World Water Forum College Grant Program
2007 Grant Proposals

College	Occidental College
Faculty	Dr. Adrian Hightower
Project	A Study on Applying Solar-Powered Membrane Filtration Systems to the Treatment of Malian Ground Water

11. PROPOSAL CONTENT REQUIREMENTS FOR **APPLICATION**

Responses to this RFP must provide all of the information requested below.

A.

College	Occidental College
Address	1600 Campus Road
City, State, Zip Code	Los Angeles, CA, 90041
Website	www.oxy.edu
Make Check Payable To:	Name College Foundation (if applicable): Occidental College

Note: All checks will be made payable to the community college or university of the grantee.

B.

Applicant	Check One
First Time – Local Project	
First Time – Global Project	X
Existing Project – Local Focus	
Existing Project – Global Focus	

C.

Student Project Manager	Amanda Lounsbury
Undergraduate or Graduate	Undergraduate
Department	Physics
School Address	1600 Campus Road, Los Angeles, CA 90041
Telephone	**(323)** 259-1414
Mobile Phone	
Email Address	alounsbury@oxy.edu
Home Address (optional)	

D.

Faculty Project Manager	Adrian Hightower
Department	Physics
School Address	1600 Campus Road, Los Angeles, CA 90041
Telephone	323-259-2826
Mobile Phone	213-447-3363
Email Address	hightower@oxy.edu
Home Address (optional)	1577 Glen Aylsa Ave, Los Angeles, CA 90041

Note: The faculty member must be a part time or full time employee of the grantee's college. This person will serve as the project liaison and signatory on the contract between MWD and the college or university.

E.

Organizational Background (1 – 2 pages):

Provide a brief history and overall description of your school and department(s) conveying a clear understanding of its mission and goals. This should include a brief description of other relevant projects developed (if applicable).

F. PROJECT DESCRIPTION (3 – 5 PAGES)

Provide a detailed business plan identifying all project activities. It is required that the proposed work plan address one or more of the following:

- What is the anticipated outcome of your research? An outcome may be short-term (i.e., changes in knowledge or attitude) or long-term (i.e., changes in condition of natural resources).
- Where will the research and data collection take place?
- Describe your team's experience and technical capabilities (including in-house and/or outside hired individuals) to accomplish the project. List the roles and responsibilities of each team member.
- Provide a project schedule with key milestone dates and deliverables with measurable outcomes.

Describe expected benefits to regional water supply including how the innovative idea enhances potential water supply sources and their quality for Metropolitan's service area.

Or

Provide examples where this proposed project enhances at least one of the following factors in providing applicability to a developing region:

- Addresses an immediate water supply and/or quality concern
- Adaptability within a developing region's cultural, political and economic conditions
- Creates a strategic communication outreach plan to implement conservation education and change

Section E: Organizational Background

In response to the United Nations International Decade for Action "Water for Life", Occidental College proposes to demonstrate a prototype Multifunctional Solar-Powered Membrane Filtration system (MFSPMF) to convert Malian brackish water to potable water. Occidental College seeks investigate technical strategies to make established pressure-driven membrane filtration systems accessible to rural Malian communities. This work builds on an existing collaboration with the University of Bamako, Mali to move their laboratory pressure-driven membrane filtration system into a rural community. While the MFSPMF project has specific goals in the area of international development of water resources, the underlying theme of this project is educational. Thus this proposal on MFSPMF is used as a vehicle to increase the population of a technically skilled labor force in Mali and in the U.S. with a particular focus on underrepresented students. This proposal draws on the talents of academic and industrial partners both domestic and international. Team members have been assembled from PALL Corporation, University of Bamako, the University of Texas at Austin, the Mali Folk Center, Los Angeles City College and Occidental College. Team efforts will be coordinated by Prof. Adrian Hightower of the Occidental College Physics department who has worked in renewable energy education programs in Mali for the past six years and has develop renewable energy curriculum based on the pedagogy of "Community Based Learning". The organization of this collaboration is described below.

Occidental College

Prof. Hightower will mentor a group of Occidental and Los Angeles City College students to develop a theoretical model to analyze the energy utilization and performance of a MFSPMF. This model will be compared with an existing laboratory prototype in the Chemical Engineering Department at the Faculte' des Science et Techniques (FAST), University of Bamako, Mali. Occidental College will focus on determining the most cost effective solar panel size and pumping system to drive a rural MFSCMF to meet or exceed the World Health Organization's (WHO requirements for potable water at about 500 L/day. Special note will be taken on the utilization of local suppliers, cost effective and standardized components.

A team of 3-4 Occidental and Los Angeles City College (LACC) students will be lead by Amanda Lounsbury, junior physics major. Amanda has stood out in her thermodynamics and laboratory courses. Furthermore Amanda has worked with Builders Beyond Borders, www.buildersbeyondborders.org and traveled went to Tortugeuro, Costa Rica, Mao Dominican Republic, and Santarem Brazil. In Tortugeuro, she helped build a day care center and in Mao she helped build a health care center.

For the past two years, Prof. Hightower has traveled with students to West Africa. In 2006, he traveled with three Occidental students to Mali to collaborate with Malian university students of the Ecole Nationale d'Ingenieurs, Bamako, Mali. Kether Hayden, Tope Sosanya and Ryan Bowen each participated in an installation as well as conducted research in respect to their perspective academic focuses. Kether Hayden analyzed the impact on gender and women's issues, Tope Sosanya focused on the political aspects of security of solar panel installations, and Ryan Bowen studied the cultural aspects of Mali's exceptional religious tolerance. In 2007 Occidental students collaborated with local teachers on the installation of a geothermal cooling system on a secondary school outside of Accra, Ghana. Prof. Hightower coordinates with a network of local nongovernmental organizations (Mali Folk Center) and the United States Agency of International Development (USAID) to choose potential village for the installation of renewable energy systems.

The Pall Corporation

Dr Abdoulaye Doucoure, Senior Scientist at the Pall Corporation will actively support the design and planning of the filtration experiments. Dr A. Doucouré defended his PhD at the "Ecole Nationale Supérieure de Chimie de Montpellier" in 1995 – France. He received the same year a national distinction from the Marcel Bleustein-Blanchet "Fondation pour la Vocation" and spent 2 years as a postdoctoral fellow in the Chemical Engineering department of the University of Minnesota, in Minneapolis – USA. He has been working in the research division of Pall Corporation since 1998, first as a project manager and currently as a senior staff scientist. Abdoulaye Doucouré's expertise in the field of water purification and membrane processes will be extremely helpful to conduct this research program. Since 2003 he has worked on developing nanofiltration membrane and reverse osmosis filtration systems in Mali.

The University of Texas at Austin

Mr. Wolaver is currently a candidate in Hydrogeology, Jackson School of Geosciencesworks and has woeked professionally as a hydrogeologist for GEOSCIENCE, a Claremont, California-based ground water resources development company. Mr. Wolaver possesses a masters degree from the Department of Hydrology and Water Resources at the University of Arizona, where he completed research initiated as a Fulbright Scholar in Santiago, Chile. He will apply his skills in natural resource management to benefit the project. He possesses French speaking and reading skills.

Faculty of Science and Technology (FAST), U. Bamako, Mali

Dr Adama Tolofoudyé, head of the Water Quality group of the Chemistry department from the "Faculté des Sciences et Techniques (FAST)" de Bamako will be coordinating this program. He will work closely with Dr Lassina Sidibé, head of the Chemistry department at FAST.

Los Angeles City College

Earic Peters, Associate Dean, Los Angeles City College has spent 15 years in student affairs and will serve to identify 1-2 gifted LACC underrepresented science students at to work on this project. This collaboration between Occidental College and LACC will serve to foster the participation in science of underrepresented students by providing the facilities and research opportunities rarely found at the junior college level.

California Institute of Technology

Jim Barry lived in West Africa for over ten years and has been developing Web-based curriculum for the region in collaboration with Prof. Hightower. Mr. Barry will serve as a cultural advisor as well as lead efforts to document all research and results on a local Malian web server.

Section F: Project Description

Mali is located in a semi-arid region from West Africa, faces a crucial problem for producing drinkable water. Only 5% of its population can access water that is considered safe for consumption according to the World Health Organization (W.H.O) standards. But the vast majority of citizens are forced to consume water from wells that often contains high doses of nitrate and nitrite agents, heavy metals such as chromium VI, divalent ions (Ca2+, Mg2+), and exhibit pH oscillating beyond recommended standards - in the 4-9 range. Water improvement projects also have been shown to significantly decrease the incidence and effects of childhood diseases particularly diarrhea (1) and schistosomiasis (2).

In the capital city Bamako, industrial wastewater is released in Niger river, while pretreatment steps are almost nonexistent –a coagulation step is very scarcely implemented. Unfortunately, the river water is used for consumption in the neighboring towns located downstream Bamako. It is therefore critical to develop effective and affordable treatment methods suitable for producing safe drinking water. For this purpose, local researchers seek to investigate whether membrane filtration units powered with photovoltaic modules can produce clean water that meets W.H.O. standards. If this technology proves to be effective, outcome of this research can not only impact drinking water management in the Bamako but also in the northern cities of Mali (Goundam, Timbuktu, Gao, Bourem, Assongo etc.) where drought has had disastrous consequences over the past two decades.

Outline of the Research

Objective of this proposal is to determine whether brackish and ground water can be cost-effectively treated by use of pressure-driven nanofiltration membrane processes. These technologies are known to produce high quality water at affordable prices, and they are easily scalable. The Prior Art shows that renewable energy produced from photovoltaic cells can drive reverse osmosis ("RO") unit and produce safe drinking water (references can be provided upon demand). This work builds on an existing collaboration with the University of Bamako, Mali to move their laboratory pressure-driven membrane filtration system into a rural community. A second filtration unit will be designed at Occidental College and built at FAST-Mali will serve for field evaluations. It will comprise the following items:

Feed tank (contaminated synthetic water, local brackish/ground water);
Photovoltaic ("PV") module (425Wp, total power);
DC pump (e.g.: "Shurflo" 24V/48V DC pump);
Prefiltration with local activated carbon or clay (removal of heavy organics/minerals);
Nanofiltration membrane.

The testing of PV modules is of particular interest as Mali possesses one of the highest daily solar irradiation in the world. PV technology is environmentally friendly and offers an economically sound solution to produce electricity. The module is to be installed in parallel to supply enough current to drive a 24 V DC pump – with two 12V batteries. The originality of this feasibility study is highlighted below:

a) Local natural resources (clay, ground coconuts etc.) will be utilized to perform the pre-filtration step rather than synthetic materials.

b) PV modules are usually coupled with RO filtration installation in the literature, but to our knowledge no one has yet assessed PV-driven nanofiltration ("NF") systems. Because NF membranes are more open than their RO counterparts, the required energy to pump water through these should be reduced.

c) The Prior Art only discloses studies for which a single type of membrane is characterized within a PV-driven RO unit; and it is often not clear how the same filtration system would behave with other RO/NF membranes or if cleaning cycles are introduced. Our experimental design will include such variables, as a means to optimize the water treatment process via membrane and solar PV technologies.

Phase 1 (2005) will be dedicated to setting up the PV-powered filtration unit. We anticipate that six months will be necessary to order all parts and complete the design of this experiment. Afterwards, focus will be on characterizing a couple of RO membranes (types: cellulose acetate and polyamide membranes) and repeating some experimental protocols described in the literature - over the next semester. Specifically, we will determine whether the test procedure from D Loureiro et al. (3) helps confirm our system reliability. These two membranes will be tested with synthetic water prepared with an increasing number of solutes – from 1 to 4 solutes - until the feed composition resembles that of Bamako's ground water for one particular neighborhood. Outcome of this study will serve to establish the effect of process parameters on the membrane filtration performances and determine the membrane reflection coefficient and solute permeability data –for a "single solute". These results will be summarized and presented to an international journal –e.g.: Journal of Membrane Science, Desalination.

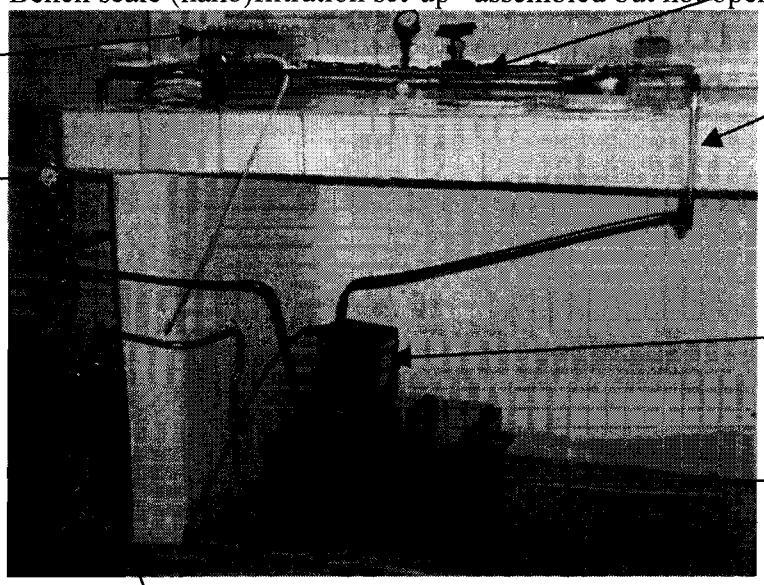
Phase 2 (2006) will target the characterization of NF membranes, as these usually operate at lower pressure than the RO materials – or yield greater permeate flux under a similar operating pressure- and would help save energy. To our knowledge, such study has not been conducted with NF membranes but only with PV-RO systems for seawater desalination. Thus, our findings will introduce a new approach for the treatment of brackish water. Tests conducted during the first six months will start with five different commercial NF membranes chosen for their attractive permselective properties – low fouling, high flux, high rejection to Mg2+ and SO42-, and full retention of humic substances with Mw>600 daltons. This period will be used to screen NF samples based on their filtration properties and structurally characterize the two most effective membranes – surface area, surface energy, surface roughness/morphology. Approach for the functional evaluation (screening) will be similar to the one implemented in phase 2. During the second semester of 2006, we will invite Dr Abdoulaye Doucouré (our consultant, expert in membrane filtration) and Dr G. Tamizh-Mani (referee, expert in photovoltaics) for MSAS2006 (August) and discuss improvement on our experimental set-up. Our graduate students will also attend tutorials presented by these specialists at the MSAS conference. Optimization experiments will serve to introduce simple cleaning methods (60deg. C water, H2O2, citric acid etc.) and increase NF membrane resistance to fouling. Results collected during the year will be presented for publication in well-recognized scientific journals.

Phase 3 (2007) will be dedicated to raw water filtration tests. Rather than synthetic water, PV-powered NF treatment will be used with brackish water samples collected in Bamako. Simultaneously, pre-filtration will also be added upstream the NF unit to prevent fouling. We will investigate two methods of pre-filtration: a) adsorption onto local clay and carbonized waste – b) microfiltration element. The optimized protocol developed during phase 2 will be used to purify pre-filtered brackish raw water with the best two NF membranes. A similar protocol will

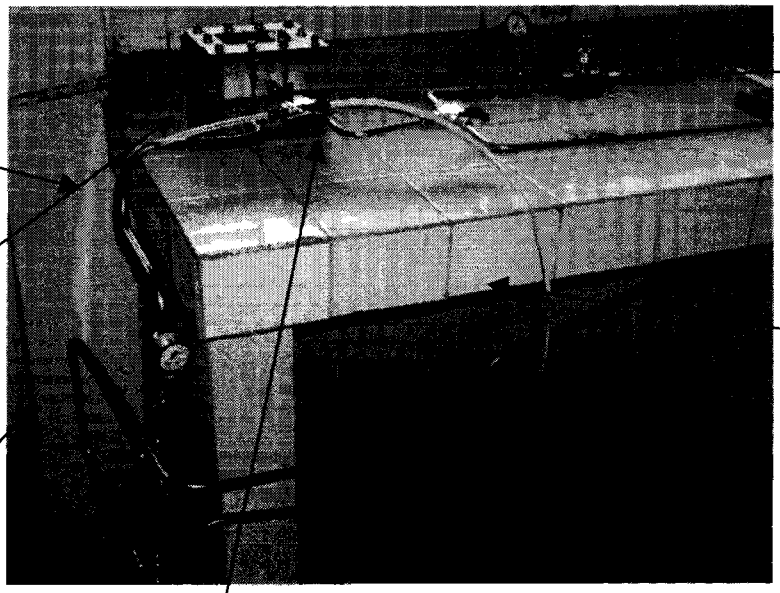
be conducted with the RO specimens tested during phase 1. These results will be summarized and prepared for submission in new scientific journals.

Past phase 3, we anticipate to scale up the PV-NF/RO technology in collaboration with the National School of Engineering in Mali. Our group unit will likely keep working on photovoltaics for water applications (e.g.:plug/unplug PV module et evaluate the PV-NF system autonomy)

Bench scale (nano)filtration set-up –assembled but not operati



Set-up: [drinking water]-maker / filtering device



Mali Symposium on Applied Sciences (MSAS) August 2008

Team members, including students, will participate actively in the Mali Symposium on Applied Sciences (held every 2 years in Mali) in order to network and foster collaborations with scientists and industrials from the region and countries from West Africa. The conference traditionally focuses on Engineering and Environmental Sciences and includes a symposium on Water and Renewable Energy. Experts in water filtration and purification will come from Algeria, Senegal, Morocco, Canada, France, Cyprus and the USA.

References

(1): Plate, D. K., et Al. Tropical Medicine & International Health, 9(3): 416-425.

(2): Declercq, D, et al. Transactions of the Royal Society of Tropical Medicine and Hygiene, 88(6): 653-656;

(3): D. Loureiro , A. Joyce et al., Desalination, (137), 39-44, 2001;

(4): I Kumakiri et al., J. of Chem Eng. of Japan, (33)3, pp 414-419, 2000;

(5) C.K. Diawara, J. Membrane Science, (219), pp103-112, 2003.

G. PROJECT MANAGEMENT TEAM

Identify the team members of the project (i.e., project manager, budget, research, technology etc.). Add rows, as needed.

	NAME	TITLE	ADDRESS	PHONE & EMAIL
1	Dr. Adrian Hightower Asst. Professor of Physics, Occidental College	Project Manager, Solar Research Leader	Occidental College 1600 Campus Rd., Los Angeles CA 90041	323-259-2826 hightower@oxy.edu
2	Dr. Ablo Doucoure, Pall Coorporation,	Membrane Filtration, Technical Leader	Pall Corporation 2200 Northern Boulevard East Hills, NY 11548	(516) 250-6033 ablodoucoure@hotmail.com
3	Brad D. Wolaver, Ph.D. Candidate in Hydrogeology, Jackson School of Geosciences	Hydrology Research Leader	The University of Texas at Austin, 4412 Spicewood Springs Rd, Austin, TX	(512) 922-9152 brad_wolaver@yahoo.com
4	Earic Peters, Associate Dean, Los Angeles City College	Administrator of Student Affairs	LA City College 855 N. Vermont, Los Angeles, CA 90029	(323) 953-4000 ext. 2450 peterseb@lacitycollege.edu
5	Dr. Adama Tolofoudye Prof. of Chemical Engineering at Faculty of Science and Technology (FAST)	Water Processing, Research Leader	Faculté des Sciences et Techniques (FAST), BPE 32 06, Bamako, Mali	011 (223) 222 32 44 soachim.sp@fasonet.bf
6	Jim Barry, Faculty of Fine Arts, California Institute of Technology	Multimedia and Web-based education	California Institute of Technology 1201 E. California, Pasadena, CA 91125	(626) 807-7047 jimbarry7@gmail.com

H.1.

In order to provide perspective on reasonable grant requests, the respondents are reminded that $10,000 is the maximum grant amount allowable. Budget must reflect all anticipated expenses.

DESCRIPTION	AMOUNT	NOTES
GRANT FUNDS REQUESTED FROM MWD	$10,000	Primary Funding Sources
Occidental College Reneable Energy Education Fund and Under graduate Research Center	$6000	DATE ISSUED (if applicable): In-kind Contribution
Los Angeles City College, Student Affairs	$2000	DATE ISSUED (if applicable): In-kind Contrbution
PROJECT TOTAL	$18000	

H.2.

LINE ITEM	AMOUNT	DESCRIPTION
STIPENDS	$2000	Stipends for: Dr. Doucoure, Dr. Hightower, Dr. Tolofoudye, Mr. Wolaver
LAB FEES	$1000	
OFFICE SUPPLIES		
CONSULTANT	$1000	
OVERHEAD FEE		
CONFERENCE REGISTRATION	$2000	Registration team MSAS 2008
EQUIPMENT	$4000	Solar panels, pumps, plumbing
OTHER (Travel)	$8000	Travel for three students, Prof. Hightower and Mr. Wolaver
TOTAL	$1800	

Important Financial Criteria:

Each applicant must demonstrate how they will provide the **minimum match of 25 percent** of the total cost of the proposal. The **matching funds** can be categorized as: (1) Grants, (2) In-kind contributions, (3) Volunteer time and (4) Donated equipment. The **money cannot be used for** travel and related expenses.

Where applicable, the **college overhead fee may not exceed 10%** of the proposed budget. Where applicable, the **stipends may not exceed 50%** of the proposed budget.

I. SIGNATURE BLOCK

	NAME	SIGNATURE	DATE
Faculty Project Manager			
Student Project Manager			
Member Agency Representative [1]			

Note: On a voluntary basis, the Member Agency, has agreed to serve as the local partner for the college / university. As a non-fiscal partner, the Member Agency is not required to provide financial assistance for the Project. At their discretion and strictly on an as-needed basis, the Member Agency will provide in-kind resources and technical assistance for the college / university, pending availability of requested resources or personnel (subject matter experts). *Excerpt from MWD-College Funding Agreement*

[1] For a list of local water agencies (member agencies), log onto www.mwdh2o.com or you may contact the Project Coordinator, Benita Lynn Horn at waterforum@mwdh2o.com or (888) 42-WATER.