2.0 ECONOMIC FEASIBILITY STUDY

2.1 Definition of Terms

2.1.1 Project or Product Life

The life cycle of an engineering project or product consists of several stages, namely:

1) Planning and design;
2) Manufacture or construction;
3) Operation and maintenance.

2.1.2 Value of product or services

The human needs which are targeted by the project or product are only satisfied during the last stage of the product or project life cycle, the stage of operation and maintenance. The services that satisfy the targeted human needs are valued by attaching a market price to them and counting them. In this way, the utility value of the product or service is determined.

2.1.3 Cost of product or services

The various stages in the life cycle of an engineering product or project are also associated with costs, or value sacrificed to create utility value. These costs are incurred during all the stages, namely:

a) Planning and design costs;
b) Manufacture or construction costs;
c) Operation and maintenance costs.

2.1.4 Accounting profit

The accounting concept of profit is defined as value created in excess of value sacrificed, by an economic unit or investment project, during an accounting period (usually not exceeding one year). This can also be expressed through the accounting principles of revenue (value created during the period), and expense (value sacrificed to create revenue).

Investment projects or businesses regularly produce two types of financial reports to measure their financial performance. These are the income statement, more often called the profit and loss account, and the statement of financial position, more often called the balance sheet. An example of such statements is shown in the annual reports of Kenya Airways Ltd[1], and that of East African Breweries Ltd[2].
The income statement or **profit and loss account** states that for the quoted calendar period, Income or Revenue, less Expenditure equals Profit.

[1] *Kenya Airways Ltd, Annual Report for year ending March 2006, Page 48, 49*
[2] *East African Breweries Ltd. Annual Report for the year ending June 2005, page 31, 32*

The **balance sheet** shows the value of assets, liabilities, and owner's equity (net assets) at particular points in time, the beginning and the end of the accounting period.

2.1.5 Return on investment

The accounting concept of profit can be used to study economic feasibility and to measure the financial performance of an investment project. This is done by measuring the return on investment or profitability, defined as the profit at the end of the accounting period, divided by the net assets or owner's equity (capital employed) at the beginning of the period.

Table 1 below shows a summary of the financial statements for the two businesses, namely Kenya Airways and East African Breweries, and how the accounting concepts of net assets (owner's equity) and net profit are used to measure return on investment for the two companies for the specified period.

Table 1: Rate of return based on accounting statements

Company-Period	Net assets (MKshs).	Net profit (MKshs).	Return on assets	Shares issued	Net Assets Per share	Earnings per Share
KQ-2005/6	12340	4829	39%	461615484	26.7	10.45
EABL-2004/5	13544.51	4770	35%	658978530	20.6	7.24

The return on investment is **39 %** and **35 %** for **Kenya Airways** and **East African Breweries** respectively.

2.1.6 Dividend Yield-AN INDICATOR OF RETURN ON INVESTMENT

The Dividend Yield is an investment performance indicator that is similar to the return on investment defined at section 2.1.5 above. It is used for measuring the investment performance of businesses quoted in the stock exchange. This indicator is included in the Weekly Market Report on the Nairobi Stock Exchange shown at **Table 2** for the week ending 18th August, 2006.

The indicator is computed from the ratio of the latest annual dividend paid per share (DPS) to the current price per share (Closing Price This Week), and reported as a percentage.

This indicator of investment performance therefore measures return on investment in terms of profit actually distributed to shareholders through payment of dividends. It ignores profit withheld in the business as retained earnings, which is still a return to the investment. Secondly, the performance indicator is based on the current market value of net assets, instead of the value of net assets shown in the balance sheet.

TABLE 2: WEEKLY MARKET STATISTICS-NAIROBI STOCK EXCHANGE

WEEK ENDING 18TH AUGUST 2006

WEEKLY MARKET STATISTICS FOR THE WEEK ENDING FRIDAY 18th AUGUST 2006									
Ordinary Shares	**Average Prices Last Fri:**	**Average Prices This Fri:**	**Shares Traded During week**	**Total Shares Issued**	**Mkt Cap Million Kshs**	**EPS**	**DPS**	**P/E**	**Dividend Yield**
MAIN INVESTMENT MARKET SEGMENT (MIMS)									
Agricultural									
Unilever Tea	88.50	88.50	2,729	48,875,000	4,325	1.41	2.00	62.8	2.26%
Kakuzi	34.50	35.25	1,800	19,599,999	691	(3.76)	0.00	-9.4	0.00%
Rea Vipingo	19.00	21.00	331,939	60,000,000	1,260	2.07	0.80	10.1	3.81%
Sasini	29.75	29.75	105,081	38,009,250	1,131	-10.17	0.00	-2.9	0.00%
Commerc.and Allied									
Car & Gen	37.00	34.25	46,300	22,279,616	763	8.71	0.67	3.9	1.96%
CMC	82.00	89.00	########	48,559,120	4,322	7.00	1.50	12.7	1.69%
Hutchings Biemer	20.25	20.25	-	360,000	7	-18.34	0.00	-1.1	0.00%
Kenya Airways ltd	117.00	115.00	########	461,615,484	53,086	10.45	1.75	11.0	1.52%
Marshalls	32.75	32.75	-	14,393,106	471	3.11	1.00	10.5	3.05%
Nation Media Group.	202.00	201.00	113,241	71,305,260	14,332	10.04	6.00	20.0	2.99%
TPS Eastern Africa (Serena) Ltd	100.00	101.00	98,262	89,865,588	9,076	4.96	1.25	20.4	1.24%
Uchumi Supermarkets	14.50	14.50	-	180,000,000	2,610	-6.82	0.00	-2.1	0.00%
Finance & Invest.									
Barclays Bank	290.00	294.00	123,503	203,682,600	59,883	18.00	14.00	16.3	4.76%
CFC Bank	82.00	82.00	162,720	156,000,000	12,792	3.17	0.84	25.9	1.02%
Diamond Trust	72.00	68.50	398,634	124,218,750	8,509	2.43	0.00	28.2	0.00%
Equity Bank Ltd	122.00	120.00	614,267	90,564,550	10,868	3.80	2.00	31.6	1.67%
Housing Finance	36.50	41.00	########	115,000,000	4,715	0.51	0.00	80.4	0.00%
ICDC	135.00	145.00	173,532	54,995,188	7,974	5.37	3.00	27.0	2.07%
Jubilee Holdings Ltd	163.00	163.00	18,526	36,000,000	5,868	9.66	4.00	16.9	2.45%
K.C.B Bank	179.00	176.00	########	199,600,000	35,130	6.00	4.00	29.3	2.27%
National Bank	54.00	49.25	875,586	200,000,000	9,850	1.29	0.00	38.2	0.00%
National Industrial Credit	96.50	96.00	164,891	82,414,551	7,912	3.34	2.50	28.7	2.60%
Pan Africa Insurance Holdings Ltd	52.00	85.00	51,334	48,000,000	4,080	3.68	1.20	23.1	1.41%
Standard Chartered Bank	155.00	156.00	91,126	271,967,810	42,427	8.72	7.50	17.9	4.81%
D.Indust. & Allied									
Athi River Mining Ltd	79.00	84.50	528,317	94,000,000	7,943	2.10	0.75	40.2	0.89%
BOC (K)	160.00	160.00	-	19,525,446	3,124	10.62	5.50	15.1	3.44%
Bamburi	150.00	164.00	198,225	362,959,275	59,525	5.52	5.30	29.7	3.23%
British American Tobacco	192.00	192.00	20,318	100,000,000	19,200	13.82	12.50	13.9	6.51%
Carbacid	137.00	137.00	-	11,326,755	1,552	10.01	5.00	13.7	3.65%
Crown Berger	35.00	34.25	32,034	23,727,000	813	1.45	1.00	23.6	2.92%
E.A.Cables	524.00	525.00	370,852	20,250,000	10,631	10.40	5.00	50.5	0.95%
E.A.Portland	130.00	130.00	14,100	90,000,000	11,700	6.75	2.50	19.3	1.92%
E.A.Breweries	135.00	138.00	681,000	658,978,630	90,939	7.24	4.50	19.1	3.26%
Kenol	130.00	117.00	5,939	100,796,120	11,793	8.92	2.25	13.1	1.92%
K.Pow.& L.	150.00	183.00	985,535	79,128,000	14,480	16.05	1.50	11.4	0.82%
KenGen	32.75	32.00	########	###########	70,348	0.80	0.23	40.0	0.72%
Mumias	56.00	55.50	########	510,000,000	28,305	2.53	1.50	21.9	2.70%
Olympia Capital Holdings	14.70	14.70	1,000	10,000,000	147	1.14	0.00	12.9	0.00%
Sameer Africa Ltd	15.25	14.90	784,306	278,342,393	4,147	0.74	0.50	20.1	3.36%
Total	37.25	37.50	332,788	175,064,706	6,565	3.04	2.50	12.3	6.67%
Unga	15.85	15.50	197,487	63,090,728	978	1.15	0.00	13.5	0.00%

The dividend yield indicator is similar to the return on investment defined at section 2.1.5, except that profit is replaced by dividend, while the balance sheet value of net assets is replaced by market value.

The dividend yield is therefore more relevant to the short-term investing shareholder buying the shares currently in expectation of the next dividend. To such an investor, the **market value paid** today and represented by the price of share, is more realistic than the value of **net assets** per share shown in the **balance sheet**. Secondly, the **dividend** expected **at end of the year** is more certain than the future growth of investment that might arise from retained earnings. The dividend yields of the two companies quoted are reproduced in **Table 3** below for comparison:

TABLE 3: KENYA AIRWAYS AND EAST AFRICAN BREWERIES
NAIROBI STOCK EXCHANGE-WEEK ENDING 18TH AUGUST 200

Ordinary Shares	Average Prices Last Fri:	Average Prices This Fri:	Shares Traded During week	Total Shares Issued	Mkt Cap Million Kshs	EPS	DPS	P/E	Dividend Yield
MAIN INVESTMENT MARKET SEGMENT (MIMS)									
Commerc.and Allied									
Kenya Airways ltd	117.00	115.00	1,360,621	461,615,484	53,086	10.45	1.75	11.0	1.52%
D.Indust. & Allied									
E.A.Breweries	135.00	138.00	681,000	658,978,630	90,939	7.24	4.50	19.1	3.26%

For the two businesses quoted, dividend yield as shown in Table 3 is 1.52 % and 3.26 % for Kenya Airways and East African Breweries respectively. **East African Breweries** is therefore a **better investment** when the **dividend yield** is used as the **indicator**.

The return on investment measured as dividend yield in Table 3 is however much lower that the return on investment measured by the accounting statements (return on net assets) shown in Table 1.

This is firstly because the **market value** of net assets (current share prices), used to measure dividend yield in Table 3, is higher than the **balance sheet value** of net assets used in Table 1, and secondly because **dividend** paid used in Dividend yield, is lower than earnings per share or **net profit** used in Table 1.

The Weekly Market Report of the Nairobi Stock Exchange shown at Table 2 therefore reveals an investment opportunity.

The dividend yields for the various quoted companies indicate short-term returns on investment that can be compared to other short term Investment opportunities such as the savings accounts in banks, unit trusts managed by fund managers of investment banks, or Government of Kenya (GOK) securities, such as treasury bills and bonds.

A word of caution however. Dividends are returns, which fluctuate from year to year, depending on the actual investment performance of the business for that year, and the company's dividend policy. There is therefore greater uncertainty in the dividend yields than in the fixed interest investments such as bank savings accounts, unit trusts in the money market, and GOK securities. The investor must therefore consider this difference in risk.

For the period considered of the year 2005/6, the return on investment of the two companies can be compared with other investment alternatives such as:

1) Money market unit trusts, Old Mutual was offering a rate of 6.95%, for a minimum investment of Kshs. 500000 on 22 August 2006.
2) Treasury bill rate[3] were reported as shown below

   The average 91 days Treasury Bill rate, the TB rate has steadily increased from a low of 5.5 per cent in to a high of 7.5 per cent as of last week.

   The short-term Treasury Bill rate increased from an average of 5.52 per cent in the week ending August 9, to an average of 5.63 per cent in the week ending August 16.
3) The interest rates for savings accounts in banks were lower than the TB rates, and money market unit trusts.

2.1.7 Economic feasibility (worthwhileness) of an investment project

The return on investment computation, based on the accounting concept of profit (see section 2.1.5), is only valid for the accounting period (not exceeding one year), rather than the entire project life.

The economic feasibility (worthwhileness) of a project or product, on the other hand, is measured by the extent to which the utility value received during the **entire project or product life**, exceeds the proper costs incurred in creating the utility value.

In economic feasibility study, utility value (over the project or product life) is equivalent to accounting revenue, while costs (also over the project life) are equivalent to the accounting expense. However, the terms are not synonymous, because the accounting terms are applicable to short periods (not exceeding one year), during which period, the time value of money is ignored. The equivalent terms for the economic feasibility, apply to the entire project or product life (usually of several years), during which period, the time value of money must be taken into consideration.

2.1.7 Time value of money

Time value of money is the recognition that one shilling received today is worth more than one shilling received in the future. The rent or interest each investor charges for its use can quantify this time value money. Time value of money therefore depends on the investment opportunities available to each investor.

For example, in August 2006, an investor who could set aside Kshs. 500000, could invest in unit trusts with a return of 6.95%. A second investor could invest Kshs. 1 million in GOK securities (Treasury Bills) with a return on investment of 5.5 %. A third investor who could not raise the minimum required for investment in money market unit trusts or GOK securities, but was able to set aside Kshs. 30,000 could invest in a savings account with a commercial bank or finance company with a return on investment or interest that is lower than the 6.95 % in the money market unit trusts or 5.5 % in the TB rates.

The **first investor** could therefore rightly consider **6.95 % per annum** as the minimum return on investment or interest he should accept for his money. The **second investor** would consider **5.5 % per annum** as his minimum return. On the other hand, the **third investor** would consider a lower interest (possibly **3% per annum** in commercial banks) as the practical minimum return

[3] *The Standard, 23 August 2006, Banks hold 48pc of T-Bills, Kimathi Njoka and Benson Kathuri*

on investment he should accept. All the three investment opportunities have similar and low risks (provided the bank or finance company is carefully chosen).

These investment opportunities with lowest risks and offering the minimum returns to a particular investor comprise the **opportunity** that the investor would **forego** for any other **alternative investment**. Economists refer to the returns offered by such investments as the **opportunity cost** for the investor. Clearly, the opportunity cost varies with each investor and with time.

Other factors influencing an investor's opportunity cost is the information available to the individual investor regarding available investment opportunities. Such factors are assumed equal, but this is often not so.

For example, an investor may not be aware that GOK Securities such as treasury bills or bonds offer higher returns on investment, at risks, which are similar to savings accounts at commercial banks. This similarity in levels of risk is indicated by the fact that commercial banks[4] and finance companies invest the deposits of other investors in GOK securities as quoted below.

Close to 48 per cent of Treasury Bills and Bonds investments are held by commercial banks, according to data released by Central Bank of Kenya….CBK says in its weekly bulletin released yesterday that demand for the securities from banks has been rising steadily in the last three months despite the investments' low return…."Banking institutions continue to dominate the Government securities market," says the bulletin.

The fact that investors other than commercial banks do not invest directly in GOK securities is therefore due largely to lack of information.

Because the opportunity cost is the **minimum return on investment** that a particular investor is willing to accept, other **alternative investment** projects will only be attractive if they **offer higher returns**, other factors such as risks, remaining equal. The **opportunity cost** therefore represents the **minimum rent or interest** that the investor will charge for the use of his money. The **opportunity costs** of different investors therefore represent the minimum time value of money for each investor.

Engineering projects are investments undertaken by either individuals or business organisations. They are therefore subject to the opportunity cost of the prospective investor in the same manner as any other investment. The only difference will be that Engineering projects may involve large investments requiring huge resources.

2.2.0 Methods for Economic Feasibility Studies

Several methods are available for carrying out economic feasibility study of engineering (investment) projects. These are:

1) Payback period method
2) Present worth method-Net Present value (NPV)
3) Rate of return method-Internal Rate of Return (IRR)
4) Benefit–cost ratio method
5) Annual cost (capital recovery) method-Present Value of Costs (NPV)

[4] *The Standard, 23 August 2006, Banks hold 48pc of T-Bills, Kimathi Njoka and Benson Kathuri*

2.2.1 Payback Period Method

The payback period[5] is the time it takes for the cumulative present value of benefits to become equal to the cumulative present value of costs. In general, shorter payback periods are better

2.2.2 Price over Earnings (P/E) Ratio –AND RETURN ON INVESTMENT

A simplified version of the payback period method is used as an investment performance indicator for businesses quoted in the Stock Exchange. In this application, the current value of the business, determined from current price of shares, is assumed to represent the value of the **initial investment**.

The Payback period method is then simplified by ignoring the time value of money. The initial investment is simply divided by the **annual profit**, to obtain an estimate of the number of years of profit required to pay back the initial investment, assuming future annual profit remains constant.

The argument behind this indicator is that after the investor recovers his initial investment from profit, he will feel compensated and be satisfied.

The Price over Earnings ratio is a reasonable indicator to an investor who is purchasing the shares currently. The latest earnings per share (as reported in the latest annual accounts), is taken to represent annual profit. The Earnings Per Share (EPS) is computed by dividing the annual profit after taxation by the number of shares issued. The payback period is then obtained as the ratio of current price per share, to the latest earnings per share, a price over earnings (P/E) ratio.

The (P/E) ratio is reported in the Weekly Market Report of the Nairobi Stock Exchange, which is shown at Table 2. Applying this investment performance indicator to the profit and loss accounts of Kenya Airways and East African Breweries shown at Table 2, yields the comparisons in **Table 3** repeated below:

TABLE 3: KENYA AIRWAYS AND EAST AFRICAN BREWERIES
NAIROBI STOCK EXCHANGE-WEEK ENDING 18TH AUGUST 200

Ordinary Shares	Average Prices Last Fri:	Average Prices This Fri:	Shares Traded ring the week	Total Shares Issued	Mkt Cap. Kshs Mn.	EPS	DPS	P/E	Dividend Yield
MAIN INVESTMENT MARKET SEGMENT (MIMS)									
Commerc.and Allied									
Kenya Airways ltd	**117.00**	**115.00**	1,360,621	461,615,484	53,086	10.45	1.75	11.0	1.52%
D.Indust. & Allied									
E.A.Breweries	**135.00**	**138.00**	681,000	658,978,630	90,939	7.24	4.50	19.1	3.26%

The P/E ratio of Kenya Airways is then found to be 11 compared to 19 for East African Breweries. **Kenya Airways** is therefore a **better investment** when **P/E ratio** is used as the **indicator**.

A word of caution however. The earnings per share shown for quoted companies is not necessarily paid out to shareholders as dividend. Each company decides what part of this EPS is to be paid out as dividend. Usually, only part of the EPS is paid out as dividend. On rare

[5] Cost Benefit Manual, Rideau Strategy Consultants Ltd., Kenneth Watson, Section 6, www.RideauGroup.com, 2005

occasions, a dividend exceeding the EPS is paid out using part of previously retained earnings. When the dividend is less than the EPS, the balance of the EPS is retained in the business, often to finance expansion or for similar reasons.

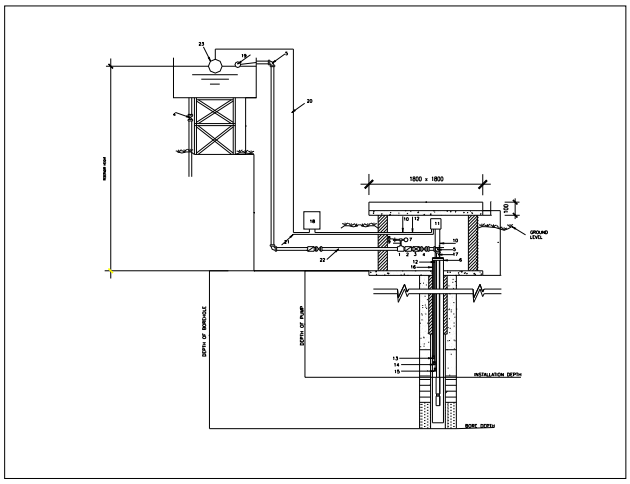
The payback period represented by the (P/E) ratio in the Weekly Market Report of the Nairobi Stock Exchange, shown at Table 3, is therefore more relevant to the long term business, rather than to the short term investing shareholder.

The short-term shareholder may not be prepared to wait for the 11 or 19 years payback period, to benefit from any earnings retained in the business. The indicator is however relevant to the long-term investor who would benefit from the growth or capital gains in value of shares that would arise from retained earnings being used to expand or modernise the business.

The various methods for investment analysis, namely: Payback period method, Net Present value (NPV), Internal Rate of Return (IRR), Benefit–cost ratio method, Present Value of Costs (NPV), are summarised in the cost benefit manual[6]

[6] Cost Benefit Manual, Rideau Strategy Consultants Ltd., Kenneth Watson, Section 6, www.RideauGroup.com, 2005

EXAMPLE 1: UGUNJA WATER SUPPLY PROJECT



ANNUAL COST METHOD

CAPITAL COSTS FOR THE PROJECT

TABLE 2.1: CONSTRUCTION, INSTALLATION, AND COMMISSIONING COSTS

	ASSET DESCRIPTION	COST (KSHS.)
1	**MECHANICAL & ELECTRICAL EQUIPMENT**	**150,000.00**
	Submersible pump, Electrical Cabling, Switch-gear & Controls, Power Supply equipment	
2	**PIPELINES**	**833,000.00**
	Excavation (Kshs. 268,000.00)	
	Purchase and laying pipes (Kshs. 565,000)	
3	**RESERVOIRS (MASONRY)**	**20,000.00**
5	**BUILDINGS**	**950,000.00**
	Power house (Kshs. 50,000.00)	
	Staff Housing (Kshs. 500,000.00)	
	Offices (Kshs. 400,000.00)	
7	**WATER KIOSKS**	**50,000.00**
	TOTAL CAPITAL COST	**2,003,000.00**

2.4.1 Annual cost of Capital for Project

The annual cost of each capital item is computed as the product of the capital cost of the asset, and the capital recovery factor for the asset. The capital recovery factor in turn is a function of the interest charged for capital and the expected economic life of the asset.

Capital recovery factors for various asset lives and interest rates are shown in **Appendix 1**. The resulting values of annual cost of capital for various assets in the Ugunja Water project are tabulated **Table 2.2** below.

TABLE 2.2: CAPITAL RECOVERY COSTS (Interest RATE -20% per year)

	ASSET TYPE	LIFE (YEARS)	CAPITAL COST (KSHS.)	C.R. FACTOR	ANNUAL COST (KSHS.)
1	Mech./Elect.	10	150,000.00	0.2385	37,775.00
2	Pipelines	15	833,000.00	0.2139	178,1789.00
3	Tanks	20	20,000.00	0.2054	4108.00
4	Buildings	30	900,000.00	0.2008	180,720.00
5	Kiosks	10	50,000.00	0.2385	11,925.00
	TOTAL	**********	**2,003,000.00**	**********	**412,707.00**

2.4.2 Unit Cost of Capital for Service or Product

The annual cost of capital for Ugunja Water Project is Kshs. 412,707.00 annually. The volume of services or product delivered is 98 cubic metres of water per day for 365 days annually. The unit capital cost of water delivered is therefore Kshs. 11.50 for every cubic metre.

2.4.3 Operation and Maintenance Costs for Project annually

Table 2.3: Manpower costs

	Manpower category	Number	Monthly Rate Kshs.	Annual cost Kshs.
1	Operator/Pump attendant	1	2500.00	**30,000.00**
2	Pipe fitter	2	1500.00	**36,000.00**
3	Labour, un-skilled	3	950.00	**34,200.00**
	Total annual labour cost			**100,200.00**

Electric Power cost

Power rating of borehole pump (estimated during preliminary design) = 3.1 Kw.
Operating hours of pump annually = 10*365 hours per year;
Electric energy consumed = 3.1* 10 * 365 kWh per year;
Current charges for electric power = 11.00 Kshs. Per kWh
Annual cost of power = 11.00 * 3.1 *10 * 365 Kshs. Per year =Kshs. 124,465.00 per year.

Annual cost of power =Kshs. 124,465.00 per year.

Table 2.4: Maintenance costs

	Asset category	Capital cost (Kshs)	Annual Rate % of Capital	Annual cost Kshs.
1	Borehole	Existing	1	**20,000.00**
2	Elect./Mech Plant	150,000.00	5	**7,500.00**
3	Pipelines	833,000.00	2	**16,660.00**
4	Storage tanks (masonry)	20,000.00	1	**200.00**
5	Buildings (masonry)	900,000.00	1	**90,000.00**
6	Buildings (wooden)	50,000.00	2	**1,000.00**
	Annual maintenance cost	********	**********	**135,360.00**

Table 2.5: Annual cost of Operation and Maintenance

	Cost Item	Annual cost (Kshs.)
1	Annual Manpower costs	**100,200.00**
2	Annual Electrical power costs	**124,465.00**
3	Annual Asset Maintenance costs	**135,360.00**
	Total annual costs for Operation and Maintenance	**360,025.00**

2.4.4 Unit cost of Operation and Maintenance

The unit cost of operation and maintenance is obtained by dividing the total annual cost by the volume of product or services delivered during the period. This is 98 * 365 cubic metres of water. The unit (O&M) cost is therefore Kshs. 10.1 per cubic metre of water.

2.4.5 Annual Cost computed from Equivalent Uniform Annual Costs (EUAC)

This is summarised in **Table 2.6** below.

Table 2.6: Equivalent Uniform Annual Cost (EUAC) for Ugunja water Project

	Cost Item	Annual cost (Kshs.)
1	**Annual** Cost of Capital for project	**412,707.00**
2	**Annual** Operation and Maintenance cost for project,	**360,025.00**
	Equivalent Uniform Annual Cost (EUAC) for project	**772,732.00**

2.4.6 Equivalent Uniform Annual Cost (EUAC)

The annual cost computed from Table 2.6 is the Equivalent Uniform Annual Cost (EUAC) for this investment alternative. Any other investment alternative, which accomplish the same purpose, but has unequal life must be compared by the annual cost method. In this case, the project's purpose is to provide a specified quantity and quality of water annually. The restrictions are that the alternatives must be mutually exclusive and infinitely renewed up to the duration of the longest-lived alternative. The annual cost method assumes that each alternative will be replaced by an identical twin at the end of its useful life (infinite renewal) (1).

2.4.7 Unit cost of water

The total unit cost of water from the Ugunja Water Project is then determined by dividing the total annual cost with the volume of product delivered during the year. The volume of water delivered annually is 98* 365 cubic metres.

The unit cost of water is therefore Kshs. 22.00 per cubic metre.

This is then the indicator of the economic worth-whileness of the project.

2.5.0 Applying the annual cost method

As shown in the example given above, the annual cost method determines the total annual cost by analysing the two components of project costs, which are: Capital costs; Operation and maintenance costs

2.5.1 Recovery of Capital Costs

Capital costs are costs that finance long-lived assets intended to provide service to the project for many years. The annual component of these capital costs therefore depends on the service life of the asset and the time value of money during that service life of the asset.

The capital recovery concept converts the capital cost of each asset, into an annual cost. This annual cost is computed as the product of the asset's capital cost, and an appropriate capital recovery factor. Capital recovery factors for various asset lives and interest rates are given in **Appendix 1.** The annual cost method is therefore also known as the Capital Recovery Method.

2.5.2 Operation and Maintenance Costs

Operation cost are recurrent costs comprising:

1) Labour;
2) Materials;
3) Services

These costs are estimated from past experience with similar projects. Maintenance costs are estimated by applying maintenance rates to the capital costs of each asset. These maintenance rates are also derived from past experience with similar assets. Typical maintenance factors for the assets used in the Ugunja Water Project are shown in **Table 2.4**.

APPENDIX 1: CAPITAL RECOVERY FACTORS FOR ASSET LIVES AND INTEREST RATES

LIFE IN YEARS (n)	ASSET TYPE	INTEREST (i) % per year	C.R.F[7]
5	MOTOR VEHICLES	6	0.2374
		8	0.2505
		10	0.2638
		12	0.2774
		15	0.2983
		20	0.3344
		25	0.3718
		30	0.4106
10	MECHANICAL ELECTRICAL PLANT & MACHINERY	6	0.1359
		8	0.1490
		10	0.1627
		12	0.1770
		15	0.1993
		20	0.2385
		25	0.2801
		30	0.3235
15	UPVC PIPELINES MECHANICAL ELECTRICAL PLANT	6	0.1030
		8	0.1168
		10	0.1315
		12	0.1468
		15	0.1710
		20	0.2139
		25	0.2591
		30	0.3060
20	ELECTRICAL POWER PLANT TRANSMISSION LINES	6	0.0872
		8	0.1019
		10	0.1175
		12	0.1339
		15	0.1598
		20	0.2054
		25	0.2529
		30	0.3016
25	RAILWAY TRACTION EQUIPMENT	6	0.0782
		8	0.0937
		10	0.1102
		12	0.1275
		15	0.1547
		20	0.2021
		25	0.2509
		30	0.3004
30	RAILWAY ROLLING STOCK BUILDING STRUCTURES CIVIL WORKS	6	0.0726
		8	0.0888
		10	0.1061
		12	0.1241
		15	0.1523
		20	0.2008
		25	0.2503
		30	0.3001
40	STRUCTURES BUILDINGS CIVIL WORKS	6	0.0665
		8	0.0839
		10	0.1023
		12	0.1213
		15	0.1506
		20	0.2001
		25	0.2500
		30	0.3000

[7] Capital Recovery Factor (CRF) = $\frac{i(1+i)^n}{((1+i)^n - 1)}$

CRF converts present amount P to an annuity A recovered at (i) % interest rate per year for (n) years

1.0 NET PRESENT VALUE [8]

NPV is the present value of all benefits, discounted at the appropriate discount rate, minus the present value of all costs discounted at the same rate. An NPV is always specific to a particular point in time, generally $\mathbf{t_a}$, the time of the analysis, or $\mathbf{t_0}$ the start of the project.

The formula for the calculation of net present value is as follows:

NPV = initial investment costs + the sum of the present values of costs and benefits for each period within the investment horizon.

The NPV can be calculated in several different ways. Obviously, you could calculate the NPV of benefits and the NPV of costs separately and then subtract them. More often, the analyst subtracts costs from benefits in each period, giving a single line of net cash flow, and then discounts the net cash flow to give the NPV. The arithmetic of this latter procedure is a little simpler, but, more important, the net cash flow is itself useful information for managers. Many projects and enterprises with a positive NPV have failed because of cash-flow problems.

For example, if the initial investment were \$100 and there were \$70 in benefits and \$25 in costs for each of 3 years, and the discount rate were 10 per cent per annum, then the NPV would be:

$$\begin{aligned} \text{NPV} &= \$100 + (\$70 - \$25)/(1 + 0.1)^1 + (\$70 - \$25)/(1 + 0.1)^2 + (\$70 - \$25)/(1 + 0.1)^3 \\ &= -\$100 + \$40.91 + \$37.19 + \$33.81 \\ &= \$11.91 \end{aligned}$$

This formula follows the accounting convention discussed in Chapter 2; that is, all costs and benefits are assumed to occur at the end of their period, except for large initial expenditures, which occur at t0 and are not discounted.

1.1 Net present value and break even

An NPV of zero does not mean 'break even' in the normal sense of costs equalling benefits. NPV is more like excess profit than it is like profit. If a project has an NPV of zero, the project earns the normal rate of return (which is, of course, equal to the discount rate). For example, if a project earns 10 per cent per annum and its cash flows are discounted by 10 per cent per annum, the result will be an NPV of zero.

We value NPV not because it tells us whether the project breaks even, but because it tells us whether it is worth doing the project instead of leaving the money in the normal alternative investment (which earns 10% per annum).

1. 2 Two essential decision rules

Many projects have complex patterns of costs and benefits over time, and you cannot use the 'eyeball' method to determine which project is preferable. We need decision rules to guide us.

[8] Cost Benefit Manual, Rideau Strategy Consultants Ltd., Kenneth Watson, Section 6, www.RideauGroup.com, 2005

Many decision rules have been proposed. Some work well only in particular situations; others are prone to error. Only two rules are consistently accurate and reliable. These are given below.

Case 1: Single project, unconstrained budget, 'go' or 'no go' decision

Decision rule 1: Do not undertake projects whose NPV is less than zero, unless you are willing to 'lose money' to achieve a non-economic objective.

Example 1

	NPV	Decision
Project A	+$3	Accept
Project B	+$0	Indifferent
Project C	- $1	Reject

1.3 Unreliable decision rules

1.3.1 The internal rate of return

The Internal Rate of Return (IRR) is the discount rate that makes the NPV of the project zero. An IRR higher than the standard discount rate indicates that you should go ahead with the project, and when you are choosing among alternative projects, a higher IRR is preferred. If project A earns an IRR of 15 per cent, for example, whereas the ordinary project earns 10 per cent, then project A is an attractive investment.

The IRR has three important limitations (see boxes below) that make it a poor substitute for NPV as a decision rule. Nevertheless, many managers find the IRR intuitively appealing in a way that the NPV is not. They tend to think that the meaning of an IRR is transparent, but it is not. When you calculate the IRR, you need to interpret it with care.

The underlying formula for the IRR is the same as for the NPV. If you know the discount rate, you can calculate the NPV and vice versa. The mathematics of the IRR calculation, however, is not based on a proof and a formula. In practice, the analyst uses a computer to calculate the IRR by trial and error iterations. Given a guess at the likely IRR, the computer enters higher and lower values for i in the formula until it results in an NPV of zero.

Most spreadsheets in common use have a limit on the number of iterations the computer will try. If the computer does not find a discount rate that gives an NPV of zero within this limited number of iterations, it gives an error message. The analyst then has to start the process again with a different guess at the value of the IRR. In addition to this procedural awkwardness, the IRR has two other limitations that make its use doubtful. These are given below.

Limitation 1: Simple comparisons between IRRs may be misleading if the projects are not the same size. A project with an IRR of 7 per cent is not necessarily a better choice than one with an IRR of 6 per cent. The size of each project and the discount rate can influence which project is best.

EXAMPLE 2

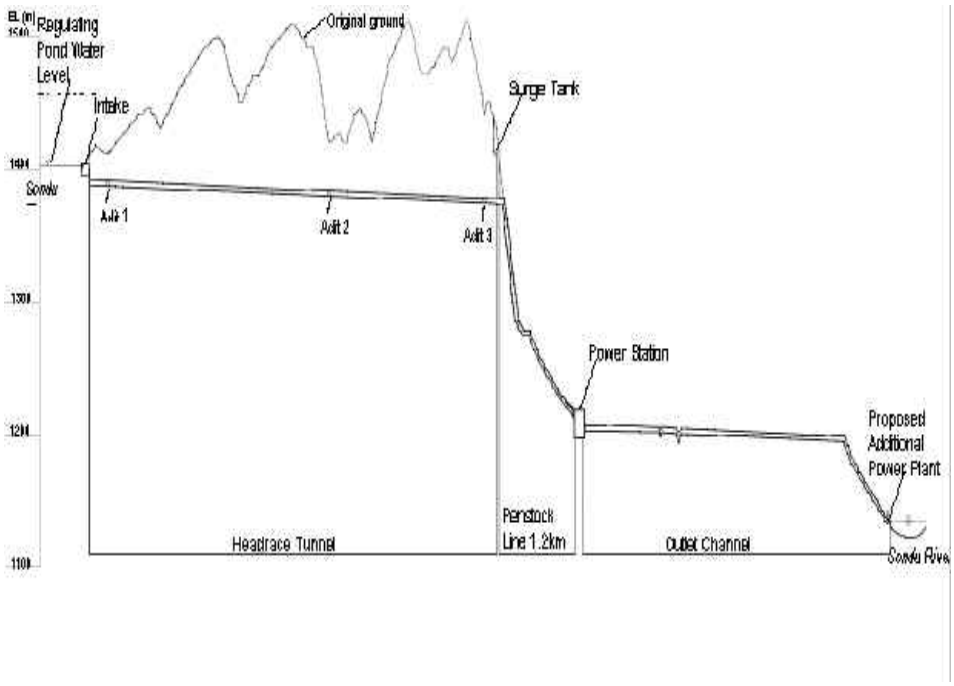
	PROJECT A	**PROJECT B**
TOTAL COST	$100	$10000
IRR	6%	7%
DISCOUNT RATE	5%	5%

If you choose project A, you will have $100 earning 7 per cent plus the residual $9,900 earning 5 per cent (total return = $7 + $495 = $502). If you choose project B, you will have the whole $10,000 earning 6 per cent ($600). Project B is better, even though it has a lower IRR than project A

Limitation 2: In many cases, more than one value of the IRR will solve the equation, and it may not be apparent to the analyst that other equally good values exists because the computer typically stops when it finds any acceptable value of the IRR.

Multiple values of the IRR (some negative, some positive) are especially likely if the annual net cash flow of the project alternates between positive and negative figures, a common event because of the cyclical re-capitalisation requirements of projects and/or fluctuations in the prices of inputs and outputs. In some cases, analysts 'bend' the accounting rules to obtain a cash-flow pattern that gives a single value for the IRR, but this is not a satisfactory solution. At best, the possible existence of multiple values of the IRR throws a shadow over its use; at worst, it may lead to incorrect choices among projects.

EXAMPLE 2: SONDU-MIRIU HYDRO-ELECTRIC POWER PROJECT



COST-BENEFIT ANALYSIS METHOD

An example of the type of studies required to properly inform investment policy decisions is the "River Profile studies"[9] carried out for the Lake Basin development Authority in 1986, by C. Lotti & Associates and WLPU consultants.

In those studies, the catchment areas of the seven rivers that flow into in Lake Victoria were examined for irrigation and hydro-electric power production potential. Four rivers were found to have viable hydro-electric power potential.

The outcome of these studies for hydro-electric power production without irrigation are summarized as shown in **Table 1**.

Table 1:Benefit/Cost ratios for river development based on power benefits alone

Hydro power project Rivers in the catchment of Lake Victoria Basin	Installed capacity (MW)	Costs of Dam, Transfer, Power station (Million Kshs.)	Benefit/cost ratio (Power benefits alone)
Miriu Scheme, Sondu River	84	2639	1.73
Nandi Forest, Yala River	50	1564	1.31
Hemsted Bridge, Nzoia River	60	2700	0.98
Gogo Falls, Kuja River	18	770	0.72

[9] *Summary Report, United Nations project KEN/82/001; Lake Basin River Catchment Development, River Profile Studies. 1986.*

The concepts and the cost estimates for the various potential power projects are summarized in **Appendix 1** (Miriu Scheme), **Appendix 2** (Nandi Forest), **Appendix 3** (Hemsted Bridge), **Appendix 4** (Gogo Falls). It an be seen that the benefit/cost ratios of the various projects shows that while the Miriu Scheme, and the Nandi Forest project were both financially viable, the Miriu scheme had a higher profitability and would therefore be the first option in a phased programme. The Miriu scheme was therefore initiated first in the year 2001.This example illustrates the value of cost/benefit analysis as a tool for guiding investment policy decisions. Similar cost/benefit analysis is required to inform investment decisions in all other sectors of the economy.

Appendix 1 A: Miriu Scheme (Alternative Concept) Scheme summary

RESERVOIR		
Dam crest level	1463 m	
Full supply level	1458 m	
Gross storage	770*10 ^{6} m^3	
Live storage	693*10 ^{6} m^3	
Mean annual Runoff (MAR)	1335*10 ^{6} m^3	
Live storage (% MAR)	52%	
Gross yield (% MAR)	52%	
Gross yield	22 m^3/s	
Net yield	20.3 m^3/s	
Dam Type	Earthfill Embankment	
Dam Height	102 m	
Fill Volume	10.9* 10 ^{6} m^3	
Spillway Type	Free overflow chute	
Spillway capacity	1550 m^3/s	
Spillway length	800 m	
Diversion Tunnel capacity	530 m^3/s	
Diversion Tunnel Diameter	7.3 m	
Diversion Tunnel length	550 m	
POWER SYSTEM	**Main**	**Auxilliary**
Gross head	315 m	258m
Net head	308m	250 m
Installed capacity	84 MW	16 MW
Power tunnel Length	6000 m	400 m (adit)
Power Tunnel Diameter	3.4 m (lined) 5.0 m (unlined)	

Appendix 1 B: Miriu Scheme (Alternative Concept) Cost Estimate

Item	**Ksh. million**
Access read	13.20
Camp and site facilities	110.00
Embankment	599.50
Spillway	91.10
Diversion Works	50.60
Intake	28.88
Power Tunnels	151.74
Surge chamber and shaft	40.11
Power House and Services shaft	113.74
Control Building and Switchyard	41.48
Adits	48.09
Sub-total	**1288.44**
Unmeasured items 10%	128.84
	1417.28
Preliminary and General 15 %	212.59
Mechanical and Electrical plant	327.60
Trasmission lines	36.00
	1993.47
Contigencies (15 %)	299.02
Engineering and Administration (10 %)	199.35
	2491.84
Auxilliary power scheme (16 MW)	146.98
Total	**2638.82**

Appendix 2 A: Nandi Forest (Kano Plain Transfer) Scheme summary

RESERVOIR	
Dam crest level	1837.5 m
Full supply level	1832.5 m
Gross storage	$305 * 10^6 m^3$
Live storage	$275 * 10^6 m^3$
Mean annual Runoff (MAR)	$361 * 10^6 m^3$
Live storage % Mar	76 %
Gross yoeld % Mar	57 %
Gross yield	$6.6\ m^3/s$
Net yield	$6.0\ m^3/s$
Dam Type	Earthfill Embankment
Dam Height	58 m
Fill Volume	$3.1 * 10^6 m^3$
POWER SYSTEM	
Gross head	552.5 m
Net head	542 m
Installed capacity	50 mw
Power tunnel Length	17.2 km
Power Tunnel Diameter	3 m
Spillway Type	Free overflow Chute
Spillway capacity	$400\ m^3/s$

Appendix 2 B: Nandi Forest (Kano Plain Transfer) Cost Estimate

Item	**Ksh. million**
Access road	48.40
Camp and site facilities	100.00
Embankment	172.43
Spillway	23.48
Diversion and Outlet Works	31.83
Intake	28.43
Headrace and tailrace tunnels	195.62
Surge chamber and riser	15.81
Shaft and penstocks	25.15
Services Adit	47.02
Control building and switchyard	41.92
Underground powerhouse	67.76
Acess Adits	47.02
Sub-total	**826.10**
Unmeasured items 10%	82.61
Preliminary and General 15 %	136.31
Mechanical and Electrical plant	200.00
Trasmission lines	6.00
	1251.02
Contigencies (15 %)	187.65
Engineering and Administration (10 %)	125.10
Total	**1563.77**

Appendix 3 A: Hemsted Bridge (Kerio Transfer) Scheme summary

RESERVOIR	
Dam crest level	1778.5 m
Full supply level	1773.5 m
Gross storage	$252*10^6 m^3$
Live storage	$226*10^6 m^3$
Mean annual Runoff (MAR)	$505*10^6 m^3$
Live storage % Mar	45 %
Gross yield % Mar	62 %
Gross yield	$9.9\ m^3/s$
Net yield	$9.0\ m^3/s$
Dam Type	Earthfill Embanlment
Dam Height	47.5 m
Fill Volume	$3.60*10^6 m^3$
POWER SYSTEM	
Gross head	553.5 m
Net head	498.5 m
Installed capacity	60 mw
Power tunnel Length	53400 m
Power Tunnel Diameter (lined)	2.5 m
Power Tunnel Diameter (unlined)	3.2 m
Spillway Type	Free overflow Chute
Spillway capacity	$1000\ m^3/s$
Diversion Type	Conduit
Diversion capacity	$340\ m^3/s$

Appendix 3 B: Hemsted Bridge (Kerio Transfer) Cost Estimate

Item	**Ksh. million**
Access road	22.00
Camp and site facilities	160.00
Embankment	198.00
Spillway	75.51
Diversion and Outlet Works	43.04
Power Intake	27.21
Tunnel and shafts	860.87
Surge chamber and riser	15.96
Penstocks	67.36
Power House	53.50
Tailrace Channel	4.35
Sub-Total	**1527.80**
Unmeasured items 10%	152.78
	1680.58
Preliminary and General 15 %	252.09
Mechanical and Electrical plant	240.00
Transmission lines	35.00
	2207.67
Contigencies (15 %)	331.15
Engineering and Administration (10 %)	220.77
Total	**2759.59**

FEASIBILITY STUDY: ANNUAL COST-WATER SUPPLY PROJECT-20 % DISCOUNT RATE

ANNUAL COST OF CAPITAL BY CAPITAL RECOVERY METHOD

DAILY WATER DEMAND/SUPPLY **420 CUBIC METRES**

Item No.	Description of Capital Asset	Asset life years	Capital cost Shs	Discount Rate %	1+*i*	$(1+i)^n$	$i(1+i)^n$	$(1+i)^n-1$	CRF $\frac{i(1+i)^n}{(1+i)^n-1}$	Annual cost
1	Mechanical and Electrical equipment and	15	2,750,000	20					0.2138821	588,176
2	GI Water pipelines	20	1,250,000	20					0.2053565	256,696
3	Reservoirs, concrete and masonry	30	550,000	20					0.2008461	110,465
4	Buildings and structures, concrete and ma	30	750,000	20					0.2008461	150,635
5	Water kiosks, wooden	5	250,000	20					0.3343797	83,595
				TOTAL ANNUAL COST OF CAPITAL						1,189,566

ANNUAL COST OF LABOUR

Item No.	Description of Labour category	Monthly Cost Kshs	Number	Annual cost Kshs
1	Operator/Pump attendant	8,000	1	96,000
2	Pipe fitter	8,000	1	96,000
3	Labour, unskilled	6,000	1	72,000
	ANNUAL LABOUR COST			264,000

ANNUAL COST OF ELECTRIC POWER

Power Rating of Pump in Kw	Operating duty Hours per day	Electric Energy per year Kwh	Electric Power charges Shs per Kwh	Electric Power costs per year Kshs
18	10	65700	11	722,700

ANNUAL COST OF MAINTENANCE

Item No.	Description of Capital Asset	Maint. Factor % Capital	Capital cost Shs	Ann.Maint. Cost Kshs.
1	Mechanical and Electrical equipment and	5	2,750,000	137,500
2	GI Water pipelines	2	1,250,000	25,000
3	Reservoirs, concrete and masonry	1	550,000	5,500
4	Buildings and structures, concrete and ma	1	750,000	7,500
5	Water kiosks, wooden	2	250,000	5,000
	Total annual maintenance cost			180,500

SUMMARY OF ANNUAL COSTS

ANNUAL CAPITAL COST	1,189,566
ANNUAL LABOUR COST	264,000
ANNUAL POWER COST	722,700
ANNUAL MAINTENANCE COST	180,500

Equivalent Uniform Annual Cost (EUAC) Kshs	2,356,766
Annual water demand-supply (cubic metres)	153,300
Unit cost of water per cubic metre (Kshs/m^3)	15

EUAC	2,356,766

COST STRUCTURE OF WATER SUPPLY SERVICES

UNIT CAPITAL COST	SHS/M^3	7.8
UNIT LABOUR COST	SHS/M^3	1.7
UNIT POWER COST	SHS/M^3	4.7
UNIT MAINT. COST	SHS/M^3	1.2
UNIT COST OF WATER	SHS/M^3	15.4

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FEASIBILITY STUDY: ANNUAL COST-WATER SUPPLY PROJECT-35 % DISCOUNT RATE

ANNUAL COST OF CAPITAL BY CAPITAL RECOVERY METHOD

DAILY WATER DEMAND/SUPPLY 420 CUBIC METRES

Item No.	Description of Capital Asset	Asset life years	Capital cost Shs	Discount Rate %	1+*i*	$(1+i)^n$	$i(1+i)^n$	$(1+i)^n-1$	CRF $\frac{i(1+i)^n}{(1+i)^n-1}$	Annual cost
1	Mechanical and Electrical equipment and	15	2,750,000	35					0.3539256	973,295
2	GI Water pipelines	20	1,250,000	35					0.3508679	438,585
3	Reservoirs, concrete and masonry	30	550,000	35					0.3500431	192,524
4	Buildings and structures, concrete and ma	30	750,000	35					0.3500431	262,532
5	Water kiosks, wooden	5	250,000	35					0.4504583	112,615
				TOTAL ANNUAL COST OF CAPITAL						1,979,551

ANNUAL COST OF LABOUR

Item No.	Description of Labour category	Monthly Cost Kshs	Number	Annual cost Kshs
1	Operator/Pump attendant	8,000	1	96,000
2	Pipe fitter	8,000	1	96,000
3	Labour, unskilled	6,000	1	72,000
	ANNUAL LABOUR COST			264,000

ANNUAL COST OF ELECTRIC POWER

Power Rating of Pump in Kw	Operating duty Hours per day	Electric Energy per year Kwh	Electric Power charges Shs per Kwh	Electric Power costs per year Kshs
18	10	65700	11	722,700

ANNUAL COST OF MAINTENANCE

Item No.	Description of Capital Asset	Maint. Factor % Capital	Capital cost Shs	Ann.Maint. Cost Kshs.
1	Mechanical and Electrical equipment and	5	2,750,000	137,500
2	GI Water pipelines	2	1,250,000	25,000
3	Reservoirs, concrete and masonry	1	550,000	5,500
4	Buildings and structures, concrete and ma	1	750,000	7,500
5	Water kiosks, wooden	2	250,000	5,000
	Total annual maintenance cost			180,500

SUMMARY OF ANNUAL COSTS

ANNUAL CAPITAL COST	1,979,551
ANNUAL LABOUR COST	264,000
ANNUAL POWER COST	722,700
ANNUAL MAINTENANCE COST	180,500

EUAC	3,146,751

Equivalent Uniform Annual Cost (EUAC) Kshs	3,146,751
Annual water demand-supply (cubic metres)	153,300
Unit cost of water per cubic metre (Kshs/m^3)	21

COST STRUCTURE OF WATER SUPPLY SERVICES

UNIT CAPITAL COST	SHS/M^3	12.9
UNIT LABOUR COST	SHS/M^3	1.7
UNIT POWER COST	SHS/M^3	4.7
UNIT MAINT. COST	SHS/M^3	1.2
UNIT COST OF WATER	SHS/M^3	20.5

FEASIBILITY STUDY: ANNUAL COST-WATER SUPPLY PROJECT-45 % DISCOUNT RATE

ANNUAL COST OF CAPITAL BY CAPITAL RECOVERY METHOD

DAILY WATER DEMAND/SUPPLY **420 CUBIC METRES**

Item No.	Description of Capital Asset	Asset life years	Capital cost Shs	Discount Rate %	1+*i*	$(1+i)^n$	$i(1+i)^n$	$(1+i)^n-1$	CRF $\frac{i(1+i)^n}{(1+i)^n-1}$	Annual cost
1	Mechanical and Electrical equipment and	15	2,750,000	45					0.4517153	1,242,217
2	GI Water pipelines	20	1,250,000	45					0.4502668	562,833
3	Reservoirs, concrete and masonry	30	550,000	45					0.4500065	247,504
4	Buildings and structures, concrete and ma	30	750,000	45					0.4500065	337,505
5	Water kiosks, wooden	5	250,000	45					0.5331834	133,296
				TOTAL ANNUAL COST OF CAPITAL						2,523,355

ANNUAL COST OF LABOUR

Item No.	Description of Labour category	Monthly Cost Kshs	Number	Annual cost Kshs
1	Operator/Pump attendant	8,000	1	96,000
2	Pipe fitter	8,000	1	96,000
3	Labour, unskilled	6,000	1	72,000
	ANNUAL LABOUR COST			264,000

ANNUAL COST OF ELECTRIC POWER

Power Rating of Pump in Kw	Operating duty Hours per day	Electric Energy per year Kwh	Electric Power charges Shs per Kwh	Electric Power costs per year Kshs
18	10	65700	11	722,700

ANNUAL COST OF MAINTENANCE

Item No.	Description of Capital Asset	Maint. Factor % Capital	Capital cost Shs	Ann.Maint. Cost Kshs.
1	Mechanical and Electrical equipment and	5	2,750,000	137,500
2	GI Water pipelines	2	1,250,000	25,000
3	Reservoirs, concrete and masonry	1	550,000	5,500
4	Buildings and structures, concrete and ma	1	750,000	7,500
5	Water kiosks, wooden	2	250,000	5,000
	Total annual maintenance cost			180,500

SUMMARY OF ANNUAL COSTS

ANNUAL CAPITAL COST	2,523,355
ANNUAL LABOUR COST	264,000
ANNUAL POWER COST	722,700
ANNUAL MAINTENANCE COST	180,500

EUAC	3,690,555

Equivalent Uniform Annual Cost (EUAC) Kshs	3,690,555
Annual water demand-supply (cubic metres)	153,300
Unit cost of water per cubic metre (Kshs/m^3)	24

COST STRUCTURE OF WATER SUPPLY SERVICES

UNIT CAPITAL COST	SHS/M^3	16.5
UNIT LABOUR COST	SHS/M^3	1.7
UNIT POWER COST	SHS/M^3	4.7
UNIT MAINT. COST	SHS/M^3	1.2
UNIT COST OF WATER	SHS/M^3	24.1

ENGINEERING ECONOMY STUDY: WATER SUPPLY PROJECT- NET PRESENT VAJUE-INTERNAL RATE OF RETURN

NET PRESENT VALUE FOR DISCOUNT RATES OF 10, 15 % UNTIL FIRST NEGATIVE VALUE OF NPV

SINGLE PAYMENT PRESENT WORTH $1/(i+1)^n$

WATER HAULAGE PROJECT **Annual water demand-supply (cubic metres)**

ONE WATER TANKER AND ONE DRIVER 365 days*2 Trips *5 m^3/day = 3650 m3/year

TWO TRIPS PER DAY Price of water = 250 shs/m^3

$i=5$	DISCOUNT RATE	YEAR OF PAYMENT n									
	YEAR 0	1	2	3	4	5	6	7	8	9	10
CAPITAL ASSET	10	0.9091	0.8264	0.7513	0.6830	0.6209	0.5645	0.5132	0.4665	0.4241	0.3855
WATER TANKER	-2,500,000										
CAPACITY											
5											
M^3											
Revenue		912,500	912,500	912,500	912,500	912,500	912,500	912,500	912,500	912,500	912,500
O&M											
Operations(Staff)		-240,000	-240,000	-240,000	-240,000	-240,000	-240,000	-240,000	-240,000	-240,000	-240,000
Operations(Fuel)		-10,000	-10,000	-10,000	-10,000	-10,000	-10,000	-10,000	-10,000	-10,000	-10,000
Operations(services)											
Operations(services)											
Maintenance-% Asset	5	-125,000	-125,000	-125,000	-125,000	-125,000	-125,000	-125,000	-125,000	-125,000	-125,000
NET CASH	**-2,500,000**	**537,500**	**537,500**	**537,500**	**537,500**	**537,500**	**537,500**	**537,500**	**537,500**	**537,500**	**537,500**
PRESENT VALUE		**488,636**	**444,215**	**403,832**	**367,120**	**333,745**	**303,405**	**275,822**	**250,748**	**227,952**	**207,230**
NPV	**802,705**										
Discount rate	**15**	0.8696	0.7561	0.6575	0.5718	0.4972	0.4323	0.3759	0.3269	0.2843	0.2472
Presesnt Value		467,391	406,427	353,415	307,317	267,232	232,376	202,066	175,710	152,791	132,862
NPV	**197,588**										
Discount rate	**20**	0.8333	0.6944	0.5787	0.4823	0.4019	0.3349	0.2791	0.2326	0.1938	0.1615
Presesnt Value		447,917	373,264	311,053	259,211	216,009	180,008	150,006	125,005	104,171	86,809
NPV	**-246,546**										
Discount rate	**16**	0.8621	0.7432	0.6407	0.5523	0.4761	0.4104	0.3538	0.3050	0.2630	0.2267
Presesnt Value		463,362	399,450	344,353	296,856	255,911	220,613	190,183	163,951	141,337	121,842
NPV	**97,860**										
Discount rate	**17**	0.8547	0.7305	0.6244	0.5337	0.4561	0.3898	0.3332	0.2848	0.2434	0.2080
Presesnt Value		459,402	392,651	335,599	286,837	245,160	209,538	179,093	153,071	130,830	111,820
NPV	**3,999**										
Discount rate	**18**	0.8475	0.7182	0.6086	0.5158	0.4371	0.3704	0.3139	0.2660	0.2255	0.1911
Presesnt Value		455,508	386,024	327,139	277,237	234,946	199,107	168,735	142,996	121,183	102,697
NPV	**-84,429**										

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ENGINEERING ECONOMY STUDY: WATER SUPPLY PROJECT- NET PRESENT VALUE-INTERNAL RATE OF RETURN

NET PRESENT VALUE FOR DISCOUNT RATES 10, 15 % UNTIL FIRST NEGATIVE VALUE OF NPV

SINGLE PAYMENT PRESENT WORTH $1/(i+1)^n$

WATER HAULAGE PROJECT **Annual water demand-supply (cubic metres)**

ONE WATER TANKER AND ONE DRIVER 365 days*2 Trips *5 m^3/day = 3650 m3/year

TWO TRIPS PER DAY Price of water = 250 shs/m^3

$i=5$	DISCOUNT RATE	YEAR OF PAYMENT n									
	YEAR 0	1	2	3	4	5	6	7	8	9	10
CAPITAL ASSET	10	0.9091	0.8264	0.7513	0.6830	0.6209	0.5645	0.5132	0.4665	0.4241	0.3855
WATER TANKER	-1,750,000										
CAPACITY											
5											
M^3											
Revenue		912,500	912,500	912,500	912,500	912,500	912,500	912,500	912,500	912,500	912,500
O&M											
Operations(Staff)		-240,000	-240,000	-240,000	-240,000	-240,000	-240,000	-240,000	-240,000	-240,000	-240,000
Operations(Fuel)		-10,000	-10,000	-10,000	-10,000	-10,000	-10,000	-10,000	-10,000	-10,000	-10,000
Operations(services)											
Operations(services)											
Maintenance-% Asset	5	-87,500	-87,500	-87,500	-87,500	-87,500	-87,500	-87,500	-87,500	-87,500	-87,500
NET CASH	**-1,750,000**	**575,000**	**575,000**	**575,000**	**575,000**	**575,000**	**575,000**	**575,000**	**575,000**	**575,000**	**575,000**
PRESENT VALUE		**522,727**	**475,207**	**432,006**	**392,733**	**357,030**	**324,573**	**295,066**	**268,242**	**243,856**	**221,687**
NPV	**1,783,126**										
Discount rate	**15**	0.8696	0.7561	0.6575	0.5718	0.4972	0.4323	0.3759	0.3269	0.2843	0.2472
Presesnt Value		500,000	434,783	378,072	328,758	285,877	248,588	216,164	187,969	163,451	142,131
NPV	**1,135,792**										
Discount rate	**20**	0.8333	0.6944	0.5787	0.4823	0.4019	0.3349	0.2791	0.2326	0.1938	0.1615
Presesnt Value		479,167	399,306	332,755	277,296	231,080	192,566	160,472	133,727	111,439	92,866
NPV	**660,671**										
Discount rate	**25**	0.8000	0.6400	0.5120	0.4096	0.3277	0.2621	0.2097	0.1678	0.1342	0.1074
Presesnt Value		460,000	368,000	294,400	235,520	188,416	150,733	120,586	96,469	77,175	61,740
NPV	**303,039**										
Discount rate	**30**	0.7692	0.5917	0.4552	0.3501	0.2693	0.2072	0.1594	0.1226	0.0943	0.0725
Presesnt Value		442,308	340,237	261,721	201,323	154,864	119,126	91,636	70,489	54,222	41,709
NPV	**27,635**										
Discount rate	**35**	0.7407	0.5487	0.4064	0.3011	0.2230	0.1652	0.1224	0.0906	0.0671	0.0497
Presesnt Value		425,926	315,501	233,704	173,114	128,233	94,987	70,361	52,119	38,607	28,598
NPV	**-188,850**										