Sample Proposal for the Installation of a PROtector Water Treatment Plant

A Guideline for NGO’s and CBO’s
Dear Project Co-ordinator,

If you are in charge of your organisation’s health, hygiene, water & sanitation (watsan) or community development program, then you may well have considered the purchase and installation of a PROtector treatment system. However, in order to implement a PROtector installation, you will first be required to make a formal project proposal that will secure the required funding from prospective donors.

This document has been especially written to provide a guideline for non-government organisations (NGO’s), community based organisations (CBO’s) and other charitable associations interested in acquiring a PROtector water purification system for their various programs. It explains the optimal format and content of a successful proposal, which uses uncomplicated language and numerous illustrations for a clear and effective message. The text boxes shaded in blue provide notes and instructions at frequent intervals, whilst all other text, illustrations, photographs, tables and graphs provide an example of the optimal content.

The most important objective of the proposal is to provide a clear and informative ‘case’ for the need to improve the drinking water supply for a given community, or communities, and that the most feasible solution is to install a PROtector treatment system. The residents living in the community (the ‘beneficiaries’) must be properly identified and represented, with evidence that they have been consulted on both the existing problem, and the proposed solution; and that they agree to uphold their obligations and responsibilities as defined in the ‘Terms of Reference’ chapter.

The proposal must also provide a cost-benefit analysis of the project, using fully justified quantities, values and estimates. All prospective donors will want to know the justification for the requested funds, in terms of the direct and indirect benefit that the residents of the community will receive. This document includes an explanation of how this benefit can be calculated, using a number of ‘variables’ and justified assumptions.

One of the most important things to make clear in the proposal is the breakdown of the funds required, and also an indication of where or whom these funds will be sought from. The philanthropic project investors of PROtector Treatment Systems will make contributions to all humanitarian installations, in accordance with their wish to support the United Nations in achieving the ‘Millennium Development Goals’ (MDG’s).

It should be noted that prospective donors are far more likely to contribute towards the cost of a project when they are approached for 40% of the total amount or less. The ‘applicant’ organisation (i.e. your respective NGO or CBO which will be making the proposal and seeking the funds) should make as many of its own cash and ‘in-kind’ contributions as possible, in order to demonstrate a serious level of dedication to the project.
For all PROtector installations, it is recommended that ownership, operation and maintenance of the system is by the beneficiary community, or by a person or persons duly appointed by the beneficiary community. Ideally, the operation and maintenance of the PROtector will be conducted as a business, whereby treated water is vended to residents of the community in order to generate the funds required for the purchase of replacement parts. This is widely accepted as the most sustainable way of keeping machinery properly looked after, as it does not rely upon the intervention of external organisations. Always remember that with any machinery or equipment, there is no such thing as ‘maintenance free’.

The proposal should be comprised of the following chapters: Executive Summary, Introduction, Project Details, Terms of Reference, Qualification and Experience of Project Personnel, Budget, Project Evaluation, Sustainability, Contact Details and Appendix. Each of these is fully explained throughout the document.

I sincerely hope that you find this document useful in helping to secure the funding for your PROtector installation. If you need any assistance in developing your proposal, please be sure to contact us directly.

Thank you.

Kind regards,

George Rose  
Director of International Programs
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I. EXECUTIVE SUMMARY

Every day, the residents of the Mathare Valley slum in Nairobi, Kenya are exposed to the risk of death and disease from drinking contaminated water. They have to rely upon leaky, illegal connections to the city’s water supply system, which are prone to contamination with raw sewage from nearby open sewers. The average Mathare household cannot afford to pay for ‘legal’, metered connections to the city system, and in any case, the supply is frequently cut off due to Nairobi’s ongoing water rationing regime. Outbreaks of cholera and typhoid are commonplace during the rainy season, when storm water containing concentrated sewage submerges and infiltrates the water supply pipes. Consequently, women such as the one pictured on the front cover are forced to walk long distances carrying buckets and cans in search of clean water elsewhere.

(Name of Applicant Organisation) would like to install a ‘PROtector’ water treatment system on the bank of the polluted Nairobi River, which flows through the middle of the slum, enabling as many as 3000 residents to extract water directly from the river and purify it to a safe and potable standard. The PROtector water treatment system is operated entirely manually, by means of pushing a rotational handle, and it is capable of removing silt, cysts, bacteria, viruses, chemicals and heavy metals from water. There is no need for electricity or fuel in its operation, and it can produce fresh, safe drinking water at a rate of 1,000 litres per hour. The PROtector is simple and robust enough to be operated and owned entirely by the community. The proposed Mathare PROtector installation will provide the following key benefits:

- Water purified directly from Nairobi River
- Treated water 100% safe & compliant with World Health Organization guidelines
- Enough water for 3,000 people per day
- Low Cost - USD $0.02 per 20 litres (5.28 gal)
- Green Tech - No power source required
- Community health and productivity greatly improved, saving 2% GDP per capita, per annum
- Ownership & operation by community
- Opportunity for microenterprise (water kiosk)

The projected net benefit to the beneficiary community (based upon improved health and productivity) is estimated to be USD $200,000.00 over a period of five years. This equates to a return of USD $5.00 for every $1 invested in the project.

It should be noted that many executives on the board of directors of donor organisations are commercially minded business people. Therefore it is important to present the project as a worthwhile investment that will pay for itself and make a ‘return’ for the beneficiary community, rather than just another ‘handout’ for charity.
II. INTRODUCTION

Nairobi is the capital city of Kenya in East Africa. It has a population of approximately 3 million, and is well established as a regional hub for business and culture. However, despite being one of the most prominent cities in Africa, a large proportion of Nairobi’s inhabitants reside within ‘informal’ slum settlements. These include Kibera in the south, Kangemi in the west and Mathare Valley, Nairobi’s oldest slum, in the north-east of the city. Over half a million people are crammed into the shanty village of Mathare, which covers an area just over a mile long and 300 metres wide. Disease is rampant with up to half the residents infected with HIV.

Housing is inadequate with most houses measuring around 2m x 2.5m (8 by 6 feet) made of old tin and mud, holding around 10 people. The single room is divided into different areas where the kitchen, bedroom, living room, and storage areas are located. Many children have to sleep on pieces of cardboard on the dirt floors because there is no space to share the one bed with the parents.

The houses do not have mains electricity, running water or a sewer connection. There are some public toilets shared by up to 100 people but residents have to pay to use them. Those who cannot afford to pay must use the alleys and ditches between the shanties. "Flying toilets" are plastic bags that have been used by the residents as a receptacle for their excrement, which are then thrown into the Nairobi River, which flows through the heart of the slum. Although a plentiful and easily accessible source of water, this river has been made unusable having collected all kinds of litter, refuse and sewage on its journey through the city. Even usage for ‘non-potable’ activities such as doing laundry, washing dishes, and bathing are not possible because the water is so contaminated. Instead of providing a valuable resource, the Nairobi River poses a huge health hazard to the residents of Mathare.
Defining The Problem
The residents of Mathare rely upon a number of illegal connections to Nairobi’s municipal water supply, such as the one pictured below. Although this water is properly treated and chlorinated at source, its freshness and suitability for drinking is extremely dubious by the time it reaches the tap.

This is because the municipal supply pipes that pass through the slum are corroded and leaky, especially at places where the illegal connections have been made, making them vulnerable to contamination from the outside. The following picture shows an illegal connection at a location where the water main crosses an open sewer. The potential for contamination is extremely high.
The picture below shows a location where a buried municipal pipe is leaking water to the ground above. Children are collecting this water to drink, despite the obvious risk of contamination from the dirt, refuse and faecal matter surrounding them.

The picture below shows yet another location where a leaky water main passes directly over an open sewer. During the rainy season, these ‘sewers’ become overwhelmed with surface water, submerging the pipes and allowing faeces, bacteria, viruses and other disease causing pathogens to directly contaminate the supply.
Over the last two years, the municipal water supply company in Nairobi has imposed a water rationing regime across the city. This has been mainly due to the available supply not being able to cope with Nairobi’s rapid expansion and development, but also in response to the increasing number of unpaid illegal connections in the informal settlements. Mathare can be cut off for weeks at a time. The picture below shows a boy trying to find a few drops to drink from a standpipe.

In Mathare, the only alternative water supply is the Nairobi River, which flows from west to east through the centre of the city, and directly through the slum itself. At its source near the Karura forest, to the north-west of Nairobi, the river is relatively clean with a healthy and balanced mineral content. However, once it reaches the city it becomes polluted with dust, soil and surface run-off, giving it a grey, cloudy appearance (see picture below).
By the time the river reaches Mathare (east of the city centre and the industrial area), it has become contaminated with industrial waste, human excrement and general refuse. The contamination is so high that the water has a very dark, almost black colour similar to that that would be found inside a septic tank. The picture below shows a woman crossing the river in Mathare, using some rather precarious stepping stones, carrying a jerry can in search of clean drinking water for her family. She may have to walk up to 2km to find a reliable source, which will most likely be from a private vendor charging in the region of USD $0.20 for a 20 litre jerry can.

An Appeal by the Community
In order to help clearly define the community water problems, and also to prove the desire for intervention, references should be made to accounts of residents describing the severity of the water supply situation: “We have to walk for two or three hours every day to collect clean water. The water from the river is too dirty to use and it makes us sick. We would like to have the means to purify this water so that we can drink it” - Mathare resident, August 2010.

A petition appealing for intervention signed by a number of residents, or a committee appointed by the community, should also be referred to and included in the appendix.

The introduction should offer a comparison between the PROtector and two other water treatment technologies that could be used by the community. This is to help justify the choice of the PROtector as the preferred solution.
Providing a Solution

If the residents of Mathare are to have any chance of working themselves out of poverty, they first of all need a safe, plentiful and affordable source of drinking water: A safe source of water will enable them to be more productive, reducing the occurrence of diarrhoea and thus preventing days off work and costly medical bills; A plentiful source of water will prevent women having to walk for hours every day in search of an alternative source during times of drought or rationing; An affordable source of water will ensure that all residents can acquire the full amount of drinking water they require on a daily basis, without having to worry about the cost.

Many companies and hotels in the Nairobi area have drilled their own private boreholes in order to gain a reliable source of water. However, in most cases the water extracted has a high fluoride and iron content, requiring some form of treatment before being used. With a high capital cost, as well as a high energy cost to continuously pump water from underground, a borehole is not a viable option for the people of Mathare.

The Nairobi River provides an abundant source of water throughout the year, right on the ‘doorstep’ of the Mathare Valley community. Although it is highly contaminated, it must be realised that it is Mathare’s only accessible source of water. Therefore, the treatment of this water for drinking purposes must be given some serious consideration. There are several available technologies pertaining to the treatment of contaminated surface water:

- The PUR Sachet
- Household Ceramic Filters
- The PROtector
- BioSand Filters

The PUR Sachet
The PUR “Purifier of Water” sachet contains a powder that is both a flocculant and disinfectant, which can separate particles and organisms from the water and kill microbes. After administering the powder, shaking and waiting 30mins, the water is then filtered through a cloth to remove the debris. PUR contains ferric sulphate and calcium hypochlorite. It is delivered in small sachets which are priced at USD $0.05 each. One sachet treats 10 litres of water.

Data source: http://www.safewaterintl.org/clearinghouse/chemical/pur/pur-purifier.html

Household Ceramic Filter
The ‘FilterPure’ household filter consists of a round-bottom ceramic pot, made from a mixture of clay, a combustible material (sawdust or rice husks) and colloidal silver. The colloidal silver is a naturally occurring anti-bacterial ingredient which improves the bacteria removal rate of the filter. During the kilning process the combustible material is transformed into a layer of activated carbon, providing millions of silver-impregnated micro-pores. The filter, which is designed with a rim, is placed onto a 20 litre (5 gallon) plastic storage bucket with a spigot at the bottom for dispensing. A lid is placed on the filter to prevent contamination. Safe drinking water is easily poured from the spigot by all members of the household.
The flow rate of the filter is 20 litres per day depending upon the turbidity and sediment content of the raw water. Filters are cleaned by lightly scrubbing the surface whenever the flow rate is reduced, and also by immersing the filter in boiling water every three months to ensure optimum effectiveness. The effective useful life of the filter is 5 years, and the cost is USD $30.00.


**The PROtector**
The PROtector is a self-contained community scale water treatment plant, capable of producing 750 - 1000 litres of purified drinking water per hour. It is operated without the need for electricity or fuel, by means of turning a rotational handle. The handle converts manual energy into the torque required to draw in raw water and pass it through a series of proprietary prefiltration and membrane filtration stages. This treatment process is adequate to remove all contaminants from water to safe and acceptable levels. The capital cost is USD $24,900.00 with an annual maintenance cost of USD $2,500.00.

**BioSand Filters**
It should be noted that many communities and organisations have also considered the use of ‘BioSand’ filters for the treatment of surface water for potable use. These systems are designed on a household scale, using a combination of biological digestion and physical filtration to remove particulate and organic substances from raw water: A ‘biolayer’ of bacteria forms on the surface of the sand, at the top of the filter, which actively digests dissolved organic matter as it passes through; and the sand bed beneath this layer filters out cysts, silt, dust and other colloidal matter. However, as the water produced by the BioSand filter requires post-disinfection with chlorine or by boiling, it cannot be compared with the aforementioned ‘total’ treatment technologies. In order to provide a fair comparison, only the technologies that operate without the need for pre or post treatment have been considered.

**Comparison of Treatment Technologies**
The main consideration when comparing the appropriateness of water treatment technologies is that of cost. This includes the capital cost associated with the purchase of any equipment and/or infrastructure, and also the ongoing cost associated with operation and maintenance.

In order to take into account the long term implications of employing these technologies, their cost of ownership should be projected and compared over a time span of ten years. This can be done using the following methods:

1. By calculating the ‘cost of treated water’, per 20 litre (5 gallon) jerry can, based upon the overall capital cost plus the cost of maintenance over ten years
2. By projecting the total ‘cumulative cost’ as a graph of cost vs. time over a period of ten years

These methods will provide a clear graphical comparison between the relative costs of ownership of each of the three treatment technologies.
Cost of Treated Water
The cost to treat or produce drinking water, in terms of US dollars per 20 litre (5 gallon) jerry can, is widely recognised as the benchmark for the efficiency of a water supply scheme. Using the information from the previous pages, it is possible to calculate and tabulate the efficiency of the three water treatment technologies over a ten year period:

<table>
<thead>
<tr>
<th>Treatment Technology</th>
<th>Initial Capital Cost USD (^1)</th>
<th>Annual Cost of Maintenance USD (^2)</th>
<th>Total Cost for 10 Years USD (^3)</th>
<th>Cost per 20 litre (5 gallon) jerry can USD (^4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PUR Sachet</td>
<td>-</td>
<td>-</td>
<td>$273,750.00</td>
<td>$0.100</td>
</tr>
<tr>
<td>Ceramic Filter</td>
<td>$22,500.00</td>
<td>$2,500.00</td>
<td>$90,000.00</td>
<td>$0.033</td>
</tr>
<tr>
<td>PROtector</td>
<td>$24,900.00</td>
<td>$2,500.00</td>
<td>$47,400.00</td>
<td>$0.017</td>
</tr>
</tbody>
</table>

The following chart has been made using the results from the table above:

1This is the cost to buy enough equipment to provide an output of 15,000 litres per day. This amount is sufficient to supply a community of 3000 people at a rate of 5 litres per capita, per day.

2For the ceramic filter, which requires complete replacement every five years, the cost of annual maintenance has been calculated by dividing the cost of one set of replacement filters by nine years ($22,500.00 / 9 = $2,500.00).

3Total cost for 10 years = Initial capital cost + cost of maintenance for nine years. For PUR Sachet, total cost for 10 years = total number of sachets required throughout the whole period.

4Cost per 20 litre (5 gallon) jerry can = (total cost for 10 years / total litres produced for 10 years) x 20. Total litres produced for 10 years = 15,000 x 365 x 10 = 54,750,000
Cumulative Cost
The following table and corresponding graph show the differences in ‘cumulative cost’ between the three treatment technologies.

<table>
<thead>
<tr>
<th>Year</th>
<th>PUR Sachet</th>
<th>Ceramic Filter</th>
<th>PROtector</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$0.00</td>
<td>$22,500.00</td>
<td>$24,900.00</td>
</tr>
<tr>
<td>1</td>
<td>$27,375.00</td>
<td>$22,500.00</td>
<td>$24,900.00</td>
</tr>
<tr>
<td>2</td>
<td>$54,750.00</td>
<td>$22,500.00</td>
<td>$27,400.00</td>
</tr>
<tr>
<td>3</td>
<td>$82,125.00</td>
<td>$22,500.00</td>
<td>$29,900.00</td>
</tr>
<tr>
<td>4</td>
<td>$109,500.00</td>
<td>$22,500.00</td>
<td>$32,400.00</td>
</tr>
<tr>
<td>5</td>
<td>$136,875.00</td>
<td>$45,000.00</td>
<td>$34,900.00</td>
</tr>
<tr>
<td>6</td>
<td>$164,250.00</td>
<td>$45,000.00</td>
<td>$37,400.00</td>
</tr>
<tr>
<td>7</td>
<td>$191,625.00</td>
<td>$45,000.00</td>
<td>$39,900.00</td>
</tr>
<tr>
<td>8</td>
<td>$219,000.00</td>
<td>$45,000.00</td>
<td>$42,400.00</td>
</tr>
<tr>
<td>9</td>
<td>$246,375.00</td>
<td>$45,000.00</td>
<td>$44,900.00</td>
</tr>
<tr>
<td>10</td>
<td>$273,750.00</td>
<td>$90,000.00</td>
<td>$47,400.00</td>
</tr>
</tbody>
</table>

Cumulative Cost Comparison

Please note that the data used was derived from the information on the previous page.
**Practicality & Durability**

The true comparison between the three technologies is not just down to cost. Practicality and durability must also be considered when gauging their appropriateness. The logistics of training an entire community on the correct procedure to use the PUR sachet could pose quite a challenge, and allowances must be made for ‘user error’ in future. The same may also be said for the household ceramic filter, with regards to the correct maintenance procedure. Furthermore, the ceramic filter is quite fragile and there is a high risk of breakage during routine maintenance. The PROtector has been designed to operate consistently in harsh, tropical environments, and it features its own self-priming pump to draw raw water directly from the river. This means that users do not need to have any physical contact with the raw, dirty water, as they would when using PUR or the ceramic.

**Conclusion**

The graphs on the previous pages show that the PROtector is the most cost effective treatment technology, albeit by a narrow margin when compared to the ceramic filter. However, the PROtector has some clear advantages over the ceramic filter in terms of practicality and durability. The following table summarises the advantages and disadvantages of all three technologies:

<table>
<thead>
<tr>
<th><strong>Treatment Technology</strong></th>
<th><strong>Advantages</strong></th>
<th><strong>Disadvantages</strong></th>
</tr>
</thead>
</table>
| **PUR Sachet**           | • No infrastructure required other than cloth and jerry can  
                           • ‘Point of use’ treatment for freshness | • Very high cost per capita  
                           • All users must be trained on the correct procedure  
                           • All users have to handle raw contaminated water when collecting from the river |
| **Household Ceramic Filter** | • No infrastructure required other than jerry can with spigot  
                               • Low cost per capita  
                               • ‘Point of use’ treatment for freshness | • Fragile and easily breakable  
                               • All users must be trained on the correct maintenance  
                               • All users have to handle raw contaminated water when collecting from the river |
| **PROtector**            | • Operation and maintenance can be carried out by a select few, rather than having to train the whole community  
                           • Low cost per capita  
                           • Strong and durable construction  
                           • Also removes dyes, proteins, surfactants and agro-chemicals  
                           • Pumps and treats raw water directly from river, preventing users from handling contaminated water | • Requires some infrastructure for installation (soakaway and concrete platform)  
                           • Requires manual effort in operation |
The project details should include the technical specifications of the PROtector system, as well as details of construction, installation and maintenance of the machine. Project details should also include a comprehensive cost-benefit analysis of the project.

III. PROJECT DETAILS

Having determined the PROtector to be the most appropriate treatment technology for the purification of the Nairobi River, the details of the design, installation and maintenance of the machine need to be established. The cost-benefit analysis of the proposed project investment will also be outlined. The following annotated picture shows the operation of the machine and the position of the controls, gauges, intake and outlets:

**Design & Construction of the PROtector**

The self priming PROtector draws in raw water and passes it through several stages of proprietary pre-filtration and pressure regulation, before entering a membrane filtration stage. By the time the water enters the membrane filtration stage, it meets all the criteria necessary for optimal filtration. The unit features a rotational drive mechanism, transforming manual effort into the torque required to drive the system. The PROtector can raise water from as deep as 8.5m (28ft). The following flow diagram shows the treatment process contained within the PROtector:
What is Membrane Filtration?

Membrane filtration is a treatment process that separates many types of large molecules and ions (associated with salts and dissolved contaminants) from pure water. The process works by applying pressure to the contaminated water on one side of a semi-permeable membrane. The result is that a brine containing the dissolved contaminants (known as ‘concentrate’) is retained on the pressurized side of the membrane, and the purer water (known as ‘permeate’) is allowed to pass through to the other side. The diagram below shows the membrane separation process:

![Membrane Filtration Diagram]

In membrane filtration, pore sizes can vary from 0.1 to 5,000 nanometres (nm) depending on the filter type. ‘Particle filtration’ removes particles of 1,000nm or larger. Microfiltration removes particles of 50nm or larger. ‘Ultrafiltration’ removes particles of roughly 3nm or larger. ‘Nanofiltration’ removes particles of 1 nm or larger. Reverse osmosis is in the final category of membrane filtration, ‘hyperfiltration’, and it removes particles larger than 0.1nm. This level of filtration is adequate to remove salts, metals and other dissolved contaminants such as fluoride and arsenic.

The membranes used in the PROtector are selected according to the quality of the raw water to be treated, and the nature of the contaminants that need to be removed. For brackish water applications, or where fluoride is excessive, RO membranes rated for brackish water treatment (BWRO) are used. For turbid surface water applications where industrial / agricultural run-off is an issue, or where organic waste may be present, Nanofiltration (NF) membranes are selected. Both RO and NF membranes are able to remove bacteria, viruses and protozoa from water. However, only RO is able to treat water with an excessive salt and/or fluoride content to a safe and acceptable standard.

The membranes used in the PROtector are selected according to the quality of the raw water to be treated, and the nature of the contaminants that need to be removed. For brackish water applications, or where fluoride is excessive, RO membranes rated for brackish water treatment (BWRO) are used. For turbid surface water applications where industrial / agricultural run-off is an issue, or where organic waste may be present, Nanofiltration (NF) membranes are selected. Both RO and NF membranes are able to remove bacteria, viruses and protozoa from water. However, only RO is able to treat water with an excessive salt and/or fluoride content to a safe and acceptable standard.
General Specification of PROtector

Treated water output: 750 – 1,000 litres per hour (3 – 4.4gpm)*

Permeate recovery rate: 50 – 75%

Salt & mineral rejection rate: 50 - 99% (according to level of treatment required)

Maximum suction depth: 8.5m (28ft)

Rotational Drive System

As maintenance may not take place on a regular basis, all drive components are industrially coated, and/or designed to meet Marine Quality standards. This also allows the systems to be installed in the harshest of environments, where conditions such as high humidity and even salt spray will not pose a problem.

Membranes Elements

- The RO and NF membrane elements are of a spiral wound design and are manufactured of the highest quality materials.
- High quality reinforced membrane housings withstand extremely high pressure.
**Installation of the PROtector**
The PROtector is installed onto a circular concrete pad, 7m (23ft) in diameter, close to the riverbank. This is large enough to accommodate both the machine and the circular path around it, used by those operating the rotational handle. The intake hose with protecting ‘basket’ screen is lowered into the river, secured inside a length of PVC or concrete pipe which is firmly anchored to the riverbank. The waste concentrate hose is directed to a soakaway situated along the riverbank, downstream of the intake, and freshly treated ‘product’ water is dispensed on a small concrete platform adjacent to the circular pad. Please refer to the appendix for detailed installation diagrams.

![Installation of PROtector](image1)

**Maintenance of the PROtector**
Maintenance of the PROtector essentially consists of ‘chemical flushing’ the RO or NF membranes. Every few weeks, the membranes are flushed through with a citric acid solution, to ensure that any mineral deposits or bacterial growth that may accumulate on the surface of the membranes are safely broken down and flushed away, in order to prevent ‘fouling’. The cost of replacement membranes and other components works out at approximately USD $2,500 per annum.

![Maintenance of PROtector](image2)
**Cost - Benefit Analysis**

In addition to the immediate ‘human’ costs of a lack of access to clean water and sanitation, there is also a wider economic cost to consider. The costs associated with medical bills, loss of productivity and labour diversions are greatest in some of the poorest countries.

It has been estimated that Sub-Saharan Africa loses about 5% of GDP, or approx. USD $28.4 billion annually – a figure that exceeds the total aid flows and debt relief to the region in 2003 (United Nations Human Development Report 2006). It therefore follows that any scheme that physically improves sustainable access to water or sanitation for a community or communities will have a quantifiable economic value.

The countries of Sub-Saharan Africa are fairly widespread in terms of economic wealth, with their individual GDP’s ranging from USD $190 through to USD $1,370 per capita, per annum. Therefore, the relative cost of a lack of clean water and sanitation, expressed as a percentage of GDP, is also widespread across these countries. Proportionately, the cost is higher in the poorer nations, and lower in the richer nations. The following table provides a guideline for the approximate cost of a lack of clean water and sanitation in Sub-Saharan African nations, expressed as a percentage of GDP across a range of GDP per capita values:

<table>
<thead>
<tr>
<th>National GDP (USD per capita, per annum)</th>
<th>Annual Cost (% GDP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>150 - 300</td>
<td>6.0%</td>
</tr>
<tr>
<td>301 - 450</td>
<td>5.0%</td>
</tr>
<tr>
<td>451 - 600</td>
<td>4.0%</td>
</tr>
<tr>
<td>601 - 750</td>
<td>3.0%</td>
</tr>
<tr>
<td>751 - 900</td>
<td>2.0%</td>
</tr>
<tr>
<td>901 - 1050</td>
<td>1.0%</td>
</tr>
<tr>
<td>&gt;1050</td>
<td>0.5%</td>
</tr>
</tbody>
</table>

In order to scrutinise the validity of this data, let’s look at the Mathare Valley case study, as referred to in chapters 1 and 2 of this sample proposal:

- The average monthly household income in Mathare = USD $45 (USD $2.20 per day)
- The medical bill to treat a bout of diarrhoeal sickness costs USD $13
- The total cost of a bout of sickness therefore costs one day’s loss of earnings at $2.20, plus a medical bill of $13 = $15.20
- For 750 households, the total cost of one bout of sickness = USD $11,400.00
- Assuming a conservative ‘sickness frequency’ of four bouts of illness, per household, per year, the total annual cost of diarrhoeal sickness for 750 households = **USD $45,600.00**
- The GDP of Kenya = USD $800 per capita, per annum
- The number of beneficiaries for a River PROtector installation in Mathare Valley = 3000 (or 750 households at 4 persons per household)
- 2% GDP multiplied by 3000 persons = **USD $48,000.00**, which is consistent with the above
The data on the previous page can also be used to formulate a ‘cost-benefit forecast’ for the project, which will graphically compare the projected ‘cumulative cost’ with the ‘cumulative benefit’ over a period of five years:

### Project Details

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount USD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kenya GDP</td>
<td>$30,400,000,000.00</td>
</tr>
<tr>
<td>GDP / Capita</td>
<td>$800.00</td>
</tr>
<tr>
<td>Loss of Productivity @ 2% GDP / Capita</td>
<td>$16.00</td>
</tr>
<tr>
<td>Annual Benefit = Loss of Productivity x Project Beneficiaries (4000)</td>
<td>$48,000.00</td>
</tr>
<tr>
<td>Annual Cost = Cost of Maintenance</td>
<td>$2,500.00</td>
</tr>
<tr>
<td>Initial Cost of Project Implementation</td>
<td>$30,000.00</td>
</tr>
<tr>
<td>Total Project Benefit for 5 Years</td>
<td>$240,000.00</td>
</tr>
<tr>
<td>Total Project Cost for 5 Years</td>
<td>$40,000.00</td>
</tr>
<tr>
<td>Net Benefit over 5 Years</td>
<td>$200,000.00</td>
</tr>
</tbody>
</table>

### Cost - Benefit Forecast

The forecast provides a quick visual reference for the time taken for the project to pay for itself (the time where the lines cross) and also the ‘Net Benefit’ (the difference between the lines) as time progresses.
IV. TERMS OF REFERENCE

Project Objectives

1. To provide the beneficiary community with sustainable access to clean, safe drinking water

2. To improve the health and productivity of the beneficiary community, by preventing diarrhoeal sickness and waterborne disease

3. To contribute towards the achievement of Millennium Development Goal (MDG) Target 7c “To reduce by half the proportion of people without access to safe drinking water and basic sanitation”.

4. To contribute towards the achievement of Millennium Development Goal (MDG) Target 7d “To achieve significant improvement in the lives of at least 100 million slum dwellers, by 2020”.

The terms of reference provide a clear guideline on the objectives of the project; the identity of the project stakeholders and their individual roles and responsibilities; and the schedule of activities and timescale for the implementation of the project.
### Project Stakeholders and their Responsibilities

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Roles &amp; Responsibilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>PROtector Systems</td>
<td>To liaise with the applicant organisation on the application of a PROtector system to their project or program; To assist the applicant organisation in making a formal project proposal; To ensure that the design of the PROtector satisfies all relevant criteria; To manufacture, supply and install the PROtector; To provide guidance and training on the operation and maintenance of the PROtector; To fully co-operate with the applicant organisation during installation, guidance, training and monitoring of the equipment in the field; To co-operate with the applicant organisation in setting up a supply chain of replacement parts</td>
</tr>
<tr>
<td>Applicant Organisation</td>
<td>To provide evidence that the beneficiary community has requested the help of the applicant organisation to improve their access to safe and sustainable drinking water; and also to provide evidence that the beneficiary community has agreed to the purchase and installation of a PROtector system; To co-ordinate the sourcing and application for all funds required for the project; To purchase the PROtector on behalf of the beneficiary community; To facilitate the installation of the PROtector in the field; To facilitate the guidance and training of community members and/or elected personnel on the operation and maintenance of the PROtector; To conduct the monitoring of the PROtector in the field, including sampling and analysis of product water and collating feedback from residents; To assist the community with maintenance of the PROtector if and when required</td>
</tr>
<tr>
<td>Sponsors &amp; Donors</td>
<td>To provide the applicant organisation with clear guidelines on how to apply for funding; To assist in the funding of the project, with monies payable to the applicant organisation</td>
</tr>
<tr>
<td>Beneficiary Community</td>
<td>To co-operate with PROtector Systems and the applicant organisation in the installation and commissioning of the PROtector, and also throughout the guidance, training and monitoring process; To liaise with the applicant organisation to appoint personnel who will take responsibility for operating and maintaining the unit; To ensure that the appointed personnel honour their responsibility to the community in operating and maintaining the unit properly;</td>
</tr>
</tbody>
</table>
Schedule of Activities & Timescale

<table>
<thead>
<tr>
<th>Project Stage</th>
<th>Action Required</th>
<th>Time &amp; Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Funding &amp; Purchasing</td>
<td>Funding sought from prospective sponsors and donors</td>
<td>Week 1 (8 weeks)</td>
</tr>
<tr>
<td></td>
<td>Purchase order raised for the supply and installation of a PROtector water treatment system</td>
<td>Week 9 (2 weeks)</td>
</tr>
<tr>
<td>Fabrication &amp; Shipping</td>
<td>Construction and factory testing of PROtector</td>
<td>Week 11 (6 weeks)</td>
</tr>
<tr>
<td></td>
<td>Shipping, clearing and forwarding of equipment to site</td>
<td>Week 17 (8 weeks)</td>
</tr>
<tr>
<td></td>
<td>Site preparation*</td>
<td>Week 25 (1 week)</td>
</tr>
<tr>
<td>Installation &amp; Commissioning</td>
<td>Installation of unit and connection of all hoses</td>
<td>Week 26 (1 day)</td>
</tr>
<tr>
<td></td>
<td>Operational training for community stewards and any personnel from the Applicant Organisation</td>
<td>Week 26 (1 week)</td>
</tr>
</tbody>
</table>

The Qualification & Experience of Project Personnel chapter is intended to identify the key personnel who will be involved in the implementation of the project, and to give an overview of their qualification, experience and authority to undertake their various responsibilities as laid out in the terms of reference.

V. QUALIFICATION & EXPERIENCE OF PROJECT PERSONNEL

PROtector Treatment Systems

PROtector Treatment Systems is a collaboration between Green Commercial Group, LLC and Environmental Products of Minnesota, INC. All equipment manufactured under the PROtector Treatment Systems brand is especially designed and built for use in developing countries with harsh, tropical climates. Please refer to the appendix for a case study of a PROtector installation in Kenya.

Jim Ellis – Product Designer & Chief Commissioning Engineer

Jim has over 32 years of experience in the design and fabrication of environmental systems, including equipments for membrane water filtration, heat recovery, air filtration and dust collection. Over the years, he has designed, fabricated and installed over 500 customised aeration, air filtration and air handling systems. Jim has also designed a groundbreaking Vertical Axis Wind Turbine that is silent, and requires almost zero maintenance.
George Rose – Product Consultant & Project Engineer
George has over 12 years of experience in the capacity of project engineer and consultant for a range of infrastructure improvement schemes. His focus is on water treatment and he has provided design and recommendations for a number of new and existing plants in Kenya. George has conducted a great deal of research into sustainable water treatment technology for rural communities, with an emphasis on salt and fluoride removal from contaminated groundwater.

The Applicant Organisation section should contain a description of the applicant organisation’s identity, history, activities and geographical influence. Special mention should be given to any ongoing water and sanitation (watsan) program that this project may be a part of. You should also cover the following areas:

**Program Manager / Co-ordinator – Applicant Organisation**
A brief biography of the Program Manager / Co-ordinator or equivalent from the applicant organisation should be made here.

**Field Engineer / Technician – Applicant Organisation**
A brief biography of the Field Engineer / Technician or equivalent from the applicant organisation should be made here.

**Appointed Steward(s) – Beneficiary Community**
The identity of the steward(s) who have been duly appointed by the beneficiary community to operate and maintain the River PROtector should be made here. Evidence of their election, authority and understanding of the community needs should also be provided.

**Applicant Organisation**
Insert text here.

**Program Manager / Co-ordinator – Applicant Organisation**
Insert text here.

**Field Engineer / Technician – Applicant Organisation**
Insert text here.

**Appointed Steward(s) – Beneficiary Community**
Insert text here.
The Project Budget should be laid out as a balance sheet between projected funding and expenses. It should identify precisely whom the required funds will be sourced from, and indicate any remaining balance that has yet to be sought from other donors. It should also provide a clear breakdown of the allocation of required funds, so that prospective donors can see exactly how the money will be spent. The following provides a basic example of the format for the project budget, although in practice it should be detailed with as many specific items as possible:

**VI. BUDGET**

<table>
<thead>
<tr>
<th>Project Funding</th>
<th>Amount (USD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applicant Organisation</td>
<td>$10,000.00</td>
</tr>
<tr>
<td>Local Sponsors / Donors</td>
<td>$5,000.00</td>
</tr>
<tr>
<td>Beneficiary Community</td>
<td>$1,000.00</td>
</tr>
<tr>
<td><strong>Total Funding</strong></td>
<td><strong>$16,000.00</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Project Expenses</th>
<th>Amount (USD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purchase of PROtector M2-N Water Purification Plant</td>
<td>-$24,900.00</td>
</tr>
<tr>
<td>Shipping of Equipment from MN, USA</td>
<td>-$1,500.00</td>
</tr>
<tr>
<td>Customs Clearing of Shipment</td>
<td>-$600.00</td>
</tr>
<tr>
<td>Installation &amp; Commissioning of Plant (Including O&amp;M Training)</td>
<td>-$2,000.00</td>
</tr>
<tr>
<td>Cost of Groundworks &amp; Community Preparation</td>
<td>-$1000.00</td>
</tr>
<tr>
<td><strong>Total Expenses</strong></td>
<td><strong>-$30,000.00</strong></td>
</tr>
</tbody>
</table>

**Balance Sought From Donors (Expenses less income)** $14,000.00

**Please Note:** The expenses outlined above are standard for any PROtector installation, anywhere in the world. However, for each individual installation there will be a number of additional expenses, such as the initial research undertaken by the applicant organisation to locate a suitable beneficiary community; the consultation with the beneficiary community; and any administrative costs incurred in these activities (including use of vehicles, fuel and other resources). All of these activities have a value, and they should be listed accordingly as part of the project expenses. The applicant organisation should then pledge this total amount as an ‘in kind’ contribution and itemise as part of the project funding.
VII. PROJECT EVALUATION

Success Factors
The following table lists a number of success factors for the installation of a PROtector, with reference to the relevant project objective and the way in which the level success can be assessed:

<table>
<thead>
<tr>
<th>Success Factor</th>
<th>Relevant Project Objective</th>
<th>Method of Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality of treated water is compliant with WHO drinking water standards</td>
<td>1. To provide the beneficiary community with sustainable access to clean, safe drinking water</td>
<td>Frequent sampling and analysis of product water for physical, chemical and bacteriological quality. Also ask whether community members can see and taste the difference.</td>
</tr>
<tr>
<td>Quantity of treated water produced is enough for the drinking and cooking requirements of the community</td>
<td>1. To provide the beneficiary community with sustainable access to clean, safe drinking water</td>
<td>Frequent assessment of time taken to fill one 20 litre jerry can, and number of jerry cans filled in an hour. Also, frequent record of water meter readings to assess average daily, weekly and monthly usage.</td>
</tr>
<tr>
<td>The PROtector equipment is strong and durable enough to cope with the daily level of use</td>
<td>1. To provide the beneficiary community with sustainable access to clean, safe drinking water</td>
<td>Record of any ‘non-routine’ repairs required to keep machine working, and record of number of days per month where machine is not working due to breakdown.</td>
</tr>
<tr>
<td>The PROtector is cost effective to own and maintain, costing no more than USD $2,500.00 per annum in replacement filters / membranes</td>
<td>1. To provide the beneficiary community with sustainable access to clean, safe drinking water</td>
<td>Record of the frequency of replacing filters and membranes, with corresponding costs for one year.</td>
</tr>
<tr>
<td>The beneficiary community are healthier and more productive as a result of drinking clean, safe water</td>
<td>2. To improve the health and productivity of the beneficiary community, by preventing diarrhoeal sickness and waterborne disease</td>
<td>From the time of project implementation, the number of cases of diarrhoeal sickness in the community should be monitored over a period of one year, and compared to the previous year. Any cases of other waterborne disease should also be monitored and compared in the same way.</td>
</tr>
</tbody>
</table>
Risks & Restraints

<table>
<thead>
<tr>
<th>Project Risks</th>
<th>Mitigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>The beneficiary community do not accept the PROtector</td>
<td>Allow for adequate consultation with the community at the planning stages of the project, to ensure that they are in full agreement.</td>
</tr>
<tr>
<td>The PROtector is not able to purify the source water to the WHO drinking water standard</td>
<td>Ensure that adequate information regarding the source water is relayed to PROtector Treatment Systems. This should ideally include photos and a water quality lab report.</td>
</tr>
<tr>
<td>Community members are not able to undertake the necessary maintenance of the PROtector</td>
<td>Ensure that the community are briefed on the need to appoint persons who will be responsible for operating and maintaining the River PROtector. The appointed persons will receive adequate training upon commissioning of the installation.</td>
</tr>
<tr>
<td>Components and parts of the PROtector are stolen following installation and commissioning</td>
<td>Ensure that the community adopts a good sense of ownership of the machine, and an understanding of its value in the benefits it is bringing to all of them. In any case, the machine does not feature any ‘attractive’ components such as electric motors or solar panels that would have a lucrative local resale value.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Project Restraints</th>
<th>Consideration</th>
</tr>
</thead>
<tbody>
<tr>
<td>The maximum depth of water that can be reached by the PROtector is 8.5m</td>
<td>Ensure that the chosen installation site is not more than 8.5m above the surface of the source water to be treated. Any seasonal fluctuations in water level should also be considered, so that the water is always ‘in reach’.</td>
</tr>
<tr>
<td>The maximum output of treated water produced by the PROtector is 1000 litres per hour</td>
<td>According to WHO, the minimum daily availability of potable water should be 5 litres per person. Therefore, based upon 15 hours of continuous use (from 5am – 8pm), the maximum ‘design’ population that can be served by one PROtector is 3000.</td>
</tr>
</tbody>
</table>
Managing Changes in the Project Environment

The PROtector is designed and constructed to remain strong and durable, with consistent performance in the harshest of environments. However, there are two main points to consider with regards to changes in the project environment:

1. Size of Population
2. Source of Raw Water

Size of Population
As mentioned in the project restraints, the maximum ‘design’ population that can be served by the PROtector is 3000, based upon 15 hours’ continuous daily operation at an output of 1000 litres per hour. The ‘design’ population of the community to be served should be clearly indicated from the beginning of the project. If the population grows much beyond this, and the demand for water produced by the PROtector becomes too great, then a second installation should be considered.

Source of Raw Water
The PROtector has been designed to treat either contaminated groundwater, or polluted surface waters such as rivers, streams and lakes that are contaminated with sediment, organic matter and agro-chemicals. If it is decided that the community wishes to change the source of raw water originally selected, then a water quality report of the new source will be required. This is because the mineral content of the water will need to be assessed, in order to determine whether nanofiltration (NF) or reverse osmosis (RO) membranes should be selected.
The sustainability of the project is reliant upon the commitment of the beneficiary community, and to some extent the applicant organisation, in ensuring that the River PROtector is properly operated and maintained for years to come, long after the initial funds have been made available by the prospective donors. In order to ensure such long term success, a number of

**VIII. SUSTAINABILITY**

**Ownership of the PROtector**

Although the PROtector will be initially purchased by the applicant organisation, it will be the property of the beneficiary community. As such, it should be considered to be a valuable and essential piece of infrastructure, an asset to be looked after. If the community accepts this, then they will ensure that it is well looked after for a very long time.

**Operation of the PROtector**

Operation of the machine will be conducted by the members of the community themselves, and/or by persons duly elected by the community to operate it on their behalf. Ideally, the water produced by the machine will be vended to the members of the community at an agreed price; with the revenue collected used to raise funds for any employment of those persons operating the machine, and also to purchase replacement filters and membranes as and when required.

**Training**

Training of the elected persons on the operation and maintenance of the machine will be conducted by personnel from PROtector Treatment Systems, as part of the installation and commissioning procedure. The training will include instruction on routine maintenance, as well as troubleshooting.

**Maintenance of the PROtector**

Maintenance of the machine will be carried out by the elected persons from the community, who will utilise funds from the revenue raised in water vending to afford the replacement filters and membranes. The elected persons will be equipped with all tools and materials required to conduct maintenance activities.

**Availability of Spare Parts**

As part of the installation and commissioning process, personnel from PROtector Treatment Systems will help to set up a local supply chain for the purchase of replacement filters and membranes. As there are no ‘proprietary’ replacement parts or components used inside the machine, the sourcing of replacement items is straightforward. All of the filters and membranes are of standard specification, available from a number of manufacturers worldwide.
Technical Support
Personnel from PROtector Treatment Systems will offer technical support to members of the community and the applicant organisation by telephone and email. Any ‘non-routine’ repairs or alterations will be organised by PROtector Treatment Systems directly.

For a regional ‘roll-out’ program, whereby a number of PROtector machines have been installed simultaneously throughout a specific region, PROtector Treatment Systems will establish a central technical support team.

Contact details should be provided for the following persons:

Program Manager / Co-ordinator – Applicant Organisation
Name, address, telephone numbers and email address

Appointed Steward(s) – Beneficiary Community
Name(s), address(es), telephone numbers and email address(es)

IX. CONTACT DETAILS

Program Manager / Co-ordinator – Applicant Organisation
Insert text here.

Appointed Steward(s) – Beneficiary Community
Insert text here.

Project Engineer – PROtector Treatment Systems
George Rose
21 Surrey Street,
Arundel, West Sussex,
BN18 9DT
United Kingdom
Tel. +44 (0)1903 884768
Email: george.rose@protectorsystems.com
Website: http://protectorsystems.com
The appendix should include any reports or material referred to in the main body of the proposal, such as:

**Engineering Drawing of PROtector**
Showing the various dimensions of the machine, and the general arrangement

**Installation Case Study for PROtector**
To show evidence of an existing installation in Sub-Saharan Africa, and give a detailed description of the installation procedure

**Humanitarian Reports / Research Specific to Community and Region**
To back up any facts or figures referred to in the main body of the proposal, and/or to provide further insight into the idiosyncrasies of the beneficiary community, their culture and their environment

**Evidence of Liaison between Applicant Organisation and Beneficiary Community**
Such as minutes and photos from meetings, signed petitions, and personal accounts from community members

**X. APPENDIX**