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A Financial Analysis
of the
Eden Hardwood Project

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ANTICIPATED RETURNS FROM HARDWOOD FOREST
MANAGEMENT IN THE EDEN DISTRICT OF NEW
SOUTH WALES: A FINANCIAL ANALYSIS OF A
LARGE SCALE HARVESTING AND DEVELOPMENT
PROJECT.

N. Davies, A.J. Watt & G.J. Deacon

SUMMARY

The management of some 700,000 acres of the publicly owned forested lands of the Eden forestry district is being intensified. Over 110,000 acres have been allocated to the control of the National Parks and Wildlife Service. The remainder has been dedicated as State Forest. On this latter area, the existing overmature and unproductive timber stands are being harvested over a forty year period to provide logs for the local sawmills and pulpwood billets for paper manufacture.

It is proposed to manage 450,000 acres of the State Forests for the continuing supply of hardwood pulpwood and to establish more than 100,000 acres of Pinus radiata plantations on the remainder.

As part of the continuing process of management planning, analyses have been made of the financial returns that may be expected from the harvesting of the old growth and continued management of the eucalypt pulpwood working circle.

Detailed data and results for two of these analyses are presented here.

These indicate that stumpage returns to the Forestry Commission of New South Wales, less expenditures to be incurred by the Commission, have a present value in excess of \$20 million and that each dollar of investment will yield a return of nearly two dollars.

INTRODUCTION

The Eden Forestry District in southeastern New South Wales contains an extensive resource of publicly owned timbered land. Over 110,000 acres have been allocated to the control of the National Parks & Wildlife Service for permanent management as National Parks or Nature Reserves. Approximately 600,000 acres have been dedicated as State Forest with a proposed primary use for timber production. More than half of the State Forest resource consists of dry eucalypt forests dominated by silvertop ash (*Eucalyptus sieberi*) or by one of several species of stringybark. In the moister coastal gullies and the higher rainfall ranges to the west, there are taller forests dominated by mountain grey

gum (*E. cypellocarpa*), brown barrel (*E. fastigata*), messmate (*E. obliqua*) and river peppermint (*E. elata*).

Harvesting of sawlogs and minor quantities of other forest products has been under way in the forests of the area for eighty years. Because of remoteness from major markets, past operations were selective and were undertaken relatively close to the processing centres of Eden and Bombala.

In the Eden supply zone, utilization was too selective to achieve significant silvicultural development, and forest values were such that post-logging treatments could not be financially justified.

Forestry activities in the Bombala zone concentrated on the establishment and culture of plantations of exotic softwoods, with hardwood logging being largely restricted to the salvage of merchantable timber prior to planting.

Due to the low level of forestry development and the climatic features of the region, the area has had a long record of severe wild-fires. These have further lowered forest values by killing trees over many thousands of acres and by severely damaging the stems and slowing the growth of survivors.

During the 1930's, this low quality but extensive resource was on the short list of alternatives being considered by Australian Paper Manufacturers Ltd. as the fibre base for a pulp and paper complex. Whilst it was passed over in favour of the timbered lands in the Latrobe Valley, Victoria, at that time, commercial interest in utilizing the Eden resource for paper-making re-arose in the 1960's.

As a result of increased demands by Japanese paper manufacturing interests for hardwood wood chips, the New South Wales Government, in 1968, issued a 20 year Special Licence, for the sale of hardwood to a wood chip exporter. The committed rate of sale of chippable wood from crown forest areas is 500,000 tons per annum.

The chipmill at Edrom, on Twofold Bay started production in late 1969. Since shortly before that time, harvesting of the Eden forests has intensified. It has been primarily carried out as an integrated operation, providing logs for the local sawmills and pulp-wood billets for conversion into wood-chips.

In the planning of a large scale forest development project by a Government agency, a multitude of considerations must be taken into account. This paper is concerned with only one of these - the direct financial return that is expected to accrue to the State of New South Wales as a result of the increased nett revenues that will flow to the Forestry Commission with management of the area for sustained wood production.

From the viewpoint of this paper, the considerable indirect financial and social benefits that may be expected to flow to the State have been ignored. Forest management tactics and their environmental impacts have also been considered to be outside the scope of this paper.

This is not to deny the importance of these factors. Account is being taken of them in the constant monitoring and re-planning processes that form an integral part of forest management at Eden.

EVALUATING FINANCIAL RETURNS FROM FOREST HARVESTING AND DEVELOPMENT PROJECTS

Project Modelling

The typical approach for evaluating forestry ventures involves the consideration of a representative acre to which all project expenditures and returns are apportioned. Discounting is then applied to bring the apportioned cash flow to a common time point, and the project is evaluated by one of the standard decision rules of cash flow analysis.

This representative or model acre approach has two major theoretical limitations. First, it is difficult to define cost and return flows for a representative acre of a large project, particularly if infrastructure investments are required. Second, and again a problem in the case of larger projects, the approach implicitly assumes a temporal as well as a physical average, so that any operation on the model area duplicates instantaneously over the whole project.

Fortunately, with the development of ready access to electronic computers the necessity to use simplistic models has diminished. It is quite feasible to analyze a whole project by constructing a computer model of it and simulating its development.

The development of adequate simulation models is highly demanding of analytical resources. To allocate its scarce resources of this type efficiently, the Forestry Commission of New South Wales is constructing a series of generalised models.

The model used for the Eden analyses places primary emphasis on the harvesting of existing crops, with a relatively simple treatment of stand replacement and development.

It caters for a clear-cutting system, with the re-establishment and continued management of the forest on an even-aged basis. Existing stands are assumed to be mature or overmature with mortality balancing increment so that there is no nett growth.

Provision is made for expenditures applying to the project as a whole and for expenditures and incomes separately for a number of sub-projects. This permits the modelling of differential yields, harvesting periods, unit costs and returns for varying geographical units within the total project.

Allowance can be made within each sub-project for both capital and recurrent expenditures.

Harvesting is allocated to a period of time and proceeds evenly throughout the period, cutting equal areas annually.

Subsequent crops can be established at variable times after initial harvesting and can be managed on variable rotations, with optional intermediate yields.

In operation, the model simulates the development of each sub-project over the specified planning period, generating cash flows which are aggregated for the whole project. The aggregate is then reduced by discounting with a range of interest rates to yield three of the standard financial appraisal measures - Nett Discounted Revenue (NDR), Benefit Cost Ratio (B:C) and Internal Rate of Return (IRR), notes on which form Appendix 4.

Secular Price Changes

In addition to using simplistic average acre models, many past financial analyses in Forestry, have ignored the reality of

prices changing over time, both generally and relative one to another.

This assumption of price constancy usually results in substantial under-estimates of the profitability of forest investments: firstly, because of the existence of a long-term trend of rises in the real price of wood; secondly, because of the long time span between expenditures and income; and, thirdly, because of an apparent non-linear, as well as non-additive, relationship between real interest rates and inflation, on one side, and monetary interest rates on the other.

The model used in the Eden analysis therefore allows for secular price changes for all expenditures and revenue items.

Length of Planning Period

With the traditional model the usual measure of financial performance is the Soil Expectation Value, a variant of NDR. This assumes an infinite planning period.

However, in a model which builds up expected cash flows as the project is simulated, a finite planning period must be adopted. If this equals the time required to harvest the present crops, no account will be taken of the incomes arising from the first set of subsequent crops, although in a complete project analysis most of the expenditure made on these crops will be charged. This is an extreme case, but it is indicative of the general situation that whatever period is selected, some crops will not reach maturity and project incomes will be understated relative to project costs.

For this reason the income from at least the first set of replacement crops should be accounted for, and therefore the planning period should be sufficient to permit this. In this analysis the planning period adopted has been 100 years which more than meets this requirement.

ANALYSES OF THE EDEN PROJECT

A number of analyses have been made of the Eden Project in the ongoing process of developing and modifying plans for its management.

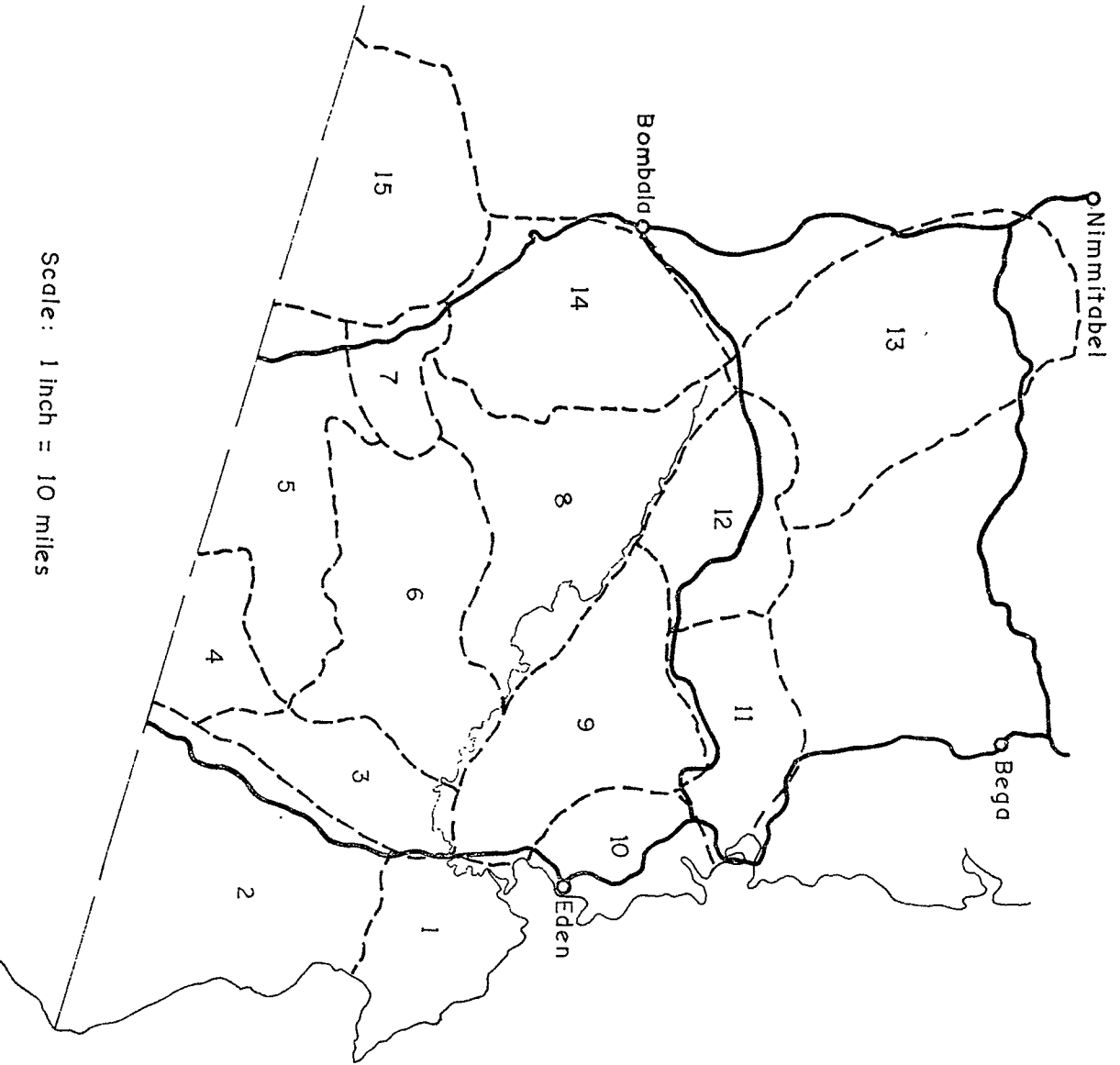


Figure 1. Boundaries of Management Units of the Eden Project.

The majority of these have been based on the premise that the total resource will be managed in two working circles.

In the Bombala Circle, softwood plantations will continue to be established at a rate rising to a minimum of 4,000 acres annually. This planting rate will provide an annual salvage quantity of approximately 200,000 tons of hardwood pulpwood until 1992.

The Eden Working Circle will be managed for continuing pulpwood yields. During the plantation establishment period at Bombala, annual pulpwood yields from Eden will be approximately 300,000 tons, rising to 500,000 tons annually between 1992 and 2011. After this date, the data used provides for an increase in yield potential as regrowth stands become available for harvesting.

Figure 1 and Appendix 1 indicate the extent of the Eden resource, geographically and in terms of volume respectively. Management Units 7, 13, 14 and 15 comprise the Bombala Working Circle, with the other eleven Units making up the Eden Circle.

Within the range of financial analyses made of alternative strategies for the development of the resource, two are of particular interest and will be reported here.

In the first of these, Strategy 1, there is progressive clear-cutting on a face of the old growth (except for approximately 40,000 acres to be preserved for reasons of watershed management, roadside aesthetics or logging difficulty) as logging proceeds successively through each Management Unit of each Working Circle.

Apart from some inherent forest management disadvantages, it is possible that this strategy would have an undesirable environmental impact, particularly with regard to the short-term aesthetics of areas cut.

In Strategy 2, therefore, there is a reduction of coupe size in the Eden Working Circle, and accelerated development of its major access system. The old growth is harvested over two twenty year cutting cycles, with coupes always adjacent to either old growth or regrowth stands of at least ten years and usually twenty years of age.

Appendix 2 details the estimated expenditure, in 1972 prices, for each of these strategies, and Appendix 3 gives estimates of incomes, again in 1972 prices.

The prediction of actual prices at times of expenditure and income accrual is, of course, very difficult. In these analyses it was assumed that adequate forecasts could be made by simple extrapolation of past trends.

For all direct expenditures, a secular price change rate of 3% per annum was adopted. This is considerably below the rate of change of the general price level over the last few years, but is similar to the long-term average rate for the period 1952-1972.

A rate of change of 4% per annum was adopted for administrative expenditures. This is lower than the probable long term rate for salaries, the major component of administrative expenditure, but it is expected that the increasing scale of operations will increase administrative efficiency.

Historically, stumpages have moved in a series of irregular jumps. Between 1960/61 and 1972/73 the average stumpage rate increased at a mean annual rate of 2½%. However, over the same period harvesting generally advanced into more remote areas, and a growing proportion of more defective logs and less desirable species was processed. Hence the prices for produce of a given quality from a specific location would have increased more than the average, probably by approximately 3% per annum.

This is the rate adopted in the present analyses. Thus it has been assumed that stumpage prices will not change relative to the general price level. Considering the apparent trend towards a developing world scarcity of roundwood this appears to be a conservative assumption.

These rates of price change were combined with the data of Appendices 1, 2 and 3 and the development of the Eden Project for the one hundred years 1972 to 2071 was simulated using the model outlined in the preceding Section. Discounting of the cash flows generated by this process indicated that at the appraisal level of the Forestry Commission, the Project has the financial expectations shown in Table 1.

Table 1

Anticipated Financial Returns from the Eden Project

	Management Strategy	Discounting Interest Rate (%)				
		4	5	6	7	8
Nett Discounted Revenue	1	46.2	31.0	22.3	16.9	13.5
(\$ million)	2	45.6	30.5	21.8	16.4	13.0
Benefit Cost Ratio	1	1.89	1.90	1.91	1.91	1.91
	2	1.88	1.87	1.86	1.85	1.84

In that for each and every year of the planning period incomes exceed expenditures for both strategies, their Internal Rates of Return are not defined.

DISCUSSION

The results given in Table 1 were derived from analyses adopting realistic expenditures, including all administrative overheads, and returns for the project. It is, therefore, apparent that management of the Eden resource under either Strategy 1 or Strategy 2 has high financial soundness. Even at 8% interest, potential profits from the Project have an estimated present value of more than \$13 million, and it is indicated that, in present value terms, every \$1 invested will yield a return in excess of \$1.80. At lower interest rates, potential profitability is even higher, although in the case of Strategy 1, the estimated time pattern of expenditures and incomes is such that with lower interest rates there is a slight decline in the Benefit Cost Ratio.

The selection of the appropriate interest rate for financial analysis raised difficult questions. Hence the standard practice has been followed here and results have been presented using a range of rates.

Considering that the current aim is the estimation of the direct financial returns to the State of Forestry Commission expenditure

and incomes, the appropriate rate is that charged on advances to the Commission from the New South Wales Treasury. This is approximated by the long-term bond rate. Excluding the current loading on this rate for the present high rate of inflation, it approximates 6% per annum.

At this interest rate, the Eden Project has a Nett Discounted Revenue of approximately \$22 million.

With a 6% interest rate the N.D.R. under option 2 is $\frac{1}{2}$ million less than that for option 1, but the greater insurances of silvicultural biological and aesthetic success inherent in the former more than outweigh this relatively minor financial differential.

Of more relevance, the analysis of strategy 2 indicates that the process of developing the major part of the Eden natural forest resource for multiple forest use can be achieved with considerable financial returns to the Forestry Commission, and hence New South Wales.

It has been mentioned several times that forestry planning is a continuing adaptive process of appraisal, monitoring and re-appraisal. As time progresses, data availability and analytical methods improve and estimates of the consequences of various courses of action become sharper. The analyses presented here should therefore not be regarded as giving final answers. The current answers, however, strongly confirm the financial validity of the original decision to develop the Eden resource.

Appendix 1Eden Project: Current Yield Availability by Management Units

Mgt. Unit	Gross Area (['] 000 acres)	Nett Area	Assessed Pulp Yield (['] 000 tons)	Assessed Sawlog Yield (mill. s. ft. gross)
1	30.7	29.3	707	26.8
2	63.7	53.0	1867	70.9
3	50.2	47.9	1696	64.4
4	26.5	25.1	989	37.6
5	40.0	37.7	1433	54.4
6	72.1	67.4	2700	102.5
7	22.3	21.8	779	29.6
8	50.2	43.7	1971	74.9
9	55.8	49.3	1823	69.2
10	13.9	13.9	553	21.0
11	25.6	20.9	609	23.1
12	32.5	31.1	1143	43.4
13	53.9	49.7	1695	114.9
14	24.2	22.8	861	58.3
15	42.8	32.5	1208	81.9
Total	604.4	546.3	20034	873.9

Appendix 2Eden Project: Expenditure Details for Financial Analyses

The simulation program used in the analyses of the Project makes allowance for expenditures of the following types:

1. Investment Expenditure on the Whole Project,
2. Recurrent Expenses for the Whole Project,
3. Investment Expenditures on Individual Blocks or Sub-Projects,
4. Recurrent Expenditures on These,
5. Logging Costs on Individual Sub-Projects, and,
6. Subsequent Crop Expenditure on Sub-Projects.

This Appendix details the expenditures allowed for under these headings. Unless stated otherwise, amounts are in terms of 1972 prices.

1. Investment Expenditures for the Whole Project

1.1 Accumulated Deficit on Project Start-up.

Year	Expenditure ¹	Income (\$'000, actual prices)	Accumulated Deficit
1967/8	59.0	59.1	-0.1
1968/9	129.6	67.9	61.6
1969/0	431.2	145.2	347.6
1970/1	376.4	232.9	491.1
1971/2	467.6	562.5	396.2

1 Direct costs + 100% overhead

1.2 Construction of Mt. Imlay Road.

40 miles @ average \$50,000/mile = \$2,000,000
\$700,000 in 1973 and 1974, \$600,000 in 1975.

1.3 Construction of Eden Workshop.

Actual Cost of \$53,000.

- 1.4 Stumpage Rebates to Chipmiller for road construction during Project Start-up, to allow for cost of major roading carried out by company.

Year	\$'000, actual prices
1972/3	300
1973/4	175
1974/5	50

2. Recurrent Expenditures on Whole Project

2.1 Administrative Expenditure	\$'000/Year
Project Level Salaries	101
Other Project Level Expenses (Travelling, rents, postage etc.)	15
Proportionate Head Office Expenses (Includes field staff superannuation)	134
	<hr/>
	250

2.2 Research

This includes only direct costs charged in the District. This averaged \$1,000 annually over the period 1969/70 to 1971/72. Research staffing is by salaried officers, and a number of other expenditure items are also charged to Head Office funds. These approximate \$30,000 annually, and are included in the total for 2.1.

2.3 Fire Protection

Annual costs vary greatly with season severity. Direct outlays in average years are estimated to be \$4,000. Additional expenditure with very severe 1972/73 season approximated \$180,000. Such a season may be expected, on average, each thirteen years. Estimate therefore equals

$$\$4,000 + .077 \times \$180,000 = \$18,000$$

2.4 Maintenance of Mt. Imlay Road.

Annual maintenance \$200/mile.

Annual contribution to 6% interest bearing contingency fund for resealing Mt. Imlay Road @ \$5,000/mile every eight years, \$17,900.

3. Investment Expenditures on Individual Sub-Projects.

3.1 Major Access Roading

3.1.1 Strategy 1.

Each Management Unit a Sub-Project. Units in the Bombala Working Circle roaded as part of the Pine Project. Units 1, 2 and 10 already provided with adequate main access. The following table indicates mileages for the remaining eight management units, together with estimated expenditures for survey, construction and the felling of snags within 1½ chains of road centre lines.

Sub Project	Major Access Mileage	Estimated Expenditure (\$'000)
3	10	77.7
4	10	78.0
5	17	132.1
6	35	272.0
8	34	192.1
9	43	294.8
11	3	23.3
12	10	77.7
Total	162	1,147.7

3.1.2 Strategy 2.

Sub Project 1 made up of Management Units 1-6, 9 and 10, Sub-Project 2 of Units 8, 11 and 12 and Sub Projects 3, 4, 5 and 6 the four Units comprising the Bombala Working Circle. Estimated expenditures are therefore:

Sub Project	Major Access Mileage	Estimated Expenditure (\$'000)
1	115	854.6
2	47	293.1
Total	162	1,147.7

3.2 Minor Access Roding

For Strategy 1, this was allowed as a logging expense (see under 5)

For Strategy 2:

Sub Project	Minor Access Mileage	Estimated Expenditure (\$'000)
1	458	2,535.5
2	151	835.9
Total	609	3,371.4

In the analysis for Strategy 2, Major and Minor Access was charged as an annual expenditure, over twenty years from 1972 for Sub Project 1, and over ten years from 1992 for Sub Project 2. From the above tables annual expenditures (in 1972 prices) were therefore estimated to be:

1972-1992,	\$169,500
1993-2003,	\$112,900.

4. Recurrent Expenditures on Individual Sub Projects

4.1 Marketing Supervision.

Eight cents/ton were allowed for supervising pulpwood cutting and five cents per 100 s.ft. gross for sawlogs.

From these and the resource quantities given in Appendix 1, the following were derived:

4.1.1. Strategy 1.

Sub Project	Cutting Commences (year)	Cutting Period (years)	Marketing Total (\$'000, 1972 prices)	Supervision per Year
1	1972	9	70.0	7.8
2	1972	10	184.8	18.5
3	1982	8	167.9	21.0
4	1990	3	97.9	32.6
5	1998	3	141.8	47.3
6	1993	5	267.2	53.5
7	1982	4	77.1	19.3
8	2006	4	195.1	48.8
9	2001	5	180.4	36.1
10	1981	9	54.7	6.1
11	2001	5	60.3	12.1
12	2010	2	113.1	56.6
13	1986	7	193.0	27.6
14	1972	10	98.0	9.8
15	1972	10	137.6	13.8
4.1.2 Strategy 2				
1	1972	40	116.5	29.1
2	1993	19	368.5	19.4
3	1982	4	77.1	19.3
4	1972	10	137.6	13.8
5	1972	10	98.0	9.8
6	1986	7	193.0	27.6

4.2 Road Maintenance

4.2.1 Strategy 1

Allowance was made for heavy maintenance of main access roads in each Sub Project at \$200/mile/year during logging of the old growth. Following logging, allowance was at the rate of \$30/mile/year for all roads. (Allowance for maintenance of spur roading during logging was made as a logging expense under Category 5).

4.2.2 Strategy 2

Sub Projects 3 to 6 were allowed for as in Strategy 1. For Sub Projects 1 and 2, main access maintenance during old growth

logging was treated as a logging expense (see 5). Within Sub Project 1, the total mileage of permanent maintenance rises to 600 miles, at \$30/mile/year, in equal annual increments over forty years, and within Sub Project 2 to 191 miles over nineteen years.

5. Logging Costs on Individual Sub Projects.

The analytical model used caters for these expenses on a per acre basis.

5.1 Strategy 1.

Allowance was made for:

Survey, construction and snag falling of minor roads at \$5,540/mile. Heavy maintenance of these during logging at \$200/mile/year, and, pre and post logging burning at 20c/acre.

Within the Eden Working Circle, these harvesting costs reduced to \$7/acre for Sub-Projects 2 and 6, \$8 for 4 and 9, \$9 for 1, 5, 8 and 12, \$10 for 3 and 11 and \$11 for 10.

Only the road maintenance expenses were charged within the Bombala Working Circle. Additionally, a credit of \$5/acre was allowed for the marginal reduction of pine plantation expenses resulting from prior hardwood utilization.

5.2 Strategy 2.

As mentioned, spur road construction was allowed for as an annual expense under Category 3 for Sub Projects 1 and 2. Maintenance and burning was allowed for at \$1/acre.

Sub Projects 3 to 6 were treated as in Strategy 1.

6. Subsequent Crop Expenditures.

6.1 Ripping and Planting of Log Dumps.

\$10/acre on 10% of area = \$1/acre for all Sub Projects of the Eden Working Circle.

6.2 Non Commercial Thinning.

With present harvesting technology, non-commercial thinning will be required to induce an adequate piece size after a forty year growing period. Research is underway into means of limiting initial stocking so that growth will be concentrated on fewer stems, but in the present analyses, thinning at age 15 @ \$30/acre was allowed for.

6.3 Marketing Expenses

Supervision expenses @ 5c/ton for 80 tons/acre = \$4/acre, and additional road maintenance during heavy logging usage adds another \$1/acre.

Appendix 3

Eden Project: Income Details for Financial Analysis.

The only incomes allowed for in the analyses were stumpages to be obtained from the sale of sawlogs and pulpwood billets.

For sawlogs, mean stumpage values per 100 s.ft. gross hoppus volume were appraised using the Forestry Commission's standard appraisal methods and criteria. Within each Management Unit, haulage distances were based on the projected roading system at time of harvest-
ing the Unit. Allowance was made for an average defect of 20%.

For pulpwood stumpages, rates for individual Management Units were derived from the stumpage zones and the rates applying thereto in the Sales Agreement with the chipmiller. Rates for regrowth were assumed to rise by a conservative 4 cents/ton (in 1972 prices) because of higher yields per acre of higher quality pulpwood.

The following tables give estimated average unit incomes, by Sub Projects, for each Strategy. Rates are in terms of 1972 prices.

1. Strategy 1.

Sub Project	Old Growth		Regrowth
	Pulpwood (\$/ton)	Sawlogs (\$/100 s.ft.H.)	Pulpwood (\$/ton)
1	2.21	1.63	2.25
2	2.21	1.40	2.25
3	2.21	1.62	2.25
4	2.21	1.33	2.25
5	2.17	1.27	2.21
6	2.17	1.30	2.21
7	2.01	1.22	-
8	2.04	1.16	2.08
9	2.20	1.78	2.24
10	2.21	2.03	2.25
11	2.21	1.87	2.25
12	2.07	1.73	2.11
13	1.67	1.14	-
14	1.86	1.26	-
15	1.86	1.28	-

2. Strategy 2

Sub Project	Old Growth		Regrowth
	Pulpwood (\$/ton)	Sawlogs (\$/100 s.ft.H.)	Pulpwood (\$/ton)
1	2.19	1.49	2.25
2	2.09	1.45	2.13
3	2.01	1.22	-
4	1.86	1.28	-
5	1.86	1.26	-
6	1.67	1.14	-

Appendix 4Notes on Three Standard Financial Appraisal Measures

The model used for the Eden Project analyses generates anticipated cash flows. These are then reduced to the financial appraisal measures of Nett Discounted Revenue (NDR), Benefit Cost Ratio (B:C) and Internal Rate of Return (IRR).

Briefly considering each of these in turn,

$$\text{NDR} = \sum_{i=1}^n R_i (1+p)^{-i} - \sum_{i=1}^n E_i (1+p)^{-i}$$

Where

- R_i = Revenue obtained in year i .
- E_i = Expenditure in that year,
- n = Number of years in the planning period, and,
- p = The discounting interest rate.

If the second term on the right hand side of the expression exceeds the first, discounted expenditures exceed discounted revenues, NDR is negative and the project being analysed is financially unsound.

The decision rule for financial acceptability of a project is therefore that NDR must be non-negative. If it is zero, the project should just break even, and if positive, there are potential profits.

The NDR estimates the return to the land on which a project is conducted. If expenditures on land purchase are not included in the analysis, it gives the value of land for the purpose of the project.

In the case of the Eden Project, however, the value of the land for wood production is considerably greater than the estimated NDR of \$22 million. This amount is only the value for wood production usage to the Forestry Commission, not to the community at large.

The efficiency with which a project will use the capital invested in it cannot be estimated from NDR. For two alternative projects, a

larger NDR for one may merely mean that it is a larger project.

Where investment efficiency is of more concern than land use efficiency an alternative measure is required. One such measure is the Benefit Cost Ratio. In the form used for the Eden Project analyses this is given by:

$$B:C = \frac{\sum_{i=1}^n R_i (1+p)^{-i}}{\sum_{i=1}^n E_i (1+p)^{-i}}$$

where the various items are as previously defined.

The decision rule for financial acceptability with this measure is that B:C must be equal to or greater than unity.

The IRR is another measure for the efficiency of capital usage. It is defined as the discounting interest rate which equates discounted revenue with discounted expenditure, i.e. the rate at which NDR equals zero and B:C equals unity.

With this measure, a proposed project is indicated to be financially sound if its IRR equals or exceeds the rate of interest charged on investment funds.

There are a number of theoretical difficulties inherent in the IRR concept. In general B:C is a preferred measure of financial efficiency.

Typically, forest investment analyses concern projects commencing with heavy expenditures (for stand establishment) with a following period of fairly low expenditures (for stand maintenance) occasional small revenues (from thinnings) and then a large revenue (from clear cutting).

Under these circumstances, both NDR and B:C decline with rising interest rates, to eventually indicate the IRR.

However there is no mathematical necessity for the inverse relationship between interest and NDR and B:C. With certain types of cash flow, rising interest may induce either or both rising NDR

or rising B:C, and there may be either multiple values of IRR, or it may not be defined at all.

Projects having excess anticipated revenues over expenditures in most of their early years are quite likely to give such results.