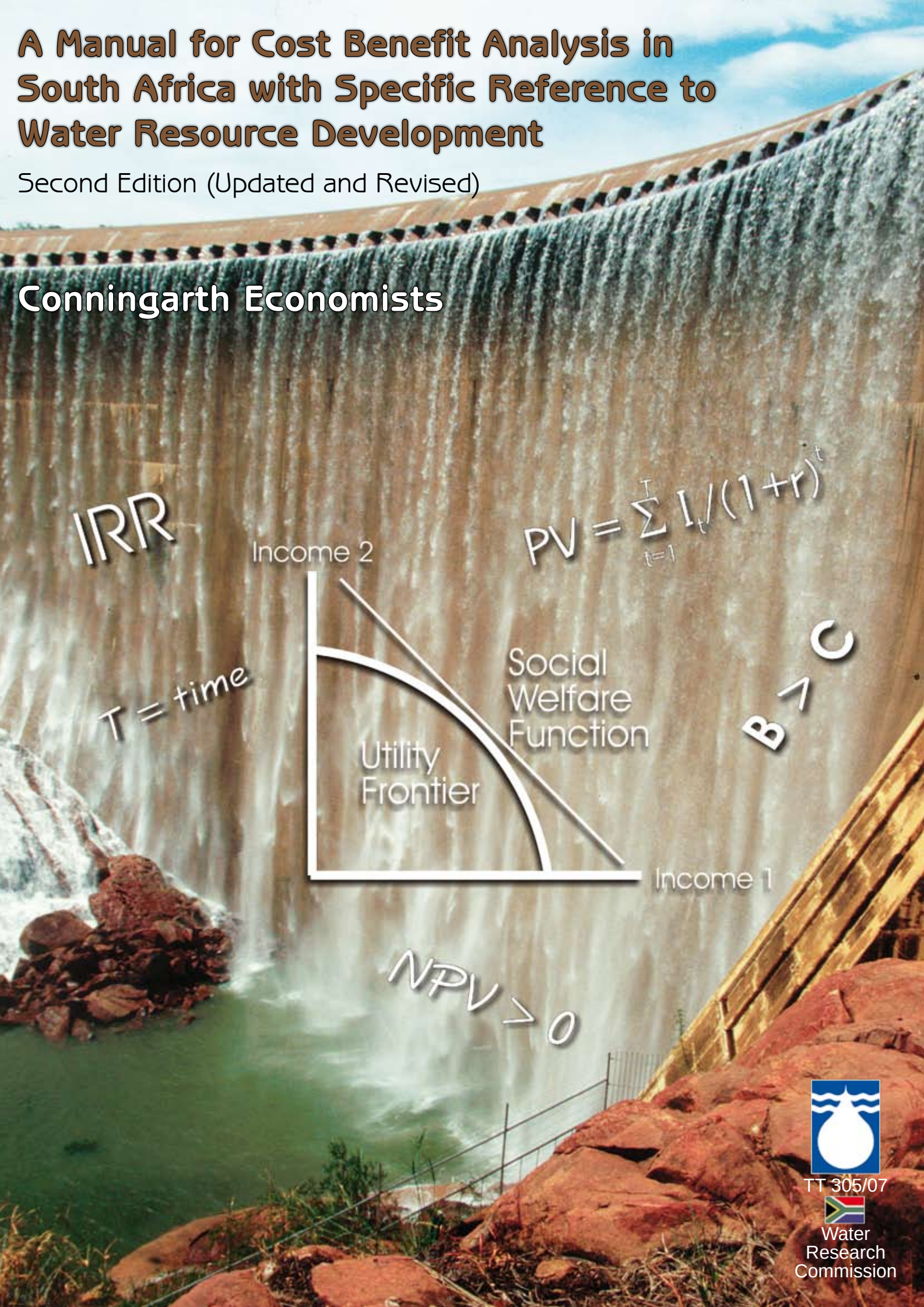
A Manual for Cost Benefit Analysis in South Africa with Specific Reference to Water Resource Development

Second Edition (Updated and Revised)

Conningarth Economists



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Water Research Commission

A MANUAL FOR COST BENEFIT ANALYSIS IN SOUTH AFRICA WITH SPECIFIC REFERENCE TO WATER RESOURCE DEVELOPMENT

Second Edition (updated and revised)

Prepared for the

WATER RESEARCH COMMISSION

by

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CONNINGARTH ECONOMISTS

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In 1998, the then Central Economic Advisory Services produced the original *Manual for Cost-Benefit Analysis in South Africa*. This original manual was updated to reflect 2000 prices and extended to include additional concepts and explanations in October 2002 with the publication of *A Manual for Cost-Benefit Analysis in South Africa with Special Reference to Water Resource Development* (WRC Report No. TT 177/02). This report presents an update of the October 2002 manual to reflect 2006 prices.

It is vitally important that, from time to time, such updates are made in order to provide users of this Cost-Benefit Analysis (CBA) manual with a set of standardised, uniform parameters that will enable decision makers to arrive at sound conclusions and decisions. This current updating exercise focused on the following aspects of the CBA manual:

- The updating and expansion of shadow and surrogate prices: It is important to provide users with a set of standardised, uniform parameters so as to ensure that undertaking a CBA produces scientifically valid results that enable reliable interpretations and comparisons to be made.
- The updating of the social discount rate: The level of interest in South Africa, and abroad, has decreased since the CBA manual was published in 2002. As such, this current update provides the perfect platform for revising the social discount rate used in cost benefit analyses. As part of this element of the exercise, a literature survey has been conducted on the social discount rate and appears as a separate document appended to this report (Appendix 1).
- The updating of the computerised model for the determination of a weighted average shadow price for the inputs of capital projects.

It is important for users of this CBA to be aware that all other aspects of the CBA manual remain unchanged, with the exception of the above-mentioned updates. All of the underlying theory that is contained in the manual is still valid for CBA and, as such, there was no need for these elements of the manual to be changed.

The following people were involved in the 2007 update. The time and effort spent by these individuals is highly appreciated by the consultants:

Dr G.R. Backeberg	Water Research Commission
Mr F.X. Jurgens	Development Bank of Southern Africa
Mr B. Rossouw	Development Bank of Southern Africa
Mr D. van Niekerk	Development Bank of Southern Africa
Mr P. Mabuza	Development Bank of Southern Africa
Mr I. Schutte	CSIR, Transportek
Mr G. Matras	Development Bank of Southern Africa
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Mr R. Downing	South African Chamber of Business

The Steering Committee that was responsible for the 2002 publication comprised the following individuals:

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ABBREVIATIONS

BCR	–	Benefit-cost Ratio
CAPM	–	Capital Asset Pricing Model
CBA	–	Cost-Benefit Analysis
CGE	–	Computable General Equilibrium
c.i.f.	–	Cost-insurance freight
CVM	–	Contingent Valuation Method
DBSA	–	Development Bank of South Africa
DCF	–	Discount Cash Flows
DWAF	–	Department of Water Affairs and Forestry
ERR	–	Economic Rate of Return
f.o.b.	–	free on board
FRA	–	Financial Rate of Return
GDP	–	Gross Domestic Product
HDM	–	Highway Development and Management
HP	–	Hedonic Pricing
I-O	–	Input-Output
IRR	–	Internal Rate of Return
JSE	–	Johannesburg Stock Exchange
LFS	–	Labour Force Survey
LP	–	Linear Programming
MCDA	–	Multi-criteria Decision Analysis
NPV	–	Net Present Value
PSA	–	Public Servants Association of South Africa
RAF	–	Road Accident Fund
RED	–	Roads Economic Decision
SADC	–	Southern African Development Community
SAM	–	Social Accounting Matrix
SARB	–	South African Reserve Bank
SARS	–	South African Revenue Service
SETA	–	Sector Education and Training Authority
SSA	–	Statistics South Africa
STPR	–	Social Time Preference Rate
TCM	–	Travel Cost Method
UK	–	United Kingdom
VAT	–	Value Added Tax
WCD	–	World Commission on Dams
WfW	–	Working for Water
WMA	–	Water Management Area
WRC	–	Water Research Commission
WTA	–	Willingness to Accept
WTP	–	Willingness to Pay
WUA	–	Water Use Authority

EXECUTIVE SUMMARY

This document entails the guidelines in the format of a manual for conducting Cost-Benefit Analysis (CBA) in South Africa with specific reference to evaluating the development and management of water resources. This evaluation of projects is often a difficult task since costs and benefits do not occur only once but appear over time. Furthermore, costs and benefits are often hidden, making them hard to identify, and are also frequently difficult to measure. The same problems occur when the decision maker has to make a choice between a number of mutually exclusive projects intended to achieve the same goal via a number of different routes. These problems are not limited to capital projects; they also occur when decisions have to be made regarding the merits of current expenditure programmes. The CBA method, also known as benefit cost analysis, provides a logical framework by means of which projects can be evaluated, serving as an aid in the decision making process. This manual is specifically aimed at the decision maker in the public sector, but can also be used outside the public sector.

To ensure that this manual provides practical guidelines for the CBA practitioners the research was conducted in close cooperation with the research manager at the Water Research Commission, members of the Steering Committee of the project, Development Bank of Southern Africa, the Department of Water Affairs and Forestry and leading CBA practitioners. As part of the process, four major workshops were held during the course of the project. At these workshops valuable inputs were given.

It is interesting to note a few highlights of the CBA Manual. For example a broader approach is followed to incorporate the relationships between CBA and other aspects of the economy. In this regard the following aspects have been included:

- The relationship between the principles of CBA and welfare economics;
- CBA as one component of the range of decision making support instruments;
- the equity and efficiency principles;

thus it deals specifically with the uses, limitations and basic principles of CBA in order to explain the underlying conceptual framework to the reader.

The manual provides information for not only the analyst, but also contains insight into the CBA application possibilities for the decision makers. This information is contained in the introduction and background which form a separate section in the document.

This manual advocates that the CBA concept needs to be widened to include the broader social costs and benefits derived from a project. Furthermore it is also accepted that CBA is only one of several instruments for evaluating proposed projects. One of the main objectives therefore was to incorporate an income weighting system. This system provides for the recognition of some of the macroeconomic policies of the government e.g. combating poverty and promoting regional development. The impact of income distribution on CBA is specifically addressed in this manual. The fundamental point of departure is that additional incomes for lower income groups should be relatively more important than additional incomes for higher income groups.

The manual also propagates the need for sensitivity analysis. In most cases, a CBA is performed for future projects and thus entails the estimation of certain key variables such as expected prices and quantities. Although it could be accepted that the decision-maker is fully aware of the fact that the projected outcome of a project cannot be interpreted in absolute certain terms, it is important that the analyst provides the decision-maker with some idea of the degree of certainty/uncertainty to which the project outcome would be subjected to. In this regard both selective as well as general sensitivity analysis are discussed. A general sensitivity analysis hinges on the derivation of a probability distribution of possible outcomes.

As far as possible a practical approach is followed in this manual. This applies specifically to the guidelines for shadow and surrogate prices. In this regard the following shadow/surrogate prices are provided:

- shadow wages for unskilled labourers per province
- estimated annual remuneration for occupational categories in South Africa per province
- index of projected real effective exchange rate of the Rand
- index of projected prices for petrol and diesel
- index of estimated relative changes in electricity prices
- estimated time cost according to income groups
- economic value of productive life

As mentioned above, the focus in this manual is on evaluating the development and management of water resources. In this regard various issues relating to such evaluation are discussed. For example, attention is given to water development and river basin management cost. The subject of the opportunity cost of water is also addressed. The user of this manual is further provided with a list of environmental aspects related to water development. Methodologies to calculate the economic value of water for various water usages are discussed in detail. The researcher is assisted in the application of the guidelines in this manual by providing him or her with practical examples which appear on the website of the Water Research Commission (www.wrc.org.za). These examples include electricity, potable water, roads and municipal versus irrigation water schemes.

The main subjects discussed in this manual are the following:

- applications and limitations of CBA
- methodology
- criteria for project assessment
- shadow and surrogate prices for South Africa
- issues relating to water development
- practical examples

INTRODUCTION AND BACKGROUND

INTERNATIONAL HISTORY OF COST-BENEFIT APPLICATIONS

Cost-Benefit Analysis (CBA) has its roots in the middle of the nineteenth century, when economists started to link the theory of consumers' surplus with the net gain of communities from government spending projects. The link between the surplus theory and the indirect third-party losses and gains from capital projects was again revived in the 1930's in the United States with the United States Flood Control Act of 1936. That CBA should start in the USA in practice is not surprising, because academic economists secured links with the US government at an earlier stage than in any other country. The earliest application of CBA in the United Kingdom was only in 1960 in respect of the M1 motorway. In 1967, the British Government officially directed its nationalised industries to adopt CBA.

The increasing interest and application of CBA in recent times can be based on two distinct factors:

Firstly, public expenditure in the developed economies has risen substantially since World War II. Furthermore, in developing countries the need for infrastructure expenditures has increased substantially, often financed by governments of developed countries and international aid agencies – requiring some "standardised" framework and method to evaluate these huge capital projects and minimise, as far as possible, the risk of failure.

Secondly, such appraisal techniques were already fairly well developed in the private sector in the form of discounted cash flows (DCFs) and also allowing for identified risks and causal sensitivities. These two factors, have given impetus to the prevailing notion that the principle of efficiency should be extended to drastically increased government expenditures.

THE SOUTH AFRICAN EXPERIENCE

The economic and political experiences in South Africa over the past three decades or so do not differ materially from the international one discussed above. The main difference between South Africa and other developing countries is to be found in the added pressures that the apartheid policy placed on scarce national resources. Since the 1970s, government expenditure as percentage of the gross domestic product (GDP) rose constantly, reaching high levels of ±30 percent. Due to direct and indirect international economic sanctions, over time, the need for economic self-sufficiency and security, forced government to channel a disproportionate amount of resources for government use. This led to large budget deficits, high inflation and declining GDP growth.

The need for some kind of framework and method to evaluate spending priorities on a more rational and systematic basis arose. With the help of the then Office of the Prime Minister's Economic Advisor, the concept and practice of CBA was steadily promoted for use in state departments with the backing of the Finance department. In order to facilitate consistency and comparability it was decided in the mid-eighties to compile a manual for CBA. Hence

the appearance of the first CBA Manual in August 1989 for restricted use in the public sector. It should be emphasised that the 1989 manual was developed by the government of the day. To a large extent that manual was prescriptive for use in the evaluation of public sector projects.

MAIN FEATURES OF THE MANUAL

This manual is again aimed at the decision maker in the public sector; but can also be used outside the public sector. Where the public sector planner usually works with concepts and criteria that usually do not fall under the rigours of the market system, use has to be made of proxies and other substitutes to simulate the workings of the market system in its "perfect" format. This is not easy because the evaluation of projects is often a difficult task since costs and benefits do not occur only once but appear over time in the future.

Furthermore, costs and benefits are often hidden, making them difficult to identify, and they are also frequently difficult to measure. The same problems occur when the decision maker has to make a choice between a number of mutually exclusive projects intended to achieve the same goal via a number of different routes. These problems are not limited to capital projects; they also occur when decisions have to be made regarding the merits of current expenditure programmes.

The following examples of proposed projects, in a much abbreviated form, illustrate the difficult tasks facing the decision maker when applying the principles of CBA:

(i) The construction of a new road (Transport)

A new road is proposed. The road will be of benefit to certain landowners/tenants and road users – in the form of savings in vehicle maintenance costs and time – while being to the detriment of other landowners or tenants. The construction costs are a further burden to the community. The road will mean air and noise pollution for some, but there is the likelihood that accidents and therefore injuries and deaths will decline. The authority concerned must consider these diverse consequences and decide whether to build the road.

(ii) Flood control-irrigation project (Agriculture)

Consideration is being given to the building of a dam in an area where periodic rains cause great flood damage. The dam can be used for irrigation purposes and will relieve periodic water shortages in neighbouring areas. Besides the high financial cost of constructing the dam, there is a possibility that the proposed dam may silt up rapidly. In addition, a bird sanctuary housing red data species will be flooded once the dam is completed and full of water. Once again the decision-maker must consider all the advantages and disadvantages before making a decision.

(iii) A large-scale inoculation programme (Health)

A large-scale inoculation programme against anthrax is planned. The vaccine is expensive and there are additional costs connected to the remuneration of the medical personnel and the distribution of the vaccine. The programme should reduce mortality, morbidity and the loss of working time. Not only will those inoculated benefit, but also the rest of the community as a whole, because of the reduced risk of infection. However, there is a small risk of serious side-effects after inoculation which may lead to death. The decision-maker must weigh up the potential benefits against the cost and decide whether the programme should be adopted and on what scale.

(iv) Natural resource development restoration

The Working for Water Program (WfW) is a multi-departmental initiative co-ordinated through the Department of Water Affairs & Forestry (DWAF) since 1995. The main aim of WfW is to eradicate invading alien plants from rivers, mountain catchments and other natural areas to improve runoff, conserve biodiversity and improve the productive potential of the land. Although the initial emphasis of WfW was on water conservation, it has a significant environmental, economic and socio-economic impact felt mainly by very poor rural communities. In many cases, it contributes a significant proportion of the cash income of those communities and has the potential to provide members of the communities with opportunities for investment. To maximise and to identify the various projects in the WfW Program it is necessary to develop a better understanding of the full economic impact of these projects.

A CBA Model has been developed to calculate the economic costs and benefits at a project or quaternary catchment level. To capture the cost and the benefits of a specific project on a structured way the model has been developed in various components:

- Clearing of alien plants
- Use of natural vegetation
- Development of small secondary industries
- Additional water supply and costs
- Veld fire management
- Training to improve the quality of life, including improved earning potential for the local communities.

The above projects differ widely in terms of objectives but demonstrate the important principle that every project provides benefits for the community or some groups in the community, but at the same time involves disadvantages or costs for the community or some groups in the community. It is the task of the decision-maker in the public sector to weigh up the benefits against the costs in order to decide whether a project will have a net benefit for the relevant community. The CBA method (also known as benefit-cost analysis) provides a logical framework and other means by which projects such as those above can be evaluated, thereby serving as an aid in the decision-making process.

The compilers do not claim that it is the ultimate authority on CBA in South Africa. It is stated that both the theory and the evaluation systems are in the process of evolutionary development and as such are subject to further refinement. At the same time the structure is sufficiently developed to enable one to look sceptically upon anyone who wishes to deviate from the basic principles. As a result any such person or institution should bear the burden of proof and persuasion for such deviation. This is therefore the basic point of departure pertaining to this CBA Manual. Nevertheless, partly due to demand from users, it was decided that this time round somewhat more emphasis should be put on a more in-depth description and evaluation of the basic economic theory and principles underlying CBA. In Chapter 1 the theory of CBA as a sub-section of general classical economic theory is presented in more detail. In addition a specific part is devoted to other possible project evaluation methods such as multi-criteria analysis for decision making (MCDA). As indicated earlier it is not the intention of this manual to criticise the existence or inferiority of other evaluation methods as compared to CBA. On the contrary, in Chapter 1 the point is made that it is accepted that CBA has its own shortcomings.

Recent international and local experience has shown that criticism of CBA is only admissible if it can be demonstrated that alternative prescriptive procedures are in some way superior – which in reality could not yet be proven.

However, it is today accepted that in many situations in the world and also in South Africa, the scope of CBA probably needs to be widened somewhat to include the broader social cost and benefits derived from a project. Consequently, in Chapter 3 a presentation is made of how the "standard" cost-benefit practices and procedures contained in this manual can be extended to include, for example, the income-distribution and welfare effects of a specific project. It is also shown how the advent of modern analytical models, such as the Input-Output, Social Accounting Matrices (SAMs) and Computable General Equilibrium (CGE) models can be used in support of CBA. In Chapter 4 as in the previous manual, the use and composition of a capital programme for planning purposes is presented.

An important aim of this CBA Manual is to provide the decision-maker with practical guidelines and procedures to apply the CBA methodology. Based on experience with CBA analysis over the past 12 years by various development agencies such as the Development Bank of Southern Africa, the Sector Education and Training Authority (SETA) programs of the Department of Labour and the DWAF and the WRC, the proposed standard procedures for the application of CBA are given in Chapter 5. These proposed steps and procedures are of a generic nature and will have a general applicability to all kinds of projects (capital and recurrent).

Another aim of this manual is to provide the user with an extensive and up to date data bank of shadow and surrogate prices in South Africa in Chapter 6. It is proposed that this new feature will further enhance the use of the manual. The baseline year is 2000.

Having regard for the fact that over the past 12 years CBA has found extensive applications in the field of water development, it was found necessary to devote a specific chapter (Chapter 7) in the manual to this important topic. Important issues such as the opportunity

cost of water and a method to calculate the economic (opportunity cost) value of water are discussed in this chapter.

Lastly, in Chapter 8 of this manual, several examples of CBA applications in practical terms for South Africa are presented with specific reference to water utilisation. These examples are the outcome of the use of the theory, principles, procedures and data bases of CBA as discussed in this manual.

The document is also accompanied by a CD. This CD contains various examples of practical CBA applications as well as a dynamic computer model to calculate shadow prices for various capital and operational costs.

CHAPTER 1: POLICY OBJECTIVES AND THE UTILITY, NATURE, APPLICATIONS AND LIMITATIONS OF COST-BENEFIT ANALYSIS (CBA)

1.1 Theoretical Foundation of CBA

1.1.1 Background

The origin of the basic theory and principles behind the practice of Cost-Benefit Analysis (CBA) dates back to the middle of the nineteenth century. The idea of measuring the net advantages of a capital investment project in terms of society's net utility gains (welfare economics) originated with Dupuit's well-known publication in 1844[1]. He started to develop his definition of what is now called consumers' surplus (i.e. the willingness to pay for a good or service over and above its market prices) as a measure of the net welfare gained from a project. This aspect of the definition of net social benefit is fundamental to CBA, and is extended to instances where persons who are not direct beneficiaries of a project obtain some form of spillover benefit. Accordingly the measurement of net social benefits requires the estimation of all the consumers' surpluses to whoever they accrue.

According to Boardman et al.[2], CBA can be thought of as providing a protocol to measure allocative efficiency in the economy. This approach is based on the work of the famous Pareto, who formulated the Pareto optimum condition viz: "An allocation of goods is Pareto efficient if no alternative allocation can make at least one person better off without making anyone worse off" [3].

There is a direct relationship between net benefits and the Pareto efficiency. As long as all impacts are valued in terms of the willingness-to-pay concept and all required inputs in terms of opportunity costs, then the sign (positive or negative) of the net benefits indicates whether or not it would be possible to compensate those who bear costs sufficiently so that no one is made worse off. Positive net benefits indicate the potential for compensation to make the policy Pareto efficient; negative net benefits indicate the absence of this potential.

This state of affairs is sometimes also referred to as the Kaldor-Hicks criterion[4]. Important pre-conditions are that gainers must be able to compensate losers and still be better off.

1 Dupuit J. "On the Management of the Utility of Public Works" 1844. Translated from the French, in International Economic Papers, no.2 (London 1952).
2 Boardman AE. et al.; CBA – Concepts and Practice, Prentice-Hall Inc. 1996 – pp 28/29.
3 Boardman etc., pp 29.
4 Sassone PG & Schaffer WA. CBA, A Handbook: Academic Press; New York 1978, p 9.

1.1.2 The function of profits

Based on the classical theory of economics (including welfare economics) which has as its main underpinnings perfect free-market conditions with the rule of laissez-fair, profits (must) measure the gain which society derives from investment. Profits also serve as an essential signalling mechanism for guiding investment decisions. CBA in its traditional format does assume that actual receipts (benefits) adequately measure social benefits and actual expenditure measures social costs.

The traditional approach to CBA assumes that if the private capital markets in a country were perfect and if there were no taxes or subsidies at the margin on profits and income, the market interest rate would be the appropriate rate for discounting future costs and benefits. If the Economic Rate of Return (ERR) on investments equals that of market interest rates, the balance between investment and consumption at any point in time would be correct; that is, the economy would be on its optimal growth path.

If the economy was on an optimal growth path, then the objective function for the National Income i.e. (Y) can be stated in terms of the maximisation of the sum of aggregate consumption (C) and investment (I) that is national income, at any point in time. Thus maximum social benefit is simply C + I, given that changes in C are equally as valuable as changes in I. Those who use the traditional approach usually talk, not about consumption effects but about national income effects. There is no difference as long as investment is equally as valuable as present consumption at the margin – Social Rate of Return therefore equates to the ERR. This also implies a "fair" distribution of income and wealth between the population and income groups [Equity = Efficiency].

1.1.3 The use of shadow prices

In the real world, because market imperfections such as tariffs, quotas and monopolies create distortions in demand and supply, there is little chance that the market price will reflect the true economic value and cost of inputs and outputs.

To rectify this situation in order to demonstrate the real measure of efficiency with which the economy utilises its scarce resources does require adjustments to the current prices of services and commodities. These adjusted prices are referred to as shadow prices.

1.1.4 The situation in developing countries

The traditional approach to CBA discussed in the previous section, even adjusted for shadow prices, is mainly aimed at determining the economic (efficient) rate of return of a specific project. For in practice, due to market distortions, the Financial Rate of Return (FRR) of a private investment project, usually differs from the ERR. Put in another way, the FRR is not necessarily a true reflection of the most efficient utilisation of scarce resources.

One of the main criticisms against the traditional approach to CBA is that even if shadow prices are used, the impact on wealth and income distribution is neglected. [We must remember that the traditional Pareto principles use as departure point full employment and equilibrium in all markets at the margin]. For example, a 2 percent rate of growth with an even distribution of benefits is hardly the same as a 2 percent rate of growth with a highly uneven distribution. Trade-offs between growth and distribution pose important policy choices that cannot be dismissed by putting forward "trickle-down" or similar theories of the development process.

Much of the recent published work on growth and development has criticised the social valuation implicit in the traditional approach. This has led to the development of a new approach that is quite open-ended in its social valuation. This new approach does not compel one to reject the traditional view, but allows the use of different judgements. Decision-makers can use it as a flexible tool – for example, to place a greater weight on investments than implied by the traditional approach or to incorporate the objective of redressing poverty and economic inequality.

This new approach has been called "social" to distinguish it from the traditional, or so-called efficiency approach.

If different fundamental objectives are selected, the valuation of benefits and costs will also differ. The shadow prices used in the new approach are often called social prices to distinguish them from the shadow prices used in the traditional approach, which are correspondingly called efficiency prices. To illustrate, the efficiency shadow wage rate will be the marginal product of labour in certain cases. The social shadow wage rate may differ, however. If the employment of an additional unit of labour in the project would increase labour income, then the social shadow wage rate would reflect, in addition to the effect on output, both the benefit of that increased income in redressing poverty and the cost of any reduced savings and reinvestment.

The main objective of the "new" approach is to bring the ERR as close as possible to the Social Rate of Return.

1.2 CBA In Relation To Other Decision Making Support Tools

1.2.1 Economic impact analysis

Whereas CBA is concerned exclusively with comparisons of direct benefits and costs to society created by an investment project, economic impact analysis examines the distribution of many secondary economic impacts and outcomes that traditionally fall outside the scope of CBA. An economic impact analysis does this by studying changes occurring across broadly defined sectors of the economy. The intent is to ascertain who gains and who loses as a result of the project, and by how much.

The types of impacts and outcomes addressed in an economic impact analysis coincide, to a certain extent, with those considered in any macroeconomic analysis. These impacts represent indirect effects on markets, rather than direct shifts in consumer or producer surpluses that are the focus of CBA. Nonetheless, these effects may have significant implications on how particular groups fare as a result of a particular project. Major categories of potential economic impacts are described below:

- Changes in economic growth and productivity: Negative impacts on regional or national productivity and economic growth can result if an investment project creates significant opportunity costs, such as the "crowding out" of investments. Alternatively, new outputs may improve the overall productivity of capital.

- Price impacts: Large projects may create a significant supply of outputs that may in turn stimulate shifts in supply or demand for related goods. During the operational life of a project for example, irrigation water supplied by a dam may affect markets and prices for substitutes (such as water conservation equipment) and, for example, equipment for higher-value irrigated crops.

- Production and employment impacts: When a project's construction requires significant capital, workers and construction materials, this may create shortages in related markets for labour and other factors of production (i.e. land, capital).

- Changes in government revenues and expenditures: If a project is financed with public funds, this may require large fiscal outlays by the government that may in turn have repercussions on the money supply, inflation, and government indebtedness. Conversely, a project located in a depressed area may boost regional economies (through household and business incomes) and generate higher tax revenues for the government.

- International trade and competitiveness impacts: If a project is large enough to increase productivity and lower the cost of production at a national level, a country's exchange rate, export position, balance of payments, and international competitiveness may improve.

1.2.2 General equilibrium approaches

Several analytical economic tools are available to assess "ripple" (secondary and tertiary market) effects on the economy of the region or country. These tools, known as "general equilibrium" models, attempt to capture the interactions of a project's direct and indirect impacts throughout the economy. Three general equilibrium approaches for assessing macroeconomic effects follow below:

Input-Output (I-O) Models. These models characterise the interdependence of sectors within an economy by generating data on multipliers and leakages. Multipliers show that the impact of a particular sector on the regional/national economy (in terms of some of the above criteria) is larger than the value/volume associated solely with that sector's output. Leakages

indicate where economic impacts, such as project revenues, move ("leak") from one region or economy to another.

Social Accounting Matrices (SAMs). SAMs use a mathematically based matrix presentation to represent the flow of funds linked to demand, production and income within a national or regional economy. SAMs can be designed with a special emphasis on social rather than economic attributes (e.g. low income households) and, thereby, also provide information about equity and distribution issues. SAMs can be regarded as an extension of I-O models.

Computable General Equilibrium (CGE) Models. CGE models incorporate more realistic descriptions of consumer and producer behaviour than do I-O models and SAMs, by accounting for reactions to changes in market conditions (e.g. price). Yet their detailed breakdown of industries and commodities and regions are usually limited in order to achieve a workable model solution by approximation.

It is important to remember that CBA is not designed to evaluate macroeconomic performance. As noted earlier where standard assumptions regarding CBA, such as full employment of resources are non-existent, measuring the secondary effects may be admissible as additional welfare indicators. In this regard, projects that have regional development goals in rural areas of developing countries where underemployment may exist may wish to consider the wider economic impacts of the projects. Of course, as the objective of the project – i.e. regional development – has an inherent distributional objective, models for the evaluation of regional impacts should be considered as a tool in project planning, monitoring and evaluation in any event. [This aspect will be dealt with in more detail in Chapter 3].

1.2.3 Multi-Criteria Decision Analysis (MCDA)

Another analytical instrument for project evaluation is Multi-Criteria Decision Analysis (MCDA). MCDA aims to take into account multiple criteria to arrive at a scientific conclusion on the impact of the proposed project or program on various aspects of society. MCDA allows for the application of both quantitative and qualitative criteria. Consequently the types of key issues which are to be considered at a project or program level are not restricted by requiring monetary values.

As touched upon in the theoretical section above (par 1.1) the theoretical origin of CBA is based on Neo-Classical economic theory. Criticism against this theory and method of determining the welfare impacts of a project is mainly directed at the fact that CBA attempts to achieve efficiency by mimicking a perfectly competitive market. Maximising efficiency does not necessarily promote equity and sustainability. By introducing the use of income distribution weights in CBA, the issue is addressed to some extent.

On the other hand the MCDA does not limit the number and nature of objectives and criteria. According to a WRC Report on MCDA, trade-offs between different stakeholders and

criteria are a focus of attention[5]. In contrast with CBA, the gains to one group of stakeholders are not assumed to compensate for losses to another stakeholder groups.

The World Commission on DAMS (WCD) also advocates the use of MDCA as an alternative approach to a decision support system exclusively based on CBA[6]. In this regard the WCD "recognises that projects often have multiple objectives and not simply economic welfare maximisation. Experience to date with these multi-criteria approaches suggest that while economic criteria remain important, these decision frameworks have the benefit of allowing disaggregated information on social and environmental impacts to enter directly into the decision analysis. Such decision support systems appear particularly appropriate and useful in the case of large dams when implemented within a participatory, transparent multi-stakeholder approach.

It is not the intention of this report to present an extensive comparison between the main features of the CBA vs. MCDA. Suffice to say at this stage is that both methods have their merits and demerits depending on the nature of the project involved and circumstantial characteristics. Based on evidence up to date, there is no way that the one method could profess superiority over the other and should absolutely exclude one another. There is in any case a large degree of overlapping between the two methods/approaches. (see Stewart et al., 1997; Table 3.1).

1.2.4 Other Practices

As can be deduced from the above, particular situations require specific approaches in terms of the format and structure of analytical frameworks and modelling. A good example is the way in which the Development Bank of Southern Africa (DBSA) does project evaluation. Based on its "Guidelines"-publication[7], the project appraisal process is conducted on macro as well as micro level and entails a number of very different types of analytical work.

In terms of the skill capacities required for integrated macro and micro-level analysis the following analyses are included by the DBSA:

- Macroeconomic Analysis – Ability to identify macroeconomic impact of projects or programs (including quantitative estimation via SAM modelling techniques where appropriate).
- Spatial Development Planning and Analysis – Ability to identify and assess spatial and community problems, needs and potential and to generate appropriate economic planning solutions. Understanding of government and civil society participatory integrated planning initiatives.
- Sector Development Planning and Analysis (where dictated by the purpose of the project) – Ability to identify and assess sectoral problems, needs and potential and to

5 Stewart JT. et al. Tlou; Multiple Criteria Decision Analysis: Procedures for Consensus Seeking in Natural Resource Management – WRC Report No. 512/1/97.

6 World Commission on Dams (WCD), Dams and Development; A new framework for decision-making, 2000. P 182.

7 DBSA , Guidelines for Economic Appraisal of Projects and Programs in DBSA --2000

generate appropriate planning solutions. Understanding of sectoral planning initiatives.

- Project Economic Risk Analysis – Ability to identify and assess the nature of risk to the project or programme economic viability and developmental efficacy.
- Cost Benefit Analysis – Ability to conduct project or program cost benefit analysis[8].

It is interesting to note that in the CBA done by DBSA, a component is included called "inventory of non-quantified costs and benefits" which is then weighted or ranked according to their relative significance vis-à-vis its impact on welfare[9].

Lastly, regarding the application of project evaluation techniques in South Africa, reference is made to the appraisal of a skills development strategy in South Africa (SETA)[10]. Again the basic CBA was applied to estimate the economic efficiency of a SETA program. The basic structure of the CBA employed is summed up in the following example:

Example 1: Benefits and costs of a Human Investment Program

	INDIVIDUAL	***OTHERS***	***SOCIETY***
Benefits			
Increase in earnings after tax	x		x
Future increase in taxes paid		x	x
Non-monetary satisfaction	x		x
Costs			
Tuition costs	x		x
Costs of bursaries		x	x
Higher living expenses	x		x
Earnings foregone after tax	x		x
Taxes foregone		x	x
Transfer payments foregone	x	x	

In this way one tries to distinguish between those individual benefits and costs that reflect net social gains and losses from those that reflect only transfers from or to other members of society.

A novel characteristic of the SETA-approach is the use of certain elements of the CBA to simulate the performance of the training programmes over time. These are:

1. Increase in productivity
2. Increase in production/output
3. Increase in employment levels.

8 DBSA – report; Part A, par 6.

9 DBSA – Ibid.

10 Methodologies for the Appraisal of Skills Development strategy (SETA program) – Conningarth 2000.

Using these performance indicators, to some extent renders the yearly conducting of a CBA unnecessary – which can be expensive and time consuming.

1.3 The Need For and Usefulness of CBA in the Public Sector

1.3.1 Background

The limited economic means and boundless needs inevitably forces government to rational decision-making in the provision of collective goods and services by spending limited funds in such a way that they more or less reflect the likes and dislikes over and above the financial acceptability of the project. CBA is a technique which can be used to determine the relative merits of alternative projects in order to reach a high degree of economic efficiency in the application of funds. It is ideally suited to the evaluation of capital projects, i.e. projects that require immediate capital expenditure but which only realise net benefits over time. CBA can also be applied to current programmes, i.e. projects that require minimal initial capital expenditure but involve costs incurred over the entire analysis period. The inoculation programme referred to in the introduction is an example of such a programme.

The efficient allocation of scarce resources should be one of the primary objectives of the public sector in its entirety. By the public sector is meant all tiers of government, e.g. central, provincial and local government as well as public corporations i.e. parastatals. Where the State is involved in large investment projects in the private sector, it is desirable to carry out cost-benefit studies because relatively large projects can influence the economic structure and price levels, as well as the environment, or they can cause externalities in the form of additional non-allocable costs to the community.

It is also possible that large investment projects in the private sector, particularly of an infrastructural nature, could result in certain social benefits, on the grounds of which the private sector can expect the co-operation of the State. Against this background it is clear that CBA techniques have a potentially wide scope of application in the public sector. It is important therefore, that, as far as possible, a uniform set of guidelines (or principles) should be laid down for CBA in this sector and that all the institutions concerned should adopt them. If this consensus is not achieved, the comparison of results becomes more difficult and there is increased arbitrariness in the choice between projects, with the result that an overall efficient allocation of resources cannot be achieved.

1.3.2 Policy objectives

In many ways public sector projects form the vehicle by which governments pursue their policy goals and express their priorities. The following fundamental considerations are at stake here.

1.3.2.1 Present and future consumption

An important objective of economic policy is the improvement of living standards, which implies the increased consumption of goods and services. As a result of the scarcity of economic resources, current consumption competes with future consumption. As a result the policy-maker should, implicitly or explicitly, weigh current consumption against consumption at every stage in the future. Where the government emphasises current consumption, the situation will probably be characterised by relatively low tax rates and low levels of saving and investment. Should the premium be placed on deferred consumption, the opposite will most likely occur. Naturally, it is politically difficult to persuade the public to defer consumption because this is normally associated with unpopular policy measures such as higher taxation.

It is possible for a project to influence current and future consumption patterns. It can serve as a tool to encourage savings when relatively capital-intensive projects (which contribute to savings via profits and depreciation allowances) are undertaken – this is in contrast with labour-intensive projects, where the relatively higher wage payments are usually channelled to consumption. Capital-intensive projects therefore tend to discourage short-term consumption and employment, while encouraging savings and therefore growth and potential future consumption.

The value that a given community attaches to present versus future consumption is calculated in CBA through the use of what is called a social discount rate. This rate is discussed in detail in Chapter 3.

1.3.2.2 Division of consumption between contemporaries

A further important objective of economic policy is that of equity. In this case it is necessary for the planner to allocate weights to the value that consumption has for different individuals, normally grouped into certain income-groups and/or regions. These weights can be derived from the principles underlying the policy and do not necessarily have to be quantified. For example, progressive taxation systems reflect the greater weight that the planner assigns to the lower-income groups relative to the higher-income groups.

A project can serve as an instrument of income distribution in that both the geographical situation and the labour-intensity of the project are related to the redistribution possibilities of the project. In studying the distributive aspects of a project, the first problem is to determine the net benefit of a project by geographical region. Thereafter weights are assigned to the consumption that is generated in different regions, with the aim of valuing the consumption generated in poorer areas higher than that in more affluent areas. Project choices also have an influence on income distribution in that projects that depend heavily on labour (relative to capital) promote the redistribution of income over the short term.

1.3.2.3 Secondary objectives

In addition to the above-mentioned two primary objectives, there are secondary objectives which are reflected either explicitly or implicitly in a project choice.

(i) One such objective is the creation of employment opportunities, which is often seen as an objective on its own, but is essentially a derivative of the goal of equity, since it promotes the division of consumption between contemporaries. To the extent that the creation of job opportunities goes hand in hand with political stability, such an objective has an independent right of existence.

(ii) A further objective is the achievement of economic independence with respect to certain goods or natural resources obtained from overseas. This is particularly important where the foreign supply is unstable or where it is possible that such supply could be completely cut off.

(iii) The acquisition of power and prestige is another objective which may influence project choices without consumption considerations being taken into account. In such circumstances it is particularly important for CBA to be applied so that the price which is paid for such projects in terms of the general standard of living is not hidden.

The decision-maker must therefore in any CBA consider a mixture of objectives, some of which may be contradictory. Dealing with the situation analytically is not easy, but the decision-maker should attach conceptual weights, be it implicitly or explicitly, to the different objectives involved in the optimisation.

1.4 Analytical Framework of CBA

1.4.1 The nature of CBA

When a private institution evaluates the merits of different investment options, the first step is to ensure that all the projects are feasible at the technical level. After this, the firm applies capital budgeting techniques to ensure that the project will be financially profitable, in other words that it will contribute to increasing the net value of the business. The net value is the surplus of assets over liabilities as reflected in the balance sheet of the firm. In order to contribute to the net value of the firm, it is necessary for the project to be profitable, and the firm will therefore discount the expected stream of profits and/or losses to the present time in order to determine the effect on the net value.

In the public sector (with the exception of the government business enterprises and public corporations which at least have to break even) profit is not the main objective. A variety of financial analyses can, however, be carried out in the place of profit determination. One of these, for example, amounts to an analysis of the source and application of productive resources valued at market prices with the aim of determining whether the use of the limited resources is efficient. Since the objectives of the processes of profit determination and of the

analysis of the source and application of funds differ, there are important differences between the two methods of analysis (See Section 1.5).

In the first place, with profit determination, depreciation is accounted for by the systematic write-off method because it reduces gross profit, while in the case of the source and application of funds, depreciation is not taken into account, since it affects both the source and application of funds. Secondly, income tax is included in profit determination but excluded from the determination of the source and application of funds since it does not directly contribute to a more effective or less effective application of funds. In the third place, interest payments are included in profit determination but excluded from the analysis of the source and application of funds because these do not influence the conversion of inputs into outputs, and can therefore be considered merely as a transfer payment.

There are a number of aspects, however, which are considered neither in profit determination nor in the analysis of the source and application of funds, such as the determination of the actual scarcity value of inputs and outputs and the measurement of intangible advantages and disadvantages. For this it is necessary to carry out a complete economic analysis.

However, a comprehensive economic analysis should include the following:

(i) As a starting point it is necessary to do a financial analysis reflecting the profitability of the relevant project at market prices. It should be noted that the financial analysis can, depending on the context in which it is used, refer to one or more accounting techniques, e.g. cash-flow analysis, profit determination, or the analysis of the source and application of funds. "Financial analysis" as used in this manual refers to an analysis at market prices from which present and future expenditure and income is calculated to determine the financial feasibility of a project.

(ii) The economic analysis, to determine the real scarcity value of goods and services used in the project and arising from the project; this is mainly based on opportunity-cost considerations; and

(iii) The social analysis, which is an investigation into the effect of the project on the distribution of welfare and other social aspects.

This manual focuses mainly on the economic and social analysis. The financial analysis in the broader sense is used as a fairly standard practice in the public and private sectors and this manual therefore does not expand thereon.

1.4.2 The financial analysis

For the financial analysis the calculations are done at either current or constant prices. In the case of public projects such an analysis (in current prices) normally gives an indication of the pressure the project will place on the exchequer and the degree of subsidisation it will require.

1.4.3 The economic analysis

By economic analysis is meant that the project is re-evaluated at prices which reflect the relative scarcity of inputs and outputs. The economic analysis normally follows the analysis of the source and application of productive funds, which is done at market prices. In the economic analysis, prices actually represent opportunity costs and reflect the actual economic value of inputs and outputs. The opportunity cost is the value of the best alternative application of an input or an output of the project. The market price of land, for example, does not necessarily reflect the opportunity cost of the land. Thus, when a price has to be determined, for example, for a piece of agricultural land used for maize farming but on which an airport is planned, the opportunity cost of the land is the discounted net output from the maize. The uses and calculation of shadow prices as a substitute for market prices are set out in more detail in Chapter 2.

1.4.4 The social analysis

With the help of this analysis the consequences of a project for the distribution of welfare in the community can be analysed and an evaluation can also be made of the effects on other social factors such as security, equity and the aesthetic values of the community. This aspect will be discussed later (See Section 3.4) for more detail.

1.5 The Differences between CBA in the Public Sector and Profit Determination in the Private Sector

Important differences exist between CBA in the public sector and profit determination in the private sector. The first difference to be found is the fact that private enterprise is concerned only with the interests of its owners or shareholders when profits are being calculated, while the interests of the community are the focus of CBA. The result is that a much wider spectrum of costs and benefits have to be considered than in the case of pure profit determination. Consider, for example, a new transport system which is cheaper and provides more comfortable transport for a part of the population, but entails environmental costs in the form of air and noise pollution. The latter aspects would be ignored in the determination of profits in the private sector, but will be taken into account in a CBA as part of the costs that the community must bear.

In the second place CBA differs from pure profit determination in that all variables in the latter case are measured in terms of market prices, while the economic and/or social benefits in the former case are often provided at subsidised prices so that the market prices of inputs and outputs, where they exist, often do not reflect the actual economic and/or opportunity costs and benefits. Because, as has been mentioned, CBA depends on the use of opportunity costs, market prices have to be adjusted to reflect the actual economic value of costs and benefits. The third important difference between CBA and the determination of profits as applied in the private sector, is in the interest rate used in the discounting process. While the discount rate in the case of profit determination is a market related rate which reflects the cost

of funds, uncertainties and risk, the discount rate used in CBA represents the time preference of the community and is referred to as the social time-preference rate.

The most important differences between CBA as practised in the public sector and profit determination in the private sector are summarised in Table 1:

Table 1: The Main Differences between Cost-Benefit Analysis in the Public Sector and Profit Determination in the Private Sector

		CBA	***Profit determination***
1.	From the point of view of	Community	Shareholders
2.	Goal	Apply scarce resources effectively and efficiently	Maximise net value of firm
3.	Discount rate	Social time-preference rate	Market rate or weighted marginal cost of capital plus uncertainty and risk premium
4.	Value unit	Opportunity cost	Market price
5.	Dimensions	All aspects necessary for a rational decision	Limited to aspects of decision-making that may affect profits
6.	"Advantages"	Additional goods, services, products, income and/or cost savings	Money income
7.	"Disadvantages"	Opportunity costs in terms of goods and services foregone.	Money payments and depreciation calculated according to accounting principles (GAAP)

1.5.1 Constant vs. Current Prices

Using constant prices to value the economic effects of a project is usually sufficient for decision making. The basic decision in project analysis is whether to invest in a project. The alternative is to assign the scarce investment resources to other more lucrative investment possibilities. Moreover, it is necessary for resources to be valued at present economic prices to reflect their values for different uses or opportunities at the time when the investment decision is made.

If constant present prices are used throughout the project analysis – for future years as well as the initial year – then resources will be consistently valued at prices reflecting their value in alternative uses at present. Future economic developments will then be valued in the same unit prices as in present times. The use of constant prices is relevant both to capital from a national point of view and equity capital in particular. From both points of view the basic question to answer is: is the project worthwhile?

Another price adjustment that is required is to provide for changes in relative prices over the life span of a project. It is possible that prices of certain commodities or services will rise or fall relative to others pertinent to the project. For example, it may be foreseen that the prices of energy inputs will rise relative to the present prices for outputs and other inputs; or it may be foreseen that the price of an agricultural output such as rice may fall relative to the present prices of other intermediate inputs including labour. Where a particular price is expected to change in real terms, that is, relative to other items in the project statement, then the constant price analysis can be adjusted for this relative price change as it will affect the feasibility of the project.

1.6 The Uses and Limitations of CBA

It has already been noted that CBA is aimed at evaluating the costs and benefits of alternative investment projects or programme expenditures on a comparable basis as far as possible, especially through the use of a common measuring instrument, namely prices that are determined on a consistent basis. In this way the problem of choice is simplified since qualitative arguments for or against a certain project are backed up by numerical criteria. The main problems with CBA arise from the question of quantification. These aspects are discussed in more detail in later chapters (refer also to the theoretical discussion of CBA, Section 1.1).

The following aspects among others should be kept in mind when using CBA:

(i) CBA in reality constitutes a particular conceptual framework which can be viewed as a model, where the latter represents a simplified version of reality that can be dealt with in an analytical way. Through the application of the conceptual framework the policy-maker is forced to think through the full repercussions of the expenditure decision. This prevents people from misunderstanding each other and thus increases the effectiveness of joint decision-making, even if no formal analysis is done.

(ii) CBA is a technique used in an attempt to bring about a more effective distribution of resources with, as the criterion, the achievement of what is referred to as Pareto optimality (See paragraph 1.1.1), which indicates that at least one person in the community is better off while no one is worse off. A necessary prerequisite here is that the social benefits of the proposed project should exceed the social cost. The central role that the Pareto principle plays means that CBA is aimed at distributional effectiveness. It should also be ensured, however, that a given aim is achieved with the application of the minimal resources possible by carrying out cost-effectiveness studies. Attempts to find a single criterion which covers all the essential aspects of importance in a decision on a project have not been very successful. Where possible, therefore, the Pareto criterion must continue to be supplemented with additional criteria and additional analyses. These include performance auditing, utility studies, impact studies, operational research, systems analysis, organisational analysis, econometric studies, sensitivity analysis etc.

(iii) In general CBA is aimed at decision-making in respect of projects to be undertaken in the future and therefore involves projections and assumptions regarding future developments. This implies that a boundary of uncertainty will necessarily exist, thereby affecting decisions in respect of the future taken on the grounds of this methodology. It is therefore desirable that CBA should where necessary be supplemented by the analysis of risk and uncertainty, as well as related information.

(iv) The specific criteria used to rank alternative projects should be supplemented with sensitivity analysis to show the effect of possible alterations in selected parameters.

(v) CBA is not equally suitable for all projects and therefore it is desirable to clarify the type of expenditure programmes (current as well as capital) on which CBA can be performed. Many experts believe that CBA is particularly useful in the fields of agriculture, infrastructure and industrial development, but the latest studies indicate that it can be applied to almost any field. In those fields where CBA is not readily applicable, there is a need for cost-effectiveness analyses so that the policy-maker can be sure that objectives are achieved with the use of minimal resources. Even with the field of application clearly described, the information which the analysis provides is not always sufficient for the decision which has to be made in the public sector. This is because different national economic objectives of a strategic or political nature will not necessarily always be reconcilable.

In any CBA the ranking of alternative projects or programmes according to certain criteria must be supplemented with the results of all other analyses, apart from economic and social analyses, and all of these must as far as possible be quantitatively evaluated. In addition, qualitative analyses should be done where quantification is not possible. All the impacts and consequences of a project should thus be pointed out in sufficient detail to promote "optimal" decisions concerning the project.

(vi) Unfortunately there are differences of opinion amongst experts concerning the way in which certain aspects, e.g. shadow prices and the social discount rate, should be dealt with in CBA. As mentioned, the aim of this manual is therefore to bring about, as far as possible, a uniformity of approach and method between institutions in the public sector, given all the underlying limitations.

(vii) An important aspect of the application of CBA is that the secondary economic impacts of the projects under review outside the immediate sphere of influence of the project, i.e. factors such as consequences for the balance of payments or potential for employment creation, are omitted or they should be evaluated independently. In cases where such limitations apply to the field of influence, reference is made to CBA on the grounds of partial equilibrium analysis. If, however, the evaluation of the consequences is significant for the price levels, production or structure of large parts of the economy which lie outside the fields directly affected, would require general equilibrium analysis as embodied, for example, in structural econometric models, I-O models and semi-input-output models (See paragraph 1.2.1).

(viii) It must be emphasised that reliable statistics are very important for the implementation of a CBA system. Specific aspects will be spelt out in detail in later chapters.

(ix) It is generally recognised that errors may arise in CBA studies. According to Boardman[11], one must guard against self-interest when conducting a CBA. There is considerable evidence that managers systematically overestimate benefits and underestimate costs. It can therefore be more useful to make use of independent analysts to counter this type of bias.

From the discussion above it is clear that the methodology and application of CBA requires not only technical skills, but also a broad knowledge, profound insight and a clear-headed approach to problem solving. It is particularly important that the key aspects that are essential to the reaching of sound decisions should be separated from secondary information, of which note should also be taken. Exceptional expert knowledge, insight and experience are therefore required for the successful application of the technique along with complementary methodology. In spite of the limitations mentioned, no other evaluation method provides more satisfactory results than CBA.

[11] Boardman, Greenberg, et al. Ibid Chapter 15.

CHAPTER 2: DETERMINATION OF VALUES IN COST-BENEFIT ANALYSIS

In this chapter important principles and criteria relating to the calculation of values in CBA are discussed. This includes some observations on scarce resources that can be used for the achievement of economic objectives and on the prices of such resources.

2.1 Prices in CBA

Since resources are limited, an important consideration in their application is to find optimal combinations of resources through which the net community benefit can be maximised. The values of inputs and outputs depend to a large degree on the level of development of the economy in which prices are determined. Market prices of products and services often do not reflect the real value (scarcity value) of products and services, since governments interfere in the operation of product and services markets through, for example, tariff protection, taxes or subsidies[12]. *To assess the economic effectiveness of the application of resources within projects, it is, as previously mentioned, essential that the prices of inputs and outputs indicate their economic scarcity value*.

Scarce resources are traded at specific prices, namely market prices. Provided certain conditions are met (see paragraph 2.1.2.4.1), prices are the best criteria upon which the allocation of resources for specific uses can be based. The assumption is that markets are perfectly competitive and that supply and demand determines the prices of inputs and outputs. When the free operation of the markets is interfered with, by for example the restriction or stimulation of either supply or demand or by price interference, market prices do not reflect economic scarcity values and the use of shadow prices becomes necessary.

2.1.1 Terminology

To prevent possible confusion it is necessary to describe the definition of shadow prices. In the literature on CBA, "shadow prices" and "accounting prices" have different interpretations. Key terminology in the cost-benefit literature related to shadow prices are therefore defined below to prevent confusion. Although the terminology may possibly not coincide with that which the reader is familiar with, it is important to ensure uniformity in concepts for the purpose of this manual.

2.1.1.1 Market prices

Market prices are those perceived prices at which products and services trade, irrespective of the level of interference in the market, e.g. the market wages of labour, the price of 2 kg of

[12] There are other factors that also impede the free workings of the market mechanism. For example, the presence of monopolistic tendencies in industries.

maize meal, the price of 1 kilowatt-hour of electricity, etc. In theory, market prices are indeed manifestations of the willingness to pay.

2.1.1.2 Shadow prices

Shadow prices are the opportunity costs of products and services when the market price, for whatever reason, does not reflect these costs in full. Examples are shadow wages of labour where the fact that minimum wages are fixed, is taken into account, a shadow price for fuel where taxes and subsidies are excluded, the marginal cost of generating 1 kilowatt-hour of electricity, etc.

2.1.1.3 Accounting prices

Some writers use "social accounting prices", or "accounting prices" for short, as a substitute for the shadow price concept when a specific type of shadow price is referred to. The shadow prices used in the new approach are often called social prices – because of additional endeavours to "adjust" shadow prices to better reflect social costs/benefits. In the rest of this manual the original definition of shadow prices is referred to.

2.1.1.4 World prices

The world price is the cost-insurance-freight (c.i.f.) price of imported or locally produced products or services that are internationally traded and that are locally consumed in South Africa. The f.o.b. (free on board) price is used for exported products or services. These prices reflect the opportunity cost of products and services when the possibility of international trade exists. The c.i.f. price of imported capital equipment and the f.o.b. price of exported iron-ore or deciduous fruit are examples of world prices. It is important to consider the transport costs of imported products up to the point where the product is economically applied.

2.1.1.5 Shadow exchange rate

The shadow exchange rate gives the future value of the rand relative to other currencies when there is no intervention in the foreign exchange market through, for example, the pegging of exchange rates or limits on capital flows. The shadow exchange rate is therefore the nominal exchange rate adjusted for the effect of interventions[13].

In this manual an adjustment to the future effective exchange rate is recommended. This adjustment is to make provision for the change in relative prices of imports and exports. This is necessary to specifically provide for the fact that the South African exchange rate does not

[13] This adjustment is in line with the United Nations Industrial Development Organisation, where the adjustment factor roughly equates the level of protection in the economy – Guide to Practical Project Appraisal; Social Benefit-Cost Analysis in Developing Countries. Unido, Vienna, 1986, pp 46.

follow the trend of the buying parity theorem. According to this theorem the exchange rate will behave according to the difference in the South African inflation rate and that of its major trading partners. Over the long term the Rand is, however, depreciating faster than the relative difference in those inflation rates.

2.1.1.6 Surrogate prices

Surrogate prices are used to value costs and benefits when no market prices exist or where no market price can be determined. Examples are the value of time and the value of a human life. The prices can be determined with the aid of the willingness to pay principle and other products or services of a similar nature. The price of, for example, clean air can be derived from what the community (as represented by the State) is prepared to pay for combating air pollution.

Surrogate prices for water are discussed in Chapter 7.

2.1.2 Use of shadow prices

2.1.2.1 General considerations

In practice, shadow prices should be used in CBA only when the market prices of products and services clearly do not reflect their scarcity value or economic contributions. In cases where market prices give an accurate indication of the scarcity of products and services, market prices are used not only in the financial analysis but also in the economic analysis.

Under circumstances where the effectiveness of projects is not reflected by market prices, project input and output prices should be adjusted. Examples of these are where the market mechanism does not equate the marginal cost and marginal revenue of products and services or where serious structural imbalances exist in markets. The decision to use shadow prices will be influenced by the likelihood and consequences of the wrong use of market prices. A reasonable knowledge of the relevant economy is therefore a prerequisite for responsible price choices in CBA.

The calculation of the shadow prices of products and services is often difficult and is further complicated because it may be necessary to calculate shadow prices on a regional basis, since structural imbalances may exist between regions that are not reflected in market prices.

2.1.2.2 Regional considerations

CBA is usually used to evaluate the effectiveness of projects undertaken within a specific national economy. Furthermore, the distribution of income between different population groups, income groups and regions is affected in this way. Regional differences in costs and

benefits are indeed very important when the effectiveness of projects is researched and the distributional consequences are assessed.

From the above it follows that when market prices are used to value resources they should reflect the value for different regions. In cases where market prices are not acceptable, shadow prices should reflect the value of resources for the region where they are purchased. The same applies to surrogate prices.

In order to consider the above aspects correctly in project evaluation, it is necessary to investigate the political aspects which influence shadow and surrogate prices.

2.1.2.3 Political aspects and shadow prices

Political ideologies, objectives and choices to a large extent determine the nature of community costs and benefits and the way in which they are maximised, and influence, amongst other, the following:

(i) the social time preference rate;
(ii) the value of capital;
(iii) market prices;
(iv) job opportunities and wages and consequently the value of recreational time;
(v) the value of externalities, e.g. noise and damage to the ecology; and
(vi) the income distribution and regional weightings.

Political considerations therefore constitute an integral part of the decision-making process. The analyst is therefore forced to specifically take them into account when analysing any project.

2.1.2.4 Conditions for the use of shadow prices

It is important to distinguish between the generally valid conditions for the use of shadow prices and the conditions specific to the use of shadow prices in South Africa.

2.1.2.4.1 General conditions

An optimisation process presupposes limited resources. The economic problem is to find that combination of resources that maximises some specific objectives. Scarce resources are traded at specific prices. If certain conditions are met, the price mechanism is the best way in which scarce resources can be allocated to those who will use them to the maximum social advantage. These conditions are that –

(i) the prices of final consumption goods should reflect their social benefit (value); and
(ii) the prices of scarce resources should give an indication of relative scarcity (costs).

Provided both conditions are met, supply and demand in the goods and factor markets will tend towards equilibrium. As has been argued, however, disturbances occur in practice which result in market prices not being true measures of scarcity, and this should lead to the use of shadow prices.

2.1.2.4.2 Pre-conditions for the use of shadow prices in South Africa

In order to apply CBA effectively in South Africa it is important to keep in mind the limitations under which shadow prices are used. At the same time it must be remembered that shadow prices are a prerequisite for responsible expenditure decisions. To ensure that shadow prices are used appropriately, it is necessary that:

(i) South Africa should be viewed as a constitutional entity, with the reservation that regional and local objectives should be included in project assessment as long as this can be accommodated within the broader political objectives;

(ii) a list of advantages and/or disadvantages should be drawn up and allocated to those communities who are to benefit and/or be adversely affected before any attempt is made at quantifying or analysing;

(iii) the financial costs of projects be allocated to the principal i.e. owner that is investing, irrespective of the origin of funds;

(iv) costs and/or benefits be allocated to those stakeholders who are to benefit and/or be adversely affected, irrespective of who the investor, donor, lender or principal for project analysis is; and

(v) apart from the analysis implied in (i) to (iv), every CBA undertaken should be done from the view of the whole of South Africa in order to prevent any unnecessary duplication of projects. Under some circumstances the principal may feel that the cost-benefit study should be applied to the whole of Southern African e.g. Southern African Customs Union and/or Southern African Development Community (SADC).

2.2 Principles in the Calculation of Shadow Prices

There are a number of important approaches relating to the way in which shadow prices ought to be calculated. The first can broadly be called the world price approach and the second the opportunity cost approach. The opportunity cost approach refers to the marginal social cost and marginal social benefit of a commodity. The marginal social cost in terms of shadow prices, is the value of the resources required to produce an extra unit of the relevant commodity. On the other hand, the marginal social benefit reflects the benefit evaluated in social terms derived from supplying an additional unit of the relevant commodity in the economy.

A third important approach rests on the willingness of the community or groups in the community to pay for goods or services. The first two approaches form the basis of shadow price calculation while the willingness-to-pay approach is only a method of calculating the marginal social benefit or cost.

2.2.1 World Price Approach

The world price approach takes into account world prices of products and services, especially with regard to those goods that are freely traded on international markets. Important examples are mineral and agricultural products for which active free international markets exist. Where local market prices are distorted because one or more of the conditions discussed in paragraph 2.1.2 is not met, the relevant world price serves as the shadow price after adjustments have been made for costs in the import and export of goods. This approach is not always reliable, however, because governments often peg currencies at artificial levels that do not reflect their scarcity value. Adjustments are then required in the value of the currencies. However, not all inputs and outputs can necessarily be converted to an appropriate currency value. For example, labour is one of the most important inputs in developing countries, but there is no free international market making it possible to attach a currency value to surplus labour.

2.2.2 Opportunity Cost Approach

The opportunity cost (marginal social cost) approach uses, as the shadow price of production inputs, the production that is given up elsewhere by withdrawing these inputs from their alternative use. On the other hand, for the shadow price of outputs (marginal social benefit), the additional incremental benefit achieved by undertaking the project, relative to the situation had the project not been undertaken, is used. In this way an attempt is made to accentuate internal considerations in order to find a reliable measure of the acceptability to the community of projects.

According to UNIDO[14] the following should be taken into account:

"A central issue in shadow pricing is whether a good is "tradable", that is, can it be imported or exported? If a good is tradable, the international market-place offers an option to domestic production and consumption and thus a measure of its economic opportunity cost or its "real" value to the country in terms of pure efficiency."

In line with this approach it is therefore recommended that where projects substitute imports or promote exports, the world price approach is adopted. Locally purchased inputs are valued at international prices where the possibility exists that they could be imported or exported. The inputs for which no international prices exist are valued at the local opportunity costs.

In practice it seems that the following line of reasoning is applicable[15].

[14] UNIDO-publication. 1986. p 22.

[15] For a summed-up version of this approach, see UNIDO-publication. Ibid. p. 22.

Impact	Basis for shadow pricing
Consumption within in the economy	Marginal social benefit (consumer willingness to pay)
Production within the economy	Marginal social cost of production
International trade	World prices

2.3 General Problems with the Determination of Shadow Prices

Shadow prices should be determined as scientifically as possible so that different project evaluators can achieve the same results. Therefore, it is important to take a stand on how externalities, inflation, taxation and subsidies, the project life and the value of the relevant currency should be dealt with.

2.3.1 Externalities

Externalities are the effects of a project on the environment, ecology or general standard of living of a community which are not reflected by the prices of inputs or outputs. Externalities are difficult to include in project assessment because they can not be directly allocated to the project and furthermore are difficult to quantify. *The requirement that prices of products and services should reflect their relative scarcity value on the basis of all costs and benefits continues to apply, however, and therefore externalities should be considered in the analysis of a project.* For example the cost to the community of polluted air can be approached by using the degree to which government is prepared to bear the cost of eliminating air pollution as a measure of the community's willingness to pay for clean air. Where it is suspected that a project will produce some form of externality this aspect should be carefully investigated.

2.3.2 Inflation

The objective of a CBA is to measure community advantages and disadvantages after the relative scarcity value of project inputs and outputs have been taken into account. However, inflation, the continued rise in general price levels, makes the determination of relative scarcity values more difficult. Inflation is not taken into account in the economic analysis and all evaluations are done in base year prices with allowance for relative price shifts. (The financial results of profit-orientated projects viewed in nominal terms, on the other hand, are affected by the inflation rate, and the internal yield rate will have to be at least equal to, but preferably higher than the inflation rate to ensure that the project continues to exist. Alternatively the net present value of the project must be positive when costs and benefits are discounted by means of the inflation rate.)

2.3.3 Indirect taxes and subsidies

Taxes and subsidies influence the optimal application of production factors and the analyst will have to take these into account indirectly when he/she forecasts the combination of inputs that will apply after the implementation of the project. It is not, however, easy to deal with indirect taxes and subsidies in CBA.

From the point of view of the economy as a whole, indirect taxes and subsidies are transfer payments, and when new inputs that have to be taxed or subsidised are looked at in the national interest, the value is calculated from the point of view of the producer by subtracting taxes and adding subsidies. When the impact of a project on a particular area is considered, however, the effect of indirect taxes and subsidies on the local economy also has to be taken into account. In such a case the market prices, including the taxes and after subtracting the subsidy, indicate the social marginal value of the input or benefit. The tax loss or subsidy gain of the region should be shown as a redistribution effect to or from the overall authority respectively.

It must be kept in mind that certain "taxes" added on to prices should be taken into account as part of the project cost. An example is where a component of a certain tax can be viewed as a users charge e.g. the fuel levy for the building of roads.

Sometimes uncertainty arises with regard to surcharges which are levied for specific purposes, which in reality serves as a consumer charge. The general point of departure here is that in circumstances where tax would normally be subtracted, all taxation (even taxes that serve as user charges) is subtracted from market prices to calculate the scarcity value, and that a cost-element is added for the use of the input. Where it is very difficult to impute the value, the analyst can consider keeping the relevant tax in the price as an estimate of the user charge. For example, part of the tax on petrol serves as a user charge for the use of roads. The analyst can consider not subtracting this tax from the price of petrol so that it can serve as an estimate of the damage to existing roads that results from a project.

All direct taxation (e.g. income tax) and indirect taxation is included in the financial analysis, but direct taxation is not taken into account in the economic analysis and indirect tax is to be dealt with as set out above.

2.3.4 Project life

The project life is equal to the expected economic life of the project, which means that the analysis period will vary from project to project. As is well-known, many factors have a determining influence on the decision of how long the economic life of a particular project would be. This decision would obviously have a crucial impact on the outcome of the CBA calculations. One important factor that will determine the economic life and results of the CBA, is the expected growth of the benefit stream over the time horizon chosen for the project. For example, the future demand for irrigation water in a particular area will be determined by the expected demand (locally and overseas) for the agricultural products made

possible by irrigation. Various methods exist by which such demand forecasts can be made; of which macroeconomic forecasting models are explicit examples.

Any assets which may remain at the end of the economic life of the project should appear as a residual item and be imputed either as a positive or negative impact on the cost stream.

In most cases it will be possible to sell the residual part of the assets for a positive amount. This value should be subtracted from the cost stream.

In some cases, however, there is a cost involved to get rid of the assets. For example, in the case of the closing down of an open cast coal mine, the rehabilitation cost involved should be brought in as an add-on cost.

In the CBA calculations one should also take into account a situation where the economic life of some assets could be shorter than the analysis period. In such instances the capital expenditure should be repeated for the relevant year.

2.3.5 Currency

The price of any imported product or mineral is converted by means of an exchange rate to internal price levels. Irrespective of restrictions on the flow of capital, the rand is fairly representative of the forces of supply and demand as determined by imports and exports and is therefore used as the shadow price of currency. It has already been argued that in the absence of free currency markets, the exchange rate does not necessarily reflect the scarcity value of a currency and that it will therefore be necessary to determine a shadow exchange rate by some other method. For this the purchasing power parity or currency-cost-approaches can be used. Since the use of these alternative approaches is not recommended, they are not discussed any further.

Because of the volatility of the exchange rate it is essential that exchange rate calculations are combined with sensitivity analysis.

2.4 Valuation of Inputs and Outputs

The sources (or production means) are the scarce factors that are needed in the production process and that lead to the supply of goods and services by the private sector and government. The discussion that follows concentrates on general characteristics of sources and the determination of their financial value (market prices) and the shadow prices.

During the production process, project inputs are transformed to outputs. The most important project inputs are capital, raw materials, labour and purchased services. Price information is usually available at market prices, but, as has been mentioned, the use of shadow prices is sometimes necessary.

2.4.1 Capital goods

Capital goods are those production inputs that are not consumed in one or two years in the production process. For the purpose of this manual they are divided into land, buildings and machinery, equipment and transport equipment. Capital goods are usually viewed as the fixed assets utilized in the project. Capital goods, like any other product, can be subject to imperfect market conditions which result in the market price not reflecting the relative scarcity of the product. Therefore it is necessary to investigate the valuation of these production means for possible incorrectly determined prices.

Normally capital expenditure takes place at the start of a project. This may also, however, occur during the economic life of the project and it may even be necessary to replace capital goods during the life of the project. The residual value of capital goods at the end of a project should be written back as a negative cost.

However, it could also be a further cost if regarded as an externality (for example in the case a rehabilitation requirement at mines).

The following table is provided to assist the researcher to take into account the replacement of capital goods during the life time of the project as well as to estimate the residual value[16]:

Table 2: Replacement of Capital Goods

Type of asset	*Sector*	*Lifetime years*
Residential buildings		50
Non-residential buildings		50
Construction works	Agriculture	80
	Mining	30
	General government*	80
	Other	50
Transport equipment		8
Machinery and other equipment	Manufacturing	8
	Mining and electricity, gas and water	16
	Other	10

2.4.1.1 Land

Land can be used in the economic process in a number of ways, e.g. as agricultural land, an industrial input or the basis of infrastructure creation. The market price of a given piece of land cannot simply be accepted as a measure of its scarcity. The inherent value of land is dependent on its physical characteristics, the climate, and the production technology applied to it. The shadow price of land is based on its opportunity cost, in other words the optimal alternative use. In order to calculate this price, the following information should be available.

[16] SARB, 1999, South Africa's national accounts 1946-1998, An overview of sources and methods, p. 9.

(i) The historical use of the land and the value of the output derived from it in the past;
(ii) Other developments in the area which can affect it; and
(iii) Information concerning the proposed use of the land and the output from the alternative application.

It is important to remember that the expected return of any project is determined by prices which most probably reflect interventions and imperfections in the past and will manifest itself in the economy for the duration of the project. Therefore the expected return should be adjusted so that the economic value of the land can be calculated in terms of the economic value of the production given its optimal (most efficient) application.

An example can illustrate these aspects. The Department of Transport has to decide whether a local airport should be retained and upgraded or a new airport developed. An opportunity cost of nil (besides maintenance costs) is allocated to the existing runways on the grounds that there are no other uses for the runways and that their scrap value is zero. The land surrounding the airport does, however, have alternative uses in the form of low quality agricultural land, housing, or even industrial applications which should be taken into account.

2.4.1.2 Buildings

Buildings are essential to protect the production process from the ravages of nature and as such are included in any CBA. In order to determine economic prices, the following information may be useful:

(i) The date when the building was bought or built;
(ii) The current construction i.e. replacement cost of an equivalent building and the book value of the building; and
(iii) Alternative applications of the relevant building.

The shadow prices of existing buildings are calculated on the opportunity-cost basis and that of new buildings on the basis of construction costs. Where construction costs serve as a basis for these calculations, adjustments have to be made for possible distorted labour prices which serve as an input, as well as possible tariff protection on any locally purchased material inputs.

2.4.1.3 Machinery, equipment and transport equipment

Machinery and equipment are not usually consumed immediately in the production process. Except where they are destroyed by natural phenomena or man-made disasters, the machinery and equipment becomes obsolete as a result of wear and tear and the availability of improved production technologies. Depreciation on machinery and equipment is never, however, reflected directly in any CBA. Depreciation is taken into account indirectly in that the initial cost of the fixed assets normally appears at the beginning of the analysis period and the scrap or residual value appears as a credit at the end of that period.

The shadow price of machinery and equipment is determined in the same way as that of raw materials (see paragraph 2.4.2) by making a classification in terms of –

(i) Machinery imported, with and without any restrictions on quantity and price; and
(ii) Machinery purchased locally or made by the contractor of the project.
(iii) Where equipment is leased or where machinery is carried over from other projects to the proposed project, the use value is shadowed for labour content, tariff protection, other indirect taxes and subsidies.

2.4.2 Raw materials

Raw materials are found in a variety of formats and are converted through a variety of processes, by the addition of labour and capital into goods and services. The opportunity cost (scarcity value) of a raw material, and consequently the shadow price of the raw material, depends on a number of factors.

(i) Where a country is richly endowed with a raw material but the raw material is a diminishing asset, e.g. coal, it cannot simply be accepted that the market price reflects the relative scarcity of the asset, since the Government may influence the price for other reasons, e.g. in order to achieve a better balance of payments position.
(ii) Monopolies or cartels are in a position to force up the price of the raw material artificially to a level higher than its scarcity value.
(iii) The subsidisation or taxing of the use of raw materials will distort the prices so that they no longer reflect scarcity values.
(iv) Rationing restricts the demand for or supply of certain goods and distorts the market prices so that the economic value is not reflected in the price.

For discussion of the shadow price of raw materials it is necessary to identify three possibilities.

(i) Where raw materials are imported without tariff protection or purchased locally, the market price, which by definition is the world price plus freight and insurance (c.i.f.) to the point of consumption, is used in the economic analysis. In the case of quotas which increase the price of the imported product on the local market the same approach is used, in other words the shadow price is equated to the c.i.f. world price of the product. If government interferes with the operation of the currency market, however, adjustments should be made in the exchange rate (see paragraph 2.3.5).

(ii) Where raw materials on which import tariffs are applicable are imported or purchased locally, the shadow price is calculated by subtracting the percentage tariff protection from the local price. In the case of quotas the c.i.f. world price approach is used.

(iii) Where raw materials are purchased locally and these raw materials are not normally traded globally without influencing the local price or the local availability of the raw

material (e.g. bricks) it can be accepted that the scarcity value of the product is reflected by its market price, adjusted for indirect taxes and subsidies.

2.4.3 Labour

Labour differs in many aspects from other production factors. In South Africa, for example, it is possible that there can simultaneously be a shortage of skilled labour and a surplus of semi-skilled and unskilled labour. At the same time certain factors apply to the labour market which results in the labour wage not reflecting relative scarcity. One such factor is the fixing of minimum wages (through the pressure from trade unions and/or government policy), which forces the wage above the marginal product of labour and thus restricts employment. All factors that cause the price of labour to deviate from the marginal product of labour should be considered in a CBA.

The following approach for determining the shadow price of labour is proposed.

(i) Where unemployment does not exist, the market price of labour is used for all labourers. If the quality of a specific category of labour within a sector is homogeneous and the market operates fairly freely, then the average wage of that category in that sector can be accepted as reflecting the market price in the relevant sector. Under conditions of full employment, and especially where skilled labour is scarce, this method will probably underestimate the opportunity cost of labour, but in the absence of specific information it is not normally possible to calculate it more accurately.

(ii) For a worker who has very poor technical skills and who lives in a region where unemployment exists, the income per earner in the region is used as a measure of the production lost (shadow wage) when the worker is employed. Such income is usually lower than the minimum wage and is a more correct reflection of the opportunity cost of labour. The minimum wage is artificially set too high as a result of the power of trade unions and social pressure.

2.4.4 Services

Purchased services are not always concrete or visible in the final product of a product or service that is produced, but nevertheless form an integral part of the product or service, e.g. electricity, gas, water, transport, promotions, advertising and research and development. The opportunity cost of a service is the value that the remainder of the community has to forgo if they are denied the service or the cost imposed on them to deliver the service. If, for example, a project needs electricity, the shadow price of the electricity in a given region will be equal to the long term marginal cost of provision. The same approach applies to the cost of water, gas and transport.

2.5 Surrogate Prices

2.5.1 Advantages and disadvantages not reflected by a market

Some intangibles have a value but are not tradable in a market. Examples are the value of time or a human life. In order to determine the value of these the following approach is recommended:

In determining the value of time a decision has to be made as to whether the valuation is done in respect of working time or leisure time. The value of working time is theoretically equal to the marginal productivity of labour, and in a perfect labour market it would be reflected in ruling wages. It must be noted, however, that wages are not paid only for the free time that has to be given up to work, but also for the exertion required. Therefore the value of free time is equal to the ruling wage less the compensation for the working effort. Where free time is saved as a result of faster transport, the value must be increased or decreased in order to take into account the value of travelling pleasure, or the productive application of travel time, or the unpleasantness of the journey. In practice it is difficult to deduce the value of free time from the value of working time by means of this approach, and it is customary to estimate it in an empirical way by means of observations of time savings and related expenditure.

The accurate estimation of the value of working time by analysing wage packets for those involved on a sample basis and by conducting surveys to derive the value of free time is necessarily a time-consuming process, but it is essential where the results will be of critical importance for decision-making. Where the value of time savings for the general public is included as one of the benefits of a project, it is normally sufficient to accept the average per capita income per time unit as representative.

In determining the value of a human life, the economically productive life of an individual must be calculated in order to determine the lost production caused by death. The consequences and costs of injuries and, if the injury is temporary, the lost production attached to it, must also be determined.

This is not, however, the only method for determining the value of a life. Thompson (1983)[17] also refers to the Pareto method, the consumption-value method, the value according to potential earnings, the willingness-to-pay method and the social value method. According to him the last method is preferable, but the lost production method is most often used in practice.

2.6 Alternative Approach

In some cases the benefits are difficult to quantify in terms of market prices or even surrogate prices. The benefits should therefore be valued by calculating the saving between the situations after the project is completed and the situation before it was started. If the costs

[17] Thompson MS. 1980. *Benefit Cost Analysis for Program Evaluation*. London: Sage Publications.

with the project are lower than the costs without the project then the project provides benefits for the user. The opposite is true where "without-project" costs are lower than the "with-project" costs. This analysis is known as incremental benefit analysis and it calculates the incremental saving that a project brings about. An example of this is the benefits of an e-mail service relative to fax machine, where communication resulted in a higher labour content.

CHAPTER 3: CRITERIA FOR PROJECT ASSESSMENT

After completion of the financial and economic analyses, every project should be assessed individually in order to determine whether it will increase community welfare. Regarding the composition of a capital expenditure programme, the projects should be ranked in priority order in terms of financial and economic criteria. In this chapter the project assessment criteria are discussed systematically and an indication is given of the most suitable criterion to use under certain conditions. This is followed by a discussion of sensitivity analysis and income distribution measurement. The composition of a capital expenditure programme is discussed in Chapter 4.

3.1 Definition of Terminology

3.1.1 Mutually exclusive and independent projects

By mutually exclusive projects is meant alternative methods of performing the same task or reaching the same goal. For example, if the aim is to protect vehicles against weathering, a variety of alternatives can be considered. Eventually, only one of the alternatives will be chosen. The economic assessment of mutually exclusive alternatives therefore involves choosing the most cost-effective alternative.

Independent projects are completely unrelated and more than one of the projects can be carried out. In fact, it is possible to carry out all independent projects when there is no shortage of funds. Examples of independent projects are the construction of a new highway between towns A and B and the construction of a bridge between towns C and D. Where funds are scarce, however, it is important to rank the projects in order of acceptability so as to determine which projects should enjoy the higher priority. Even if it is possible to finance all the projects, it is still important to have criteria that can be applied to ensure that each project is in the interests of the community.

Logically speaking, projects are assessed in a predetermined order. The mutually exclusive projects are usually assessed first to find the most cost effective alternative, after which the chosen project competes for funds with other projects, which are chosen in the same way (all independently of each other), in a second assessment phase. The most effective alternative in a particular situation is not necessarily the best project when a programme is initially being compiled (See Chapter 4).

3.1.2 Discounting

Costs that are immediately incurred and benefits that are gained in the present time are judged differently by the community from costs and benefits that materialise over a period of time. The community would rather prefer to receive a benefit today than in the future, while

deferred costs are more attractive than immediate payment. Therefore the money value of costs and benefits over time cannot simply be added together; the time preference of the community has to be taken into account through the use of a weighting process. This weighting by the community is done with the aid of a rate that reflects the value of a benefit or cost over time. It is known as the social discount rate.

Suppose b_0, b_1, …, b_n are the project benefits in years 0,1,2, …, n and c_0, c_1, …, c_n are the costs in years 0,1,2, …, n, respectively, and i is the social discount rate, then the present value of the benefits is given by

$$b_0/(1 + i)_0 + b^1/(1 + i)1 + \ldots + b_n/(1 + i)^n$$

and the present value of the costs are given by

$$c_0/(1 + i)^0 + c_1/(1 + i)^1 + \ldots + c_n/(1 + i)^n$$

3.1.2.1 The choice of a social discount rate

When considering an appropriate social discount rate, note must be taken of the various points of departure in the economic literature[18], as well as of the rates applied in other countries and by international development institutions.

The points of departure in the literature can be divided broadly into three schools of thought, namely those who argue that the discount rate should be equal to the marginal return on capital (opportunity costs of capital), those whose argument rests on long-term real interest rates (cost of funding to the State), and those who advocate a social time preference rate.

The first two schools take an economic view while the third school adopts a multiple-goal approach which includes social aims. In the debate in the literature, arguments and criticism are based on purely economic grounds, as well as on the basis of what exactly the "public interest" involves. A lack of space makes detailed discussion of the arguments impossible, and the reader who wants more background on this interesting (and sometimes deeply philosophical) debate is referred to the book by Sugden and Williams (1983)[19].

There is no consensus concerning what method should be used to determine the social discount rate. A relative pragmatic approach is proposed which takes the following into account:

(i) The discount rate should not be influenced by business cycle conditions and policy, since the preferences that find expression in this rate are aimed at the extension of the long-term welfare structure.

[18] For an up-to-date presentation of the theoretical foundations of social discount rates, as well as alternative social discount rates methods in the absence of perfect markets, see Boardman, Greenberg, et al., Ibid Chapter 5.

[19] Sugden R and William A. 1978. *Principles of Practical Cost-Benefit Analysis*. Oxfort University Press.

(ii) A low discount rate generally favours projects with a high initial capital cost and low future current costs, while the opposite applies to high discount rates. Since labour costs are part of current expenditure, a high discount rate favours the employment of labour in future.

(iii) If the real social discount rate is lower than the real implicit discount rate in the private sector, then investment by the public sector will be encouraged at the expense of investment by the private sector. The larger the gap between the two, the stronger the effect.

3.2 Project Assessment Criteria

There are several project assessment criteria, which can be classified broadly as limited methods or more comprehensive methods.

3.2.1 Limited methods

These criteria include the payback period method, the peak profit method and the average profit method. All three are very simple and are restrictive because efficiency is not the main consideration. As a result, these limited methods may produce misleading results. The use of these methods is not recommended, and therefore they are not discussed here in detail.

3.2.2 More comprehensive methods

3.2.2.1 Net present value method

According to this method the difference between the benefits and costs (the net benefit) in the specified year is discounted to the present by using the social discount rate. The discounted sum of all these net benefits over the economic project life is defined as the net present value (NPV). In terms of the terminology set out above.

$$NPV = \Sigma b_j/(1 + 1)j - \Sigma c_j/(1 + i)^j.$$

The criterion for the acceptance of a project is that the NPV must be positive; in other words, funds will be voted for a project only if the analysis produces a positive net present value. Where a choice has to be made between mutually exclusive projects, the project with the highest net present value will be chosen since it maximises the net benefit to the community.

3.2.2.2 The internal rate of return

The internal rate of return (IRR) is the discount rate at which the present values of cost and benefits are equal. It is therefore the value of the discount rate r which satisfies the following equation:

$$\Sigma b_j/(1 + r)^j - \Sigma c_j/(1 + r)^j = 0.$$

Only projects with an IRR higher than the social discount rate, which forms a lower limit, will be considered for funding. The IRR must be handled carefully, because there are situations in which the mathematical solution of the above equation is not unique. This happens when the stream of net benefits over the assessment period changes its sign (positive or negative) more than once.

3.2.2.3 The discounted benefit-cost ratio

The discounted benefit-cost ratio (BCR) is the ratio of the present value of the benefits relative to the present value of the costs, i.e.

$$BCR = \{\Sigma b_j/(i + 1)^j\} / \{\Sigma c_j/(1 + i)^j\}$$

There exists doubt in the relevant literature about how costs and benefits should be dealt with. In practice, it is probably more common not to compute the BCR using gross costs and gross benefits, but rather to compare the present worth of the net benefit with the present worth of capital costs. There are, however, some institutions that include some operating and maintenance costs as part of the costs with which the net benefit should be compared. As far as this manual is concerned, it is recommended that only costs of a capital nature (assets and equipment with a life of more than a year) should form part of the costs with which the net benefit should be compared.

A project will only be considered for funding if the BCR is greater than 1.

The NPV, IRR and BCR criteria are not the only discounting measures used in CBA. There are also the net discounted end value, the net benefit-investment ratio and the yearly value method. The first-mentioned three are, however, theoretically well founded and are the ones most commonly used in practice. These three criteria should be applied in respect of every project analysed.

An example will illustrate the use of the NPV and BCR methods. The Table 3 contains the present values of the benefits and costs involved in the construction of a dam.

Table 3: The Present Value of Benefits and Costs of the Construction of a Dam (Rand)

Benefit/Cost	*Present benefit*	*Present cost*
Construction of dam		2 501 000
Annual Maintenance		259 000
Household Water Benefits	2 851 000	
Irrigation Water Benefits	473 000	
Recreation	716 000	
TOTAL	R4 040 000	R2 760 000

In the previous example the NPV = R4,04 million – R2,76 million = R1,28 million and the BCR = (R4 040 000 – 259 000)/2 501 000 = 1,51.

In terms of both measures the project can therefore lay claim to funding. The internal rate of return method would have arrived at the same results.

A further example will illustrate the use and limitations of the NPV and BCR measures in comparing a number of mutually exclusive projects. The road analysed above now competes with two mutually exclusive projects for funds. The details are contained in Table 4.

Table 4: Present Values of Costs and Benefits: Three Mutually Exclusive Projects (different dam sites)

(Rand)

Dam Sites	*Present value of benefits*	*Present value of capital costs*	*Net present benefits*	*BCR*
1	3 781 000	2 501 000	1 280 000	1,51
2	5 000 000	3 500 000	1 500 000	1,43
3	3 350 000	2 200 000	1 150 000	1,52

Looking only at the BCR, it appears that dam site number 3 is the best choice, since it will provide R1,52's worth of benefits for every rand spent. However, it can be seen that this reasoning is incorrect if site 1 is compared with site 3. By spending a further R301 000 on site 1, a benefit of R431 000 more than that of site 3 is achieved. This means that site 1 provides a Pareto improvement relative to site 3. Those who benefit from site 1 can compensate all losers and still leave a surplus of R130 000. Using a similar argument it can be shown that site 2 is an improvement on site 1 and is therefore the best of the three alternatives. Generally, it can be argued that, in the case of mutually exclusive projects, the project with the highest NPV has the highest potential Pareto improvement.

3.3 General Sensitivity Analysis

3.3.1 Background

In most cases, a CBA is performed for new future projects and thus entails the estimation of certain key variables such as expected price and quantity. Although it could be accepted that the decision-maker is fully aware of the fact that the projected outcome of a project cannot be interpreted in absolute terms, it is important that the analyst provides the decision-maker with some idea of the degree of certainty/uncertainty to which the project outcome would be subjected to.

3.3.1.1 Selective sensitivity analysis

Project-evaluators usually perform a so-called Selective Sensitivity Analysis in order to establish the sensitivity of a project's outcome to changes in a limited number of key input variables. In essence, the analyst selects a key variable/parameter, one which he feels is both subject to wide variations and capable of significantly affecting the results of the CBA. The analyst then selects likely high and low (best and worst) outcomes for this parameter and repeats the computation of the CBA using these values. The decision maker is thereby presented with several possible results for each project – high, a medium and a low outcome for each of the parameters selected for the sensitivity analysis.

The major drawback of this limited approach is that it is not very suitable for the analysis of anything more than a few parameters. It not only causes problems when attempting to present the results in a scientific manner, but it also omits a great deal of information important to the decision-maker. Normally, the impact on the viability of a project through the change in any single parameter is compared to the base scenario. The ideal, however, is to calculate all the combinations of worst, standard and best for each parameter selected for the sensitivity analysis. Although this is technically possible, the presentation of such an analysis could be a major problem. To illustrate, when doing a sensitivity analysis with 10 parameters, each with a worst, medium and best value, the model calculated 3^{10} or 59 049 possible outcomes for the project.

3.3.2 General sensitivity analysis

In using General Sensitivity Analysis, the problems encountered in Selective Sensitivity Analysis, namely the limitations with regard to the number of input parameters are overcome to a large degree. A General Sensitivity Analysis hinges on the derivation of a probability distribution of possible outcomes. Hereby, all the information contained in the above-mentioned 59 049 individual possible outcomes is captured in a format which is very convenient to the decision-maker for interpretative purposes. Without describing the methodology of the General Sensitivity Analysis in detail, it can be mentioned that it involves the following:

a) The calculation of results using all possible combinations of input parameters;
b) The probability of occurrence of each combination; and
c) The construction of a cumulative probability distribution function.

The following information can be obtained from the analysis:

a) The probability of the project being viable;
b) The probability that the project will not be viable;
c) The probability that the project will yield a particular return; and
d) The expected return (or best single estimate).

3.3.3 Computer model

The General Sensitivity Analysis is done by making use of a computer programme called @RISK (advanced risk analysis for spreadsheets) by the Palisade Corporation, USA, September 1996.

@RISK uses simulation, sometimes called Monte Carlo simulation, to do a Risk Analysis. Simulation in this sense refers to a method whereby the distribution of possible outcomes generated by letting a computer re-calculate the CBA worksheet over and over again, each time using different randomly selected sets of values for the probability distributions of each key input variable. In effect, the computer is trying all valid combinations of the values of input variables to simulate all possible outcomes. This is similar to running hundreds or thousands of "what-if" analyses on the worksheet, simultaneously.

3.4 Income Distribution (Welfare Distribution between Contemporaries)

As mentioned in Paragraph 1.4.4, CBA is geared to the improved allocation of scarce resources. The guideline is the achievement of Pareto optimality. This means that resources are used in such a way that at least one person will be better off while in the process no-one will be worse off. If the discounted benefits of a proposed project exceed the discounted costs, the possibility exists of bringing about a Pareto improvement, provided that the winners compensate all the losers for their losses while at the same time retaining their surpluses. In practice this does not necessarily happen and the practical effects of the project on income distribution have to be determined.

All the project assessment criteria discussed so far, have been exclusively concerned with the achievement of a potential Pareto improvement and have not touched on the equitable distribution of consumption between contemporaries. Since this is one of the important objectives of economic policy, the government should quantify the most important distribution aims by allocating weights to specific groups. The fundamental point of departure is that additional incomes for lower income groups should be relatively more important than additional incomes for higher income groups. It is important to analyse the

project in order to determine who the winners and losers will be. The following effects are of importance:

- who pays more and who pays less as a result of the project;
- who receives more and who receives less as a result of the project; and
- who benefits and who loses in other ways as a result of the project.

The following serve as broad guidelines concerning the role-players that could be involved in such as evaluation:

- the contractor of the project;
- other businesses that provide project inputs;
- government, which may profit from charging tariffs or may have to support the project financially in one way or another;
- the workers, or different categories of workers;
- the end-users of the product or service; and
- foreign countries, which may be affected through imports and exports.

The role-players who are referred to can also be seen in the context of a local, regional or national perspective. Accordingly use can be made of regional or local weights to achieve specific development objectives for an area.

The weights to be allocated to the different groups are not easily determined and depend largely on political decisions. It should, however, be related to the marginal utility that additional income provides for each of the groups. In order to make effective decisions, it is important for the decision-maker in the government sector to know what weights the politicians attach to particular groups or regions at a particular point in time, so that, after the completion of the financial and economic analysis, the income distribution potential of each project can be pointed out in detail. In South Africa such weights are not explicitly available. Nevertheless, recent development in the compilation of more contemporary SAMs, have made it possible to include such weights for household income groups for CBA-purposes. The theory and practice are set out in the following section.

3.4.1 Income weighting systems

3.4.1.1 Theory

From the above discussion, it is obvious that the concept and practice of weighting of different income groups should be viewed with a great deal of circumspection. Especially in the South African context where large differences between high and low income groups do occur.

For the purposes of this manual it is proposed that the first round of calculating the distributed impact (with the help of a SAM-based model) is done without a weighting system. After obtaining the initial results, use can be made of appropriate ratios to demonstrate the relative impact on the lower income groups. For example what percentage of the total impact (direct and indirect) on personal income is earmarked for the lower, medium and higher income groups. In the absence of elasticity data, as a first round of weighting, use can be made of deviations from the mean / average national income per capita of each income group.

As stated previously, in principle, distributional objectives can be incorporated in project selection by assigning weights to income changes to different groups. This weighting of income flows to different groups allows revised NPV and IRR measures to be calculated and hence allows a distributional objective concern to be built into conventional decision-taking criteria.

In response to the perceived importance of distributional issues there is a well developed methodology for income weighting[20].

The best known form of weighting involves a simple formula that assumes that the social value placed on a unit of income declines at a constant rate for all income levels. Application of this approach requires two parameters. The first is a reference level of income that will have a weight of unity. The main candidate for this reference level is average per capita income in the economy, but alternatives include a poverty line estimate or the income at which individuals become eligible for government subsidies. The second parameter is technically the elasticity of the social utility function for income. It reflects the rate at which the income weight for an individual or group declines as per capita income rises and in principle captures the strength of society's preference for income equality. By assumption this rate of decline or elasticity is constant for all income levels.

The income weight formula is thus:

$$di = (Ya/Yi)^n \qquad (1)$$

[20] For more detail please consult:
Guide to Practical Project Appraisal, Social Benefit – Cost Analysis in Developing countries, Under Vienna; 1986 in Chapter VII.
Project Analysis in Developing Countries – Second Edition – Steve Curry and John Weiss, Maccullian Press Ltd. – Second Edition, 2000, Chapter II.

where

di is the weight for group or individual i
Yi is per capita income for i
Ya is the reference income, which we assume is the national average per capita income,
n is the elasticity parameter

Using (1) income weights will decline the higher Yi is relative to Ya – that is, the better-off i is relative to the national average, and the higher n is, the stronger is society's commitment to equality. Use of this formula can be illustrated using values of n of 0.5 and unity (Table 5).

Table 5: Illustration of Income Weights

Income (Ya = 100)	***n = 0.5 weights***	***n = 1.0***
Yi = 50	1.41	2.00
Yi = 80	1.12	1.25
Yi = 200	0.71	0.50
Yi = 300	0.58	0.33

Table 6: Re-valuation of Telecommunications Project with Income Weights

Stakeholders	***NPV***	***Average income***	***Income n = 1.0, Ya = 100***	***Weighted NPV***
(Pesos million)				
Project owners	0.46	500	0.20	0.09
Lenders	-2.20	500	0.20	-0.35
Government	-2.04	100	1.00	-2.04
Project workers	0.91	80	1.25	1.14
Telephone users	6.15	70	1.43	8.79
TOTAL	3.28			7.63

Source: S. Curry and J. Weiss – pp 290-291.

Using such income weights to revalue the telecommunications project presented in Curry and Weiss[21] would require a choice of n and an estimate of the average income of the different groups affected by the project. Table 6 illustrates the approach using the income figures at domestic prices. They assume that 20 percent of telephone users are poor with a per capita income of Pesos 50 whilst the remaining 80 percent have a per capita income of 75, which is 75 percent of the national average. The weighted average income of users is therefore Pesos 70. They then use the national average income as the reference level for weighting. It is assumed that project owners have an income five times the national average and that lenders are a private sector institution whose losses represent a reduction in profits for shareholders again with an income level five times the national average. Reductions in government income are assumed ultimately to affect those on average incomes through higher taxes.

[21] "Project Analysis Ibid on cit. p 290.

Finally project workers are assumed to have an income 80 percent of the national average. In calculating the weights a value of n = 1.0 is used.

With the use of income weights the project's NPV has increased substantially to Pesos 7.63 million. This is primarily because its main beneficiaries, the users, have below average incomes and some have very low incomes and are classed as poor. On the other hand, one of the losing groups, the lenders, have high incomes and their losses have little social value. When weights are applied consistently projects can be ranked by their economic NPVs and in this case the project should look better relative to alternatives because of its egalitarian distributional effect.

Although this methodology of weighting is well known, it is rarely applied in practice. This is in part owing to what are seen as the complications regarding its additional data requirements. More importantly, perhaps, is the point that the use of a particular set of weights is essentially subjective since their value will vary with the assumed elasticity parameter n. In the absence of any agreement on this parameter there is the possibility of inconsistency in decision-taking with comparisons between projects where different weighting regimes have been applied. In addition weights such as those in Table 1 have been criticized since they can imply the justification of a high level of economic inefficiency in pursuit of distributional goals.

For example, with n = 1.0 a project with benefits of 25 and costs of 100 (that is, with a net loss of 75) would be justified if the benefits went solely to those with an income of half the national average (and thus a weight of 2.0), whilst it's costs were borne solely by those with an income twice the national average (and thus a weight of 0.5). The point here is that whilst raising the income of the project beneficiaries by 25 may be justified in terms of social priorities, doing it at a net cost of 75 is likely to be a very inefficient means of reaching this target group. The expectation would be that there would be less costly means of affecting the transfer (for example, through subsidy schemes or targeted work programmes) than implementing a loss-making project.

3.4.1.2 Practice

As discussed above the income weight system is still being debated. Although the theoretical principle is probably sound, the practical application is still problematic. In view of this it is recommended that the principle of the income weight system should be introduced gradually. In this regard it is proposed that the elasticity of the social utility function for income could be set as a guideline at 0.20. This factor is in line with the priority that the government has given to income distribution indirectly via the percentage allocation in respect of government tenders to previously disadvantaged individuals.

In view of the fact that the income weighting system is subject to criticism, a rather conservative elasticity of 0.20 is therefore suggested. It is important that the relevant CBA results should be presented to the decision-maker before and after the weights are applied. Furthermore it is also important that sensitivity analysis is applied by means of different elasticity parameters.

With regard to the reference level of income it is proposed that the average per capita income in the South African economy is used. The relevant figures can be obtained from the SARB Quarterly Bulletin. Table 6.1 also reflects provincial per capita income levels for unskilled workers. However, it is important to note that the decision maker should always be supplied with the results of the CBA analyses before and after the income weights are applied.

3.5 Welfare Consequences

The reallocative effect of a project is only one of the effects that can be classified as of welfare consequence. In general, welfare effects include all the consequences that a project has for a human being's social milieu. These effects are related to changing living standards, new opportunities for development and self-improvement and the protection of the environment, but also with population movements and all the negative consequences attached to them, etc. Welfare effects are hard to quantify, but it is important that the analyst should point out any such effect in detail and systematically to the decision-maker, even if it is by qualitative means, to enable him/her to attach a subjective weight to it in order to arrive at a more considered decision.

3.6 Political and Constitutional Consequences

The project evaluator always operates within a certain constitutional environment which influences the shadow prices and the choice of distributive weights. Analysts will, however, endeavour to point out all the consequences of a project as objectively as possible. When decision makers act contrary to the recommendations of the analyst it must be very clear what price the community is paying for such politically inspired action.

It is not always possible to include all the political consequences in the CBA on a quantified basis, although it is the responsibility of the analyst to point them out in detail on a qualitative basis.

3.7 Strategic Consequences

Projects may be classified as strategic on grounds of the following philosophies:

- The self-preservation philosophy, which emphasises the survival of the community; or
- The egoistic philosophy, which wishes to deny other parties access to the markets but is often disguised as per the above.

Strategic projects are aligned to both national objectives and sectional objectives that are presented as national objectives. The objectives can be of various kinds – self sufficiency in abnormal times, national prestige, the development of new technology, etc. The calculation of the strategic value of projects should be done on the basis of the probability that the circumstances being guarded against, will materialise and the degree to which the country is

already dependent on the party against whom the project gives protection. This type of analysis should form part of the sensitivity analysis of the project.

Since strategic consequences are also difficult to quantify, care should be taken to guard against the misuse of the strategic argument in cost-benefit analyses.

In the last three sections it has been argued that the analyst must point out non-quantifiable consequences in detail and systematically to the decision-maker in order to enable him/her to allocate a subjective weight to them and so to make an optimal decision. Where an analyst or decision-maker expresses an opinion or decides between alternative projects, it is expected of the analyst or decision-maker unambiguously to indicate the considerations that have led to the decision.

CHAPTER 4: COMPOSITION OF A CAPITAL EXPENDITURE PROGRAMME

This chapter deals with methods of putting together a capital expenditure programme subject to a fixed budget when (i) only independent projects are presented for consideration and (ii) both independent and mutually exclusive projects are considered. The examples are derived from the book by M.S. Thompson (1980)[22].

4.1 Independent Projects

When a choice has to be made between a number of independent projects, given a fixed budget, the BCR measure is the preferred criterion. An example will illustrate this point. Suppose a local authority with a limited budget of R5 million has to make a choice between twenty-six independent projects, five of which are summed up in Table 7.

Table 7: Present Value of Benefits and Costs for a Number of Independent Projects (Rand)

Project	*Present benefit*	*Present capital cost*	*Net present benefit*	*BCR*
A	420 000	300 000	120 000	1,4
B	1 350 000	1 000 000	350 000	1,35
C	350 000	200 000	150 000	1,75
D	900 000	600 000	300 000	1,5
•	•	•	•	•
•	•	•	•	•
Z	640 000	400 000	240 000	1,6

Here the BCR criterion is the preferred measure to use. The project with the highest BCR value is selected first, followed by the one with second highest BCR value, and so on until the budget is exhausted. Thus, the five projects in Table 7 will be chosen in the order C, Z, D, A and B. In this way the benefit per rand spent is maximised.

[22] Thompson MS. 1980. Benefit Cost Analysis for Program Evaluating. London.

4.2 Independent and Mutually Exclusive Projects

Suppose the objective of the decision-maker is to maximise community benefits subject to the restriction of a fixed budget and that both mutually exclusive and independent projects are under consideration. A method of project assessment based on the incremental principle is recommended. The method consists of seven steps, and although it is complicated, it can easily be carried out with the aid of a computer. The steps are as follows:

(i) Determine the size of the budget. Where some degree of freedom exists as to the total amount available, the amount can be expanded incrementally, and the marginal benefits compared with the marginal expenditure to determine whether any expansion of the budget is justified.

(ii) Eliminate all projects that exceed the budget limits and all projects which do not satisfy the minimum acceptance criteria as set out above.

(iii) Determine which project has the highest BCR within each group of mutually exclusive alternatives and then leave out the rest of the possible projects in the group.

(iv) From the projects under consideration choose the one with the highest BCR.

(v) Review the choice of the best project in each group of mutually exclusive projects by reconsidering all the more expensive projects and noting the marginal BCR. Within each group of mutually exclusive projects by firstly reconsidering all more expensive projects and noting the BCR. Within each group of mutually exclusive projects the project with the highest marginal BCR is identified and compared with the rest of the independent projects. Secondly, the available budget is adjusted to reflect the effect of the projects already chosen, and all remaining projects that exceed the balance of the budget are left out.

(vi) Repeat steps (iv) and (v) for as long as possible. The iteration process ends when the budget is exhausted or when no acceptable projects remain for consideration.

(vii) Consider adjustments to chosen projects when the budget is not completely exhausted and a small adjustment in a chosen project may provide marginal net benefits.

An example will clarify this procedure. Suppose a government has R1 million to spend. The projects under consideration are summed up in Table 8. Projects A1, A2, A3 and A4 are four mutually exclusive projects.

Table 8: Present Value of Costs, Benefits and Benefit-Cost Ratios of a Number of Projects

Project	*Present capital cost (R'000)*	*Present benefit (R'000)*	*BCR*
A_1	135	280	2,07
A_2	170	370	2,18
A_3	210	440	2,10
A_4	270	530	1,96
B	150	250	1,67
C_1	250	315	1,26
C_2	280	405	1,45
C_3	600	890	1,48
D_1	110	175	1,59
D_2	150	235	1,57
E_1	100	220	2,20
E_2	200	480	2,40
E_3	300	670	2,23
E_4	400	830	2,08
E_5	500	1030	2,06
E_6	600	1170	1,95
F	60	140	2,33

There is no project that exceeds the budget limit of R1 million and, furthermore, there is no project with a BCR of less than one. All projects are therefore included in further analysis. In Step (iii) the best projects are chosen from groups A, C, D, and E, and the projects that enjoy attention in the next step are reduced to the following:

Project	*Present capital cost*	*Present benefit*	*BCR*
A_2	170	370	2,18
B	150	250	1,67
C_3	600	890	1,48
D_1	110	175	1,59
E_2	200	480	2,40
F	60	140	2,33

E_2 is chosen from these six projects. Now the more expensive projects in the E group are considered in terms of the marginal BCR. The marginal BCRs of the four projects more expensive than E_2 are as follows:

Project	*Marginal capital cost*	*Marginal benefit*	*Marginal BCR*
$E_3.E_2$	100	190	1,90
$E_4.E_2$	200	350	1,75
$E_5.E_2$	300	550	1,83
$E_6.E_2$	400	690	1,72

The greatest marginal benefit is achieved by replacing E_2 with E_3; this replacement within the E group must now be considered together with the other projects. There is now R800 000 left and none of the project exceeds this limit. The six alternatives now under consideration are as follows:

Project	***Present capital cost***	***Present benefit***	***BCR***
A_2	170	370	2,18
B	150	250	1,67
C_3	600	890	1,48
D1	110	175	1,59
$E_3.E_2$	100	190	1,90
F	60	140	2,33

Project F is therefore chosen and R740 000 of the budget is left. The next project to include is A_2, which immediately places the more expensive project in group A under the spotlight. The relevant marginal ratios are as follows: $A_3.A_2 = 1,75$ and $A_4.A_2 = 1,6$. The former is now compared with the remaining projects. There is R570 000 left to spend, and this eliminates projects C_3, which is more expensive. C_2 takes the place of C_3 on the basis of the BCR criteria. The list under consideration is now as follows:

Project	***Present capital cost***	***Present benefit***	***BCR***
$A_3.A_2$	40	70	1,75
B	150	250	1,67
C_2	280	405	1,45
D_1	110	175	1,59
$E_3.E_2$	100	190	1,90

$E_3.E_2$ has the best ratio and E_3, replaces E_2 as chosen project. This costs an additional R100 000, leaving R470 000 for spending. The marginal BCR measures within the E group are as follows: $E_4.E_3 = 1,60$, $E_5.E_3 = 1,80$ and $E_6.E_3 = 1,67$. The list of competing projects is now as follows:

Project	***Present capital cost***	***Present benefit***	***BCR***
$A_3.A_2$	40	70	1,75
B	150	250	1,67
C_2	280	405	1,45
D_1	110	175	1,59
$E_5.E_3$	100	360	1,80

Project E5.E3 has the largest BCR, which means that E3 is replaced at a cost of R200 000. This leaves only R270 000 and means that C1 now replaces C2 on the list of competing projects.

Project	*Present capital cost*	*Present benefit*	*BCR*
$A_3.A_2$	40	70	1,75
B	150	250	1,67
C_1	250	315	1,26
D_1	110	175	1,59
$E_6.E_5$	100	140	1,40

Project A3 is chosen to replace project A2 which leaves R230 000 and eliminates C1. The following projects remain for consideration:

Project	*Present capital cost*	*Present benefit*	*BCR*
$A_4.A_3$	60	90	1,50
B	150	250	1,67
D_1	110	175	1,59
$E_6.E_5$	100	140	1,40

Project B is now chosen, leaving R80 000. Since only A4.A3 falls within this limit, A4 replaces A3, leaving another R20 000 in the budget. Therefore it is decided to fund A4, B, E5 and F at a total cost of R980 000. Benefits to the value of R1 950 000 are gained in the process.

In the last step small adjustments are made to increase the total benefits. The most attractive project eliminated on the grounds of the budget limit was D1. Sufficient funds can be acquired to pay for D1 if A2 is funded instead of A4. This leaves R15 000 of additional benefits at R10 000 of additional cost, and the final list of projects is therefore:

A2, B, D1, E5 and F.

Underlying this complicated procedure is the very simple notion that the decision-maker should endeavour to achieve the greatest possible benefit for every rand that (s)he spends. A small computer programme will greatly simplify this technique.

CHAPTER 5: PROCEDURE FOR THE APPLICATION OF COST-BENEFIT ANALYSIS

5.1 Introduction

In this chapter the procedure proposed for the practical application of CBA is set out. The procedure is of a general nature and is therefore appropriate for a wide range of public sector projects.

Although the procedure implies a number of steps taken in a specific order, the proposed order must not be viewed as absolutely rigid. It may be necessary for the analyst to return to previous steps once (s)he has acquired greater insight into the problem.

Furthermore, it is important that there should be constant interaction between the principal and the analyst. This interaction implies, among other things that the analyst can make suggestions to the principal with regard to the amendment of the alternatives and/or the identification of new alternatives.

Such interaction is only meaningful if the principal is acquainted with the theoretical points of departure of CBA, the scope and limitations of the technique and possible problems with regard to the availability of data. The principal must realise that CBA is part of the decision-making process in order to promote rational decision-making.

5.2 Application Procedures

In simplified terms a CBA entails:

- Identification of the impact of a project in terms of the costs and benefits resulting from it.

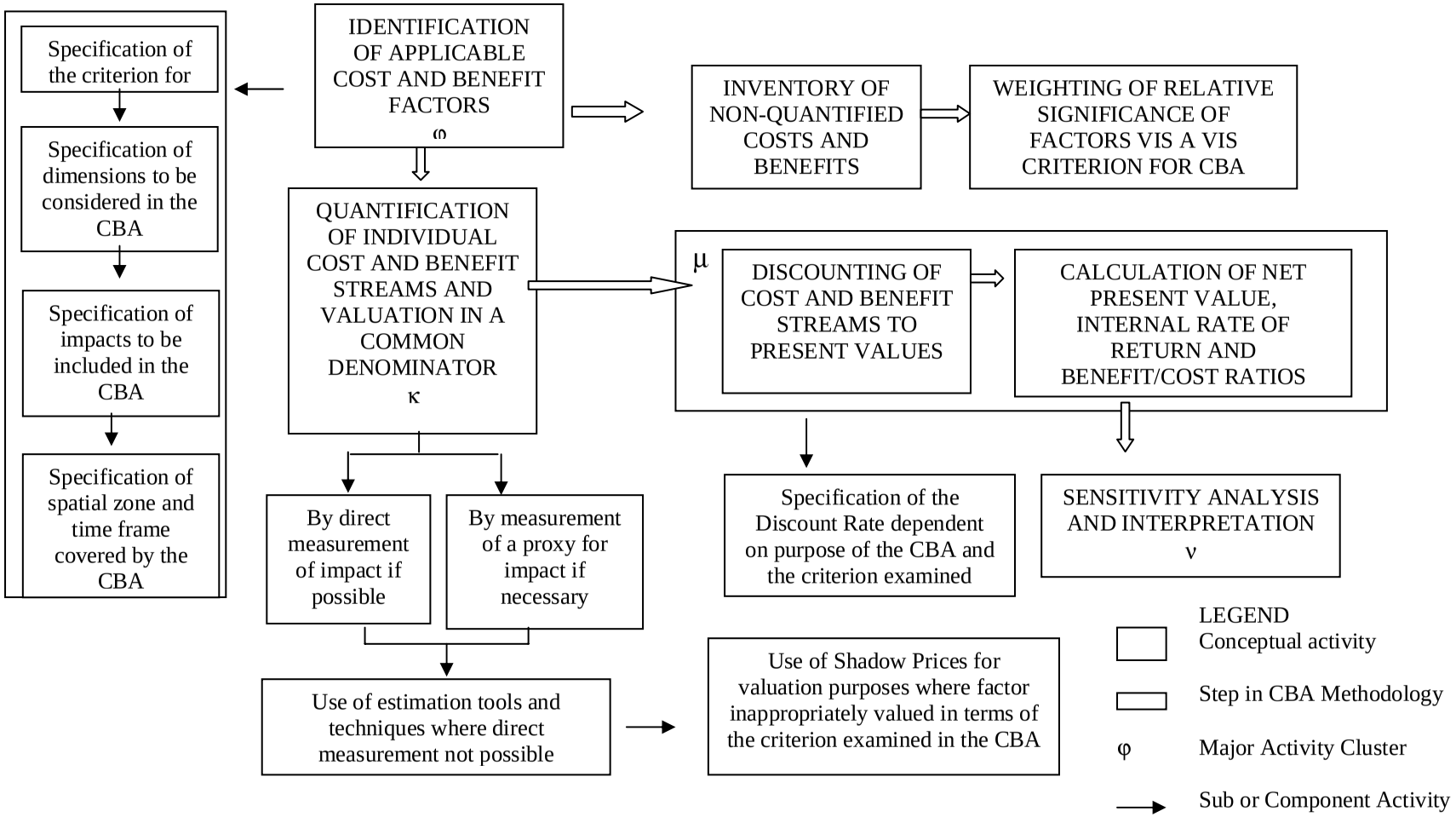
- Quantification by measurement or estimation of the streams of costs and benefits, which are generated by a project. Measurement and estimation techniques vary according to the nature of the costs and benefits. Cost and benefit streams are expressed, i.e. valued, in a common, usually monetary denominator. Shadow prices are used in valuation of some cost or benefit streams when market prices are either unavailable or inappropriate because they are distorted due to market imperfections. Discounting of the streams of costs and benefits to present values to allow comparison of the value of costs and benefits, which are incurred, or which accrue over different periods of time. A standardised rate is selected as discount rate for the calculation of present values of all cost and benefit streams.

- Determine the present value of costs and benefits and calculation of the internal rate of return of the project (the IRR) and the ratio of benefits to costs (the BCR).

- Sensitivity analysis of impact of variation of cost and benefit streams on project IRR and BCR. (The IRR in the economic application of CBA is known as the economic rate of return, ERR).

In Figure 1, a conceptual framework is set out for the development of cost benefit analysis. The framework charts the process and steps of CBA and indicate the activities required.

Figure 1: Conceptual Framework for Development of Cost Benefit Analysis Practice



Source: © Development Bank of Southern Africa, 2000.

Some of these activities are of a conceptual nature, being required to define the scope and focus of the analysis (such as specification of the purpose of the analysis, the criterion to be examined, dimensions to be considered, and impacts to be included). Other conceptual activities are required to give effect to the intent of the analysis (such as use of shadow prices where necessary and the defining of a discount rate with which to calculate the present values of cost and benefit streams).

With the aid of the above framework the generic nature and process of CBA is described below.

5.2.1 Steps in execution of Cost-Benefit Analysis[23]

The practical steps required to execute CBA are summarised in Table 9:

Table 9: Practical Steps in Execution of CBA

Step	***Activity***
1	Specification of purpose of the CBA and specification of project boundaries within which the analysis is to be conducted. By the setting of a perspective it is important that the analyst will acquaint her/himself with all the relevant facts in order to develop a feeling for the problem, the proposed solutions and the milieu within which a recommendation is to be made.
2	Identification of all impacts i.e. costs and benefits generated by a project within the boundaries specified for analysis. It must once again be emphasised that the analyst should measure the costs and benefits relative to the nil alternative. Further, it is important that the analysis should not be done in terms of only a single set of parameters, but that a whole number of critical scenarios should be investigated with the aid of sensitivity analysis.
3	Quantification of cost and benefit streams via direct measurement of the impact itself or, if necessary, measurement of an appropriate proxy for the impact. If direct measurement of the impact or proxy is not possible, the impact or proxy should be estimated using appropriate estimation tools and techniques.
4	Impacts, which are difficult to measure, should nevertheless be recorded in qualitative terms and if possible ranked in order of importance. The analyst should also, as far as possible, quantify the social consequences of a project, and where such quantification is not possible they should be reported qualitatively. The following social consequences of a project should be addressed: Distributional effects between income groups, population groups or geographical regions; Welfare consequences; Political and constitutional implications; Strategic consequences; Prestige; The creation of job opportunities; The achievement of economic independence; and Population movements.
5	Discounting of project cost and benefit streams to present values
6	Calculation of NPV, ERR and BCR to define the value of the project in economic terms.
7	Sensitivity analysis on the cost and benefit streams. The analysis should be based on risk factors, which have been identified in the project setting.
8	Interpretation and reporting of the results of the analysis.

[23] Procedures used by DBSA.

5.3 Report Writing

It is necessary that the research should be well documented for future references. However, it is important to convey to the decision maker the results of the CBA in such a manner that (s)he understands the project and is able to take a decision without studying detailed unnecessary information.

The last task of the analyst involves the completion of a summary that gives the decision-maker an overview of the most important aspects of the analysis.

The summary should preferably not be longer than five pages and should cover the following aspects (it is important to note that the following should be seen as a guideline that can be deviated from by way of exception where valid reasons exist):

Purpose of CBA

This section contains a short specification of the purpose of the CBA, formulated as a problem statement. The boundaries (project boundaries) within which the analysis was conducted are also specified. In more detail it entails the following:

(i) An introductory paragraph that covers the following aspects:

- The long-term expenditure programme and the expenditure vote/programme within which the project must/can be accommodated;
- The fact that the summary is intended to set out the most important financial, economic and social implications of the project.

(ii) The project identification, which includes the following:

- The determination of a need; an explanation of the present situation, the nature of the problem that gave rise to the need for a solution, and the solution that is presented;
- The technical solutions; an explanation of the alternatives identified by the principal and evaluated in the analysis.

(iii) The aim of the analysis:

- An explanation of the fact that the aim of the analysis is to identify the financial, economic and social implications of the alternatives in order to identify the best alternative.
- An explanation of the costs and benefits included and excluded from the analysis.

(iv) The limitations:

- An explanation of any considerations that may lead to the elimination of any of the alternatives, for example strategic or political implications, or legal restrictions.

Key assumptions

This section contains a specification of the key assumptions and proxies used in the calculation of the CBA.

Results of CBA

- In this section the results of the cost-benefit analysis calculations of NPV, ERR and BCR are reported. They are then interpreted against project selection criteria.
- Aspects that should be reported on include:
    - tariffs
    - government and other subsidies
    - funding options.

Inventory of non-quantified costs and benefits

In this section an inventory of non-quantified costs and benefits is made and their relative significance to project economic impact, indicated. It should indicate the social, welfare, political, constitutional and strategic consequences.

Sensitivity Analysis

A description of the sensitivity and critical considerations, which include:

- The identification of that parameter (assumption or prediction) that has been pointed out as the most critical;
- provision of the most likely spectrum of values of this parameter;
- Identification of the cut-off point within this spectrum of values;
- Explanation that the success of the project may depend on the completion and/or success of another project or projects.

Reasoned recommendation

In this section the rationale for recommending or declining support for a project on the basis of impact on society welfare is summarised.

CHAPTER 6: DETERMINING SHADOW AND SURROGATE PRICES FOR SOUTH AFRICA

6.1 Introduction

In practice, determining shadow and surrogate/associated prices for use in a CBA is normally a task that requires the application of underlying economic principles to specific circumstances. This requires a basic knowledge of the relevant economic principles, and the specific inputs and outputs being analysed. However, it is important to bear in mind that, in the light of the various prices, and the variation in prices used in a CBA, it is not possible to calculate shadow and surrogate prices for every input and output.

Nevertheless, general practical guidelines and broad estimates can be provided for prices of certain inputs and outputs. This is done on the understanding that certain cases may require a more detailed approach. Where the results of a CBA can be largely dependent on the method of shadow price calculation, the effect of alternative shadow prices on the results of a project should be subjected to a sensitivity analysis.

6.2 Calculation of the Real Social Discount Rate

According to Sassone and Schaffer[24] "…economists have devoted scores, perhaps hundreds, of man-years to investigating the discounting issue. It is unlikely that significant progress would be made in the confines of a single applied project, yet it is likely that research into the discounting issue would quickly expend project funds best put to other uses. We feel very strongly that cost-benefit analysts should be aware of and familiar with the nuances of discounting, but at the same time the research program – the actual CBA – is not the place for further research aimed at finding the true social discount rate."

In comparing discount rates used by different countries, it is important to bear in mind the specific economic circumstances prevailing in different countries, and the availability of capital resources for investment. These circumstances will not only have implications for the real cost of capital, but will also influence the absolute amount that is available for investment, i.e. the type and number of projects that can be financed from available resources.

Since the last update of the CBA manual in 2002, South Africa's gross domestic saving-to-GDP ratio has deteriorated from 15.8% in 2000, to 13.7% in 2005. As such, given the tighter capital supply situation, the inclination should be to increase the real discount rate rather than to lower it. Given the substantial increase in public sector infrastructural spending that is anticipated over the 2006 to 2020 period, there will be substantial pressure on capital resources, and the selection of projects in the public sector should be determined by those projects that deliver the best real return-on-investment.

[24] Sassone PG & Schaffer WA. 1978. *Cost-Benefit Analysis. A Handbook*. Academic Press, Inc. p 127.

6.2.1 Current international developments

According to Kirkpatrick and Weiss[25] "…in a 1967 White Paper (Cmnd 3437) it was recommended that publicly owned industries in the UK should use a test rate of discount of 8 percent in their appraisal of all important projects". In 1968 that rate was increased to 10 percent. In 1978 the social rate of discount was reduced to 5 percent, referred to as the required rate of return. However, in 1988 it was again increased to 8 percent. The most recent recommended real discount rate in the UK is 3.5% across all departments[26].

The New Zealand Treasury uses a 10% real discount rate whenever there is no agreed sector discount rate. There is no prescription from the New Zealand Cabinet Office that the 10% must be used, but if not used, CBAs should "…identify and detail the discount rate used and its derivation." [27]

In the USA, a more tailored approach is presently (2006) being followed by evaluating external government investment at 7% while internal investments are valued at the rate of treasury bonds (4.8%)[28].

As will be discussed later, the discount rates quoted above are well above the theoretical discount rates calculated by using the underlying theory of the long-term real interest rate (i.e. the cost of funding to the State), and the social time preference rate (STPR).

In South Africa, an 8% real discount rate was recommended in the original CBA manual dated August 1998. This rate was retained in the updated CBA manual published in 2002[29]. It is important to note that this 8% rate conforms to the discount rate recommended by major international development institutions such as the World Bank that, in the recent past, has used a rate as high as 10 percent.

6.2.2 Methods of estimating the discount rate

Although the STPR is very difficult to determine, this has not stopped some analysts attempting empirical estimates. According to Kirkpatrick and Weiss (1996) [30] "…..such estimates are normally in the 1 percent to 5 percent range, since per capita consumption growth will rarely exceed 3 percent annually and the conventional estimates of the elasticity of the marginal utility of consumption are typically between 1.0 and 1.5". Walshe and Dafferen[31] calculate that the STPR is slightly in excess of the growth rate of an economy. Given that the long-term growth rate for South Africa is in the order of 2.5 to 5 percent, the STPR will be substantially lower than the 8 percent officially confirmed as the discount rate.

25 Kirkpatrick C and Weiss J. 1996. *Cost-Benefit Analysis and Project Appraisal in Developing Countries*. Edward Elgar Publishing Limited. pp 81-82.

26 HM Treasury. 2003, The Green Book: Appraisal and Evaluation in Central Government. London: HM: Treasury.

27 Young, L.September 2002, *Determining the Discount Rate for Government Projects*, The Treasury, New Zealand. Rawa.

28 Newell, R and Pizer,W. 2001. *Discounting the Benefits of Climate Change Mitigation*, Economics – Technical Series, Arlington, VA.

29 Water Research Commission. 2002. A Manual for Cost Benefit Analysis in South Africa with Special Reference to Water Resource Development. Conningarth Economists

30 Kirkpatrick and Weiss. 1996. Ibid. p 11.

31 Walshe G and Daffern P. 1990. *Managing Cost-Benefit Analysis*. Published by Macmillan Education Ltd. P 26

Apart from the theoretical approach to determining social discount rates such as the real long term interest rate and the STPR, countries also base their social discount rate on the principles that underpin the Capital Asset Pricing Model (CAPM), which aims to determine a yield that is equivalent to the rate of a risk free investment (i.e. government bonds), plus a risk premium and a relative volatility factor attached to projects in the private sector. The CAPM can also contain a beta coefficient captures systemic, or market-related, risk, which will marginally alter the real risk premium. The discount rate determined by the CAPM can also be seen as the social opportunity cost of investing in the public sector versus an alternative investment in the private sector, where returns are determined by market forces.

The CAPM provides an expected return that is equal to a risk-free yield, plus a market-related risk premium. The difference between the expected yield on a benchmark investment in the private sector, and the yield on a risk-free investment is the market risk-premium.

The annual yield on Government Bonds, which attract the minimum risk, can be obtained from the Government Bond Index of South Africa, as published by the Reserve Bank, and can be used as a proxy for the return on a risk-free investment. The JSE All Share Index can be used as a market-related benchmark investment.

An investment in (risk free) Government Bonds generated an average annual real yield of 3.2% from 1980 to 2005. Over the same time period, an all-share investment on the JSE rendered an average annual real yield of 9.5%. This implies an average real risk premium of about 6.1%, which is on the high side.

E.F. Brigham and L.C. Gapenski[32] calculate a real market interest rate in a similar way to that described by the CAPM, but that includes a liquidity premium and a maturity premium over and above the 9.5%. These premiums can be anywhere between 2% and 4%, which implies that the current official 8% real discount rate is probably not too high, and could even be higher.

6.2.3 Proposed discount rate

Taking into account the international discount rate benchmarks and the marginal return on capital approach, the current 8% discount rate applicable in South Africa still seems to be appropriate, and possibly even generous.

Given the low domestic savings in South Africa, and the abundance of savings (capital) in capital exporting countries, the real discount rate in South Africa is relatively low. Both the real interest rate and the STPR are well below 8%, and do not reflect South Africa's true shortage of investment capital and, therefore, the premium on using capital resources more productively. At present, gross domestic investment in South Africa was at a level of only 17% of GDP in 2005. In order to attain a more appropriate level of investment of 25% of GDP that will be able to support a sustainable growth of 6%, it will be necessary to use scarce capital resources productively.

Since the type of technology used will also be strongly influenced by the choice of a social discount rate, sensitivity analyses should also be carried out in respect of other discount rates, and the results presented to decision-makers. In this regard, it is recommended that discount

[32] Brigham E & Gapenski L. 1990. Financial Management – Theory and Practice. Fifth edition. The Dryden Press.

rates of between 6 and 10 are used, with 8% being used as the base discount rate. In general, experience shows that lower discount rates tend to promote more capital intensive production methods.

6.2.4 Discount rate for environmental purposes

The discount rate has received renewed attention as part of a revived debate on discounting, stimulated in recent years by the issue of how to handle long-term environmental effects. According to Kirkpatrick and Weiss "…. it seems counter-intuitive if what everyone can agree are serious long-run environmental effects are discounted to insignificance by the application of conventional rates of 10% to 12%".

Weitzman (2001)[33] proposed a new theoretical approach to resolving the dilemma of a discount rate for resources that are not replaceable by the proceeds of economic growth. According to him "……society should be using effective discount rates that decline from a mean value of, say, around 4 percent per annum for the immediate future, down to around zero for the far-distant future". Groom (2005)[34] are also in favour of a "…discount rate which declines with time according to some predetermined trajectory, thus raising the weight attached to the welfare of future generations…..and contribute to the goal of sustainable development."

In view of the contrasting views by economists regarding the discount rate that should be used for environmental projects and for other social and industrial projects, it is proposed that environmental projects in South Africa should be discounted at the official discount rate of 8%, and that this base rate should be further tested against much lower rates as well. Once again, these differing results should be disclosed to the policy maker.

6.3 Shadow Prices for Labour Inputs

As was discussed under the heading of shadow prices for labour (Paragraph 2.4.3), it is highly probable that the price of labour will deviate from the marginal product of labour, and, as such, shadow prices for labour should be used to determine the correct impact of labour utilisation.

6.3.1 Unskilled labour

The full employment basis for the pricing of labour is the market price of labour for all workers. Where unemployment does exist, shadow wages are estimated for unskilled, and in some instances, semi-skilled workers. Professionals, managers and skilled labour should be valued at market prices, even where unemployment exists. The principles that apply to the determination of shadow wages are set out in detail in Paragraph 2.4.3.

The methodology used for the calculation of shadow wages for unskilled workers is discussed in Box 1.

[33] Weitzman ML. 2000. Gamma discounting, The American Economic Review. March 2001.

[34] Groom,G., Hepburn C., Koundouri P. and Pearce D. 2005. *Declining Discount Rates: The Long and the Short of It*. Environmental & Resource Economics.

Box 1

The wage rate of unskilled labour used in this study was obtained from the Labour Force Survey (LFS) 2003. The survey is compiled bi-annually by Statistics South Africa, however, specific tables are not published by Statistics South Africa, which means that they need to be compiled from the original data, and transformed and aggregated into the correct format.

Nine occupational groups are provided in the survey. In order to obtain a wage rate for unskilled labour, the group entitled "elementary occupation" was utilised. As labour wages were in 2003 prices, they were converted to 2006 prices, with the remuneration-per-worker in the non-agricultural sector published in the June 2006 Reserve Bank Bulletin being used for this purpose. The index of 149.3 for the first quarter of 2006 was divided by the index of 117.8 for 2003 to obtain a wage inflator, which was applied to the 2003 to obtain wage levels in 2006 prices.

In principle, the shadow price for unskilled labourers is equal to the per-capita income in urban and non-urban areas in the various provinces, with the per-capita income of labourers being viewed as the economic value of labour. This shadow price is used as a proxy of labour's opportunity cost, i.e. the value of production lost to the economy when labour moves from an existing job to a newly created job, or from an unemployed situation to a new job.

Table 10 reflects the weekly, monthly and annual market wages for unskilled labourers by province. These shadow wages are used only where unemployment exists, and the skill levels of workers are low. If the workers for a project cannot be limited to a specific province, then the relevant national figure should be used. If sufficient information cannot be found, unemployment amongst workers involved should be viewed as insignificant. However, it should be borne in mind that unemployment amongst unskilled workers was endemic in all provinces in 2006.

For practical purposes, it is sometimes useful to work with a shadow wage rate factor, and not with nominal wage rates as such. To calculate such a factor, it is necessary to select an appropriate wage for unskilled labourers being paid in the South African economy. The entry level wage for public servants was selected for this purpose. According to the Public Servants Association of South Africa (PSA)[35], this wage amounted to R2 993 per month in July 2006, including a 13th cheque, but excluding all service benefits as there are pre-requisites for qualifying for such benefits. The entry level of R2 993 is obviously in line with the minimum wages of most trade unions as it is supplied by PSA.

Table 6.1(a) reflects the factors for adjustment of the market wage rate for unskilled labourers per province. In view of the low monetary wages paid to agricultural and forestry workers, the factors in Table 10(a) are too low, and lead to an underestimation of the shadow wage rate in such cases where existing remuneration is being used as the point of departure. However, as a result of the high unemployment levels, such an underestimation of the economic value of wages can probably be tolerated.

[35] Official reply by Btwampe, J. dated 25 October 2006.

6.3.1.1 Skilled labour

As mentioned above, professionals, managers and skilled labour should be valued at market prices even where unemployment exists. However, for purposes of completeness and convenience the relevant remuneration for these categories are given to assist users of this manual. The methodology used for the relevant calculations is given in Box 2.

Box 2

The wage rate of skilled labour was obtained from the Labour Force Survey (LFS) 2003. Nine occupation groups were given in the survey:

1. Legislators, senior officials and managers
2. Professionals
3. Technicians
4. Office clerks
5. Service, shop and market sales
6. Skilled agriculture and fishing
7. Crafts and related trades
8. Plant and machine operators
9. Elementary occupations

The first 8 groups were used as they were seen to be skilled and semi-skilled, with elementary occupations being deemed to be unskilled. The same process used to inflate wage rates for unskilled labour from 2003 to 2006 was utilised to inflate the wage rates for skilled labour

Table 11 provides the estimated remuneration for the 8 occupational categories that make up skilled labour.

6.4 Foreign Exchange

The shadow price of the real effective exchange rate of the Rand (i.e. the weighted average exchange rate of the Rand against the currencies of the RSA's most important trading partners, taking into account inflation differentials) is given in Table 12. The methodology for determining the relevant rate is explained in Box 3.

Box 3

A historical series of the real effective exchange rate of the Rand from 1990 to 2005 was obtained from the South African Reserve Bank (SARB), with 2000 being used as the base year. This series was converted so that 2005 becomes the base year, and a long-term (1990-2006) time series and trend analysis was applied to the data in order to determine a long-term estimate of the direction of the real effective exchange rate of the Rand.

The long-term trend of the real effective exchange rate was then used to estimate the real effective exchange rate up to the year 2025. The trend that best fits the series implies a regressive depreciation of the real effective Rand over the long-term, which translates into an average depreciation of 1.67% per annum from 2007 to 2025, and then remains constant, as shown in Table 12.

Given the various explanatory variables (i.e. time, politics, international commodity prices, international capital flows, etc.) that play a role in influencing the exchange value of the Rand, the Rand remains volatile. The reason for this is that developments related to the variables mentioned above are unpredictable over the medium- to long-term.

The Current Account Balance of the Balance of Payments, but, more so, the movements on the Financial Account of the Balance of Payments, tend to have a profound impact on the Rand as financial flows not only reflect the investor mood, but also sentiments towards South Africa. This long term trend, nevertheless, captures the major impacts on the Rand, i.e. that of import and export volumes, forex market perceptions, foreign financial flows, the exchange value of the currencies of South Africa's most important trading partners, and inflation differentials between South Africa and its trading partners.

It is accepted that currencies in Southern Africa that are on par with the Rand will follow the same trend as the effective real exchange rate of the Rand. As such, the shadow price for foreign currencies also applies to projects in Swaziland and Lesotho.

6.5 Goods and Services (Excluding Fuel and Electricity)

The underlying principles for the valuation of inputs and outputs have been discussed in Paragraph 2.4.2. In this regard the following guidelines are provided:

(i) The opportunity costs of agricultural products traded internationally are indicated by commodity prices on world markets, as given in International Financial Statistics[36], which as issued monthly by the International Monetary Fund. For restricted imports that require permits, and to which import duties and surcharges are applied, reference is made to the Customs Tariff Book issued by Jacobsons Publishers (Pty) Limited[37]. This data is also available from Cargo Info Africa[38].

(ii) Details of goods on which excise and other domestic taxes are payable are given in the schedule to the Customs and Excise Act. As a result of ongoing adjustments made in

[36] International Financial Statistics, IMF, Washington DC.
[37] Jacobsons Publishers (Pty) Ltd., Durban.
[38] http://rapidttp.com/tariff/chpindx.html

the National Budget of the Department of Finance, it is necessary to ensure that the most recent information is obtained from the relevant Departments.

Details of goods on which VAT (Value Added Tax) is payable can be obtained from the Receiver of Revenue. An extract from the SARS publication "VAT 404- VAT Guide for Vendors" [39], March 2004, that explains the various VAT levels for businesses is provided in Box 4.

Box 4

TAXABLE SUPPLIES

A taxable supply is any supply of goods or services by a vendor in the course of furtherance of an enterprise. Tax is charged at one of the following rates:

– Standard rate, currently 14%
– Zero-rate (i.e. 0%)

Standard rated supplies

As a general rule, all goods and services are standard rated unless specifically zero-rated or exempt.

Standard rated supplies are taxable supplies, taxed at the rate of 14%. These include the supply of both goods and services that are not taxed at the rate of 0%, or exempt. Some examples of standard rated supplies are the supply of :

- aircraft fuel
- books and newspapers
- building materials and services
- business assets sold
- cigarettes, cool drinks and liquor
- white bread
- electricity, water and refuse removals
- clothing -
- furniture
- hotel accommodation
- meat or fish
- lawyer's services
- medicines
- local aeroplane flights
- medical services (other than by State hospitals)
- transport of goods
- motor repairs
- motor vehicles and spares
- paraffin (excluding illuminating kerosene)
- postage stamps
- telephone services
- restaurant services

[39] South African Revenue Service. April 2004. *VAT 204 – VAT Guide for Vendors*.

- washing powder
- entrance fees to sporting events

Zero-rated supplies

Zero-rated supplies are taxable supplies, taxed at a rate of 0%. These include:

- certain foodstuffs (except when sold as a meal or refreshment)

– brown bread
– dried mealies
– brown bread flour excl. bran
– samp
– eggs
– fresh/frozen fruit and vegetables
– maize meal
– dried beans
– lentils
– pilchards in tins or cans
– rice
– vegetable oil excluding olive oil
– milk, cultured milk, milk powder and dairy powder blend
– edible legumes and pulses of leguminous plants
– illuminating kerosene

- fuel levy goods (e.g. petrol and diesel)
- sale of a business or part of a business as a going concern (if in writing and meeting certain requirements).
- certain services provided to foreign residents and businesses – provided goods are temporarily imported for modification, service or repair and the importer furnishes you with a VAT 262 form which has been completed and certified by the Controller of Customs
- direct exports (See Chapter 10 of VAT 404 VAT Guide for Vendors)

DEEMED SUPPLIES

As a registered vendor, you may sometimes be required to pay output tax even though you have not supplied any goods or services. These are called deemed supplies.

Circumstances that will give rise to deemed taxable supplies include the following:

– goods/services taken for own use
– certain fringe benefits to staff
– assets retained at the time of deregistering as a vendor
– Short-term insurance claims that have been paid to you in respect of your business (e.g. insurance payout received for damaged stock.
– subsidies or grants received from the State
– goods acquired under an instalment credit agreement that have been repossessed from you

EXEMPT SUPPLIES

Exempt supplies are supplies of goods or services on which VAT is not chargeable at either the standard rate or the zero-rate and do not form part of your taxable turnover. If you make only exempt supplies, you may not register as a vendor for VAT purposes. VAT incurred on any expenses in order to make exempt supplies may not be claimed as an input tax credit.

Exempt supplies include the following:

- financial services (interest, life insurance, medical schemes, provident, pension and retirement annuity funds)
- donated goods or services sold by non-profit bodies (e.g. church bazaars)
- renting a dwelling for use as a private home (but not holiday accommodation)
- passenger transport in South Africa by taxi, bus or train
- educational services (creches, primary and secondary schools, universities, technikons and other institutions registered under an educational Act.)

(iii) The prices of services provided by Transnet and the Post Office are determined administratively. Since the prices of many of Transnet's services are supposed to be market-related, and the new national transport policy in the RSA allows for free competition between the different modes of transport, the difference between market-determined and controlled prices for land transport should gradually disappear. Therefore, as the public transport component of most projects is fairly small, it is doubtful whether the calculation of shadow prices for this purpose is necessary. It may, however, be important where the transport content of a project is high, or where a decision has to be made concerning the establishment of transport infrastructure.

(iv) The same approach should be adopted in respect of services delivered by the Post and Telecommunication services.

6.6 Shadow Fuel Prices

The shadow price of fuel is the pump price of fuel, minus levies and taxes that do not directly benefit the fuel consumer. As such, taxes that can be viewed as consumer levies on roads are included, while other general fuel taxes that are used to the benefit of other general public services are excluded.

The shadow price of farm diesel differs from the shadow price of diesel for road transport in that the user levies for roads and vehicle accident insurance are excluded. The diesel rebate for farmers includes the refund on diesel for farming purposes.

The shadow price of diesel used for construction purposes differs from the road transport diesel price in that the construction diesel price excludes the Road Accident Fund (RAF) levy and government expenditure on roads.

General government (including national, provincial and local tiers of government) recurrent expenditure on roads includes spending on road maintenance, traffic management and road safety. Dividing the above mentioned recurrent expenditure on existing roads with the volume

of fuel consumed by road traffic users reflects the spending-per-litre of fuel consumed, which is about 25 cents per litre.

The composition of the pump price of diesel and petrol was obtained from the Department of Minerals and Energy in Pretoria[40].

The calculated shadow prices for petrol and diesel must further be adjusted for transport costs according to magisterial districts. Table 13 provides shadow prices for the various types of fuel in price zone 9C, Gauteng. In order to calculate shadow prices for the other provinces, a transport adjustment factor must be calculated according to magisterial district. Table 14 provides a list of these adjustment factors. In Table 6.5, the Gauteng zone 9C forms the cut-off point. The magisterial districts and the zones in which they appear, are indicated in Appendix 2.

Table 6.6 can be used for estimating fuel prices in future. This index is based on the projection for crude oil prices from 2005 to 2025, as well as a perspective on the real effective exchange rate of the Rand, as reflected in Table 15. All other costs that are part of the pump price of fuel remain constant.

6.7 Electricity Prices

Eskom's tariffs are based in part on historical costs, and hence do not necessarily fully reflect the opportunity cost that is entailed in providing electricity to users. Consequently, it is necessary to calculate a shadow price for electricity.

Electricity tariffs are comprised of generation, transmission and distribution costs. Currently, demand and supply are in close match, however, future user demand for electricity is expected to increase significantly, with the result that it is imperative that new electricity generation plants will have to be constructed, which will cause an increase in generation costs.

In view of the envisaged expansion by Eskom (the main supplier of electricity in South Africa) over the next five years (i.e. 2006 to 2011), projections of the relative price movements for electricity will have to be made. Eskom's 2006 annual report envisages that R97 billion will be invested in additional capacity. An estimation of the probable real (above inflation) tariff increases for electricity that will be required to service and repay these capital outlays over twenty years implies real increases in Eskom's tariffs. Eskom has already announced that real tariffs from 2006 to 2008 will increase by 1% per annum. It is estimated that real tariffs will have to increase by a further 2.9% per year from 2009 to 2025, and that these increases must be included in the shadow price of electricity.

Table 16 provides the estimated relative real tariff movements of the generation and distribution of electricity in the form of an index. This index should be applied to the existing electricity tariff over the period of the project being evaluated in order to make provision for changes in relative movements in electricity tariffs. In the relevant calculations, provision has been made so that only generation costs will increase. Therefore, the index in Table 16 should be applied to total electricity costs.

[40] Department of Minerals and Energy, Press Release, 29 September 2006, Pretoria.

6.8 Surrogate Prices

6.8.1 Value of time

Table 17 provides an estimate of the value of time per working and recreational hour for low, middle and high income groups in each province, as well as the value of time for all workers, expressed in 2006 prices. The relevant methodology is discussed in Box 5.

Box 5

- The average provincial annual remuneration for 9 occupational categories (see Table 11) served as the basis for the calculations for Table 17. The figures for these 9 categories were aggregated to represent high, middle and low remuneration groups, with "legislators, senior officials, managers" and "professionals" being classified in the high income group, whereas the "elementary occupations" was assumed to represent the low income groups. The remaining categories were then aggregated to form the middle income group.

- The value of a working hour per income group in each province (see column 1 in Table 17) was obtained by dividing the average for a specific income group by the total number of working hours for that group per annum. The total number of working hours per year was calculated as the product of the total number of weeks (52), and the average number of working hours per week (40). The result was 2 080 hours, which was rounded off to 2 000 hours in order to take into account that not all workers are fully employed on a yearly basis.

- The value of a recreational hour for workers per income group per province was calculated as the value of a working hour per income group, divided by the total number of hours per annum, i.e. 365.25 days times 24 hours, which equals 8 766 hours.

- In order to calculate the provincial value of a recreational hour for all persons (see column 2 of Table 17), a dependency ratio per income group in each province was required. The first Labour Force Survey (LFS 1) of 2006 provides the basic information from which a dependency ratio per province for the total population could be calculated. This dependency ratio was then used as a control. The methodology for obtaining the dependency ratios per income group is explained below. As the same method was followed for each province, only the method for the Western Cape Province will be explained.

- Census 2001 provides, on a race basis, the number of people working in each occupational group in each province, as well as the total population per race group per province. By dividing the total population (per race group) in the Western Cape by the total number of employed individuals (per race group) in the province, the dependency ration per race group was obtained.

- From the Census 2001, the number of people employed in each occupation could be aggregated into a high medium and low income category as follows.

1) High income category: legislators, managers, and professionals except teaching professionals, teaching associate professionals and life science and health associate professionals.
2) Low income category: Extraction and building trade workers; subsistence agriculture and fishery workers; sales and services elementary occupations; agricultural, fishery and related labourers; mining, construction, manufacturing and transport labourers.
3) Middle income category: The rest of the occupation categories fell into the middle income group.

The percentage distribution of black, coloured, Indian and white was obtained across the three income groups. The dependency ration calculated per race group was multiplied with the equivalent race group's distribution per income level to arrive at a weighted dependency ratio for each income level. This calculated distribution was then adjusted so the total added up to the dependency ratio calculated from the "Labour Force Survey". The dependency ratio for the Western Cape is illustrated below.

	Dependency ratio
Low	2.64
Medium	2.47
High	2.21

The value of a recreational hour for all persons was then obtained by dividing the value of a recreational hour for workers in each income group by the relevant dependency ratio per income group. As mentioned above this process was then repeated for each province, and for South Africa as a whole.

For forecasting purposes, the values in Table 17 should be viewed as constant real values. The value of time for recreation is only used if time saved or lost could include the productivity of workers, irrespective of the fact that it is not in working time. An example of this is the time a worker spends in travelling to or from work. In all the other instances, the price of workers' time for recreation is the same as the time for recreation for all persons.

6.8.2 Input data for the economic evaluation of road infrastructure projects and cost of collisions

Road vehicle running cost, the cost of travel time and the cost of road collisions are critical input variables in determining the economic feasibility of proposed investments in road infrastructure. In this regard, a useful tool is the Highway Development and Management (HDM-4) software that was developed in the late 1960s under the auspices of the World Bank, which has been constantly improved and expanded since. It is currently being managed by HDM Global.

According to McPherson and Bennett (p39)[41], "HDM-4 is a tool for economic optimisation of maintenance of road networks and has been adopted or applied in many different countries for economic analysis and prioritisation. HDM-4 can operate with Strategy, Program and Project analysis. It utilises road network inventory and condition data, traffic data, and economic data to feed a series of road deterioration models and cost models, and to formulate candidate work

[41] McPherson, Kevin and Bennett, Christopher, R, 2005. Success factors for Road Managmeent Systems. East Asia Pacific Transport Unit, the World Bank, Washington DC.

programs for road networks." The focus and scope of the strategy analysis, the programme analysis and the project analysis are described in Box 6 below.

Box 6

Strategy analysis:

Typical examples of strategy analysis by road agencies would include the following:

- "Medium to long term forecasts of funding requirements for specified target road maintenance standards.
- Forecasts of long term road network performance under varying levels of funding.
- Optimal allocation of funds according to defined budget heads; for example routine maintenance, periodic maintenance and development (capital) budgets.
- Optimal allocations of funds to sub-networks; for example by functional road class (main, feeder and urban roads, etc.) or by administrative region.
- Policy studies such as impact of changes to the axle load limit, pavement maintenance standards, energy balance analysis, provision of NMT facilities, sustainable road network size, evaluation of pavement design standards, etc." (Kerali, p13-14).

Programme analysis:

Programme analysis "… deals primarily with the prioritisation of a defined long list of candidate road projects into a one-year or multi-year work programme under defined budget constraints" (Kerali, p17[42]).

Project analysis:

Project analysis deals with the "…evaluation of one or more road projects or investment options. The application analyses a road link or section with user-selected treatments, with associated costs and benefits, projected annually over the analysis period. Economic indicators are determined for the different investment options" (Kerali, p19). Projects may typically include "…the maintenance and rehabilitation of existing roads, widening or geometric improvement schemes, pavement upgrading and new construction" (Kerali, p19).

HDM-4 is increasingly being used internationally as the preferred tool for road project evaluation in both developing and developed countries. It contains all of the required datasets needed to perform an analysis. It is, however, important that datasets should be calibrated first to local (South African) conditions so as to ensure reliable results.

For low volume road projects, the World Bank's RED (Roads Economic Decision) model (using many of the relationships of HDM-4) can be used. As with HDM-4, datasets in RED must first be calibrated to South African conditions.

[42] Kerali, Henry, G.R., 2000. Overview of HDM-4, Volume 1. The World Road Association (PIARC), Paris.

6.8.3 Economic value of a life in terms of future productive potential

Table 18 provides estimates of the economic value of a human life for different income groups in terms of their future productive potential based on their future wealth per annum, and on remaining life expectancy. The table provides the value of a human life per annum, as well as the capitalised value of the expected remaining lifetime for the relevant person. This is calculated by discounting the wealth per annum by 8% over the remaining lifetime. The relevant methodology is explained in Box 7.

Box 7

The economic value of a human life in terms of future productive potential consists of the annual wealth, and the relevant person's remaining life expectancy. The economic life is calculated by discounting the economic value over the remaining life expectancy by using an 8% discount rate.

Life expectancies derived from the 1996 Life Tables

	NPV 8%	***Total***	***Year 1***	***Year 2***	***Year 3***
Low income person	R36 184	R89 280	R2 967	R2 976	R2 976
Medium income person	R126 980	R313 315	R10 444	R10 444	R10 444
High income person	R517 838	R1 309 616	R42 246	R42 246	R42 246
Average	R170 375	R420 387	R14 013	R14 013	R14 013
Total	R2 132 599	R2 132 599	R69 678	R69 678	R69 678

Annual wealth is based on the value per recreational hour for all persons in Table 6.8. In order to express this value on an annual basis, it is multiplied by 8 766 hours (365.25 days per annum, multiplied by 24 hours per day)

In order to capitalise this wealth value over the expected remainder of a life it is necessary to calculate the remaining lifetimes in the three income categories. The basis for the life expectancy per income group is the life expectancy per population group as published by the SSA in Report No. 02-06-04: p. vi.

Table A: Life expectancies at birth as derived from the 1985-1994 life tables.

Population Group	***Male***	***Female***
RSA	54,12	65,38
African	52,51	64,62
Coloured	57,36	65,02
Indian/Asian	60,95	68,90
White	65,22	73,08
Other and unspecified	59,75	66,04

However, the above figures must be adjusted to make provision for the possibility that the relevant life expectancies are probably lower as a result of the impact of Aids. This was done by making an adjustment for the levels of completeness of death registration for South Africa.

The pessimistic SSA view of 50% of the levels of completeness of death registration was used to take the impact of Aids into account. This resulted in somewhat scaled down life

expectancies. In addition, it is necessary to weigh in the male and female life expectancies using the male/female ratios for each population group. The results are as follows:

	Average life Expectancy
Africans	53.91
Coloureds	61.31
Indians	65.01
Whites	69.25
Other	62.95

The 2006 age levels per population group were calculated by using the SSA report no. P0302 (2006) titled "Mid-year Population Estimates, South Africa 2006".

	Average life Expectancy
Africans	25.24
Coloureds	28.31
Indians	31.22
Whites	38.14

In order to calculate the remaining life period for these population groups, the difference between the average life expectancy and the 2006 age structure was calculated. The results are as follows:

	Average life Expectancy
Africans	28.67
Coloureds	32.99
Indians	33.79
Whites	31.11

For the purposes of this CBA Manual, it was necessary to convert the results for the population groups to income groups. The population per income group was already available from the value of time workings.

The source for this information was the Census 2001, where the population per occupation was given. As explained under the value of time, the occupational groups were aggregated to get the low, medium and high income groups.

This information was used, in the form of weights, to convert the life expectancies from population groups to income categories. The remaining life period for the various income groups are as follows:

	High	***Medium***	***Low***
Expected Economic lifetime	30.74	29.92	29.55

If a specific age category is used, e.g. children or the aged, the remaining expected life in years should be used for purposes of calculating the relevant capitalised wealth.

The value reflected here is merely an indication of the economic value in terms of future productive potential of a person, and is an indication of the real value of human life in South Africa society. When human lives are under discussion, the number of lives involved should

be pointed out in addition to the economic value of a life. This is essential to give the decision-maker a complete picture of the implications of his/her proposed decision so far as it relates to the preservation and protection of human lives.

Table 10: Estimated Remuneration for Unskilled Labourers per Province [Rands]

	Market wage in 2006 prices[1)]					
Provinces	***WEEK***		***MONTH***		***YEAR***	
	Urban	***Non-urban***	***Urban***	***Non-urban***	***Urban***	***Non-urban***
Western Cape	375	251	1,501	1,004	18,017	12,053
Eastern Cape	248	165	993	662	11,914	7,939
Northern Cape	357	219	1,427	878	17,121	10,531
Free State	220	171	880	682	10,562	8,184
KwaZulu-Natal	285	190	1,139	759	13,667	9,114
North West	293	225	1,174	899	14,083	10,786
Gauteng	357	289	1,426	1,155	17,113	13,864
Mpumalanga	236	224	945	894	11,335	10,734
Limpopo	316	190	1,263	761	15,156	9,138
Total	299	214	1,194	855	14,330	10,260

1) Whenever another base year is used, the above figures must be adjusted using the index for labour costs in the non-agricultural sectors, contained in the Reserve Bank Bulletin.

2) When using wages for unskilled labour the wages in table 10 should be adjusted by the shadow factor in Table 10(a).

Table 10(a): Factors for Adjustment of the Market Wage Rate for Unskilled Labourers per Province [Rands]

Provinces		
	Urban	**Non-urban**
Eastern Cape	0.70	0.46
Free State	0.62	0.48
Gauteng	1.00	0.81
KwaZulu-Natal	0.80	0.53
Mpumalanga	0.66	0.63
Northern Cape	1.00	0.62
Northern Province	0.89	0.53
North West	0.82	0.63
Western Cape	1.00	0.70

Table 11: Estimated Annual Remuneration for Occupational Categories in South Africa per Province [Rands, 2006 Prices]

	Western Cape	*Eastern Cape*	*Northern Cape*	*Free State*	*KwaZulu-Natal*	*North West*	*Gauteng*	*Mpumalanga*	*Limpopo*
Legislators, senior officials & managers	121,430	65,569	82,202	79,765	239,102	78,387	248,031	156,865	102,269
Professionals	98,750	76,952	102,426	74,523	103,544	91,206	187,327	86,257	113,923
Technicians	78,487	58,280	68,050	55,397	57,975	57,265	78,930	68,055	73,399
Office clerks	40,992	41,330	41,544	44,313	39,713	38,160	53,779	41,893	45,373
Service, shop & market sales	28,572	17,333	33,971	24,325	24,736	30,100	32,484	24,450	17,845
Skilled agricultural and fishing	33,740	12,193	97,370	37,014	12,345	39,902	48,467	34,130	27,890
Crafts & related trades	29,693	14,490	35,839	24,943	27,025	33,662	43,199	36,277	23,979
Plant & machine operators	30,205	24,800	38,615	19,498	28,830	29,180	31,425	31,247	25,733
Elementary occupations	15,854	9,282	12,942	9,418	11,437	11,918	16,841	11,355	9,996

Table 12: Index of Projected Real Effective Exchange Rate of the Rand

Year	*Foreign Exchange Index*
2005	100.00
2006	87.60
2007	86.14
2008	84.71
2009	83.29
2010	81.91
2011	80.54
2012	79.20
2013	77.88
2014	76.58
2015	75.31
2016	74.05
2017	72.82
2018	71.61
2019	70.41
2020	69.24
2021	68.09
2022	66.95
2023	65.84
2024	64.74
2025 and beyond	63.66

Table 13: Shadow Price in Cent for Petrol and Diesel on 4 October 2006 for Gauteng Zone 9C

Components	Petrol 93 ULP	Diesel Price		
		Road Transport	Construction	On-Farm Use
Pump price	606.00	638.00	638.00	638.00
Minus: Total taxes and levys included in pump price	156.50	140.50	140.50	180.50
- Fuel taxes	116.00	100.00	100.00	100.00
- Custom and excise	4.00	4.00	4.00	4.00
- Farming rebate*	0.00	0.00	0.00	76.50
- RAF (road accident fund) levy	36.50	36.50	36.50	0.00
Plus: Road related taxes and levys	69.03	79.13	0.00	0.00
- RAF	43.80	43.80	0.00	0.00
- Expenditure on roads	25.23	35.33	0.00	0.00
	0.00	0.00	0.00	0.00
Shadow price	518.53	576.63	497.50	457.50
Shadow factor	0.86	0.90	0.78	0.72

Source: Department of Minerals and Energy
(*) Farming rebate covers refund of RAF

The RAF levy has been increased by 20% to make provision for the under funding of the RAF.

Expenditure on roads for road transport was increased by 30% to make provision for the non-proportional impact on roads by heavy vehicles.

Table 14: Transport Adjustments for the Calculation of Shadow Prices for Petrol and Diesel According to Magisterial Districts

Price in cents per litre (October 2006)													
Price Zone	*Lead replacement petrol*			*Adjustment in Cents*			*Unleaded petrol*		*Adjustments in cents*		*Diesel*		
											Wholesale Price		*Adjustment in cents*	
	91 Octane	*93 Octane*	*95 Octane*	*91*	*93*	*95*	*93 Octane*	*95 Octane*	*93*	*95*	*0.05% Sulphur*	*0.005% Sulphur*	*0.05% Sulphur*	*0.005% Sulphur*
1A	590	592	594	-14	-14	-24	592	594	-14	-14	581.5	582.9	-13.6	-13.6
2A	593	595	597	-11	-11	-21	595	597	-11	-11	584.5	585.9	-10.6	-10.6
3A	594	596	598	-10	-10	-20	596	598	-10	-10	585.6	587	-9.5	-9.5
4A	596	598	600	-8	-8	-18	598	600	-8	-8	587.7	589.1	-7.4	-7.4
5A	598	600	602	-6	-6	-16	600	602	-6	-6	589.7	591.1	-5.4	-5.4
6A	602	604	606	-2	-2	-12	604	606	-2	-2	593.5	594.9	-1.6	-1.6
7A	604	606	618	0	0	0	606	608	0	0	595.5	596.9	0.4	0.4
8A	607	609	621	3	3	3	609	611	3	3	598.4	599.8	3.3	3.3
9A	610	612	624	6	6	6	612	614	6	6	601.3	602.7	6.2	6.2
10A	612	614	626	8	8	8	614	616	8	8	604	605.4	8.9	8.9
11A	614	616	628	10	10	10	616	618	10	10	606	607.4	10.9	10.9
13A	620	622	634	16	16	16	622	624	16	16	611.2	612.6	16.1	16.1
15A	620	622	634	16	16	16	622	624	16	16	611.6	613	16.5	16.5
17A	621	623	635	17	17	17	623	625	17	17	612.8	614.2	17.7	17.7
19A	622	624	636	18	18	18	624	626	18	18	614	615.4	18.9	18.9
57A	604	606	608	0	0	-10	606	608	0	0	595.5	596.9	0.4	0.4
69A	622	624	626	18	18	8	624	626	18	18	614	615.4	18.9	18.9

Source: Department of Minerals and Energy, 2006, Press release, Pretoria

Table 14 (continue): Transport Adjustments for the Calculation of Shadow Prices for Petrol and Diesel according to Magisterial Districts

Price in cents per litre (October 2006)													
Price Zone	*Lead replacement petrol*			*Adjustment in Cents*			*Unleaded petrol*		*Adjustments in cents*		*Diesel*		
											Wholesale Price		*Adjustment in cents*	
	91 Octane	*93 Octane*	*95 Octane*	*91*	*93*	*95*	*93 Octane*	*95 Octane*	*93*	*95*	*0.05% Sulphur*	*0.005% Sulphur*	*0.05% Sulphur*	*0.005% Sulphur*
3B	599	601	603	-5	-5	-15	601	603	-5	-5	590.7	592.1	-4.4	-4.4
6B	600	602	604	-4	-4	-14	602	604	-4	-4	591.7	593.1	-3.4	-3.4
7B	604	606	608	0	0	-10	606	608	0	0	595.1	596.5	0	0
8B	606	608	610	2	2	-8	608	610	2	2	597.6	599	2.5	2.5
9B	607	609	611	3	3	-7	609	611	3	3	599	600.4	3.9	3.9
10B	610	612	614	6	6	-4	612	614	6	6	601.5	602.9	6.4	6.4
12B	612	614	616	8	8	-2	614	616	8	8	603.4	604.8	8.3	8.3
14B	615	617	619	11	11	1	617	619	11	11	606.6	608	11.5	11.5
3C	592	594	596	-12	-12	-22	594	596	-12	-12	583.3	584.7	-11.8	-11.8
4C	593	595	597	-11	-11	-21	595	597	-11	-11	584.8	586.2	-10.3	-10.3
5C	596	598	600	-8	-8	-18	598	600	-8	-8	587.8	589.2	-7.3	-7.3
6C	599	601	603	-5	-5	-15	601	603	-5	-5	591	592.4	-4.1	-4.1
7C	601	603	615	-3	-3	-3	603	605	-3	-3	592.5	593.9	-2.6	-2.6
8C	602	604	616	-2	-2	-2	604	606	-2	-2	593.8	595.2	-1.3	-1.3
9C	604	606	618	0	0	0	606	608	0	0	595.1	596.5	0	0
10C	611	613	625	7	7	7	613	615	7	7	602.5	603.9	7.4	7.4

Source: Department of Minerals and Energy, 2006, Press release, Pretoria

Table 14 (continue): Transport Adjustments for the Calculation of Shadow Prices for Petrol and Diesel According to Magisterial Districts

Price in cents per litre (October 2006)													
Price Zone	*Lead replacement petrol*			*Adjustment in Cents*			*Unleaded petrol*		*Adjustments in cents*		*Diesel*		
											Wholesale Price		*Adjustment in cents*	
	91 Octane	*93 Octane*	*95 Octane*	*91*	*93*	*95*	*93 Octane*	*95 Octane*	*93*	*95*	*0.05% Sulphur*	*0.005% Sulphur*	*0.05% Sulphur*	*0.005% Sulphur*
11C	615	617	629	11	11	11	617	619	11	11	606.3	607.7	11.2	11.2
12C	620	622	634	16	16	16	622	624	16	16	611.4	612.8	16.3	16.3
13C	622	624	636	18	18	18	624	626	18	18	613.2	614.6	18.1	18.1
14C	626	628	640	22	22	22	628	630	22	22	617.1	618.5	22	22
15C	626	628	640	22	22	22	628	630	22	22	617.1	618.5	22	22
16C	626	628	640	22	22	22	628	630	22	22	617.1	618.5	22	22
17C	626	628	640	22	22	22	628	630	22	22	617.1	619.1	22	22.6
57C	601	603	605	-3	-3	-13	603	605	-3	-3	592.5	593.9	-2.6	-2.6
58C	602	604	606	-2	-2	-12	604	606	-2	-2	593.8	595.2	-1.3	-1.3
60C	611	613	615	7	7	-3	613	615	7	7	602.5	603.9	7.4	7.4
61C	615	617	619	11	11	1	617	619	11	11	606.3	607.7	11.2	11.2
62C	620	622	624	16	16	6	622	624	16	16	611.4	612.8	16.3	16.3
63C	622	624	626	18	18	8	624	626	18	18	613.2	614.6	18.1	18.1
64C	626	628	630	22	22	12	628	630	22	22	617.1	618.5	22	22
67C	626	628	630	22	22	12	628	630	22	22	617.7	619.1	22.6	22.6
31J	620	622	624	16	16	6	622	624	16	16	611.1	612.5	16	16

Source: Department of Minerals and Energy, 2006, Press release, Pretoria

Table 14 (continue): Transport Adjustments for the Calculation of Shadow Prices for Petrol and Diesel According to Magisterial Districts

Price in cents per litre (October 2006)														
Price Zone	*Lead replacement petrol*			*Adjustment in Cents*			*Unleaded petrol*		*Adjustments in cents*		*Diesel*			
											Wholesale Price		*Adjustment in cents*	
	91 Octane	*93 Octane*	*95 Octane*	*91*	*93*	*95*	*93 Octane*	*95 Octane*	*93*	*95*	*0.05% Sulphur*	*0.005% Sulphur*	*0.05% Sulphur*	*0.005% Sulphur*
32J	628	630	632	24	24	14	630	632	24	24	620	621.4	24.9	24.9
33J	633	635	637	29	29	19	635	637	29	29	624.8	626.2	29.7	29.7
34J	633	635	637	29	29	19	635	637	29	29	624.8	626.2	29.7	29.7
35J	633	635	637	29	29	19	635	637	29	29	624.8	626.2	29.7	29.7
36J	629	631	633	25	25	15	631	633	25	25	620.9	622.3	25.8	25.8
37J	644	646	648	40	40	30	646	648	40	40	635.7	637.1	40.6	40.6

Source: Department of Minerals and Energy, 2006, Press release, Pretoria

Table 15: Index of Projected Prices for Petrol and Diesel (2005 = 100)

Year	*Real*		*Nominal **	
	Petrol 93 ULP	*Diesel*	*Petrol 93 ULP*	*Diesel*
2005	100	100	100	100
2006	111	112	117	118
2007	115	117	127	128
2008	120	121	139	140
2009	124	125	151	152
2010	129	130	164	166
2011	133	135	179	181
2012	138	140	195	196
2013	143	145	212	214
2014	148	150	230	232
2015	154	155	250	252
2016	158	160	271	274
2017	164	166	294	297
2018	170	171	320	323
2019	175	177	347	350
2020	181	183	377	380
2021	187	189	409	413
2022	193	195	443	448
2023	200	202	481	485
2024	206	208	521	526
2025	213	215	565	570
2025 and beyond	219	221	611	617

(*) Estimated CPIX inflation of 5% per annum.

Table 16: Index (2000 = 100) of Estimated Increase In Electricity Tariffs above CPIX Inflation

Year	*Shadow price index*
2005	*100*
2006	*101*
2007	*102*
2008	*103*
2009	*106*
2010	*109*
2011	*112*
2012	*115*
2013	*119*
2014	*122*
2015	*126*
2016	*129*
2017	*133*
2018	*137*
2019	*141*
2020	*145*
2021	*149*
2022	*154*
2023	*158*
2024	*163*
2025 and beyond	*167*

Table 17: Estimated Time Cost According to Income Groups in 2006 Prices

	1	2	3
Income group	***Value of a working hour (Rand)***	***Value per recreational hour for all persons (Rand)***	***Value of recreational hour for workers (Rand)***
Eastern Cape			
Low income group	4.64	0.23	1.06
Middle income group	14.04	0.77	3.20
High income group	35.63	2.76	8.13
Total population	17.79	0.94	4.06
Free State			
Low income group	4.71	0.27	1.07
Middle income group	17.12	1.05	3.91
High income group	38.57	2.86	8.80
Total population	20.51	1.23	4.68
Gauteng			
Low income group	8.42	0.65	1.92
Middle income group	24.02	1.99	5.48
High income group	108.84	10.71	24.83
Total population	41.14	3.38	9.39

Table 17 (continue): Estimated Time Cost According to Income Groups in 2006 Prices

	1	2	3
Income group	***Value of a working hour (Rand)***	***Value per recreational hour for all persons (Rand)***	***Value of recreational hour for workers (Rand)***
Kwazulu-Natal			
Low income group	5.72	0.27	1.30
Middle income group	15.89	0.88	3.62
High income group	85.66	6.69	19.54
Total population	30.26	1.56	6.90
Mpumalanga			
Low income group	5.68	0.31	1.30
Middle income group	19.67	1.13	4.49
High income group	60.78	4.38	13.87
Total population	27.25	1.54	6.22
Northern Cape			
Low income group	6.47	0.39	1.48
Middle income group	26.28	1.74	6.00
High income group	46.16	2.02	10.53
Total population	28.50	1.79	6.50

Table 17 (continue): Estimated Time Cost According to Income Groups in 2006 Prices

Income group	*Value of a working hour (Rand)*	*Value per recreational hour for all persons (Rand)*	*Value of recreational hour for workers (Rand)*
Limpopo			
Low income group	5.00	0.15	1.14
Middle income group	17.85	0.57	4.07
High income group	54.05	1.64	12.33
Total population	24.47	0.77	5.58
North West			
Low income group	5.96	0.30	1.36
Middle income group	19.02	1.00	4.34
High income group	42.40	2.58	9.67
Total population	22.77	1.19	5.19
Western Cape			
Low income group	7.93	0.68	1.81
Middle income group	20.14	1.86	4.60
High income group	55.04	5.68	12.56
Total population	26.54	2.37	6.06

Table 17 (continue): Estimated Time Cost According to Income Groups in 2006 Prices

Income group	*Value of a working hour (Rand)*	*Value per recreational hour for all persons (Rand)*	*Value of recreational hour for workers (Rand)*
GRAND TOTAL			
Low income group	6.06	0.34	1.38
Middle income group	19.34	1.19	4.41
High income group	58.57	4.82	13.36
Total population	26.58	1.60	6.06

* In terms of 2006 prices, a worker earns about :
R 0.00 - R 15854 in the low income category,
R 15855 - R 78487 in the middle income category and
R 78488 and more in the high income category.

** Remaining life expectancies of persons in the following income groups are as follows:

Low:	30.55	years
Middle:	30.92	years
High:	30.74	years
Average:	30.07	years

*** Whenever another base year is used, the above figures must be adjusted using to consumer price index.

Table 18: Economic Value of Life in 2006 prices (Rand)

Income group	*Value of a life per year*	*Discounted life-time value of an average person*
Low	2,976	89,280
	-	-
Middle	10,444	313,315
	-	-
High	42,246	1,309,616
	-	-
Average	14,013	420,387

* In terms of 2006 prices, a worker earns about :
R 0.00 - R 15854 in the low income category,
R 15855 - R 78487 in the middle income category and
R 78488 and more in the high income category.

** Remaining lifespan of persons in the following income groups are as follows:

Low:	30.55	years
Middle:	30.92	years
High:	30.74	years
Average:	30.07	years

*** Whenever another base year is used, the above figures must be adjusted using to consumer price index.

CHAPTER 7: ISSUES RELATING TO WATER RESOURCE DEVELOPMENT

In this chapter various issues relating to water resource development will be discussed. In most cases the discussions should only be viewed as guidelines to address a problem and not as prescribed rules for CBA.

7.1 Issues Relating to the Cost of Water Resource Development

In this section three aspects will be discussed which form the building blocks for calculating the cost of water resource development.

7.1.1 Water development and river basin management cost

South Africa is in the process of establishing a water pricing strategy.

On 12 November 1999 the South African Government published their raw water pricing strategy[43]. This strategy is based on the principle that a specific catchment's revenue should pay for the delivery cost of the relevant water. This is in line with the basic costing principles set out in the manual for capturing the financial and opportunity cost (economic cost).

The objectives of the pricing strategy can be summarised as:

- **Social Equity**

Redressing the imbalances of the past with respect to:

- inequitable access to basic water services at affordable tariffs within municipal areas, by facilitating a conditional subsidy on raw water cost where stepped tariffs are introduced
- inequitable access to water for productive use purposes by subsidising tariffs for emerging farmers for a limited time period.

- **Ecological Sustainability**

Pricing will take account of the cost of:

- safeguarding the ecological reserve
- the ecological management of the catchment
- water quality protection
- water conservation and use management

- **Financial Sustainability**

Generating adequate revenue for funding the annual cost related to:

- the management of water resources
- the operation and maintenance of existing schemes

[43] Raw Water Pricing Strategy, 1999, DWAF, Pretoria.

- the rehabilitation of existing schemes
- the development of augmentation schemes

In the process of annual tariff increases to reach this objective, the constraints within various user sectors to adapt to price increases will be taken into account.

- **Economic Efficiency**

- To promote the efficient allocation and beneficial use of water, water should be priced at its opportunity cost.
- The Pricing Strategy provides for administrative as well as market-related measures to achieve this goal.

The nucleus of the policy is based on the principle of user charges. Cost allocations to user types (sectors) are as follows:

- Water resource management activity costs must be allocated to sectors in proportion to volumetric average annual sectoral use.
- Registered sectoral water use will take into account the assurance of supply from State and Water Use Authority (WUA) schemes.
- The Pricing Strategy determines that the following activity costs must not be allocated to the Forestry sector.
  - Dam safety control
  - "Working for Water" (WfW) programme in South Africa

The specific setting of sectoral charges will take into account the following:

- Unit costs per sector will be determined for each Water Management Area (WMA) by dividing budgeted activity costs by the allocable sectoral use.
- Unit charges in cents per m3 for pricing purposes will take into account the subsidies granted i.r.o the Pricing Strategy.
- The WfW unit cost for irrigation is subsidised by 90%.
- In under-utilised WMAs the charges are based on allocatable water and the under-recovery in revenue is subsidised by DWAF.

In Table 19 an example is given of the calculation of water costs for various users. It should be noted that this is only an example which is not to be used in actual CBA calculations.

Table 19: Summary of Calculation of the Water Costs for a Typical River Basin

Dam Unit Cost	***Current 2006***
Domestic and Industrial	
Return on asset cost c/m^3	7.80
Depreciation cost c/m^3	0.557
Betterments cost c/m^3	0
Operation and maintenance cost c/m^3	1.03699942
Functional support cost c/m^3	0
Infrastructure cost c/m3	9.40
Catchment management cost c/m3	0.039
Working for water cost c/m^3	0.026
Afforestation/Abstraction cost c/m^3	0.013
Total unit cost c/m^3	9.48
Irrigation (full quota: 11000m^3/ha)	
Betterments cost R/ha	0
Operation and maintenance cost R/ha	154.90
Functional support cost R/ha	0
Infrastructure cost R/h	154.90
Catchment management cost R/h	2.05
Working for water cost R/h	0.39
Afforestation/Abstraction cost R/h	1.66
Sub Total	158.90
10% increase into SAAU Agreement	15.90
Total unit cost R/h	174.90
Total unit cost c/m^3	1.59

7.1.2 Opportunity cost of water

Water is a scarce resource in South Africa. In most of the drainage regions an additional demand of water implies that there is not only storage and transfer cost involved but also an economic cost (opportunity cost). This is due to the fact that this additional water demand in some cases deprives a current or a future user of water. For example, only in a few water catchments in South Africa, where water in the low flow periods is still adequate, forestry permits are issued readily, which attest to the scarcity of water. This example supports the opportunity cost argument.

In addition to the cost calculations proposed by the above-mentioned raw water pricing strategy, the opportunity cost of water should also be taken into consideration. In theory the opportunity cost of water in a specific catchment is equal to the application with the highest economic use of water. This will differ from catchment to catchment.

Internationally and also in South Africa the economic value of water for industrial and urban use is much higher than the economic value of water for irrigation and forestry use. The practical implication of this is that in the event of a shortage of water for industrial and urban

use, water will be channelled away from irrigation and forestry in favour of industrial and urban water use. In such a case the economic value of water for industrial and urban use should at least be equal to the economic cost to the country (the so-called opportunity cost) of reduced forestry and/or irrigation activity.

7.1.2.1 Application of opportunity cost

The opportunity cost should be added to the water development and river basin management cost of water as proposed by the raw water strategy (See paragraph 7.1.1) to obtain the full cost of water for a specific catchment. It is important to note that the opportunity cost should be zero if there is ample water. It is important to realise that ample water refers not so much to high seasonal flows, but to the continuous base flow. A high proportion of household demand as well as irrigation is supplied directly from rivers and streams and not from large water storage facilities. Accordingly it is not only the volume of water that plays a role, but the fact whether the supply is continuous throughout the year. In principle this should be the case for Southern KwaZulu Natal and the northern portions of the former Transkei.

7.1.3 Environmental cost of water development

The inclusion of the impact on the environment in CBA was highlighted by the publication of the Pearce Report, commissioned by the Secretary of State for the Environment in the United Kingdom (UK) government. A result thereof is that the UK government recommended that environmental impacts must be brought into formal appraisal procedures wherever possible.

In the raw water pricing strategy the ecological sustainability is also highlighted as one of the main objectives of the pricing strategy.

In Table 20 a checklist is provided which should assist the CBA researcher to identify the positive and negative impacts that water development could have on the environment.

Table 20: Environmental Aspects Related to Water Development

Ecosystem Goods and Services	***Ecosystem Functions***	***Examples***
Gas regulation	Regulation for chemical composition of the atmosphere	Carbon sequestration, oxygen and ozone production
Climate regulation	Regulation of temperatures, precipitation at local levels	Urban heat amelioration, wind generation
Disturbance regulation	Regulation of episodic and large environmental fluctuations on ecosystem functioning	Flood control, drought recovery, refuges from pollution events
Water supply and regulation	Supply and regulation of water flow	Provision of water for agricultural, industrial and household use
Sediment supply and regulation	Regulation of sediment supply to estuary and marine environment	Maintenance of beaches, sand-bars, sand banks
Erosion control	Retention of soil within an ecosystem	Prevention of soil loss by vegetation cover, and by capturing soil in wetlands
Soil formation	Soil formation processes	Weathering of rock by water and accumulation of organic material in wetlands
Nutrient cycling	Storage, recycling, capture and processing of nutrients	Nitrogen fixation, nitrogen cycling through food chains
Waste treatment	Recovery of nutrients, removal and breakdown of excess nutrients	Breaking down of waste, detoxifying pollution
Biological control	Regulation of animal and plant populations	Predator control of prey species, maintain population balance
Refugia	Habitat for resident and migratory populations	Nurseries, habitat for migratory fish and birds, regional habitats for species
Food production	Primary production for food	Production of fish and plants
Raw materials	Primary production for raw materials	Production of craftwork materials, house building materials and fodder
Genetic resources / Natural products	Unique biological materials and products	Genes for food and ornamental fish species, plant fibres
Nature appreciation	Providing opportunities for the appreciation of natural features and wildlife	Providing access to features and wildlife for viewing and walking
Recreation and fishing	Provision of opportunities for sport in or on water, and for sport fishing	Swimming, sailing, canoeing, skiing, fly-fishing and conventional fishing
Transport	Provision of opportunities for water-based transport	Harbours, ferries, ski-boat launching
Archaeological/historical/cultural	Providing opportunities for non-commercial use	Aesthetic, educational, spiritual, intrinsic and scientific values of ecosystems
Scenery	Provision of scenic views	Residential houses, flats and offices with scenic views

Source: Miles Mander, Institute of Natural Resources, Pietermaritzburg.

For the purpose of CBA, the economic value of environmental goods is measured mainly through the concepts of willingness to pay (WTP) and willingness to accept (WTA) compensation.

Four methods are mainly used in the valuating of environmental goods (Hanley and Spash 1993), namely:

i) Contingent valuation method (CVM) (Hanley and Spash)[44]

"CVM works by directly soliciting from a sample of consumers, their WTP and/or WTA for a change in the level of environmental service flows, in a carefully structured hypothetical market."

ii) Hedonic Pricing Method (HP) (Hanley and Spash)[45]

"The method identifies environmental service flows as elements of a vector of characteristics describing a marketed good, typically housing. HP seeks to find a relationship between the levels of environmental services (such as noise levels or total suspended particulate levels), and the prices of the marketed goods (houses). HP has been used to value such things as noise levels around airports, earthquake risks and urban air quality."

iii) Travel Cost Method (TCM) (Hanley and Spash)[46]

"The travel cost method seeks to place a value on non-market environmental goods by using consumption behaviour in related markets. Specifically, the costs of consuming the services of the environmental asset are used as a proxy for price. These consumption costs will include travel costs, entry fees, on-site expenditures and outlay on capital equipment necessary for consumption."

iv) Production Function Approaches (Hanley and Spash)[47]

Production function approaches "link environmental quality changes to changes in production relationships. When a change in environmental quality occurs, households are able to react. In the case of decreasing quality, expenditures will be made to mitigate the effects and protect the household from welfare reductions. An example is an increase in aircraft noise due to a new airport. In the absence of intervention households will engage in averting behaviour, such as moving away from the area (an impact measurable via hedonic pricing) or noise-proofing their home."

7.2 Methodology to Calculate Economic Value of Water

The objective of this section is to give some guidelines to determine the economic value of water for different categories of water users.

The value of water is loosely defined as the maximum amount the user would be willing to pay for the use of an amount of water. In the absence of market clearing prices, there are a number of alternate means of estimating the value. (See Gibbons (1986)[48]). First, there may be some evidence of market-like transactions within a given sector. Payments of this level for

[44] Hanley, N. and Spash, C.L. 1993. *Cost-benefit analysis and the environment*. Edward Edgar, Vermont, p. 53.

[45] Hanley, N. and Spash, C.L. Ibid p. 74.

[46] Hanley, N. and Spash, C.L. Ibid p. 83.

[47] Hanley, N. and Spash, C.L. Ibid pp 98-99.

[48] Gibbons, D.C., 1986, "The Economic Value of Water", A Study from Resources for the Future, Washington DC, the Johns Hopkins University Press.

water indicate that the user is willing to pay at least a certain amount, which points to a lower limit put on the value for water in that sector.

More complete demand information may be required for a formal demand curve for a particular use thereof. If enough tariff and quantity data are available, a consumer or producer water demand curve can be estimated, from which, in turn, estimates can be made of marginal values/benefits of the resource use at different levels of demand.

Financial budget information on a single productive process can also be used to impute a share of total product value to the water input. If all factors of production are remunerated i.t.o. their marginal returns, the residual, after subtraction of all other intermediate inputs, is assumed to be the maximum economic value of the water input.

Without actually studying demand relationships, the concept of alternate cost can also be used to determine the economic value of water. The cost of the least expensive alternative to water serves as a proxy for the maximum amount the user might be willing to pay for water.

7.2.1 Urban households

The first step in the calculation of the economic value of water is to derive a price demand function based on consumer demand and from that price elasticities can be calculated. This price demand function can be calculated for urban households in total or for various income groups. It could even be further broken down and calculated, for example for indoor and outdoor use.

Methods available in this regard are the following:

- **Contingent Valuation**

Information is obtained by means of questionnaires. The first step is to establish a typical user profile. After this, the effect that a price increase would have on these consumption patterns is determined.

A shortcoming of this method is that outcomes are not actually observed, but are based on expectations.

This method was used by Veck and Bill (1998)[49] to determine the price elasticity of demand for water.

- **Time Series Analysis**

Here tariff and demand quantity data are compared over time (at least 15 observations) in order to determine a relationship between them.

A shortcoming in terms of South Africa is that there is very little variance of the tariff structure in the past. During periods of drought, when the tariff was used to regulate volumes of water, it was done mostly in conjunction with direct control measures.

[49] Veck, A, and Bill, M., 2000, Estimation of the residential price elasticity of demand for water by means of a contingent valuation approach. Report 790/1/00. Water Research Commission.

- **Cross Sectional Analysis**

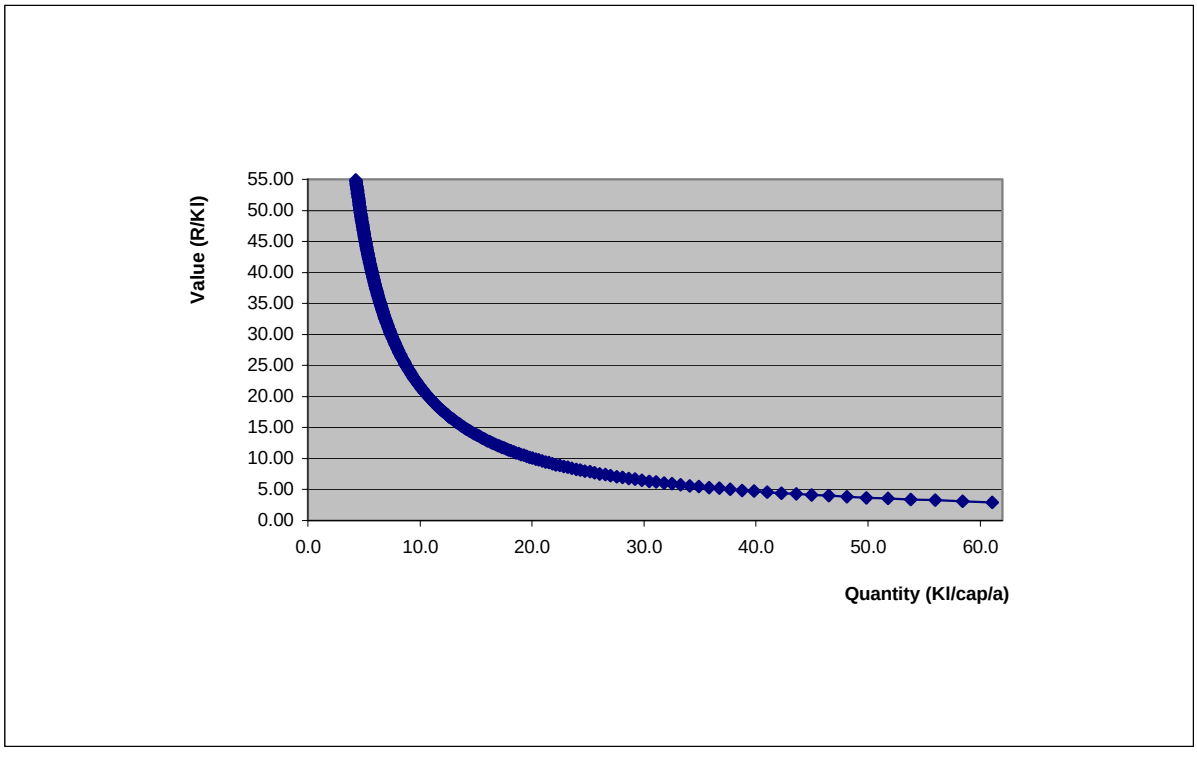
The reaction of different water users to tariff levels at the same point in time is investigated. An example of this is where a relationship is being determined between consumption and tariff data for different municipalities. An advantage of this method is that many factors influencing water consumption can be simultaneously analysed through multi-regression analysis.

At present the WRC is funding a project that uses cross-sectional analysis to determine price demand functions[50].

7.2.1.1 Calculation of economic value

For CBA purposes it is important to calculate the value of the total amount of water consumed by a specific urban household category. This can be derived from the demand schedules referred to above. Graph 7.1 is an example of the price demand schedule for the category: Urban households: High income: Outdoor[51].

Graph 1: Demand Curve: Households: High Income: Outdoor



In probably most of the cases the CBA analyst will not estimate the tariff demand schedule her/himself but will make use of secondary information. To construct a price demand

[50] Greengrowth Strategies: The Water Research Commission Project K5/990/0/1. The Value of Water as an Economic Resource in the Vaal River Catchment Study in progress.
[51] This is only a hypothetical case and the figures do not have any practical application.

schedule for her/his specific project (s)he needs the current tariff as well as the average consumption of the category of households for a specific period (per month). Further (s)he also needs the price elasticity for that specific category.

The demand curve is constructed by assuming that the value of the last unit of water consumed is equal to the tariff paid by the consumer.

The highest quantity lowest value represents the current tariff. In the case of the example in Graph 1 this equals R2,96.

The economic value of water (per capita per annum) can be defined as the total area under the curve. The value can be derived by calculating the integral under the price demand curve. To obtain the value per cubic metre of water, the total value should be divided by the volume of water use. In regard to this graph, the quantity of water consumed totals 60 kiloliter per capita per annum.

7.2.2 Rural households

7.2.2.1 Introduction

It is very difficult to assign an economic value to household water use in general and more particular to use by rural households.

Water is a good that has a value when it is consumed. However, if water is not available or unsuitable for human consumption it has wider implications for the wider society. In theory, the benefits of private goods are fully divisible and excludable, and the benefits of public goods are indivisible and non-excludable. Industrial water is a private good, but household water can provide broader health benefits and is therefore neither a purely private nor public good. On the spectrum of private to public goods, household water lies between the two extremes, probably closer to pure private goods. Although this argument applies with regard to urban household water, rural household water could probably be viewed as closer to a public good. This is also in line with current government policy where a certain amount of water is supplied free to the poor.

Public or collective benefits are generally considered difficult to quantify and are intangible. The current practice in South Africa[52] and also by the World Bank[53] is to make use of the willingness to pay concept to calculate the economic value of water use by households in developing areas. By definition, this means that rural water is regarded as a private good. However, it will be recognised from the methodology that the pure willingness to pay principle in the true sense, is only partially applied.

[52] Internal Documentation of DBSA.
[53] World Bank. Operations Evaluation Department. May 1997. Report no. 146.

7.2.2.2 Methodology

The economic value of water is determined in two components. The first component deals with the social (public) portion of 25 litres of water per capita/per day. This portion is in accordance with the government's policy on minimum water requirements for urban and rural households.

The second component deals with the volume of water consumed above the 25 litres per capita/per day. This water is regarded as a pure private good.

- **Social Portion of Water Consumption**

The DBSA currently uses 4%[54] for potable water and 3% for sewerage (World Bank 5 – 10% for water and sewerage) of a household income as the amount presenting the willingness to pay of that household to pay for the social portion of the water.

An example to illustrate the methodology to calculate the economic value for the social portion per kl for a specific rural area is as follows:

Economic value of water = $\frac{\text{4\% of actual household income}}{\text{monthly water consumption per household}}$

= $\frac{\text{R40/month/household}}{\text{4 565.63 kl/month/household}}$

= R7.49 per kl

Where:

The monthly income of a rural household consisting of six persons is R 855.02. This is the average wage for unskilled labour in rural areas across all provinces. See Table 10.

And:

Monthly Water Consumption per household = 25 litres per capita per day x 6 persons x 30,44 days

= 4,565.63 kl per month

- **Private Portion of Water Consumption**

The economic value of the balance of consumption is estimated by using the current tariff for water and also taking into account the surplus value of that water. This is done by using the average of the current tariff per kl and the economic value of the social component, per kl as calculated above.

An example of this methodology for calculating the economic value of the private portion of water consumption is as follows:

[54] 7% for water and sanitation.

$$\text{Economic value of water per kl} = \frac{\text{Value Social portion in R/kl + current tariff in R/kl}}{2}$$

$$= \frac{\text{R4.40 + R12.03}}{2}$$

$$= \text{R8.22}$$

Consequently the economic value for water is as follows:

Economic Value:	Social portion =	R7.49 per kl
	Private portion=	R8.22 per kl

The total value of water for a specific rural area is the weighted economic value of the social and private portion. An example of this for a household consuming 15 kl per month is as follows:

4565.63 kl x R7.49/kl	=	R 34.20
10 431.25 kl x R8.21/kl	=	R 83.59
Total monthly value		R119.79
Value per kl	=	R119.79/15 kl
	=	R7.99/kl

7.2.3 Irrigation agriculture[55]

The basic methodologies for estimating water values are crop-water production function analysis and farm crop budget analysis (including linear programming).

7.2.3.1 Crop – water production function analysis

The relationship between inputs and outputs of crop production can be expressed mathematically as the crop production function. If all other inputs are held constant, the marginal physical productivity of water for each unit of water used on the crop can be calculated. The marginal value of each unit of water is the marginal physical product times the crop price. This procedure relies on the assumption that applications of different amounts of water incur the same labour, fertilizer, and other non-water input costs. Since these marginal values are not dependent on the economics of crop production, they are not related to fixed or variable costs, but only to the crop selling price and the physical productivity of the water unit. In addition, they reflect the value of on-site irrigation water.

Although the theory underpinning the crop-water production function method is sound, it is not used often to calculate the economic value of irrigation water. In most places and for most crops, the actual physical productivity of water is not known. Crop-water production functions have not been scientifically established and the share of yield contributed by the water input has not been determined.

[55] The theory regarding valuation methods of water is taken from Gibbons Diana C (1985).

7.2.3.2 Farm crop budget analysis

A more popular method of estimating the economic value of irrigation agriculture is farm crop budget analysis. It is calculated as the total crop revenue less non-water input costs. This residual can be defined as the maximum amount the farmer could pay for water and still cover costs of production. It thus represents the on-site value of water. If water procurement costs are further subtracted, the net value for irrigation is then comparable to instream water values. This monetary value divided by the total quantity of water used on the crop, determines a maximum average value, or willingness to pay, for water for that crop. Depending on whether or not fixed costs are included, such values can be short-run or long-run average values.

7.2.3.2.1 Linear Programming (LP) Analysis

For calculating the economic value of a single crop the method explained above is sufficient. However, it is accepted that a farm consists of more than one crop option and switching can take place between products as the supply of water increase or decrease. In instances like this, more sophisticated methods to calculate the economic value of water with regard to irrigation agriculture will have to be applied. Probably the most important one is Linear Programming (LP) Analysis. For the calculation of irrigation water values, the LP objective is to maximise net returns for a farm of specified hectares subject to constraints which may be economic or physical, such as hectares limitations for each crop, input cost per unit, available technology, constant water requirements set for each crop, crop prices, and so forth. In the LP solution, limiting the hectares of certain risky crops is one way to incorporate the desired level of risk to the farmer.

LP analysis can also be used to estimate marginal values for irrigation water on a representative farm, but not by crop. Instead of water cost, water supply is varied and an LP solution is found for each quantity of water available to the farm, all other constraints remaining constant. When the supply of water is low, the programme solution allocates water to its highest-valued uses, but as supply increases other less valuable or more water-intensive crops are added, and the marginal value of additional units of water falls. The set of shadow prices derived at various levels of water supply forms a water demand schedule for the farm.

7.2.4 Electricity

The economic value of hydropower is frequently recognised all over the world. However, in the case of South Africa, coal based power stations generate most of the electricity consumed in the country.

In this section specific attention will be given to the development of a demand curve for coal based power stations. From this the economic value of water used for electricity generation by coal based power stations, can be deduced[56].

The main aim of the methodology is followed to calculate the economic value of water used in coal based power stations is to minimise the cost of water utilised in the process[57].

[56] For calculation of the economic value of water for electricity generation by hydropower stations (See Gibbons Ibid, p. 86).
[57] A similar approach is also discussed in Gibbons Ibid p. 50.

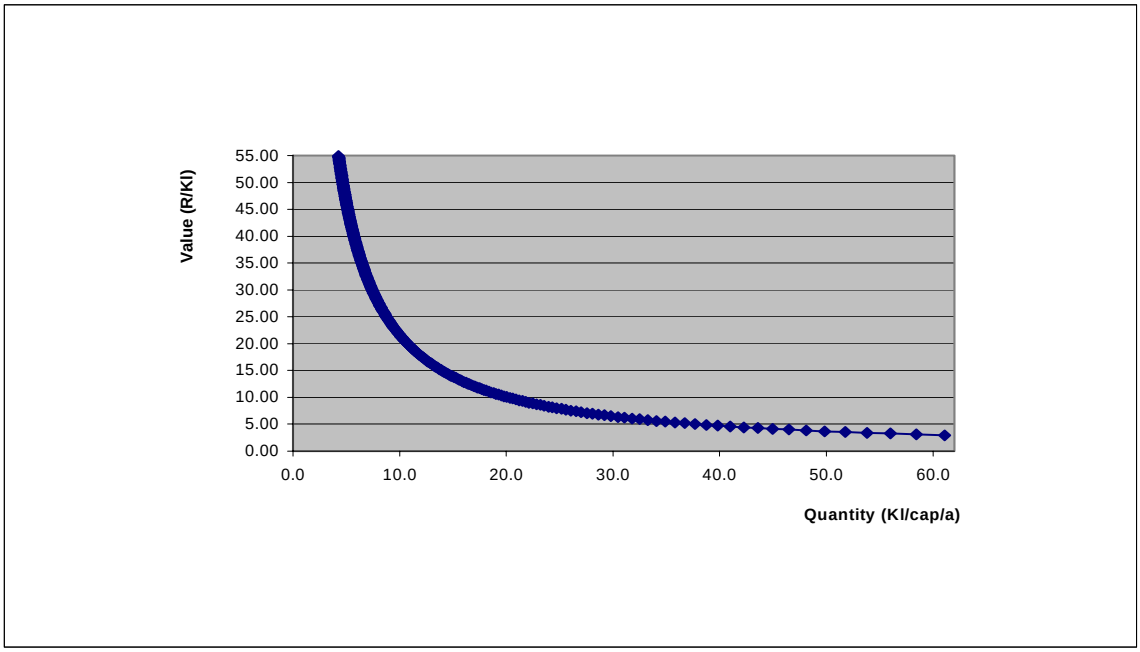
Two cooling systems are used in these South African power stations, namely wet and dry cooling systems. A wet cooling system uses much more water than a dry cooling system in order to generate the same amount of electricity. In a wet cooling system ±2.23 l of water is used to generate 1 kWh of electricity compared with the 0.22 l of water per kWh of electricity in a dry cooled system.

On the negative side it must be stated that building a dry cooling system is much more costly than a wet one. The running costs are also slightly higher. It is also difficult and very costly to convert a power station from a wet to a dry cooling system. The demand schedule for water is therefore very inelastic.

In a CBA study done by Conningarth Consultants for the WRC in 1999[58] on dry cooling, it was established that at a water tariff of R3,90 per kl the dry cooling process becomes the cheaper of the two processes.

If the above information is taken into consideration it is possible to construct a demand curve as indicated in Graph 2 below.

Graph 2: Demand Curve of Water Use: Electricity



In practice one must however, accept that not all power stations will immediately change over to the dry cooling process. Factors like the age of the power station, water tariff and other financial factors will play a role.

A more smoothed demand curve than the one depicted in Graph 2 is probably more applicable when showing the real situation.

[58] Conningarth Consultants Evaluating the Impact of Selected Water Research Commission Projects – A Cost Benefit Analysis – A CBA Approach, 2000.

7.2.5 Industry

With regard to the economic value of water used in industrial processes, it is notable that the cost of water is only a small percentage of the total cost of production. Even for industries that use huge quantities of water, the cost of water will be dwarfed by other production inputs, such as labour, energy, capital and raw materials utilised.

It is thus clear that decisions on locality, technologies used, and scale of operations to maximise profits are more important than that of effective water utilization.

Theoretically the demand and value of water used in industries could be derived from statistical industrial production functions or using the residual imputation method. However, in view of the importance of water (quantity) these methods are not used very often. Instead the economical value of water for industrial usage has been calculated by using the so-called second best cost alternative (that is the cost to recirculate water within the production process). That means that industry will normally only be willing to pay for new water supply equal to the cost to produce water of adequate quantity through treatment and reuse[59].

Currently the residual imputation method, also known as the budget approach, is applied in a study to analyse various industries in South Africa in order to derive a demand curve for industrial water. This was also used by Urban-Econ[60].

7.3 Computer Program for Conversion Factor for Assets

A computerised model has been developed, whereby a weighted shadow price of various inputs used in the production of capital assets can be calculated. The assets that are included in the model are various water augmentation assets, typical assets found in a SAM specifically the South African SAM and various other important assets. The output of the model is given in Table 21. The model is also available in electronic format on the CD enclosed. It should be noted that the figure is only given for illustrative purpose. When using the model the shadow price adjustment factors for each input need to be adjusted according to the appropriate tables in the manual. For example the factor used for unskilled labour is the wage factor for non-urban unskilled labour in the Western Cape. Thus if the project in question is taking place in an urban area in the Eastern Cape, the factor needs to be adjusted in accordance with Table 10(a) in the manual. Space has been left in the model for the user to insert additional assets. If this is done coefficients for the inputs used in the production of that asset need to be calculated and placed in the model. Additional inputs can also be incorporated into the model for each of the assets listed. Once the relevant coefficients are entered into the model, it will run automatically. In the case of additional inputs, shadow price factors will have to be inserted into the model over and above the coefficients.

The model has been extended to include the operational sectors contained in the South African SAM. These sectors are not included in the output displayed in Table 21, however, they are available electronically.

[59] See Gibbons, Ibid, for more explanations.

[60] Urban-Econ. The determination of Economic Value of Water for the Vaal River System Area. A report by Urban-Econ for Department of Water Affairs. PC 000/00/10291. May 1991.

Table 21: Conversion Factors

Development of Conversion Factors for Assets

CONVERSION FACTORS

RELATIVE IMPORTANCE OF INPUTS WHERE SHADOW PRICES ARE APPLICABLE	DIESEL	PETROL	PETROLEUM PRODUCTS (includes petrol and diesel)	ELECTRICITY	UNSKILLED LABOUR	(EXCHANGE RATE)	CUSTOMS DUTY	Other 1	Other 2	Other 3	Other 4	WEIGHTED SHADOW PRICE FACTOR
A. ASSETS CONTAINED IN THE SOUTH AFRICAN SOCIAL ACCOUNTING MATRIX												
1. Furniture	0.000	0.000	0.005	0.007	0.001	0.569	0.569	0.000	0.000	0.000	0.000	1.099
2. Rubber products	0.000	0.000	0.062	0.022	0.016	0.426	0.426	0.000	0.000	0.000	0.000	1.064
3. Structural Metal Products	0.000	0.000	0.005	0.002	0.015	0.475	0.475	0.000	0.000	0.000	0.000	1.077
4. Other Fabricated metal products	0.000	0.000	0.020	0.014	0.015	0.190	0.190	0.000	0.000	0.000	0.000	1.029
5. Machinery and equipment	0.000	0.000	0.021	0.005	0.010	0.668	0.668	0.000	0.000	0.000	0.000	1.109
6. Electrical machinery and apparatus	0.000	0.000	0.022	0.004	0.010	0.458	0.458	0.000	0.000	0.000	0.000	1.073
7. Manufacturing of transport equipment	0.000	0.000	0.005	0.001	0.007	0.844	0.844	0.000	0.000	0.000	0.000	1.142
8. Other manufacturing and recycling	0.000	0.000	0.005	0.003	0.011	0.279	0.279	0.000	0.000	0.000	0.000	1.045
9. Buildings	0.000	0.000	0.023	0.001	0.016	0.136	0.136	0.000	0.000	0.000	0.000	1.014
10. Civil Construction	0.000	0.000	0.048	0.002	0.020	0.138	0.138	0.000	0.000	0.000	0.000	1.009
11. Business activities (architects, attorneys, etc.)	0.000	0.000	0.025	0.001	0.011	0.10	0.10	0.000	0.000	0.000	0.000	1.009
B. WATER AUGMENTATION COMPONENTS												
12. Bulk water (dams)	0.120	0.060	0.000	0.020	0.130	0.000	0.000	0.000	0.000	0.000	0.000	0.934
13. Reservoirs	0.030	0.000	0.000	0.000	0.170	0.070	0.070	0.000	0.000	0.000	0.000	0.956
14. Pump stations (water & sewer)	0.030	0.000	0.000	0.000	0.170	0.100	0.100	0.000	0.000	0.000	0.000	0.961
15. Bulk pipelines (water & sewer)	0.070	0.000	0.000	0.000	0.170	0.170	0.170	0.000	0.000	0.000	0.000	0.964
16. Treatment works (water & sewer)	0.030	0.000	0.000	0.000	0.170	0.070	0.070	0.000	0.000	0.000	0.000	0.956
17. Reticulation (water & sewer)	0.030	0.000	0.000	0.000	0.170	0.100	0.100	0.000	0.000	0.000	0.000	0.961
18. Storm water	0.100	0.050	0.000	0.010	0.130	0.000	0.000	0.000	0.000	0.000	0.000	0.936
C. Other Assets												
19. Roads	0.210	0.120	0.000	0.000	0.120	0.000	0.000	0.000	0.000	0.000	0.000	0.902
20. Parks and Recreation	0.210	0.120	0.000	0.000	0.120	0.000	0.000	0.000	0.000	0.000	0.000	0.902

21. Schools, Creches, etc.	0.080	0.020	0.000	0.050	0.140	0.000	0.000	0.000	0.000	0.000	0.000	0.956
D. Costs Associated with Construction												
22. Maintenance and operation	0.160	0.090	0.000	0.020	0.170	0.000	0.000	0.000	0.000	0.000	0.000	0.909
23. Earth works	0.000	0.000	0.111	0.000	0.102	0.065	0.065	0.000	0.000	0.000	0.000	0.959
24. Research and development	0.000	0.000	0.007	0.018	0.017	0.022	0.022	0.000	0.000	0.000	0.000	1.004
25. Relocation costs	0.000	0.000	0.009	0.000	0.044	0.062	0.062	0.000	0.000	0.000	0.000	0.996
26. Other 1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000
27 Other 2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000
28. Other 3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000
29. Other 4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000
Shadow Price Adjustment Factor	**0.791**	**0.844**	**0.804**	**1.337**	**0.704**	**1.222**	**0.950**	**1.000**	**1.000**	**1.000**	**1.000**	

Note: 1. Customs duty (shadow price adjustment factor) is already adjusted to take into account the direct import content of the plant.

2. The shadow price adjustment factor used for unskilled labour is the factor for non-urban unskilled labour in the Western Cape. This factor needs to be adjusted according to the location of the project in question using table 6.1a

CHAPTER 8: PRACTICAL EXAMPLES

8.1 Introduction

In this chapter a few practical examples are given of CBA applications that were done in South Africa. The project description of each example is given. However, the detailed examples appear on the enclosed CD, where a researcher can follow the methodology used in a detailed step by step approach.

The set of examples are:

1. Electricity
2. Potable water
3. Roads
4. Municipal versus Irrigation Water Schemes.

8.2 Example 1: Electricity

1 OBJECTIVE

The objective of Example 1: Electricity is to evaluate the feasibility of a community project with regard to the delivery of electricity connections. This is as a result of a community that had to be resettled due to the construction of a new dam for irrigation purposes.

2 FEATURES OF EXAMPLE

The model is a complete dynamic integrated model that makes provision for various discount rates covering a study period of 20 years.

The example makes provision for:

- Consumption for household and commercial users
- Different income-levels
- Differentiated tariff structure
- Financial and economic analysis
- Various capital cost items
- Increases in number of connections and individual consumption over time.
- Operational and maintenance costs
- Model determines shadow prices for capital and operational elements interactively.

3 LAYOUT OF EXAMPLE

- Project details sheet
- Other details sheet
- Summary sheet
- Input assumptions
- Graphs sheet
- Sensitivity sheet
- Sensitivity graphs sheet

4 PROJECT COST

- Capital Cost:
- Bulk-supply
- Reticulation
- Connections
- Purchase of bulk supply from the bulk supplier - c/kWh
- Operating & maintenance cost of reticulation - R/customer/month

5 PROJECT BENEFITS

- Revenue from electricity sales
- Connection fees

6 CBA EVALUATION CRITERIA

- Internal Rate of Return (IRR)
- Net Present value (NPV)
- Benefit/Cost Ratio (BCR)
  (Definition of BCR: NPV of total benefits divided by NPV of total costs)

8.3 Example 2: Potable Water

1 OBJECTIVE

The objective of Example 2: Potable Water is to evaluate the feasibility of a community project with regard to the delivery of potable water. This is as a result of a community that had to be resettled due to the construction of a new dam for irrigation purposes.

2 FEATURES OF EXAMPLE

The model is a complete dynamic integrated model that makes provision for various discount rates covering a study period of 30 years.

The example makes provision for:

- Consumption for household and commercial users
- Different income-levels
- Differentiated tariff structure
- Financial and economic analysis
- Various capital cost items
- Increases in number of connections and individual consumption over time.
- Operational and maintenance costs
- Model determines shadow prices for capital and operational elements interactively.

3 LAYOUT OF EXAMPLE

- Separate input and result sheets
- Financial analysis sheet
- Economic analysis sheet

4 PROJECT COST

- Capital Cost:
  Reservoirs
  Pipelines
- Pump stations, etc
- Purchase of purified water from the bulk supplier - c/Kl
- Operating & maintenance cost of reticulation (including administration costs) - R/Kl
- Connection costs

5 PROJECT BENEFITS

- Revenue from water sales
- Reduction in water losses
- Savings in operation & maintenance costs, if any

6 CBA EVALUATION CRITERIA

- Internal Rate of Return (IRR)
- Net Present value (NPV)
- Benefit/Cost Ratio (BCR)
  (Definition of BCR: NPV of total benefits divided by NPV of total costs)

8.4 Example 3: Roads

1 OBJECTIVE

The objective of Example 3: Roads, is to evaluate the feasibility of constructing a new road. This is as a result of a road that will be inundated when a new dam will be constructed for irrigation purposes.

2 FEATURES OF EXAMPLE

The model is a complete dynamic integrated model that makes provision for various discount rates covering a study period of 20 years.

The example makes provision for:

- Vehicle operating costs for different types of roads
- Accident costs
- Time costs for vehicle occupants
- Economic analysis
- Specific capital costs
- Maintenance costs for different types of roads
- Model determines shadow prices for capital and maintenance elements interactively.

3 LAYOUT OF EXAMPLE

- Separate input and result sheets
- Economic analysis sheet

4 PROJECT COST

- Capital Cost:
- Maintenance cost

5 PROJECT BENEFITS

- Maintenance cost of the present road
- Vehicle operating, accident and time costs for road users for the present road

6 CBA EVALUATION CRITERIA

- Internal Rate of Return (IRR)
- Net Present value (NPV)
- Benefit/Cost Ratio (BCR)
  (Definition of BCR: NPV of total benefits divided by NPV of total costs)

8.5 Example 5: Rationale for the Substitution of Irrigation Water Rights for Municipal Household Usage

1 OBJECTIVE

The main objective of a CBA of this nature is to evaluate the merit of using irrigation water to satisfy domestic and industrial requirements in relation to other water augmentation options. The CBA measures the magnitude of the impact on various stakeholders who will be directly affected by the re-allocation of water being used for irrigation i.e. farmers and farm workers as well as urban dwellers who will purchase water for domestic and industrial purposes.

2 FEATURES OF EXAMPLE

The model is a complete dynamic integrated model that makes provision for various discount rates covering a study period of 50 years.

The example makes provision for:

- Financial and economic analysis
- Various capital and operational cost items -
  - Well field
  - Pipelines
  - Pump station
  - Treatment works
- Revenue from the sale of water for domestic and industrial use
- Opportunity costs in regard of the loss of farming production

3 LAYOUT OF EXAMPLE

- Separate input and result sheets
- Financial analysis sheet
- Economic analysis sheet

4 PROJECT COST

- Capital Cost:
  - Well field
  - Pipelines
  - Pump station
  - Treatment works
- Opportunity costs in regard of the loss of farming production

5 PROJECT BENEFITS

- Revenue from the sale of water for industrial and household purposes

6 CBA EVALUATION CRITERIA

- Internal Rate of Return (IRR)
- Net Present value (NPV)
- Benefit-Cost ratio (BCR)

LIST OF REFERENCES AND SOURCES

1. Boardman G & Vinning W. 1996. Cost-Benefit Analysis concepts and practice. Prentice Hall: Upper Saddle River New Jersey.

2. Brigham E & Gapenski L. 1990. Financial Management – Theory and Practice. Fifth edition. The Dryden Press.

3. CEAS. 1989. Manual for Cost-Benefit Analysis in South Africa.

4. Curry S. & Weiss J. 2000. Project Analysis in Developing Countries. Second edition. Maccullian Press Ltd: Houndmills.

5. Conningarth Consultants. 2000. Evaluating the impact of selected Water Research Commission Projects. A Cost-Benefit Analysis – A CBA approach. The Water Research Project Report no. K8/351.

6. Cargo Info Africa. 2006. South African Customs Tariffs. Available: http://www.rapidttp.co/tariff/chpindx.html

7. Department of Minerals and Energy. 2006. Petroleum Products Act, 1997. Amendments of the Regulations in Respect of Petroleum Products. Visagie Street, Pretoria.

8. Department of Minerals and Energy. 2006. Press Release. Pretoria

9. Nathan Associates. 2000. Methodologies for the Appraisal of Skills Development Strategy for Department of Labour, Pretoria.

10. Dupuit J. 1844. On the management of the utility of Public Works. Translated from the French in International Economic papers, no. 2: London.

11. DWAF. 1999. Raw Water Pricing Strategy. Pretoria

12. Gramlich EM. 1981. Benefit cost analysis of government programs. Prentice-Hall International, ICN: New Jersey.

13. Groom B. et al. 2005. Declining Discount Rates: The Long and the Short of it. Environmental and Resource Economics. Department of economics, School of Oriental and African Studies, London, UK Environmental Change Institute and Department of Economics, St Hugh's College, Oxford University, UK, Department of business, Department of Economics, Reading University, UK. Department of Economics, University College London, UK.

14. Hanley N & Spash CL. 1993. Cost-Benefit Analysis in the Environment. Edward Edgar: Vermont.

15. Gibbons DC. 1986. The Economic Value of Water. A study from resources for the future. The Johns Hopkins University Press: Washington DC.

16. Government Gazette. 3 October 2000. Government Printer. Pretoria.

17. Greengrowth Strategies. 2001. Study in Progress. The Value of water as an Economic Resource in the Vaal River Catchment. The Water Research Commission Project K5/990/0/1.

18. HM Treasury. 2003. The Green Book: Appraisal and Evaluation in Central Government. London

19. IMF. 2006. International Financial Statistics. Washington DC, USA

20. Jacobsons Publishers (Pty) Ltd. 2006. Customs Tariff Book. Durban. Available: http://www.rapidttp.co/tariff/chpindex.html

21. Kerali, Henry, G.R., 2000. Overview of HDM-4, Volume 1. The World Road Association (PIARC), Paris.

22. Kirkpatrick K & Weiss J. 1996. Cost-Benefit Analysis and Project appraisal for developing countries. Edward Elgar: UK.

23. McPherson, Kevin and Bennett, Christopher, R, 2005. Success factors for Road Management Systems. East Asia Pacific Transport Unit, The World Bank, Washington DC.

24. Newell R & Pizer W. 2001. Discounting the Benefits of Change Mitigation. Economics – Technical Series, Arlington, VA.

25. Public Servants Association of South Africa. 2006. Salary Scales for Employees on Salary Level 1-12 (Public Servants). Official reply by Mr J. Ntwampe

26. Sassone P. & Schaffer W. 1978. Cost-Benefit Analysis: A Handbook. Academic Press, Incorporation: London.

27. South African Revenue Services. 2002. Diesel Refund Guide. Available: http://www.sars.gov.za

28. South African Revenue Services. 2004. Vat 204 – Vat Guide for Vendors. Available: http://www.statssa.gov.za

29. South African Reserve Bank. September 2006. Quarterly Bulletin. Research Department, Pretoria. Available: http://www.reservebank.co.za/quarterlybulletin

30. Statistics South Africa. 2006. Mid-year Population Estimates, South Africa. Statistical release P0302. Available: http://www.statssa.gov.za

31. Statistics South Africa. 1996. South African Life Tables, 1985-1994 and 1996. Report number 02-06-04. Available: http://www.statssa.gov.za

32. Statistics South Africa. 2003. Labour Force Survey 2003. Available: http://www.statssa.gov.za

33. Statistics South Africa. 2006. Labour Force Survey 2006.Available: http://www.statssa.gov.za

34. Statistics South Africa. 2003. Census 2001. Available: http://www.statssa.gov.za

35. Stewart TJ, Joubert A, Scott L, Low T. 1997. et al. Multiple criteria decision analysis: procedure for consensus seeking in Natural Resources Management: WRC Report No. 512/1/97. University of Cape Town.

36. Sugden R & Williams A. 1978. Principles of Practical Cost-Benefit Analysis. Oxford University Press: Oxford.

37. Thompson MS. 1980. Benefit Cost Analysis for Program Evaluation. Sage Publications: London.

38. UNIDO. 1986. Guide to Practical Project Appraisal. Social Benefit-Cost Analysis in Developing Countries. UNIDO Publication: Vienna.

39. Urban-Econ. May 1991. The determination of Economic Value of Water for the Vaal River System area. A report by Urban-Econ for Department of Water Affairs. Report No. PC. 000/00/10291.

40. Veck A & Bill M. 2000. Estimation of the residential price elasticity of demand for water by means of a contingent valuation approach. The Water Research Commission, Report 790/1/00, Pretoria.

41. Walshe G & Daffern P. 1990. Managing Cost-Benefit Analysis. Macmillan Education Ltd: London.

42. Weitzman ML. 2001. Gamma discounting. The American Economic Review.

43. World Commission on Dams WCD. 2000. Dams Development: A new framework for decision making. Earthcan Publications Ltd: UK.

44. World Bank. May 1997. Operations Department. Report No. 146.

45. Young L. 2002. Determining the Discount Rate for Government Projects. New Zealand Treasury

APPENDIX 1: CBA UPDATE 2006 – A LITERATURE STUDY ON THE SOCIAL DISCOUNT RATE

1.1 Introduction

A literature study on the real social discount rate was done as a precursor to compile the Manual for Cost-Benefit Analysis in South Africa[1]. The purpose of this study is to update the manual for the latest theoretical and practical approaches regarding the use of an appropriate discount rate. This is done by way of revisiting the literature study that envisages (to also) capture more recent developments that are of importance to the process of determining an appropriate social discount rate.

The social discount rate in South Africa calls for some original research and considerations to again investigate and recommend a discount rate that is suitable to South Africa's special economic circumstances.

1.2 Real Social Discount Rates – Important Perspectives

Lots of time and money have been spent on determining the 'appropriate' real social discount rate. Sassone and Schaffer[2] remarked that "…economists have devoted scores, perhaps hundreds, of man-years to investigating the discounting issue. It is unlikely that significant progress would be made in the confines of a single applied project, yet it is likely that research into the discounting issue would quickly expend project funds best put to other uses. We feel very strongly that cost-benefit analysts should be aware of and familiar with the nuances of discounting, but at the same time the research program – the actual CBA – is not the place to further research aimed at finding the true social discount rate."

Discount rates are widely used in the public sector to assess project proposals where costs and benefits accrue over long time periods. Socially optimal policy choices require an appropriate choice of discount rate and assess the applicability of the two key theoretical approaches in selecting discount rates in the public sector. The two key theoretical approaches to consider are the social rate of time preferences (STPR) - the real value attached to future benefits and/or costs, and the social opportunity cost (the real cost of public sector funding). The social rate of time preference is considered to be the appropriate approach. When estimates of the social rate of time preference are unavailable or clearly unreliable and the Government is considering financing a project, the social opportunity cost should be used. The social opportunity cost can also be used as a proxy for the social rate of time preference.[3]

This debate on a suitable discount rate will not easily be concluded and is even finding a slight slant towards the qualitative assessment of the present value of future costs and benefits. The debate even becomes philosophical and although the Kaldor-Hicks (KH) criterion has long been the standard for benefit-cost analysis, it has also been widely criticised for ignoring equity and, arguably, moral sentiments in general. The new

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[1] Water Research Commission, 2002. A Manual for Cost-Benefit Analysis in South Africa, WRC Report TT 172/02

[2] Sassone PG & Schaffer WA, 1978. p 127.

[3] Young L, September 2002.

approach suggests replacing KH with an aggregate measure called KHM, where the M stands for moral sentiments.[4]

The last few years have witnessed important advances in our understanding of the value of time and its influence on decision making as measured by social discounting. In particular, several rationales for the use of time-varying social discount rates have emerged. These rationales range from the *ad hoc* to the formal, with some founded solely in economic theory while others reflect principles of intergenerational equity. While these advances are to be applauded, the practitioner is left with a confusing array of rationales and the sense that almost any discount rate can be justified. One should try and draw these different strands together and provide a critical review of past and present contributions.[5]

The current emphasis on the financial rate of return (FRR) and the weighted average cost of capital (WACC) in multidisciplinary project evaluation, however, emphasises the increasing importance of commercial and national rather than local and social criteria in public projects.[6]

The ambiguities and manipulability that render BCA generally controversial are exacerbated in the realm of environmental policy by: long time horizons and uncertainty about which social discount rates to use; the absence of primary or secondary markets for many environmental goods, which makes any prices assigned to them inherently contestable; and the sheer impossibility of assigning universally acceptable values to human lives.[7]

In comparing discount rates between countries it remains important to note the specific economic circumstances prevailing in a country and the availability of resources for investment. This will not only have implications for the real cost of capital, but will also influence the absolute amount that is available for investment, and thus the type and number of projects that could be financed from available resources. Since the last (2001) update of the CBA manual for South Africa, South Africa's gross domestic saving to GDP ratio has deteriorated from 15.8% in 2000 to 13.7% in 2005. Therefore the inclination should be to rather increase the real discount rate than lowering it given the tighter capital supply situation. Given the substantial increase in public sector infrastructural spending anticipated over the next number of years (+/- 15 years) there will be substantial pressure on capital resources. The selection of projects in the public sector should be determined by those projects delivering the best real return on investment, otherwise the private sector can be "crowded out" of the capital market. This could cause lower GDP growth and more unemployment.

Assessments regarding the effectiveness of sovereign debt restructuring for debt ridden countries are often summarised by comparisons of the net present value of debt service before and after the restructuring. These calculations are inherently sensitive to the choice of discount rate. Therefore it seems advisable to explore a range of discount rates and centring the analysis on the internal rate of return to assess whether the debt restructuring has generated net present value savings or costs to the debtor.[8]

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[4] Zerber Jr RO et al., July 2005.
[5] Groom B et al., March 2005.
[6] McFarquhar A, 2006.
[7] Cole DH & Townsend RB, 2006.
[8] IMF, May 2006.

1.3 Developments in Other Countries

According to Kirkpatrick and Weiss[9] "…in a 1967 White Paper (Cmnd 3437) it was recommended that publicly owned industries in the UK should use a test rate of discount of 8 percent in their appraisal of all important projects". In 1968 that rate was increased to 10 percent. In 1978 the social rate of discount was reduced to 5 percent, referred to as the required rate of return. However, in 1988 it was again increased to 8 percent. The most recent recommended real discount rate in the UK is 3.5% across all departments[10].

The New Zealand Treasury uses a 10% real discount rate whenever there is no agreed sector discount rate. There is no prescription from the New Zealand Cabinet Office that the 10% must be used, but if not used, CBAs should "…identify and detail the discount rate used and its derivation."[11]

In the US a more tailored approach is presently (2006)[12] being propagated followed by evaluating external government investment at 7% while internal investments are valued at the rate of treasury bonds (4.8%)[13].

Regular International Development Association (IDA) credits have a maturity of 40 years with a grace period of 10 years. NPVs (Net Present Value) represent the value today of a future stream of payments and are calculated using a 5% discount rate per annum. A 5% discount rate has been used in all prior discussions and notes on the subject of grant financing.[14]

The discount rates quoted above are well above the theoretical discount rates calculated by using the underlying theory of the long-term real interest rates (cost of funding to the State), and the STPR. It seems that the discount rate becomes more adherent to the ability (capital resources) of a country to finance projects and thus to determine a discount rate that could serve as cut-off point for the amount available for investment.

1.4 Discount Rate for Environmental Purposes

The discount rate has received renewed attention as part of a revived debate on discounting, stimulated in recent years by the issue of how to handle long-term environmental effects. According to Kirkpatrick and Weiss: "….it seems counter-intuitive if what everyone can agree are serious long-run environmental effects are discounted to insignificance by the application of conventional rates of 10 % to 12 %".

Weitzman (2001)[15] proposed a new theoretical approach to resolving the dilemma of a discount rate for resources that are not replaceable by the proceeds of economic growth. According to him "……society should be using effective discount rates that decline from a mean value of, say, around 4 percent per annum for the immediate future, down to around zero for the far-distant future".

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[9] Kirkpatric C & Weiss J, 1996.
[10] H.M. Treasury, 2003.
[11] Young L, September 2002.
[12] Cole DH & Townsend RB, May 2006.
[13] Newell R & Pizer W, 2001.
[14] IDA, March 2004.
[15] Weitzman ML, 2001.

Groom et al. (2005)[16] are also in favour of a "…discount rate which declines with time according to some predetermined trajectory, thus raising the weight attached to the welfare of future generations…..and contribute to the goal of sustainable development."

Recent research suggests that social cost-benefit analysis should be conducted with a declining discount rate. It builds on the line of research, estimating autoregressive and regime-switching models of real interest rates to determine certainty-equivalent discount rates in countries like Australia, Canada, Germany and the United Kingdom.[17]

"If saving a life is worth spending $1 million today, how much should we spend to save a life in twenty years? The answer, according to the federal Office of Management and Budget (OMB), is $150,000. OMB uses a ten percent annual "discount rate" to convert future regulatory costs and benefits into their "present value". Because government regulation of carcinogens cannot be expected to affect the cancer rate for twenty or thirty years, OMB's choice of discount rates has dramatic implications for regulatory policy. Its choice of discount rates has even greater impact on long-term global environmental issues such as ozone depletion and the greenhouse effect. For instance, if the greenhouse effect will cost society $100 billion twenty years from now, OMB's current discount rate would indicate that it is not worth spending $20 billion today to avert the harm".[18]

1.5 An Appropriate Discount Rate

"Discounting reflects the time value of money. Benefits and costs are worth more if they are experienced sooner. All future benefits and costs, including non-monetised benefits and costs, should be discounted. The higher the discount rate, the lower is the present value of future cash flows. For typical investments, with costs concentrated in early periods and benefits following in later periods, raising the discount rate tends to reduce the net present value".[19]

It is therefore important to consider more than just the discount rate and an example of a grid investment in Australia highlights the fact that while the discount rate is important to the grid investment process, it is one of many parameters, and has a relatively small impact on project selection. It was shown by the practical application of Australian regulatory tests that other parameters are likely to be more important in determining outcomes than the discount rate.[20]

Taking into account the international discount rate benchmarks and the marginal return on capital approach, the current 8 percent discount rate applicable in South Africa still seems to be appropriate and even generous. Given the low domestic savings in South Africa and the abundance of savings (capital) in capital exporting countries, the real discount rate in South Africa is relatively low. Compared to the discount rate in advanced economies, it is only about 1 percent lower than in South Africa. Both the real interest rate and the STPR are well below 8 percent and do not reflect South Africa's true shortage of investment capital and therefore the premium on using capital resources more productively. At present

[16] Groom G et al., 2005.
[17] Hepburn CJ et al., May 2006.
[18] Farber DA & Hemmersbaugh PA, 1993.
[19] Office of Management and Budget, 1992.
[20] Electricity Commission, 2004.

gross domestic investment in South Africa is at a level of only 17% of GDP in 2005. To attain a more appropriate level of investment of 25% of GDP in order to generate 6% sustainable economic growth will imply more pressure on using scarce capital resources productively.

Since the type of technology is also strongly influenced by the choice of a social discount rate, sensitivity analyses should also be carried out in respect of other discount rates and the results presented to the decision-maker. Discount rates of 6 and 10 percent are recommended in this regard, with 8% used as the base discount rate. The general experience is that the lower discount rates would promote more capital intensive production methods.

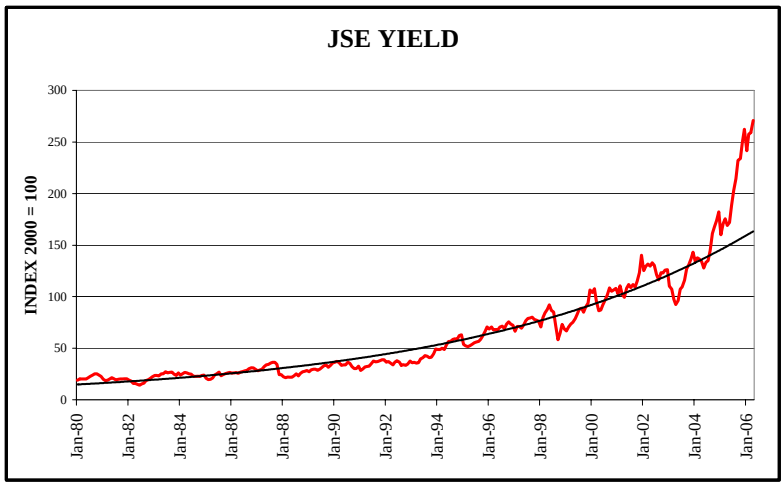
1.6 Real Cost of Public Sector Funding in South Africa

Estimates of the social rate of time preference (STPR) are usually unobtainable and/or difficult to determine. These calculations may also be clearly unreliable and open to controversy. This is also the case in South Africa and when the public sector is considering financing a project, the social opportunity cost is the best to use – the opportunity cost of public sector financing. The social opportunity cost can also be seen as the best proxy for the STRP.

By financing public sector projects, the state is applying financial resources that can be utilised in the private sector where a certain yield could be obtained over the longer term. By applying these financial resources in the public sector, a certain opportunity cost is attached to these resources that are foregone. In order to determine the social opportunity cost (cost of state funding) in South Africa, the capital asset pricing model (CAPM) can be used to establish the expected return that should follow on a public sector investment. The CAPM determines the yield that is equal to a risk free yield plus a market related risk premium. The difference between the expected yield on a benchmark investment in the private sector and the yield on a risk free investment is regarded as the market risk premium.

The annual yield on government bonds is obtained from the government bond index of South Africa as published by the Reserve Bank. The yield on the government bond index is used as proxy for the return on a risk free investment. These bonds attract the minimum risk. The JSE all-share index is used as a market related benchmark investment.

The analysis revealed that an investment in government bonds (risk free) generated an average annual real yield of 3.2% from 1980 to 2005. Over the same period an all-share investment on the JSE rendered an average annual real yield of 9.5% - see chart below. This implies an average real risk premium of about 6.1% - which is high.



Therefore given an average annual real risk premium of 6.1% and added to the average annual real risk free bond rate, a discount rate of 9.5% is obtained. The 9.5% is the real annual average opportunity cost of funds to the public sector in South Africa and should be used as the applicable discount rate. This implies that the current official 8% real discount rate is probably not too high.

1.7 Concluding remarks

The major challenges that inform the mindset around the social discount rate can be summarised as:

- The real cost of capital for a specific country that could serve as threshold for selecting deserving projects, and
- Environmental implications and sustainable development calling for a declining real discount rate in special cases.

It follows therefore that the present real 8% discount rate in South Africa should remain, but that the CBAs should be sensitive to environmental issues and to the merit of selecting projects in a capital scarce environment.

Annexure A is attached for further reference in respect of the discount rate issues as incorporated in the Manual on CBA for South Africa.

ANNEXURE A

ABSTRACT FROM UPDATED UNPUBLISHED MANUAL ON CBA FOR SOUTH AFRICA

Real Social Discount Rates

According to Sassone and Schaffer[21] "…economists have devoted scores, perhaps hundreds, of man-years to investigating the discounting issue. It is unlikely that significant progress would be made in the confines of a single applied project, yet it is likely that research into the discounting issue would quickly expend project funds best put to other uses. We feel very strongly that cost-benefit analysts should be aware of and familiar with the nuances of discounting, but at the same time the research program – the actual CBA – is not the place to further research aimed at finding the true social discount rate."

In comparing discount rates between countries it remains important to note the specific economic circumstances prevailing in that country and the availability of resources for investment. This will not only have implications for the real cost of capital, but will also influence the absolute amount that is available for investment, inter alia, the type and number of projects that could be financed from the available resources. Since the last (2001) update of the CBA manual, South Africa's gross domestic saving to GDP ratio has deteriorated from 15.8% in 2000 to 13.7% in 2005. Therefore the inclination should be to rather increase the real discount rate than lowering it given the tighter capital supply situation. Given the substantial increase in public sector infrastructural spending anticipated over the next number of years (+/- 15 years) there will be substantial pressure on capital resources. The selection of projects in the public sector should be determined by those projects delivering the best real return on investment.

Current International Developments

An 8 % real discount rate was recommended by the CEAS[22] manual dated August 1998 for South Africa. This rate was again confirmed in 2002 in the new CBA manual[23]. This rate is in line with the discount rate recommended by major international development institutions like for instance the World Bank that in the past has used a rate of 10 percent.

According to Kirkpatrick and Weiss[24] "…in a 1967 White Paper (Cmnd 3437) it was recommended that publicly owned industries in the UK should use a test rate of discount of 8 percent in their appraisal of all important projects". In 1968 that rate was increased to 10 percent. In 1978 the social rate of discount was reduced to 5 percent, referred to as the required rate of return. However, in 1988 it was again increased to 8 percent. The most recent recommended real discount rate in the UK is 3.5% across all departments[25].

The New Zealand Treasury uses a 10% real discount rate whenever there is no agreed sector discount rate. There is no prescription from the New Zealand Cabinet Office that the

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[21] Sassone PG & Schaffer WA, 1978.
[22] CEAS, 1989. Manual for CBA in South Africa.
[23] Water Research Commission, 2002. A Manual for Cost-Benefit Analysis in South Africa, WRC Report TT 172/02
[24] Kirkpatrick C and Weiss J, 1996.
[25] HM Treasury, 2003.

10% must be used, but if not used, CBAs should "…identify and detail the discount rate used and its derivation."[26]

In the US a more tailored approach is presently (2006) being followed by evaluating external government investment at 7% while internal investments are valued at the rate of treasury bonds (4.8%)[27].

As will be discussed later the discount rates quoted above are well above the theoretical discount rates calculated by using the underlying theory of the long-term real interest rates (cost of funding to the State), and the social time preference rate (STPR).

Methods of Estimating the Discount Rate

Although the calculation of the STPR is very difficult to determine, this has not stopped some analysts attempting empirical estimates. According to Kirkpatrick and Weiss (1996)[28] "…..such estimates are normally in the 1 percent to 5 percent range, since per capita consumption growth will rarely exceed 3 percent annually and the conventional estimates of the elasticity of the marginal utility of consumption are typically between 1.0 and 1.5". Walshe and Dafferen[29] calculate that the STPR is slightly in excess of the potential growth rate of an economy. The long-term growth rate for South Africa is in the order of 2.5 to 5 percent. Once again the STPR is substantially lower than the 8 percent officially accepted.

Apart from the theoretical approach to determine the discount rate such as the long term interest rate and the STPR, countries also base their social discount rate on the principles of the Capital Asset Pricing Model (CAPM). The CAPM model aims to determine a yield that is equivalent to the rate of a risk free investment, i.e. government bonds, plus a risk premium and a relative volatility attached to projects in general in the private sector. The discount rate so determined can also be seen as the social opportunity cost of investing in the public sector versus the next best alternative in the private sector where yields are determined by market forces.

The CAPM gives an expected return that is equal to a risk free yield plus a market related risk premium. The difference between the expected yield on a benchmark investment in the private sector and the yield on a risk free investment is the market risk premium.

The annual yield on government bonds can be obtained from the government bond index of South Africa as published by the Reserve Bank. The yield on the government bond index is used as proxy for the return on a risk free investment. These bonds attract the minimum risk. The JSE all-share index is used as a market related benchmark investment.
An investment in government bonds (risk free) generated an average annual real yield of 3.2% from 1980 to 2005. Over the same period an all-share investment on the JSE rendered an average annual real yield of 9.5%. This implies an average real risk premium of about 6.1% - which is high.

[26] Young L, September 2002.
[27] Newell R and Pizer W, 2001.
[28] Kirkpatrick and Weiss, 1996. Ibid. p 11.
[29] Walshe G and Daffern P, 1990.

Therefore if a real risk premium of 6.1% is added to the real risk free bond rate, a discount rate of 9.5% is obtained. This implies that the current official 8% real discount rate is probably not too high.

Proposed Discount Rate

Taking into account the international discount rate benchmarks and the marginal return on capital approach, the current 8 percent discount rate applicable in South Africa still seems to be appropriate and even generous. Given the low domestic savings in South Africa and the abundance of savings (capital) in capital exporting countries, the real discount rate in South Africa is relatively low. Compared to the discount rate in advanced economies, it is only about 1 percent lower than in South Africa. Both the real interest rate and the STPR are well below 8 percent and do not reflect South Africa's true shortage of investment capital and therefore the premium on using capital resources more productively. At present gross domestic investment in South Africa is at a level of only 17% of GDP in 2005. To attain a more appropriate level of investment of 25% of GDP in order to generate 6% sustainable economic growth will imply more pressure on using scarce capital resources productively.

Since the type of technology is also strongly influenced by the choice of a social discount rate, sensitivity analyses should also be carried out in respect of other discount rates and the results presented to the decision-maker. Discount rates of 6 and 10 percent are recommended in this regard, with 8% used as the base discount rate. The general experience is that the lower discount rates would promote more capital intensive production methods.

Discount Rate for Environmental Purposes

The discount rate has received renewed attention as part of a revived debate on discounting, stimulated in recent years by the issue of how to handle long-term environmental effects. According to Kirkpatrick and Weiss "….it seems counter-intuitive if what everyone can agree are serious long-run environmental effects are discounted to insignificance by the application of conventional rates of 10 % to 12 %".

Weitzman (2001)[30] proposed a new theoretical approach to resolving the dilemma of a discount rate for resources that are not replaceable by the proceeds of economic growth. According to him "……society should be using effective discount rates that decline from a mean value of, say, around 4 percent per annum for the immediate future, down to around zero for the far-distant future". Groom et al. (2005)[31] are also in favour of a "…discount rate which declines with time according to some predetermined trajectory, thus raising the weight attached to the welfare of future generations…..and contribute to the goal of sustainable development."

In view of contrasting views by economists that the same discount rate should be used for environmental projects than for other social and industrial projects, it is proposed that environmental projects in South Africa should be discounted at the official discount rate of 8%, and further tested against rates that are much lower. The result should be disclosed to the policy maker.

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[30] Weitzman ML, 2001.
[31] Groom et al., 2005.

LIST OF REFERENCES AND SOURCES

Broadway R. 2006. *Principles of Cost-Benefit Analysis.* Queens University, Kingston, Canada.

CEAS. 1989. Manual for Cost-Benefit Analysis in South Africa

Cole D. & Townsend R. 2006. *Towards Best Practice Standards in Environmental Benefit-Cost Analysis.* Prepared for conference on "What We Can Do to Improve the Use of Benefit-Cost Analysis". School of Law and Department of Economics, University of Washington, Seattle, Washington.

Electricity Commission. 2004. *Discount Rate for Application in Grid Investment Test.* SAHA International. Available: http://www.sahainternational.com

Farber D.A. & Hemmersbaugh P.A. 1993. The Shadow of the Future: Discount Rates, Later Generations and the Environment. Vanderbilt Law Review.

Groom B., Hepburn C., Koundouri P,. & Pearce D. 2005. *Declining Discount Rates: The Long and the Short of it.* Environmental and Resource Economics. Department of economics, School of Oriental and African Studies, London, Environmental Change Institute and Department of Economics, Oxford University, UK. Department of Business, Department of Economics, Reading University, UK.

HM Treasury. 2003. The Green Book: Appraisal and Evaluation in Central Government. London

Hepburn C.J., Koundouri P., Panapoulou E. and Pantelidis T., May 2006. *Declining Discount Rates: A Cross-Country Comparison*. Oxford University. London

IDA. March 2004. Modalities of IDA 13 Grant Financing – Technical Note. Washington DC.

IMF. Considerations in the Choice of the Appropriate Discount Rate for Evaluating Sovereign Debt Restructuring. December 2005. Policy Discussion Paper. Washington DC.

International Monetary Fund and International Development Association. 2006. Debt Sustainability in Low-Income Countries: Further Considerations on an Operational Framework and Policy Implications. IMF and World Bank

Kirkpatrick K & Weiss J. 1996, Cost-Benefit Analysis and Project Appraisal for Developing Countries. Edward Elgar: UK

Kozack J. 2005. Considerations in the Choice of the Appropriate Discount Rate for Evaluating Sovereign Debt Restructurings. IMF Policy Discussion Paper, Policy Development and Review Department.

McFarquhar A. 2006. *Economic and Financial Assessment.* Planning and Markets, Downing College, University of Cambridge, Cambridge.

McFarquhar A. 2006. *Environmental Valuation, Project Appraisal And Political Consensus In The Third World.* Planning and Markets, Downing College, University of Cambridge, Cambridge.

Newell R & Pizer W. 2001. *Discounting the Benefits of Change Mitigation.* Economics – Technical Series, Arlington, VA.

Office of Management and Budget. 1992. Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs. Washington DC.

Policy and Economics team. 2004. *A Guide to Valuing Natural Resources Wealth.* Environmental Department, World Bank. Available: http://www.worldbank.org

Sassone P. & Schaffer W. 1978. *Cost Benefit Analysis: A Handbook.* Academic Press, Incorporation: London

University of Southern California. 2000. *Planning and markets.* LA, California. Available: http://www-pam.usc.edu/volume4/v4ila3s2.html

Walshe G. & Daffern P. 1990. *Managing Cost-Benefit Analysis.* Macmillan Education Ltd. London

Water Research Commission, 2002. *A manual for Cost Benefit Analysis in South Africa.* Water Research Commission Report No TT 172/02 (compiled by Conningarth Economists).

Weitzman M. 2001. *Gamma discounting*. The American Review.

Young L. 2002. Determining the Discount Rate for Government Projects. New Zealand Treasury

Zerbe R O., Bauman Y. & Finkle A. 2004. *An Aggregate Measure for Benefit-Cost Analysis.* Science Direct. Available: www.sciencedirect.com

Zerbe R O., Bauman Y. & Finkle A. 2005. *An Aggregated Measure for Benefit-Cost Analysis.* School of Public Affairs, University of Washington, Seattle, WA. United States Department of Economics Willamette University, Salem, OR. Department of Economics Whitman College, Walla Walla, WA. Available: http://www.sciencedirect.com

Appendix 2: Revised Magisterial Districts per Fuel Price Zone

MAGISTERIAL DISTRICT	*PRICE ZONE*
Aberdeen	9B
Adelaide	5A
Albany	4A
Albert (Burgersdorp)	7A
Alberton	9C
Alexandria	4A
Alfred	5A
Aliwal North	7A
Amersfoort	8C
Babanango	6A
Bafokeng	10C
Balfour	8C
Barberton	10C
Barkly East	8A
Barkly West	11C
Bathurst	5A
Beaufort West	8B
Bedford	5A
Belfast	9C
Bellville	1A
Benoni	9C
Bergville	6C
Bethal	8C
Bethlehem	7C
Bethulie	8A

MAGISTERIAL DISTRICT	*PRICE ZONE*
Bizana	7B
Bloemfontein	10C
Bloemhof	10C
Bochum	13C
Boksburg	9C
Bolobedu	13C
Boshof	10C
Bothaville	9C
Botshabelo	10C
Brakpan	9C
Brandfort	10C
Bredasdorp	6A
Brits	10C
Britstown	9A
Bronkhorstspruit	9C
Bultfontein	10C
Cacadu (Glen Grey)	6A
Caledon	5A
Calitzdorp	4A
Calvinia (west of 20° longitude)	12B
Calvinia (east of 20° longitude)	14B
Camperdown	2A
Cape Town	1A
Carnarvon	10B
Carolina	9C

MAGISTERIAL DISTRICT	*PRICE ZONE*
Cathcart	5A
Ceres	5A
Chatsworth	1A
Christiana	10C
Clanwilliam	7B
Clocolan	8C
Cofimvaba	5A
Colesberg	8A
Coligny	10C
Cradock	8B
Cullinan	9C
Dannhauser	6C
De Aar	8A
Delareyville	11C
Delmas	9C
Dewetsdorp	10C
Ditsobotla	12C
Dundee	6C
Durban	1A
Dzanani Central	13C
Dzanani North	14C
Dzanani South	13C
East London	1A
Edenburg	8A
Eerstehoek	9C

MAGISTERIAL DISTRICT	*PRICE ZONE*
Elliot	8A
Ellisras	13C
Embumbulu	2A
Engcobo	7A
Ermelo	8C
Eshowe	4A
Estcourt	5C
Excelsior	9C
Fauresmith	9A
Ficksburg	8C
Fort Beaufort	5A
Fouriesburg	7C
Frankfort	8C
Fraserburg	8B
Ganyesa	15C
Gatyana	5A
Gcuwa (Butterworth)	5A
George	3A
Germiston	9C
Giyani	14C
Glencoe	6C
Goodwood	1A
Gordonia (south of 28° latitude)	13A
Gordonia (between 27°30' and 28° latitude)	17A
Gordonia (north of 27°30' latitude)	19A

MAGISTERIAL DISTRICT	*PRICE ZONE*
Graaff-Reinet	9B
Groblersdal	10C
Hankey	3A
Hanover	8A
Harrismith	6C
Hartswater	11C
Hay	11A
Heidelberg (Cape)	4A
Heidelberg (Tvl.)	9C
Heilbron	8C
Hennenman	8C
Herbert	10C
Hermanus	5A
Herschel	8A
Hewu	5A
Highveld Ridge	8C
Hlabisa	5A
Hofmeyr	7A
Hoopstad	10C
Hopefield	5A
Hopetown	9A
Humansdorp	3B
Idutywa	5A
Impendle	5C
Inanda	1A

MAGISTERIAL DISTRICT	*PRICE ZONE*
Indwe	7A
Ingwavuma	7A
Ixopo	4A
Jacobsdal	10C
Jagersfontein	8A
Jansenville	7B
Johannesburg	9C
Joubertina	7B
Kamhlushwa	10C
Keiskammahoek	4A
Kempton Park	9C
Kenhardt (east of 20° longitude)	15A
Kenhardt (west of 20° longitude)	19A
Kentane	5A
Kimberley	11C
King William's Town	3A
Kirkwood	3A
Klerksdorp	9C
Kliprivier	5C
Knysna	4A
Koffiefontein	9A
Komga	3A
Koppies	8C
Koster	10C
Kranskop	5A

MAGISTERIAL DISTRICT	*PRICE ZONE*
Kriel	8C
Kroonstad	8C
Krugersdorp	9C
Kudumane	15C
Kuils River	1A
Kuruman (south of 27° latitude)	13C
Kuruman (north of 27° latitude)	17C
Kwabhaca (Mount Frere)	10B
KwaMhlanga	10C
Ladismith (Cape)	6B
Lady Grey	8A
Ladybrand	8C
Lahurushe	11C
Laingsburg	7B
Letaba	13C
Lichtenburg	11C
Lindley	8C
Lions River	4C
Lower Tugela	3A
Lower Umfolozi	5A
Lusikisiki	10B
Lydenburg	10C
Maclear	8A
Madikwe	11C
Mahlabatini	6A

MAGISTERIAL DISTRICT	*PRICE ZONE*
Malamulele	14C
Malmesbury	3A
Malmesbury (south of 33°30' latitude)	1A
Maluki (Matatiële)	7A
Mankwe	10C
Mapulaneng	11C
Mapumulo	3A
Marico	11C
Marquard	8C
Maxesibeni (Mount Ayliff)	8B
Mbibana	10C
Mdutjana (Siyabuswa)	10C
Messina (east of 30° longitude)	14C
Messina (west of 30° longitude)	16C
Mdantsane	1A
Mhala	11C
Middelburg (Cape)	7A
Middelburg (Tvl.)	10C
Middledrift	4A
Mitchells Plain	1A
Mkobola	10C
Moanduli	7A
Mokerong 1	16C
Mokerong 2	11C
Mokerong 3	11C
Molopo	11C

MAGISTERIAL DISTRICT	*PRICE ZONE*
Molteno	6A
Montagu	5A
Mooi River	5C
Morreesburg	4A
Moretele 1	9C
Moretele 2	9C
Mossel Bay	1A
Mount Currie	7A
Mount Fletcher	10B
Moutse	10C
Mpofu (Stockenström)	5A
Msinga	5C
Mtonjaneni	5A
Mtunzini	4A
Murraysburg	12B
Mutale	14C
Namakgale	12C
Namakwaland (south of 30° latitude)	31J
Namakwaland (between 29°-30° lat. & 17°30'-18°30' long.)	32J
Namakwaland (north of 30° lat. & east of 18°30' long.)	33J
Namakwaland (north of 29° lat. & east of 17° long.)	34J
Namakwaland (south of 29° lat. & west of 17° long.)	35J
Namakwaland (between 29°-30° lat. & 17°-17°30' long.)	36J
Namakwaland (north of 29° lat. & west of 17° long.)	37J
Naphuno	12C

MAGISTERIAL DISTRICT	*PRICE ZONE*
Ndwedwe	2A
Nebo	11C
Nelspruit	10C
New Hanover	5C
Newcastle	6C
Ngotshe	7A
Ngqeleni	7A
Nigel	9C
Nkandla	5A
Nongoma	6A
Noupoort	7A
Nqamakwe	5A
Nqutu	6C
Nsikazi	10C
Oberholzer	9C
Odendaalsrus	9C
Odi	9C
Oudtshoorn	4A
Paarl	2A
Parys	9C
Paulpietersburg	7C
Pearston	8B
Peddie	4A
Petrusburg	10C

MAGISTERIAL DISTRICT	*PRICE ZONE*
Phalaborwa	12C
Philipstown	9A
Philippolis	8A
Piet Retief	8C
Pietermaritzburg	3C
Pietersburg (south of Tropic of Capricorn)	12C
Pietersburg (north of Tropic of Capricorn)	13C
Piketberg	6B
Pilgrim's Rest	11C
Pinetown	1A
Polela	5C
Port Elizabeth	1A
Port Shepstone	4A
Postmasburg	13C
Potchefstroom	9C
Potgietersrus (south of Tropic of Capricorn)	11C
Potgietersrus (north of Tropic of Capricorn)	16C
Pretoria	9C
Prieska	10A
Prince Albert	7B
Queenstown	5A
Qumbu	7A
Randburg	9C
Randfontein	9C
Reddersburg	8A

MAGISTERIAL DISTRICT	*PRICE ZONE*
Reitz	8C
Richmond (Cape)	8A
Richmond (Natal)	3A
Ritavi	13C
Riversdale	4A
Robertson	5A
Roodepoort	9C
Rouxville	8A
Rustenburg	10C
Sasolburg	9C
Schweizer-Reneke	11C
Sekgosese	13C
Sekhukhuneland	11C
Senekal	8C
Seshego	12C
Simon's Town	1A
Sipangeni (Flag Staff)	8B
Smithfield	8A
Somerset East	7B
Somerset West	2A
Soshanguve	9C
Soutpansberg (east of 29°30' longitude)	13C
Soutpansberg (west of 29°30' longitude)	16C
Springs	9C
Standerton	8C

MAGISTERIAL DISTRICT	*PRICE ZONE*
Stellenbosch	2A
Sterkstroom	5A
Steynsburg	7A
Steytlerville	7B
Stockenström	5A
Strand	2A
Stutterheim	4A
Sutherland	12B
Swartruggens	10C
Swellendam	5A
Tabankulu	10B
Tarka	5A
Taung	11C
Thabamoopo	12C
Thaba ‘Nchu	10C
Thabazimbi (east of 27° longitude)	12C
Thabazimbi (west of 27° longitude)	13C
Theunissen	9C
Thohoyandou East	17C
Thohoyandou West	13C
Trompsburg	8A
Tsolo	7A
Tsomo	5A
Tulbagh	4A
Ubombo	7A

MAGISTERIAL DISTRICT	*PRICE ZONE*
Uitenhage	2A
Umlazi	1A
Umtata	6A
Umvoti	5C
Umzimkulu	5A
Umzimvubu	10B
Umzinto	3A
Underberg	5C
Uniondale	6B
Utrecht	7C
Vanderbijlpark	9C
Vanrhynsdorp	9B
Ventersburg	8C
Ventersdorp	10C
Venterstad	8A
Vereeniging	9C
Victoria East	4A
Victoria West	12B
Viljoenskroon	9C
Virginia	9C
Volksrust	7C
Vrede	8C
Vredefort	9C
Vredenburg	5A
Vredendal	9B
Vryburg (south of 26°30' latitude)	12C
Vryburg (east of 24° long. & north of 26°30' lat)	13C
Vryburg (west of 24° longitude)	17C

MAGISTERIAL DISTRICT	*PRICE ZONE*
Vryheid	6C
Vuwani	13C
Wakkerstroom	8C
Warm Baths	10C
Warrenton	11C
Waterberg	11C
Waterval Boven	9C
Weenen	5C
Welkom	9C
Wellington	2A
Wepener	8A
Wesselsbron	9C
Westonaria	9C
White River	10C
Williston	10B
Willowmore	7B
Winburg	9C
Witbank	9C
Witsieshoek	7C
Wodehouse	6A
Wolmaransstad	10C
Wonderboom	9C
Worcester	5A
Wynberg	1A
Xalanga	7A
Xhora (Elliotdale)	7A
Zastron	8A
Zwelitsha	3A