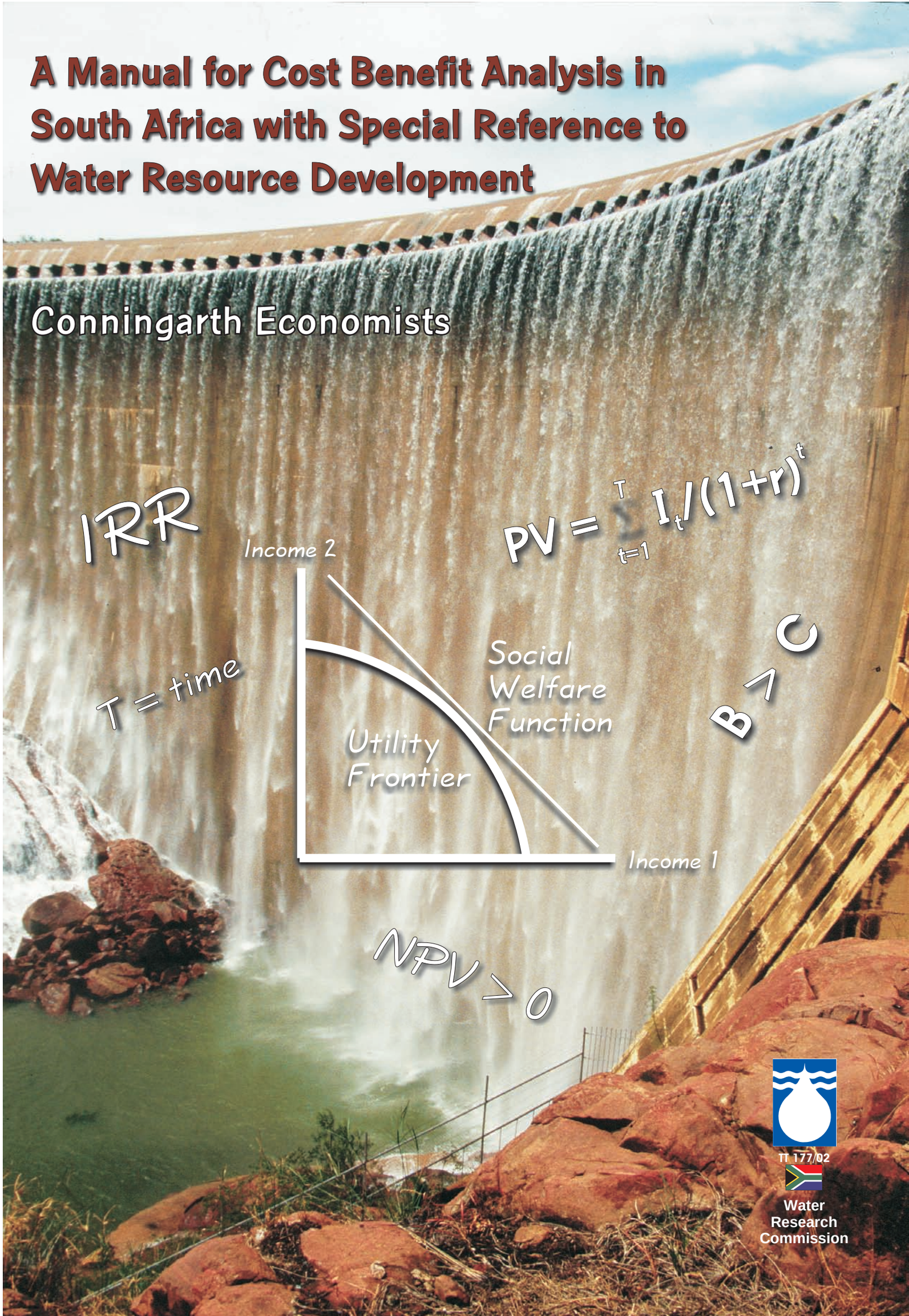
A Manual for Cost Benefit Analysis in South Africa with Special Reference to Water Resource Development

Conningarth Economists



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

Prepared for the
WATER RESEARCH COMMISSION
by

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CONTENTS

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 be used outside the public sector too.

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 Resource 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:

- 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; and
- it deals specifically with the uses, limitations and basic principles of cost-benefit analysis 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 macro-economic 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 also provided with a list of environmental aspects related to water development. Methodologies to calculate the economic value of water for various water usages are also 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 (WRC). 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

LIST OF TABLES

GLOSSARY

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

BCR	-	Benefit-Cost Ratio
C.I.F	-	Cost-Insurance-Freight
CBA	-	Cost Benefit Analyses
CGEs	-	Computable General Equilibrium Models
CVM	-	Contingent Valuation Method
DBSA	-	Development Bank of Southern Africa
DCFs	-	Discounting Cash Flow
DWAF	-	Department of Water Affairs and Forestry
ERR	-	Economic Rate of Return
F.O.B.	-	Free on Board
FRR	-	Financial Rate of Return
GAAP	-	General Accepted Accounting Principles
GNP	-	Gross National Product
HP	-	Hedonic Pricing Method
IMF	-	International Monetary Fund
I-O	-	Input-Output Models
IRR	-	Internal Rate of Return
MCDA	-	Multi-Criteria for Decision Analysis
NPV	-	Net Present Value
@RISK	-	Advanced Risk Analysis for Spreadsheets
SADC	-	Southern African Development Community
SAMs	-	Social Accounting Matrices
SARB	-	South African Reserve Bank
SARS	-	South African Receiver of Revenue
SETA	-	Sector Education and Training Authority
SSA	-	Statistics South Africa
STPR	-	Social Time Preference Rate
TCM	-	Travel Cost Method
UK	-	United Kingdom
UNIDO	-	United Nations Industrial Development Organization
VAT	-	Value Added Tax
WCD	-	World Commission on Dams
WfW	-	Working for Water Program
WMA	-	Water Management Area
WRC	-	Water Research Commission
WtA	-	Willingness to Accept
WtP	-	Willingness to Pay
WUA	-	Water Use Authority

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 MI motorway. In 1967, the British Government officially directed its nationalized 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 "standardized" 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 does 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 emphasized 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 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 neigbouring 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 with 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 those inoculated will benefit, but the rest of the community as a whole too, because of a 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 an 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 somewhat more emphasis should be put on a more indepth 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 criticize 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 Department of Water Affairs and Forestry and the Water Research Commission, 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 to the fact that over the past 12 years CBA has found extensive application 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 in South Africa are presented with specific reference to water utilization. These examples are the outcome of the use of the theory, principles, procedures and data bases of CBA as discussed in this manual.

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.

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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 freemarket 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 a optimal growth path, then the objective function for the National Income i.e (Y) can be stated in terms of the maximization 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 Economic Rate of Return (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 utilizes 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 economic rate of return. Put in another way, the FRR is not necessarily a true reflection of the most efficient utilization 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. Tradeoffs 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 criticized 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. Decisionmakers 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 (e.g. 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 characterize 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. Maximizing 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

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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.

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 generate appropriate planning solutions. Understanding of sectoral planning initiatives.

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

- *Project Economic Risk Analysis* – Ability to identify and assess the nature of risk to the project or progamme 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 1:

Example 1: Benefits and costs of a human investment program

		INDIVIDUAL	OTHERS	SOCIETY
Benefits				
1.	Increase in earnings after tax	x		x
2.	Future increase in taxes paid		x	x
3.	Non-monetary satisfaction	x		x
Costs				
4.	Tuition costs	x		x
5.	Costs of bursaries		x	x
6.	Higher living expenses	x		x
7.	Earnings foregone after tax	x		x
8.	Taxes foregone		x	x
9.	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.

8) DBSA – report; Part A, par 6.

9) DBSA – Ibid.

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

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.

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 emphasizes 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 3.4) in 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 1.1: 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, see 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 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 be always 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, input-output models and semi-input-output models (See 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

11) Boardman, Greenberg, et al Ibid Chapter 15.

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.

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[1)]. *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 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 determine 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.

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

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 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[2)].

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 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

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2) This adjustment is in line with the United Nations Industrial Development Organzation, 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.

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 take them specifically 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 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[3)] the following should be taken into account:

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3) UNIDO-publication. 1986. p 22.

"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[4)].

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

4) For a summed up version of this approach, see UNIDO-publication. Ibid. p. 22.

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 form 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[5)]:

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.

5) 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 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 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 result 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)[6)] 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 situation after the project is completed and the situation before it was started. If the costs 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 are the benefits of an e-mail service relative to fax machine, where communication resulted in a higher labour content.

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6) Thompson MS. 1980. *Benefit Cost Analysis for Program Evaluation*. London: Sage Publications.

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[1)], 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

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1) 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.

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)[2].

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.

(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.

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

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 net present value 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 maximizes 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 internal rate of return higher than the social discount rate, which forms a lower limit, will be considered for funding. The internal rate of return 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 benefit-cost ratio 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 benefit-cost ratio 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 following table 3.1 contains the present values of the benefits and costs involved in the construction of a dam.

Table 3.1: 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 of 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 3.2

Table 3.2: 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 benefit-cost ratios (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 net present value 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 recalculate the Cost Benefit Analysis 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 section 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 roleplayers 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 roleplayers 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[3)].

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

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

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:

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

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 3.3).

Table 3.3: 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 3.4: 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[4)] would require a choice of n and an estimate of the average income of the different groups affected by the project. Table 3.4 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. 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.

4) "Project Analysis Ibid on cit. P 291.

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 emphasizes 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)[1)].

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 4.1.

Table 4.1: 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 4.1 will be chosen in the order C, Z, D, A and B. In this way the benefit per rand spent is maximised.

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1) 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 benefit-cost ratio 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 benefit-cost ratio.

(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 benefit-cost ratios. Within each group of mutually exclusive projects by firstly reconsidering all more expensive projects and noting the benefit-cost ratio. Within each group of mutually exclusive projects the project with the highest marginal benefit-cost ratio 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 4.2. Projects A_1, A_2, A_3 and A_4 are four mutually exclusive projects.

Table 4.2: 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 benefit-cost ratio. The marginal BCR's 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 $E_5.E_3$ has the largest benefit-cost ratio, which means that E_3 is replaced at a cost of R200 000. This leaves only R270 000 and means that C_1 now replaces C_2 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 A_3 is chosen to replace project A_2 which leaves R230 000 and eliminates C_1. 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 $A_4.A_3$ falls within this limit, A_4 replaces A_3, leaving another R20 000 in the budget. Therefore it is decided to fund A_4, B, E_5 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 D_1. Sufficient funds can be acquired to pay for D_1 if A_2 is funded instead of A_4. This leaves R15 000 of additional benefits at R10 000 of additional cost, and the final list of projects is therefore –

A_2, B, D_1, E_5 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

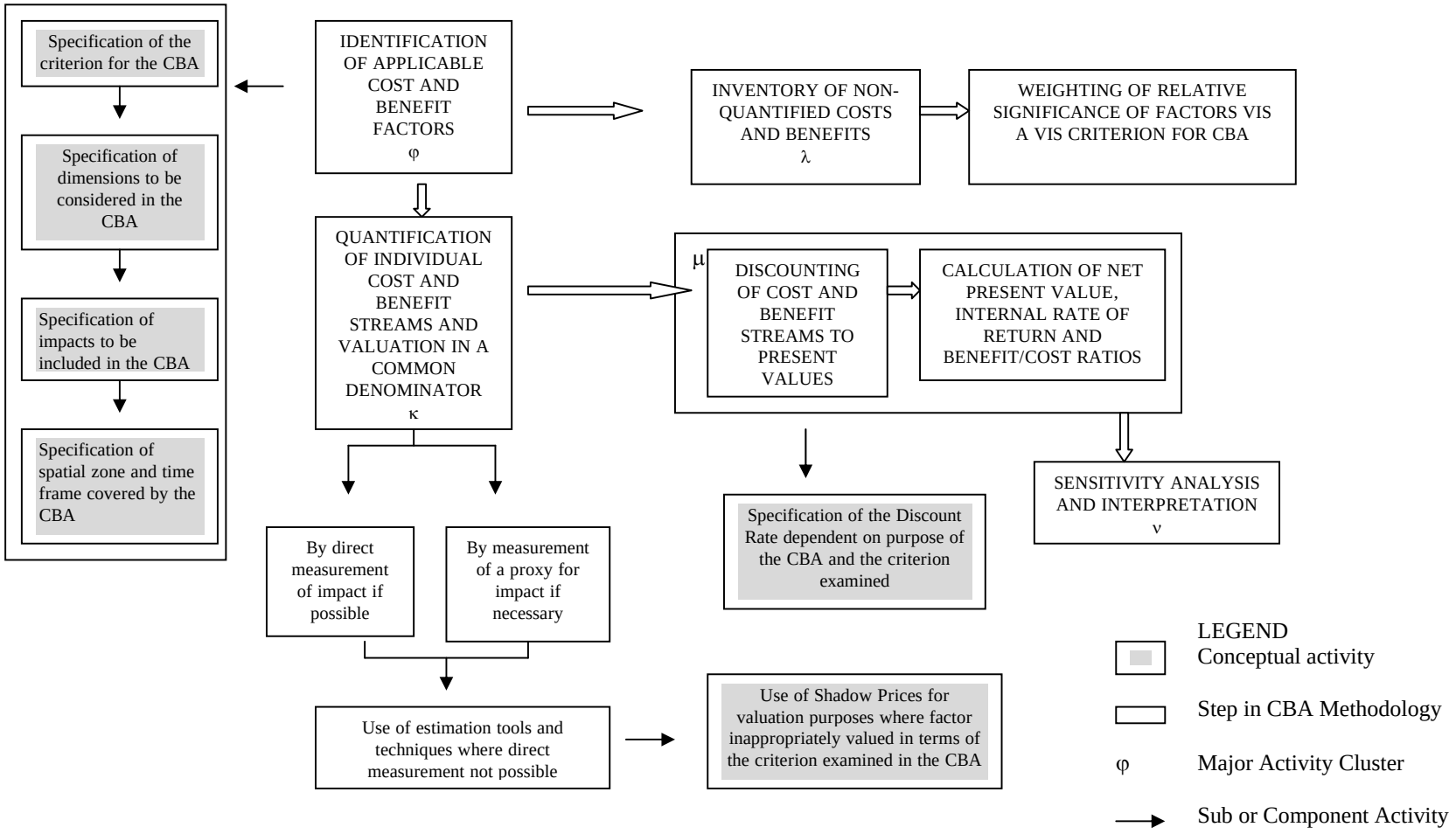
selected as *discount rate* for the calculation of present values of all cost and benefit streams.

- 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[1)]**

The practical steps required to execute CBA are summarised in Table 5.1:

1) Procedures used by DBSA.

Table 5.1: 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: (i) Distributional effects between income groups, population groups or geographical regions; (ii) Welfare consequences; (iii) Political and constitutional implications; (iv) Strategic consequences; (v) Prestige; (vi) The creation of job opportunities; (vii) The achievement of economic independence; and (viii) 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.

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: SHADOW AND SURROGATE PRICES FOR SOUTH AFRICA

6.1 INTRODUCTION

In practice the determination of shadow and surrogate prices for the purpose of CBA is normally a task that requires the application of the underlying economic principles in the specific circumstances. This requires a basic knowledge of those economic principles and the inputs and outputs in question. Especially in he light of the number of and variation in prices, it is therefore not possible to calculate shadow and surrogate prices in this manual for every input and output.

Nevertheless, general practical guidelines and broad estimates can be provided in respect 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 are largely dependent on the method of shadow price calculation, the effect of a change in shadow prices on the results of a project should be subjected to a sensitivity analysis.

6.2 REAL SOCIAL DISCOUNT RATES

According to Sassone and Schaffer[1)] "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 analysists 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."

The current (2001) official real discount rate is 8 percent. This was the rate recommended in the CEAS manual dated August 1989[2)]. This rate is in line with the discount rate recommended by major international development institutions, for instance the World Bank, who uses 10 percent. According to Kirkpatrick and Weiss[3)] "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

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

2) CEAS, 1989. *Manual for CBA in South Africa*.

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

reduced to 5 percent, referred to as the required rate of return. However, in 1988 it was increased again to 8 percent.

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).

The average long-term real interest rate of South Africa over the long-term (last 15 years) is approximately 5 percent. As stated previously, this is significantly lower than the preferred 8 percent presented above.

Although the calculation of the social time preference rate is very difficult to determine, this has not stopped some analysts attempting empirical estimates. According to Kirkpatrick and Weiss (1996)[4] "such estimates are normally in the 1 percent to 5 percent range, since per capital 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[5] calculate that the STPR is slightly in excess of the growth rate of an economy. The long-term growth rate for South Africa is only in the order of 2,5 to 5 percent. Once again the STPR is substantially lower than the 8 percent officially accepted.

The marginal return on capital approach (opportunity cost of capital) is more in line with the current official real discount rate of 8 % for South Africa. Currently an investment in government bonds, where no risk is attached, is giving a return of 4,5 percent in real terms (1990-2000). According to specialists in the field of investment, investors are looking for a return on investment of 5 percent above these no-risk government bond investment. This implies a return on capital in real terms of around 9 percent on risk attached investments.

In conclusion, taking into account the international discount rate benchmarks of 8 percent and high and the marginal return on capital approach that is in the order of 9 percent, the current 8 percent discount rate functioning in South Africa seems appropriate irrespective of the fact that both the real interest rate and the STPR are well below 8 percent.

Since the type of technology is 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.

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4) Kirkpatrick and Weiss. 1996. Ibid. p 11.

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

6.2.1 **Discount Rate for Environmental Purposes**

The discount rate has received renewed attention as part of the revived debate on discounting, stimulated in recent years by the issue of how to handle long-term environmental effects. According to Kirkpatrick and Weiss[6] "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)[7] proposed a new theoretical approach to resolving the dilemma of a discount rate for resources that are not replaceable by products that are the fruits 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".

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 should be discounted at the official discount rate of 8 %, and at rates which are much lower. The result should be disclosed to the policy maker.

6.3 **LABOUR INPUTS**

As was discussed under the issue of shadow prices for labour (See 2.4.3) it is highly probable that the price of labour will deviate from the marginal product of labour and that shadow prices for labour should be used to determine the correct impact of labour use.

6.3.1 **Unskilled labour**

The basis for the pricing of labour is that where unemployment does not exist, the market price of labour is used for all labourers. Where unemployment does exist, shadow wages are estimated for unskilled, and in some instances semiskilled workers. Professionals, managers and skilled labour should be valued at market prices even where unemployment exists. (The principles that apply in the determination of shadow wages are set out in detail in 2.4.3).

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

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6) Kirkpatrick and Weiss. 1996. Ibid. p 11.

7) Weitzman ML. 2000. *Gamma discounting, The American Economic Review*. March 2001.

In principle this shadow price for unskilled labourers is equal to per capita income in the various provinces for urban and non-urban areas separately. The per capita income of labourers is viewed as the economic value of labour. This is used as a proxy of its 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 such new job.

Box 1

The calculation of per capita income in South Africa separately for the urban and non-urban areas is not available. By using the following steps the intricate calculations of estimating the relevant figures are explained.

The basic data source for the calculation of shadow wages for unskilled workers per province is the 1996 census of Statistics South Africa (SSA)[8]. SSA Table 2.36 (1998:56) which reflects the individual monthly income amongst the employed by province aged 15-65 years (excluding institutions) was used. The category "unspecified" was distributed proportionally over the other categories. The monthly data were then converted to annual figures. Average annual incomes per worker were then calculated per province which were divided between urban and non-urban economically active persons as follows for each province:

- The SSA income intervals (Table 2.36) were reconciled with the income intervals used by the Development Bank for Southern Africa (DBSA)[9] in their 1995 provincial profiles. In this regard it is noteworthy that standardized DBSA tables were available for KwaZulu-Natal, Western Cape, North West, Mpumalanga, Free State and Northern Cape provinces.

- The DBSA income interval limits were reported in 1995 prices. These were inflated to 1996 prices (using the GDP inflator based on published figures of the SARB)[10] in order to coincide with the SSA income intervals in their abovementioned Table 2.36.

- The next step was to arrive at percentages for urban and non-urban income earners. SSA Table 2.4 (1998:6) reflects the urban and non-urban population per province in percentages. An arithmetic mean was applied to reconcile the available DBSA data with the relevant SSA data. The total number of workers per income category was then calculated by

8) SSA, 1996. Census in Brief Report No. 03-01-11.
9) DBSA, 1995. Provincial profiles.
10) SARB, September 2000, Quarterly Bulletin, S 131.

applying the relevant percentages of each income interval per province.

- For provinces for which the DBSA did not have the relevant data available, it was necessary to make assumptions. In this regard similarities in the relevant economic structures of provinces were taken into account. Eastern Cape province, for example, shares such similarities with KwaZulu Natal province and North West province with the Northern province. In the case of Gauteng province the relevant percentages per income category were a simulation of various factors one of which was the income structure in the Western Cape province.

- The total average per capita income calculated in the previous step, was calibrated to coincide with the average per capita income figure for South Africa in 1996 as implied in the South African Reserve Bank Quarterly Bulletin September 2000. This figure was obtained by dividing the current income of Households (6244J) on S131 by the total population as per SSA Census in Brief. The provincial per capita incomes were then adjusted proportionally.

- The average provincial personal income figures per capita were obtained from Annexure A in the DBSA publication "South Africa: Inter-Provincial Comparative Report" (2000:121). These relevant average provincial figures of the DBSA were adjusted to coincide with the relevant SARB total. The above-mentioned urban and non-urban figures were also adjusted accordingly.

- The last step was to inflate the resulting figures to 2000 prices by using the relevant SARB figure for 1999 as a proxy on a weekly, monthly and annual basis as reflected in the SARB Quarterly Bulletin for September 2000.

In Table 6.1 the weekly, monthly and annual shadow wages for unskilled labourers are reflected by province. These shadow wages are used only where unemployment exists and the skill levels of the 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 the workers involved should be viewed as insignificant. However, unemployment amongst unskilled workers in 2000 can be regarded as endemic in all provinces.

For practical purposes, it is sometimes useful to work with a shadow wage rate factor and not with the nominal wage rates as such. To calculate such factor it is necessary to select an appropriate wage for unskilled labourers paid in the

South African economy. The entry level for public servants was selected for this purpose. According to the Department of Public service and Administration[11)] this level amounted to R2 170 per month which includes the 13th cheque. However, all service benefits were excluded as there are pre-requisites to qualify for such benefits. Other sectors of the economy do not have similar remuneration packages for unskilled workers. The entry level of R2 170 is also in line with the minimum wages of most trade unions. 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 6.1(a) are too low and lead to an underestimation of the shadow wage rate in such cases where the existing remuneration is being used as the point of departure. However, as a result of the high unemployment levels such underestimation of the economic value of wages can probably be tolerated.

6.3.2 **Skilled labour**

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

Box 2

In order to calculate the remuneration for professional and semi-skilled income categories unpublished SSA data sources were used. These were obtained from the SSA by special request and are based on the 1996 population census. The original data sources consisted of 172 occupational categories per province which were then aggregated to reflect the 13 categories per province shown in Table 6.2. These monthly income figures were then converted to annual income figures per category for 1996. The latter figures were inflated to 2000 prices using current income 2000 divided by current income 1996 as per the SARB Quarterly Bulletin, September 2000, Table S131.

Consequently Table 6.2 provides the estimated remuneration for 13 occupational categories.

11) Official reply by Nkontwana, B.N. dated 19 October 2001.

6.4 FOREIGN EXCHANGE

The shadow price of the effective rand exchange rate (weighted average exchange rate against the currency of the RSA's most important trading partners) is given in Table 6.3. The methodology for calculating the relevant indices is explained in Box 3.

Box 3

An historical series of the effective rand exchange rate from 1990 to 1999 was obtained from the SARB Quarterly Bulletin September 2000 with 1995 as base year. This was converted to a series with 2000 as the base year. Both longterm (1970-2000) and shorter term (1985 to 2000) regression analyses were applied to the historical data. Explanatory variables namely time, politics and the gold price were used in various combinations in the regression analyses. The most reliable regression results were obtained for the long term analysis when all the three variables were incorporated. This latter regression equation was then used to make forecasts up to the year 2020. From 2020 the effective rand exchange rate was held constant.

For individual currencies, it is accepted that they will follow the same trend as the effective real rand exchange rate.

The shadow price for foreign currency also applies to projects in Swaziland and Lesotho.

6.5 GOODS AND SERVICES (EXCLUDING FUEL AND ELECTRICITY)

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

(i) The opportunity costs of agricultural products traded internationally are indicated by the commodity prices on the world markets as given in *International Financial Statistics*[12] (issued monthly by the International Monetary Fund). For imports that are banned, that need permits and to which import duties and surcharges are applied, reference is made to the Customs Tariff Book issued by Jacobsons Publishers (Pty) Limited[13].

(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

12) International Financial Statistics, IMF, Washington DC.
13) Jacobsons Publishers (Pty) Ltd., Durban.

ongoing changes as made public in the National Budget of the Department of Finance it is necessary to ensure that the most recent information is obtained from the relevant Department.

Details of goods on which VAT (value added tax) is payable can be secured from the Receiver of Revenue. An extract from the SARS publication "VAT Guide for Vendors"[14], April 2000, explaining the various VAT levels for businesses is given 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
- building materials and services
- cigarettes, cooldrinks and liquor
- electricity, water and refuse removals
- hotel accommodation
- lawyer's services
- local aeroplane flights
- transport of goods
- motor vehicles and spares
- paraffin
- telephone services
- washing powder
- books and newspapers
- business assets sold
- white bread
- clothing
- furniture
- meat or fish
- medicines
- medical services (other than by State hospitals)
- motor repairs
- postage stamps
- restaurant services

14) South African Revenue Services, April 2000, "VAT Guide for Vendors".

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

- fuel levy goods (e.g. petrol and diesel, but not paraffin)
- sale of a going concern (if in writing and meeting certain requirements – no input may be claimed by the purchaser in this case).
- 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)

DEEMED SUPPLIES

As a registered person, 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
- subsidies or grants received from the State
- goods acquired under an installment 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 the services of Transnet and the Post Office are often also determined administratively. Since the prices of many of Transnet services are supposed to be market-related, while the new national transport policy in the RSA allows for free competition between the different modes of transport with the exception of air transport, the difference between market-determined and controlled prices for land transport should gradually disappear. For this reason and 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. 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. So, for example, taxes that can be viewed as consumer levies on roads are included, while other general taxes that are used to the benefit of the general public are excluded. The shadow farmer diesel price differs from the shadow price of diesel for road transport in that the

user levies for roads and vehicle accident insurance are excluded in the case of the former. The relevant taxes and levies were obtained from the Department of Minerals and Energy in Pretoria[15)].

The calculated shadow prices for petrol and diesel must be adjusted for transport costs according to magisterial districts. In Table 6.4 the shadow prices of the various types of fuel are indicated in price zone 9C (Gauteng). For the calculation of shadow prices elsewhere, the transport adjustment according to magisterial district in Table 6.5 must be calculated. In this Table 6.5 the Gauteng zone C forms the cut-off point. The magisterial districts and the zones in which they appear, are indicated in Appendix A. Table 6.6 must be used for forecasting fuel prices. This index is based on the projection for crude oil prices by the World Bank, as well as the view on the exchange rate as reflected in Tables 6.6 and 6.3 respectively, while all other costs, which are part of the pump price of fuel, remain constant. The relevant pump prices were obtained from the Government Gazette dated 3 October 2000[16)].

6.7 **ELECTRICITY PRICES**

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

Electricity tariffs are comprised of generation, transmission and distribution costs. Currently (2001) there is an over supply of capacity in terms of generation. However, as over time the user demand is expected to increase, new generation plants will have to be constructed. This will cause a considerable increase in the current generating cost.

In view of the sensitiveness resulting from the planned privatisation of Eskom, the main supplier of electricity in South Africa, official projections of the relative price movements for electricity are not available. After consultation with authoritative sources an estimation of the probable relative price increases for electricity was done by the project team. In future the National Electricity Regulator (NER), Electricity Price Section, should be contacted for more up to date information. This should be done especially where the use or supply of electricity is of paramount importance.

In Table 6.7 the estimated relative price movements of the generation and distribution of electricity are given in the form of indices. These indices should be applied to the existing tariff over the period of the project being evaluated in

15) Department of Minerals and Energy, October 2000, Pretoria.
16) Government Gazette, 3 October 2000, Government Printer, Pretoria.

order to make provision for changes in relative movements in electricity tariffs. In the relevant calculations provision has been made that it is only the generating cost which will increase relatively. Therefore, the indices provided in Table 6.7 should be applied to the total electricity cost.

6.8 SURROGATE PRICES

6.8.1 Value of time

In Table 6.8 the value of time per working and recreational hour is estimated for workers as well as the value of time for all workers. It is expressed in 2000 prices and is calculated for low, middle and high income groups in each province. The relevant methodology is discussed in Box 5.

Box 5

- The average provincial annual remuneration for 13 occupational categories (see Table 6.2) served as the basis for the calculations for Table 6.8. The figures for these 13 categories were aggregated to represent high, middle and low remuneration groups. In this regard the "professional" and "manager executive" categories were classified to be the high income group whereas the category "workers" 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 6.8) was obtained by dividing the average for a specific income group by the total number of working hours 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 2080 hours which was rounded off to 2000 hours. This was done in order to take into account that not all workers are fully employed on a year 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 8766 hours.

- In order to calculate the provincial value of a recreational hour for all persons (see column 2 of Table 6.8) the labour force dependency ratio per province as published by the DBSA (ibid 2000:121) was used. The

value per recreational hour was obtained by dividing the value of a recreational hour for workers for the total population per province by the dependency rate per province.

- The SSA (1996, Report No. 03-01-12) published the dependency ratios per province only on an aggregated basis. For purposes of the CBA manual a dependency ratio is needed also for the three income groups i.e. low, medium and high. The nearest grouping to a dependency ratio per income group is a dependency ratio according to population groups which is also contained in the aforementioned SSA report. It was decided to apply the population group dependency ratio to proxy dependency income ratios. This was done by a somewhat complex mathematical method.

- Firstly, it was assumed that the African population dependency represents mostly the low income group. The coloured and asians are regarded as being the middle income group whereas it was assumed that the white population group represents mainly the high income group. By using the population group distribution by province the income dependency was adjusted upwards or downwards to be synchronized with the average employment dependency ratios per province as published by the SSA. Criticism could be levied at this methodology because it is assumed that the relative income dependency ratios in the income categories (population group) the same would remain for the various provinces. However, this methodology allows that for example the dependency ratio for the low income group in the Western Cape, may differ from that of Gauteng province.

- An example of how the employment dependency ratio for Western Cape province was calculated, is given below.

  ***** Average employment dependency is 2.8 which is the target which the three income groups should be added up to.

  * The national employment dependency ratios for low, medium and high income groups are as follows:

Low	(R0 – R22 688)	5.40
Medium	(R22 688 – R104 841)	3.05
High	(more than R104 841)	2.40

  * The population composition for the Western Cape is as follows (SSA 1996:8).

	Western Cape
Low	826 691
Medium	2 186 485
High	821 551
Total	**3 834 727**

* Should the income dependency ratios be weighed with the population composition per income group, the average employment dependency ratio is 3.42 which is higher than the objective of 2.8. Consequently each of the income dependency ratios had to be adjusted downwards by 0.82 to achieve the target of 2.8.

For forecasting purposes the values in Table 6.8 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 the 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 his 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 Road vehicle running cost and cost of collisions

Road vehicle running cost and cost of collisions for project evaluation on a national basis can be calculated with the aid of the information supplied in the following publications of CSIR Transportek:

Road vehicle running cost:

Program COSTDATA, available on the *i* Port CD.

Collision cost:

(a) Schutte, IC. Formats for expressing road collision cost and guidelines for accommodating inflation. Technical Report TR-2000/13, Transportek, CSIR, Pretoria, 2000.
(b) Department of Transport. An estimate of the unit cost of road traffic collisions in South Africa for 1998. Project Report CR-2000/4, Department of Transport, Pretoria, March 2000.
(c) Department of Transport. Methodology for the determination of the unit cost of road traffic collisions in South Africa as an input in to economic

evaluation. Project Report CR-99/009, Department of Transport, Pretoria, March 1999.

Attention is, however, drawn to the fact that these costs are given as national averages. Where the justification for new projects necessarily rests on regional or area differences in vehicle running and/or collision costs, it will be necessary to estimate the costs concerned at market prices. The same conversion factors as those given in program COSTDATA can then be used to estimate the resource costs of inputs.

It is also necessary to note that, in the calculation of collision costs in the abovementioned reports, use is made of the gross output method. With this method the share of the gross national product (GNP) allocated to road collisions is estimated. It does not provide the social costs of road collisions as could be calculated from the willingness of the community to pay for their prevention. If the "willingness-to-pay" principle were to be applied, a higher figure would probably have been obtained for collision costs. In the light of this, the information in the report concerned must be considered as a conservative estimate of collision cost.

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

In Table 6.9 the economic value of a human life in terms of future productive potential is estimated for different income groups on the basis of their future welfare per annum and on the remaining life expectancy. In Table 6.9 the value of a human life per annum is given as well as the capitalized value of the expected remaining lifetime for the relevant person. This is calculated by discounting the welfare per annum by 10 percent over the remaining lifetime. The relevant methodology is explained in Box 6.

Box 6

The economic value of a human life in terms of future productive potential consists of the annual welfare 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	R 30 563	88 421	2 947	2 947	2 947
Medium income person	R138 582	412 014	13 291	13 291	13 291
High income person	R500 152	1 608 900	47 321	47 321	47 321
Average	R 92 545	282 607	8 831	8 831	8 831
Total	**R761 841**	**2 391 941**	**72 390**	**72 390**	**72 390**

The annual welfare 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 welfare value over the expected remainder of a life it is necessary to have 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
SA	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 have been adjusted to make provision for the possibility that the relevant life expectancies are probably lower as a result of specifically the impact of Aids. This was done by making an adjustment for the levels of completeness of death registration for South Africa as also published in the aforementioned SSA report.

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 was 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 1996 age levels per population group were calculated by using Table A2.6 as in SSA report no. 03-01-12 (1996).

	Average age per population group
Africans	24.33
Coloureds	25.69
Indian	28.17
Whites	33.91
Other	27.62

In order to calculate the remaining life period for these population groups the difference between the average life expectancy and the 1996 age structure was calculated. The results are as follows:

	Difference
Africans	29.58
Coloureds	35.62
Indians	36.83
Whites	35.34
Other	40.33

For the purposes of this CBA manual it was necessary to convert the results for the population groups to income groups. This was done by making use of an income structure for the various population groups as given below:

	Total	High income households	Medium income households	Low income households	Total
Africans	31 127 631	6 %	44 %	50 %	100 %
Coloureds	3 600 446	12 %	49 %	39 %	100 %
Indians	1 045 596	30 %	56 %	14 %	100 %
Whites	4 434 697	64 %	29 %	7 %	100 %
Other	375 204	64 %	29 %	7 %	100 %

The source for this information was the SSA report No. 03-01-12 (1996), p. 58 and p. 117, where the income structure per population group is given and the total population respectively.

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	33.76	30.93	30.25

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 capitalized welfare.

The value reflected here is merely an indication of the economic value in terms of future productive potential of a person and it is by no means suggested that it 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 6.1

Estimated shadow wages for unskilled labourers per province

[Rands]

Provinces	Shadow wage in 2000 prices[1)]					
	WEEK		MONTH		YEAR	
	Urban	Non-urban	Urban	Non-urban	Urban	Non-urban
Eastern Cape	229	78	990	338	11,883	4,055
Free State	304	192	1,318	833	15,811	10,001
Gauteng	578	248	2,503	1,073	30,039	12,874
KwaZulu-Natal	333	113	1,441	492	17,293	5,901
Mpumalanga	357	157	1,547	679	18,564	8,145
Northern Cape	243	179	1,053	774	12,634	9,287
Northern Province	269	92	1,167	398	14,001	4,777
North West	284	96	1,231	415	14,770	4,981
Western Cape	425	324	1,842	1,405	22,105	16,865
Total	409	114	1,772	492	21,267	5,906

1) Whenever another base year is used, the above figures must be adjusted using the consumer price index for lower income groups.

Table 6.1(a)

Factors for adjustment of the market wage rate for unskilled labourers per province

[Rands]

Provinces		
	Urban	**Non-urban**
Eastern Cape	0.46	0.16
Free State	0.61	0.38
Gauteng	1.00	0.49
KwaZulu-Natal	0.66	0.23
Mpumalanga	0.71	0.31
Northern Cape	0.49	0.36
Northern Province	0.54	0.18
North West	0.57	0.19
Western Cape	0.85	0.65
Average	0.82	0.23

Table 6.2

Estimated annual remuneration for occupational categories in South Africa per province
[Rands, 2000 Prices]

Profession	Eastern Cape	Free State	Gauteng	KwaZulu-Natal	Mpumalanga	Northern Cape	Northern Province	North West	Western Cape	Total
Professional	106,599	90,945	125,579	112,223	101,252	104,784	73,823	71,250	123,224	114,759
Other professional	50,806	54,079	71,818	55,634	52,441	58,454	50,349	49,119	68,016	60,315
Technical	49,519	55,200	71,700	56,876	66,414	59,408	47,185	46,355	63,416	62,444
Manager executive	76,908	69,629	123,462	91,355	70,200	72,342	53,965	59,660	100,282	97,431
Clerical	33,847	32,521	43,667	35,101	32,795	31,118	31,724	30,489	38,585	38,017
Sales worker	20,045	22,356	35,448	23,359	19,053	21,083	16,089	19,621	30,612	26,502
Transport and communication	23,774	19,801	30,057	24,881	22,608	26,045	23,318	23,081	30,441	25,909
Service worker	33,651	32,414	33,740	29,396	28,443	36,601	29,004	29,833	35,272	32,290
Farming	29,758	25,085	32,186	23,204	28,439	60,577	14,659	34,731	63,577	31,431
Artisan	35,213	31,404	41,248	37,305	38,036	39,111	25,688	29,938	43,635	37,729
Production worker	23,211	23,514	30,588	25,830	26,981	26,470	20,821	23,331	29,789	27,002
Labourer	13,841	14,229	18,872	13,994	13,245	10,817	10,715	11,960	16,135	14,597
Other	17,715	13,481	29,201	25,435	15,886	17,017	15,503	17,002	25,740	22,687

Table 6. 3

Index of projected real effective exchange rate of the Rand (weighted average exchange rate against currencies of the most important trading partners)

Year	Foreign Exchange Index
2000	100
2001	93.70
2002	85.80
2003	84.32
2004	82.87
2005	81.44
2006	80.04
2007	78.66
2008	77.31
2009	75.98
2010	74.67
2011	73.38
2012	72.12
2013	70.88
2014	69.66
2015	68.46
2016	67.28
2017	66.12
2018	64.98
2019	63.86
2020 and beyond	62.76

Table 6. 4

Shadow price in cents for petrol and diesel on 4 October 2000 for Gauteng Zone 9C

Components	Petrol	Diesel	
	93 Octane	Road Transport	Construction and on Farm Use
Pump price	372.000	344.750	333.000
Less: Total taxes (included):	94.600	80.100	80.100
- Fuel taxes	90.600	76.100	76.100
- Customs and excise	4.000	4.000	4.000
Plus: Taxes as user charges (RAF)	14.500	10.300	-
- Expenditure on roads	3.000	3.000	-
Shadow price	294.900	277.950	252.900
Shadow factor	0.793	0.806	0.759

Source: Department of Mineral and Energy Affairs

Table 6.5

Transport adjustments for the calculation of shadow prices for petrol and diesel according to magisterial districts

Price zone	Price in cents per litre (October 2000)									
	Leaded petrol		Adjustment in cents		Unleaded petrol		Adjustment in cents		Diesel	
	93 Octane	97 Octane	93	97	93 Octane	95 Octane	93	95	Wholesale Price	Adjustment in cents
1A	361	365	-11	-11	361	361	-11	-11	334	-11
2A	363	367	-9	-9	363	363	-9	-9	336	-9
3A	364	368	-8	-8	364	364	-8	-8	336	-8
4A	365	369	-7	-7	365	365	-7	-7	338	-7
5A	367	371	-5	-5	367	367	-5	-5	340	-5
6A	370	374	-2	-2	370	370	-2	-2	342	-2
7A	371	375	-1	-1	371	371	-1	-1	344	-1
8A	373	377	1	1	373	373	1	1	346	1
9A	375	379	3	3	375	375	3	3	348	3
10A	377	381	5	5	377	377	5	5	350	5
11A	379	383	7	7	379	379	7	7	351	7
13A	383	387	11	11	383	383	11	11	355	11
15A	383	387	11	11	383	383	11	11	355	11
17A	383	387	11	11	383	383	11	11	356	11
19A	385	389	13	13	385	385	13	13	358	13
3B	367	371	-5	-5	367	367	-5	-5	339	-6
6B	369	373	-3	-3	369	369	-3	-3	341	-4

Source: Government Gazette, 3 October 2000 p3&4
& the Department of Mineral and Energy Affairs

Table 6.5 (continue)

Transport adjustments for the calculation of shadow prices for petrol and diesel according to magisterial districts

Price zone	Price in cents per litre (October 2000)									
	Leaded petrol		Adjustment in cents		Unleaded petrol		Adjustment in cents		Diesel	
	93 Octane	97 Octane	93	97	93 Octane	95 Octane	93	95	Wholesale Price	Adjustment in cents
7B	371	375	-1	-1	371	371	-1	-1	343	-2
8B	372	376	0	0	372	372	0	0	345	0
9B	373	377	1	1	373	373	1	1	345	1
10B	374	378	2	2	374	374	2	2	346	2
12B	375	379	3	3	375	375	3	3	348	3
14B	379	383	7	7	379	379	7	7	352	7
3C	363	367	-9	-9	363	363	-9	-9	335	-10
4C	364	368	-8	-8	364	364	-8	-8	336	-8
5C	366	370	-6	-6	366	366	-6	-6	339	-6
6C	368	372	-4	-4	368	368	-4	-4	341	-4
7C	369	373	-3	-3	369	369	-3	-3	342	-3
8C	371	375	-1	-1	371	371	-1	-1	344	-1
9C	372	376	0	0	372	372	0	0	345	0
10C	375	379	3	3	375	375	3	3	347	3

Source: Government Gazette, 3 October 2000 p3&4
& the Department of Mineral and Energy Affairs

Table 6.5 (continue)

Transport adjustments for the calculation of shadow prices for petrol and diesel according to magisterial districts

Price zone	Price in cents per litre (October 2000)									
	Leaded petrol		Adjustment in cents		Unleaded petrol		Adjustment in cents		Diesel	
									Wholesale	Adjustment
	93 Octane	97 Octane	93	97	93 Octane	95 Octane	93	95	Price	in cents
11C	377	381	5	5	377	377	5	5	349	5
12C	378	382	6	6	378	378	6	6	351	6
13C	380	384	8	8	380	380	8	8	353	8
14C	382	386	10	10	382	382	10	10	355	10
15C	382	386	10	10	382	382	10	10	355	10
16C	382	386	10	10	382	382	10	10	355	10
17C	383	387	11	11	383	383	11	11	356	11
31J	380	384	8	8	380	380	8	8	353	8
32J	386	390	14	14	386	386	14	14	358	14
33J	389	393	17	17	389	389	17	17	361	17
34J	389	393	17	17	389	389	17	17	361	17
35J	389	393	17	17	389	389	17	17	361	17
36J	386	390	14	14	386	386	14	14	359	14
37J	396	400	24	24	396	396	24	24	368	24

Source: Government Gazette, 3 October 2000 p3&4
& the Department of Mineral and Energy Affairs

Table 6.6

Index of projected prices for petrol and diesel

(2000 = 100)

Year	Petrol 93 Octane	Diesel
2000	100.00	100.00
2001	102.66	103.04
2002	106.54	107.48
2003	107.34	108.40
2004	108.16	109.34
2005	109.00	110.30
2006	109.85	111.27
2007	110.71	112.26
2008	111.59	113.27
2009	112.49	114.29
2010	113.40	115.33
2011	114.33	116.39
2012	115.27	117.47
2013	116.23	118.57
2014	117.21	119.69
2015	118.20	120.83
2016	119.21	121.98
2017	120.24	123.16
2018	121.29	124.36
2019	122.35	125.58
2020 and beyond	123.43	126.82

Table 6.7

Index of estimated relative changes in electricity prices

(base year 2000)

YEAR	Shadow Index
2000	100.00
2001	100.00
2002	102.00
2003	104.04
2004	106.12
2005	108.24
2006	110.41
2007	112.62
2008	114.87
2009	119.58
2010	124.48
2011	129.58
2012	134.89
2013	140.42
2014	146.17
2015	152.16
2016	158.40
2017	164.89
2018	171.64
2019	178.68
2020 and beyond	186.00

TABLE 6.8:
Estimated time cost according to income groups in 2000 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	6.92	0.19	1.58
Middle income group	17.36	0.83	3.96
High income group	43.14	2.63	9.84
Total population	**17.61**	**0.51**	**4.02**
Free State			
Low income group	7.11	0.49	1.62
Middle income group	15.38	1.87	3.51
High income group	39.01	6.04	8.90
Total population	**14.50**	**0.89**	**3.31**
Gauteng			
Low income group	9.44	0.65	2.15
Middle income group	21.41	2.61	4.89
High income group	62.19	9.62	14.19
Total population	**25.11**	**2.05**	**5.73**
Kwazulu-Natal			
Low income group	7.00	0.28	1.60
Middle income group	17.49	1.22	3.99
High income group	49.91	4.43	11.39
Total population	**18.19**	**0.78**	**4.15**

* A worker is a person who has indicated in the 1996 CENSUS that he was employed. (full time as well as part time)

** Life expectancies of persons in the following income R 0.00 - R 22 688 in the low income category, R 22 688 - R 104 841 in the middle income category and more than R 104 841 in the high income category.

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

TABLE 6.8: (continue)

Estimated time cost according to income groups in 2000 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)**
Mpumalanga			
Low income group	6.62	0.31	1.51
Middle income group	15.63	1.30	3.57
High income group	39.88	4.20	9.10
Total population	**15.06**	**0.75**	**3.44**
Northern Cape			
Low income group	5.41	0.23	1.23
Middle income group	19.36	1.43	4.42
High income group	42.05	3.95	9.59
Total population	**15.64**	**0.94**	**3.57**
Northern Province			
Low income group	5.36	0.14	1.22
Middle income group	15.21	0.70	3.47
High income group	30.10	1.77	6.87
Total population	**13.71**	**0.36**	**3.13**

* A worker is a person who has indicated in the 1996 CENSUS that he was employed. (full time as well as part time)

** Life expectancies of persons in the following income R 0.00 - R 22 688 in the low income category, R 22 688 - R 104 841 in the middle income category and more than R 104 841 in the high income category.

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

TABLE 6.8: (continue)

Estimated time cost according to income groups in 2000 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)**
North West			
Low income group	5.98	0.28	1.36
Middle income group	14.80	1.24	3.38
High income group	31.91	3.40	7.28
Total population	**14.21**	**0.70**	**3.24**
Western Cape			
Low income group	8.07	0.42	1.84
Middle income group	21.19	1.93	4.83
High income group	54.18	6.29	12.36
Total population	**21.22**	**1.73**	**4.84**
GRAND TOTAL			
Low income group	7.30	0.34	1.67
Middle income group	18.59	1.52	4.24
High income group	52.08	5.40	11.88
Total population	**19.43**	**1.01**	**4.43**

* A worker is a person who has indicated in the 1996 CENSUS that he was employed. (full time as well as part time)

** Life expectancies of persons in the following income R 0.00 - R 22 688 in the low income category, R 22 688 - R 104 841 in the middle income category and more than R 104 841 in the high income category.

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

Table 6.9

Economic value of productive life in 2000 prices (Rand)

Income group	Value of a life per year	Discounted life-time value of an average person
Low	2,947	R 30,563
Middle	13,291	R 138,582
High	47,321	R 500,152
Average	8,831	R 92,545

* In terms of 2000 prices, a worker earns :
R 0.00 - R 22 688 in the low income category,
R 22 688 - R 104 841 in the middle income category and
R 104 841 and more in the high income category.

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

Low:	30 years
Middle:	31 years
High:	34 years
Average:	32 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[1)]. 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

1) Raw Water Pricing Strategy, 1999, DWAF, Pretoria.

* 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
  * 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 m^3 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 7.1 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 7.1: Summary of calculation of the water costs for a typical River Basin

Dam Unit Cost	**Current 2000/01**
Domestic and Industrial	
Return on asset cost c/m ^{3}	6.02
Depreciation cost/m ^{3}	0.43
Betterments cost c/m ^{3}	0.00
Operation & maintenance cost c/m ^{3}	0.80
Functional support cost c/m ^{3}	0.00
Infrastructure cost	**7.24**
Catchment management cost c/m ^{3}	**0.03**
Working for water	0.02
Afforestation/Abstraction cost c/m ^{3}	0.01
Total unit cost c/m ^{3}	**7.27**
Irrigation (full quota: 11000/ha in m ^{3}	
Betterment cost R/ha	0.00
Operation & maintenance cost R/ha	119.50
Functional support cost R/ha	0.00
Infrastructure cost	**119.50**
Catchment management cost	1.58
Working for water cost R/ha	0.30
Abstraction/Afforestation cost R/ha	1.28
Sub Total	121.08
10 % increase ito SAAU Agreement	12.11
Total unit cost R/ha	**133.19**
Total unit cost c/m ^{3}	**0.0089**

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 a 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 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 7.2 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 7.2: Environmental aspects related to water development

Ecosystem Goods and Services	Ecosystem Functions	Examples
Gas regulation	Regulation for chemical composition of the atmoshpere	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, housebuilding 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, flyfishinf 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 officeswith 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)[2)]

"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)[3)]

"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)[4)]

"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)[5)]

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

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

3) Hanley, N. and Spash, C.L. Ibid p. 74.

4) Hanley, N. and Spash, C.L. Ibid p. 83.

5) Hanley, N. and Spash, C.L. Ibid pp 98-99.

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)[6)]). First, there may be some evidence of market-like transactions within a given sector. Payments of this level for 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

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

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)[7)] 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.

- **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 Water Research Commission is funding a project that uses cross-sectional analysis to determine price demand functions[8)].

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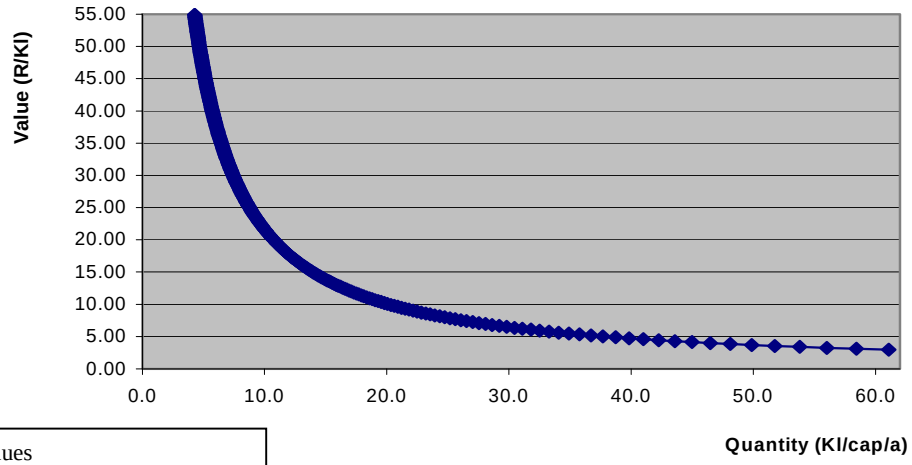
7) Veck, A, and Bill, M., 2000, Estimation of the residential price elasticity of demand for water by means of a contingent valuation approach. Report 790/1/00. Water Research Commission.

8) 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.

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[9)]

Graph 7.1 : Demand Curve : Households: High Income : Outdoor



Raw Water Values		
Base Tariff	=	R 2.96
Total Value	=	R483.34
Value/m3	=	R 7.91

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 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.

9) This is only a hypothetical case and the figures do not have any practical application.

The highest quantity lowest value represents the current tariff. In the case of the example in Graph 7.1 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[10)] and also by the World Bank[11)] 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.

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10) Internal Documentation of DBSA.

11) 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 Development Bank of Southern Africa currently uses 4 %[12)] 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 k*l* for a specific rural area is as follows:

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

  $$= \frac{\text{R40/month/household}}{\text{4,575 k}l\text{/month/household}}$$

  $$= \text{R8,74 per k}l$$

  Where:

  The monthly income of a rural household consisting of six persons is R1 000

  And:

  Monthly Water Consumption per household = 25 litres per capita per day x 6 persons x 30,5 days

  = 4,575 k*l* per month

12) 7 % for water and sanitation.

- 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 k*l* and the economic value of the social component, per k*l* as calculated above.

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

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

$$= \frac{\text{R3,20} + \text{R8,74}}{2}$$

$$= \text{R5,97}$$

Consequently the economic value for water is as follows:

Economic Value:	Social portion =	R8,74 per k*l*
	Private portion =	R5,97 per k*l*

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 an household consuming 15 k*l* per month, is as follows:

4,575 k*l* x R8,74/k*l*	=	R 39,99
10,425 k*l* x R5,97/k*l*	=	R 62,24
Total monthly value		R102,23

Value per k*l*	=	R102,23/15 k*l*
	=	R6,82/k*l*

7.2.3 **Irrigation Agriculture**[13)]

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

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

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 nonwater 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.

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 nonwater 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 maximize 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.

Linear programming 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[14)].

The main aim of the methodology is followed to calculate the economic value of water used in coal based power stations is to minimize the cost of water utilized in the process[15)].

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

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14) For calculation of the economic value of water for electricity generation by hydropower stations (See Gibbons Ibid, p. 86).

15) A similar approach is also discussed in Gibbons Ibid p. 50.

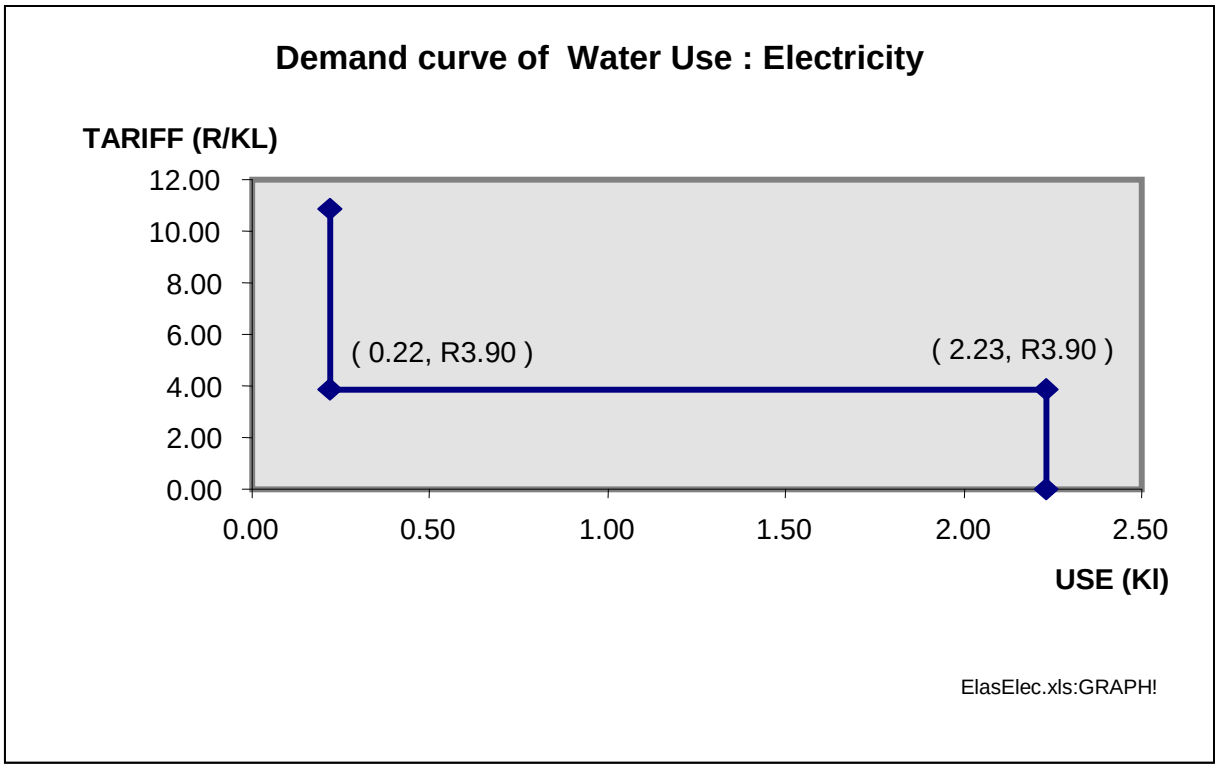
wet cooling system ± 2.23 *l* of water is used to generate 1 kWh of electricity compared with the 0.22 *l* of water per kWh of electricity in a dry cooled system.

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 Water Research Commission in 1999[16)] on dry cooling, it was established that at a water tariff of R3,90 per k*l* 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 7.2 below.

GRAPH 7.2



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

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 7.2 is probably more applicable when showing the real situation.

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 utilized.

It is thus clear that decisions on locality, technologies used, and scale of operations to maximize 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[17)].

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[18)].

7.3 **COMPUTER PROGRAM FOR CONVERSION FACTOR FOR ASSETS**

A computerized methodology has been developed whereby shadow price of various water augmentation assets, for instance types of dams pump stations etc, as well as of any other asset can be calculated. The output of the model is given in Table 7.3. The model will also be available in electronic format as part of

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17) See Gibbons, Ibid, for more explanations.

18) 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

the manual. It should be noted that the figures are only given for illustrative purposes.

Table 7.3

CONVERSION FACTORS

RELATIVE IMPORTANCE OF INPUTS WHERE SHADOW PRICES ARE APPLICABLE	DIESEL	PETROL	ELECTRICITY	UNSKILL LABOUR	SUGAR PRICE (EXCHANGE RATE)	CUSTOMS DUTY	MATERIALS	OVERHEADS & PROFIT	ENGINEER FEES	FACTOR NO.10	WEIGHTED SHADOW PRICE FACTOR
WATER AUGMENTATION COMPONENTS											
CONSTRUCTION											
1. STORM WATER	0.10	0.05	0.01	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.9019
2. SANITATION & BULK WATER											
2.1 Treatment works (water & sewer)	0.03	0.00	0.00	0.17	0.00	0.07	0.40	0.20	0.13	0.00	0.9120
2.2 Pumpstations (water & sewer)	0.03	0.00	0.00	0.17	0.00	0.10	0.37	0.20	0.13	0.00	0.9105
2.3 Bulk pipelines (water & sewer)	0.07	0.00	0.00	0.17	0.00	0.17	0.27	0.20	0.13	0.00	0.8962
2.4 Reticulation (water & sewer)	0.03	0.00	0.00	0.17	0.00	0.10	0.37	0.20	0.13	0.00	0.9105
2.5 Reserviors	0.03	0.00	0.00	0.17	0.00	0.07	0.40	0.20	0.13	0.00	0.9120
3. BULK WATER	0.12	0.06	0.02	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.8947
4. ELECTRICITY	0.07	0.02	0.01	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.9361
5. FURNITURE	0.07	0.00	0.09	0.29	0.00	0.43	0.00	0.00	0.00	0.00	0.8385
6. VEHICLES	0.06	0.00	0.07	0.18	0.00	0.34	0.00	0.00	0.00	0.00	0.8920
7. ROADS	0.21	0.12	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.8567
8. PARKS & RECREATION	0.21	0.12	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.8567
9.COMPUTER & OFFICE EQUIPMENT	0.06	0.00	0.06	0.19	0.00	0.40	0.00	0.00	0.00	0.00	0.8842
10. EXTRA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.0000
11. SCHOOLS, CRECHES, ETC.	0.08	0.02	0.05	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.9147
MAINTENANCE											
12. MAINTENANCE & OPERATION - ROADS	0.16	0.09	0.02	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.8578
											1.0000
13. SANITATION & BULK WATER											
13.1 Treatment works (water & sewer)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.9990
											1.0000
13.2 Pumpstations (water & sewer)	0.00	0.00	0.00	0.01	0.00	0.01	0.02	0.00	0.00	0.00	0.9950
13.3 Bulk pipelines (water & sewer)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.9988
13.4 Reticulation (water & sewer)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.9990
13.5 Reserviors	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.9984
14. ELECTRICITY, PARKS, SCHOOLS	0.03	0.01	0.01	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.9676
SHADOW PRICE ADJUSTMENT FACTOR	**0.73**	**0.73**	**1.09**	**0.55**	**1.17**	**0.95**	**1.00**	**1.00**	**1.00**	**1.00**	

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 website http://www.wrc.org.za 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
  - Pumpstation
  - 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
  - Pumpstation
  - 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)

ANNEXURE A

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
Belville	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
Graaf-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
Moorreesburg	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

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