DWA&F Report No. PY000/00/0193



**DEPARTMENT OF WATER AFFAIRS AND FORESTRY**

**Directorate of Project Planning**

# WALVIS BAY WATER SUPPLY
# DESALINATION OF SEAWATER

## ALTERNATIVE DESALINATION PROCESSES

**Volume 2**
**Detailed Economic Comparisons**

**July 1993**

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WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
REVERSE OSMOSIS



ALTERNATIVE A WITH NO ULTRA-FILTRATION PRETREATEMNT

| | | | |
|---|---|---|---|
| Raw Water Source | Sea Wells Located near Walvis Bay | | |
| Raw Water Requirements | 11 200 m^3/d | Pretreatment Losses | 1% |
| Output Capacity of Plant | 5 000 m^3/d | Filtration Losses | |
| Plant Design Factor | 90% | U.F.Plant Losses | |
| Annual Water Production | 1 643 Ml/annum | R.O.Plant Recovery Factor | 45% |

COSTS OF POWER

| | |
|---|---|
| kW Charges/month | 26.50 R/kW/Month |
| Unit Charges | 10.50 c/kWh |

| DEPRECIATION PERIOD | Civils | Mechanical Electrical | Desal Equipment | Membranes R. O. |
|---|---|---|---|---|
| Years | 40 | 15 | 20 | 5 |

| | | | | |
|---|---|---|---|---|
| MAINTENANCE FACTORS | 0.50% | 4.00% | 2.00% | |

PROGRAMMME REQUIIREMENTS

| | |
|---|---|
| Design Tender & Award | 9 Months |
| Construction | 12 Months |
| Start Up Period | 1 Month |

| CAPITAL COSTS (See Page 2) | Civils | Mechanical Electrical | Desal Equipment | Membranes R. O. | Totals |
|---|---|---|---|---|---|
| | R*1000 | R*1000 | R*1000 | R*1000 | R*1000 |
| Direct Non Depreciable | 100 | | | | 100 |
| Direct Depreciable | 7 795 | 780 | 17 500 | 3 000 | 29 075 |
| Indirect | 1 810 | 180 | 2 330 | 400 | 4 720 |
| Start Up Costs | | | | | 188 |
| TOTAL CAPITAL COSTS | 9 705 | 960 | 19 830 | 3 400 | 34 083 |
| ANNUAL MAINTENANCE COSTS | 39 | 31 | 350 | | 420 |

| ANNUAL RECURRING COSTS | R*1000 |
|---|---|
| Fixed | 1 051 |
| Flow Related (5 000 m^3/d) | 1 848 |
| TOTAL | 2 899 |

ECONOMIC ANALYSIS

| Discount Rate | 0.0% | 4.0% | 6.0% | 8.0% | 10.0% |
|---|---|---|---|---|---|
| Capital NPV | 52 | 39 | 35 | 33 | 31 |
| Operating NPV | 133 | 61 | 44 | 34 | 27 |
| Total NPV | 185 | 100 | 80 | 67 | 57 |
| Water Produced Discounted | 66 | 30 | 22 | 17 | 13 |
| REFERENCE UNIT VALUE Rand/m^3 | 2.81 | 3.32 | 3.63 | 3.97 | 4.33 |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
REVERSE OSMOSIS
ALTERNATIVE A WITH NO ULTRA-FILTRATION PRETREATEMNT
ESTIMATED CAPITAL COSTS

| DIRECT CAPITAL COSTS | Civils | Mechanical Electrical | Desal Equipment | Membranes R. O. | Totals |
|---|---|---|---|---|---|
| Non Depreciable | R*1000 | R*1000 | R*1000 | R*1000 | R*1000 |
| 1 Purchase of Land | 100 | | | | 100 |
| Depreciable | | | | | |
| 1 Wellfield | 425 | 275 | | | 700 |
| 2 Delivery Pipelines | 50 | | | | 50 |
| 3 Site Development | 200 | 60 | | | 260 |
| 4 Raw Water Storage (2 000 m^3) | 950 | | | | 950 |
| 5 Pretreatment Works and Pumpstations | 40 | 55 | | | 95 |
| 6 Administrative & Miscellaneous Buildings | 100 | | | | 100 |
| 7 Desalination Equipment Buildings (1 200 m^2) | 1 800 | | | | 1 800 |
| 8 Desalination Equipment | | | 17 500 | 3 000 | 20 500 |
| 9 Product Storage Reservoir (625 m^3) | 445 | | | | 445 |
| 10 Incoming Power Supply | | 230 | | | 230 |
| 11 Product Pipeline & Pumpstation | 3 735 | 160 | | | 3 895 |
| 12 Brine Pipeline | 50 | | | | 50 |
| Total of Depreciable Costs | 7 795 | 780 | 17 500 | 3 000 | 29 075 |
| INDIRECT CAPITAL COSTS | | | | | |
| Contingencies 10.00%of Net Cost | 780 | 80 | 1 750 | 300 | 2 910 |
| Escalation 0.00%per Month | | | | | |
| Engineering Fees | | | | | |
| Civil and Mechanical 12.0% | 1 030 | 100 | | | 1 130 |
| Desalination Equipment 3.0% | | | 580 | 100 | 680 |
| Totals of Indirect Depreciable Costs | 1 810 | 180 | 2 330 | 400 | 4 720 |

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START UP COSTS (Pro Rata on Start Up Period )

| | R*1000 |
|---|---|
| Chemicals | 22 |
| Power | |
| Electrical | 118 |
| Staff | 49 |
| Totals | 188 |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
REVERSE OSMOSIS
ALTERNATIVE A WITH NO ULTRA-FILTRATION PRETREATEMNT
ESTIMATED CAPITAL COSTS
CALCULATION OF ENERGY COSTS

Based on operation at full rated output of 5 000 m^3/d

ELECTRICAL ENERGY

| Component | Absorbed Power kW | Installed Power kW | % Utilisation | Average kWh/day |
|---|---|---|---|---|
| Seawater pumps | 22 | 30 | 90.0% | 484 |
| Reverse Osmosis Feed Pumps | 103 | 110 | 90.0% | 2 233 |
| Reverse Osmosis Pumps | 962 | 1 260 | 90.0% | 20 783 |
| Clear Water Pumps | 60 | 75 | 90.0% | 1 304 |
| Totals | 1 148 | 1 475 | | 24 804 |

| | | R*1000 |
|---|---|---|
| Fixed Annual Power costs | | 469 |
| Flow Related Power costs | Electrical Energy | 951 |

CALCULATION OF ANNUAL RECURRING COSTS

| | | R*1000 |
|---|---|---|
| FIXED | | |
| Salaries and Labour | | 448 |
| Labour Overhead | ( 30.0%) | 134 |
| Fixed electrical energy costs | | 469 |
| Total | | 1 051 |
| FLOW RELATED | | |
| Power-Electrical | | 951 |
| Chemicals | | 259 |
| Miscellaneous Supplies | | 38 |
| R.O.Membrane Replacement | (5 Yearly) | 600 |
| Total | | 1 848 |

STAFFING

| | Util | No. | Salary R | Total Salaries R |
|---|---|---|---|---|
| Super-intndt | 100% | 1 | 70 000 | 70 000 |
| Snr Operator | 100% | 4 | 39 000 | 156 000 |
| Jnr Operator | 100% | 5 | 32 500 | 162 500 |
| Operating Asst | 0% | 0 | 12 400 | 0 |
| Labourers | 100% | 3 | 12 400 | 37 200 |
| Lab. Techn. | 20% | 1 | 32 500 | 6 500 |
| Mech. Maint. | 20% | 1 | 44 800 | 8 960 |
| Elec. Maint. | 15% | 1 | 44 800 | 6 720 |
| TOTAL | | | | 448 000 |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
REVERSE OSMOSIS
ALTERNATIVE A WITH NO ULTRA-FILTRATION PRETREATEMNT
CHEMICAL USAGE

| | Daily Quantity m^3/d | Dosage Rate mg/l | Annual Quantity tons | Unit Cost R/ton | Total Cost R |
|---|---|---|---|---|---|
| Sulphuric acid | 11 200 | 25 | 91.98 | 300.00 | 27 594 |
| Lime | 5 000 | 20 | 32.85 | 495.00 | 16 261 |
| Sodium bi-Sulphite | 11 088 | 5 | 18.21 | 2 050.00 | 37 335 |
| Flocon ( Anti-Scalant ) | 11 088 | 5 | 18.21 | 9 000.00 | 163 908 |
| Chlorine Raw Water | 11 200 | 5 | 18.40 | 700.00 | 12 877 |
| Chlorine Product Water | 5 000 | 1 | 1.64 | 700.00 | 1 150 |
| TOTAL FOR CHEMICALS | | | | | 259 000 |

MISCELLANEOUS SUPPLIES

| ITEM | Unit | Annual Quantity Unit/a | Unit Cost R per unit | Total Cost R |
|---|---|---|---|---|
| Cartridge Filters | No. | 200.00 | 80.00 | 16 000 |
| Citric acid | Ton | 0.50 | 8 750.00 | 4 375 |
| Detergent | Ton | 2.00 | 7 000.00 | 14 000 |
| Tannic acid | kg | 65.00 | 60.00 | 3 900 |
| TOTAL FOR CONSUMABLES | | | | 38 275 |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
REVERSE OSMOSIS
CALCULATION OF PUMP REQUIREMENTS

ALTERNATIVE A

## CALCULATION OF PUMPING REQUIREMENTS

Based on operation at full rated output of 5 000 m^3/d

| 1 Sea Water Pumps | | |
|---|---|---|
| Pumping Rate | 130 | l/s |
| Length of Main | 300 | m |
| Diameter | 288 | mm |
| Friction Head | 3.0 | m |
| Static Head | 10.0 | m |
| Total Head | 13.0 | m |
| Efficiency of Pump | 75.0% | Percent |
| Power Absorbed | 22 | kW |
| Power Installed | 30 | kW |

| 2 Reverse Osmosis Feed Pumps | |
|---|---|
| Pumping Rate | 129 l/s |
| Length of Main | 30 m |
| Diameter | 288 mm |
| Friction Head | 0.3 m |
| Static Head | 60.0 m |
| Total Head | 60.3 m |
| Efficiency of Pump | 75.0%Percent |
| Power Absorbed | 103 kW |
| Power Installed | 110 kW |

| 3 Reverse Osmosis Pumps | | |
|---|---|---|
| Pumping Rate | 129 | l/s |
| Length of Main | 1 000 | m |
| Equivalent Diameter | 280 | mm |
| Friction Head | 11.1 | m |
| Static Head | 550.0 | m |
| Total Head | 561.1 | m |
| Efficiency of Pump | 75.0% | Percent |
| Power Absorbed | 962 | kW |
| Power Installed | 1 260 | kW |

| 4 Clear Water Pumps | |
|---|---|
| Pumping Rate | 58 l/s |
| Length of Main | 15 000 m |
| Diameter | 288 mm |
| Friction Head | 33.2 m |
| Static Head | 45.0 m |
| Total Head | 78.2 m |
| Efficiency of Pump | 75.0%Percent |
| Power Absorbed | 60 kW |
| Power Installed | 75 kW |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
REVERSE OSMOSIS
ALTERNATIVA WITH NO ULTRA-FILTRATION PRETREATEMNT

| YEAR | FLOW | FLOW | CAPITAL | FIXED COSTS | COSTS PROP TO FLOW | MAINTNCE COSTS | TOTAL |
|---|---|---|---|---|---|---|---|
| | m^3/d | Ml/a | R*1000 | R*1000 | R*1000 | R*1000 | R*1000 |
| 1993 | | | | | | | |
| 1994 | | | 3 986 | | | | 3 986 |
| 1995 | | | 30 097 | | | | 30 097 |
| 1996 | 5 000 | 1 643 | | 1 051 | 1 848 | 420 | 3 319 |
| 1997 | 5 000 | 1 643 | | 1 051 | 1 848 | 420 | 3 319 |
| 1998 | 5 000 | 1 643 | | 1 051 | 1 848 | 420 | 3 319 |
| 1999 | 5 000 | 1 643 | | 1 051 | 1 848 | 420 | 3 319 |
| 2000 | 5 000 | 1 643 | | 1 051 | 1 848 | 420 | 3 319 |
| 2001 | 5 000 | 1 643 | | 1 051 | 1 848 | 420 | 3 319 |
| 2002 | 5 000 | 1 643 | | 1 051 | 1 848 | 420 | 3 319 |
| 2003 | 5 000 | 1 643 | | 1 051 | 1 848 | 420 | 3 319 |
| 2004 | 5 000 | 1 643 | | 1 051 | 1 848 | 420 | 3 319 |
| 2005 | 5 000 | 1 643 | | 1 051 | 1 848 | 420 | 3 319 |
| 2006 | 5 000 | 1 643 | | 1 051 | 1 848 | 420 | 3 319 |
| 2007 | 5 000 | 1 643 | | 1 051 | 1 848 | 420 | 3 319 |
| 2008 | 5 000 | 1 643 | | 1 051 | 1 848 | 420 | 3 319 |
| 2009 | 5 000 | 1 643 | | 1 051 | 1 848 | 420 | 3 319 |
| 2010 | 5 000 | 1 643 | | 1 051 | 1 848 | 420 | 3 319 |
| 2011 | 5 000 | 1 643 | 780 | 1 051 | 1 848 | 420 | 4 099 |
| 2012 | 5 000 | 1 643 | | 1 051 | 1 848 | 420 | 3 319 |
| 2013 | 5 000 | 1 643 | | 1 051 | 1 848 | 420 | 3 319 |
| 2014 | 5 000 | 1 643 | | 1 051 | 1 848 | 420 | 3 319 |
| 2015 | 5 000 | 1 643 | | 1 051 | 1 848 | 420 | 3 319 |
| 2016 | 5 000 | 1 643 | 17 500 | 1 051 | 1 848 | 420 | 20 819 |
| 2017 | 5 000 | 1 643 | | 1 051 | 1 848 | 420 | 3 319 |
| 2018 | 5 000 | 1 643 | | 1 051 | 1 848 | 420 | 3 319 |
| 2019 | 5 000 | 1 643 | | 1 051 | 1 848 | 420 | 3 319 |
| 2020 | 5 000 | 1 643 | | 1 051 | 1 848 | 420 | 3 319 |
| 2021 | 5 000 | 1 643 | | 1 051 | 1 848 | 420 | 3 319 |
| 2022 | 5 000 | 1 643 | | 1 051 | 1 848 | 420 | 3 319 |
| 2023 | 5 000 | 1 643 | | 1 051 | 1 848 | 420 | 3 319 |
| 2024 | 5 000 | 1 643 | | 1 051 | 1 848 | 420 | 3 319 |
| 2025 | 5 000 | 1 643 | | 1 051 | 1 848 | 420 | 3 319 |
| 2026 | 5 000 | 1 643 | 780 | 1 051 | 1 848 | 420 | 4 099 |
| 2027 | 5 000 | 1 643 | | 1 051 | 1 848 | 420 | 3 319 |
| 2028 | 5 000 | 1 643 | | 1 051 | 1 848 | 420 | 3 319 |
| 2029 | 5 000 | 1 643 | | 1 051 | 1 848 | 420 | 3 319 |
| 2030 | 5 000 | 1 643 | | 1 051 | 1 848 | 420 | 3 319 |
| 2031 | 5 000 | 1 643 | | 1 051 | 1 848 | 420 | 3 319 |
| 2032 | 5 000 | 1 643 | | 1 051 | 1 848 | 420 | 3 319 |
| 2033 | 5 000 | 1 643 | | 1 051 | 1 848 | 420 | 3 319 |
| 2034 | 5 000 | 1 643 | | 1 051 | 1 848 | 420 | 3 319 |
| 2035 | 5 000 | 1 643 | | 1 051 | 1 848 | 420 | 3 319 |
| | | | (1 382) | | | | (1 382) |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
REVERSE OSMOSIS
ALTERNATIVE B WITH ULTRA-FILTRATION PRETREATMENT



| | | | |
|---|---|---|---|
| Raw Water Source | Sea Wells Located near Walvis Bay | | |
| Raw Water Requirements | 12 500 m^3/d | Pretreatment Losses | 1% |
| Output Capacity of Plant | 5 000 m^3/d | Filtration Losses | |
| Plant Design Factor | 90% | U.F.Plant Losses | 10% |
| Annual Water Production | 1 643 Ml/annum | R.O.Plant Recovery Factor | 45% |

COSTS OF POWER

| | |
|---|---|
| kW Charges/month | 26.50 R/kW/Month |
| Unit Charges | 10.50 c/kWh |

| DEPRECIATION PERIOD | Civils | Mechanical Electrical | Desal & UF Equipment | Membranes U. F. | Membranes R. O. |
|---|---|---|---|---|---|
| Years | 40 | 15 | 20 | 2 | 5 |

| | | | | | |
|---|---|---|---|---|---|
| ANNUAL MAINTENANCE FACTORS | 0.50% | 4.00% | 2.00% | | |

PROGRAMMME REQUIIREMENTS

| | |
|---|---|
| Design Tender & Award | 9 Months |
| Construction | 12 Months |
| Start Up Period | 1 Month |

| CAPITAL COSTS (See Page 2) | Civils | Mechanical Electrical | Desal & UF Equipment | Membranes U. F. | Membranes R. O. | Totals |
|---|---|---|---|---|---|---|
| | R*1000 | R*1000 | R*1000 | R*1000 | R*1000 | R*1000 |
| Direct Non Depreciable | 100 | | | | | 100 |
| Direct Depreciable | 8 535 | 780 | 18 630 | 930 | 3 000 | 31 875 |
| Indirect | 1 980 | 180 | 2 470 | 120 | 400 | 5 150 |
| Start Up Costs | | | | | | 210 |
| TOTAL CAPITAL COSTS | 10 615 | 960 | 21 100 | 1 050 | 3 400 | 37 335 |
| ANNUAL MAINTENANCE COSTS | 43 | 31 | 373 | | | 446 |

| ANNUAL RECURRING COSTS | R*1000 |
|---|---|
| Fixed | 1 131 |
| Flow Related ( 5 000 m^3/d ) | 2 501 |
| TOTAL | 3 632 |

ECONOMIC ANALYSIS

| Discount Rate | 0.0% | 4.0% | 6.0% | 8.0% | 10.0% |
|---|---|---|---|---|---|
| Capital NPV | 56 | 43 | 39 | 36 | 33 |
| Operating NPV | 163 | 75 | 55 | 42 | 33 |
| Total NPV | 219 | 117 | 93 | 77 | 66 |
| Water Produced Discounted | 66 | 30 | 22 | 17 | 13 |
| REFERENCE UNIT VALUE Rand/m^3 | 3.34 | 3.90 | 4.24 | 4.61 | 5.00 |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
REVERSE OSMOSIS
ALTERNATIVE B WITH ULTRA-FILTRATION PRETREATMENT
ESTIMATED CAPITAL COSTS

| DIRECT CAPITAL COSTS | Civils | Mechanical Electrical | Desal & UF Equipment | Membranes U. F. | Membranes R. O. | Totals |
|---|---|---|---|---|---|---|
| Non Depreciable | R*1000 | R*1000 | R*1000 | R*1000 | R*1000 | R*1000 |
| 1 Purchase of Land | 100 | | | | | 100 |
| Depreciable | | | | | | |
| 1 Wellfield | 425 | 275 | | | | 700 |
| 2 Delivery Pipelines | 50 | | | | | 50 |
| 3 Site Development | 200 | 60 | | | | 260 |
| 4 Raw Water Storage (2 000 m^3) | 950 | | | | | 950 |
| 5 Pretreatment Works and Pumpstations | 40 | 55 | 1 130 | 930 | | 2 155 |
| 6 Administrative & Misc. Buildings | 120 | | | | | 120 |
| 7 Desalination Equipment Buildings (1 680m^2) | 2 520 | | | | | 2 520 |
| 8 Desalination Equipment | | | 17 500 | | 3 000 | 20 500 |
| 9 Product Storage Reservoir (625 m^3) | 445 | | | | | 445 |
| 10 Incoming Power Supply | | 230 | | | | 230 |
| 11 Product Pipeline & Pumpstation | 3 735 | 160 | | | | 3 895 |
| 12 Brine Pipeline | 50 | | | | | 50 |
| Total of Depreciable Costs | 8 535 | 780 | 18 630 | 930 | 3 000 | 31 875 |
| INDIRECT CAPITAL COSTS | | | | | | |
| Contingencies 10.00%of Net Cost | 850 | 80 | 1 860 | 90 | 300 | 3 180 |
| Escalation 0.00%per Month | | | | | | |
| Engineering Fees | | | | | | |
| Civil and Mechanical 12.0% | 1 130 | 100 | | | | 1 230 |
| Desalination Equipment 3.0% | | | 610 | 30 | 100 | 740 |
| Totals of Indirect Depreciable Costs | 1 980 | 180 | 2 470 | 120 | 400 | 5 150 |

START UP COSTS (Pro Rata on Start Up Period )

| | R*1000 |
|---|---|
| Chemicals | 22 |
| Power | |
| Electrical | 140 |
| Staff | 49 |
| Totals | 211 |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
REVERSE OSMOSIS
ALTERNATIVE B WITH ULTRA-FILTRATION PRETREATMENT
ESTIMATED CAPITAL COSTS
CALCULATION OF ENERGY COSTS

Based on operation at full rated output of 5 000 m^3/d

ELECTRICAL ENERGY

| Component | Absorbed Power kW | Installed Power kW | % Utilisation | Average kWh/day |
|---|---|---|---|---|
| Seawater pumps | 26 | 30 | 90.0% | 568 |
| Ultra-Filtration | 218 | 250 | 90.0% | 4 702 |
| Reverse Osmosis Feed Pumps | 103 | 110 | 90.0% | 2 233 |
| Reverse Osmosis Pumps | 962 | 1 260 | 90.0% | 20 783 |
| Clear Water Pumps | 60 | 75 | 90.0% | 1 304 |
| Totals | 1 370 | 1 725 | | 29 590 |

| | R*1000 | |
|---|---|---|
| Fixed Annual Power costs | 549 | |
| Flow Related Power costs | 1 134 | Electrical Energy |

CALCULATION OF ANNUAL RECURRING COSTS

| | R*1000 |
|---|---|
| FIXED | |
| Salaries and Labour | 448 |
| Labour Overhead ( 30.0%) | 134 |
| Fixed electrical energy costs | 549 |
| Total | 1 131 |
| FLOW RELATED | |
| Power-Electrical | 1 134 |
| Chemicals | 264 |
| Miscellaneous Supplies | 38 |
| U.F.Membrane Replacement ( 2 Yearly) | 465 |
| R.O.Membrane Replacement ( 5 Yearly) | 600 |
| Total | 2 501 |

STAFFING

| | Util | No. | Salary R | Total Salaries R |
|---|---|---|---|---|
| Super-intndt | 100% | 1 | 70 000 | 70 000 |
| Snr Operator | 100% | 4 | 39 000 | 156 000 |
| Jnr Operator | 100% | 5 | 32 500 | 162 500 |
| Operating Asst | 0% | 0 | 12 400 | 0 |
| Labourers | 100% | 3 | 12 400 | 37 200 |
| Lab. Techn. | 20% | 1 | 32 500 | 6 500 |
| Mech. Maint. | 20% | 1 | 44 800 | 8 960 |
| Elec. Maint. | 15% | 1 | 44 800 | 6 720 |
| TOTAL | | | | 448 000 |

CHEMICAL USAGE

| | Daily Quantity m^3/d | Dosage Rate mg/l | Annual Quantity tons | Unit Cost R/ton | Total Cost R |
|---|---|---|---|---|---|
| Sulphuric acid | 12 500 | 25 | 102.66 | 300.00 | 30 797 |
| Lime | 5 000 | 20 | 32.85 | 495.00 | 16 261 |
| Sodium bi-Sulphite | 11 125 | 5 | 18.27 | 2 050.00 | 37 459 |
| Flocon ( Anti-Scalant ) | 11 125 | 5 | 18.27 | 9 000.00 | 164 455 |
| Chlorine Raw Water | 12 500 | 5 | 20.53 | 700.00 | 14 372 |
| Chlorine Product Water | 5 000 | 1 | 1.64 | 700.00 | 1 150 |
| TOTAL FOR CHEMICALS | | | | | 264 000 |

MISCELLANEOUS SUPPLIES

| ITEM | Unit | Annual Quantity Unit/a | Unit Cost R per unit | Total Cost R |
|---|---|---|---|---|
| Cartridge Filters | No. | 200.00 | 80.00 | 16 000 |
| Citric acid | Ton | 0.50 | 8 750.00 | 4 375 |
| Detergent | Ton | 2.00 | 7 000.00 | 14 000 |
| Tannic acid | kg | 65.00 | 60.00 | 3 900 |
| TOTAL FOR CONSUMABLES | | | | 38 275 |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
REVERSE OSMOSIS
WITH ULTRA-FILTRATION PRETREATMENT

ALTERNATIVE B

CALCULATION OF PUMPING REQUIREMENTS

Based on operation at full rated output of 5 000 m^3/d

1 Sea Water Pumps

| | | |
|---|---|---|
| Pumping Rate | 145 | l/s |
| Length of Main | 300 | m |
| Diameter | 288 | mm |
| Friction Head | 3.6 | m |
| Static Head | 10.0 | m |
| Total Head | 13.6 | m |
| Efficiency of Pump | 75.0% | Percent |
| Power Absorbed | 26 | kW |
| Power Installed | 30 | kW |

2 Ultra Filtration Pumps

| | |
|---|---|
| Pumping Rate | 143 l/s |
| Length of Main | 20 m |
| Diameter | 280 mm |
| Friction Head | 0.3 m |
| Static Head | 114.0 m |
| Total Head | 114.3 m |
| Efficiency of Pump | 75.0%Percent |
| Power Absorbed | 218 kW |
| Power Installed | 250 kW |

3 Reverse Osmosis Feed Pumps

| | | |
|---|---|---|
| Pumping Rate | 129 | l/s |
| Length of Main | 30 | m |
| Diameter | 288 | mm |
| Friction Head | 0.3 | m |
| Static Head | 60.0 | m |
| Total Head | 60.3 | m |
| Efficiency of Pump | 75.0% | Percent |
| Power Absorbed | 103 | kW |
| Power Installed | 110 | kW |

4 Reverse Osmosis Pumps

| | |
|---|---|
| Pumping Rate | 129 l/s |
| Length of Main | 1 000 m |
| Equivalent Diameter | 280 mm |
| Friction Head | 11.1 m |
| Static Head | 550.0 m |
| Total Head | 561.1 m |
| Efficiency of Pump | 75.0%Percent |
| Power Absorbed | 962 kW |
| Power Installed | 1 260 kW |

5 Clear Water Pumps

| | |
|---|---|
| Pumping Rate | 58 l/s |
| Length of Main | 15 000 m |
| Diameter | 288 mm |
| Friction Head | 33.2 m |
| Static Head | 45.0 m |
| Total Head | 78.2 m |
| Efficiency of Pump | 75.0%Percent |
| Power Absorbed | 60 kW |
| Power Installed | 75 kW |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
REVERSE OSMOSIS
ALTERNATIVE B WITH ULTRA-FILTRATION PRETREATMENT

| YEAR | FLOW | FLOW | CAPITAL | FIXED COSTS | PROPMAINTNCE TO FLOW COSTS | | TOTAL |
|---|---|---|---|---|---|---|---|
| | m^3/d | Ml/a | R*1000 | R*1000 | R*1000 | | R*1000 |
| 1993 | | | | | | | |
| 1994 | | | 4 358 | | | | 4 358 |
| 1995 | | | 32 977 | | | | 32 977 |
| 1996 | 5 000 | 1 643 | | 1 131 | 2 501 | 446 | 4 078 |
| 1997 | 5 000 | 1 643 | | 1 131 | 2 501 | 446 | 4 078 |
| 1998 | 5 000 | 1 643 | | 1 131 | 2 501 | 446 | 4 078 |
| 1999 | 5 000 | 1 643 | | 1 131 | 2 501 | 446 | 4 078 |
| 2000 | 5 000 | 1 643 | | 1 131 | 2 501 | 446 | 4 078 |
| 2001 | 5 000 | 1 643 | | 1 131 | 2 501 | 446 | 4 078 |
| 2002 | 5 000 | 1 643 | | 1 131 | 2 501 | 446 | 4 078 |
| 2003 | 5 000 | 1 643 | | 1 131 | 2 501 | 446 | 4 078 |
| 2004 | 5 000 | 1 643 | | 1 131 | 2 501 | 446 | 4 078 |
| 2005 | 5 000 | 1 643 | | 1 131 | 2 501 | 446 | 4 078 |
| 2006 | 5 000 | 1 643 | | 1 131 | 2 501 | 446 | 4 078 |
| 2007 | 5 000 | 1 643 | | 1 131 | 2 501 | 446 | 4 078 |
| 2008 | 5 000 | 1 643 | | 1 131 | 2 501 | 446 | 4 078 |
| 2009 | 5 000 | 1 643 | | 1 131 | 2 501 | 446 | 4 078 |
| 2010 | 5 000 | 1 643 | | 1 131 | 2 501 | 446 | 4 078 |
| 2011 | 5 000 | 1 643 | 780 | 1 131 | 2 501 | 446 | 4 858 |
| 2012 | 5 000 | 1 643 | | 1 131 | 2 501 | 446 | 4 078 |
| 2013 | 5 000 | 1 643 | | 1 131 | 2 501 | 446 | 4 078 |
| 2014 | 5 000 | 1 643 | | 1 131 | 2 501 | 446 | 4 078 |
| 2015 | 5 000 | 1 643 | | 1 131 | 2 501 | 446 | 4 078 |
| 2016 | 5 000 | 1 643 | 18 630 | 1 131 | 2 501 | 446 | 22 708 |
| 2017 | 5 000 | 1 643 | | 1 131 | 2 501 | 446 | 4 078 |
| 2018 | 5 000 | 1 643 | | 1 131 | 2 501 | 446 | 4 078 |
| 2019 | 5 000 | 1 643 | | 1 131 | 2 501 | 446 | 4 078 |
| 2020 | 5 000 | 1 643 | | 1 131 | 2 501 | 446 | 4 078 |
| 2021 | 5 000 | 1 643 | | 1 131 | 2 501 | 446 | 4 078 |
| 2022 | 5 000 | 1 643 | | 1 131 | 2 501 | 446 | 4 078 |
| 2023 | 5 000 | 1 643 | | 1 131 | 2 501 | 446 | 4 078 |
| 2024 | 5 000 | 1 643 | | 1 131 | 2 501 | 446 | 4 078 |
| 2025 | 5 000 | 1 643 | | 1 131 | 2 501 | 446 | 4 078 |
| 2026 | 5 000 | 1 643 | 780 | 1 131 | 2 501 | 446 | 4 858 |
| 2027 | 5 000 | 1 643 | | 1 131 | 2 501 | 446 | 4 078 |
| 2028 | 5 000 | 1 643 | | 1 131 | 2 501 | 446 | 4 078 |
| 2029 | 5 000 | 1 643 | | 1 131 | 2 501 | 446 | 4 078 |
| 2030 | 5 000 | 1 643 | | 1 131 | 2 501 | 446 | 4 078 |
| 2031 | 5 000 | 1 643 | | 1 131 | 2 501 | 446 | 4 078 |
| 2032 | 5 000 | 1 643 | | 1 131 | 2 501 | 446 | 4 078 |
| 2033 | 5 000 | 1 643 | | 1 131 | 2 501 | 446 | 4 078 |
| 2034 | 5 000 | 1 643 | | 1 131 | 2 501 | 446 | 4 078 |
| 2035 | 5 000 | 1 643 | | 1 131 | 2 501 | 446 | 4 078 |
| | | | (1 457) | | | | (1 457) |

M

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
MECHANICAL VAPOUR COMPRESSION
ALTERNATIVE C WITH NO PRETREATMENT

| | | | |
|---|---|---|---|
| Raw Water Source | Sea Wells Located near Walvis Bay | | |
| Raw Water Requirements | 10 100 m^3/d | Pretreatment Losses | 1% |
| Output Capacity of Plant | 5 000 m^3/d | Filtration Losses | |
| Plant Design Factor | 90% | U.F.Plant Losses | |
| Annual Water Production | 1 643 Ml/annum | Plant Recovery Factor | 50% |

COSTS OF POWER

| | |
|---|---|
| kW Charges/month | 26.50 R/kW/Month |
| Unit Charges | 10.50 c/kWh |

| DEPRECIATION PERIOD | | Civils | Mechanical Electrical | Desal Equipment |
|---|---|---|---|---|
| | Years | 40 | 15 | 20 |
| ANNUAL MAINTENANCE FACTORS | | 0.50% | 4.00% | 2.00% |

PROGRAMMME REQUIIREMENTS

| | |
|---|---|
| Design Tender & Award | 9 Months |
| Construction | 12 Months |
| Start Up Period | 1 Month |

| CAPITAL COSTS (See Page 2) | Civils | Mechanical Electrical | Desal Equipment | Totals |
|---|---|---|---|---|
| | R*1000 | R*1000 | R*1000 | R*1000 |
| Direct Non Depreciable | 100 | | | 100 |
| Direct Depreciable | 6 800 | 780 | 20 700 | 28 280 |
| Indirect | 1 580 | 180 | 2 750 | 4 510 |
| Start Up Costs | | | | 210 |
| TOTAL CAPITAL COSTS | 8 480 | 960 | 23 450 | 33 100 |
| MAINTENANCE COSTS | 34 | 31 | 414 | 479 |

| ANNUAL RECURRING COSTS | R*1000 |
|---|---|
| Fixed | 1 001 |
| Flow Related (5 000 m^3/d ) | 1 425 |
| TOTAL | 2 426 |

ECONOMIC ANALYSIS

| Discount Rate | 0.0% | 4.0% | 6.0% | 8.0% | 10.0% |
|---|---|---|---|---|---|
| Capital NPV | 54 | 39 | 35 | 32 | 30 |
| Operating NPV | 116 | 53 | 39 | 30 | 23 |
| Total NPV | 170 | 93 | 74 | 62 | 54 |
| Water Produced Discounted | 66 | 30 | 22 | 17 | 13 |
| REFERENCE UNIT VALUE Rand/m^3 | 2.59 | 3.08 | 3.38 | 3.70 | 4.04 |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
MECHANICAL VAPOUR COMPRESSION
ALTERNATIVE C WITH NO PRETREATMENT
ESTIMATED CAPITAL COSTS

| DIRECT CAPITAL COSTS | Civils | Mechanical Electrical | Desal Equipment | Totals |
|---|---|---|---|---|
| Non Depreciable | R*1000 | R*1000 | R*1000 | R*1000 |
| 1 Purchase of Land | 100 | | | 100 |
| Depreciable | | | | |
| 1 Wellfield | 425 | 275 | | 700 |
| 2 Delivery Pipelines | 50 | | | 50 |
| 3 Site Development | 200 | 60 | | 260 |
| 4 Raw Water Storage (2 000 m^3) | 950 | | | 950 |
| 5 Pretreatment Works | 25 | 55 | | 80 |
| 6 Administrative & Miscellaneous Buildings | 80 | | | 80 |
| 7 Desalination Equipment Buildings (560 m^2) | 840 | | | 840 |
| 8 Desalination Equipment | | | 20 700 | 20 700 |
| 9 Product Storage Reservoir (625 m^3) | 445 | | | 445 |
| 10 Incoming Power Supply | | 230 | | 230 |
| 11 Product Pipeline & Pumpstation | 3 735 | 160 | | 3 895 |
| 12 Brine Pipeline | 50 | | | 50 |
| Total of Depreciable Costs | 6 800 | 780 | 20 700 | 28 280 |
| INDIRECT CAPITAL COSTS | | | | |
| Contingencies 10.00%of Net Cost | 680 | 80 | 2 070 | 2 830 |
| Escalation 0.00%per Month | | | | |
| Engineering Fees | | | | |
| Civil and Mechanical 12.0% | 900 | 100 | | 1 000 |
| Desalination Equipment 3.0% | | | 680 | 680 |
| Totals of Indirect Depreciable Costs | 1 580 | 180 | 2 750 | 4 510 |

START UP COSTS (Pro Rata on Start Up Period )

| | R*1000 |
|---|---|
| Chemicals | 5 |
| Power | |
| Electrical | 159 |
| Heavy Fuel Oil | 5 |
| Staff | 39 |
| Totals | 207 |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
MECHANICAL VAPOUR COMPRESSION
ALTERNATIVE C WITH NO PRETREATMENT
ESTIMATED CAPITAL COSTS
CALCULATION OF ENERGY COSTS

Based on operation at full rated output of 5 000 m^3/d

ELECTRICAL ENERGY

| Component | Absorbed Power kW | Installed Power kW | % Utilisation | Average kWh/day |
|---|---|---|---|---|
| Seawater pumps | 19 | 22 | 90.0% | 419 |
| Clear Water Pumps | 60 | 75 | 90.0% | 1 304 |
| Compressor | 1 560 | 1 575 | 90.0% | 34 020 |
| Totals | 1 640 | 1 672 | | 35 743 |

| | | R*1000 |
|---|---|---|
| Fixed Annual Power costs | | 532 |
| Flow Related Power costs | Electrical Energy | 1 370 |

CALCULATION OF ANNUAL RECURRING COSTS

| | R*1000 |
|---|---|
| FIXED | |
| Salaries and Labour | 361 |
| Labour Overhead ( 30.0%) | 108 |
| Fixed electrical energy costs | 532 |
| Total | 1 001 |
| FLOW RELATED | |
| Power-Electrical | 1 370 |
| Chemicals | 55 |
| Miscellaneous Supplies | |
| Total | 1 425 |

STAFFING

| | Util | No. | Salary R | Total Salaries R |
|---|---|---|---|---|
| Superintendant | 100% | 1 | 70 000 | 70 000 |
| Snr Operator | 100% | 5 | 39 000 | 195 000 |
| Jnr Operator | 100% | 0 | 32 500 | 0 |
| Operating Asst | 100% | 4 | 12 400 | 49 600 |
| Labourers | 100% | 2 | 12 400 | 24 800 |
| Lab. Techn. | 10% | 1 | 32 500 | 3 250 |
| Mech. Maint. | 30% | 1 | 44 800 | 13 440 |
| Elec. Maint. | 10% | 1 | 44 800 | 4 480 |
| TOTAL | | | | 361 000 |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
MECHANICAL VAPOUR COMPRESSION
WITH NO PRETREATMENT

M

ALTERNATIVE C

CHEMICAL USAGE

| | Daily Quantity | Dosage Rate | Annual Quantity | Unit Cost | Total Cost |
|---|---|---|---|---|---|
| | m^3/d | mg/l | tons | R/ton | R |
| Lime | 5 000 | 20 | 32.85 | 495.00 | 16 261 |
| Anti-Scalant | 9 999 | 4 | 13.14 | 2 000.00 | 26 277 |
| Chlorine Raw Water | 10 100 | 5 | 16.59 | 700.00 | 11 612 |
| Chlorine Product Water | 5 000 | 1 | 1.64 | 700.00 | 1 150 |
| TOTAL FOR CHEMICALS | | | | | 55 000 |

MISCELLANEOUS SUPPLIES

| ITEM | Annual Quantity | Unit Cost | Total Cost |
|---|---|---|---|
| | Unit | Unit/a | R per unit | R |
| TOTAL FOR CONSUMABLES | | | | |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
MECHANICAL VAPOUR COMPRESSION
WITH NO PRETREATMENT

ALTERNATIVE C

CALCULATION OF PUMPING REQUIREMENTS

Based on operation at full rated output of 5 000 m^3/d

| 1 Sea Water Pumps | | | 2 Clear Water Pumps | | |
|---|---|---|---|---|---|
| Pumping Rate | 117 | l/s | Pumping Rate | 58 | l/s |
| Length of Main | 300 | m | Length of Main | 15 000 | m |
| Diameter | 288 | mm | Diameter | 288 | mm |
| Friction Head | 2.4 | m | Friction Head | 33.2 | m |
| Static Head | 10.0 | m | Static Head | 45.0 | m |
| Total Head | 12.4 | m | Total Head | 78.2 | m |
| Efficiency of Pump | 75.0% | Percent | Efficiency of Pump | 75.0% | Percent |
| Power Absorbed | 19 | kW | Power Absorbed | 60 | kW |
| Power Installed | 22 | kW | Power Installed | 75 | kW |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
MECHANICAL VAPOUR COMPRESSION
ALTERNATIVE C WITH NO PRETREATMENT

| YEAR | FLOW | FLOW | CAPITAL | FIXED COSTS | PROPMAINTNCE TO FLOW COSTS | | TOTAL |
|---|---|---|---|---|---|---|---|
| | m^3/d | Ml/a | R*1000 | R*1000 | R*1000 | R*1000 | R*1000 |
| 1993 | | | | | | | |
| 1994 | | | 3 819 | | | | 3 819 |
| 1995 | | | 29 281 | | | | 29 281 |
| 1996 | 5 000 | 1 643 | | 1 001 | 1 425 | 479 | 2 905 |
| 1997 | 5 000 | 1 643 | | 1 001 | 1 425 | 479 | 2 905 |
| 1998 | 5 000 | 1 643 | | 1 001 | 1 425 | 479 | 2 905 |
| 1999 | 5 000 | 1 643 | | 1 001 | 1 425 | 479 | 2 905 |
| 2000 | 5 000 | 1 643 | | 1 001 | 1 425 | 479 | 2 905 |
| 2001 | 5 000 | 1 643 | | 1 001 | 1 425 | 479 | 2 905 |
| 2002 | 5 000 | 1 643 | | 1 001 | 1 425 | 479 | 2 905 |
| 2003 | 5 000 | 1 643 | | 1 001 | 1 425 | 479 | 2 905 |
| 2004 | 5 000 | 1 643 | | 1 001 | 1 425 | 479 | 2 905 |
| 2005 | 5 000 | 1 643 | | 1 001 | 1 425 | 479 | 2 905 |
| 2006 | 5 000 | 1 643 | | 1 001 | 1 425 | 479 | 2 905 |
| 2007 | 5 000 | 1 643 | | 1 001 | 1 425 | 479 | 2 905 |
| 2008 | 5 000 | 1 643 | | 1 001 | 1 425 | 479 | 2 905 |
| 2009 | 5 000 | 1 643 | | 1 001 | 1 425 | 479 | 2 905 |
| 2010 | 5 000 | 1 643 | | 1 001 | 1 425 | 479 | 2 905 |
| 2011 | 5 000 | 1 643 | 780 | 1 001 | 1 425 | 479 | 3 685 |
| 2012 | 5 000 | 1 643 | | 1 001 | 1 425 | 479 | 2 905 |
| 2013 | 5 000 | 1 643 | | 1 001 | 1 425 | 479 | 2 905 |
| 2014 | 5 000 | 1 643 | | 1 001 | 1 425 | 479 | 2 905 |
| 2015 | 5 000 | 1 643 | | 1 001 | 1 425 | 479 | 2 905 |
| 2016 | 5 000 | 1 643 | 20 700 | 1 001 | 1 425 | 479 | 23 605 |
| 2017 | 5 000 | 1 643 | | 1 001 | 1 425 | 479 | 2 905 |
| 2018 | 5 000 | 1 643 | | 1 001 | 1 425 | 479 | 2 905 |
| 2019 | 5 000 | 1 643 | | 1 001 | 1 425 | 479 | 2 905 |
| 2020 | 5 000 | 1 643 | | 1 001 | 1 425 | 479 | 2 905 |
| 2021 | 5 000 | 1 643 | | 1 001 | 1 425 | 479 | 2 905 |
| 2022 | 5 000 | 1 643 | | 1 001 | 1 425 | 479 | 2 905 |
| 2023 | 5 000 | 1 643 | | 1 001 | 1 425 | 479 | 2 905 |
| 2024 | 5 000 | 1 643 | | 1 001 | 1 425 | 479 | 2 905 |
| 2025 | 5 000 | 1 643 | | 1 001 | 1 425 | 479 | 2 905 |
| 2026 | 5 000 | 1 643 | 780 | 1 001 | 1 425 | 479 | 3 685 |
| 2027 | 5 000 | 1 643 | | 1 001 | 1 425 | 479 | 2 905 |
| 2028 | 5 000 | 1 643 | | 1 001 | 1 425 | 479 | 2 905 |
| 2029 | 5 000 | 1 643 | | 1 001 | 1 425 | 479 | 2 905 |
| 2030 | 5 000 | 1 643 | | 1 001 | 1 425 | 479 | 2 905 |
| 2031 | 5 000 | 1 643 | | 1 001 | 1 425 | 479 | 2 905 |
| 2032 | 5 000 | 1 643 | | 1 001 | 1 425 | 479 | 2 905 |
| 2033 | 5 000 | 1 643 | | 1 001 | 1 425 | 479 | 2 905 |
| 2034 | 5 000 | 1 643 | | 1 001 | 1 425 | 479 | 2 905 |
| 2035 | 5 000 | 1 643 | | 1 001 | 1 425 | 479 | 2 905 |
| | | | (1 517) | | | | (1 517) |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
THERMAL VAPOUR COMPRESSION
ALTERNATIVE D WITH NO PRETREATMENT
ESTIMATED CAPITAL COSTS

| DIRECT CAPITAL COSTS | Civils | Mechanical Electrical | Desal Equipment | Totals |
|---|---|---|---|---|
| Non Depreciable | R*1000 | R*1000 | R*1000 | R*1000 |
| 1 Purchase of Land | 100 | | | 100 |
| Depreciable | | | | |
| 1 Wellfield | 425 | 275 | | 700 |
| 2 Delivery Pipelines | 50 | | | 50 |
| 3 Site Development | 200 | 60 | | 260 |
| 4 Raw Water Storage (2000 m^3) | 950 | | | 950 |
| 5 Pretreatment Works | 25 | 55 | | 80 |
| 6 Administrative & Miscellaneous Buildings | 80 | | | 80 |
| 7 Desalination Equipment Buildings (543 m^2) | 815 | | | 815 |
| 8 Desalination Equipment | | | 21 000 | 21 000 |
| 9 Steam Generation Equipment | 750 | 7 500 | | 8 250 |
| 10 Product Storage Reservoir (625 m^3) | 445 | | | 445 |
| 11 Incoming Power Supply | | 230 | | 230 |
| 12 Product Pipeline & Pumpstation | 3 735 | 160 | | 3 895 |
| 13 Brine Pipeline | 50 | | | 50 |
| Totals of Depreciable Costs | 7 525 | 8 280 | 21 000 | 36 805 |
| INDIRECT CAPITAL COSTS | | | | |
| Contingencies 10.00%of Net Cost | 750 | 830 | 2 100 | 3 680 |
| Escalation 0.00%per Month | | | | |
| Engineering Fees | | | | |
| Civil and Mechanical 12.0% | 990 | 1 090 | | 2 080 |
| Desalination Equipment 3.0% | | | 690 | 690 |
| Totals of Indirect Depreciable Costs | 1 740 | 1 920 | 2 790 | 6 450 |

START UP COSTS (Pro Rata on Start Up Period )

| | R*1000 |
|---|---|
| Chemicals | 5 |
| Power | |
| Electrical | 28 |
| Heavy Fuel Oil | 394 |
| Staff | 39 |
| Totals | 466 |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
THERMAL VAPOUR COMPRESSION
ALTERNATIVE D WITH NO PRETREATMENT
ESTIMATED CAPITAL COSTS
CALCULATION OF ENERGY COSTS

Based on operation at full rated output of 5 000 m^3/d

ELECTRICAL ENERGY

| Component | Absorbed Power kW | Installed Power kW | % Utilisation | Average kWh/day |
|---|---|---|---|---|
| Seawater pumps | 19 | 22 | 90.0% | 419 |
| Clear Water Pumps | 60 | 75 | 90.0% | 1 304 |
| Additional Energy | 208 | 210 | 90.0% | 4 493 |
| Totals | 288 | 307 | | 6 216 |

| | | |
|---|---|---|
| Heavy Fuel Oil Consumption | | |
| Boiler Efficiency | 82.0% | |
| Required evaporation rate | 20.00 t/h | |
| Heavy Fuel Oil Consumption Rat | 1.28 t/h | |
| | | R*1000 |
| Fixed Power Costs | | 98 |
| Flow Related Power costs | Electrical Energy | 238 |
| Flow Related Power costs | Heavy Fuel Oil | 4 726 |

| CALCULATION OF ANNUAL RECURRING COSTS | R*1000 |
|---|---|
| FIXED | |
| Salaries and Labour | 361 |
| Labour Overhead ( 30.0%) | 108 |
| Fixed electrical energy costs | 98 |
| Total | 567 |
| FLOW RELATED | |
| Power-Electrical | 238 |
| Heavy Fuel Oil | 4 726 |
| Chemicals | 55 |
| Miscellaneous Supplies | |
| Total | 5 019 |

STAFFING

| | Util | No. | Salary R | Total Salaries R |
|---|---|---|---|---|
| Superintendant | 100% | 1 | 70 000 | 70 000 |
| Snr Operator | 100% | 5 | 39 000 | 195 000 |
| Jnr Operator | 100% | 0 | 32 500 | 0 |
| Operating Asst | 100% | 4 | 12 400 | 49 600 |
| Labourers | 100% | 2 | 12 400 | 24 800 |
| Lab. Techn. | 10% | 1 | 32 500 | 3 250 |
| Mech. Maint. | 30% | 1 | 44 800 | 13 440 |
| Elec. Maint. | 10% | 1 | 44 800 | 4 480 |
| TOTAL | | | | 361 000 |

T

ALTERNATIVE D

CHEMICAL USAGE

| | Daily Quantity | Dosage Rate | Annual Quantity | Unit Cost | Total Cost |
|---|---|---|---|---|---|
| | m^3/d | mg/l | tons | R/ton | R |
| Lime | 5 000 | 20 | 32.85 | 495.00 | 16 261 |
| Anti-Scalant | 9 999 | 4 | 13.14 | 2 000.00 | 26 277 |
| Chlorine Raw Water | 10 100 | 5 | 16.59 | 700.00 | 11 612 |
| Chlorine Product Water | 5 000 | 1 | 1.64 | 700.00 | 1 150 |
| TOTAL FOR CHEMICALS | | | | | 55 000 |

MISCELLANEOUS SUPPLIES

| ITEM | Annual Quantity | Unit Cost | Total Cost |
|---|---|---|---|
| | Unit | Unit/a | R per unit | R |
| TOTAL FOR CONSUMABLES | | | | |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
THERMAL VAPOUR COMPRESSION
WITH NO PRETREATMENT

ALTERNATIVE D

CALCULATION OF PUMPING REQUIREMENTS

Based on operation at full rated output of 5 000 m^3/d

| 1 Sea Water Pumps | | | 2 Clear Water Pumps | |
|---|---|---|---|---|
| Pumping Rate | 117 | l/s | Pumping Rate | 58 l/s |
| Length of Main | 300 | m | Length of Main | 15 000 m |
| Diameter | 288 | mm | Diameter | 288 mm |
| Friction Head | 2.4 | m | Friction Head | 33.2 m |
| Static Head | 10.0 | m | Static Head | 45.0 m |
| Total Head | 12.4 | m | Total Head | 78.2 m |
| Efficiency of Pump | 75.0% | Percent | Efficiency of Pump | 75.0%Percent |
| Power Absorbed | 19 | kW | Power Absorbed | 60 kW |
| Power Installed | 22 | kW | Power Installed | 75 kW |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
MULTIPLE EFFECT DISTILLATION
ALTERNATIVE E WITH NO PRETREATMENT
ESTIMATED CAPITAL COSTS

| DIRECT CAPITAL COSTS | Civils | Mechanical Electrical | Desal Equipment | Totals |
|---|---|---|---|---|
| Non Depreciable | R*1000 | R*1000 | R*1000 | R*1000 |
| 1 Purchase of Land | 100 | | | 100 |
| Depreciable | | | | |
| 1 Wellfield | 425 | 275 | | 700 |
| 2 Delivery Pipelines | 50 | | | 50 |
| 3 Site Development | 200 | 60 | | 260 |
| 4 Raw Water Storage (2 000 m^3) | 950 | | | 950 |
| 5 Pretreatment Works | 25 | 55 | | 80 |
| 6 Administrative & Misc. Buildings | 80 | | | 80 |
| 7 Desalination Equipment Buildings (800 m^2) | 1 200 | | | 1 200 |
| 8 Desalination Equipment | | | 21 000 | 21 000 |
| 9 Steam Generation Equipment | 750 | 7 500 | | 8 250 |
| 10 Product Storage Reservoir (625 m^3) | 445 | | | 445 |
| 11 Incoming Power Supply | | 230 | | 230 |
| 12 Product Pipeline & Pumpstation | 3 735 | 160 | | 3 895 |
| 13 Brine Pipeline | 50 | | | 50 |
| Totals of Depreciable Costs | 7 910 | 8 280 | 21 000 | 37 190 |
| INDIRECT CAPITAL COSTS | | | | |
| Contingencies 10.00%of Net Cost | 790 | 830 | 2 100 | 3 720 |
| Escalation 0.00%per Month | | | | |
| Engineering Fees | | | | |
| Civil and Mechanical 12.0% | 1 040 | 1 090 | | 2 130 |
| Desalination Equipment 3.0% | | | 690 | 690 |
| Totals of Indirect Depreciable Costs | 1 830 | 1 920 | 2 790 | 6 540 |

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START UP COSTS (Pro Rata on Start Up Period )

| | R*1000 |
|---|---|
| Chemicals | 5 |
| Power | |
| Electrical | 39 |
| Heavy Fuel Oil | 497 |
| Staff | 39 |
| Totals | 579 |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
MULTIPLE EFFECT DISTILLATION
ALTERNATIVE E WITH NO PRETREATMENT
ESTIMATED CAPITAL COSTS
CALCULATION OF ENERGY COSTS

Based on operation at full rated output of 5 000 m^3/d

ELECTRICAL ENERGY

| Component | Absorbed Power kW | Installed Power kW | % Utilisation | Average kWh/day |
|---|---|---|---|---|
| Seawater pumps | 19 | 22 | 90.0% | 419 |
| Clear Water Pumps | 60 | 75 | 90.0% | 1 304 |
| Additional Energy | 313 | 320 | 90.0% | 6 912 |
| Totals | 393 | 417 | | 8 635 |

Heavy Fuel Oil Consumption

| | | |
|---|---|---|
| Boiler Efficiency | 82.0% | |
| Required evaporation Rate | 26.00 t/h | |
| Heavy Fuel Oil Consumption Rate | 1.67 t/h | |
| | | R*1000 |
| Fixed Annual Power costs | | 133 |
| Flow Related Power costs | Electrical Energy | 331 |
| Flow Related Power costs | Heavy Fuel Oil | 5 961 |

| CALCULATION OF ANNUAL RECURRING COSTS | R*1000 |
|---|---|
| FIXED | |
| Salaries and Labour | 361 |
| Labour Overhead ( 30.0%) | 108 |
| Fixed electrical energy costs | 133 |
| Total | 602 |
| FLOW RELATED | |
| Power-Electrical | 331 |
| Heavy Fuel Oil | 5 961 |
| Chemicals | 55 |
| Miscellaneous Supplies | |
| Total | 6 347 |

STAFFING

| | Util | No. | Salary R | Total Salaries R |
|---|---|---|---|---|
| Superintendant | 100% | 1 | 70 000 | 70 000 |
| Snr Operator | 100% | 5 | 39 000 | 195 000 |
| Jnr Operator | 100% | 0 | 32 500 | 0 |
| Operating Asst | 100% | 4 | 12 400 | 49 600 |
| Labourers | 100% | 2 | 12 400 | 24 800 |
| Lab. Techn. | 10% | 1 | 32 500 | 3 250 |
| Mech. Maint. | 30% | 1 | 44 800 | 13 440 |
| Elec. Maint. | 10% | 1 | 44 800 | 4 480 |
| TOTAL | | | | 361 000 |

E

ALTERNATIVE E

CHEMICAL USAGE

| | Daily Quantity | Dosage Rate | Annual Quantity | Unit Cost | Total Cost |
|---|---|---|---|---|---|
| | m^3/d | mg/l | tons | R/ton | R |
| Lime | 5 000 | 20 | 32.85 | 495.00 | 16 261 |
| Anti-Scalant | 9 999 | 4 | 13.14 | 2 000.00 | 26 277 |
| Chlorine Raw Water | 10 100 | 5 | 16.59 | 700.00 | 11 612 |
| Chlorine Product Water | 5 000 | 1 | 1.64 | 700.00 | 1 150 |
| TOTAL FOR CHEMICALS | | | | | 55 000 |

MISCELLANEOUS SUPPLIES

| ITEM | Annual Quantity | Unit Cost | Total Cost |
|---|---|---|---|
| | Unit | Unit/a | R per unit | R |
| TOTAL FOR CONSUMABLES | | | | |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
MULTIPLE EFFECT DISTILLATION
WITH NO PRETREATMENT

ALTERNATIVE E

## CALCULATION OF PUMPING REQUIREMENTS

Based on operation at full rated output of 5 000 m^3/d

| 1 Sea Water Pumps | | | 2 Clear Water Pumps | | |
|---|---|---|---|---|---|
| Pumping Rate | 117 | l/s | Pumping Rate | 58 | l/s |
| Length of Main | 300 | m | Length of Main | 15 000 | m |
| Diameter | 288 | mm | Diameter | 288 | mm |
| Friction Head | 2.4 | m | Friction Head | 33.2 | m |
| Static Head | 10.0 | m | Static Head | 45.0 | m |
| Total Head | 12.4 | m | Total Head | 78.2 | m |
| Efficiency of Pump | 75.0% | Percent | Efficiency of Pump | 75.0% | Percent |
| Power Absorbed | 19 | kW | Power Absorbed | 60 | kW |
| Power Installed | 22 | kW | Power Installed | 75 | kW |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
MULTIPLE EFFECT DISTILLATION
ALTERNATIVE E WITH NO PRETREATMENT

| YEAR | FLOW | FLOW | CAPITAL | FIXED COSTS | PROPMAINTNCE TO FLOW COSTS | | TOTAL |
|---|---|---|---|---|---|---|---|
| | m^3/d | Ml/a | R*1000 | R*1000 | R*1000 | R*1000 | R*1000 |
| 1993 | | | | | | | |
| 1994 | | | 5 462 | | | | 5 462 |
| 1995 | | | 38 948 | | | | 38 948 |
| 1996 | 5 000 | 1 643 | | 602 | 6 347 | 791 | 7 740 |
| 1997 | 5 000 | 1 643 | | 602 | 6 347 | 791 | 7 740 |
| 1998 | 5 000 | 1 643 | | 602 | 6 347 | 791 | 7 740 |
| 1999 | 5 000 | 1 643 | | 602 | 6 347 | 791 | 7 740 |
| 2000 | 5 000 | 1 643 | | 602 | 6 347 | 791 | 7 740 |
| 2001 | 5 000 | 1 643 | | 602 | 6 347 | 791 | 7 740 |
| 2002 | 5 000 | 1 643 | | 602 | 6 347 | 791 | 7 740 |
| 2003 | 5 000 | 1 643 | | 602 | 6 347 | 791 | 7 740 |
| 2004 | 5 000 | 1 643 | | 602 | 6 347 | 791 | 7 740 |
| 2005 | 5 000 | 1 643 | | 602 | 6 347 | 791 | 7 740 |
| 2006 | 5 000 | 1 643 | | 602 | 6 347 | 791 | 7 740 |
| 2007 | 5 000 | 1 643 | | 602 | 6 347 | 791 | 7 740 |
| 2008 | 5 000 | 1 643 | | 602 | 6 347 | 791 | 7 740 |
| 2009 | 5 000 | 1 643 | | 602 | 6 347 | 791 | 7 740 |
| 2010 | 5 000 | 1 643 | | 602 | 6 347 | 791 | 7 740 |
| 2011 | 5 000 | 1 643 | 8 280 | 602 | 6 347 | 791 | 16 020 |
| 2012 | 5 000 | 1 643 | | 602 | 6 347 | 791 | 7 740 |
| 2013 | 5 000 | 1 643 | | 602 | 6 347 | 791 | 7 740 |
| 2014 | 5 000 | 1 643 | | 602 | 6 347 | 791 | 7 740 |
| 2015 | 5 000 | 1 643 | | 602 | 6 347 | 791 | 7 740 |
| 2016 | 5 000 | 1 643 | 21 000 | 602 | 6 347 | 791 | 28 740 |
| 2017 | 5 000 | 1 643 | | 602 | 6 347 | 791 | 7 740 |
| 2018 | 5 000 | 1 643 | | 602 | 6 347 | 791 | 7 740 |
| 2019 | 5 000 | 1 643 | | 602 | 6 347 | 791 | 7 740 |
| 2020 | 5 000 | 1 643 | | 602 | 6 347 | 791 | 7 740 |
| 2021 | 5 000 | 1 643 | | 602 | 6 347 | 791 | 7 740 |
| 2022 | 5 000 | 1 643 | | 602 | 6 347 | 791 | 7 740 |
| 2023 | 5 000 | 1 643 | | 602 | 6 347 | 791 | 7 740 |
| 2024 | 5 000 | 1 643 | | 602 | 6 347 | 791 | 7 740 |
| 2025 | 5 000 | 1 643 | | 602 | 6 347 | 791 | 7 740 |
| 2026 | 5 000 | 1 643 | 8 280 | 602 | 6 347 | 791 | 16 020 |
| 2027 | 5 000 | 1 643 | | 602 | 6 347 | 791 | 7 740 |
| 2028 | 5 000 | 1 643 | | 602 | 6 347 | 791 | 7 740 |
| 2029 | 5 000 | 1 643 | | 602 | 6 347 | 791 | 7 740 |
| 2030 | 5 000 | 1 643 | | 602 | 6 347 | 791 | 7 740 |
| 2031 | 5 000 | 1 643 | | 602 | 6 347 | 791 | 7 740 |
| 2032 | 5 000 | 1 643 | | 602 | 6 347 | 791 | 7 740 |
| 2033 | 5 000 | 1 643 | | 602 | 6 347 | 791 | 7 740 |
| 2034 | 5 000 | 1 643 | | 602 | 6 347 | 791 | 7 740 |
| 2035 | 5 000 | 1 643 | | 602 | 6 347 | 791 | 7 740 |
| | | | (4 560) | | | | (4 560) |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
REVERSE OSMOSIS



ALTERNATIVE F OFFSHORE SEAWATER WITH PRETREATMENT
WITH NO ULTRA-FILTRATION PRETREATMENT

| | | | |
|---|---|---|---|
| Raw Water Source | Sea Intakes Located near Walvis Bay | | |
| Raw Water Requirements | 11 500 m^3/d | Pretreatment Losses | 1% |
| Output Capacity of Plant | 5 000 m^3/d | Filtration Losses | 2% |
| Plant Design Factor | 90% | U.F.Plant Losses | |
| Annual Water Production | 1 643 Ml/annum | R.O.Plant Recovery Factor | 45% |

COSTS OF POWER

| | |
|---|---|
| kW Charges/month | 26.50 R/kW/Month |
| Unit Charges | 10.50 c/kWh |

| DEPRECIATION PERIOD | Civils | Mechanical Electrical | Desal Equipment | Membranes R. O. |
|---|---|---|---|---|
| Years | 40 | 15 | 20 | 5 |

| | | | | |
|---|---|---|---|---|
| MAINTENANCE FACTORS | 0.50% | 4.00% | 2.00% | |

PROGRAMMME REQUIIREMENTS

| | |
|---|---|
| Design Tender & Award | 9 Months |
| Construction | 12 Months |
| Start Up Period | 1 Month |

| CAPITAL COSTS (See Page 2) | Civils | Mechanical Electrical | Desal Equipment | Membranes R. O. | Totals |
|---|---|---|---|---|---|
| | R*1000 | R*1000 | R*1000 | R*1000 | R*1000 |
| Direct Non Depreciable | 100 | | | | 100 |
| Direct Depreciable | 12 750 | 4 645 | 17 500 | 3 000 | 37 895 |
| Indirect | 2 960 | 1 070 | 2 330 | 400 | 6 760 |
| Start Up Costs | | | | | 190 |
| TOTAL CAPITAL COSTS | 15 810 | 5 715 | 19 830 | 3 400 | 44 945 |
| MAINTENANCE COSTS | 64 | 186 | 350 | | 600 |

| ANNUAL RECURRING COSTS | R*1000 |
|---|---|
| Fixed | 1 063 |
| Flow Related (5 000 m^3/d) | 1 880 |
| TOTAL | 2 943 |

ECONOMIC ANALYSIS

| Discount Rate | 0.0% | 4.0% | 6.0% | 8.0% | 10.0% |
|---|---|---|---|---|---|
| Capital NPV | 69 | 52 | 47 | 43 | 41 |
| Operating NPV | 142 | 65 | 47 | 36 | 29 |
| Total NPV | 210 | 117 | 94 | 80 | 69 |
| Water Produced Discounted | 66 | 30 | 22 | 17 | 13 |
| REFERENCE UNIT VALUE Rand/m^3 | 3.20 | 3.88 | 4.29 | 4.74 | 5.21 |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
REVERSE OSMOSIS
ALTERNATIVE F OFFSHORE SEAWATER WITH PRETREATMENT
WITH NO ULTRA-FILTRATION PRETREATMENT
ESTIMATED CAPITAL COSTS

| DIRECT CAPITAL COSTS | Civils | Mechanical Electrical | Desal Equipment | Membranes R. O. | Totals |
|---|---|---|---|---|---|
| Non Depreciable | R*1000 | R*1000 | R*1000 | R*1000 | R*1000 |
| 1 Purchase of Land | 100 | | | | 100 |
| Depreciable | | | | | |
| 1 Sea Intake & Pumpstation | 3 290 | 330 | | | 3 620 |
| 2 Delivery Pipelines | 50 | | | | 50 |
| 3 Site Development | 200 | 60 | | | 260 |
| 4 Raw Water Storage (12 000 m^3) | 2 805 | | | | 2 805 |
| 5 Pretreatment Works and Pumpstations | 275 | 3 865 | | | 4 140 |
| 6 Administrative & Miscellaneous Buildings | 100 | | | | 100 |
| 7 Desalination Equipment Buildings (1 200 m^2) | 1 800 | | | | 1 800 |
| 8 Desalination Equipment | | | 17 500 | 3 000 | 20 500 |
| 9 Product Storage Reservoir ( 625 m^3) | 445 | | | | 445 |
| 10 Incoming Power Supply | | 230 | | | 230 |
| 11 Product Pipeline & Pumpstation | 3 735 | 160 | | | 3 895 |
| 12 Brine Pipeline | 50 | | | | 50 |
| Totals of Depreciable Costs | 12 750 | 4 645 | 17 500 | 3 000 | 37 895 |
| INDIRECT CAPITAL COSTS | | | | | |
| Contingencies 10.00%of Net Cost | 1 280 | 460 | 1 750 | 300 | 3 790 |
| Escalation 0.00%per Month | | | | | |
| Engineering Fees | | | | | |
| Civil and Mechanical 12.0% | 1 680 | 610 | | | 2 290 |
| Desalination Equipment 3.0% | | | 580 | 100 | 680 |
| Totals of Indirect Depreciable Costs | 2 960 | 1 070 | 2 330 | 400 | 6 760 |

START UP COSTS (Pro Rata on Start Up Period )

| | R*1000 |
|---|---|
| Chemicals | 22 |
| Power | |
| Electrical | 122 |
| Staff | 49 |
| Totals | 192 |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
REVERSE OSMOSIS
ALTERNATIVE F OFFSHORE SEAWATER WITH PRETREATMENT
WITH NO ULTRA-FILTRATION PRETREATMENT
CALCULATION OF ENERGY COSTS

Based on operation at full rated output of 5 000 m^3/d

ELECTRICAL ENERGY

| Component | Absorbed Power kW | Installed Power kW | % Utilisation | Average kWh/day |
|---|---|---|---|---|
| Seawater pumps | 23 | 30 | 90.0% | 502 |
| Pretreatment Works | 36 | 37 | 90.0% | 783 |
| Reverse Osmosis Feed Pumps | 103 | 110 | 90.0% | 2 233 |
| Reverse Osmosis Pumps | 962 | 1 260 | 90.0% | 20 783 |
| Clear Water Pumps | 60 | 75 | 90.0% | 1 304 |
| Totals | 1 185 | 1 512 | | 25 605 |

| | R*1000 | |
|---|---|---|
| Fixed Annual Power costs | 481 | |
| Flow Related Power costs | 981 | Electrical Energy |

CALCULATION OF ANNUAL RECURRING COSTS

| | R*1000 |
|---|---|
| FIXED | |
| Salaries and Labour | 448 |
| Labour Overhead ( 30.0%) | 134 |
| Fixed electrical energy costs | 481 |
| Total | 1 063 |
| FLOW RELATED | |
| Power-Electrical | 981 |
| Chemicals | 261 |
| Miscellaneous Supplies | 38 |
| R.O.Membrane Replacement (5 Yearly) | 600 |
| Total | 1 880 |

STAFFING

| | Util | No. | Salary R | Total Salaries R |
|---|---|---|---|---|
| Super-intndt | 100% | 1 | 70 000 | 70 000 |
| Snr Operator | 100% | 4 | 39 000 | 156 000 |
| Jnr Operator | 100% | 5 | 32 500 | 162 500 |
| Operating Asst | 0% | 0 | 12 400 | 0 |
| Labourers | 100% | 3 | 12 400 | 37 200 |
| Lab. Techn. | 20% | 1 | 32 500 | 6 500 |
| Mech. Maint. | 20% | 1 | 44 800 | 8 960 |
| Elec. Maint. | 15% | 1 | 44 800 | 6 720 |
| TOTAL | | | | 448 000 |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
REVERSE OSMOSIS
ALTERNATIVE F OFFSHORE SEAWATER WITH PRETREATMENT
WITH NO ULTRA-FILTRATION PRETREATMENT
CHEMICAL USAGE

| | Daily Quantity m^3/d | Dosage Rate mg/l | Annual Quantity tons | Unit Cost R/ton | Total Cost R |
|---|---|---|---|---|---|
| Sulphuric acid | 11 500 | 25 | 94.44 | 300.00 | 28 333 |
| Lime | 5 000 | 20 | 32.85 | 495.00 | 16 261 |
| Sodium bi-Sulphite | 11 155 | 5 | 18.32 | 2 050.00 | 37 560 |
| Flocon ( Anti-Scalant ) | 11 155 | 5 | 18.32 | 9 000.00 | 164 899 |
| Chlorine Raw Water | 11 500 | 5 | 18.89 | 700.00 | 13 222 |
| Chlorine Product Water | 5 000 | 1 | 1.64 | 700.00 | 1 150 |
| Coagulant | | | | | |
| TOTAL FOR CHEMICALS | | | | | 261 000 |

MISCELLANEOUS SUPPLIES

| ITEM | Annual Unit | Unit Cost Quantity Unit/a | Total Cost R per unit | R |
|---|---|---|---|---|
| Cartridge Filters | No. | 200.00 | 80.00 | 16 000 |
| Citric acid | Ton | 0.50 | 8 750.00 | 4 375 |
| Detergent | Ton | 2.00 | 7 000.00 | 14 000 |
| Tannic acid | kg | 65.00 | 60.00 | 3 900 |
| TOTAL FOR CONSUMABLES | | | | 38 275 |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
REVERSE OSMOSIS
OFFSHORE SEAWATER WITH PRETREATMENT
ALTERNATIVE F WITH NO ULTRA-FILTRATION PRETREATMENT

CALCULATION OF PUMPING REQUIREMENTS

Based on operation at full rated output of 5 000 m^3/d

1 Sea Water Pumps

| | | |
|---|---|---|
| Pumping Rate | 133 | l/s |
| Length of Main | 300 | m |
| Diameter | 288 | mm |
| Friction Head | 3.1 | m |
| Static Head | 10.0 | m |
| Total Head | 13.1 | m |
| Efficiency of Pump | 75.0% | Percent |
| Power Absorbed | 23 | kW |
| Power Installed | 30 | kW |

2 Pretreatment Works

| | |
|---|---|
| Pumping Rate | 133 l/s |
| Length of Main | 50 m |
| Diameter | 288 mm |
| Friction Head | 0.5 m |
| Static Head | 20.0 m |
| Total Head | 20.5 m |
| Efficiency of Pump | 75.0%Percent |
| Power Absorbed | 36 kW |
| Power Installed | 37 kW |

3 Reverse Osmosis Feed Pumps

| | |
|---|---|
| Pumping Rate | 129 l/s |
| Length of Main | 30 m |
| Diameter | 288 mm |
| Friction Head | 0.3 m |
| Static Head | 60.0 m |
| Total Head | 60.3 m |
| Efficiency of Pump | 75.0%Percent |
| Power Absorbed | 103 kW |
| Power Installed | 110 kW |

4 Reverse Osmosis Pumps

| | |
|---|---|
| Pumping Rate | 129 l/s |
| Length of Main | 1 000 m |
| Equivalent Diameter | 280 mm |
| Friction Head | 11.1 m |
| Static Head | 550.0 m |
| Total Head | 561.1 m |
| Efficiency of Pump | 75.0%Percent |
| Power Absorbed | 962 kW |
| Power Installed | 1 260 kW |

5 Clear Water Pumps

| | |
|---|---|
| Pumping Rate | 58 l/s |
| Length of Main | 15 000 m |
| Diameter | 288 mm |
| Friction Head | 33.2 m |
| Static Head | 45.0 m |
| Total Head | 78.2 m |
| Efficiency of Pump | 75.0%Percent |
| Power Absorbed | 60 kW |
| Power Installed | 75 kW |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
REVERSE OSMOSIS
ALTERNATIVF OFFSHORE SEAWATER WITH PRETREATMENT
OFFSHORE SEAWATER WITH PRETREATMENT

| YEAR | FLOW | FLOW | CAPITAL | FIXED COSTS | COSTS PROPMAINTNCE TO FLOW COSTS | | TOTAL |
|---|---|---|---|---|---|---|---|
| | m^3/d | Ml/a | R*1000 | R*1000 | R*1000 | R*1000 | R*1000 |
| 1993 | | | | | | | |
| 1994 | | | 5 635 | | | | 5 635 |
| 1995 | | | 39 310 | | | | 39 310 |
| 1996 | 5 000 | 1 643 | | 1 063 | 1 880 | 600 | 3 543 |
| 1997 | 5 000 | 1 643 | | 1 063 | 1 880 | 600 | 3 543 |
| 1998 | 5 000 | 1 643 | | 1 063 | 1 880 | 600 | 3 543 |
| 1999 | 5 000 | 1 643 | | 1 063 | 1 880 | 600 | 3 543 |
| 2000 | 5 000 | 1 643 | | 1 063 | 1 880 | 600 | 3 543 |
| 2001 | 5 000 | 1 643 | | 1 063 | 1 880 | 600 | 3 543 |
| 2002 | 5 000 | 1 643 | | 1 063 | 1 880 | 600 | 3 543 |
| 2003 | 5 000 | 1 643 | | 1 063 | 1 880 | 600 | 3 543 |
| 2004 | 5 000 | 1 643 | | 1 063 | 1 880 | 600 | 3 543 |
| 2005 | 5 000 | 1 643 | | 1 063 | 1 880 | 600 | 3 543 |
| 2006 | 5 000 | 1 643 | | 1 063 | 1 880 | 600 | 3 543 |
| 2007 | 5 000 | 1 643 | | 1 063 | 1 880 | 600 | 3 543 |
| 2008 | 5 000 | 1 643 | | 1 063 | 1 880 | 600 | 3 543 |
| 2009 | 5 000 | 1 643 | | 1 063 | 1 880 | 600 | 3 543 |
| 2010 | 5 000 | 1 643 | | 1 063 | 1 880 | 600 | 3 543 |
| 2011 | 5 000 | 1 643 | 4 645 | 1 063 | 1 880 | 600 | 8 188 |
| 2012 | 5 000 | 1 643 | | 1 063 | 1 880 | 600 | 3 543 |
| 2013 | 5 000 | 1 643 | | 1 063 | 1 880 | 600 | 3 543 |
| 2014 | 5 000 | 1 643 | | 1 063 | 1 880 | 600 | 3 543 |
| 2015 | 5 000 | 1 643 | | 1 063 | 1 880 | 600 | 3 543 |
| 2016 | 5 000 | 1 643 | 17 500 | 1 063 | 1 880 | 600 | 21 043 |
| 2017 | 5 000 | 1 643 | | 1 063 | 1 880 | 600 | 3 543 |
| 2018 | 5 000 | 1 643 | | 1 063 | 1 880 | 600 | 3 543 |
| 2019 | 5 000 | 1 643 | | 1 063 | 1 880 | 600 | 3 543 |
| 2020 | 5 000 | 1 643 | | 1 063 | 1 880 | 600 | 3 543 |
| 2021 | 5 000 | 1 643 | | 1 063 | 1 880 | 600 | 3 543 |
| 2022 | 5 000 | 1 643 | | 1 063 | 1 880 | 600 | 3 543 |
| 2023 | 5 000 | 1 643 | | 1 063 | 1 880 | 600 | 3 543 |
| 2024 | 5 000 | 1 643 | | 1 063 | 1 880 | 600 | 3 543 |
| 2025 | 5 000 | 1 643 | | 1 063 | 1 880 | 600 | 3 543 |
| 2026 | 5 000 | 1 643 | 4 645 | 1 063 | 1 880 | 600 | 8 188 |
| 2027 | 5 000 | 1 643 | | 1 063 | 1 880 | 600 | 3 543 |
| 2028 | 5 000 | 1 643 | | 1 063 | 1 880 | 600 | 3 543 |
| 2029 | 5 000 | 1 643 | | 1 063 | 1 880 | 600 | 3 543 |
| 2030 | 5 000 | 1 643 | | 1 063 | 1 880 | 600 | 3 543 |
| 2031 | 5 000 | 1 643 | | 1 063 | 1 880 | 600 | 3 543 |
| 2032 | 5 000 | 1 643 | | 1 063 | 1 880 | 600 | 3 543 |
| 2033 | 5 000 | 1 643 | | 1 063 | 1 880 | 600 | 3 543 |
| 2034 | 5 000 | 1 643 | | 1 063 | 1 880 | 600 | 3 543 |
| 2035 | 5 000 | 1 643 | | 1 063 | 1 880 | 600 | 3 543 |
| | | | (3 052) | | | | (3 052) |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
REVERSE OSMOSIS
ALTERNATIVE G WITH ULTRA-FILTRATION PRETREATMENT

| | | | |
|---|---|---|---|
| Raw Water Source | Sea Intake Located near Walvis Bay | | |
| Raw Water Requirements | 12 600 m^3/d | Pretreatment Losses | 1% |
| Output Capacity of Plant | 5 000 m^3/d | Filtration Losses | 1% |
| Plant Design Factor | 90% | U.F.Plant Losses | 10% |
| Annual Water Production | 1 643 Ml/annum | R.O.Plant Recovery Factor | 45% |

COSTS OF POWER

| | |
|---|---|
| kW Charges/month | 26.50 R/kW/Month |
| Unit Charges | 10.50 c/kWh |

| DEPRECIATION PERIOD | Civils | Mechanical Electrical | Desal & UF Equipment | Membranes U. F. | Membranes R. O. |
|---|---|---|---|---|---|
| Years | 40 | 15 | 20 | 2 | 5 |
| ANNUAL MAINTENANCE FACTORS | 0.50% | 4.00% | 2.00% | | |

PROGRAMMME REQUIIREMENTS

| | |
|---|---|
| Design Tender & Award | 9 Months |
| Construction | 12 Months |
| Start Up Period | 1 Month |

| CAPITAL COSTS (See Page 2) | Civils | Mechanical Electrical | Desal & UF Equipment | Membranes U. F. | Membranes R. O. | Totals |
|---|---|---|---|---|---|---|
| | R*1000 | R*1000 | R*1000 | R*1000 | R*1000 | R*1000 |
| Direct Non Depreciable | 100 | | | | | 100 |
| Direct Depreciable | 13 405 | 2 850 | 18 630 | 930 | 3 000 | 38 815 |
| Indirect | 3 110 | 670 | 2 470 | 120 | 400 | 6 770 |
| Start Up Costs | | | | | | 210 |
| TOTAL CAPITAL COSTS | 16 615 | 3 520 | 21 100 | 1 050 | 3 400 | 45 895 |
| MAINTENANCE COSTS | 67 | 114 | 373 | | | 554 |

| ANNUAL RECURRING COSTS | R*1000 |
|---|---|
| Fixed | 1 140 |
| Flow Related (5 000 m^3/d ) | 2 526 |
| TOTAL | 3 666 |

ECONOMIC ANALYSIS

| Discount Rate | 0.0% | 4.0% | 6.0% | 8.0% | 10.0% |
|---|---|---|---|---|---|
| Capital NPV | 68 | 52 | 47 | 44 | 41 |
| Operating NPV | 169 | 77 | 57 | 43 | 34 |
| Total NPV | 237 | 129 | 104 | 87 | 75 |
| Water Produced Discounted | 66 | 30 | 22 | 17 | 13 |
| REFERENCE UNIT VALUE Rand/m^3 | 3.60 | 4.30 | 4.72 | 5.17 | 5.66 |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
REVERSE OSMOSIS
ALTERNATIVE G WITH ULTRA-FILTRATION PRETREATMENT
ESTIMATED CAPITAL COSTS

| DIRECT CAPITAL COSTS | Civils | Mechanical Electrical | Desal & UF Equipment | Membranes U. F. | Membranes R. O. | Totals |
|---|---|---|---|---|---|---|
| Non Depreciable | R*1000 | R*1000 | R*1000 | R*1000 | R*1000 | R*1000 |
| 1 Purchase of Land | 100 | | | | | 100 |
| Depreciable | | | | | | |
| 1 Sea Intake & Pumpstation | 3 290 | 330 | | | | 3 620 |
| 2 Delivery Pipelines | 50 | | | | | 50 |
| 3 Site Development | 200 | 60 | | | | 260 |
| 4 Raw Water Storage (12 000 m^3) | 2 805 | | | | | 2 805 |
| 5 Pretreatment Works and Pumpstations | 190 | 2 070 | 1 130 | 930 | | 4 320 |
| 6 Administrative & Misc. Buildings | 120 | | | | | 120 |
| 7 Desalination Equipment Buildings(1 680m^2) | 2 520 | | | | | 2 520 |
| 8 Desalination Equipment | | | 17 500 | | 3 000 | 20 500 |
| 9 Product Storage Reservoir (625 m^3) | 445 | | | | | 445 |
| 10 Incoming Power Supply | | 230 | | | | 230 |
| 11 Product Pipeline & Pumpstation | 3 735 | 160 | | | | 3 895 |
| 12 Brine Pipeline | 50 | | | | | 50 |
| Totals of Depreciable Costs | 13 405 | 2 850 | 18 630 | 930 | 3 000 | 38 815 |
| INDIRECT CAPITAL COSTS | | | | | | |
| Contingencies 10.00%of Net Cost | 1 340 | 290 | 1 860 | 90 | 300 | 3 880 |
| Escalation 0.00%per Month | | | | | | |
| Engineering Fees | | | | | | |
| Civil and Mechanical 12.0% | 1 770 | 380 | | | | 2 150 |
| Desalination Equipment 3.0% | | | 610 | 30 | 100 | 740 |
| Totals of Indirect Depreciable Costs | 3 110 | 670 | 2 470 | 120 | 400 | 6 770 |

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START UP COSTS (Pro Rata on Start Up Period )

| | R*1000 |
|---|---|
| Chemicals | 22 |
| Power | |
| Electrical | 143 |
| Staff | 49 |
| Totals | 214 |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
REVERSE OSMOSIS
ALTERNATIVE G WITH ULTRA-FILTRATION PRETREATMENT
CALCULATION OF ENERGY COSTS

Based on operation at full rated output of 5 000 m^3/d

ELECTRICAL ENERGY

| Component | Absorbed Power kW | Installed Power kW | % Utilisation | Average kWh/day |
|---|---|---|---|---|
| Seawater pumps | 27 | 30 | 90.0% | 574 |
| Pretreatment Works | 30 | 30 | 90.0% | 645 |
| Ultra-Filtration | 218 | 250 | 90.0% | 4 701 |
| Reverse Osmosis Feed Pumps | 103 | 110 | 90.0% | 2 233 |
| Reverse Osmosis Pumps | 962 | 1 260 | 90.0% | 20 783 |
| Clear Water Pumps | 60 | 75 | 90.0% | 1 304 |
| Totals | 1 400 | 1 755 | | 30 241 |

| | | R*1000 |
|---|---|---|
| Fixed Annual Power costs | | 558 |
| Flow Related Power costs | Electrical Energy | 1 159 |

CALCULATION OF ANNUAL RECURRING COSTS

| | R*1000 |
|---|---|
| FIXED | |
| Salaries and Labour | 448 |
| Labour Overhead ( 30.0%) | 134 |
| Fixed electrical energy costs | 558 |
| Total | 1 140 |
| FLOW RELATED | |
| Power-Electrical | 1 159 |
| Chemicals | 264 |
| Miscellaneous Supplies | 38 |
| U.F.Membrane Replacement ( 2 Yearly) | 465 |
| R.O.Membrane Replacement ( 5 Yearly) | 600 |
| Total | 2 526 |

STAFFING

| | Util | No. | Salary R | Total Salaries R |
|---|---|---|---|---|
| Super-intndt | 100% | 1 | 70 000 | 70 000 |
| Snr Operator | 100% | 4 | 39 000 | 156 000 |
| Jnr Operator | 100% | 5 | 32 500 | 162 500 |
| Operating Asst | 0% | 0 | 12 400 | 0 |
| Labourers | 100% | 3 | 12 400 | 37 200 |
| Lab. Techn. | 20% | 1 | 32 500 | 6 500 |
| Mech. Maint. | 20% | 1 | 44 800 | 8 960 |
| Elec. Maint. | 15% | 1 | 44 800 | 6 720 |
| TOTAL | | | | 448 000 |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
REVERSE OSMOSIS
ALTERNATIVE G WITH ULTRA-FILTRATION PRETREATMENT

CHEMICAL USAGE

| | Daily Quantity m^3/d | Dosage Rate mg/l | Annual Quantity tons | Unit Cost R/ton | Total Cost R |
|---|---|---|---|---|---|
| Sulphuric acid | 12 600 | 25 | 103.48 | 300.00 | 31 043 |
| Lime | 5 000 | 20 | 32.85 | 495.00 | 16 261 |
| Sodium bi-Sulphite | 11 088 | 5 | 18.21 | 2 050.00 | 37 335 |
| Flocon ( Anti-Scalant ) | 11 088 | 5 | 18.21 | 9 000.00 | 163 908 |
| Chlorine Raw Water | 12 600 | 5 | 20.70 | 700.00 | 14 487 |
| Chlorine Product Water | 5 000 | 1 | 1.64 | 700.00 | 1 150 |
| Coagulant | | | | | |
| TOTAL FOR CHEMICALS | | | | | 264 000 |

MISCELLANEOUS SUPPLIES

| ITEM | Annual Unit | Unit Cost Quantity Unit/a | Total Cost R per unit | R |
|---|---|---|---|---|
| Cartridge Filters | No. | 200.00 | 80.00 | 16 000 |
| Citric acid | Ton | 0.50 | 8 750.00 | 4 375 |
| Detergent | Ton | 2.00 | 7 000.00 | 14 000 |
| Tannic acid | kg | 65.00 | 60.00 | 3 900 |
| TOTAL FOR CONSUMABLES | | | | 38 275 |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
REVERSE OSMOSIS
WITH ULTRA-FILTRATION PRETREATMENT

ALTERNATIVE G

## CALCULATION OF PUMPING REQUIREMENTS

Based on operation at full rated output of 5 000 m^3/d

### 1 Sea Water Pumps

| | | |
|---|---|---|
| Pumping Rate | 146 | l/s |
| Length of Main | 300 | m |
| Diameter | 288 | mm |
| Friction Head | 3.7 | m |
| Static Head | 10.0 | m |
| Total Head | 13.7 | m |
| Efficiency of Pump | 75.0% | Percent |
| Power Absorbed | 27 | kW |
| Power Installed | 30 | kW |

### 2 Pretreatment Works

| | |
|---|---|
| Pumping Rate | 146 l/s |
| Length of Main | 30 m |
| Diameter | 288 mm |
| Friction Head | 0.4 m |
| Static Head | 15.0 m |
| Total Head | 15.4 m |
| Efficiency of Pump | 75.0%Percent |
| Power Absorbed | 30 kW |
| Power Installed | 30 kW |

### 3 Ultra Filtration Pumps

| | | |
|---|---|---|
| Pumping Rate | 143 | l/s |
| Length of Main | 20 | m |
| Diameter | 288 | mm |
| Friction Head | 0.2 | m |
| Static Head | 114.0 | m |
| Total Head | 114.2 | m |
| Efficiency of Pump | 75.0% | Percent |
| Power Absorbed | 218 | kW |
| Power Installed | 250 | kW |

### 4 Reverse Osmosis Feed Pumps

| | |
|---|---|
| Pumping Rate | 129 l/s |
| Length of Main | 30 m |
| Diameter | 288 mm |
| Friction Head | 0.3 m |
| Static Head | 60.0 m |
| Total Head | 60.3 m |
| Efficiency of Pump | 75.0%Percent |
| Power Absorbed | 103 kW |
| Power Installed | 110 kW |

### 5 Reverse Osmosis Pumps

| | | |
|---|---|---|
| Pumping Rate | 129 | l/s |
| Length of Main | 1 000 | m |
| Equivalent Diameter | 280 | mm |
| Friction Head | 11.1 | m |
| Static Head | 550.0 | m |
| Total Head | 561.1 | m |
| Efficiency of Pump | 75.0% | Percent |
| Power Absorbed | 962 | kW |
| Power Installed | 1 260 | kW |

### 6 Clear Water Pumps

| | |
|---|---|
| Pumping Rate | 58 l/s |
| Length of Main | 15 000 m |
| Diameter | 288 mm |
| Friction Head | 33.2 m |
| Static Head | 45.0 m |
| Total Head | 78.2 m |
| Efficiency of Pump | 75.0%Percent |
| Power Absorbed | 60 kW |
| Power Installed | 75 kW |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
REVERSE OSMOSIS
ALTERNATIVE G WITH ULTRA-FILTRATION PRETREATMENT

| YEAR | FLOW | FLOW | CAPITAL | FIXED COSTS | PROPMAINTNCE TO FLOW COSTS | | TOTAL |
|---|---|---|---|---|---|---|---|
| | m^3/d | Ml/a | R*1000 | R*1000 | R*1000 | | R*1000 |
| 1993 | | | | | | | |
| 1994 | | | 5 662 | | | | 5 662 |
| 1995 | | | 40 234 | | | | 40 234 |
| 1996 | 5 000 | 1 643 | | 1 140 | 2 526 | 554 | 4 220 |
| 1997 | 5 000 | 1 643 | | 1 140 | 2 526 | 554 | 4 220 |
| 1998 | 5 000 | 1 643 | | 1 140 | 2 526 | 554 | 4 220 |
| 1999 | 5 000 | 1 643 | | 1 140 | 2 526 | 554 | 4 220 |
| 2000 | 5 000 | 1 643 | | 1 140 | 2 526 | 554 | 4 220 |
| 2001 | 5 000 | 1 643 | | 1 140 | 2 526 | 554 | 4 220 |
| 2002 | 5 000 | 1 643 | | 1 140 | 2 526 | 554 | 4 220 |
| 2003 | 5 000 | 1 643 | | 1 140 | 2 526 | 554 | 4 220 |
| 2004 | 5 000 | 1 643 | | 1 140 | 2 526 | 554 | 4 220 |
| 2005 | 5 000 | 1 643 | | 1 140 | 2 526 | 554 | 4 220 |
| 2006 | 5 000 | 1 643 | | 1 140 | 2 526 | 554 | 4 220 |
| 2007 | 5 000 | 1 643 | | 1 140 | 2 526 | 554 | 4 220 |
| 2008 | 5 000 | 1 643 | | 1 140 | 2 526 | 554 | 4 220 |
| 2009 | 5 000 | 1 643 | | 1 140 | 2 526 | 554 | 4 220 |
| 2010 | 5 000 | 1 643 | | 1 140 | 2 526 | 554 | 4 220 |
| 2011 | 5 000 | 1 643 | 2 850 | 1 140 | 2 526 | 554 | 7 070 |
| 2012 | 5 000 | 1 643 | | 1 140 | 2 526 | 554 | 4 220 |
| 2013 | 5 000 | 1 643 | | 1 140 | 2 526 | 554 | 4 220 |
| 2014 | 5 000 | 1 643 | | 1 140 | 2 526 | 554 | 4 220 |
| 2015 | 5 000 | 1 643 | | 1 140 | 2 526 | 554 | 4 220 |
| 2016 | 5 000 | 1 643 | 18 630 | 1 140 | 2 526 | 554 | 22 850 |
| 2017 | 5 000 | 1 643 | | 1 140 | 2 526 | 554 | 4 220 |
| 2018 | 5 000 | 1 643 | | 1 140 | 2 526 | 554 | 4 220 |
| 2019 | 5 000 | 1 643 | | 1 140 | 2 526 | 554 | 4 220 |
| 2020 | 5 000 | 1 643 | | 1 140 | 2 526 | 554 | 4 220 |
| 2021 | 5 000 | 1 643 | | 1 140 | 2 526 | 554 | 4 220 |
| 2022 | 5 000 | 1 643 | | 1 140 | 2 526 | 554 | 4 220 |
| 2023 | 5 000 | 1 643 | | 1 140 | 2 526 | 554 | 4 220 |
| 2024 | 5 000 | 1 643 | | 1 140 | 2 526 | 554 | 4 220 |
| 2025 | 5 000 | 1 643 | | 1 140 | 2 526 | 554 | 4 220 |
| 2026 | 5 000 | 1 643 | 2 850 | 1 140 | 2 526 | 554 | 7 070 |
| 2027 | 5 000 | 1 643 | | 1 140 | 2 526 | 554 | 4 220 |
| 2028 | 5 000 | 1 643 | | 1 140 | 2 526 | 554 | 4 220 |
| 2029 | 5 000 | 1 643 | | 1 140 | 2 526 | 554 | 4 220 |
| 2030 | 5 000 | 1 643 | | 1 140 | 2 526 | 554 | 4 220 |
| 2031 | 5 000 | 1 643 | | 1 140 | 2 526 | 554 | 4 220 |
| 2032 | 5 000 | 1 643 | | 1 140 | 2 526 | 554 | 4 220 |
| 2033 | 5 000 | 1 643 | | 1 140 | 2 526 | 554 | 4 220 |
| 2034 | 5 000 | 1 643 | | 1 140 | 2 526 | 554 | 4 220 |
| 2035 | 5 000 | 1 643 | | 1 140 | 2 526 | 554 | 4 220 |
| | | | (2 407) | | | | (2 407) |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
MECHANICAL VAPOUR COMPRESSION
ALTERNATIVE H WITH SCREENING PRETREATMENT

| | | | |
|---|---|---|---|
| Raw Water Source | Sea Intake Located near Walvis Bay | | |
| Raw Water Requirements | 10 100 m^3/d | Pretreatment Losses | 1% |
| Output Capacity of Plant | 5 000 m^3/d | Filtration Losses | |
| Plant Design Factor | 90% | U.F.Plant Losses | |
| Annual Water Production | 1 643 Ml/annum | Plant Recovery Factor | 50% |

COSTS OF POWER

| | |
|---|---|
| kW Charges/month | 26.50 R/kW/Month |
| Unit Charges | 10.50 c/kWh |

| | | Civils | Mechanical Electrical | Desal Equipment |
|---|---|---|---|---|
| DEPRECIATION PERIOD | Years | 40 | 15 | 20 |
| ANNUAL MAINTENANCE FACTORS | | 0.50% | 4.00% | 2.00% |

PROGRAMMME REQUIIREMENTS

| | |
|---|---|
| Design Tender & Award | 9 Months |
| Construction | 12 Months |
| Start Up Period | 1 Month |

| CAPITAL COSTS (See Page 2) | Civils | Mechanical Electrical | Desal Equipment | Totals |
|---|---|---|---|---|
| | R*1000 | R*1000 | R*1000 | R*1000 |
| Direct Non Depreciable | 100 | | | 100 |
| Direct Depreciable | 11 520 | 865 | 20 700 | 33 085 |
| Indirect | 2 670 | 200 | 2 750 | 5 620 |
| Start Up Costs | | | | 200 |
| TOTAL CAPITAL COSTS | 14 290 | 1 065 | 23 450 | 39 005 |
| MAINTENANCE COSTS | 58 | 35 | 414 | 506 |

| ANNUAL RECURRING COSTS | R*1000 |
|---|---|
| Fixed | 1 001 |
| Flow Related (5 000 m^3/d ) | 1 412 |
| TOTAL | 2 413 |

ECONOMIC ANALYSIS

| Discount Rate | 0.0% | 4.0% | 6.0% | 8.0% | 10.0% |
|---|---|---|---|---|---|
| Capital NPV | 60 | 45 | 41 | 38 | 35 |
| Operating NPV | 117 | 53 | 39 | 30 | 24 |
| Total NPV | 177 | 98 | 80 | 67 | 59 |
| Water Produced Discounted | 66 | 30 | 22 | 17 | 13 |
| REFERENCE UNIT VALUE Rand/m^3 | 2.69 | 3.27 | 3.63 | 4.01 | 4.42 |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
MECHANICAL VAPOUR COMPRESSION
ALTERNATIVE H WITH SCREENING PRETREATMENT
ESTIMATED CAPITAL COSTS

| DIRECT CAPITAL COSTS | Civils | Mechanical Electrical | Desal Equipment | Totals |
|---|---|---|---|---|
| Non Depreciable | R*1000 | R*1000 | R*1000 | R*1000 |
| 1 Purchase of Land | 100 | | | 100 |
| Depreciable | | | | |
| 1 Sea Intake & Pumpstation | 3 290 | 330 | | 3 620 |
| 2 Delivery Pipelines | 50 | | | 50 |
| 3 Site Development | 200 | 60 | | 260 |
| 4 Raw Water Storage (12 000 m^3) | 2 805 | | | 2 805 |
| 5 Pretreatment Works | 25 | 85 | | 110 |
| 6 Administrative & Miscellaneous Buildings | 80 | | | 80 |
| 7 Desalination Equipment Buildings (560m^2) | 840 | | | 840 |
| 8 Desalination Equipment | | | 20 700 | 20 700 |
| 9 Product Storage Reservoir (625 m^3) | 445 | | | 445 |
| 10 Incoming Power Supply | | 230 | | 230 |
| 11 Product Pipeline & Pumpstation | 3 735 | 160 | | 3 895 |
| 12 Brine Pipeline | 50 | | | 50 |
| Totals of Depreciable Costs | 11 520 | 865 | 20 700 | 33 085 |
| INDIRECT CAPITAL COSTS | | | | |
| Contingencies 10.00%of Net Cost | 1 150 | 90 | 2 070 | 3 310 |
| Escalation 0.00%per Month | | | | |
| Engineering Fees | | | | |
| Civil and Mechanical 12.0% | 1 520 | 110 | | 1 630 |
| Desalination Equipment 3.0% | | | 680 | 680 |
| Totals of Indirect Depreciable Costs | 2 670 | 200 | 2 750 | 5 620 |

START UP COSTS (Pro Rata on Start Up Period )

| | R*1000 |
|---|---|
| Chemicals | 5 |
| Power | |
| Electrical | 157 |
| Heavy Fuel Oil | |
| Staff | 39 |
| Totals | 201 |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
MECHANICAL VAPOUR COMPRESSION
ALTERNATIVE H WITH SCREENING PRETREATMENT
ESTIMATED CAPITAL COSTS
CALCULATION OF ENERGY COSTS

Based on operation at full rated output of 5 000 m^3/d

ELECTRICAL ENERGY

| Component | Absorbed Power kW | Installed Power kW | % Utilisation | Average kWh/day |
|---|---|---|---|---|
| Seawater pumps | 19 | 22 | 90.0% | 419 |
| Clear Water Pumps | 60 | 75 | 90.0% | 1 304 |
| Compressor | 1 560 | 1 575 | 90.0% | 33 696 |
| Totals | 1 640 | 1 672 | | 35 419 |

| | | R*1000 |
|---|---|---|
| Fixed Annual Power costs | | 532 |
| Flow Related Power costs | Electrical Energy | 1 357 |

CALCULATION OF ANNUAL RECURRING COSTS

| | R*1000 |
|---|---|
| FIXED | |
| Salaries and Labour | 361 |
| Labour Overhead ( 30.0%) | 108 |
| Fixed electrical energy costs | 532 |
| Total | 1 001 |
| FLOW RELATED | |
| Power-Electrical | 1 357 |
| Heavy Fuel Oil | |
| Chemicals | 55 |
| Miscellaneous Supplies | |
| Total | 1 412 |

STAFFING

| | Util | No. | Salary R | Total Salaries R |
|---|---|---|---|---|
| Superintendant | 100% | 1 | 70 000 | 70 000 |
| Snr Operator | 100% | 5 | 39 000 | 195 000 |
| Jnr Operator | 100% | 0 | 32 500 | 0 |
| Operating Asst | 100% | 4 | 12 400 | 49 600 |
| Labourers | 100% | 2 | 12 400 | 24 800 |
| Lab. Techn. | 10% | 1 | 32 500 | 3 250 |
| Mech. Maint. | 30% | 1 | 44 800 | 13 440 |
| Elec. Maint. | 10% | 1 | 44 800 | 4 480 |
| TOTAL | | | | 361 000 |

M

ALTERNATIVE H

CHEMICAL USAGE

| | Daily Quantity | Dosage Rate | Annual Quantity | Unit Cost | Total Cost |
|---|---|---|---|---|---|
| | m^3/d | mg/l | tons | R/ton | R |
| Lime | 5 000 | 20 | 32.85 | 495.00 | 16 261 |
| Anti-Scalant | 9 999 | 4 | 13.14 | 2 000.00 | 26 277 |
| Chlorine Raw Water | 10 100 | 5 | 16.59 | 700.00 | 11 612 |
| Chlorine Product Water | 5 000 | 1 | 1.64 | 700.00 | 1 150 |
| Coagulant | | | | | |
| TOTAL FOR CHEMICALS | | | | | 55 000 |

MISCELLANEOUS SUPPLIES

| ITEM | Annual Quantity | Unit Cost | Total Cost |
|---|---|---|---|
| | Unit | Unit/a | R per unit | R |
| TOTAL FOR CONSUMABLES | | | | |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
MECHANICAL VAPOUR COMPRESSION
WITH SCREENING PRETREATMENT

ALTERNATIVE H

CALCULATION OF PUMPING REQUIREMENTS

Based on operation at full rated output of 5 000 m^3/d

| 1 Sea Water Pumps | | | 2 Clear Water Pumps | |
|---|---|---|---|---|
| Pumping Rate | 117 | l/s | Pumping Rate | 58 l/s |
| Length of Main | 300 | m | Length of Main | 15 000 m |
| Diameter | 288 | mm | Diameter | 288 mm |
| Friction Head | 2.4 | m | Friction Head | 33.2 m |
| Static Head | 10.0 | m | Static Head | 45.0 m |
| Total Head | 12.4 | m | Total Head | 78.2 m |
| Efficiency of Pump | 75.0% | Percent | Efficiency of Pump | 75.0%Percent |
| Power Absorbed | 19 | kW | Power Absorbed | 60 kW |
| Power Installed | 22 | kW | Power Installed | 75 kW |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
MECHANICAL VAPOUR COMPRESSION
ALTERNATIVE H WITH SCREENING PRETREATMENT

| YEAR | FLOW | FLOW | CAPITAL | FIXED COSTS | PROPMAINTNCE TO FLOW COSTS | | TOTAL |
|---|---|---|---|---|---|---|---|
| | m^3/d | Ml/a | R*1000 | R*1000 | R*1000 | R*1000 | R*1000 |
| 1993 | | | | | | | |
| 1994 | | | 4 716 | | | | 4 716 |
| 1995 | | | 34 289 | | | | 34 289 |
| 1996 | 5 000 | 1 643 | | 1 001 | 1 412 | 506 | 2 919 |
| 1997 | 5 000 | 1 643 | | 1 001 | 1 412 | 506 | 2 919 |
| 1998 | 5 000 | 1 643 | | 1 001 | 1 412 | 506 | 2 919 |
| 1999 | 5 000 | 1 643 | | 1 001 | 1 412 | 506 | 2 919 |
| 2000 | 5 000 | 1 643 | | 1 001 | 1 412 | 506 | 2 919 |
| 2001 | 5 000 | 1 643 | | 1 001 | 1 412 | 506 | 2 919 |
| 2002 | 5 000 | 1 643 | | 1 001 | 1 412 | 506 | 2 919 |
| 2003 | 5 000 | 1 643 | | 1 001 | 1 412 | 506 | 2 919 |
| 2004 | 5 000 | 1 643 | | 1 001 | 1 412 | 506 | 2 919 |
| 2005 | 5 000 | 1 643 | | 1 001 | 1 412 | 506 | 2 919 |
| 2006 | 5 000 | 1 643 | | 1 001 | 1 412 | 506 | 2 919 |
| 2007 | 5 000 | 1 643 | | 1 001 | 1 412 | 506 | 2 919 |
| 2008 | 5 000 | 1 643 | | 1 001 | 1 412 | 506 | 2 919 |
| 2009 | 5 000 | 1 643 | | 1 001 | 1 412 | 506 | 2 919 |
| 2010 | 5 000 | 1 643 | | 1 001 | 1 412 | 506 | 2 919 |
| 2011 | 5 000 | 1 643 | 865 | 1 001 | 1 412 | 506 | 3 784 |
| 2012 | 5 000 | 1 643 | | 1 001 | 1 412 | 506 | 2 919 |
| 2013 | 5 000 | 1 643 | | 1 001 | 1 412 | 506 | 2 919 |
| 2014 | 5 000 | 1 643 | | 1 001 | 1 412 | 506 | 2 919 |
| 2015 | 5 000 | 1 643 | | 1 001 | 1 412 | 506 | 2 919 |
| 2016 | 5 000 | 1 643 | 20 700 | 1 001 | 1 412 | 506 | 23 619 |
| 2017 | 5 000 | 1 643 | | 1 001 | 1 412 | 506 | 2 919 |
| 2018 | 5 000 | 1 643 | | 1 001 | 1 412 | 506 | 2 919 |
| 2019 | 5 000 | 1 643 | | 1 001 | 1 412 | 506 | 2 919 |
| 2020 | 5 000 | 1 643 | | 1 001 | 1 412 | 506 | 2 919 |
| 2021 | 5 000 | 1 643 | | 1 001 | 1 412 | 506 | 2 919 |
| 2022 | 5 000 | 1 643 | | 1 001 | 1 412 | 506 | 2 919 |
| 2023 | 5 000 | 1 643 | | 1 001 | 1 412 | 506 | 2 919 |
| 2024 | 5 000 | 1 643 | | 1 001 | 1 412 | 506 | 2 919 |
| 2025 | 5 000 | 1 643 | | 1 001 | 1 412 | 506 | 2 919 |
| 2026 | 5 000 | 1 643 | 865 | 1 001 | 1 412 | 506 | 3 784 |
| 2027 | 5 000 | 1 643 | | 1 001 | 1 412 | 506 | 2 919 |
| 2028 | 5 000 | 1 643 | | 1 001 | 1 412 | 506 | 2 919 |
| 2029 | 5 000 | 1 643 | | 1 001 | 1 412 | 506 | 2 919 |
| 2030 | 5 000 | 1 643 | | 1 001 | 1 412 | 506 | 2 919 |
| 2031 | 5 000 | 1 643 | | 1 001 | 1 412 | 506 | 2 919 |
| 2032 | 5 000 | 1 643 | | 1 001 | 1 412 | 506 | 2 919 |
| 2033 | 5 000 | 1 643 | | 1 001 | 1 412 | 506 | 2 919 |
| 2034 | 5 000 | 1 643 | | 1 001 | 1 412 | 506 | 2 919 |
| 2035 | 5 000 | 1 643 | | 1 001 | 1 412 | 506 | 2 919 |
| | | | (1 669) | | | | (1 669) |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
MULTIPLE EFFECT DISTILLATION
ALTERNATIVE J WITH SCREENING PRETREATMENT

| | | | |
|---|---|---|---|
| Raw Water Source | Sea Intake Located near Walvis Bay | | |
| Raw Water Requirements | 10 100 m^3/d | Pretreatment Losses | 1% |
| Output Capacity of Plant | 5 000 m^3/d | Filtration Losses | |
| Plant Design Factor | 90% | U.F.Plant Losses | |
| Annual Water Production | 1 643 Ml/annum | Plant Recovery Factor | 50% |

COSTS OF POWER

| | | | |
|---|---|---|---|
| kW Charges/month | 26.50 R/kW/Month | Heavy Fuel Oil | 46.0 c/litre |
| Unit Charges | 10.50 c/kWh | S.G. | 0.985 |

| | | Civils | Mechanical Electrical | Desal Equipment |
|---|---|---|---|---|
| DEPRECIATION PERIOD | Years | 40 | 15 | 20 |
| ANNUAL MAINTENANCE FACTORS | | 0.50% | 4.00% | 2.00% |

PROGRAMMME REQUIIREMENTS

| | |
|---|---|
| Design Tender & Award | 9 Months |
| Construction | 12 Months |
| Start Up Period | 1 Month |

| CAPITAL COSTS (See Page 2) | Civils | Mechanical Electrical | Desal Equipment | Totals |
|---|---|---|---|---|
| | R*1000 | R*1000 | R*1000 | R*1000 |
| Direct Non Depreciable | 100 | | | 100 |
| Direct Depreciable | 12 630 | 8 365 | 21 000 | 41 995 |
| Indirect | 2 930 | 1 940 | 2 790 | 7 660 |
| Start Up Costs | | | | 590 |
| TOTAL CAPITAL COSTS | 15 660 | 10 305 | 23 790 | 50 345 |
| MAINTENANCE COSTS | 63 | 335 | 420 | 818 |

| ANNUAL RECURRING COSTS | R*1000 |
|---|---|
| Fixed | 602 |
| Flow Related (5 000 m^3/d ) | 6 524 |
| TOTAL | 7 126 |

ECONOMIC ANALYSIS

| Discount Rate | 0.0% | 4.0% | 6.0% | 8.0% | 10.0% |
|---|---|---|---|---|---|
| Capital NPV | 83 | 61 | 54 | 50 | 46 |
| Operating NPV | 318 | 145 | 106 | 81 | 64 |
| Total NPV | 401 | 206 | 161 | 131 | 110 |
| Water Produced Discounted | 66 | 30 | 22 | 17 | 13 |
| REFERENCE UNIT VALUE Rand/m^3 | 6.11 | 6.86 | 7.31 | 7.80 | 8.32 |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
MULTIPLE EFFECT DISTILLATION
ALTERNATIVE J WITH SCREENING PRETREATMENT
ESTIMATED CAPITAL COSTS

| DIRECT CAPITAL COSTS | Civils | Mechanical Electrical | Desal Equipment | Totals |
|---|---|---|---|---|
| Non Depreciable | R*1000 | R*1000 | R*1000 | R*1000 |
| 1 Purchase of Land | 100 | | | 100 |
| Depreciable | | | | |
| 1 Sea Intake & Pumpstation | 3 290 | 330 | | 3 620 |
| 2 Delivery Pipelines | 50 | | | 50 |
| 3 Site Development | 200 | 60 | | 260 |
| 4 Raw Water Storage (12 000 m^3 ) | 2 805 | | | 2 805 |
| 5 Pretreatment Works | 25 | 85 | | 110 |
| 6 Administrative & Miscellaneous Buildings | 80 | | | 80 |
| 7 Desalination Equipment Buildings (800 m^2) | 1 200 | | | 1 200 |
| 8 Desalination Equipment | | | 21 000 | 21 000 |
| 9 Steam Generation Equipment | 750 | 7 500 | | 8 250 |
| 10 Product Storage Reservoir (625 m^3) | 445 | | | 445 |
| 11 Incoming Power Supply | | 230 | | 230 |
| 12 Product Pipeline & Pumpstation | 3 735 | 160 | | 3 895 |
| 13 Brine Pipeline | 50 | | | 50 |
| Totals of Depreciable Costs | 12 630 | 8 365 | 21 000 | 41 995 |
| INDIRECT CAPITAL COSTS | | | | |
| Contingencies 10.00%of Net Cost | 1 260 | 840 | 2 100 | 4 200 |
| Escalation 0.00%per Month | | | | |
| Engineering Fees | | | | |
| Civil and Mechanical 12.0% | 1 670 | 1 100 | | 2 770 |
| Desalination Equipment 3.0% | | | 690 | 690 |
| Totals of Indrect Depreciable Costs | 2 930 | 1 940 | 2 790 | 7 660 |

START UP COSTS (Pro Rata on Start Up Period )

| | R*1000 |
|---|---|
| Chemicals | 5 |
| Power | |
| Electrical | 38 |
| Heavy Fuel Oil | 512 |
| Staff | 39 |
| Totals | 594 |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
MULTIPLE EFFECT DISTILLATION

| | | R*1000 |
|---|---|---|
| Fixed Annual Power costs | | 133 |
| Flow Related Power costs | Electrical Energy | 325 |
| Flow Related Power costs | Heavy Fuel Oil | 6 144 |

| CALCULATION OF ANNUAL RECURRING COSTS | | R*1000 |
|---|---|---|
| FIXED | | |
| Salaries and Labour | | 361 |
| Labour Overhead | ( 30.0%) | 108 |
| Fixed electrical energy costs | | 133 |
| Total | | 602 |
| FLOW RELATED | | |
| Power-Electrical | | 325 |
| Heavy Fuel Oil | | 6 144 |
| Chemicals | | 55 |
| Miscellaneous Supplies | | |
| Total | | 6 524 |

STAFFING

| | Util | No. | Salary R | Total Salaries R |
|---|---|---|---|---|
| Superintendant | 100% | 1 | 70 000 | 70 000 |
| Snr Operator | 100% | 5 | 39 000 | 195 000 |
| Jnr Operator | 100% | 0 | 32 500 | 0 |
| Operating Asst | 100% | 4 | 12 400 | 49 600 |
| Labourers | 100% | 2 | 12 400 | 24 800 |
| Lab. Techn. | 10% | 1 | 32 500 | 3 250 |
| Mech. Maint. | 30% | 1 | 44 800 | 13 440 |
| Elec. Maint. | 10% | 1 | 44 800 | 4 480 |
| TOTAL | | | | 361 000 |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
MULTIPLE EFFECT DISTILLATION
WITH SCREENING PRETREATMENT

E

ALTERNATIVE J

CHEMICAL USAGE

| | Daily Quantity | Dosage Rate | Annual Quantity | Unit Cost | Total Cost |
|---|---|---|---|---|---|
| | m^3/d | mg/l | tons | R/ton | R |
| Lime | 5 000 | 20 | 32.85 | 495.00 | 16 261 |
| Anti-Scalant | 9 999 | 4 | 13.14 | 2 000.00 | 26 277 |
| Chlorine Raw Water | 10 100 | 5 | 16.59 | 700.00 | 11 612 |
| Chlorine Product Water | 5 000 | 1 | 1.64 | 700.00 | 1 150 |
| Coagulant | | | | | |
| TOTAL FOR CHEMICALS | | | | | 55 000 |

MISCELLANEOUS SUPPLIES

| ITEM | Annual Quantity | Unit Cost | Total Cost |
|---|---|---|---|
| | Unit | Unit/a | R per unit | R |
| TOTAL FOR CONSUMABLES | | | | |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
MULTIPLE EFFECT DISTILLATION
WITH SCREENING PRETREATMENT

ALTERNATIVE J

## CALCULATION OF PUMPING REQUIREMENTS

Based on operation at full rated output of 5 000 m^3/d

| 1 Sea Water Pumps | | | 2 Clear Water Pumps | |
|---|---|---|---|---|
| Pumping Rate | 117 | l/s | Pumping Rate | 58 l/s |
| Length of Main | 300 | m | Length of Main | 15 000 m |
| Diameter | 288 | mm | Diameter | 288 mm |
| Friction Head | 2.4 | m | Friction Head | 33.2 m |
| Static Head | 10.0 | m | Static Head | 45.0 m |
| Total Head | 12.4 | m | Total Head | 78.2 m |
| Efficiency of Pump | 75.0% | Percent | Efficiency of Pump | 75.0%Percent |
| Power Absorbed | 19 | kW | Power Absorbed | 60 kW |
| Power Installed | 22 | kW | Power Installed | 75 kW |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
MULTIPLE EFFECT DISTILLATION
ALTERNATIVE J WITH SCREENING PRETREATMENT

| YEAR | FLOW | FLOW | CAPITAL | FIXED COSTS | PROPMAINTNCE TO FLOW COSTS | | TOTAL |
|---|---|---|---|---|---|---|---|
| | m^3/d | Ml/a | R*1000 | R*1000 | R*1000 | R*1000 | R*1000 |
| 1993 | | | | | | | |
| 1994 | | | 6 366 | | | | 6 366 |
| 1995 | | | 43 979 | | | | 43 979 |
| 1996 | 5 000 | 1 643 | | 602 | 6 524 | 818 | 7 944 |
| 1997 | 5 000 | 1 643 | | 602 | 6 524 | 818 | 7 944 |
| 1998 | 5 000 | 1 643 | | 602 | 6 524 | 818 | 7 944 |
| 1999 | 5 000 | 1 643 | | 602 | 6 524 | 818 | 7 944 |
| 2000 | 5 000 | 1 643 | | 602 | 6 524 | 818 | 7 944 |
| 2001 | 5 000 | 1 643 | | 602 | 6 524 | 818 | 7 944 |
| 2002 | 5 000 | 1 643 | | 602 | 6 524 | 818 | 7 944 |
| 2003 | 5 000 | 1 643 | | 602 | 6 524 | 818 | 7 944 |
| 2004 | 5 000 | 1 643 | | 602 | 6 524 | 818 | 7 944 |
| 2005 | 5 000 | 1 643 | | 602 | 6 524 | 818 | 7 944 |
| 2006 | 5 000 | 1 643 | | 602 | 6 524 | 818 | 7 944 |
| 2007 | 5 000 | 1 643 | | 602 | 6 524 | 818 | 7 944 |
| 2008 | 5 000 | 1 643 | | 602 | 6 524 | 818 | 7 944 |
| 2009 | 5 000 | 1 643 | | 602 | 6 524 | 818 | 7 944 |
| 2010 | 5 000 | 1 643 | | 602 | 6 524 | 818 | 7 944 |
| 2011 | 5 000 | 1 643 | 8 365 | 602 | 6 524 | 818 | 16 309 |
| 2012 | 5 000 | 1 643 | | 602 | 6 524 | 818 | 7 944 |
| 2013 | 5 000 | 1 643 | | 602 | 6 524 | 818 | 7 944 |
| 2014 | 5 000 | 1 643 | | 602 | 6 524 | 818 | 7 944 |
| 2015 | 5 000 | 1 643 | | 602 | 6 524 | 818 | 7 944 |
| 2016 | 5 000 | 1 643 | 21 000 | 602 | 6 524 | 818 | 28 944 |
| 2017 | 5 000 | 1 643 | | 602 | 6 524 | 818 | 7 944 |
| 2018 | 5 000 | 1 643 | | 602 | 6 524 | 818 | 7 944 |
| 2019 | 5 000 | 1 643 | | 602 | 6 524 | 818 | 7 944 |
| 2020 | 5 000 | 1 643 | | 602 | 6 524 | 818 | 7 944 |
| 2021 | 5 000 | 1 643 | | 602 | 6 524 | 818 | 7 944 |
| 2022 | 5 000 | 1 643 | | 602 | 6 524 | 818 | 7 944 |
| 2023 | 5 000 | 1 643 | | 602 | 6 524 | 818 | 7 944 |
| 2024 | 5 000 | 1 643 | | 602 | 6 524 | 818 | 7 944 |
| 2025 | 5 000 | 1 643 | | 602 | 6 524 | 818 | 7 944 |
| 2026 | 5 000 | 1 643 | 8 365 | 602 | 6 524 | 818 | 16 309 |
| 2027 | 5 000 | 1 643 | | 602 | 6 524 | 818 | 7 944 |
| 2028 | 5 000 | 1 643 | | 602 | 6 524 | 818 | 7 944 |
| 2029 | 5 000 | 1 643 | | 602 | 6 524 | 818 | 7 944 |
| 2030 | 5 000 | 1 643 | | 602 | 6 524 | 818 | 7 944 |
| 2031 | 5 000 | 1 643 | | 602 | 6 524 | 818 | 7 944 |
| 2032 | 5 000 | 1 643 | | 602 | 6 524 | 818 | 7 944 |
| 2033 | 5 000 | 1 643 | | 602 | 6 524 | 818 | 7 944 |
| 2034 | 5 000 | 1 643 | | 602 | 6 524 | 818 | 7 944 |
| 2035 | 5 000 | 1 643 | | 602 | 6 524 | 818 | 7 944 |
| | | | (4 712) | | | | (4 712) |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
THERMAL VAPOUR COMPRESSION
ALTERNATIVE K WITH SCREENING PRETREATMENT

| | | | |
|---|---|---|---|
| Raw Water Source | Sea Intake Located near Walvis Bay | | |
| Raw Water Requirements | 10 100 m^3/d | Pretreatment Losses | 1% |
| Output Capacity of Plant | 5 000 m^3/d | Filtration Losses | |
| Plant Design Factor | 90% | U.F.Plant Losses | |
| Annual Water Production | 1 643 Ml/annum | Plant Recovery Factor | 50% |

COSTS OF POWER

| | | | |
|---|---|---|---|
| kW Charges/month | 26.50 R/kW/Month | Heavy Fuel Oil | 46.0 c/litre |
| Unit Charges | 10.50 c/kWh | S.G. | 0.985 |

| | Civils | Mechanical Electrical | Desal Equipment |
|---|---|---|---|
| DEPRECIATION PERIOD Years | 40 | 15 | 20 |
| ANNUAL MAINTENANCE FACTORS | 0.50% | 4.00% | 2.00% |

PROGRAMMME REQUIIREMENTS

| | |
|---|---|
| Design Tender & Award | 9 Months |
| Construction | 12 Months |
| Start Up Period | 1 Month |

| CAPITAL COSTS (See Page 2) | Civils | Mechanical Electrical | Desal Equipment | Totals |
|---|---|---|---|---|
| | R*1000 | R*1000 | R*1000 | R*1000 |
| Direct Non Depreciable | 100 | | | 100 |
| Direct Depreciable | 12 245 | 8 365 | 21 000 | 41 610 |
| Indirect | 2 840 | 1 940 | 2 790 | 7 570 |
| Start Up Costs | | | | 470 |
| TOTAL CAPITAL COSTS | 15 185 | 10 305 | 23 790 | 49 750 |
| MAINTENANCE COSTS | 61 | 335 | 420 | 816 |

| ANNUAL RECURRING COSTS | R*1000 |
|---|---|
| Fixed | 567 |
| Flow Related (5 000 m^3/d ) | 5 019 |
| TOTAL | 5 586 |

ECONOMIC ANALYSIS

| Discount Rate | 0.0% | 4.0% | 6.0% | 8.0% | 10.0% |
|---|---|---|---|---|---|
| Capital NPV | 83 | 60 | 54 | 49 | 46 |
| Operating NPV | 256 | 117 | 86 | 65 | 52 |
| Total NPV | 339 | 177 | 140 | 115 | 98 |
| Water Produced Discounted | 66 | 30 | 22 | 17 | 13 |
| REFERENCE UNIT VALUE Rand/m^3 | 5.16 | 5.90 | 6.35 | 6.83 | 7.35 |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
THERMAL VAPOUR COMPRESSION
ALTERNATIVE K WITH SCREENING PRETREATMENT
ESTIMATED CAPITAL COSTS

| DIRECT CAPITAL COSTS | Civils | Mechanical Electrical | Desal Equipment | Totals |
|---|---|---|---|---|
| Non Depreciable | R*1000 | R*1000 | R*1000 | R*1000 |
| 1 Purchase of Land | 100 | | | 100 |
| Depreciable | | | | |
| 1 Sea Intake & Pumpstation | 3 290 | 330 | | 3 620 |
| 2 Delivery Pipelines | 50 | | | 50 |
| 3 Site Development | 200 | 60 | | 260 |
| 4 Raw Water Storage ( 12 000 m^3) | 2 805 | | | 2 805 |
| 5 Pretreatment Works | 25 | 85 | | 110 |
| 6 Administrative & Miscellaneous Buildings | 80 | | | 80 |
| 7 Desalination Equipment Buildings (543 m^2) | 815 | | | 815 |
| 8 Desalination Equipment | | | 21 000 | 21 000 |
| 9 Steam Generation Equipment | 750 | 7 500 | | 8 250 |
| 10 Product Storage Reservoir ( 625 m^3) | 445 | | | 445 |
| 11 Incoming Power Supply | | 230 | | 230 |
| 12 Product Pipeline & Pumpstation | 3 735 | 160 | | 3 895 |
| 13 Brine Pipeline | 50 | | | 50 |
| Totals of Depreciable Costs | 12 245 | 8 365 | 21 000 | 41 610 |
| INDIRECT CAPITAL COSTS | | | | |
| Contingencies 10.00%of Net Cost | 1 220 | 840 | 2 100 | 4 160 |
| Escalation 0.00%per Month | | | | |
| Engineering Fees | | | | |
| Civil and Mechanical 12.0% | 1 620 | 1 100 | | 2 720 |
| Desalination Equipment 3.0% | | | 690 | 690 |
| Totals of Indirect Depreciable Costs | 2 840 | 1 940 | 2 790 | 7 570 |

START UP COSTS (Pro Rata on Start Up Period )

| | R*1000 |
|---|---|
| Chemicals | 5 |
| Power | |
| Electrical | 28 |
| Heavy Fuel Oil | 394 |
| Staff | 39 |
| Totals | 466 |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
THERMAL VAPOUR COMPRESSION
ALTERNATIVE K WITH SCREENING PRETREATMENT
ESTIMATED CAPITAL COSTS
CALCULATION OF ENERGY COSTS

Based on operation at full rated output of 5 000 m^3/d

ELECTRICAL ENERGY

| Component | Absorbed Power kW | Installed Power kW | % Utilisation | Average kWh/day |
|---|---|---|---|---|
| Seawater pumps | 19 | 22 | 90.0% | 419 |
| Clear Water Pumps | 60 | 75 | 90.0% | 1 304 |
| Additional Energy | 208 | 210 | 90.0% | 4 493 |
| Totals | 288 | 307 | | 6 216 |

Heavy Fuel Oil Consumption

| | | |
|---|---|---|
| Boiler Efficiency | 82.0% | |
| Required evaporation rate | 20.00 t/h | |
| Heavy Fuel Oil Consumption Rate | 1.28 t/h | |
| | | R*1000 |
| Fixed Annual Power costs | | 98 |
| Flow Related Power costs | Electrical Energy | 238 |
| Flow Related Power costs | Heavy Fuel Oil | 4 726 |

CALCULATION OF ANNUAL RECURRING COSTS R*1000

| | |
|---|---|
| FIXED | |
| Salaries and Labour | 361 |
| Labour Overhead ( 30.0%) | 108 |
| Fixed electrical energy costs | 98 |
| Total | 567 |
| FLOW RELATED | |
| Power-Electrical | 238 |
| Heavy Fuel Oil | 4 726 |
| Chemicals | 55 |
| Miscellaneous Supplies | |
| Total | 5 019 |

STAFFING

| | Util | No. | Salary R | Total Salaries R |
|---|---|---|---|---|
| Superintendant | 100% | 1 | 70 000 | 70 000 |
| Snr Operator | 100% | 5 | 39 000 | 195 000 |
| Jnr Operator | 100% | 0 | 32 500 | 0 |
| Operating Asst | 100% | 4 | 12 400 | 49 600 |
| Labourers | 100% | 2 | 12 400 | 24 800 |
| Lab. Techn. | 10% | 1 | 32 500 | 3 250 |
| Mech. Maint. | 30% | 1 | 44 800 | 13 440 |
| Elec. Maint. | 10% | 1 | 44 800 | 4 480 |
| TOTAL | | | | 361 000 |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
THERMAL VAPOUR COMPRESSION
WITH SCREENING PRETREATMENT

T

ALTERNATIVE K

CHEMICAL USAGE

| | Daily Quantity | Dosage Rate | Annual Quantity | Unit Cost | Total Cost |
|---|---|---|---|---|---|
| | m^3/d | mg/l | tons | R/ton | R |
| Lime | 5 000 | 20 | 32.85 | 495.00 | 16 261 |
| Anti-Scalant | 9 999 | 4 | 13.14 | 2 000.00 | 26 277 |
| Chlorine Raw Water | 10 100 | 5 | 16.59 | 700.00 | 11 612 |
| Chlorine Product Water | 5 000 | 1 | 1.64 | 700.00 | 1 150 |
| Coagulant | | | | | |
| TOTAL FOR CHEMICALS | | | | | 55 000 |

MISCELLANEOUS SUPPLIES

| ITEM | Annual Quantity | Unit Cost | Total Cost |
|---|---|---|---|
| | Unit | Unit/a | R per unit | R |
| TOTAL FOR CONSUMABLES | | | | |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
THERMAL VAPOUR COMPRESSION
WITH SCREENING PRETREATMENT

ALTERNATIVE K

CALCULATION OF PUMPING REQUIREMENTS

Based on operation at full rated output of 5 000 m^3/d

| 1 Sea Water Pumps | | | 2 Clear Water Pumps | |
|---|---|---|---|---|
| Pumping Rate | 117 | l/s | Pumping Rate | 58 l/s |
| Length of Main | 300 | m | Length of Main | 15 000 m |
| Diameter | 288 | mm | Diameter | 288 mm |
| Friction Head | 2.4 | m | Friction Head | 33.2 m |
| Static Head | 10.0 | m | Static Head | 45.0 m |
| Total Head | 12.4 | m | Total Head | 78.2 m |
| Efficiency of Pump | 75.0% | Percent | Efficiency of Pump | 75.0%Percent |
| Power Absorbed | 19 | kW | Power Absorbed | 60 kW |
| Power Installed | 22 | kW | Power Installed | 75 kW |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
THERMAL VAPOUR COMPRESSION
ALTERNATIVE K WITH SCREENING PRETREATMENT

| YEAR | FLOW | FLOW | CAPITAL | FIXED COSTS | PROPMAINTNCE TO FLOW COSTS | | TOTAL |
|---|---|---|---|---|---|---|---|
| | m^3/d | Ml/a | R*1000 | R*1000 | R*1000 | R*1000 | R*1000 |
| 1993 | | | | | | | |
| 1994 | | | 6 295 | | | | 6 295 |
| 1995 | | | 43 455 | | | | 43 455 |
| 1996 | 5 000 | 1 643 | | 567 | 5 019 | 816 | 6 402 |
| 1997 | 5 000 | 1 643 | | 567 | 5 019 | 816 | 6 402 |
| 1998 | 5 000 | 1 643 | | 567 | 5 019 | 816 | 6 402 |
| 1999 | 5 000 | 1 643 | | 567 | 5 019 | 816 | 6 402 |
| 2000 | 5 000 | 1 643 | | 567 | 5 019 | 816 | 6 402 |
| 2001 | 5 000 | 1 643 | | 567 | 5 019 | 816 | 6 402 |
| 2002 | 5 000 | 1 643 | | 567 | 5 019 | 816 | 6 402 |
| 2003 | 5 000 | 1 643 | | 567 | 5 019 | 816 | 6 402 |
| 2004 | 5 000 | 1 643 | | 567 | 5 019 | 816 | 6 402 |
| 2005 | 5 000 | 1 643 | | 567 | 5 019 | 816 | 6 402 |
| 2006 | 5 000 | 1 643 | | 567 | 5 019 | 816 | 6 402 |
| 2007 | 5 000 | 1 643 | | 567 | 5 019 | 816 | 6 402 |
| 2008 | 5 000 | 1 643 | | 567 | 5 019 | 816 | 6 402 |
| 2009 | 5 000 | 1 643 | | 567 | 5 019 | 816 | 6 402 |
| 2010 | 5 000 | 1 643 | | 567 | 5 019 | 816 | 6 402 |
| 2011 | 5 000 | 1 643 | 8 365 | 567 | 5 019 | 816 | 14 767 |
| 2012 | 5 000 | 1 643 | | 567 | 5 019 | 816 | 6 402 |
| 2013 | 5 000 | 1 643 | | 567 | 5 019 | 816 | 6 402 |
| 2014 | 5 000 | 1 643 | | 567 | 5 019 | 816 | 6 402 |
| 2015 | 5 000 | 1 643 | | 567 | 5 019 | 816 | 6 402 |
| 2016 | 5 000 | 1 643 | 21 000 | 567 | 5 019 | 816 | 27 402 |
| 2017 | 5 000 | 1 643 | | 567 | 5 019 | 816 | 6 402 |
| 2018 | 5 000 | 1 643 | | 567 | 5 019 | 816 | 6 402 |
| 2019 | 5 000 | 1 643 | | 567 | 5 019 | 816 | 6 402 |
| 2020 | 5 000 | 1 643 | | 567 | 5 019 | 816 | 6 402 |
| 2021 | 5 000 | 1 643 | | 567 | 5 019 | 816 | 6 402 |
| 2022 | 5 000 | 1 643 | | 567 | 5 019 | 816 | 6 402 |
| 2023 | 5 000 | 1 643 | | 567 | 5 019 | 816 | 6 402 |
| 2024 | 5 000 | 1 643 | | 567 | 5 019 | 816 | 6 402 |
| 2025 | 5 000 | 1 643 | | 567 | 5 019 | 816 | 6 402 |
| 2026 | 5 000 | 1 643 | 8 365 | 567 | 5 019 | 816 | 14 767 |
| 2027 | 5 000 | 1 643 | | 567 | 5 019 | 816 | 6 402 |
| 2028 | 5 000 | 1 643 | | 567 | 5 019 | 816 | 6 402 |
| 2029 | 5 000 | 1 643 | | 567 | 5 019 | 816 | 6 402 |
| 2030 | 5 000 | 1 643 | | 567 | 5 019 | 816 | 6 402 |
| 2031 | 5 000 | 1 643 | | 567 | 5 019 | 816 | 6 402 |
| 2032 | 5 000 | 1 643 | | 567 | 5 019 | 816 | 6 402 |
| 2033 | 5 000 | 1 643 | | 567 | 5 019 | 816 | 6 402 |
| 2034 | 5 000 | 1 643 | | 567 | 5 019 | 816 | 6 402 |
| 2035 | 5 000 | 1 643 | | 567 | 5 019 | 816 | 6 402 |
| | | | (4 702) | | | | (4 702) |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
MECHANICAL VAPOUR COMPRESSION
ALTERNATIVE L WITH SINGLE MEDIA FILTRATION

| | | | |
|---|---|---|---|
| Raw Water Source | Sea Intake Located near Walvis Bay | | |
| Raw Water Requirements | 10 300 m^3/d | Pretreatment Losses | 2% |
| Output Capacity of Plant | 5 000 m^3/d | Filtration Losses | 1% |
| Plant Design Factor | 90% | U.F.Plant Losses | |
| Annual Water Production | 1 643 Ml/annum | Plant Recovery Factor | 50% |

COSTS OF POWER

| | |
|---|---|
| kW Charges/month | 26.50 R/kW/Month |
| Unit Charges | 10.50 c/kWh |

| | Civils | Mechanical Electrical | Desal Equipment |
|---|---|---|---|
| DEPRECIATION PERIOD Years | 40 | 15 | 20 |
| ANNUAL MAINTENANCE FACTORS | 0.50% | 4.00% | 2.00% |

PROGRAMMME REQUIIREMENTS

| | |
|---|---|
| Design Tender & Award | 9 Months |
| Construction | 12 Months |
| Start Up Period | 1 Month |

| CAPITAL COSTS (See Page 2) | Civils | Mechanical Electrical | Desal Equipment | Totals |
|---|---|---|---|---|
| | R*1000 | R*1000 | R*1000 | R*1000 |
| Direct Non Depreciable | 100 | | | 100 |
| Direct Depreciable | 11 675 | 2850 | 20 700 | 35 225 |
| Indirect | 2 710 | 670 | 2 750 | 6 130 |
| Start Up Costs | | | | 200 |
| TOTAL CAPITAL COSTS | 14 485 | 3520 | 23 450 | 41 655 |
| MAINTENANCE COSTS | 58 | 114 | 414 | 586 |

| ANNUAL RECURRING COSTS | R*1000 |
|---|---|
| Fixed | 1 010 |
| Flow Related (5 000 m^3/d ) | 1 434 |
| TOTAL | 2 444 |

ECONOMIC ANALYSIS

| Discount Rate | 0.0% | 4.0% | 6.0% | 8.0% | 10.0% |
|---|---|---|---|---|---|
| Capital NPV | 66 | 55 | 52 | 51 | 50 |
| Operating NPV | 121 | 62 | 48 | 39 | 33 |
| Total NPV | 187 | 117 | 101 | 90 | 83 |
| Water Produced Discounted | 66 | 30 | 22 | 17 | 13 |
| REFERENCE UNIT VALUE Rand/m^3 | 2.84 | 3.90 | 4.58 | 5.36 | 6.24 |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
MECHANICAL VAPOUR COMPRESSION
ALTERNATIVE L WITH SINGLE MEDIA FILTRATION
ESTIMATED CAPITAL COSTS

| DIRECT CAPITAL COSTS | Civils | Mechanical Electrical | Desal Equipment | Totals |
|---|---|---|---|---|
| Non Depreciable | R*1000 | R*1000 | R*1000 | R*1000 |
| 1 Purchase of Land | 100 | | | 100 |
| Depreciable | | | | |
| 1 Sea Intake & Pumpstation | 3 290 | 330 | | 3 620 |
| 2 Delivery Pipelines | 50 | | | 50 |
| 3 Site Development | 200 | 60 | | 260 |
| 4 Raw Water Storage (12 000 m^3) | 2 805 | | | 2 805 |
| 5 Pretreatment Works and Pumpstations | 180 | 2070 | | 2 250 |
| 6 Administrative & Miscellaneous Buildings | 80 | | | 80 |
| 7 Desalination Equipment Buildings (560 m^2) | 840 | | | 840 |
| 8 Desalination Equipment | | | 20 700 | 20 700 |
| 9 Product Storage Reservoir (625 m^3) | 445 | | | 445 |
| 10 Incoming Power Supply | | 230 | | 230 |
| 11 Product Pipeline & Pumpstation | 3 735 | 160 | | 3 895 |
| 12 Brine Pipeline | 50 | | | 50 |
| Totals of Depreciable Costs | 11 675 | 2850 | 20 700 | 35 225 |
| INDIRECT CAPITAL COSTS | | | | |
| Contingencies 10.00%of Net Cost | 1 170 | 290 | 2 070 | 3 530 |
| Escalation 0.00%per Month | | | | |
| Engineering Fees | | | | |
| Civil and Mechanical 12.0% | 1 540 | 380 | | 1 920 |
| Desalination Equipment 3.0% | | | 680 | 680 |
| Totals of Indirect Depreciable Costs | 2 710 | 670 | 2 750 | 6 130 |

START UP COSTS (Pro Rata on Start Up Period )

| | R*1000 |
|---|---|
| Chemicals | 5 |
| Power | |
| Electrical | 160 |
| Staff | 39 |
| Totals | 204 |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
MECHANICAL VAPOUR COMPRESSION
ALTERNATIVE L WITH SINGLE MEDIA FILTRATION
ESTIMATED CAPITAL COSTS
CALCULATION OF ENERGY COSTS

Based on operation at full rated output of 5 000 m^3/d

ELECTRICAL ENERGY

| Component | Absorbed Power kW | Installed Power kW | % Utilisation | Average kWh/day |
|---|---|---|---|---|
| Seawater pumps | 20 | 22 | 90.0% | 430 |
| Pretreatment Works | 24 | 30 | 90.0% | 524 |
| Clear Water Pumps | 60 | 75 | 90.0% | 1 304 |
| Compressor | 1 560 | 1 575 | 90.0% | 33 696 |
| Totals | 1 665 | 1 702 | | 35 954 |

| | | R*1000 |
|---|---|---|
| Fixed Annual Power costs | | 541 |
| Flow Related Power costs | Electrical Energy | 1378 |

CALCULATION OF ANNUAL RECURRING COSTS

| | R*1000 |
|---|---|
| FIXED | |
| Salaries and Labour | 361 |
| Labour Overhead ( 30.0%) | 108 |
| Fixed electrical energy costs | 541 |
| Total | 1010 |
| FLOW RELATED | |
| Power-Electrical | 1378 |
| Chemicals | 56 |
| Miscellaneous Supplies | |
| Total | 1434 |

STAFFING

| | Util | No. | Salary R | Total Salaries R |
|---|---|---|---|---|
| Superintendant | 100% | 1 | 70 000 | 70 000 |
| Snr Operator | 100% | 5 | 39 000 | 195 000 |
| Jnr Operator | 100% | 0 | 32 500 | 0 |
| Operating Asst | 100% | 4 | 12 400 | 49 600 |
| Labourers | 100% | 2 | 12 400 | 24 800 |
| Lab. Techn. | 10% | 1 | 32 500 | 3 250 |
| Mech. Maint. | 30% | 1 | 44 800 | 13 440 |
| Elec. Maint. | 10% | 1 | 44 800 | 4 480 |
| TOTAL | | | | 361 000 |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
MECHANICAL VAPOUR COMPRESSION
WITH SINGLE MEDIA FILTRATION

M

ALTERNATIVE L

CHEMICAL USAGE

| | Daily Quantity | Dosage Rate | Annual Quantity | Unit Cost | Total Cost |
|---|---|---|---|---|---|
| | m^3/d | mg/l | tons | R/ton | R |
| Lime | 5 000 | 20 | 33 | 495.00 | 16 261 |
| Anti-Scalant | 9 991 | 4 | 13 | 2 000.00 | 26 256 |
| Chlorine Raw Water | 10 300 | 5 | 17 | 700.00 | 11 842 |
| Chlorine Product Water | 5 000 | 1 | 2 | 700.00 | 1 150 |
| Coagulant | | | | | |
| TOTAL FOR CHEMICALS | | | | | 56 000 |

MISCELLANEOUS SUPPLIES

| ITEM | Annual Quantity | Unit Cost | Total Cost |
|---|---|---|---|
| | Unit | Unit/a | R per unit | R |
| TOTAL FOR CONSUMABLES | | | | |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
MECHANICAL VAPOUR COMPRESSION
WITH SINGLE MEDIA FILTRATION

ALTERNATIVE L

CALCULATION OF PUMPING REQUIREMENTS

Based on operation at full rated output of 5 000 m^3/d

1 Sea Water Pumps

| | | |
|---|---|---|
| Pumping Rate | 119 | l/s |
| Length of Main | 300 | m |
| Diameter | 288 | mm |
| Friction Head | 2.5 | m |
| Static Head | 10.0 | m |
| Total Head | 12.5 | m |
| Efficiency of Pump | 75.0% | Percent |
| Power Absorbed | 20 | kW |
| Power Installed | 22 | kW |

2 Pretreatment Works

| | |
|---|---|
| Pumping Rate | 119 l/s |
| Length of Main | 30 m |
| Diameter | 288 mm |
| Friction Head | 0.3 m |
| Static Head | 15.0 m |
| Total Head | 15.3 m |
| Efficiency of Pump | 75.0%Percent |
| Power Absorbed | 24 kW |
| Power Installed | 30 kW |

3 Clear Water Pumps

| | |
|---|---|
| Pumping Rate | 58 l/s |
| Length of Main | 15 000 m |
| Diameter | 288 mm |
| Friction Head | 33.2 m |
| Static Head | 45.0 m |
| Total Head | 78.2 m |
| Efficiency of Pump | 75.0%Percent |
| Power Absorbed | 60 kW |
| Power Installed | 75 kW |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
MECHANICAL VAPOUR COMPRESSION
ALTERNATIVE L WITH SINGLE MEDIA FILTRATION

| YEAR | FLOW | FLOW | CAPITAL | FIXED COSTS | PROPMAINTNCE TO FLOW COSTS | | TOTAL |
|---|---|---|---|---|---|---|---|
| | m^3/d | Ml/a | R*1000 | R*1000 | R*1000 | R*1000 | R*1000 |
| 1993 | | | | | | | |
| 1994 | | | 5 123 | | | | 5 123 |
| 1995 | | | 36 532 | | | | 36 532 |
| 1996 | 5 000 | 1 643 | | 1 010 | 1 434 | 586 | 3 030 |
| 1997 | 5 000 | 1 643 | | 1 010 | 1 434 | 586 | 3 030 |
| 1998 | 5 000 | 1 643 | | 1 010 | 1 434 | 586 | 3 030 |
| 1999 | 5 000 | 1 643 | | 1 010 | 1 434 | 586 | 3 030 |
| 2000 | 5 000 | 1 643 | | 1 010 | 1 434 | 586 | 3 030 |
| 2001 | 5 000 | 1 643 | | 1 010 | 1 434 | 586 | 3 030 |
| 2002 | 5 000 | 1 643 | | 1 010 | 1 434 | 586 | 3 030 |
| 2003 | 5 000 | 1 643 | | 1 010 | 1 434 | 586 | 3 030 |
| 2004 | 5 000 | 1 643 | | 1 010 | 1 434 | 586 | 3 030 |
| 2005 | 5 000 | 1 643 | | 1 010 | 1 434 | 586 | 3 030 |
| 2006 | 5 000 | 1 643 | | 1 010 | 1 434 | 586 | 3 030 |
| 2007 | 5 000 | 1 643 | | 1 010 | 1 434 | 586 | 3 030 |
| 2008 | 5 000 | 1 643 | | 1 010 | 1 434 | 586 | 3 030 |
| 2009 | 5 000 | 1 643 | | 1 010 | 1 434 | 586 | 3 030 |
| 2010 | 5 000 | 1 643 | | 1 010 | 1 434 | 586 | 3 030 |
| 2011 | 5 000 | 1 643 | 2 850 | 1 010 | 1 434 | 586 | 5 880 |
| 2012 | 5 000 | 1 643 | | 1 010 | 1 434 | 586 | 3 030 |
| 2013 | 5 000 | 1 643 | | 1 010 | 1 434 | 586 | 3 030 |
| 2014 | 5 000 | 1 643 | | 1 010 | 1 434 | 586 | 3 030 |
| 2015 | 5 000 | 1 643 | | 1 010 | 1 434 | 586 | 3 030 |
| 2016 | 5 000 | 1 643 | 20 700 | 1 010 | 1 434 | 586 | 23 730 |
| 2017 | 5 000 | 1 643 | | 1 010 | 1 434 | 586 | 3 030 |
| 2018 | 5 000 | 1 643 | | 1 010 | 1 434 | 586 | 3 030 |
| 2019 | 5 000 | 1 643 | | 1 010 | 1 434 | 586 | 3 030 |
| 2020 | 5 000 | 1 643 | | 1 010 | 1 434 | 586 | 3 030 |
| 2021 | 5 000 | 1 643 | | 1 010 | 1 434 | 586 | 3 030 |
| 2022 | 5 000 | 1 643 | | 1 010 | 1 434 | 586 | 3 030 |
| 2023 | 5 000 | 1 643 | | 1 010 | 1 434 | 586 | 3 030 |
| 2024 | 5 000 | 1 643 | | 1 010 | 1 434 | 586 | 3 030 |
| 2025 | 5 000 | 1 643 | | 1 010 | 1 434 | 586 | 3 030 |
| 2026 | 5 000 | 1 643 | 2 850 | 1 010 | 1 434 | 586 | 5 880 |
| 2027 | 5 000 | 1 643 | | 1 010 | 1 434 | 586 | 3 030 |
| 2028 | 5 000 | 1 643 | | 1 010 | 1 434 | 586 | 3 030 |
| 2029 | 5 000 | 1 643 | | 1 010 | 1 434 | 586 | 3 030 |
| 2030 | 5 000 | 1 643 | | 1 010 | 1 434 | 586 | 3 030 |
| 2031 | 5 000 | 1 643 | | 1 010 | 1 434 | 586 | 3 030 |
| 2032 | 5 000 | 1 643 | | 1 010 | 1 434 | 586 | 3 030 |
| 2033 | 5 000 | 1 643 | | 1 010 | 1 434 | 586 | 3 030 |
| 2034 | 5 000 | 1 643 | | 1 010 | 1 434 | 586 | 3 030 |
| 2035 | 5 000 | 1 643 | | 1 010 | 1 434 | 586 | 3 030 |
| | | | (2 467) | | | | (2 467) |

ALTERNATIVE M

| | | | |
|---|---|---|---|
| Raw Water Source | Sea Intake Located near Walvis Bay | | |
| Raw Water Requirements | 10 300 m^3/d | Pretreatment Losses | 2% |
| Output Capacity of Plant | 5 000 m^3/d | Filtration Losses | 1% |
| Plant Design Factor | 90% | U.F.Plant Losses | |
| Annual Water Production | 1 643 Ml/annum | Plant Recovery Factor | 50% |

COSTS OF POWER

| | | | | |
|---|---|---|---|---|
| kW Charges/month | 26.50 R/kW/Month | Heavy Fuel Oil | 46.0 | c/litre |
| Unit Charges | 10.50 c/kWh | S.G. | 0.985 | |

| | | Civils | Mechanical Electrical | Desal Equipment |
|---|---|---|---|---|
| DEPRECIATION PERIOD | Years | 40 | 15 | 20 |
| ANNUAL MAINTENANCE FACTORS | | 0.50% | 4.00% | 2.00% |

PROGRAMMME REQUIIREMENTS

| | |
|---|---|
| Design Tender & Award | 9 Months |
| Construction | 12 Months |
| Start Up Period | 1 Month |

| CAPITAL COSTS (See Page 2) | Civils R*1000 | Mechanical Electrical R*1000 | Desal Equipment R*1000 | Totals R*1000 |
|---|---|---|---|---|
| Direct Non Depreciable | 100 | | | 100 |
| Direct Depreciable | 12 785 | 10 350 | 21 000 | 44 135 |
| Indirect | 2 970 | 2 410 | 2 790 | 8 170 |
| Start Up Costs | | | | 600 |
| TOTAL CAPITAL COSTS | 15 855 | 12 760 | 23 790 | 53 005 |
| MAINTENANCE COSTS | 64 | 414 | 420 | 898 |

| ANNUAL RECURRING COSTS | R*1000 |
|---|---|
| Fixed | 611 |
| Flow Related (5 000 m^3/d ) | 6 546 |
| TOTAL | 7 157 |

ECONOMIC ANALYSIS

| Discount Rate | 0.0% | 4.0% | 6.0% | 8.0% | 10.0% |
|---|---|---|---|---|---|
| Capital NPV | 89 | 65 | 58 | 53 | 49 |
| Operating NPV | 322 | 147 | 108 | 82 | 65 |
| Total NPV | 411 | 212 | 166 | 135 | 114 |
| Water Produced Discounted | 66 | 30 | 22 | 17 | 13 |
| REFERENCE UNIT VALUE Rand/m^3 | 6.26 | 7.06 | 7.53 | 8.04 | 8.59 |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
MULTIPLE EFFECT DISTILLATION
ALTERNATIVE M WITH SINGLE MEDIA FILTRATION
ESTIMATED CAPITAL COSTS

| DIRECT CAPITAL COSTS | Civils | Mechanical Electrical | Desal Equipment | Totals |
|---|---|---|---|---|
| Non Depreciable | R*1000 | R*1000 | R*1000 | R*1000 |
| 1 Purchase of Land | 100 | | | 100 |
| Depreciable | | | | |
| 1 Sea Intake & Pumpstation | 3 290 | 330 | | 3 620 |
| 2 Delivery Pipelines | 50 | | | 50 |
| 3 Site Development | 200 | 60 | | 260 |
| 4 Raw Water Storage (12 000 m^3 ) | 2 805 | | | 2 805 |
| 5 Pretreatment Works and Pumpstations | 180 | 2 070 | | 2 250 |
| 6 Administrative & Miscellaneous Buildings | 80 | | | 80 |
| 7 Desalination Equipment Buildings (800 m^2) | 1 200 | | | 1 200 |
| 8 Desalination Equipment | | | 21 000 | 21 000 |
| 9 Steam Generation Equipment | 750 | 7 500 | | 8 250 |
| 10 Product Storage Reservoir (625 m^3) | 445 | | | 445 |
| 11 Incoming Power Supply | | 230 | | 230 |
| 12 Product Pipeline & Pumpstation | 3 735 | 160 | | 3 895 |
| 13 Brine Pipeline | 50 | | | 50 |
| Totals of Depreciable Costs | 12 785 | 10 350 | 21 000 | 44 135 |
| INDIRECT CAPITAL COSTS | | | | |
| Contingencies 10.00%of Net Cost | 1 280 | 1 040 | 2 100 | 4 420 |
| Escalation 0.00%per Month | | | | |
| Engineering Fees | | | | |
| Civil and Mechanical 12.0% | 1 690 | 1 370 | | 3 060 |
| Desalination Equipment 3.0% | | | 690 | 690 |
| Totals of Indirect Depreciable Costs | 2 970 | 2 410 | 2 790 | 8 170 |

START UP COSTS (Pro Rata on Start Up Period )

| | R*1000 |
|---|---|
| Chemicals | 5 |
| Power | |
| Electrical | 41 |
| Heavy Fuel Oil | 512 |
| Staff | 39 |
| Totals | 596 |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
MULTIPLE EFFECT DISTILLATION
ALTERNATIVE M WITH SINGLE MEDIA FILTRATION
ESTIMATED CAPITAL COSTS
CALCULATION OF ENERGY COSTS

Based on operation at full rated output of 5 000 m^3/d

ELECTRICAL ENERGY

| Component | Absorbed Power kW | Installed Power kW | % Utilisation | Average kWh/day |
|---|---|---|---|---|
| Seawater pumps | 20 | 22 | 90.0% | 430 |
| Pretreatment Works | 24 | 30 | 90.0% | 524 |
| Clear Water Pumps | 60 | 75 | 90.0% | 1 304 |
| Additional Energy | 313 | 320 | 90.0% | 6 761 |
| Totals | 418 | 447 | | 9 019 |

Heavy Fuel Oil Consumption

| | | |
|---|---|---|
| Boiler Efficiency | 82.0% | |
| Required evaporation rate | 26.00 t/h | |
| Heavy Fuel Oil Consumption Rate | 1.67 t/h | |
| | | R*1000 |
| Fixed Annual Power costs | | 142 |
| Flow Related Power costs | Electrical Energy | 346 |
| Flow Related Power costs | Heavy Fuel Oil | 6 144 |

CALCULATION OF ANNUAL RECURRING COSTS

| | R*1000 |
|---|---|
| FIXED | |
| Salaries and Labour | 361 |
| Labour Overhead ( 30.0%) | 108 |
| Fixed electrical energy costs | 142 |
| Total | 611 |
| FLOW RELATED | |
| Power-Electrical | 346 |
| Heavy Fuel Oil | 6 144 |
| Chemicals | 56 |
| Miscellaneous Supplies | |
| Total | 6 546 |

STAFFING

| | Util | No. | Salary R | Total Salaries R |
|---|---|---|---|---|
| Superintendant | 100% | 1 | 70 000 | 70 000 |
| Snr Operator | 100% | 5 | 39 000 | 195 000 |
| Jnr Operator | 100% | 0 | 32 500 | 0 |
| Operating Asst | 100% | 4 | 12 400 | 49 600 |
| Labourers | 100% | 2 | 12 400 | 24 800 |
| Lab. Techn. | 10% | 1 | 32 500 | 3 250 |
| Mech. Maint. | 30% | 1 | 44 800 | 13 440 |
| Elec. Maint. | 10% | 1 | 44 800 | 4 480 |
| TOTAL | | | | 361 000 |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
MULTIPLE EFFECT DISTILLATION
WITH SINGLE MEDIA FILTRATION

E

ALTERNATIVE M

CHEMICAL USAGE

| | Daily Quantity | Dosage Rate | Annual Quantity | Unit Cost | Total Cost |
|---|---|---|---|---|---|
| | m^3/d | mg/l | tons | R/ton | R |
| Lime | 5 000 | 20 | 32.85 | 495.00 | 16 261 |
| Anti-Scalant | 9 991 | 4 | 13.13 | 2 000.00 | 26 256 |
| Chlorine Raw Water | 10 300 | 5 | 16.92 | 700.00 | 11 842 |
| Chlorine Product Water | 5 000 | 1 | 1.64 | 700.00 | 1 150 |
| Coagulant | | | | | |
| TOTAL FOR CHEMICALS | | | | | 56 000 |

MISCELLANEOUS SUPPLIES

| ITEM | Annual Quantity | Unit Cost | Total Cost |
|---|---|---|---|
| | Unit | Unit/a | R per unit | R |
| TOTAL FOR CONSUMABLES | | | | |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
MULTIPLE EFFECT DISTILLATION
WITH SINGLE MEDIA FILTRATION

ALTERNATIVE M

## CALCULATION OF PUMPING REQUIREMENTS

Based on operation at full rated output of 5 000 m^3/d

| 1 Sea Water Pumps | | |
|---|---|---|
| Pumping Rate | 119 | l/s |
| Length of Main | 300 | m |
| Diameter | 288 | mm |
| Friction Head | 2.5 | m |
| Static Head | 10.0 | m |
| Total Head | 12.5 | m |
| Efficiency of Pump | 75.0% | Percent |
| Power Absorbed | 20 | kW |
| Power Installed | 22 | kW |

| 2 Pretreatment Works | |
|---|---|
| Pumping Rate | 119 l/s |
| Length of Main | 30 m |
| Diameter | 288 mm |
| Friction Head | 0.3 m |
| Static Head | 15.0 m |
| Total Head | 15.3 m |
| Efficiency of Pump | 75.0%Percent |
| Power Absorbed | 24 kW |
| Power Installed | 30 kW |

| 3 Clear Water Pumps | |
|---|---|
| Pumping Rate | 58 l/s |
| Length of Main | 15 000 m |
| Diameter | 238 mm |
| Friction Head | 33.2 m |
| Static Head | 45.0 m |
| Total Head | 78.2 m |
| Efficiency of Pump | 75.0%Percent |
| Power Absorbed | 60 kW |
| Power Installed | 75 kW |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
MULTIPLE EFFECT DISTILLATION
ALTERNATIVE M WITH SINGLE MEDIA FILTRATION

| YEAR | FLOW | FLOW | CAPITAL | FIXED COSTS | PROPMAINTNCE TO FLOW COSTS | | TOTAL |
|---|---|---|---|---|---|---|---|
| | m^3/d | Ml/a | R*1000 | R*1000 | R*1000 | R*1000 | R*1000 |
| 1993 | | | | | | | |
| 1994 | | | 6 773 | | | | 6 773 |
| 1995 | | | 46 232 | | | | 46 232 |
| 1996 | 5 000 | 1 643 | | 611 | 6 546 | 898 | 8 055 |
| 1997 | 5 000 | 1 643 | | 611 | 6 546 | 898 | 8 055 |
| 1998 | 5 000 | 1 643 | | 611 | 6 546 | 898 | 8 055 |
| 1999 | 5 000 | 1 643 | | 611 | 6 546 | 898 | 8 055 |
| 2000 | 5 000 | 1 643 | | 611 | 6 546 | 898 | 8 055 |
| 2001 | 5 000 | 1 643 | | 611 | 6 546 | 898 | 8 055 |
| 2002 | 5 000 | 1 643 | | 611 | 6 546 | 898 | 8 055 |
| 2003 | 5 000 | 1 643 | | 611 | 6 546 | 898 | 8 055 |
| 2004 | 5 000 | 1 643 | | 611 | 6 546 | 898 | 8 055 |
| 2005 | 5 000 | 1 643 | | 611 | 6 546 | 898 | 8 055 |
| 2006 | 5 000 | 1 643 | | 611 | 6 546 | 898 | 8 055 |
| 2007 | 5 000 | 1 643 | | 611 | 6 546 | 898 | 8 055 |
| 2008 | 5 000 | 1 643 | | 611 | 6 546 | 898 | 8 055 |
| 2009 | 5 000 | 1 643 | | 611 | 6 546 | 898 | 8 055 |
| 2010 | 5 000 | 1 643 | | 611 | 6 546 | 898 | 8 055 |
| 2011 | 5 000 | 1 643 | 10 350 | 611 | 6 546 | 898 | 18 405 |
| 2012 | 5 000 | 1 643 | | 611 | 6 546 | 898 | 8 055 |
| 2013 | 5 000 | 1 643 | | 611 | 6 546 | 898 | 8 055 |
| 2014 | 5 000 | 1 643 | | 611 | 6 546 | 898 | 8 055 |
| 2015 | 5 000 | 1 643 | | 611 | 6 546 | 898 | 8 055 |
| 2016 | 5 000 | 1 643 | 21 000 | 611 | 6 546 | 898 | 29 055 |
| 2017 | 5 000 | 1 643 | | 611 | 6 546 | 898 | 8 055 |
| 2018 | 5 000 | 1 643 | | 611 | 6 546 | 898 | 8 055 |
| 2019 | 5 000 | 1 643 | | 611 | 6 546 | 898 | 8 055 |
| 2020 | 5 000 | 1 643 | | 611 | 6 546 | 898 | 8 055 |
| 2021 | 5 000 | 1 643 | | 611 | 6 546 | 898 | 8 055 |
| 2022 | 5 000 | 1 643 | | 611 | 6 546 | 898 | 8 055 |
| 2023 | 5 000 | 1 643 | | 611 | 6 546 | 898 | 8 055 |
| 2024 | 5 000 | 1 643 | | 611 | 6 546 | 898 | 8 055 |
| 2025 | 5 000 | 1 643 | | 611 | 6 546 | 898 | 8 055 |
| 2026 | 5 000 | 1 643 | 10 350 | 611 | 6 546 | 898 | 18 405 |
| 2027 | 5 000 | 1 643 | | 611 | 6 546 | 898 | 8 055 |
| 2028 | 5 000 | 1 643 | | 611 | 6 546 | 898 | 8 055 |
| 2029 | 5 000 | 1 643 | | 611 | 6 546 | 898 | 8 055 |
| 2030 | 5 000 | 1 643 | | 611 | 6 546 | 898 | 8 055 |
| 2031 | 5 000 | 1 643 | | 611 | 6 546 | 898 | 8 055 |
| 2032 | 5 000 | 1 643 | | 611 | 6 546 | 898 | 8 055 |
| 2033 | 5 000 | 1 643 | | 611 | 6 546 | 898 | 8 055 |
| 2034 | 5 000 | 1 643 | | 611 | 6 546 | 898 | 8 055 |
| 2035 | 5 000 | 1 643 | | 611 | 6 546 | 898 | 8 055 |
| | | | (5 510) | | | | (5 510) |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
THERMAL VAPOUR COMPRESSION
WITH SINGLE MEDIA FILTRATION

ALTERNATIVE N

| | | | |
|---|---|---|---|
| Raw Water Source | Sea Intake Located near Walvis Bay | | |
| Raw Water Requirements | 10 300 m^3/d | Pretreatment Losses | 2% |
| Output Capacity of Plant | 5 000 m^3/d | Filtration Losses | 1% |
| Plant Design Factor | 90% | U.F.Plant Losses | |
| Annual Water Production | 1 643 Ml/annum | Plant Recovery Factor | 50% |

COSTS OF POWER

| | | | | |
|---|---|---|---|---|
| kW Charges/month | 26.50 R/kW/Month | Heavy Fuel Oil | 46.0 | c/litre |
| Unit Charges | 10.50 c/kWh | S.G. | 0.985 | |

| | | Civils | Mechanical Electrical | Desal Equipment |
|---|---|---|---|---|
| DEPRECIATION PERIOD | Years | 40 | 15 | 20 |
| ANNUAL MAINTENANCE FACTORS | | 0.50% | 4.00% | 2.00% |

PROGRAMMME REQUIIREMENTS

| | |
|---|---|
| Design Tender & Award | 9 Months |
| Construction | 12 Months |
| Start Up Period | 1 Month |

| CAPITAL COSTS (See Page 2) | Civils | Mechanical Electrical | Desal Equipment | Totals |
|---|---|---|---|---|
| | R*1000 | R*1000 | R*1000 | R*1000 |
| Direct Non Depreciable | 100 | | | 100 |
| Direct Depreciable | 12 400 | 10 350 | 21 000 | 43 750 |
| Indirect | 2 880 | 2 410 | 2 790 | 8 080 |
| Start Up Costs | | | | 470 |
| TOTAL CAPITAL COSTS | 15 380 | 12 760 | 23 790 | 52 400 |
| MAINTENANCE COSTS | 62 | 414 | 420 | 896 |

| ANNUAL RECURRING COSTS | R*1000 |
|---|---|
| Fixed | 576 |
| Flow Related (5 000 m^3/d ) | 5 041 |
| TOTAL | 5 617 |

ECONOMIC ANALYSIS

| Discount Rate | 0.0% | 4.0% | 6.0% | 8.0% | 10.0% |
|---|---|---|---|---|---|
| Capital NPV | 89 | 64 | 57 | 52 | 48 |
| Operating NPV | 261 | 119 | 87 | 67 | 53 |
| Total NPV | 349 | 183 | 144 | 119 | 101 |
| Water Produced Discounted | 66 | 30 | 22 | 17 | 13 |
| REFERENCE UNIT VALUE Rand/m^3 | 5.31 | 6.10 | 6.57 | 7.07 | 7.61 |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
THERMAL VAPOUR COMPRESSION
ALTERNATIVE N WITH SINGLE MEDIA FILTRATION
ESTIMATED CAPITAL COSTS

| DIRECT CAPITAL COSTS | Civils | Mechanical Electrical | Desal Equipment | Totals |
|---|---|---|---|---|
| Non Depreciable | R*1000 | R*1000 | R*1000 | R*1000 |
| 1 Purchase of Land | 100 | | | 100 |
| Depreciable | | | | |
| 1 Sea Intake & Pumpstation | 3 290 | 330 | | 3 620 |
| 2 Delivery Pipelines | 50 | | | 50 |
| 3 Site Development | 200 | 60 | | 260 |
| 4 Raw Water Storage (12 000 m^3 ) | 2 805 | | | 2 805 |
| 5 Pretreatment Works and Pumpstations | 180 | 2 070 | | 2 250 |
| 6 Administrative & Miscellaneous Buildings | 80 | | | 80 |
| 7 Desalination Equipment Buildings (543 m^2) | 815 | | | 815 |
| 8 Desalination Equipment | | | 21 000 | 21 000 |
| 9 Steam Generation Equipment | 750 | 7 500 | | 8 250 |
| 10 Product Storage Reservoir (625 m^3) | 445 | | | 445 |
| 11 Incoming Power Supply | | 230 | | 230 |
| 12 Product Pipeline & Pumpstation | 3 735 | 160 | | 3 895 |
| 13 Brine Pipeline | 50 | | | 50 |
| Totals of Depreciable Costs | 12 400 | 10 350 | 21 000 | 43 750 |
| INDIRECT CAPITAL COSTS | | | | |
| Contingencies 10.00%of Net Cost | 1 240 | 1 040 | 2 100 | 4 380 |
| Escalation 0.00%per Month | | | | |
| Engineering Fees | | | | |
| Civil and Mechanical 12.0% | 1 640 | 1 370 | | 3 010 |
| Desalination Equipment 3.0% | | | 690 | 690 |
| Totals of Indirect Depreciable Costs | 2 880 | 2 410 | 2 790 | 8 080 |

START UP COSTS (Pro Rata on Start Up Period )

| | R*1000 |
|---|---|
| Chemicals | 5 |
| Power | |
| Electrical | 31 |
| Heavy Fuel Oil | 394 |
| Staff | 39 |
| Totals | 468 |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
THERMAL VAPOUR COMPRESSION
ALTERNATIVE N WITH SINGLE MEDIA FILTRATION
ESTIMATED CAPITAL COSTS
CALCULATION OF ENERGY COSTS

Based on operation at full rated output of 5 000 m^3/d

ELECTRICAL ENERGY

| Component | Absorbed Power kW | Installed Power kW | % Utilisation | Average kWh/day |
|---|---|---|---|---|
| Seawater pumps | 20 | 22 | 90.0% | 430 |
| Pretreatment Works | 24 | 30 | 90.0% | 524 |
| Clear Water Pumps | 60 | 75 | 90.0% | 1 304 |
| Additional Energy | 208 | 210 | 90.0% | 4 493 |
| Totals | 313 | 337 | | 6 751 |

Heavy Fuel Oil Consumption

| | |
|---|---|
| Boiler Efficiency | 82.0% |
| Required Evaporation Rate | 20.00 t/h |
| Heavy Fuel Oil Consumption Rate | 1.28 t/h |

| | | R*1000 |
|---|---|---|
| Fixed Annual Power costs | | 107 |
| Flow Related Power costs | Electrical Energy | 259 |
| Flow Related Power costs | Heavy Fuel Oil | 4 726 |

| CALCULATION OF ANNUAL RECURRING COSTS | R*1000 |
|---|---|
| FIXED | |
| Salaries and Labour | 361 |
| Labour Overhead ( 30.0%) | 108 |
| Fixed electrical energy costs | 107 |
| Total | 576 |
| FLOW RELATED | |
| Power-Electrical | 259 |
| Heavy Fuel Oil | 4 726 |
| Chemicals | 56 |
| Miscellaneous Supplies | |
| Total | 5 041 |

STAFFING

| | Util | No. | Salary R | Total Salaries R |
|---|---|---|---|---|
| Superintendant | 100% | 1 | 70 000 | 70 000 |
| Snr Operator | 100% | 5 | 39 000 | 195 000 |
| Jnr Operator | 100% | 0 | 32 500 | 0 |
| Operating Asst | 100% | 4 | 12 400 | 49 600 |
| Labourers | 100% | 2 | 12 400 | 24 800 |
| Lab. Techn. | 10% | 1 | 32 500 | 3 250 |
| Mech. Maint. | 30% | 1 | 44 800 | 13 440 |
| Elec. Maint. | 10% | 1 | 44 800 | 4 480 |
| TOTAL | | | | 361 000 |

T

ALTERNATIVE N

CHEMICAL USAGE

| | Daily Quantity | Dosage Rate | Annual Quantity | Unit Cost | Total Cost |
|---|---|---|---|---|---|
| | m^3/d | mg/l | tons | R/ton | R |
| Lime | 5 000 | 20 | 32.85 | 495.00 | 16 261 |
| Anti-Scalant | 9 991 | 4 | 13.13 | 2 000.00 | 26 256 |
| Chlorine Raw Water | 10 300 | 5 | 16.92 | 700.00 | 11 842 |
| Chlorine Product Water | 5 000 | 1 | 1.64 | 700.00 | 1 150 |
| Coagulant | | | | | |
| TOTAL FOR CHEMICALS | | | | | 56 000 |

MISCELLANEOUS SUPPLIES

| ITEM | Annual Quantity | Unit Cost | Total Cost |
|---|---|---|---|
| | Unit | Unit/a | R per unit | R |
| TOTAL FOR CONSUMABLES | | | | |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
THERMAL VAPOUR COMPRESSION
WITH SINGLE MEDIA FILTRATION

ALTERNATIVE N

## CALCULATION OF PUMPING REQUIREMENTS

Based on operation at full rated output of 5 000 m^3/d

| 1 Sea Water Pumps | | |
|---|---|---|
| Pumping Rate | 119 | l/s |
| Length of Main | 300 | m |
| Diameter | 288 | mm |
| Friction Head | 2.5 | m |
| Static Head | 10.0 | m |
| Total Head | 12.5 | m |
| Efficiency of Pump | 75.0% | Percent |
| Power Absorbed | 20 | kW |
| Power Installed | 22 | kW |

| 2 Pretreatment Works | |
|---|---|
| Pumping Rate | 119 l/s |
| Length of Main | 30 m |
| Diameter | 288 mm |
| Friction Head | 0.3 m |
| Static Head | 15.0 m |
| Total Head | 15.3 m |
| Efficiency of Pump | 75.0%Percent |
| Power Absorbed | 24 kW |
| Power Installed | 30 kW |

| 3 Clear Water Pumps | |
|---|---|
| Pumping Rate | 58 l/s |
| Length of Main | 15 000 m |
| Diameter | 288 mm |
| Friction Head | 33.2 m |
| Static Head | 45.0 m |
| Total Head | 78.2 m |
| Efficiency of Pump | 75.0%Percent |
| Power Absorbed | 60 kW |
| Power Installed | 75 kW |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
THERMAL VAPOUR COMPRESSION
ALTERNATIVE N WITH SINGLE MEDIA FILTRATION

| YEAR | FLOW | FLOW | CAPITAL | FIXED COSTS | PROPMAINTNCE TO FLOW COSTS | | TOTAL |
|---|---|---|---|---|---|---|---|
| | m^3/d | Ml/a | R*1000 | R*1000 | R*1000 | R*1000 | R*1000 |
| 1993 | | | | | | | |
| 1994 | | | 6 702 | | | | 6 702 |
| 1995 | | | 45 698 | | | | 45 698 |
| 1996 | 5 000 | 1 643 | | 576 | 5 041 | 896 | 6 513 |
| 1997 | 5 000 | 1 643 | | 576 | 5 041 | 896 | 6 513 |
| 1998 | 5 000 | 1 643 | | 576 | 5 041 | 896 | 6 513 |
| 1999 | 5 000 | 1 643 | | 576 | 5 041 | 896 | 6 513 |
| 2000 | 5 000 | 1 643 | | 576 | 5 041 | 896 | 6 513 |
| 2001 | 5 000 | 1 643 | | 576 | 5 041 | 896 | 6 513 |
| 2002 | 5 000 | 1 643 | | 576 | 5 041 | 896 | 6 513 |
| 2003 | 5 000 | 1 643 | | 576 | 5 041 | 896 | 6 513 |
| 2004 | 5 000 | 1 643 | | 576 | 5 041 | 896 | 6 513 |
| 2005 | 5 000 | 1 643 | | 576 | 5 041 | 896 | 6 513 |
| 2006 | 5 000 | 1 643 | | 576 | 5 041 | 896 | 6 513 |
| 2007 | 5 000 | 1 643 | | 576 | 5 041 | 896 | 6 513 |
| 2008 | 5 000 | 1 643 | | 576 | 5 041 | 896 | 6 513 |
| 2009 | 5 000 | 1 643 | | 576 | 5 041 | 896 | 6 513 |
| 2010 | 5 000 | 1 643 | | 576 | 5 041 | 896 | 6 513 |
| 2011 | 5 000 | 1 643 | 10 350 | 576 | 5 041 | 896 | 16 863 |
| 2012 | 5 000 | 1 643 | | 576 | 5 041 | 896 | 6 513 |
| 2013 | 5 000 | 1 643 | | 576 | 5 041 | 896 | 6 513 |
| 2014 | 5 000 | 1 643 | | 576 | 5 041 | 896 | 6 513 |
| 2015 | 5 000 | 1 643 | | 576 | 5 041 | 896 | 6 513 |
| 2016 | 5 000 | 1 643 | 21 000 | 576 | 5 041 | 896 | 27 513 |
| 2017 | 5 000 | 1 643 | | 576 | 5 041 | 896 | 6 513 |
| 2018 | 5 000 | 1 643 | | 576 | 5 041 | 896 | 6 513 |
| 2019 | 5 000 | 1 643 | | 576 | 5 041 | 896 | 6 513 |
| 2020 | 5 000 | 1 643 | | 576 | 5 041 | 896 | 6 513 |
| 2021 | 5 000 | 1 643 | | 576 | 5 041 | 896 | 6 513 |
| 2022 | 5 000 | 1 643 | | 576 | 5 041 | 896 | 6 513 |
| 2023 | 5 000 | 1 643 | | 576 | 5 041 | 896 | 6 513 |
| 2024 | 5 000 | 1 643 | | 576 | 5 041 | 896 | 6 513 |
| 2025 | 5 000 | 1 643 | | 576 | 5 041 | 896 | 6 513 |
| 2026 | 5 000 | 1 643 | 10 350 | 576 | 5 041 | 896 | 16 863 |
| 2027 | 5 000 | 1 643 | | 576 | 5 041 | 896 | 6 513 |
| 2028 | 5 000 | 1 643 | | 576 | 5 041 | 896 | 6 513 |
| 2029 | 5 000 | 1 643 | | 576 | 5 041 | 896 | 6 513 |
| 2030 | 5 000 | 1 643 | | 576 | 5 041 | 896 | 6 513 |
| 2031 | 5 000 | 1 643 | | 576 | 5 041 | 896 | 6 513 |
| 2032 | 5 000 | 1 643 | | 576 | 5 041 | 896 | 6 513 |
| 2033 | 5 000 | 1 643 | | 576 | 5 041 | 896 | 6 513 |
| 2034 | 5 000 | 1 643 | | 576 | 5 041 | 896 | 6 513 |
| 2035 | 5 000 | 1 643 | | 576 | 5 041 | 896 | 6 513 |
| | | | (5 500) | | | | (5 500) |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
REVERSE OSMOSIS
ALTERNATIVE P WITH NO ULTRA-FILTRATION PRETREATEMNT

| | | | |
|---|---|---|---|
| Raw Water Source | Sea Wells Located at Paaltjies | | |
| Raw Water Requirements | 11 200 m^3/d | Pretreatment Losses | 1% |
| Output Capacity of Plant | 5 000 m^3/d | Filtration Losses | |
| Plant Design Factor | 90% | U.F.Plant Losses | |
| Annual Water Production | 1 643 Ml/annum | R.O.Plant Recovery Factor | 45% |

COSTS OF POWER

| | |
|---|---|
| kW Charges/month | 26.50 R/kW/Month |
| Unit Charges | 10.50 c/kWh |

| DEPRECIATION PERIOD | Civils | Mechanical Electrical | Desal Equipment | Membranes R. O. |
|---|---|---|---|---|
| Years | 40 | 15 | 20 | 5 |
| MAINTENANCE FACTORS | 0.50% | 4.00% | 2.00% | |

PROGRAMMME REQUIIREMENTS

| | |
|---|---|
| Design Tender & Award | 9 Months |
| Construction | 12 Months |
| Start Up Period | 1 Month |

| CAPITAL COSTS (See Page 2) | Civils | Mechanical Electrical | Desal Equipment | Membranes R. O. | Totals |
|---|---|---|---|---|---|
| | R*1000 | R*1000 | R*1000 | R*1000 | R*1000 |
| Direct Non Depreciable | 100 | | | | 100 |
| Direct Depreciable | 11 910 | 8 650 | 17 500 | 3 000 | 41 060 |
| Indirect | 2 760 | 2 010 | 2 330 | 400 | 7 500 |
| Start Up Costs | | | | | 190 |
| TOTAL CAPITAL COSTS | 14 770 | 10 660 | 19 830 | 3 400 | 48 850 |
| MAINTENANCE COSTS | 60 | 346 | 350 | | 756 |

| ANNUAL RECURRING COSTS | R*1000 |
|---|---|
| Fixed | 1 051 |
| Flow Related (5 000 m^3/d) | 1 846 |
| TOTAL | 2 897 |

ECONOMIC ANALYSIS

| Discount Rate | 0.0% | 4.0% | 6.0% | 8.0% | 10.0% |
|---|---|---|---|---|---|
| Capital NPV | 79 | 58 | 52 | 48 | 45 |
| Operating NPV | 146 | 67 | 49 | 37 | 30 |
| Total NPV | 225 | 125 | 101 | 85 | 74 |
| Water Produced Discounted | 66 | 30 | 22 | 17 | 13 |
| REFERENCE UNIT VALUE Rand/m^3 | 3.43 | 4.16 | 4.60 | 5.08 | 5.59 |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
REVERSE OSMOSIS
ALTERNATIVE P WITH NO ULTRA-FILTRATION PRETREATEMNT
ESTIMATED CAPITAL COSTS

| DIRECT CAPITAL COSTS | Civils | Mechanical Electrical | Desal Equipment | Membranes R. O. | Totals |
|---|---|---|---|---|---|
| Non Depreciable | R*1000 | R*1000 | R*1000 | R*1000 | R*1000 |
| 1 Purchase of Land | 100 | | | | 100 |
| Depreciable | | | | | |
| 1 Wellfield | 425 | 275 | | | 700 |
| 2 Delivery Pipelines | 50 | | | | 50 |
| 3 Site Development | 200 | 60 | | | 260 |
| 4 Raw Water Storage (2 000 m^3 ) | 950 | | | | 950 |
| 5 Pretreatment Works and Pumpstations | 40 | 55 | | | 95 |
| 6 Administrative & Miscellaneous Buildings | 100 | | | | 100 |
| 7 Desalination Equipment Buildings (1200 m^2) | 1 800 | | | | 1 800 |
| 8 Desalination Equipment | | | 17 500 | 3 000 | 20 500 |
| 9 Product Storage Reservoir ( 625 m^3 ) | 445 | | | | 445 |
| 10 Incoming Power Supply | | 8 060 | | | 8 060 |
| 11 Product Pipeline & Pumpstation | 7 850 | 200 | | | 8 050 |
| 12 Brine Pipeline | 50 | | | | 50 |
| Totals of Depreciable Costs | 11 910 | 8 650 | 17 500 | 3 000 | 41 060 |
| INDIRECT CAPITAL COSTS | | | | | |
| Contingencies 10.00%of Net Cost | 1 190 | 870 | 1 750 | 300 | 4 110 |
| Escalation 0.00%per Month | | | | | |
| Engineering Fees | | | | | |
| Civil and Mechanical 12.0% | 1 570 | 1 140 | | | 2 710 |
| Desalination Equipment 3.0% | | | 580 | 100 | 680 |
| Totals of Indirect Depreciable Costs | 2 760 | 2 010 | 2 330 | 400 | 7 500 |

| START UP COSTS (Pro Rata on Start Up Period ) | R*1000 |
|---|---|
| Chemicals | 22 |
| Power | |
| Electrical | 118 |
| Staff | 49 |
| Totals | 188 |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
REVERSE OSMOSIS
ALTERNATIVE P WITH NO ULTRA-FILTRATION PRETREATEMNT
ESTIMATED CAPITAL COSTS
CALCULATION OF ENERGY COSTS

Based on operation at full rated output of 5 000 m^3/d

ELECTRICAL ENERGY

| Component | Absorbed Power kW | Installed Power kW | % Utilisation | Average kWh/day |
|---|---|---|---|---|
| Seawater pumps | 22 | 30 | 90.0% | 484 |
| Reverse Osmosis Feed Pumps | 103 | 110 | 90.0% | 2 233 |
| Reverse Osmosis Pumps | 962 | 1 260 | 90.0% | 20 783 |
| Clear Water Pumps | 59 | 75 | 90.0% | 1 270 |
| Totals | 1 147 | 1 475 | | 24 770 |

| | | R*1000 |
|---|---|---|
| Fixed Annual Power costs | | 469 |
| Flow Related Power costs | Electrical Energy | 949 |

CALCULATION OF ANNUAL RECURRING COSTS

| | | R*1000 |
|---|---|---|
| FIXED | | |
| Salaries and Labour | | 448 |
| Labour Overhead | ( 30.0%) | 134 |
| Fixed electrical energy costs | | 469 |
| Total | | 1 051 |
| FLOW RELATED | | |
| Power-Electrical | | 949 |
| Chemicals | | 259 |
| Miscellaneous Supplies | | 38 |
| R.O.Membrane Replacement | (5 Yearly) | 600 |
| Total | | 1 846 |

STAFFING

| | Util | No. | Salary R | Total Salaries R |
|---|---|---|---|---|
| Super-intndt | 100% | 1 | 70 000 | 70 000 |
| Snr Operator | 100% | 4 | 39 000 | 156 000 |
| Jnr Operator | 100% | 5 | 32 500 | 162 500 |
| Operating Asst | 0% | 0 | 12 400 | 0 |
| Labourers | 100% | 3 | 12 400 | 37 200 |
| Lab. Techn. | 20% | 1 | 32 500 | 6 500 |
| Mech. Maint. | 20% | 1 | 44 800 | 8 960 |
| Elec. Maint. | 15% | 1 | 44 800 | 6 720 |
| TOTAL | | | | 448 000 |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
REVERSE OSMOSIS
ALTERNATIVE P WITH NO ULTRA-FILTRATION PRETREATEMNT
CHEMICAL USAGE

| | Daily Quantity m^3/d | Dosage Rate mg/l | Annual Quantity tons | Unit Cost R/ton | Total Cost R |
|---|---|---|---|---|---|
| Sulphuric acid | 11 200 | 25 | 91.98 | 300.00 | 27 594 |
| Lime | 5 000 | 20 | 32.85 | 495.00 | 16 261 |
| Sodium bi-Sulphite | 11 088 | 5 | 18.21 | 2 050.00 | 37 335 |
| Flocon ( Anti-Scalant ) | 11 088 | 5 | 18.21 | 9 000.00 | 163 908 |
| Chlorine Raw Water | 11 200 | 5 | 18.40 | 700.00 | 12 877 |
| Chlorine Product Water | 5 000 | 1 | 1.64 | 700.00 | 1 150 |
| TOTAL FOR CHEMICALS | | | | | 259 000 |

MISCELLANEOUS SUPPLIES

| ITEM | Annual Quantity Unit | Unit Cost Unit/a | Total Cost R per unit | R |
|---|---|---|---|---|
| Cartridge Filters | No. | 200.00 | 80.00 | 16 000 |
| Citric acid | Ton | 0.50 | 8 750.00 | 4 375 |
| Detergent | Ton | 2.00 | 7 000.00 | 14 000 |
| Tannic acid | kg | 65.00 | 60.00 | 3 900 |
| TOTAL FOR CONSUMABLES | | | | 38 275 |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
REVERSE OSMOSIS
CALCULATION OF PUMP REQUIREMENTS

ALTERNATIVE P

CALCULATION OF PUMPING REQUIREMENTS

Based on operation at full rated output of 5 000 m^3/d

1 Sea Water Pumps

| | | |
|---|---|---|
| Pumping Rate | 130 | l/s |
| Length of Main | 300 | m |
| Diameter | 288 | mm |
| Friction Head | 3.0 | m |
| Static Head | 10.0 | m |
| Total Head | 13.0 | m |
| Efficiency of Pump | 75.0% | Percent |
| Power Absorbed | 22 | kW |
| Power Installed | 30 | kW |

2 Reverse Osmosis Feed Pumps

| | |
|---|---|
| Pumping Rate | 129 l/s |
| Length of Main | 30 m |
| Diameter | 288 mm |
| Friction Head | 0.3 m |
| Static Head | 60.0 m |
| Total Head | 60.3 m |
| Efficiency of Pump | 75.0%Percent |
| Power Absorbed | 103 kW |
| Power Installed | 110 kW |

3 Reverse Osmosis Pumps

| | | |
|---|---|---|
| Pumping Rate | 129 | l/s |
| Length of Main | 1 000 | m |
| Equivalent Diameter | 280 | mm |
| Friction Head | 11.1 | m |
| Static Head | 550.0 | m |
| Total Head | 561.1 | m |
| Efficiency of Pump | 75.0% | Percent |
| Power Absorbed | 962 | kW |
| Power Installed | 1 260 | kW |

4 Clear Water Pumps

| | |
|---|---|
| Pumping Rate | 58 l/s |
| Length of Main | 25 000 m |
| Diameter | 324 mm |
| Friction Head | 31.2 m |
| Static Head | 45.0 m |
| Total Head | 76.2 m |
| Efficiency of Pump | 75.0%Percent |
| Power Absorbed | 59 kW |
| Power Installed | 75 kW |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
REVERSE OSMOSIS
ALTERNATIVP WITH NO ULTRA-FILTRATION PRETREATEMNT

| YEAR | FLOW | FLOW | CAPITAL | FIXED COSTS | COSTS PROPMAINTNCE TO FLOW COSTS | | TOTAL |
|---|---|---|---|---|---|---|---|
| | m^3/d | Ml/a | R*1000 | R*1000 | R*1000 | R*1000 | R*1000 |
| 1993 | | | | | | | |
| 1994 | | | 6 230 | | | | 6 230 |
| 1995 | | | 42 620 | | | | 42 620 |
| 1996 | 5 000 | 1 643 | | 1 051 | 1 846 | 756 | 3 653 |
| 1997 | 5 000 | 1 643 | | 1 051 | 1 846 | 756 | 3 653 |
| 1998 | 5 000 | 1 643 | | 1 051 | 1 846 | 756 | 3 653 |
| 1999 | 5 000 | 1 643 | | 1 051 | 1 846 | 756 | 3 653 |
| 2000 | 5 000 | 1 643 | | 1 051 | 1 846 | 756 | 3 653 |
| 2001 | 5 000 | 1 643 | | 1 051 | 1 846 | 756 | 3 653 |
| 2002 | 5 000 | 1 643 | | 1 051 | 1 846 | 756 | 3 653 |
| 2003 | 5 000 | 1 643 | | 1 051 | 1 846 | 756 | 3 653 |
| 2004 | 5 000 | 1 643 | | 1 051 | 1 846 | 756 | 3 653 |
| 2005 | 5 000 | 1 643 | | 1 051 | 1 846 | 756 | 3 653 |
| 2006 | 5 000 | 1 643 | | 1 051 | 1 846 | 756 | 3 653 |
| 2007 | 5 000 | 1 643 | | 1 051 | 1 846 | 756 | 3 653 |
| 2008 | 5 000 | 1 643 | | 1 051 | 1 846 | 756 | 3 653 |
| 2009 | 5 000 | 1 643 | | 1 051 | 1 846 | 756 | 3 653 |
| 2010 | 5 000 | 1 643 | | 1 051 | 1 846 | 756 | 3 653 |
| 2011 | 5 000 | 1 643 | 8 650 | 1 051 | 1 846 | 756 | 12 303 |
| 2012 | 5 000 | 1 643 | | 1 051 | 1 846 | 756 | 3 653 |
| 2013 | 5 000 | 1 643 | | 1 051 | 1 846 | 756 | 3 653 |
| 2014 | 5 000 | 1 643 | | 1 051 | 1 846 | 756 | 3 653 |
| 2015 | 5 000 | 1 643 | | 1 051 | 1 846 | 756 | 3 653 |
| 2016 | 5 000 | 1 643 | 17 500 | 1 051 | 1 846 | 756 | 21 153 |
| 2017 | 5 000 | 1 643 | | 1 051 | 1 846 | 756 | 3 653 |
| 2018 | 5 000 | 1 643 | | 1 051 | 1 846 | 756 | 3 653 |
| 2019 | 5 000 | 1 643 | | 1 051 | 1 846 | 756 | 3 653 |
| 2020 | 5 000 | 1 643 | | 1 051 | 1 846 | 756 | 3 653 |
| 2021 | 5 000 | 1 643 | | 1 051 | 1 846 | 756 | 3 653 |
| 2022 | 5 000 | 1 643 | | 1 051 | 1 846 | 756 | 3 653 |
| 2023 | 5 000 | 1 643 | | 1 051 | 1 846 | 756 | 3 653 |
| 2024 | 5 000 | 1 643 | | 1 051 | 1 846 | 756 | 3 653 |
| 2025 | 5 000 | 1 643 | | 1 051 | 1 846 | 756 | 3 653 |
| 2026 | 5 000 | 1 643 | 8 650 | 1 051 | 1 846 | 756 | 12 303 |
| 2027 | 5 000 | 1 643 | | 1 051 | 1 846 | 756 | 3 653 |
| 2028 | 5 000 | 1 643 | | 1 051 | 1 846 | 756 | 3 653 |
| 2029 | 5 000 | 1 643 | | 1 051 | 1 846 | 756 | 3 653 |
| 2030 | 5 000 | 1 643 | | 1 051 | 1 846 | 756 | 3 653 |
| 2031 | 5 000 | 1 643 | | 1 051 | 1 846 | 756 | 3 653 |
| 2032 | 5 000 | 1 643 | | 1 051 | 1 846 | 756 | 3 653 |
| 2033 | 5 000 | 1 643 | | 1 051 | 1 846 | 756 | 3 653 |
| 2034 | 5 000 | 1 643 | | 1 051 | 1 846 | 756 | 3 653 |
| 2035 | 5 000 | 1 643 | | 1 051 | 1 846 | 756 | 3 653 |
| | | | (4 633) | | | | (4 633) |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
REVERSE OSMOSIS
ALTERNATIVE R WITH ULTRA-FILTRATION PRETREATMENT

| | | | |
|---|---|---|---|
| Raw Water Source | Sea Wells Located at Paaltjies | | |
| Raw Water Requirements | 12 500 m^3/d | Pretreatment Losses | 1% |
| Output Capacity of Plant | 5 000 m^3/d | Filtration Losses | |
| Plant Design Factor | 90% | U.F.Plant Losses | 10% |
| Annual Water Production | 1 643 Ml/annum | R.O.Plant Recovery Factor | 45% |

COSTS OF POWER

| | |
|---|---|
| kW Charges/month | 26.50 R/kW/Month |
| Unit Charges | 10.50 c/kWh |

| DEPRECIATION PERIOD | Civils | Mechanical Electrical | Desal & UF Equipment | Membranes U. F. | Membranes R. O. |
|---|---|---|---|---|---|
| Years | 40 | 15 | 20 | 2 | 5 |
| ANNUAL MAINTENANCE FACTORS | 0.50% | 4.00% | 2.00% | | |

PROGRAMMME REQUIIREMENTS

| | |
|---|---|
| Design Tender & Award | 9 Months |
| Construction | 12 Months |
| Start Up Period | 1 Month |

| CAPITAL COSTS (See Page 2) | Civils | Mechanical Electrical | Desal & UF Equipment | Membranes U. F. | Membranes R. O. | Totals |
|---|---|---|---|---|---|---|
| | R*1000 | R*1000 | R*1000 | R*1000 | R*1000 | R*1000 |
| Direct Non Depreciable | 100 | | | | | 100 |
| Direct Depreciable | 12 650 | 8 650 | 18 630 | 930 | 3 000 | 43 860 |
| Indirect | 2 940 | 2 010 | 2 470 | 120 | 400 | 7 940 |
| Start Up Costs | | | | | | 210 |
| TOTAL CAPITAL COSTS | 15 690 | 10 660 | 21 100 | 1 050 | 3 400 | 52 110 |
| MAINTENANCE COSTS | 63 | 346 | 373 | | | 782 |

| ANNUAL RECURRING COSTS | R*1000 |
|---|---|
| Fixed | 1 131 |
| Flow Related (5 000 m^3/d ) | 2 507 |
| TOTAL | 3 638 |

ECONOMIC ANALYSIS

| Discount Rate | 0.0% | 4.0% | 6.0% | 8.0% | 10.0% |
|---|---|---|---|---|---|
| Capital NPV | 83 | 62 | 56 | 51 | 48 |
| Operating NPV | 177 | 81 | 59 | 45 | 36 |
| Total NPV | 260 | 143 | 115 | 96 | 83 |
| Water Produced Discounted | 66 | 30 | 22 | 17 | 13 |
| REFERENCE UNIT VALUE Rand/m^3 | 3.96 | 4.75 | 5.22 | 5.73 | 6.27 |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
REVERSE OSMOSIS
ALTERNATIVE R WITH ULTRA-FILTRATION PRETREATMENT
ESTIMATED CAPITAL COSTS

| DIRECT CAPITAL COSTS | Civils | Mechanical Electrical | Desal & UF Equipment | Membranes U. F. | Membranes R. O. | Totals |
|---|---|---|---|---|---|---|
| Non Depreciable | R*1000 | R*1000 | R*1000 | R*1000 | R*1000 | R*1000 |
| 1 Purchase of Land | 100 | | | | | 100 |
| Depreciable | | | | | | |
| 1 Wellfield | 425 | 275 | | | | 700 |
| 2 Delivery Pipelines | 50 | | | | | 50 |
| 3 Site Development | 200 | 60 | | | | 260 |
| 4 Raw Water Storage (2 000 m^3) | 950 | | | | | 950 |
| 5 Pretreatment Works and Pumpstations | 40 | 55 | 1 130 | 930 | | 2 155 |
| 6 Administrative & Miscellaneous Buildings | 120 | | | | | 120 |
| 7 Desalination Equipment Building (1680 m^2) | 2 520 | | | | | 2 520 |
| 8 Desalination Equipment | | | 17 500 | | 3 000 | 20 500 |
| 9 Product Storage Reservoir (625 m^3) | 445 | | | | | 445 |
| 10 Incoming Power Supply | | 8 060 | | | | 8 060 |
| 11 Product Pipeline & Pumpstation | 7 850 | 200 | | | | 8 050 |
| 12 Brine Pipeline | 50 | | | | | 50 |
| Totals of Depreciable Costs | 12 650 | 8 650 | 18 630 | 930 | 3 000 | 43 860 |
| INDIRECT CAPITAL COSTS | | | | | | |
| Contingencies 10.00%of Net Cost | 1 270 | 870 | 1 860 | 90 | 300 | 4 390 |
| Escalation 0.00%per Month | | | | | | |
| Engineering Fees | | | | | | |
| Civil and Mechanical 12.0% | 1 670 | 1 140 | | | | 2 810 |
| Desalination Equipment 3.0% | | | 610 | 30 | 100 | 740 |
| Totals of Indirect Depreciable Costs | 2 940 | 2 010 | 2 470 | 120 | 400 | 7 940 |

START UP COSTS (Pro Rata on Start Up Period )

| | R*1000 |
|---|---|
| Chemicals | 22 |
| Power | |
| Electrical | 140 |
| Staff | 49 |
| Totals | 211 |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
REVERSE OSMOSIS
ALTERNATIVE R WITH ULTRA-FILTRATION PRETREATMENT
ESTIMATED CAPITAL COSTS
CALCULATION OF ENERGY COSTS

Based on operation at full rated output of 5 000 m^3/d

ELECTRICAL ENERGY

| Component | Absorbed Power kW | Installed Power kW | % Utilisation | Average kWh/day |
|---|---|---|---|---|
| Seawater pumps | 26 | 30 | 90.0% | 568 |
| Ultra-Filtration | 218 | 250 | 90.0% | 4 701 |
| Reverse Osmosis Feed Pumps | 103 | 110 | 90.0% | 2 233 |
| Reverse Osmosis Pumps | 962 | 1 260 | 90.0% | 20 783 |
| Clear Water Pumps | 59 | 75 | 90.0% | 1 270 |
| Totals | 1 368 | 1 725 | | 29 555 |

| | | R*1000 |
|---|---|---|
| Fixed Annual Power costs | | 549 |
| Flow Related Power costs | Electrical Energy | 1 133 |

CALCULATION OF ANNUAL RECURRING COSTS

| | R*1000 |
|---|---|
| FIXED | |
| Salaries and Labour | 448 |
| Labour Overhead ( 30.0%) | 134 |
| Fixed electrical energy costs | 549 |
| Total | 1 131 |
| FLOW RELATED | |
| Power-Electrical | 1 133 |
| Chemicals | 264 |
| Miscellaneous Supplies | 45 |
| U.F.Membrane Replacement ( 2 Yearly) | 465 |
| R.O.Membrane Replacement ( 5 Yearly) | 600 |
| Total | 2 507 |

STAFFING

| | Util | No. | Salary R | Total Salaries R |
|---|---|---|---|---|
| Super-intndt | 100% | 1 | 70 000 | 70 000 |
| Snr Operator | 100% | 4 | 39 000 | 156 000 |
| Jnr Operator | 100% | 5 | 32 500 | 162 500 |
| Operating Asst | 0% | 0 | 12 400 | 0 |
| Labourers | 100% | 3 | 12 400 | 37 200 |
| Lab. Techn. | 20% | 1 | 32 500 | 6 500 |
| Mech. Maint. | 20% | 1 | 44 800 | 8 960 |
| Elec. Maint. | 15% | 1 | 44 800 | 6 720 |
| TOTAL | | | | 448 000 |

CHEMICAL USAGE

| | Daily Quantity | Dosage Rate | Annual Quantity | Unit Cost | Total Cost |
|---|---|---|---|---|---|
| | m^3/d | mg/l | tons | R/ton | R |
| Sulphuric acid | 12 500 | 25 | 102.66 | 300.00 | 30 797 |
| Lime | 5 000 | 20 | 32.85 | 495.00 | 16 261 |
| Sodium bi-Sulphite | 11 125 | 5 | 18.27 | 2 050.00 | 37 459 |
| Flocon ( Anti-Scalant ) | 11 125 | 5 | 18.27 | 9 000.00 | 164 455 |
| Chlorine Raw Water | 12 500 | 5 | 20.53 | 700.00 | 14 372 |
| Chlorine Product Water | 5 000 | 1 | 1.64 | 700.00 | 1 150 |
| TOTAL FOR CHEMICALS | | | | | 264 000 |

MISCELLANEOUS SUPPLIES

| ITEM | Annual Quantity | Unit Cost | Total Cost |
|---|---|---|---|
| | Unit | Unit/a | R per unit | R |
| Cartridge Filters | No. | 200.00 | 80.00 | 16 000 |
| Citric acid | Ton | 1.30 | 8 750.00 | 11 375 |
| Detergent | Ton | 2.00 | 7 000.00 | 14 000 |
| Tannic acid | kg | 65.00 | 60.00 | 3 900 |
| TOTAL FOR CONSUMABLES | | | | 45 275 |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
REVERSE OSMOSIS
WITH ULTRA-FILTRATION PRETREATMENT

ALTERNATIVE R

## CALCULATION OF PUMPING REQUIREMENTS

Based on operation at full rated output of 5 000 m^3/d

### 1 Sea Water Pumps

| | | |
|---|---|---|
| Pumping Rate | 145 | l/s |
| Length of Main | 300 | m |
| Diameter | 288 | mm |
| Friction Head | 3.6 | m |
| Static Head | 10.0 | m |
| Total Head | 13.6 | m |
| Efficiency of Pump | 75.0% | Percent |
| Power Absorbed | 26 | kW |
| Power Installed | 30 | kW |

### 2 Ultra Filtration Pumps

| | |
|---|---|
| Pumping Rate | 143 l/s |
| Length of Main | 20 m |
| Diameter | 288 mm |
| Friction Head | 0.2 m |
| Static Head | 114.0 m |
| Total Head | 114.2 m |
| Efficiency of Pump | 75.0%Percent |
| Power Absorbed | 218 kW |
| Power Installed | 250 kW |

### 3 Reverse Osmosis Feed Pumps

| | | |
|---|---|---|
| Pumping Rate | 129 | l/s |
| Length of Main | 30 | m |
| Diameter | 288 | mm |
| Friction Head | 0.3 | m |
| Static Head | 60.0 | m |
| Total Head | 60.3 | m |
| Efficiency of Pump | 75.0% | Percent |
| Power Absorbed | 103 | kW |
| Power Installed | 110 | kW |

### 4 Reverse Osmosis Pumps

| | |
|---|---|
| Pumping Rate | 129 l/s |
| Length of Main | 1 000 m |
| Equivalent Diameter | 280 mm |
| Friction Head | 11.1 m |
| Static Head | 550.0 m |
| Total Head | 561.1 m |
| Efficiency of Pump | 75.0%Percent |
| Power Absorbed | 962 kW |
| Power Installed | 1 260 kW |

### 5 Clear Water Pumps

| | |
|---|---|
| Pumping Rate | 58 l/s |
| Length of Main | 25 000 m |
| Diameter | 324 mm |
| Friction Head | 31.2 m |
| Static Head | 45.0 m |
| Total Head | 76.2 m |
| Efficiency of Pump | 75.0%Percent |
| Power Absorbed | 59 kW |
| Power Installed | 75 kW |

| YEAR | FLOW | FLOW | CAPITAL | FIXED COSTS | PROPMAINTNCE TO FLOW COSTS | | TOTAL |
|---|---|---|---|---|---|---|---|
| | m^3/d | Ml/a | R*1000 | R*1000 | R*1000 | | R*1000 |
| 1993 | | | | | | | |
| 1994 | | | 6 603 | | | | 6 603 |
| 1995 | | | 45 507 | | | | 45 507 |
| 1996 | 5 000 | 1 643 | | 1 131 | 2 507 | 782 | 4 420 |
| 1997 | 5 000 | 1 643 | | 1 131 | 2 507 | 782 | 4 420 |
| 1998 | 5 000 | 1 643 | | 1 131 | 2 507 | 782 | 4 420 |
| 1999 | 5 000 | 1 643 | | 1 131 | 2 507 | 782 | 4 420 |
| 2000 | 5 000 | 1 643 | | 1 131 | 2 507 | 782 | 4 420 |
| 2001 | 5 000 | 1 643 | | 1 131 | 2 507 | 782 | 4 420 |
| 2002 | 5 000 | 1 643 | | 1 131 | 2 507 | 782 | 4 420 |
| 2003 | 5 000 | 1 643 | | 1 131 | 2 507 | 782 | 4 420 |
| 2004 | 5 000 | 1 643 | | 1 131 | 2 507 | 782 | 4 420 |
| 2005 | 5 000 | 1 643 | | 1 131 | 2 507 | 782 | 4 420 |
| 2006 | 5 000 | 1 643 | | 1 131 | 2 507 | 782 | 4 420 |
| 2007 | 5 000 | 1 643 | | 1 131 | 2 507 | 782 | 4 420 |
| 2008 | 5 000 | 1 643 | | 1 131 | 2 507 | 782 | 4 420 |
| 2009 | 5 000 | 1 643 | | 1 131 | 2 507 | 782 | 4 420 |
| 2010 | 5 000 | 1 643 | | 1 131 | 2 507 | 782 | 4 420 |
| 2011 | 5 000 | 1 643 | 8 650 | 1 131 | 2 507 | 782 | 13 070 |
| 2012 | 5 000 | 1 643 | | 1 131 | 2 507 | 782 | 4 420 |
| 2013 | 5 000 | 1 643 | | 1 131 | 2 507 | 782 | 4 420 |
| 2014 | 5 000 | 1 643 | | 1 131 | 2 507 | 782 | 4 420 |
| 2015 | 5 000 | 1 643 | | 1 131 | 2 507 | 782 | 4 420 |
| 2016 | 5 000 | 1 643 | 18 630 | 1 131 | 2 507 | 782 | 23 050 |
| 2017 | 5 000 | 1 643 | | 1 131 | 2 507 | 782 | 4 420 |
| 2018 | 5 000 | 1 643 | | 1 131 | 2 507 | 782 | 4 420 |
| 2019 | 5 000 | 1 643 | | 1 131 | 2 507 | 782 | 4 420 |
| 2020 | 5 000 | 1 643 | | 1 131 | 2 507 | 782 | 4 420 |
| 2021 | 5 000 | 1 643 | | 1 131 | 2 507 | 782 | 4 420 |
| 2022 | 5 000 | 1 643 | | 1 131 | 2 507 | 782 | 4 420 |
| 2023 | 5 000 | 1 643 | | 1 131 | 2 507 | 782 | 4 420 |
| 2024 | 5 000 | 1 643 | | 1 131 | 2 507 | 782 | 4 420 |
| 2025 | 5 000 | 1 643 | | 1 131 | 2 507 | 782 | 4 420 |
| 2026 | 5 000 | 1 643 | 8 650 | 1 131 | 2 507 | 782 | 13 070 |
| 2027 | 5 000 | 1 643 | | 1 131 | 2 507 | 782 | 4 420 |
| 2028 | 5 000 | 1 643 | | 1 131 | 2 507 | 782 | 4 420 |
| 2029 | 5 000 | 1 643 | | 1 131 | 2 507 | 782 | 4 420 |
| 2030 | 5 000 | 1 643 | | 1 131 | 2 507 | 782 | 4 420 |
| 2031 | 5 000 | 1 643 | | 1 131 | 2 507 | 782 | 4 420 |
| 2032 | 5 000 | 1 643 | | 1 131 | 2 507 | 782 | 4 420 |
| 2033 | 5 000 | 1 643 | | 1 131 | 2 507 | 782 | 4 420 |
| 2034 | 5 000 | 1 643 | | 1 131 | 2 507 | 782 | 4 420 |
| 2035 | 5 000 | 1 643 | | 1 131 | 2 507 | 782 | 4 420 |
| | | | (4 708) | | | | (4 708) |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
REVERSE OSMOSIS
ALTERNATIVE S WITH SINGLE STAGE FILTRATION

| | | | |
|---|---|---|---|
| Raw Water Source | Sea Wells Located near Walvis Bay | | |
| Raw Water Requirements | 11 700 m^3/d | Pretreatment Losses | 1% |
| Output Capacity of Plant | 5 000 m^3/d | Filtration Losses | 4% |
| Plant Design Factor | 90% | U.F.Plant Losses | |
| Annual Water Production | 1 643 Ml/annum | R.O.Plant Recovery Factor | 45% |

COSTS OF POWER

| | |
|---|---|
| kW Charges/month | 26.50 R/kW/Month |
| Unit Charges | 10.50 c/kWh |

| DEPRECIATION PERIOD | Civils | Mechanical Electrical | Desal Equipment | Membranes R. O. |
|---|---|---|---|---|
| Years | 40 | 15 | 20 | 5 |
| MAINTENANCE FACTORS | 0.50% | 4.00% | 2.00% | |

PROGRAMMME REQUIIREMENTS

| | |
|---|---|
| Design Tender & Award | 9 Months |
| Construction | 12 Months |
| Start Up Period | 1 Month |

| CAPITAL COSTS (See Page 2) | Civils | Mechanical Electrical | Desal Equipment | Membranes R. O. | Totals |
|---|---|---|---|---|---|
| | R*1000 | R*1000 | R*1000 | R*1000 | R*1000 |
| Direct Non Depreciable | 100 | | | | 100 |
| Direct Depreciable | 7 935 | 2 795 | 17 500 | 3 000 | 31 230 |
| Indirect | 1 840 | 650 | 2 330 | 400 | 5 220 |
| Start Up Costs | | | | | 190 |
| TOTAL CAPITAL COSTS | 9 875 | 3 445 | 19 830 | 3 400 | 36 740 |
| ANNUAL MAINTENANCE COSTS | 40 | 112 | 350 | | 501 |

| ANNUAL RECURRING COSTS | R*1000 |
|---|---|
| Fixed | 1 051 |
| Flow Related (5 000 m^3/d) | 1 851 |
| TOTAL | 2 902 |

ECONOMIC ANALYSIS

| Discount Rate | 0.0% | 4.0% | 6.0% | 8.0% | 10.0% |
|---|---|---|---|---|---|
| Capital NPV | 58 | 43 | 39 | 36 | 33 |
| Operating NPV | 136 | 62 | 46 | 35 | 28 |
| Total NPV | 194 | 105 | 84 | 70 | 61 |
| Water Produced Discounted | 66 | 30 | 22 | 17 | 13 |
| REFERENCE UNIT VALUE Rand/m^3 | 2.95 | 3.50 | 3.83 | 4.19 | 4.58 |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
REVERSE OSMOSIS
ALTERNATIVE S WITH SINGLE STAGE FILTRATION
ESTIMATED CAPITAL COSTS

| DIRECT CAPITAL COSTS | Civils | Mechanical Electrical | Desal Equipment | Membranes R. O. | Totals |
|---|---|---|---|---|---|
| Non Depreciable | R*1000 | R*1000 | R*1000 | R*1000 | R*1000 |
| 1 Purchase of Land | 100 | | | | 100 |
| Depreciable | | | | | |
| 1 Wellfield | 425 | 275 | | | 700 |
| 2 Delivery Pipelines | 50 | | | | 50 |
| 3 Site Development | 200 | 60 | | | 260 |
| 4 Raw Water Storage (2 000 m^3) | 950 | | | | 950 |
| 5 Pretreatment Works and Pumpstations | 180 | 2 070 | | | 2 250 |
| 6 Administrative & Miscellaneous Buildings | 100 | | | | 100 |
| 7 Desalination Equipment Buildings (1 200 m^2) | 1 800 | | | | 1 800 |
| 8 Desalination Equipment | | | 17 500 | 3 000 | 20 500 |
| 9 Product Storage Reservoir (625 m^3) | 445 | | | | 445 |
| 10 Incoming Power Supply | | 230 | | | 230 |
| 11 Product Pipeline & Pumpstation | 3 735 | 160 | | | 3 895 |
| 12 Brine Pipeline | 50 | | | | 50 |
| Totals of Depreciable Costs | 7 935 | 2 795 | 17 500 | 3 000 | 31 230 |
| INDIRECT CAPITAL COSTS | | | | | |
| Contingencies 10.00%of Net Cost | 790 | 280 | 1 750 | 300 | 3 120 |
| Escalation 0.00%per Month | | | | | |
| Engineering Fees | | | | | |
| Civil and Mechanical 12.0% | 1 050 | 370 | | | 1 420 |
| Desalination Equipment 3.0% | | | 580 | 100 | 680 |
| Totals of Indirect Depreciable Costs | 1 840 | 650 | 2 330 | 400 | 5 220 |

START UP COSTS (Pro Rata on Start Up Period )

| | R*1000 |
|---|---|
| Chemicals | 22 |
| Power | |
| Electrical | 118 |
| Staff | 49 |
| Totals | 189 |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
REVERSE OSMOSIS
ALTERNATIVE S WITH SINGLE STAGE FILTRATION
ESTIMATED CAPITAL COSTS
CALCULATION OF ENERGY COSTS

Based on operation at full rated output of 5 000 m^3/d

ELECTRICAL ENERGY

| Component | Absorbed Power kW | Installed Power kW | % Utilisation | Average kWh/day |
|---|---|---|---|---|
| Seawater pumps | 24 | 30 | 90.0% | 515 |
| Reverse Osmosis Feed Pumps | 103 | 110 | 90.0% | 2 233 |
| Reverse Osmosis Pumps | 962 | 1 260 | 90.0% | 20 783 |
| Clear Water Pumps | 60 | 75 | 90.0% | 1 304 |
| Totals | 1 150 | 1 475 | | 24 835 |

| | | R*1000 |
|---|---|---|
| Fixed Annual Power costs | | 469 |
| Flow Related Power costs | Electrical Energy | 952 |

CALCULATION OF ANNUAL RECURRING COSTS

| | R*1000 |
|---|---|
| FIXED | |
| Salaries and Labour | 448 |
| Labour Overhead ( 30.0%) | 134 |
| Fixed electrical energy costs | 469 |
| Total | 1 051 |
| FLOW RELATED | |
| Power-Electrical | 952 |
| Chemicals | 261 |
| Miscellaneous Supplies | 38 |
| R.O.Membrane Replacement (5 Yearly) | 600 |
| Total | 1 851 |

STAFFING

| | Util | No. | Salary R | Total Salaries R |
|---|---|---|---|---|
| Super-intndt | 100% | 1 | 70 000 | 70 000 |
| Snr Operator | 100% | 4 | 39 000 | 156 000 |
| Jnr Operator | 100% | 5 | 32 500 | 162 500 |
| Operating Asst | 0% | 0 | 12 400 | 0 |
| Labourers | 100% | 3 | 12 400 | 37 200 |
| Lab. Techn. | 20% | 1 | 32 500 | 6 500 |
| Mech. Maint. | 20% | 1 | 44 800 | 8 960 |
| Elec. Maint. | 15% | 1 | 44 800 | 6 720 |
| TOTAL | | | | 448 000 |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
REVERSE OSMOSIS
ALTERNATIVE S WITH SINGLE STAGE FILTRATION
CHEMICAL USAGE

| | Daily Quantity m^3/d | Dosage Rate mg/l | Annual Quantity tons | Unit Cost R/ton | Total Cost R |
|---|---|---|---|---|---|
| Sulphuric acid | 11 700 | 25 | 96.09 | 300.00 | 28 826 |
| Lime | 5 000 | 20 | 32.85 | 495.00 | 16 261 |
| Sodium bi-Sulphite | 11 115 | 5 | 18.26 | 2 050.00 | 37 426 |
| Flocon ( Anti-Scalant ) | 11 115 | 5 | 18.26 | 9 000.00 | 164 307 |
| Chlorine Raw Water | 11 700 | 5 | 19.22 | 700.00 | 13 452 |
| Chlorine Product Water | 5 000 | 1 | 1.64 | 700.00 | 1 150 |
| TOTAL FOR CHEMICALS | | | | | 261 000 |

MISCELLANEOUS SUPPLIES

| ITEM | Unit | Annual Quantity Unit/a | Unit Cost R per unit | Total Cost R |
|---|---|---|---|---|
| Cartridge Filters | No. | 200.00 | 80.00 | 16 000 |
| Citric acid | Ton | 0.50 | 8 750.00 | 4 375 |
| Detergent | Ton | 2.00 | 7 000.00 | 14 000 |
| Tannic acid | kg | 65.00 | 60.00 | 3 900 |
| TOTAL FOR CONSUMABLES | | | | 38 275 |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
REVERSE OSMOSIS
CALCULATION OF PUMP REQUIREMENTS

ALTERNATIVE S

## CALCULATION OF PUMPING REQUIREMENTS

Based on operation at full rated output of 5 000 m^3/d

### 1 Sea Water Pumps

| | | |
|---|---|---|
| Pumping Rate | 135 | l/s |
| Length of Main | 300 | m |
| Diameter | 288 | mm |
| Friction Head | 3.2 | m |
| Static Head | 10.0 | m |
| Total Head | 13.2 | m |
| Efficiency of Pump | 75.0% | Percent |
| Power Absorbed | 24 | kW |
| Power Installed | 30 | kW |

### 2 Reverse Osmosis Feed Pumps

| | | |
|---|---|---|
| Pumping Rate | 129 | l/s |
| Length of Main | 30 | m |
| Diameter | 288 | mm |
| Friction Head | 0.3 | m |
| Static Head | 60.0 | m |
| Total Head | 60.3 | m |
| Efficiency of Pump | 75.0% | Percent |
| Power Absorbed | 103 | kW |
| Power Installed | 110 | kW |

### 3 Reverse Osmosis Pumps

| | | |
|---|---|---|
| Pumping Rate | 129 | l/s |
| Length of Main | 1 000 | m |
| Equivalent Diameter | 280 | mm |
| Friction Head | 11.1 | m |
| Static Head | 550.0 | m |
| Total Head | 561.1 | m |
| Efficiency of Pump | 75.0% | Percent |
| Power Absorbed | 962 | kW |
| Power Installed | 1 260 | kW |

### 4 Clear Water Pumps

| | | |
|---|---|---|
| Pumping Rate | 58 | l/s |
| Length of Main | 15 000 | m |
| Diameter | 288 | mm |
| Friction Head | 33.2 | m |
| Static Head | 45.0 | m |
| Total Head | 78.2 | m |
| Efficiency of Pump | 75.0% | Percent |
| Power Absorbed | 60 | kW |
| Power Installed | 75 | kW |

WALVIS BAY WATER SUPPLY SCHEME
DESALINATION OF SEAWATER
REVERSE OSMOSIS
ALTERNATIVS WITH SINGLE STAGE FILTRATION

| YEAR | FLOW | FLOW | CAPITAL | FIXED COSTS | COSTS PROP TO FLOW | MAINTNCE COSTS | TOTAL |
|---|---|---|---|---|---|---|---|
| | m^3/d | Ml/a | R*1000 | R*1000 | R*1000 | R*1000 | R*1000 |
| 1993 | | | | | | | |
| 1994 | | | 4 393 | | | | 4 393 |
| 1995 | | | 32 347 | | | | 32 347 |
| 1996 | 5 000 | 1 643 | | 1 051 | 1 851 | 501 | 3 403 |
| 1997 | 5 000 | 1 643 | | 1 051 | 1 851 | 501 | 3 403 |
| 1998 | 5 000 | 1 643 | | 1 051 | 1 851 | 501 | 3 403 |
| 1999 | 5 000 | 1 643 | | 1 051 | 1 851 | 501 | 3 403 |
| 2000 | 5 000 | 1 643 | | 1 051 | 1 851 | 501 | 3 403 |
| 2001 | 5 000 | 1 643 | | 1 051 | 1 851 | 501 | 3 403 |
| 2002 | 5 000 | 1 643 | | 1 051 | 1 851 | 501 | 3 403 |
| 2003 | 5 000 | 1 643 | | 1 051 | 1 851 | 501 | 3 403 |
| 2004 | 5 000 | 1 643 | | 1 051 | 1 851 | 501 | 3 403 |
| 2005 | 5 000 | 1 643 | | 1 051 | 1 851 | 501 | 3 403 |
| 2006 | 5 000 | 1 643 | | 1 051 | 1 851 | 501 | 3 403 |
| 2007 | 5 000 | 1 643 | | 1 051 | 1 851 | 501 | 3 403 |
| 2008 | 5 000 | 1 643 | | 1 051 | 1 851 | 501 | 3 403 |
| 2009 | 5 000 | 1 643 | | 1 051 | 1 851 | 501 | 3 403 |
| 2010 | 5 000 | 1 643 | | 1 051 | 1 851 | 501 | 3 403 |
| 2011 | 5 000 | 1 643 | 2 795 | 1 051 | 1 851 | 501 | 6 198 |
| 2012 | 5 000 | 1 643 | | 1 051 | 1 851 | 501 | 3 403 |
| 2013 | 5 000 | 1 643 | | 1 051 | 1 851 | 501 | 3 403 |
| 2014 | 5 000 | 1 643 | | 1 051 | 1 851 | 501 | 3 403 |
| 2015 | 5 000 | 1 643 | | 1 051 | 1 851 | 501 | 3 403 |
| 2016 | 5 000 | 1 643 | 17 500 | 1 051 | 1 851 | 501 | 20 903 |
| 2017 | 5 000 | 1 643 | | 1 051 | 1 851 | 501 | 3 403 |
| 2018 | 5 000 | 1 643 | | 1 051 | 1 851 | 501 | 3 403 |
| 2019 | 5 000 | 1 643 | | 1 051 | 1 851 | 501 | 3 403 |
| 2020 | 5 000 | 1 643 | | 1 051 | 1 851 | 501 | 3 403 |
| 2021 | 5 000 | 1 643 | | 1 051 | 1 851 | 501 | 3 403 |
| 2022 | 5 000 | 1 643 | | 1 051 | 1 851 | 501 | 3 403 |
| 2023 | 5 000 | 1 643 | | 1 051 | 1 851 | 501 | 3 403 |
| 2024 | 5 000 | 1 643 | | 1 051 | 1 851 | 501 | 3 403 |
| 2025 | 5 000 | 1 643 | | 1 051 | 1 851 | 501 | 3 403 |
| 2026 | 5 000 | 1 643 | 2 795 | 1 051 | 1 851 | 501 | 6 198 |
| 2027 | 5 000 | 1 643 | | 1 051 | 1 851 | 501 | 3 403 |
| 2028 | 5 000 | 1 643 | | 1 051 | 1 851 | 501 | 3 403 |
| 2029 | 5 000 | 1 643 | | 1 051 | 1 851 | 501 | 3 403 |
| 2030 | 5 000 | 1 643 | | 1 051 | 1 851 | 501 | 3 403 |
| 2031 | 5 000 | 1 643 | | 1 051 | 1 851 | 501 | 3 403 |
| 2032 | 5 000 | 1 643 | | 1 051 | 1 851 | 501 | 3 403 |
| 2033 | 5 000 | 1 643 | | 1 051 | 1 851 | 501 | 3 403 |
| 2034 | 5 000 | 1 643 | | 1 051 | 1 851 | 501 | 3 403 |
| 2035 | 5 000 | 1 643 | | 1 051 | 1 851 | 501 | 3 403 |
| | | | (2 191) | | | | (2 191) |