone and that Australia becomes increasingly reliant on the international research effort. Both outcomes could reduce the competitiveness and performance of Australia's Forest and Wood Products sector.

Limitations

Project level results

There are a number of qualifications associated with the results:

- Estimates of costs and benefits are contingent on a number of assumptions. The assumptions underpinning our estimates have been based on discussions with project leaders, industry contacts and professional judgement; however they are nonetheless subjective and should be considered indicative of the order of magnitude rather than the actual value of research.
- For many of the projects that were reviewed, identifying the counterfactual (or base case) was not always clear and it is possible that the project benefits will be either under- or over-estimated.
- Even where the assumptions about the costs and benefits have been estimated with relative certainty, the extent to which the research results are adopted by industry will have a significant bearing on the projects' overall impact. In the short term (e.g. in the five years after a project is completed), it is generally easier to consider the adoption rate, because market conditions are more certain. In the longer term, adoption is more difficult to assess as there are likely to be a number of unforeseen factors that may affect adoption. Long term adoption rates also depend on assumptions regarding whether or not industry participants would have undertaken their own research and reached similar conclusions in the absence of FWPA investment.
- Generally speaking, research results are but one factor influencing the market for timber products and the competitiveness and profitability of businesses operating in the forest and wood products industry. Movements in the exchange rate, the price of alternative products, and residential housing starts are all factors that have a significant influence on the timber products market. It is often difficult to distinguish the effects of research from these other influences.

Program level results

The projects that were selected for evaluation were done so as to be consistent with the CRRDCC requirements of representativeness and randomness. Taken literally, these two objectives are mutually exclusive as representativeness cannot be achieved if the selection process is strictly random. The approach taken in this review was to select projects from each of FWPA's broad investment categories and within these, to randomly select projects to represent high, medium and low value investments.

These estimated benefits should not be considered reflective of the actual benefits associated with the investment that has been made in each of these categories, because of the variability in BCRs that is evident at the project level. Rather, the results could best be considered as a tool for guiding the investment between and within the three broad categories.

Introduction

Forest and Wood Products Australia (FWPA) directs investment into research and development (R&D) projects that aim to increase the competitiveness and profitability of the forest and wood product-based industries. Since January 1996, FWPA has invested in 423 projects within 14 investment priority areas.

According to the protocol developed by the Council of Rural Research and Development Corporations Chairs (CRRDCC) FWPA has committed to regularly undertaking an evaluation of its investment program by considering a representative sample of projects. This specific program evaluation will also contribute to FWPA's submission to the recently announced Productivity Commission inquiry into Rural Research and Development.

URS Australia Pty Ltd (URS) has been engaged to undertake this evaluation and this report outlines the process employed to undertake the work and the results of the analysis. Section 2 of the report outlines the evaluation methodology and Section 3 provides the program-level evaluation results. A discussion of the results is presented in Section 4. Appendices A to I contain a detailed description of the projects that were assessed to inform the program-level results.

Methodology

Benefit cost analysis (BCA) has been used to undertake the evaluation of each project. The BCA framework involves defining a base case (or counterfactual) against which the project impacts can be assessed in terms of the project's Net Present Value (NPV), Benefit Cost Ratio (BCR) and the Internal Rate of Return (IRR).

The BCAs consider the total funds invested in a given project relative to the total benefits that the projects have conferred to Australian society, rather than just those costs (and benefits) incurred by FWPA. In addition to FWPA's funding, most of the projects have also obtained additional funding through either in-kind contributions or third-party investment. Environmental outcomes from the projects have been identified and quantified where possible. None of the projects were considered to have any quantifiable social value.

Project leaders and key industry contacts were consulted to inform the evaluation, with supporting information and data obtained through desktop research.

The following section describes the methodology in further detail, starting from the identification of the project population from which the sample was drawn.

2.1 Project population

FWPA requested that only projects initiated from 1 April 2002 and which had been completed and delivered before July 2009 should be included in the evaluation. Projects selected for funding after this date were subject to a standardised project approval and management system. The number of projects that have commenced since this date is 188.

In addition, the FWPA has suggested that its 14 investment priority areas should be aggregated into three broad 'working' investment categories: growing, processing, and marketing. Table 2-1 includes summary information about the population from which the projects were selected. Reference to cost is to the total investment in the R&D project regardless of the source of funds.

Table 2-1: Summary of project population

Projects with 2002-09 commencement date	Priority area			Total
	Growing	Processing	Marketing	
Number of projects	41	77	70	**188**
% of total projects funded	22%	41%	37%	**100%**
Total cost	$16,826,937	$35,149,734	$18,924,126	**$70,900,796**
% of total project cost	26%	41%	37%	
Highest cost project	$4,293,950	$4,200,000	$3,899,700	
Average cost project	$403,401	$370,533	$295,723	
Lowest cost project	$15,000	$10,000	$1,680	

2.2 Step 1: Sampling

The CRRDCC Guidelines for Evaluations describe the methodology for assessing the impact of R&D programs funded by the Research and Development Corporations (RDCs). The two most critical elements of the CRRDCC's guidelines are the need to create a representative sample of independent investments[1] and for this sample to be random.

The Guidelines specify that the population of sub-programs[2] from which a random sample is drawn should be based on a population that conforms to the following characteristics:

- *A series of 'clusters' of projects commissioned to contribute to a particular defined area of investigation that was established to produce a particular product, service or other outcome. These may be sub-programs or simply related projects leading to a specific outcome.*
- *The sampling process should be random, that is all defined sub-programs or their equivalent should be put into the population from which the pooled samples will be drawn.*
- *The 'sub-program' or cluster of projects must have reached (but not necessarily achieved) a significant milestone within the last 2-5 years.*
- *The time frame for the population from which the sample will be drawn should be long enough for some confidence in the technology to be built (usually indicated by early adoption rates) and for sufficient data to be available (such as ABS or ABARE survey reports).*
- *The pool of CBAs proposed will be based on a three year cycle. This means that the pool of sampled projects will initially be built up over three years once the process has been implemented. Once the pool has been established, each subsequent year will be added and a year dropped off. This will provide a three year moving average with results published each year.*
- *The program can have either an off-farm or on-farm orientation (supply or demand focus).*

Based on this guidance, and through our discussions with the FWPA, URS has developed the following methodology for an evaluation that is consistent with these two overarching requirements.

2.2.1 Sampling process

A fixed sampling rate for each of the three investment categories (growing, processing and marketing) was used. Six projects were randomly selected from each category which were then shortlisted to three projects for each category. For each of these categories, the sample projects were selected to represent high, low and average cost projects. Overall, nine projects were selected for evaluation.

The short-list was discussed with FWPA to help refine the selection. Some projects were rejected on the grounds that they related to the delivery of workshops. Other projects were combined, where they represented sequential research effort for a particular project outcome[3]. The Wood Quality Initiative (PN04.2004) was included at FWPA's suggestion, as a representative large-scale processing project .

2.3 Step 2: Benefit cost analysis

Following the selection of the sample, the BCA was undertaken using the following key steps:

- Specification of the objectives of the projects to be evaluated;
- Defining the base case;

[1] Note that, in the current context, an 'independent investment' is assumed to refer to a stand alone research project.
[2] Note that, from FWPA's perspective, 'sub-programs' are considered equivalent to research projects.
[3] For example the Treatment correction factors for capacitance meters with radiata pine and slash pine (PN04.2002) and the Moisture meter corrections for ACQ treated pine projects (PN07.2045).

- Identifying project impacts relative to the base case;
- Assessing project impacts (quantitatively, where possible);
- Undertaking the BCA at the project level
- Aggregating results to the program level; and
- Performing sensitivity testing of key parameters

These steps are elaborated in the following sections.

Specifying the objectives of the proposed projects to be evaluated

The objectives of the projects were determined based on the detailed project proposals, final reports and discussion with project leaders.

Defining the base case (or counterfactual)

The base case is also known as the 'counterfactual' or 'business-as-usual' scenario and was defined using input from both project staff and industry contacts. Industry contacts included:

- Representatives from hardwood and softwood plantation companies;
- Technical and business development managers and CEOs from softwood processing companies;
- Representatives from industry associations;
- Principal research scientists and managers from research organisations;
- Plant breeding managers from plantation companies;
- Industry consultants;
- Engineers from industry manufacturing companies; and
- Representatives from wood preservation companies.

The base case provides the point of reference for the assessments, and each project was assessed relative to the base case over an appropriate time period. The CRRDCC Guidelines for Evaluations recommend, as a minimum, 5, 10 and 20 year assessment horizons and all projects were assessed over these horizons. Projects were also assessed over a 50 year horizon in recognition of, for example, "growing" projects, where the benefits often accrue only after trees are grown and harvested.

It is important to recognise that the base case is not the current situation, but rather the expected future in the absence of any change from continuation of the business-as-usual scenario. For example, the industry may receive benefits from private sector investment in processing technology, regardless of whether FWPA makes an investment in this area. Therefore the base case should incorporate these benefits to the extent possible.

In defining the base case, it was also necessary to recognise that the reference year for calculating the benefit cost ratio (BCR) of each project differed. Accordingly, a CPI adjustment factor was used to ensure that projects with different reference years were compared on a consistent basis. All costs and benefits in this evaluation are based on 2009 dollars.

Identifying project impacts

A qualitative understanding of the likely impacts of implementing each of the projects, relative to the base case, was next obtained.

The project impacts were identified through the project proposals and final reports and were confirmed in discussions with project leaders and industry contacts.

The following approaches were taken to assessing the benefits:

- For projects that could result in increased forest productivity (e.g. genetics, fertiliser trials), benefits were estimated according to the potential increase in gross value resulting from increases in log volume at the stumpage level.
- For projects that could result in increases in final product value (e.g. improved timber quality), benefits were estimated according to the potential increase in gross value of the products ex-primary processing mill.
- For projects that could result in efficiency gains (e.g. improved processing tools and technologies), benefits were estimate according to the potential reduction in operating costs.
- For projects that could result in an increase in the volume of timber products sold in Australia (e.g. improved perceptions of wood products), benefits were estimated by the cost savings to consumers that purchase these products.[4]

There is a very important qualification relating to any benefits that may accrue as a result of timber product quality or reduced processing costs. Structural timber is considered to be a commodity product and the ability of any single enterprise to differentiate their products and gain a competitive advantage in terms of price or profits will be limited to early movers. These benefits are only likely to accrue for a short period of time before the rest of the market is selling a similar quality product, or has made similar reductions to costs that result in reductions in the product price.

Care was taken to avoid double-counting of benefits and costs. For example, if the benefits of an investment resulted in an increase in the value of wood production (primary market) it was not counted a second time in relation to an increase in employment (secondary market) that this may have caused.

Assessing project impacts

Following the confirmation of the impacts in physical or qualitative terms, the magnitude of costs and benefits was estimated. The most convenient metric for analysis is to measure costs and benefits in monetary terms (i.e. 2009 dollars). This is most straightforward where the project resulted in changes to the quantity or value of goods and services that are traded in markets, and hence have an associated market price. For example, the benefit of a project that results in increased forestry production can be measured by the increase in revenue arising from that project. Similarly, reductions in operating costs are a monetary measure of the benefits of a given project.

Some project impacts produced a benefit or conferred a cost to society that was not reflected in market transactions of goods and services. For example, environmental improvements are widely

[4]There is a conflict between the methodology for assessing the benefits in this analysis and the charter guiding FWPA's R&D investment in research into market access issues. While the FWPA will fund projects to maximise the value of returns to the timber industry at the expense of other competitive industries (e.g. steel), the BCA assesses the benefits to society as a whole. As such, any increase in the market share of timber is valued in terms of the net cost saving to society, not the increase in revenue to the timber industry.

recognised as a benefit to society. However, due to inherent difficulties in assigning property rights to these benefits, markets do not exist for the goods and services provided by the environmental resource. As a result, no market price exists to value these benefits.

Such values are often measured using techniques that attempt to reveal the price that people would be willing-to-pay to receive these benefits, known as non-market valuation (NMV) techniques. These include techniques such as the travel cost method, hedonic pricing, choice modelling, and contingent valuation. An alternative to these techniques is Benefit Transfer, which relies on secondary research to estimate NMV. However, the application of these techniques is usually a costly and time-consuming process.

Where possible, the environmental and social impacts of the R&D projects were estimated using existing literature that had been completed in relevant areas. Where this was not possible, a qualitative description of the impacts is provided.

Undertaking the BCA

Once the impacts associated with the projects were quantified (as far as possible), the stream of costs and benefits were converted into a single measurement at a point in time by using discounting. An MS Excel spreadsheet model was developed for this purpose.

Discounting is a common approach to accounting for costs, benefits or outputs that occur over different time periods. The process of discounting enables the direct comparison of an amount of money that accrues in different time periods. Discounting gives greater weight to initial benefits and costs and less weight to those in the distant future. The CRRDCC guidelines specify a real discount rate of five percent, which was used for the analyses.

The difference between the discounted sum of the costs and benefits associated with the project is known as the net present value (NPV). The NPV provided the basis for a number of different decision criteria, including:

- Benefit-cost ratio (BCR) – comparing benefits as a proportion of costs;
- Internal rate of return (IRR) - the discount rate at which the costs of the investment are equal to the benefits of the investment (i.e. NPV = 0).

Consistent with the CRRDCC guidelines, all three decision criteria are reported.

Aggregation of project evaluation

The project-level BCR's were 'scaled-up' based on the total expenditure in each of the three investment categories to provide a program-level evaluation for these categories.

Sensitivity analysis

Sensitivity analyses were undertaken on the parameter values of key costs and benefits to determine the relative significance of these variables in the overall evaluation. These analyses were undertaken for each project.

Results

The following section contains a summary of the BCA results for the three broad investment categories. Further detail relating to these results, including sensitivity testing, are contained in Appendices A - I.

The project-level results are followed by the program-level results.

3.1 Project results

Table 3-1 contains the summary results for the projects. For each project, results are evaluated through to 50 years after the project was completed, using a five percent discount rate. A 50 year timeframe was considered appropriate for forestry projects where the benefits often accrue only after trees are grown and harvested. Monetary values are reported in 2009 dollars. It was not possible to estimate the benefits of the medium value growing and processing projects and the high value marketing project in quantitative terms. Further details about the assessment of these projects are contained in Appendices A - I.

Table 3-1 Results for growing, processing and marketing investment projects

	Project value		
Project	**Low**	**Medium**	**High**
Growing			
BCR	1.4	NA	15.4
IRR	3%	NA	21%
Processing			
NPV ($ 000)	$346	NA	$14,717
BCR	3.1	NA	5.5
IRR	16%	NA	26%
Marketing			
NPV ($ 000)	$702	$821	NA
BCR	4.9	6.4	NA
IRR	42%	48%	NA

Note that all BCRs are evaluated over 50 years, using a 5% discount rate. Values are reported in 2009 dollars.
Source: URS estimates.

3.1.1 Summary

All projects for which the benefits were quantified provided a positive NPV. There is significant variation in the NPVs associated with the projects, with the BCR's ranging from 1.4 to 15.

3.2 Program results

The results obtained for each category have not been aggregated to obtain a measure of the overall benefits achieved from FWPA's entire investment portfolio. This was based on the assessment that such aggregation would not be reflective of the potential benefits. Rather, aggregation has been undertaken at the category level (i.e. growing, marketing, and processing). Table 3-2 contains the aggregated results for the growing, processing and marketing category projects.

Table 3-2 Growing, processing and marketing categories aggregation

	Number	Total value invested ($ 000)	Value of sample projects ($ 000)	Sample projects as % of total	Weighted average BCR	Estimated benefits from total investment ($ 000)
Growing category	33	$16,694	$2,626	16%	14.8	$247,894
Processing category	58	$35,150	$3,004	9%	5.4	$189,550
Marketing category	47	$18,924	$594	3%	2.4	$45,061

Note that all BCRs are evaluated over 50 years, using a 5% discount rate. Values are reported in 2009 dollars.
Source: URS estimates.

3.2.1 Summary

The BCRs across the categories are all positive, ranging from 2.4 to 14.8, with the growing category projects providing higher weighted average BCRs than processing or marketing projects Applying these BCRs to the total value invested provides an indication of the benefits that may be expected in each category. However, the aggregation required to calculate these potential benefits means that the estimates should be treated with a significant degree of circumspection. Not every project within these categories can be expected to achieve the estimated BCR.

3.3 Sensitivity analysis

Table 3-3 contains the results from the sensitivity analysis, reflecting both high and low estimates. The results continue to be positive for all but the low-value growing project. Further information about the assumptions that underpin the sensitivity analyses are contained in the relevant appendices.

Table 3-3 Sensitivity analysis - project results

	Benefit Cost Ratio*	
Project	Low estimate	High estimate
Growing - low	0.7	4.8
Growing - high	6.8	32.8
Processing - low	2.0	7.1
Processing - high	4.4	7.3
Marketing - low	2.8	15.2
Marketing - medium	2.9	12.2

* Note that all BCRs are evaluated over 50 years, using a 5% discount rate.
Source: URS estimates.

Discussion

BCA is widely used and is considered the most appropriate methodology to evaluate R&D investments. In this review, the BCA framework has been used to estimate the benefits and costs associated with the projects from society's perspective; however, for some projects, for example PNC053-0708, PN04.3003 and PN03.1213[5], the methodology was not as applicable.

For these projects, the research results enabled hypotheses to be disproved, but did not lead to a quantifiable market impact. Such results do not mean that the research should not have been funded. Rather, the benefits from such projects are generally more difficult to quantify and take the form of avoided future research effort or the maintenance of research capability, both of which are difficult to quantify in monetary terms. Another reason that such projects are not well-served by BCA is the difficulty associated with identifying a counterfactual scenario had the research not gone ahead. Hence it is not possible to develop two streams of costs and benefits for the 'with' and 'without' research projects scenarios to assess within the BCA framework.

Another concern with the BCA methodology is the need to quantify impacts in a common unit of assessment; namely the monetary value of the impacts. This is relatively straightforward for projects that result in, for example, changes in the volume or value of timber produced; however, for projects that incorporate environmental benefits, the estimation of value is more difficult. In this review, only a handful of projects are thought to have (or will result in) significant environmental benefits. These have been quantified where possible and where this is not the case, such benefits have been described qualitatively.

Environmental and social impacts

Environmental and social impacts were considered for all projects; however, environmental benefits could be estimated quantitatively for only one of the projects. This was the 'Assessing the ability of a large-scale fire test to predict the performance of wood poles exposed to bushfires and the ability of fire protective formulations to reduce loss of wood poles exposed to severe bushfires' project (PNA014-0708), which was assumed to result in the substitution of wooden poles for steel or concrete equivalents. In this case there was technical information available to assess the differences in embodied energy between the alternative products and some early signals on carbon prices (although this market has not yet been established). For other projects, the environmental and social impacts of the research (relative to the base case) could not be accurately quantified. There are a number of reasons for this:

- Of the projects selected for evaluation, many were considered to have no, or very limited, direct environmental or social impacts.
- For some projects that could potentially have environmental or social impacts, quantifying the impacts with any confidence was not possible because of the lack of technical or market price information.
- For other projects, many of the environmental and social benefits are already captured in the benefits derived from improved efficiency. In these cases, estimating the environmental and social benefits would result in double-counting of the project benefits.

[5] PNC053-0708 (Standing tree measurement of acoustic velocity as a predictor of kraft pulp yield in *E. nitens* across two sites); PN04.3003 (Genetic variation in wood properties of *E. dunnii* relevant to solid wood products); and PN03.1213 (A risk based approach to enhancing the perception of timber as a suitable construction material in termite prone areas).

Although direct environmental and social impacts have not been identified or estimated for a number of the projects, it is important to recognise that there may be secondary environmental and social benefits associated with projects that result in productivity improvements. Through such improvement, fewer resources are required to produce the same volume of output, potentially resulting in a smaller ecological footprint and, hence, in environmental benefits. Society also benefits through the improved living standards that result from productivity improvements.

It is also important to recognise that there is a broader benefit to society from maintaining research capacity that is capable of tackling future research needs. Research capacity, particularly in terms of scientists, engineers and technicians, cannot be established quickly. Reduction in research capacity could mean that potential productivity improvements are foregone and that Australia becomes increasingly reliant on the international research effort. Both outcomes could reduce the competitiveness and performance of Australia's Forest and Wood Products sector.

4.1 Results

The results suggest that the "growing" research provides the greatest return on investment, despite the long time horizons before some benefits are accrued. The primary reason for this is that projects resulting in genetic gains will increase yields from a given area of land without any substantial change in the costs of managing that land during the rotation. Benefits are therefore transferred straight to the bottom line of growers at the time of harvesting. This contrasts to the processing projects where the potential to increase revenue from quality improvements is limited by the commodity nature of the product and volume based costs associated with production.

The research projects associated with the growing sector also produced information with the potential to be readily applied across both the softwood and hardwood plantation industries. In addition, adoption of research outcomes in the growing sector is expected to be rapid as the beneficiaries of the research are a relatively small group.

The marketing research appears to provide the lowest estimated return on investment. However, this does not necessarily mean that this area of research is not worthwhile for the forest industry. Rather, it is likely that this result reflects a conflict between the methodology for assessing the benefits in this analysis and the charter guiding FWPA's research investment in market access issues. of the FWPA in funding marketing projects. While the FWPA will fund projects to maximise the value of returns to the timber industry at the expense of other competitive industries (e.g. steel), the BCA assesses the benefits to society as a whole. As such, any increase in the market share of timber is valued in terms of the net cost saving to society, not the increase in revenue to the timber industry. In marketing projects the 'technology' transfer (i.e. extension and marketing activity) also needs to be directed at a much broader audience than for the other research categories, which makes it particularly difficult to maximise the impact of a given marketing project.

4.2 Limitations of the analysis

Project level results

There are a number of qualifications associated with the results:

- Estimates of costs and benefits are contingent on a number of assumptions. The assumptions underpinning our estimates have been based on discussions with project leaders, industry contacts and professional judgement; however they are nonetheless subjective and should be considered indicative of the order of magnitude rather than the actual value of research.

- For many of the projects that were reviewed, identifying the counterfactual (or base case) was not always clear and it is possible that the project benefits will be either under- or over-estimated.
- Even where the assumptions about the costs and benefits have been estimated with relative certainty, the extent to which the research results are adopted by industry will have a significant bearing on the projects' overall impact. In the short term (e.g. in the five years after a project is completed), it is generally easier to consider the adoption rate, because market conditions are more certain. In the longer term, adoption is more difficult to assess as there are likely to be a number of unforeseen factors that may affect adoption. Long term adoption rates also depend on assumptions regarding whether or not industry participants would have undertaken their own research and reached similar conclusions in the absence of FWPA investment.
- Generally speaking, research results are but one factor influencing the market for timber products and the competitiveness and profitability of businesses operating in the forest and wood products industry. Movements in the exchange rate, the price of alternative products, and residential housing starts are all factors that have a significant influence on the timber products market. It is often difficult to distinguish the effects of research from these other influences.

Program level results

The selection of the projects for evaluation was undertaken to comply with the RDCC requirements of representativeness and randomness. Taken literally, these two objectives are mutually exclusive as representativeness cannot be achieved if the selection process is strictly random. The approach taken in this review was to select projects from each of FWPA's broad investment categories and within these, to randomly select projects to represent high, medium and low value investments.

Because of the inherent variability in the projects selected for assessment, a weighted average BCR was not derived for the entire R&D program funded by FWPA. Rather, a weighted average BCR was used to estimate the overall benefits for each broad investment category.

These estimated benefits should not be considered reflective of the actual benefits associated with the investment that has been made in each of these categories, because of the variability in BCRs that is evident at the project level. Rather, the results could best be considered as a tool for guiding the investment between and within the three broad categories.

4.3 Implications for future evaluations

The reliance on assumptions such as those that have been made during this evaluation could be reduced by gathering some of the relevant information at project commencement. In particular, it would be useful for project proponents to consider and report their views on the base case at the time of requesting funding. At this time the alternative routes for development of technology or information are usually much clearer than they are after the project has been completed.

It would also be helpful if project proponents were able to undertake the following steps:

- When undertaking the benefit cost analysis as part of the project proposal, clearly articulate the reasons for assumptions. In some cases the data presented for projects reviewed in this study were based on hypothetical outcomes, rather than detailed analysis; and

- At the end of the project, and as part of the deliverable, project leaders could specify the expected impacts of the project and how the information required to measure the impacts could be gathered and analysed.

It is important to recognise that project proponents are not independent of the analysis and obviously have an interest in inflating the predicted benefits. In addition, the project proponents are not always the best qualified to asses the impacts. For example, a geneticist does not necessarily have an appreciation of the factors that drive timber prices. Some form of independent review will still be necessary and project proponents should draw on industry assistance for information about impacts and adoption.

Generally speaking, there is a need for improved industry statistics throughout the value chain. The coordinated collection and reporting of such statistics would benefit the whole of industry and would assist project proponents (and independent project evaluators) to determine the value of project impacts.

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Limitations

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The methodology adopted and sources of information used by URS are outlined in this report. URS has made no independent verification of this information beyond the agreed scope of works and URS assumes no responsibility for any inaccuracies or omissions. No indications were found during our investigations that information contained in this report as provided to URS was false.

This report was prepared between 01/04/10 and 29/06/10 and is based on the conditions encountered and information reviewed at the time of preparation. URS disclaims responsibility for any changes that may have occurred after this time.

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Appendix A Fertiliser usage in forestry: current status and prospects for increasing its efficiency and profitability (PRC072-0708)

A.1 Project objective

There were five primary objectives of the project:

- To summarise the existing information on fertiliser use;
- To review the environmental impacts of fertiliser use;
- To undertake a financial analysis of different fertiliser regimes in softwood and hardwood plantations;
- To compare fertiliser use in forestry with agricultural pursuits; and
- To identify and prioritise knowledge gaps.

A.2 Project need

Prior to the project being undertaken there were no similar summaries available on fertiliser use in Australian forestry. Research into fertiliser use had also declined within some state forest management agencies.

In addition, there were perceptions regarding fertiliser use that were being used by some groups to argue against expansion of the plantation industry. It had been claimed that the industry was using more chemicals (including fertiliser) than alternative land uses and that there were negative impacts on water quality and greenhouse gas (GHG) emissions as a result. Prior to the report being published there was no authoritative comparison of the potential impacts of fertiliser use on water quality or GHG emissions from forestry compared with agricultural land uses that could be used to counter these claims.

A.3 Project costs

Research costs

The project costs are summarised in Table A-1.

Table A-1 Project costs

Project number	Operating	Capital	In-kind	Total
PRC072-0708	$64,500	–	$34,000	$98,500

Source: Project proposal documentation.

Implementation costs

For the project results to be adopted, it is assumed that further extension and communication of the results will be required and that the costs of this extension could be $10,000/annum over a two year period.

A.4 Project benefits

Economic

From a financial perspective, the output of the project that had most significance was a finding that mid-rotation fertiliser yields a superior economic return than fertiliser at establishment. However, the financial analysis was limited in that it did not evaluate some of the other benefits of fertiliser use at establishment, such as improved survival and early canopy closure (therefore less weed control).

Industry contacts from the hardwood sector considered that the conceptual outcome was sound, but questioned some of the assumptions used to quantify the impact of fertiliser. They also considered that the extent of any benefit and the rate of adoption would vary quite considerably between companies and regions. In the softwood sector, there was more agreement surrounding the basis for assumptions used, but also considerable variation in regional benefits and base case rates of adoption.

The project found that fertiliser use in forestry was generally less than other agricultural pursuits. However, data from the agricultural sector that was used for benchmarking was limited by the fact that some of the land uses provided as a comparison covered a very wide spectrum. For example, data for the grazing sector included rangelands as well as more intensive grazing in higher rainfall areas. The project also did not evaluate which alternative uses should be used as a comparison in particular regions. As such the report provided some of the background information necessary to compare fertiliser use in particular regions, but it does not provide any definitive conclusions at a regional level.

The report identified knowledge gaps including a lack of data on response to mid-rotation fertiliser of hardwood plantations and thinned softwood plantations, emissions and leaching losses associated with different fertiliser types, and analysis of the economic benefits.

Environmental and social

While the project identified the scope for fertiliser use to be reduced in plantation management, it also found that the environmental impacts of fertiliser used in plantation management are very low if codes of practice are followed. Consequently, because the potential benefits were likely to be small, no environmental benefits associated with the project were estimated as part of the analysis.

The project may improve the viability of some forestry operations and, by doing so, increase the size of the operations, hence employment in the industry. However, because data are not available about the impact on viability, these potential employment impacts have not been estimated.

A.5 Base case

In the absence of the project, it is assumed that financially sub-optimal fertiliser regimes used by some private companies and state forest management agencies would continue. However, other organisations had already adopted the practices recommended by the project. This previous adoption was the result of prior work by the project leader that was privately commissioned by plantation managers in the Green Triangle, as well as other in-house research conducted by Australian plantation managers.

For those companies that could benefit from the research it is assumed that they would have otherwise come under pressure to review fertiliser use as a part of sound business practices over the next five years. Movement of foresters between companies would also result in extension of the research previously implemented by other companies within a reasonably short period of time.

A.6 Adoption relative to base case

Some parts of the softwood industry have picked up on the financial benefits of delaying fertiliser application and made changes to silvicultural regimes as a result of the study. For others in the industry there has not yet been sufficient extension of the findings to encourage and there appears to be less willingness to change established regimes (particularly within some government agencies).

The hardwood plantation industry has been under financial pressure and the cost of inputs such as fertiliser has been reduced for reasons other than optimal silviculture. Those hardwood plantation companies that have been actively managing plantations over the last two years had some difficulty applying the results to their own situations because of the specific species, sites and soil types that they were trying to manage. However, the concepts used to evaluate the financial benefits of fertiliser use were found to be useful and could be applied to research undertaken by specific companies.

The different rates of adoption between the softwood and hardwood industries may also be because data used to evaluate fertiliser responses is considered more robust for softwood plantations than for hardwoods. This reflects the maturity of the softwood industry, which has the benefit of several decades of research. In comparison the hardwood plantation industry has rapidly increased in scale over the last decade and lacks the research on fertiliser responses on which to base the analysis in many of the regions.

At an industry level the results of the research are expected to be adopted by 5% of the softwood plantation industry within five years of completing the research. In order to achieve this adoption rate it is assumed that further extension and communication of the results will be required and that the costs of this extension will be $10,000/annum over a ten year period. The rate of adoption as a direct result of FWPA funding will decrease to 0% within ten years as the key findings were already known to a large segment of the industry and it could reasonably be expected that financial imperatives would have driven other organisations to the same conclusions over time.

A.7 Summary

Table A-2 contains a summary of the main project impacts (benefits and costs) relative to the base case and indicates whether the impact has been estimated quantitatively.

Table A-2 Summary of project impacts and adoption

Impact component	Estimated (yes/no)	Parameter value (net)	Adoption relative to base case		
			Year 5	Year 10	Year 20
Benefits					
Improved timing of fertiliser application	Yes	$200/ha of establishment fertiliser costs delayed for average of 4 years	5% of softwood establishment	0%*	0%*
Environmental benefit	No				
Costs					
Project costs	Yes	See Table A-1			
Extension costs	Yes	$10,000/annum for 2 years			

* Note that, it is assumed that the project benefits have dissipated at this time.
Source: URS estimates, derived from primary and secondary sources.

A.8 Evaluation

Table A-3 contains the evaluation results, including estimates of Net Present Value (NPV), Benefit Cost Ratio (BCR) and Internal Rate of Return (IRR) over a fifty year period using a five percent discount rate.

Table A-3 Evaluation results

Evaluation measure	5 years	10 years	20 years	50 years
NPV ($ 000)*	$469	$141	$42	$42
BCR	5.3	2.3	1.4	1.4
IRR	55%	-2%	3%	3%

*Assumes 5% real discount rate. Values are 2009 dollars.
Source: URS estimates.

A.8.1 Sensitivity analysis

High scenario

Table A-4 contains the results from a sensitivity analysis, that assumes the project benefits extend to include the hardwood industry. Adoption in the hardwood industry is assumed to peak in year 5 at 5% of the plantation area before declining to 0% in year 10. All other assumptions are unchanged.

Table A-4 Sensitivity analysis – high estimate

Evaluation measure	5 years	10 years	20 years	50 years
NPV ($ 000)*	$1,894	$758	$418	$418
BCR	18.2	7.9	4.8	4.8
IRR	112%	-4%	1%	1%

Source: URS estimates.

Low scenario

Table A-5 contains the results from a sensitivity analysis that assumes no further extension occurs and that adoption within the softwood industry peaks at 2% of the area of softwood plantation in year 5 and then declines to 0% by year 10. All other assumptions remain unchanged from the original analysis.

Table A-5 Sensitivity analysis – low estimate

Evaluation measure	5 years	10 years	20 years	50 years
NPV ($ 000)*	$118	$90	($25)	($25)
BCR	2.3	2.0	0.7	0.7
IRR	23%	22%	NA	NA

Source: URS estimates.

Appendix B Genetic variation and improvement of *E. dunnii* and *E. pilularis* (PN04.3003 and PN06.3017)

This evaluation comprises two separate, but related projects:

- Genetic Variation in Wood Properties of Eucalyptus *E. dunnii* Relevant to Solid Wood Products (PN04.3003); and
- Improving dimensional stability in plantation-grown *E. pilularis* and *E. dunnii* (PN06.3017)

B.1 Project need

Plantations of *E. dunnii* and *E. pilularis* have been established in northern NSW and southern Queensland over the last decade. Most of this resource has been established for pulpwood production, but there is also a significant area that has been established for solid wood production. For various reasons the plantation estates that have focussed on pulpwood production have not reached sufficient scale for a pulpwood industry to be sustained in the long term and hence sawn timber production is a possible means of utilising this largely unallocated resource.

The two projects were concerned with investigating cost-effective non-destructive methodologies for assessing wood quality for plantation grown *E. dunnii* and *E. pilularis.* Such methodologies could have three primary benefits:

- They provide information on wood quality to the processor prior to harvest so that sawing techniques and kiln drying regimes can be optimised;
- They provide feedback mechanisms to breeding programs about wood quality that is not dependent on waiting until the end of the rotation; and
- As non-destructive methodologies, they enable tree breeders to utilise the seed from the standing tree. An option that is obviously not available after harvest.

B.2 Project objective

The project objectives can be summarised as follows:

- Evaluate possible low-cost methods of assessing solid wood value of plantation grown *E. dunnii* and *E. pilularis* to assess wood properties;
- Relate core properties to wood properties;
- Provide information on potential kiln-drying regimes for *E. dunnii*;
- Assess the quality of kiln-dried sawn boards of plantation grown *E. dunnii;*
- Develop a toolkit for wood quality examination;
- Understand the role of wood chemistry in the control of wood behaviour, quality, drying and sawnwood characteristics; and
- Understand the extent to which wood properties can be managed through genetics.

B.3 Project costs

Research costs

The project costs are summarised in Table B-1.

Table B-1 Project costs

Project number	Operating	Capital	In-kind	Total
PN04.3003	$70,000	–	$71, 891	$141,891
PN06.3017	$183,895	–	$613, 281	$797,176
Total	**$253,895**	**–**	**$685,172**	**$939,067**

Source: Project proposal documentation.

B.4 Project benefits

Economic

The projects established that properties of wood cores do not appear to be reliable predictors of economically important sawn timber characteristics in the species that were studied. However, the project research methodology (i.e. the use of increment cores to predict wood properties) has been used and adapted in subsequent research. The method is low-cost and may, in part, reduce reliance on more expensive technologies such as Silvascan. The method has also been used to investigate the wood properties of other species, such as *E. globulus* and *E. nitens*. However, it should be noted that the technology has not been developed to a point where widespread adoption would be feasible.

In both projects there was useful information gathered regarding the sawn timber properties of *E. dunnii,* which was previously considered to be a relatively low quality sawn timber species when established in plantations. The trials undertaken in this research showed that there are still significant challenges associated with processing young plantation grown eucalypts for solid wood production because of the low dimensional stability. However, the sawing qualities of *E. dunnii* were not materially different from other plantation grown hardwoods, such *E. pilularis*.

It should also be noted that the work on improving dimensional stability also provided information on pulp yield of *E. dunnii* that showed it had very favourable pulping properties. However, the lead researcher has indicated that these properties are dependent on site, with higher quality sites providing better pulp yields. The sites sampled were on good quality sites, while the majority of the sites established have been in more marginal areas.

As a result of the project *E. dunnii* families were able to be ranked for wood properties and this information has been used by Forests NSW to establish a clonal seed orchard. This orchard has recently begun yielding high quantities of seed, with around 10kg of seed harvested last year and similar levels expected this year. If this amount of seed is planted, it would represent approximately 1,000 ha of establishment.

Environmental and social

There are no direct environmental or social benefits identified in relation to the project outcomes.

B.5 Adoption relative to base case

The project has not resulted in increased rates of establishment of *E. dunnii* for solid wood production or improvements in breeding. This is partly the result of the fact that further work is required before the tools necessary to predict sawn timber quality with confidence are developed, but also due to changes in the plantation industry as a result of the financial collapse of some MIS companies.

B.6 Evaluation

The projects identified that the techniques trialled had some limitations and refocused the means by which further research into the development of non-destructive options for assessing wood quality could be undertaken. However, positive quantification of the project results is not possible in this case.

Appendix C TREEPLAN, MATEPLAN AND SEEDPLAN genetic programs (PN03.1915 and PN07.4025)

This evaluation comprises two separate, but related projects:

- An advanced genetic evaluation system for forest tree improvement (TREEPLAN) (PN03.1915)
- Genetic gain optimisation in tree breeding (MATEPLAN) and deployment (SEEDPLAN) (PN07.4025)

C.1 Project need

At a national level, tree breeding has been characterised by a number of separate programs that have been run by different organisations. It has not been feasible to capture the cumulative benefits of these programs and a need was identified to make the most of existing knowledge by creating efficient ways of accessing and processing data.

The most immediate need for this work is to reduce the amount of inbreeding that could otherwise occur in seed orchard programs. As breeding programs develop, the level of inter-relatedness between different populations used in seed orchards also increases exponentially. In designing seed orchards it is therefore essential that relatedness is considered, so that inbreeding is minimised and gains from breeding are maximised.

TREEPLAN has consolidated the large amount of data from several independent programs and has enabled the degree of relatedness between individual trees of populations to be quantified. MATEPLAN and SEEDPLAN interpret data for end-users and allow greater efficiency in selecting crosses, designing seed orchards, and planning plantation establishment programs.

C.2 Project objective

The combined objective of the two projects was to develop three interrelated software programs:

- TREEPLAN is software that enables the evaluation of breeding values using multi-variate analysis across generations, years, sites and trials. Southern Tree Breeders Association (STBA) members and other breeders all contribute data.
- MATEPLAN is a tool for breeders aimed at assisting optimal selection and crossing in the breeding program. The aim is to limit increases in co-ancestory, which can increase exponentially if not controlled.
- SEEDPLAN is a collection of tools for selecting genotypes for a seed orchard, creating deployment values for seedlots, and optimally matching seedlots to environment. It also assists with designing seed orchards so that inbreeding is minimised. Where male parents are not known, it can be used to estimate the probability of a particular parent given, for example, flowering, timing, and abundance.

C.3 Project costs

Research costs

The project costs are summarised in Table C-1.

Table C-1 Project costs

Project number	Operating	Capital	In-kind	Total
PN03.1915	$1,062,141	$65,000	$302,920	$1,430,061
PN07.4025	$202,000	$6,000	$257,926	$465,926
Total	**$1,264,141**	**$71,000**	**$560,846**	**$1,895,987**

Source: Project proposal documentation.

Implementation costs

In addition to these costs, on-going maintenance costs for project-related software and hardware will need to be incurred. These have been estimated at approximately $60-100k per year. However, this will be offset to some extent because various independent breeding programs will have lower costs as a result of this centralised approach.

The estimated future costs of program development over approximately the next five years are around $1.6 million. This would bring the MATEPLAN and SEEDPLAN software to a point of greater useability and would enable its application across the Australian industry. It would also help to integrate the three programs, providing further operational efficiency. A proposal to undertake this work has been submitted to FWPA for consideration.

C.4 Project benefits

Economic

Prior to investment from FWPA, TREEPLAN was in a relatively early stage of development with limited useability for the forest industry. The FWPA grant funded development of a second version of the software that has contributed to its wider application. The subsequent investment from FWPA enabled further development of MATEPLAN and SEEDPLAN to improve efficiency of breeding processes and their deployment.

Beneficiaries of the projects, to date, include:

- Members of the Southern Tree Breeders Association (STBA), who can access the model outputs (genetic values of individual trees or populations), as well as improved plant material that has been developed using the programs.
- Non-members of the STBA, who can access improved plant material and contract the STBA to analyse their own data. The project leaders commented that it is encouraging wider use of the software by non-members.
- Researchers, who use the software for various applications and can add additional information to the databases, which contributes to its ongoing improvement.

Through improved orchard design, the projects have helped to reduce inbreeding. This increases output by avoiding productivity losses as well as through productivity gains. It is estimated that better-informed genetic selection decisions and associated plantation planning has resulted in improvements to yields and quality.

The project leaders and end users have suggested the projects could result in a 10% improvement in the volume of wood produced at the time of harvest and a 5-10% percent improvement in the quality (value) of selected commercial products (structural timber and hardwood pulpwood) when plantations are harvested that have been established using these tools.

In URS opinion, the financial benefits associated with the project are likely to be restricted to those that result from increased yield and these benefits will accrue at the stumpage level. At this point in the supply chain, increases in yield will result in an increase in revenue without any change in costs. Beyond this point costs are incurred per unit of volume harvested or processed and any change in net value is minimal. Increases in value associated with improved product quality are unlikely to result in an increase in the price for commodity products that otherwise meet specifications for a particular grade.

In the case of projects that improve the genetic sources used to establish forest plantations, the benefits of research will not be obtained until the trees are harvested. These harvest periods are assumed to be:

- 30 years in the case of softwood sawlog;
- 25 years for hardwood sawlogs; and
- 10 years for hardwood pulpwood.

Environmental and social

The environmental benefits associated with the project are linked to the anticipated productivity improvements. By using the same resource inputs to achieve a greater output, there is an implicit environmental benefit. However, because this benefit is encapsulated in the value of the productivity improvement, estimating this value separately would involve double counting.

There are no direct social benefits anticipated with the adoption of the project results.

C.5 Base case

Under the base case it is assumed that the projects would not have developed as quickly as they did with assistance from the FWPA. However, the potential benefits of the project are compelling enough that the plantation industry (and particularly STBA members) is likely to have undertaken the same work within five years.

C.6 Adoption relative to base case

The programs have been used to run national-scale analysis of breeding programs for *Pinus radiata*, *Eucalyptus globulus* and *E. nitens*. These species represent a large proportion of the national hardwood plantation estate. Preliminary work has been undertaken with other species which should drive wider adoption.

The project leaders believe that 80% of Australian tree breeders will adopt the technology within 10 years, resulting in improvements in plantations harvested from stock developed over this time. However, if it is assumed the work would have been undertaken through other funding sources within five years, the rate of adoption associated with FWPA funding is likely to peak at 40% and then decline as net benefits reduce compared to the base case where similar technology will become available to adoptees.

C.7 Summary

Table C-2 contains a summary of the main project impacts (benefits and costs) relative to the base case and indicates whether the impact has been estimated quantitatively.

Table C-2 Summary of project impacts and adoption

Impact component	Estimated (yes/no)	Parameter value (net)	Adoption relative to base case		
			Year 5	Year 10	Year 20
Benefits					
Improved yield	Yes	$10% increase in yield by volume over the rotation	40% of plantation establishment	0%*	0%*
Better-quality end-product	No				
Costs					
Project costs	Yes	See Table C-1			
Implementation costs	No				

* Note that, it is assumed that the project benefits have dissipated at this time.
Source: URS estimates, derived from primary and secondary sources.

C.8 Evaluation

Table C-3 contains the evaluation results, including estimates of Net Present Value (NPV), Benefit Cost Ratio (BCR) and Internal Rate of Return (IRR) over a fifty year period using a five percent discount rate.

Table C-3 Evaluation results

Evaluation measure	5 years	10 years	20 years	50 years
NPV ($ 000)*	($2,514)	($3,036)	$27,813	$47,092
BCR	0.0	0.0	9.9	15.4
IRR	NA	NA	21%	21%

*Assumes 5% real discount rate. Values are 2009 dollars.
Source: URS estimates.

C.8.1 Sensitivity analysis

High scenario

Table C-4 contains the results from a sensitivity analysis that assumes the research is not undertaken independently by industry as part of the base case until 10 years after project completion. Therefore the benefits from adoption are assumed to peak at 80% in year 10, before declining to zero by year 15. All other assumptions remain unchanged from the original analysis.

Table C-4 Sensitivity analysis – high estimate

Evaluation measure	5 years	10 years	20 years	50 years
NPV ($ 000)*	($2,514)	($3,036)	$62,136	$104,198
BCR	0.0	0.0	21	32.8
IRR	NA	NA	25%	25%

*Assumes 5% real discount rate. Values are 2009 dollars.
Source: URS estimates.

Low Scenario

Table C-5 contains the results from a sensitivity analysis that assumes that follow-up funding is not obtained and the adoption rate slows to 25% by year 5, before declining to 0% in year 10. All other assumptions remain unchanged from the original analysis.

Table C-5 Sensitivity analysis – low estimate

Evaluation measure	5 years	10 years	20 years	50 years
NPV ($ 000)*	($2,047)	($2,123)	$12,980	$21,536
BCR	0.0	0.0	6.8	10.1
IRR	NA	NA	18%	18%

*Assumes 5% real discount rate. Values are 2009 dollars.
Source: URS estimates.

Appendix D Moisture correction factors (PN04.2002 and PN07.2045)

This evaluation comprises two separate, but related projects:

- Species and CCA (chromium copper arsenic) treatment corrections for hand-held moisture meters with radiata pine and slash pine (PN04.2002)
- Moisture meter corrections for ACQ (alkaline copper quaternary), treated pine (PN07.2045)

D.1 Project need

Drying sawn timber to the desired moisture content is one of the most important steps in processing, and drying accounts for a significant component of processing costs.

Hand-held capacitance meters are used by mill operators at various stages of softwood processing. Typically, the moisture meters are used in the late stages of drying before machining. As confidence in the accuracy of the meters has been low, mills have typically developed their own correction factors, resulting in an inconsistent approach across the industry. This is likely to have resulted in timber entering the market that is at varying moisture contents, which could adversely impact of timber in some applications, giving rise to costs that could be avoided.

Accurately measured moisture content is critical for ensuring the stability of the end-product and to optimising the drying process, thereby improving efficiency.

D.2 Project objective

Hand-held moisture meters, in particular the Wagner (capacitance-type) moisture meters, are used extensively throughout the exotic softwood processing industry in Australia. While their use is widely accepted, uncertainty relating to accuracy and precision remains relating to their use on Australia's two most commercially important exotic softwood species: *Pinus radiata and Pinus elliottii*. There is also uncertainty when such species are treated with either CCA or ACQ.

The key objective of these projects was to reduce and/or remove the uncertainties associated with the use of Wagner Meters in the softwood processing industry and by doing so, provide the ability to better manage moisture content before machining into products.

D.3 Project costs

Research costs

The project costs are summarised in Table D-1.

Table D-1 Project costs

Project number	Operating	Capital	In-kind	Total
PN04.2002	$98,532	–	$10,000	$108,532
PN07.2045	$60,000	–	–	$60,000
Total	**$158,532**	**–**	**–**	**$168,532**

Source: Project proposal documentation.

Implementation costs

The costs involved with implementing the project findings are considered to be minimal, requiring a once-off adjustment of the moisture correction factors currently utilised by mill operators. This cost is considered insignificant relative to the overall operational costs of the mill and have not been estimated.

With the project, it is assumed that the time spent attending to returned products and mis-performing products for a full time staff member is 1%. The value of this time is estimated to be $1,000 per annum for a medium-sized mill.

D.4 Project benefits

Economic

The project has provided robust independent data, which has enabled moisture correction factors to be derived that can be applied across the industry.

The project benefits may be summarised as follows:

- More efficient drying processes – by applying the correction factors, mill staff have more accurate information and therefore greater understanding of the moisture content of the timber and can therefore make better-informed decisions about how to operate their drying equipment. It should be noted that kilns would only be operated more efficiently if, because of the project, the volume of wood that is over-dried is reduced.
- Better quality end-product – by enabling greater quality control at the mill, the incidence of under-dried or over-dried timber entering the market should be reduced and greater certainty could be obtained that the end-product will meet the claimed standards.
- Reduced product returns – with better-quality products entering the market there is likely to be a reduction in the incidence of products under-performing in application and hence fewer products being returned to the mill.
- Independent authority – research undertaken by an independent third-party is considered by industry to be valuable, should timber performance be contested.

Consensus on the size and nature of the project benefits was not obtained through interviews with industry contacts. Those contacted could not estimate the impact associated with the moisture correction factor in terms of tangible benefits such as reduced operating costs or improvement in product quality, because timber moisture is just one element of overall production costs and product quality. Based on these comments, the quantifiable benefit of the project is assumed to be reflected in lower costs of responding to customer complaints regarding under-performing products. Although better-quality end products are anticipated, the commodity nature of the structural timber market is such that it is not thought that the potential quality improvements would be reflected in a higher price.

Environmental and social

The main environmental benefits associated with the project are likely to be captured in the potential to operate kilns in a more efficient manner, hence avoiding over-drying, and thereby achieving a reduction the energy consumed in the drying process. Conversely, for those mills that are not sufficiently drying their timber they may need to run their kilns for longer to meet the new standards. Consequently, this benefit has not been estimated.

The social benefit associated with the project may be reflected in the greater consumer satisfaction obtained from the higher quality timber entering the market. However, because this benefit is encapsulated in reduced time spent in negotiations, estimating this value separately would involve double counting.

D.5 Base case

A number of mill operators advised that they had independently developed and were using moisture meter correction factors prior to the commencement of the project. In the absence of the project, these mills are likely to have continued to use their own meter correction factors. However, in the event of a challenge to the validity of the correction factors, these operators would not have had the benefit of independently determined correction factors that the project produced and, hence, it is assumed that time would be spent negotiating settlements for timber that under-performs in application.

For mill operators that did not have in-house capacity to develop their own moisture meter correction factors prior to the project, it is likely that they would have continued to rely on the default settings within Wagner meters and also borne the costs associated with negotiating with customers.

It is possible that the moisture correction factors could have been developed by another independent source at a later date; however, funding from FWPA allowed the project results to be made public earlier than they would have been and for the results to be implemented by all mills.

The costs associated with the base case relate to inefficient drying processes and mis-specified products that leave the sawmill and which could be returned, or require negotiations around under-performance. It is assumed that a full time member of sales staff could spend 5% of their time attending to returned products and customer negotiations around underperforming products. The value of this time is estimated to be $5,000 per annum for an average sized softwood sawmill. These costs are expected to reduce to $1,000 per annum for an average sized mill as a result of adopting the project outcomes.

While it is likely that sales staff at large enterprises spend more time than this on credit claims, underperformance due to moisture content variations is only one of the factors that is likely to impact on performance of timber products.

D.6 Adoption relative to base case

It is assumed that the project results are potentially applicable to the total volume of dry coniferous sawn timber produced annually in Australia, or approximately 80% of total coniferous sawn timber produced.

However, adoption of the research outcomes has been limited to date. Industry interviews have raised several possible reasons for this. One reason that was nominated, particularly in relation to ACQ treated timber, was that moisture content variability is a relatively small contributor to overall product variability. Even with more accurate moisture correction factors, some mill operators have not been able to achieve the desired level of control over timber quality.

A further reason suggested is that the correction factors have not been incorporated into a revision of the AS/NZS 1080.1 (1997) standard (Timber-Methods of Test. Method 1: Moisture Content). If the requirement for moisture testing was incorporated in the standard, this would become a reference point for best practice, which could be expected to result in an increase in adoption.

Given these factors, it is assumed that the adoption rate, as reflected in the number of plantation log sawmills using the technology, is limited in the short term. It is assumed that adoption starts at 5% in the third year after the project was completed and remains this way until year 5, as individual mills adopt the technology. After this time the adoption rate is assumed to grow quickly over time if the relevant standard is amended, reaching 80% of the mills by year 10. By year 15, adoption relating to this project will have declined to 0% as it is assumed that alternative equivalent research would have occurred, effectively reducing the adoption that is associated with the project, and therefore leading to a reduction in the project-related benefits.

D.7 Summary

Table D-2 contains a summary of the main project impacts (benefits and costs) relative to the base case and indicates whether the impact has been estimated quantitatively. It also contains the assumed adoption profile.

Table D-2 Summary of project impacts and adoption

Impact component	Estimated (yes/no)	Parameter value (net)	Adoption relative to base case		
			Year 5	Year 10	Year 20
Benefits					
Efficient drying processes	No				
Better-quality end-product	No				
Reduced product returns and customer and time on negotiations	Yes	$4,000 pa	5% (of mills)	80% (of mills)	0%* (of mills)
Environmental benefit	No				
Costs					
Project costs	Yes	See Table D-1			
Implementation costs	No				

* Note that, it is assumed that the project benefits have dissipated at this time.

Source: URS estimates, derived from primary and secondary sources.

D.8 Evaluation

Table D-3 contains the evaluation results, including estimates of Net Present Value (NPV), Benefit Cost Ratio (BCR) and Internal Rate of Return (IRR) over a fifty year period using a 5% discount rate and an adoption rate of 5% of mills at year 5.

Table D-3 Evaluation results

Evaluation measure	5 years	10 years	20 years	50 years
NPV ($ 000)*	($134)	$179	$346	$346
BCR	0.2	2.1	3.1	3.1
IRR	9%	13%	16%	16%

*Assumes 5% real discount rate. Values are 2009 dollars.
Source: URS estimates.

D.8.1 Sensitivity analysis

High scenario

Table D-4 contains the results from a sensitivity analysis that assumes the net benefit to mills from credit claims is higher, nominally $9,000 per mill. All other assumptions remain unchanged from the original analysis.

Table D-4 Sensitivity analysis – high estimate

Evaluation measure	5 years	10 years	20 years	50 years
NPV ($ 000)*	($98)	$605	$980	$980
BCR	0.4	4.7	7.1	7.1
IRR	18%	22%	24%	24%

*Assumes 5% real discount rate. Values are 2009 dollars.
Source: URS estimates.

Low scenario

Table D-5 contains the results from a sensitivity analysis that assumes the Standard is not revised and hence the net project benefits peak at only 25% of mills at year 5 and declines to 0% by year 10. All other assumptions remain unchanged from the original analysis.

Table D-5 Sensitivity analysis – low estimate

Evaluation measure	5 years	10 years	20 years	50 years
NPV ($ 000)*	($18)	$165	$165	$165
BCR	0.9	2.0	2.0	2.0
IRR	14%	14%	14%	14%

*Assumes 5% real discount rate. Values are 2009 dollars.
Source: URS estimates.

Appendix E Acoustic wave velocity and kraft pulp yield (PNC053-0708)

E.1 Project need

Kraft pulp yield (KPY) is the most important factor by which wood chip traders determine the price they are willing to pay for various species. A higher pulp yield is typically reflected in a higher price in the market. However, these differentials are generally not reflected at the stumpage (plantation) level because of the complexities associated with sampling in field.

A rapid, non-destructive test that enables wood chip processors to perform resource assessments of stands would allow improved sampling and improved pricing structures that reward growers of higher-yielding stands. Chip exporters could also better manage the quality of stockpiles and the information obtained could be used to target higher yielding seed sources in breeding programs.

Previous studies have shown that acoustic measurements from standing trees and felled logs may potentially provide predictions of KPY, however some doubts remained regarding the robustness of the relationship, particularly across sites.

Industry considered there was a need to conduct independent research to better understand the uncertainty and develop a more reliable test.

E.2 Project objective

The key objective was to unequivocally validate or discard the use of standing tree and/or log acoustics as a tool for predicting KPY.

E.3 Project costs

Research costs

The project costs are summarised in Table E-1.

Table E-1 Project costs

Project number	Operating	Capital	In-kind*	Total
PNC053-0708	$31,589	–	$72,431	$104,020

* Note that the project proposal estimated in-kind contributions from Gunns of $227,175; however only approximately 20 percent of this value is estimated to be directly attributable to the project.
Source: Project proposal documentation and discussions with Gunns representatives.

E.4 Project benefits

Economic

The project found that standing tree acoustic measurements explain more variance in KPY than for measurements from felled stems. However, the low level of variance explained by such measurements was unlikely to provide any major commercial incentive to acoustically screen sites or genotypes for KPY.

The project successfully achieved its objective in that it was able to provide the evidence required to discard the use of standing tree acoustics as a predictive tool for KPY. Although this finding does not result in any market benefits for industry, it has allowed future research efforts to be directed to more prospective forms of non-destructive testing such as Near Infra Red Spectroscopy (NIR). It has also prompted industry to research other techniques for improving KPY, such as through molecular genetics.

Environmental and social

There are no direct environmental or social benefits identified in relation to the project outcomes.

E.5 Base case

A number of hardwood plantation managers indicated that the research would not have been undertaken in-house because of the technical expertise that was required.

E.6 Adoption relative to base case

Based on discussions with industry contacts, it appears that industry is aware of the findings and has subsequently focussed its research investment on other means for predicting KPY.

E.7 Evaluation

Discussions with industry contacts indicate that there was a need to clarify the role of acoustic wave velocity in predicting KPY in standing trees. By confirming that acoustic wave velocity is not a reliable predictor KPY for individual trees, research effort has been directed elsewhere, particularly into NIR. However, no quantifiable benefit has been allocated to the project.

Appendix F Wood quality initiative (PN04.2004)

The Wood Quality Initiative (WQI) was a New Zealand-based consortium established to undertake industry-facing research on the wood quality of radiata pine[6]. The WQI was a major multi-year program with a broad funding base, including New Zealand public and private sector funding coupled with contributions from FWPA and CSIRO.

A broad range of projects were undertaken in the six years over which WQI operated. These fell into five key themes – appearance, resource characterisation, stability, structural, and integration. URS has not evaluated the individual projects within these themes. Rather, a high-level assessment has been undertaken based on the potential benefits of Australia's investment in this initiative.

F.1 Project need

The project need was driven by industry concern about radiata pine's declining market share in appearance and structural applications, particularly in New Zealand. For Australia, the initiative came at a time of declining research into the softwood sector of the industry and is seen by some within the industry as having been critical to maintaining research capacity.

Given the Australian market for softwood timber is dominated by structural applications, the evaluation for this review has focussed on the benefits to this segment of the industry.

F.2 Project objective

The WQI was established with two major objectives:

- To improve understanding of the factors affecting wood quality and thereby grow better wood; and
- To develop tools to enable the existing resource to be monitored and segregated into wood quality classes and matched to the most appropriate processing option and market, thereby improving resource allocation within the market.

F.3 Project costs

Research costs

Table F-1 contains the project costs that were contributed by FWPA and CSIRO, representing approximately 19% of the total cost of the WQI.

Table F-1 Project costs

Source	Operating	Capital	In-kind	Total
FWPA	$1,271,109	–	–	$1,271,109
CSIRO	$1,280,539	–	–	$1,280,539
Total	**$2,551,648**	**–**	**–**	**$2,551,648**

Source: FWPA and WQI data.

Implementation costs

The costs involved with implementing the majority of project outputs are considered to be minimal, requiring, for example, the integration of existing information within software packages or tools that are

[6] The WQI ran between 2003 and 2008 however another research program called the Solid Wood Innovation grew out of the WQI program. This evaluation focuses only on the research undertaken as part of WQI.

already commonly used. The information is free to FWPA members, but may require a small labour cost to apply the information in an operational setting. This cost is likely to be a once-off cost and is estimated to be the labour costs associated with one full time equivalent employee for one week. This costs is estimated to be in the order of $2,000.

A major output from the WQI was the negotiation of an exclusive license for warp prediction technology. To access the warp prediction technology mill owners would need to pay a one-off licensing fee, which is estimated to cost $100,000. It should be noted that to utilise the warp prediction technology, scanning equipment must also be installed in the mill. Discussions with industry contacts suggest that such equipment is already beginning to be installed in some of the larger mills, independent of the warp prediction technology. URS has therefore not included the cost of such equipment in the implementation of the warp prediction technology.

F.4 Project benefits

Economic

WQI's research outputs were intended to benefit the Australian softwood timber industry primarily through research into factors affecting the structural performance of timber products. Research outputs resulted in:

- The ability to forecast wood quality (e.g. density) and yield estimates, which allows better targeting of timber to end-users.
- Standing tree acoustic velocity tools to rank stands for stiffness. This is done to help smooth out the flow of log quality into a sawmill during the year, and can also be utilised when tendering to purchase stands.
- Algorithms for use in GF19 and GF14 material, which can be integrated into forest management support systems (YTGen and Atlas).
- Warp prediction technology. This technology was developed by Weyerhauser US, but WQI negotiated exclusive license access in Australasia for WQI shareholders.

Notwithstanding the warp prediction technology, a number of Industry contacts had difficulty identifying specific outcomes from the WQI; however this was largely attributed to the range of different outcomes associated with the project. Given this, it was difficult for industry contacts to identify the impacts in terms of tangible benefits such as reduced operating costs, or an improvement in product quality. Discussion with these contacts was more general and focussed on the benefits of specialised research for the softwood processing sector.

Based on these comments and our understanding of the project objectives, URS considers there is potential, over time, for these outputs to lead to an improvement in the quality of Australian radiata pine timber produced for structural applications.

Two benefit streams were estimated; one for the overall WQI results; and another that focused specifically on the potential benefits of the warp prediction technology.

The warp prediction technology has been adopted in the United States, providing 'performance-guaranteed' products that, anecdotally, have been attracting higher prices because of the improved stability provided by these products. Industry views about the potential benefits of this technology, if it were to be adopted in the Australian market, are mixed. Some consider that a 15% increase in price could be obtained for 20% of the total volume of structural products, through the increased end-user certainty regarding stability that such technology could provide. Others consider the Australian market to be significantly different from the US market, indicating that the Australian standards for structural performance are more rigorous, meaning that products such as MGP 10 and MGP 12 are already providing a high degree of certainty for consumers. As such, the additional benefits from producing a 'performance-guaranteed' product are not considered to be significant, by some industry contacts. Others in the industry suggested that consumers would be unwilling to pay higher prices for a quality assured product, therefore any additional production costs would have to be absorbed entirely by producers.

In URS's view there are likely to be benefits from adopting outcomes of the research and for the early adopters of these technologies to differentiate their products based on quality. This product differentiation may result in either improved prices or a reduced need to discount prices when stock levels increase. As structural timber is a commodity product, any benefits are only likely to accrue for a short period of time before the rest of the market is selling a similar quality product, or has made similar reductions to costs that result in reductions in the product price.

Environmental and social

The environmental benefits associated with the project are linked to the anticipated improvements in processing efficiency. However, because this benefit is encapsulated in the value of the efficiency gain, estimating this value separately would involve double counting.

The social benefit associated with the project may be reflected in the greater consumer satisfaction obtained from the higher quality timber entering the market. However, because this benefit is encapsulated in the estimated value of improved quality, estimating the social value separately would involve double counting.

F.5 Base case

In the absence of the project, it is assumed that some research would occur in-house, by the larger softwood mills, but the nature of this research is likely to have been fragmented and specific to a particular company's operations and location rather than being integrated and communicated across the industry. Ultimately the benefits of this research are likely to have reached the rest of the industry.

F.6 Adoption relative to base case

It is assumed that the project results are potentially applicable to the total volume of dry coniferous sawn timber produced annually in Australia, or approximately 80% of total coniferous sawn timber produced.

Estimating adoption is particularly challenging for this project as it has produced many tools and technologies, some of which are more relevant to the Australian market than others, and some of which are more likely to result in a quality improvement than others. Of these, some are likely to have a more direct affect on structural softwood sawn timber quality than others.

For the general quality improvements, URS has assumed that five years after the project ended (2011-12), adoption of the project outcomes has increased to 5% of total volume produced and a higher price for dry structural softwood sawn timber is achieved. The price improvement is assumed to be 0.5% higher than under the base case and is available to those companies that have adopted the technology. As the entry cost associated with access to these improvements is low, adoption is assumed to increase to 50% of the total volume produced in 2014-15. At this time, it is assumed that the premium diminishes to zero by 2017-18, as the rest of the industry responds to competitive pressures and adopts the research outputs (i.e. the benefit of adoption is assumed to be 0% at this time, irrespective of how many mills have adopted the technology).

In the case of the warp-prediction technology, it appears that there is minimal interest in adopting the technology at present, due largely to the absence of market demand for 'performance-guaranteed' products with greater performance compared with products that are manufactured according to Australian standards. Other industry interviewees suggested that the licensing fee is a significant barrier to adoption, especially when new generation scanning technology is also required to access the technology. Discussions with industry interviewees suggested that adoption would be much greater if the Australian market faced competition from 'performance-guaranteed' imports.

For the quality improvements associated with the warp prediction technology, URS has assumed that five years after the end of the project (2011-12), the technology will begin to be adopted by one of the biggest mills, representing 5% of the total volume of coniferous sawn timber produced. It is assumed that, as the 'first adopter', this mill is able to achieve a quality-based increase in price of 1% relative to the base case. It is assumed that the benefits of being the 'first adopter' are short-lived as other mills quickly enter the market in response to competitive pressures. However, the rate of adoption will be slightly slower than for the general quality improvements because of the capital investment necessary to access the improvements. By 2016-17 it is assumed that adoption has increased to 50% of the total volume produced. However, after this point it is assumed that the quality improvements have been become standard throughout the industry, and as such the ability for any one mill to achieve a higher price will be diminished; essentially meaning that the project benefits are no longer represented by a higher price by 2020-21.

F.7 Summary

Table F-2 and F-3 contains a summary of the main project impacts (benefits and costs) relative to the base case and indicates whether the impact has been estimated quantitatively.

Table F-2 Summary of project impacts and adoption (general quality improvements)

Impact component	Estimated (yes/no)	Parameter value (net)	Adoption relative to base case		
			Year 5	Year 10	Year 20
Benefits					
Improved product quality	Yes	Marginal increase in value with project - $5/m^3$	30*%	10%	0%***
Improved processing efficiency	Yes				
Costs					
Project costs	Yes	See Table F-1			
Implementation costs (general quality improvements)	Yes	$2,000 (once-off)			

*30% of adoptees benefit from adoption.
** Note that adoption is assumed to peak in year 8 at 50%
***Note that it is assumed that the project benefits no longer result in improved prices at this point.
Source: URS estimates.

Table F-3 Summary of project impacts and adoption (warp prediction improvements)

Impact component	Estimated (yes/no)	Parameter value (net)	Adoption relative to base case		
			Year 5	Year 10	Year 20
Benefits					
Improved product quality	Yes	Marginal increase in value with project - $2/m^3$	5%	50%	0%*
Improved processing efficiency	Yes				
Costs					
Project costs	Yes	See Table F-1			
Implementation costs (general quality improvements)	Yes		5%	80%	0%*
Implementation costs (warp technology)	Yes	$100,000 (once–off)			

* Note that it is assumed that the project benefits no longer result in improved prices at this point.
Source: URS estimates

F.8 Evaluation

Table F-4 contains the evaluation results, including estimates of Net Present Value (NPV), Benefit Cost Ratio (BCR) and Internal Rate of Return (IRR) over a fifty year period using a5 % discount rate and an adoption rate of 5% at year 5.

Table F-4 Evaluation results

Evaluation measure	5 years	10 years	20 years	50 years
NPV ($ 000)*	($2,102)	$11,073	$14,717	$14,717
BCR	0.2	4.4	5.5	5.5
IRR	22%	24%	26%	26%

*Assumes 5% real discount rate. Values are 2009 dollars.
Source: URS estimates.

F.8.1 Sensitivity analysis

High scenario

Table F-5 contains the results from a sensitivity analysis that assumes the benefits from the warp prediction technology peak at 80% in year 10. All other assumptions are unchanged from the original analysis.

Table F-5 Sensitivity analysis – high estimate

Evaluation measure	5 years	10 years	20 years	50 years
NPV ($ 000)*	($2,102)	$17,239	$23,456	$23,456
BCR	0.2	5.7	7.3	7.3
IRR	26%	29%	31%	31%

*Assumes 5% real discount rate. Values are 2009 dollars.
Source: URS estimates.

Low scenario

Table F-6 contains the results from a sensitivity analysis that assumes the benefits from the warp prediction technology peak at 30% in year 10, reflecting the fact that some mills may find the license fee a barrier to entry. All other assumptions are unchanged from the original analysis.

Table F-6 Sensitivity analysis – low estimate

Evaluation measure	5 years	10 years	20 years	50 years
NPV ($ 000)*	($2,102)	$8,394	$10,216	$10,216
BCR	0.2	3.8	4.4	4.4
IRR	NA	22%	23%	23%

*Assumes 5% real discount rate. Values are 2009 dollars.
Source: URS estimates.

Appendix G Assessing the performance of wood poles exposed to bushfires (PNA014-0708)

G.1 Project need

The electricity distribution grid has approximately five million wood poles. Loss of poles through bushfires is becoming an increasing problem for distribution grid operators. It results in increased costs to replace poles, increased costs if other materials (e.g. concrete) are used instead of wood poles, and can also lead to loss of revenue, or demands for compensation, when power supplies are interrupted.

Grid operators have responded by using alternative pole materials, such as concrete and steel and, hence, there has been a decline in the volume of wood poles used in this application.

One solution to reduce the loss of poles in bushfires would be to apply a fire retardant to the poles. However, there was no appropriate test data available to demonstrate that treating CCA-poles with fire retardants would provide adequate protection should they be exposed to severe bushfire.

G.2 Project objective

The project objectives are summarised as:

- To develop a large-scale test method that would predict the real-life outcomes for CCA-treated hardwood poles and creosote-treated hardwood poles exposed to severe bushfires;
- To assess the fire performance of CCA-treated radiata pine pole specimens; and
- To assess the efficacy of three fire retardant formulations applied as coatings and one fire retardant formulation applied by vacuum/pressure treatment to CCA-treated hardwood and softwood pole specimens.

The ultimate objective was to increase the use of treated wood power poles in use in Australia.

Two Australian Standard tests for bushfire exposure were published at the time the project testing began. As a consequence, the project aims were expanded to include testing all specimen types to one of the abovementioned methods.

G.3 Project costs

Research costs

The project costs are summarised in Table G-1.

Table G-1 Project costs

Project number	Operating	Capital	In-kind	Total
PNA014-0708	$136,000	–	$23,500	$159,500

Source: Project proposal documentation.

Implementation costs

The costs associated with using treated wood poles are the material costs of such poles and the associated costs of CO_2 emissions. Fire retardant poles are estimated to cost $825/pole, while equivalent concrete poles are estimated to cost $1,000/pole. And the cost of purchasing CO_2 permits, is estimated to be $20/permit.

G.4 Project benefits

Economic

The project identified pole products and treatments that are susceptible to bushfire, and those which are not. In particular:

- CCA-treated hardwood poles, which are the main wood pole products currently used, are easily destroyed in wildfire due to the afterglow effect caused by CCA.
- Creosote-treated hardwood poles do not ignite. However, these poles are not used widely at present as there are some concerns about the OH&S of the product.
- Fire retardant impregnated softwood poles performed very well in the fire tests. Softwood poles are not currently used by grid operators and the project findings suggest that there is potential for softwood poles to be used more often in the future.

The project has allowed grid operators to identify poles that are currently in operation within the electricity supply network which need to be managed to avoid fire damage. For example, it has allowed grid operators to prioritise the management of their stock of CCA-treated hardwood poles.

Another significant benefit of the project is the development of an accurate bushfire test, which can be used by grid operators to test new products.

Industry interviewees indicated that, as a result of the project, treated wood poles can be more confidently used in the distribution of electricity. The distributors now also have a better understanding of how to prioritise the management of its existing stock of wood poles. As a result, it is assumed that the project will contribute to the increased use of treated wood poles in the electricity distribution network, relative to concrete or untreated wooden poles. However, industry contacts could not identify the number of poles that had the potential to be replaced in fire-prone areas as a result of the project outcomes.

Environmental and social

Another benefit of utilising wood poles is the estimated avoided CO_2 emissions associated with wood relative to concrete. The life-cycle assessment (representing raw material, processing and operation and service phases) of carbon dioxide emitted in the production of a 45kV, 12m concrete electricity pole is estimated to be 257kg/pole, while for CCA treated wood poles it is estimated to be 76kg/pole (Erlandsson, Ödeen, and Edlund 1992). It should be noted that the life-cycle assessment, upon which these estimates are based, was undertaken using Swedish material input parameters. The relativities may be different in the Australian context. Fire retardant poles are estimated to cost $825/pole, while equivalent concrete poles are estimated to cost $1,000/pole.

Society is also likely to benefit from the anticipated reduction in the incidence of distribution poles burning during fires and the disruption and potential danger this causes. However, it has not been possible to quantify this benefit.

G.5 Base case

Without the project it is assumed that there would be a gradual decline in the number of wood poles (both treated and untreated) used in electricity distribution grids within areas where there is a risk of bushfires (for replacement purposes and for new grids), and an increase in poles made from concrete.

It is assumed that similar research would have been undertaken by the timber pole industry. However, this is assumed to have occurred more slowly and in a more fragmented way, than under the case with the project.

G.6 Adoption relative to base case

Industry interviews suggest that adoption of the research findings has been limited to date. Two main reasons were provided regarding the lack of adoption. The first is that the fire retardant-impregnated poles are not yet available in commercial quantities, which means that distributors are still dependent on alternatives such as concrete or steel. The second reason is that some of the fire retardants are difficult to apply, and as a consequence, cost more. Although creosote-treated poles are relatively easy and inexpensive to produce, OH&S concerns have limited the up-take of these poles in the Australian market.

It is estimated that the annual demand for poles is around 100,000 (DPI&F 2006) and comprises poles for replacement and for expansion of the electricity grid. It is assumed that five percent of these poles (5,000 poles per annum) will be used in areas where there is a risk of bushfires. Five years after the project was completed (2013-14), it is assumed that the adoption rate (i.e. the number of wood poles treated with fire retardant) is in the order of 30% of the annual demand for poles in bushfire areas. After this time, it is assumed that the benefits of alternative research undertaken as part of the base case would have influenced behaviour and the demand for fire retardant wood poles is assumed to decline significantly by year 10.

G.7 Summary

Table G-2 contains a summary of the main project impacts (benefits and costs) relative to the base case and indicates whether the impact has been estimated quantitatively.

Table G-2 Summary of project impacts

Impact component	Estimated (yes/no)	Parameter value (net)	Adoption relative to base case		
			Year 5	Year 10	Year 20
Benefits					
Reduced material costs	Yes	$175/pole	30% of demand for poles in bushfire areas	0%	0%*
Reduced CO_2 emissions	Yes	$3.62/pole			
Social (reduced disruptions from burnt poles)	No				
Costs					
Project costs	Yes	See Table G-1			

* Note that it is assumed that the project benefit no longer result accrues at this point.
Source: URS estimates.

G.8 Evaluation

Table G-3 contains the evaluation results, including estimates of Net Present Value (NPV), Benefit Cost Ratio (BCR) and Internal Rate of Return (IRR) over a fifty year period.

Table G-3 Evaluation results

Evaluation measure	5 years	10 years	20 years	50 years
NPV ($ 000)*	$464	$821	$821	$821
BCR	4.1	6.4	6.4	6.4
IRR	42%	48%	48%	48%

*Assumes 5% real discount rate. Values are 2009 dollars.
Source: URS estimates.

G.8.1 Sensitivity analysis

High scenario

Table G-5 contains the results from a sensitivity analysis that assumes alternative research does not occur and adoption peaks in year 10 at 55% of the demand for poles in bushfire prone areas. All other assumptions are unchanged from the original analysis.

Table G-5 Sensitivity analysis – high estimate

Evaluation measure	5 years	10 years	20 years	50 years
NPV ($ 000)*	$464	$1,629	$2,143	$2,143
BCR	4.1	11.8	15.2	15.2
IRR	42%	53%	53%	53%

*Assumes 5% real discount rate. Values are 2009 dollars.
Source: URS estimates.

Low scenario

Table G-6 contains the results from a sensitivity analysis that assumes that the producers of concrete poles respond by lowering the costs of concrete poles, effectively lowering the net project benefits to $125/pole. All other assumptions are unchanged from the original analysis.

Table G-6 Sensitivity analysis – low estimate

Evaluation measure	5 years	10 years	20 years	50 years
NPV ($ 000)*	$120	$277	$277	$277
BCR	1.8	2.8	2.8	2.8
IRR	19%	26%	26%	26%

*Assumes 5% real discount rate. Values are 2009 dollars.
Source: URS estimates.

Appendix H Strategy for large span second storey timber and wood products (PNA020-0809)

H.1 Project need

Steel beams are commonly used in large span structural applications. However, in this application, steel beams can be labour-intensive to install and they can also have OH&S risks owing to the machinery that is required during installation. Large span timber products can be a lower-cost alternative material, which require a lower level of skill during installation and fewer OH&S requirements.

The project need arose when it became apparent that there was little awareness of the alternatives to steel beams, despite the benefits that timber products offer.

H.2 Project objective

The project objective was to raise awareness that there are other solutions available for long-span beams, including box beams and other wood based products and thereby increase the use of such beams in the residential building market.

H.3 Project costs

Research costs

The project costs are summarised in Table H-1.

Table H-1 Project costs

Project number	Base case	Capital	In-kind	Total
PNA020-0809	$31,589	–	$72,431	$104,020

Source: Project proposal documentation.

H.4 Project benefits

Industry interviewees commented that the project's main outputs have been:

- Raising awareness within the building industry that wood beam options and solutions exist. This has been achieved by creating a link to wood beam manufacturers through the Timber Development Association (TDA) website.
- Designing span tables for box beams that have assisted in the utilisation of the product.

The benefits of using engineered timber beams relative to steel include lower material costs for equivalently-performing materials. Based on information available to URS, the potential saving associated with using timber beams depends on the application and could range from between $0 and $250/m^3. For the purpose of this analysis, URS has assumed a cost saving of $125/m^3.

Discussion with industry interviewees indicates there is mixed opinion as to whether timber beams result in lower installation costs and lower health and safety risks. One industry interviewee commented that, if the timber beam weighs more than 20kg (e.g. an 8 m length of LVL beam), then a crane would be required to be compliant with OH&S requirements.

There is demand for the project information on the TDA website; for example, it is estimated that six percent of key word searches on the TDA website are for beams/EWP. There are also 500 unique visitors to the website per day.

Industry interviewees considered the project to have made a contribution to growth in demand for wood products; however, they commented that the value of this contribution could not be readily determined because of the many other factors influencing demand for large span wood products. One industry interviewee commented that there has been growth in demand for 'split hanger' products, which is indicative of growth in demand for wood beams, but this could not be readily estimated. Industry contacts also found it difficult to estimate the number of buildings that were being built with wood beams and how many of these could be attributed to the project. ABS data on the materials used in outer walls of buildings was located; however equivalent data on beam material is not available.

Environmental and social

Current research suggests that predominantly timber-based houses contribute fewer greenhouse gas emissions than predominantly brick or steel (see, for example Ximenes, Robinson and Wright 2008). Given this, it is assumed that the project could result in environmental benefits in the form of reduced greenhouse gas emissions; however, these benefits have not been quantified as the information available to quantify embodied energy on a like-for-like basis is very limited. While a product such as steel may have more embodied energy per unit of volume than wood, a greater volume of wood may be required to meet the same purpose.

By reducing the OH&S risks associated with building, society is likely to benefit from fewer accidents and the consequential reduced stress and trauma for immediate family, work colleagues and associated communities. However, because industry interviewees had mixed opinions about the project's contribution to improved OH&S, this value has not been estimated.

H.5 Adoption relative to base case

URS estimates that EWP have the potential to directly compete with 116,000 m^3 pa of steel that is currently used in residential construction, including alterations and additions. A further 16,000 m^3 pa could be substituted into the non-residential construction sector. In total, the potential market volume for which steel and EWP beams could be considered substitutes is estimated to be 132,000 m^3 pa.

The extent to which timber beams is likely to substitute for steel is estimated to be in the order of 30% of the total market in which EWP could compete with steel - approximately 39,600m^3 pa. However, in the longer term, it is assumed that most of the growth in the use of EWP is likely to result form the positive experience of builders using the products rather than the project itself. Therefore, URS has assumed that one year after the project commenced, the adoption rate (in terms of the likely volume of EWP that will substitute for steel) is 1%. By year 5, this is assumed to increase to 6%; however by year 11, it is assumed that the project benefits have been dissipated as a result of alternative research and technology transfer.

In considering these adoption rates, it is noted that wide-scale dissemination of the project information was not possible within the project budget, and one industry interviewee considered this to be a barrier to further adoption.

H.6 Summary

Table H-2 contains a summary of the main project impacts (benefits and costs) relative to the base case and indicates whether the impact has been estimated quantitatively.

Table H-2 Summary of project impacts

Impact component	Estimated (yes/no)	Parameter value (net)	Adoption relative to base case		
			Year 5	Year 10	Year 20
Benefits					
Reduced material costs	Yes	$125/m^3 of EWP used	6% of likely substitution between EWPs and steel beams	1% of likely substitution between EWPs and steel beams	0%*
Reduced installation costs (potential)	No				
Reduced OH&S risks (potential)	No				
Environmental benefits	No				
Social benefits	No				
Costs					
Project costs	Yes	See Table H-1			

* Note that it is assumed that the project benefit no longer result accrues at this point.

Source: URS estimates.

H.7 Evaluation

Table H-3 contains the evaluation results, including estimates of Net Present Value (NPV), Benefit Cost Ratio (BCR) and Internal Rate of Return (IRR) over a fifty year period.

Table H-3 Evaluation results

Evaluation measure	5 years	10 years	20 years	50 years
NPV ($ 000)*	$207	$702	$702	$702
BCR	2.1	4.9	4.9	4.9
IRR	28%	42%	42%	42%

*Assumes 5% real discount rate. Values are 2009 dollars.
Source: URS estimates.

H.7.1 Sensitivity analysis

High scenario

Table H-4 contains the results from a sensitivity analysis that assumes the benefits from alternative technology transfer do not occur as quickly and hence adoption peaks in year 10 at 10%. All other assumptions are unchanged from the original analysis.

Table H-4 Sensitivity analysis – high estimate

Evaluation measure	5 years	10 years	20 years	50 years
NPV ($ 000)*	$243	$1,507	$2,033	$2,033
BCR	2.3	9.3	12.2	12.2
IRR	30%	51%	52%	52%

*Assumes 5% real discount rate. Values are 2009 dollars.
Source: URS estimates.

Low scenario

Table H-5 contains the results from a sensitivity analysis that assumes that the manufacturers of steel beams respond by lowering their costs, effectively lowering the net project benefits to $\$75/m^3$. All other assumptions are unchanged from the original analysis.

Table H-5 Sensitivity analysis – low estimate

Evaluation measure	5 years	10 years	20 years	50 years
NPV ($ 000)*	$51	$348	$348	$348
BCR	1.3	2.9	2.9	2.9
IRR	12%	28%	28%	28%

*Assumes 5% real discount rate. Values are 2009 dollars.
Source: URS estimates.

Appendix I Enhancing the perception of timber as a suitable construction material in termite prone areas (PN03.1213)

I.1 Project need

In the construction industry, timber competes with a number of alternative building materials, particularly steel. In the late 1990s and early 2000s, timber was losing market share to non-timber building products, in part because there was a perception that timber was inferior because of its susceptibility to termite attack.

During this time, the timber industry was in the process of developing new termite treatments for wood. However, until these products became available in the market, it was considered necessary to invest in a marketing campaign that was designed to address consumers' concerns about using timber in termite-prone areas.

I.2 Project objective

The project's objectives can be summarised as:

- To provide reassurance and improve the understanding of builders and home owners about the real risks of termite damage to timber; and
- To provide information on termite risk assessment and management options.

The project was primarily aimed at reducing the perception of risk, and actual damage from termite attack, and therefore maintaining the use of softwood timber in structural applications (e.g. framing) within the residential building market.

I.3 Project costs

Research costs

The project costs are summarised in Table I-1.

Table I-1 Project costs

Project number	Operating	Capital	In-kind	Total
PN03.1213	$174,720	-	$174,720	$349,440

Source: Project proposal documentation.

I.4 Project benefits

Economic

The project enabled the potential risks of termite attack to be validated, as well as the development of management options which could be used by builders, pest managers and consumers to minimise the likelihood of an attack, and hence damage to buildings. The Timber Development Association has also used the information produced through the project to develop a training course for builders.

As there is no tangible evidence that the issue of termite resistance was impacting on timber sales prior to the project being initiated, the value of any benefit has not been estimated. The project was largely a 'stop-gap' measure, designed to provide confidence within the market until the new termite-resistant products became available.

Environmental and social

There are no direct environmental benefits identified in relation to the project outcomes.

The social benefit associated with the project may be reflected in the availability of information about termite risks and management strategies and the associated reduced level of stress experienced by people who were unnecessarily concerned; however it has not been possible to evaluate this benefit.

I.5 Adoption relative to base case

The information and online course that was produced by the project were adopted almost immediately and are still being accessed today by consumers, builders and pest managers. However, no data are available on the extent to which the information gained through the project has been adopted; there is also some concern about the dissemination of the project information. URS understands that the large-scale dissemination of the project results was not included in the budget.

The project was largely a 'stop-gap' measure, designed to provide confidence within the market until the new termite-resistant products became available. As such the adoption of the project information and potential benefits were envisaged to be relatively short-lived.

I.6 Evaluation

While project benefits have not been quantified, discussions with industry contacts indicate that there was a desire by industry to improve the availability of information about termite risk. The project provided the means by which information about termite risk management could be disseminated, while more fundamental research into ways of improving the termite-resistance of timber products was undertaken.

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