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NAVIGATING PROPOSAL WRITING:

A Workshop for Jordanian Researchers
Final Report

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NAVIGATING PROPOSAL WRITING:

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Final Report

USAID JORDAN ECONOMIC DEVELOPMENT PROGRAM

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DELOITTE CONSULTING LLP

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BACKGROUND AND INTRODUCTION

If you needed additional funding to fully pursue your research, how would you go about pursuing it? Writing a grant proposal is the avenue for receiving funding for research. This handbook and accompanying workshop are designed to provide guidance for writing proposals for research grants. This handbook provides a roadmap for writing a proposal, covering various topics from drafting the proposal to the review process. The focus is on the proposal writer. Upon completion, the proposal writer will be ready and willing to undertake the task of writing a grant proposal.

STRATEGIC GOALS

USAID Jordan Economic Development Program (SABEQ) was designed to improve the competitiveness of sectors of the Jordanian economy. The program is focused on three broad initiatives: (i) inserting Jordan into global value chains; (ii) developing an innovation cluster in energy, water, and environment (EWE) productivity; and (iii) catalyzing regional investment. The EWE productivity innovation cluster initiative was adopted as an opportunity to engage Jordanian innovation and technical capacity to respond to the challenges facing Jordan in scarcity of water and energy resources and the impact of energy and water use on the environment. More specifically, and in relation to the topic in hand, the capacity building of researchers in the area of proposal writing increases researchers capacity to properly develop technologies and bring them to market addressing acute regional needs and global demand for green products.

Universities and research institutes in Jordan lack capacity in the area of proposal writing. This capacity gap prevents researchers from securing funding for core research, including in renewable energy and water technologies, and limits their ability to lead technologies to market that ultimately create wealth and jobs within Jordan. SABEQ assistance as committed under the memorandum of understanding (MoU) signed with the Higher Council for Science and Technology (HCST) helps in strengthening the capacities of Jordanian researchers in securing funds for core research and ultimately bringing technologies to market.

PURPOSE OF THE HANDBOOK AND WORKSHOP OBJECTIVES

The purpose of this training handbook is to provide the basis for a one-day workshop on proposal writing. The target audience is Jordanian scientists and engineers interested in improving their success in winning funding from U.S. grant making agencies. These individuals have had little to some prior experience in developing proposals and will be able to apply new learning to improve past experience.

There are three primary objectives of the handbook. The first is to understand how to develop a proposal for a U.S. grant-making agency. This includes an overview of the entire grants process from various perspectives. This also includes learning the step-by-step process for writing a proposal. The second is to learn tips and techniques to increase win probability. This includes understanding the characteristics of a successful proposal, as well as incorporating lessons learned from seasoned proposal writers and reviewers. The third is to broaden participant knowledge so that he or she may in turn teach the key points of the workshop at his or her home organization. This concept is called “train-the-trainer.” Ideally, researchers will take these materials and continue to develop them based on their own experience.

Throughout this manual, there will be illustrations, exercises, and examples/case studies. This helps to translate the theory into practical application. For the purposes of this group

the examples use the U.S. National Science Foundation as the illustrative agency and renewable energy as the illustrative research area. The exercises and case studies are incorporated to encourage participation and make the workshop more interactive. In turn, participants are welcome to share their experiences as proposal writers (and reviewers) so that the rest of the group may benefit. In that vein, here is the first exercise:

Exercise 1: What do you hope to learn about proposal writing?

WHAT IS A SUCCESSFUL PROPOSAL?

The goal of proposal writing is to be awarded funding. Why else would you invest so much time and energy into explaining your research? Therefore, the definition of a successful proposal is one that is funded. The purpose of this section is to frame your thinking about proposal writing and focus on the end goal of receiving a funding award. This section will discuss the characteristics of winning proposals and introduce a tool for ensuring compliant proposals.

CHARACTERISTICS OF WINNING PROPOSALS

The essential characteristic of any successful proposal is that it is compliant with the requirements in the solicitation.[1] While it may seem obvious to comply with the requirements, careless or arrogant proposal writers fail to do so. As a result, they have disqualified their proposal from consideration. Only proposals that pass this first hurdle have any chance for success. A fully compliant proposal will then be judged on its merits.

There are some additional characteristics of winning proposals. Winning proposals present a good idea that addresses a grantor's need. The research is a good match for the funding organization. They are compelling, convincing the granting agency that the research is worth doing. Winning proposals demonstrate how they are going to meet the organization's goals and illustrate the benefits that go beyond the initial need. Ask the following questions:

- Is the problem or topic important/significant?
- Is the approach innovative?
- What is in it for the agency? For science in general?[2]

An NSF program officer suggests the following for a successful proposal:

- "Stress the novel aspects of your approach.
- Differentiate your work from that done by others.
- Emphasize the hypothesis that your research will test.
- Respond to all aspects of the program description.
- Support your ideas with references /preliminary results.
- Describe applications that could result from the research.
- Show where the research might lead.
- Include figures and graphs to facilitate understanding—teach not show."[3]

In addition to the characteristics above, other factors can influence the success of the proposal. One is the writer himself or herself. The writer must be organized, having goals and a plan for the research. The writer muse be skilled in conveying the message and persuasive in making the case for the project.

Another factor for a successful proposal is not wholly in control of the proposal writer. It is the competition. There are usually more proposals than funding is available. While the

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[1] Throughout the text, "solicitation" will refer to any document that announces or requests proposals. This includes documents such a requests for proposals (RFPs) and program descriptions.

[2] Mickie Swisher, "Write the Winning Proposal," Briefing, <district5.extension.ifas.ufl.edu/files/proposal.ppt>.

[3] Geoffrey Prentice and Tim Anderson, "Career Development for New Engineering Faculty Workshop," Briefing, University of New Mexico, May 25, 2007, pp. 28, <http://www.nsf.gov/eng/cbet/new_faculty/new_faculty_unm_25may07.ppt>.

proposal writer can't influence the number of other proposals being submitted, he or she can build a proposal that is will get noticed above the others.[4]

It is important to understand the attributes of a successful proposal. It is also important to understand the factors other than the proposal itself that influence your chances of success. A final point: Learn from successful proposals. Learn the lessons from unsuccessful proposals, but do not use them as the basis for future proposals. This exercise focuses on the intangible aspects of proposal writing.

Exercise 2: What advice would you give to a colleague writing a proposal?

COMPLIANCE MATRIX

Since being compliant with the requirements of the solicitation is so critical to a winning proposal, it is important to have tools for achieving compliance. A compliance matrix is a simple tool for ensuring that the proposal addresses all of the requirements in the solicitation. It is essentially a table listing each individual requirement and its location in various sections of the solicitation. It also cross-references where each requirement is addressed in the proposal. Simply, it is a detailed checklist.

A compliance matrix is typically used when developing a proposal in response to a request for proposal (RFP). RFPs have more requirements than grant program announcements, but the utility of the tool is proven regardless of the complexity of the requirements. A compliance matrix is applicable to the grant proposal setting.

A compliance matrix serves both writers and reviewers. For writers, a compliance matrix is a checklist of all the topics that must be covered in the proposal. For reviewers, a compliance matrix is a guideline for internal review by the proposal team and administration. Some solicitations may require a compliance matrix to be submitted with the proposal to aid in the evaluation. Figure 1 illustrates a typical compliance matrix for an RFP, but writers should customize to the needs of the proposal.

[4] Elizabeth Howell Brunner, "Four Factors," <http://www.grantproposal.com/overview.html>.

Figure 1 Sample Compliance Matrix[5]

Proposal Paragraph Number	Requirement	Section C Statement of Work	Section L Instructions	Section M Evaluation Factors	Other RFP Sections
1.0	Technical Approach	C.5	L.8	M.2	
1.1					
1.1.1					
1.1.2					

The solicitation will specify the requirements of the proposal. Requirements are the items to be covered in the proposal. These may include the technical and management approaches, past performance, the cost/budget, as well as how the proposal should look and how it should be submitted. In standard U.S. government RFPs, the requirements are easy to find. Figure 2 outlines the Uniform Contract Format. Key locations for requirements are sections C, L, and M.

Figure 2 Uniform Contract Format[6]

Section	Title
Part I—The Schedule	
A	Solicitation/Contract Form
B	Supplies or Services and Prices/Costs
C	Description/Specifications/Statement of Work
D	Packaging and Marking
E	Inspection and Acceptance
F	Deliveries or Performance
G	Contract Administration Data
H	Special contract requirements
Part II—Contract Clauses	
I	Contract Clauses
Part III—List of Documents, Exhibits, and Other Attachments	
J	List of Attachments
Part IV—Representations and Instructions	
K	Representations, Certifications, and Other Statements of Offerors or Respondents
L	Instructions, Conditions, and Notices to Offerors or Respondents
M	Evaluation Factors for Award

[5] Deborah Kluge, "Proposal Compliance Matrix," February 3, 2005, <http://www.proposalwriter.com/weblog/archives/2005/02/proposal-compliance-matrix.html>.

[6] General Services Administration, *Federal Acquisition Regulation*, Section 15.204-1 Uniform Contract Format, March 2005, <http://www.acquisition.gov/far/current/html/Subpart%2015_2.html>.

While RFPs are less familiar in the research community, it is worthwhile to understand how a complex set of requirements can be managed during proposal writing. The compliance matrix is a detailed checklist that can help ensure compliance with solicitation requirements. The National Science Foundation (NSF) has a proposal checklist in its proposal preparation instructions. It is included in Appendix 1.

REVIEW SAMPLES OF WINNING PROPOSALS

Another tool for developing a successful proposal is to learn from winning proposals. The following abstracts were selected from the Energy for Sustainability program at NSF. This program "supports fundamental research and education in energy production, conversion, and storage and is focused on energy sources that are environmentally friendly and renewable."[7]

Exercise3: Read the following abstracts from winning proposals for renewable energy research. Answer the following questions:

- *Is the problem or topic important/significant?*
- *Is the approach innovative?*
- *What is in it for the agency? For science in general?*

Abstract A

Award Abstract #0829023 Biofuels and the Hydrologic Cycle

> *As the U.S is embarking on a dramatic increase in biofuel production, a series of studies has raised questions about the environmental impacts and sustainability of biomass feedstock production due to concerns about water use, soil erosion, nutrient transport, and greenhouse gas emissions. The focus of this interdisciplinary project is on modeling the interplay of land use, climate change, and the environment in future biofuel production systems. Understanding the role of biofuels in the water cycle is key to understanding many of the environmental impacts of biofuels. This research will address impacts of alterations in the hydrologic cycle driven by biomass feedstock production, such as changes in yield reliability, soil erosion, stream flow, and stream flow reliability. Water-driven environmental impacts of biofuel production scenarios will be assessed using a set of interconnected models. The MM5 climate simulation and Noah land surface model will be used to predict interactions between weather patterns and biofuel feedstock cropping patterns. The Soil and Water Assessment Tool (SWAT) will be used to analyze impacts on nutrient and sediment transport and surface water quality in the Upper Mississippi River Basin using weather scenarios produced by the MM5/Noah system. The Iowa Daily Erosion Project (IDEP) model will also*

[7] National Science Foundation, "Energy for Sustainability," <http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=501026>.

use MM5 outputs to predict erosion across Iowa at the field scale. The integration of these highly developed models will provide new insight into dynamic interactions through the hydrologic cycle as influenced by human manipulation of the landscape and climate-soil-vegetation dynamics of the system. The project includes four activities designed to increase diversity and learning at different levels of education. These activities are: mentoring undergraduate summer interns from the Iowa AGEP program for underrepresented minorities; mentoring of undergraduate research associates recruited through the Program for Women in Science and Engineering; developing and implementing an inquiry-based learning activity based on biofuels and the hydrologic cycle; and mentoring graduate students.[8]

Abstract B

Award Abstract #0931145 Copper Zinc Tin Sulfide Based Solar Cells

Achieving solar-to-electric energy conversion using inexpensive, abundant and nontoxic materials is an important goal. While silicon is a material that fits most of these criteria, highest efficiency solar cells are made from expensive single crystal wafers. Solar cells based on thin films of semiconductors are emerging as inexpensive alternatives to silicon but the two materials that yield the highest efficiency thin film solar cells, CdTe and CuInGaSe2 (CIGS), have toxic and rare elements (In and Cd). Finding abundant and nontoxic replacements for In and Cd in CIGS solar cells, without sacrificing the high efficiencies reached with these technologies, is a challenge. This work attempts to address this problem.

Intellectual Merit—Copper zinc tin sulfide (Cu2ZnSnS4 or CZTS) is a potential material that has promising attributes for efficient, inexpensive solar cells made from abundant and nontoxic elements. This proposal aims at developing well-controlled deposition methods for CZTS that will result in high quality absorber material for CZTS-based solar cells. We propose to use a synergistic combination of combinatorial deposition methods and careful characterization of films that are found to yield high efficiency solar cells to elucidate the fundamental principles that lead to improvements in efficiency and film quality. The proposed research is on a new material with very high potential for use in solar cells. Very little is known about the properties of CZTS and even less about the process-structure-property-performance relationships for its use in solar cells. The proposed research will result in knowledge on how to deposit high quality CZTS films and to make high efficiency CZTS based solar cells. It will establish the relation between film deposition conditions and electrical, optical and structural properties of the CZTS film. The proposed approach balances the need to establish the fundamental science behind the CZTS solar cell technology and the practical requirement of rapidly moving towards the region of the parameter space that produces high efficiency films relevant to solving a very challenging energy problem.

Broader Impacts—First, the proposed research could provide a solution to the issue related to providing energy to approximately ten billion people using a sustainable technology. Second, this project serves as a vehicle for educating next generation of scientists and engineers who must be trained

[8] National Science Foundation, "Award Abstract #0829023 Biofuels and the Hydrologic Cycle," <http://www.nsf.gov/awardsearch/showAward.do?AwardNumber=0829023&WT.z_pims_id=501026>.

broadly to function in the increasingly interdisciplinary work place. The project cuts across traditional boundaries between chemistry, physics and engineering and the students involved with this research will be educated in a culture that values interdisciplinary collaboration. Third, the research will be integrated into the outreach and educational activities beyond the training of graduate students. The plan includes five components: (i) continued interactions with Science Museum of Minnesota and Twin Cities Public Television, (ii) continued mentoring of undergraduate students, particularly those from under-represented groups, (iii) continued mentoring of high school teachers for developing science content for their classrooms, (iv) insertion of PV content into a regional center for technical education in nanotechnology, and (iv) volunteering for outreach opportunities that arise in the PIs' local community.[9]

OVERVIEW OF THE GRANTS FRAMEWORK

A successful proposal does not occur in a vacuum. There is an environment that a proposal writer is responding to. This environment is called the grants framework. The grants framework is the context where proposals are developed. It includes some definitions, agency specifics, and the grants cycle. Proposal writing is one part of the grants cycle, so this section will provide the big picture view before narrowing in on proposal writing in the next section. There is nothing magic about the grants framework, but it is important to understand how it influences the proposal writing process.

GRANTS BASICS

What is a grant? A grant is money given to an individual or organization to accomplish an objective to benefit society at large. In terms of research and development, a grant is funding given to a researcher to study a scientific research question. The funding can support personnel, facilities, equipment, materials, and other items necessary to accomplish the research.

Who provides grants? Grants come from public and private sources. In the United States, public sources are typically federal government agencies, but state and local government may offer grants as well. The best resource for federal grants is Grants.gov. Private sources are foundations and individuals. The Foundation Center (www.foundationcenter.org) is a good resource for information on private foundations. Figure 3 highlights grant organizations with an interest in renewable energy. Interestingly, NIH currently has two program announcements related to renewable energy.[10] Figure 4 gives descriptions of U.S. government grant organizations.

[9] National Science Foundation, "Award Abstract #0931145 Copper Zinc Tin Sulfide Based Solar Cells," <http://www.nsf.gov/awardsearch/showAward.do?AwardNumber=0931145&WT.z_pims_id=501026>.

[10] PA-09-100Energy Efficiency and Renewable Energy System Technology Research and Development (SBIR [R43/R44]); PA-09-101Energy Efficiency and Renewable Energy System Technology Research and Development (STTR [R41/R42]). They are for SBIR and STTR programs.

Figure 3 Selected U.S. Grant Organizations[11]

Org Type	Organization	Grants Website
Public	Agency for International Development	http://www.usaid.gov/business/business_opportunities/
Public	Department of Energy	http://www.energy.gov/sciencetech/grants.htm
Public	Environmental Protection Agency	http://www.epa.gov/ncer/
Public	National Institutes of Health	http://grants.nih.gov/grants/ocr.htm
Public	National Science Foundation	http://www.nsf.gov/funding/
Private	Petroleum Research Fund	http://www.acs.org/funding

Figure 4 Descriptions of U.S. Government Grant Agencies

Agency for International Development

- The Agency for International Development is an independent federal government agency that provides economic and humanitarian assistance in more than 100 countries to ensure a better future for us all.

Department of Energy

- The Department of Energy's goal is to advance national, economic and energy security in the U.S.; to promote scientific and technological innovation in support of that goal; and to ensure environmental cleanup of the national nuclear weapons complex.

Department of Health and Human Services (including the National Institutes of Health)

- The Department of Health and Human Services is the federal government's principal agency for protecting the health of all Americans and providing essential human services, especially to those who are least able to help themselves.

Environmental Protection Agency

- The mission of the Environmental Protection Agency is to protect human health and the environment. Since 1970, EPA has been working for a cleaner, healthier environment for the American people.

National Science Foundation

- The National Science Foundation is an independent federal agency created to promote the progress of science, to advance the national health, prosperity, and welfare and to secure the national defense. The NSF annually funds approximately 20 percent of basic, federally-supported college and university research.

Source: Grants.gov, "Agencies That Provide Grants," <http://www.grants.gov/aboutgrants/agencies_that_provide_grants.jsp>.

[11] Kirsten Armstrong; Alan Kotok, "Financing Your Research in Alternative Energy," Science Careers, July 14, 2006, <http://sciencecareers.sciencemag.org/career_magazine/previous_issues/articles/2006_07_14/financing_your_research_in_alternative_energy>.

Who is eligible for a grant? Each grant organization determines its own rules for who can apply for a grant. These rules can apply to all grant programs at the organization, or may vary depending on the program. There are several factors that can determine eligibility.

Does the granting organization fund projects in your area of research? Are you an individual or an organization? Are you a for-profit or non-profit entity? Are you a U.S. citizen or affiliated with a U.S. institution? Always check with the grant organization or program to determine eligibility.

U.S. federal agencies typically give preference to American institutions and researchers. For example, NSF does not typically fund foreign researchers: "NSF rarely provides support to foreign organizations. NSF will consider proposals for cooperative projects involving U.S. and foreign organizations, provided support is requested only for the U.S. portion of the collaborative effort."[12] On the other hand, NIH takes a slightly different approach. "Though most NIH grants go to domestic institutions, you do not need U.S. affiliation or citizenship to become either a grantee institution or a PI for most grant types. The main exceptions are small business awards, which require U.S. citizenship, and fellowships, career development awards (with one minor exception), and training awards, for which you must be a U.S. citizen or a permanent resident (have an Alien Registration Receipt Card)."[13] "Qualified foreign investigators who have unique expertise or resources not available in the U.S. have a good chance of being funded."[14]

NSF GRANTS

With an understanding of grants basics, it is helpful to examine a grant making agency in detail. Getting to know an organization and its programs will make clear whether there is a good match between the research and the grant making agency. Since the focus is the National Science Foundation, this section will provide some background on the organization and the types of grants it funds.

The National Science Foundation was created by the United States Congress in 1950. It is an independent agency supporting all fields of fundamental science and engineering and is organized into seven directorates: Biological Sciences (BIO); Computer and Information Science and Engineering (CSE); Engineering (ENG); Geosciences (GEO); Mathematics and Physical Sciences (MPS); Social, Behavioral and Economic Sciences (SBE); and Education and Human Resources (EHR). For fiscal year 2009, NSF was appropriated $6.490 billion for FY09. NSF's fiscal year 2010 budget request is $7.045 billion.[15]

NSF funds a wide swath of research areas, researchers, and proposals. It funds both research and education in science and engineering, except in health and medicine. It funds academia, businesses, and other research or science organizations. NSF funds proposals for specific projects for a stated amount of funding. It funds both single discipline and interdisciplinary proposals.

In 2008, NSF received almost 44,000 proposals and funded about 11,000, a funding rate of about 25 percent. The average time for a decision from NSF was almost six months. The mean award duration was two and a half years with a median annual award size of $100,000

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[12] National Science Foundation, *Proposal and Award Policies and Procedures Guide*, February 2009, Effective April 6, 2009, NSF 09-29, pp. I-5, <http://www.nsf.gov/pubs/policydocs/pappguide/nsf09_29/nsf0929.pdf>. Hereafter referred to as the Grant Proposal Guide (GPG).

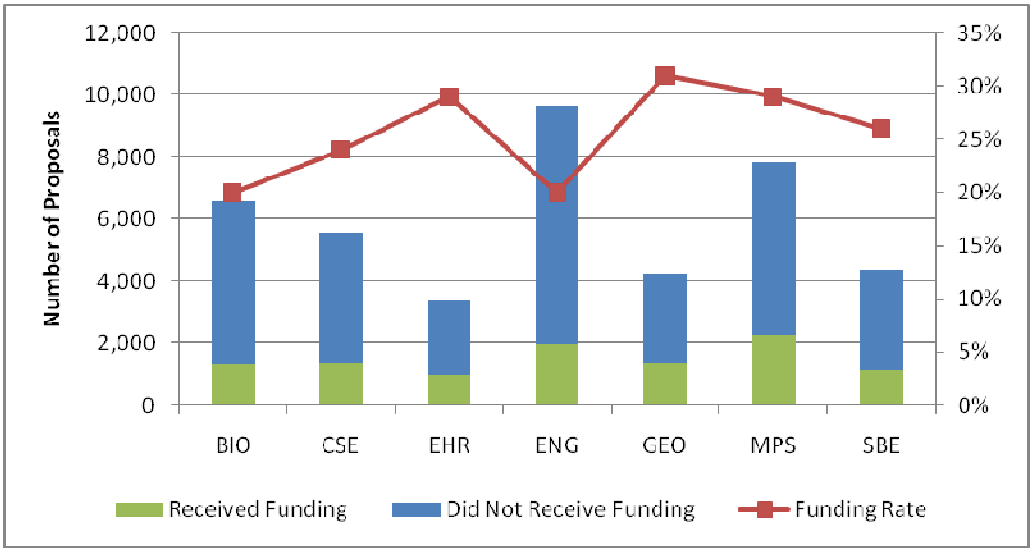
[13] National Institute of Allergy and Infectious Diseases, "NIH Grant Cycle, Part 1. Qualifying for a Grant," <http://www.niaid.nih.gov/ncn/grants/cycle/part01.htm>.

[14] National Institute of Allergy and Infectious Diseases, "NIH Grant Cycle, Part 8. Assignment and Review," <http://www.niaid.nih.gov/ncn/grants/cycle/part08.htm#f10>.

[15] National Science Foundation, "NSF Budget Requests to Congress and Annual Appropriations," <http://www.nsf.gov/about/budget/>.

USD.[16] Figure 5 illustrates the number of awards by research directorate (excludes the Office of the Director and Office of Polar Programs) and the funding rates.

Figure 5 NSF Awards by Research Directorate, 2008[17]



NSF offers two types of funding arrangements: grants and cooperative agreements. Of the two, NSF primarily uses grants to fund research proposals. Grants are typically three years in duration, but may be up to five (GPG II-5). Here are NSF's definitions of the vehicles.

> *GRANT—a type of assistance award and a legal instrument which permits an executive agency of the Federal government to transfer money, property, services or other things of value to a grantee when no substantial involvement is anticipated between the agency and the recipient during the performance of the contemplated activity.*
>
> *COOPERATIVE AGREEMENT—a type of assistance award which should be used when substantial agency involvement is anticipated during the project performance period. Substantial agency involvement may be necessary when an activity is technically and/or managerially complex and requires extensive or close coordination between NSF and the awardee. Examples of projects which might be suitable for cooperative agreements if there will be substantial agency involvement are: research centers, large curriculum projects, multi-user facilities, projects which involve complex subcontracting, construction or operations of major in-house university facilities and major instrumentation development* (GPG Section D.1).

The National Science Foundation publishes materials to assist proposal writers:

[16] National Science Foundation, "Funding Rate by State and Organization from FY 2007 to 2008 for NSF," <http://dellweb.bfa.nsf.gov/awdfr3/default.asp>.

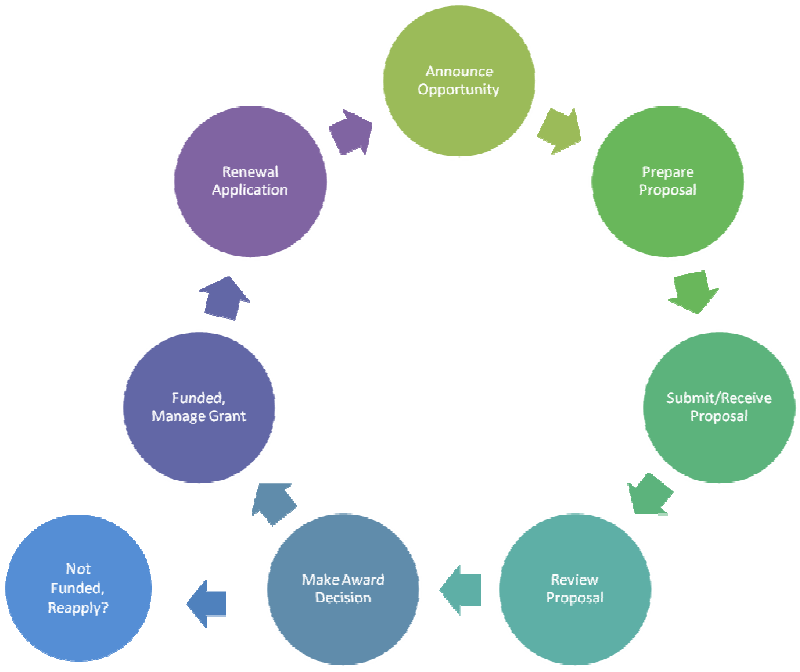
[17] National Science Foundation, "Funding Rate by State and Organization from FY 2007 to 2008 for NSF."

- National Science Foundation, *Proposal and Award Policies and Procedures Guide*, February 2009, Effective April 6, 2009, NSF 09-29, <http://www.nsf.gov/pubs/policydocs/pappguide/nsf09_29/nsf0929.pdf>. Also known as the Grant Proposal Guide (GPG).
- National Science Foundation, Directorate for Education and Human Resources, Division of Undergraduate Education, *A Guide for Proposal Writing*, NSF 04-016, <http://www.nsf.gov/pubs/2004/nsf04016/start.htm>.

GRANTS CYCLE

With an understanding of a grant making agency like NSF, it is important to become familiar with its grants cycle. The grants cycle is the series of phases used by grant making organizations to originate grants. As illustrated in Figure 6, proposal preparation is just one phase in the larger cycle. The grants cycle begins with the announcement of the opportunity by the funding organization. The researcher prepares the proposal and submits it to the grant making agency. Upon receipt, the grant making agency reviews the proposal and makes an award decision. If the proposal is not funded, the researcher can consider reapplying. If the proposal is funded, the researcher manages the grant and carries out the research. At the conclusion of the grant, the researcher can apply to renew the grant.

Figure 6 Grants Cycle[18]



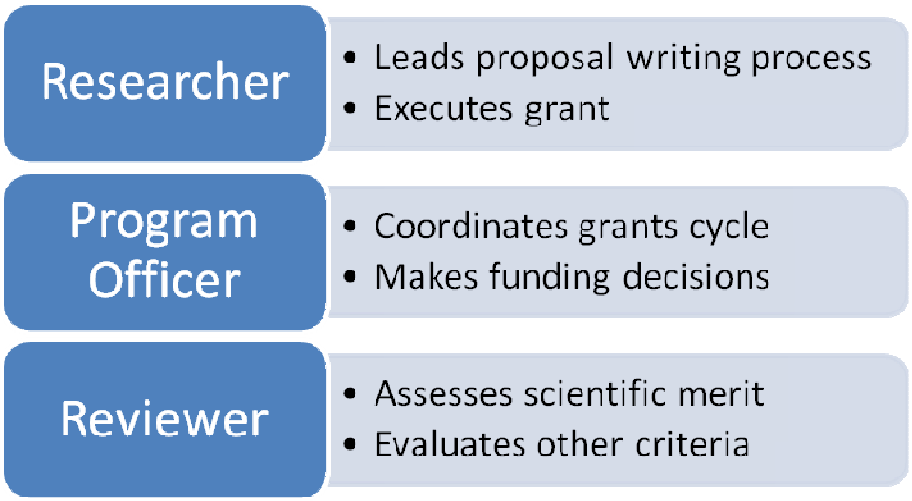
There is no specific timeline for the grants cycle. It is up to the grant making organization to determine the length of time for each phase. Because U.S. agencies are tied to the annual federal budget cycle, their grant cycles are typically on an annual cycle as well. For

[18] National Institute of Allergy and Infectious Diseases, "NIH Grant Cycle: Application to Renewal," <http://www.niaid.nih.gov/ncn/grants/cycle/default.htm>; GPG III-5; Kirsten Armstrong.

example, some NSF programs accept proposals at anytime, while others have specific deadlines for accepting proposals (GPG I-6).

Implicit within the grants cycle are several key roles. There are researchers, program officers, and reviewers. Researchers take the lead in the proposal writing process and execute the grant. Program officers coordinate the grants cycle and make funding decisions. Reviewers assess the scientific merit of proposals and evaluate other criteria. See Figure 7.

Figure 7 Roles in the Grants Framework



In conclusion, this section provided an overview of the grants framework. Basics, including grant making organizations and eligibility, were discussed. Specifics with regard to NSF grants were reviewed. The grants cycle and key roles were also covered. Each of these areas provides the context for proposal writing, assisting the writer with understanding how his or her efforts in developing a proposal fit into the larger framework.

THE PROPOSAL WRITING PROCESS

Proposal writing is a major activity in the overall grants framework. Proposal writing is a process with six main steps. Figure 8 illustrates the sequential steps of: select a research idea, search for funding organizations and opportunities, understand the requirements, draft the proposal, review the proposal, and finally, submit the proposal, grant award, and reviewer feedback. In the following sections, each of the six steps will be discussed in detail.

Figure 8 The Proposal Writing Process

STEP 1: SELECT A RESEARCH IDEA

The initial step in proposal writing is to select a research idea. What line of inquiry would you like to pursue more fully that requires additional funding? Graduate studies and research interests are two sources of research ideas. Which of these ideas is ready for more intensive pursuit? This step is essentially the pre-proposal writing for the potential research project. The three main tasks are described below.

The first task is to scope the research idea. The purpose is to make sure that the research idea is not too broad or too narrow. Researchers have been criticized for taking on a research idea that is too ambitious. Ask yourself the following: What is the scientific question to be answered? What are the goals of the research? Who would be involved: people and organizations? How will the project be accomplished? What resources (e.g., facilities, equipment, staff) will be needed? When can the project start? Why is funding needed? Answers to these questions and more will be needed, as the initial details are sketched out.

Once there is an outline of the big picture, the next task is to document the background details of the research idea. It tells the story of how the idea came to be and sets the context.

- Why is the research important? Describe how the research is unique, how the line of inquiry has not been pursued before, or how your approach is innovative.
- What research has already been conducted in the research area? Conduct a literature search to document what has already been accomplished. Discuss the limitations of this previous research.
- What have you already accomplished in this research area? Detail your past research that is relevant to the new research thrust. If you have already begun research, describe your preliminary results.
- Where might your research lead? Explain how the results of your research idea will improve the body of knowledge. Describe how the results might lower barriers to discoveries in related areas. Identify potential applications of the research, which may include commercialization potential. Also identify limits to the research.[19]

[19] "Proposal Preparation," Briefing to NSF Regional Grants Conference hosted by Arizona State University, 30-31 March 2009, pp. 12, <http://www.nsf.gov/bfa/dias/policy/docs/propprep_az.pdf>.

The last task is to flesh out a research strategy. A research strategy is the plan for investigating the research idea. This is fundamentally the methodology for executing the research. The key components of a research strategy include the research question, data gathering approach, analysis approach, and publication and dissemination approach. The timeline and milestones are also important. Is it achievable? This preliminary roadmap to conducting the research is essential to success in future steps.

In sum, this step brings focus to the research idea, documents where you've been, and outlines what you hope to accomplish. Selecting a research idea is an internal exercise to organize your thoughts. When you look at what you have written down, do you feel you are ready to pursue funding? Now may be a good time to get a pulse check from a colleague. If you are satisfied with how your research idea is coming together, now it is time to look for funding.

STEP 2: SEARCH FOR FUNDING ORGANIZATIONS AND OPPORTUNITIES

The second step in proposal writing is to search for funding organizations and opportunities. Even though the focus of the workshop is on funding from the National Science Foundation, it may be worthwhile to pursue multiple sources of funding. There are four tasks in this step.

It should come as no surprise that the easiest way to search for funding opportunities is on the internet. But where do you start looking? The first task is to brainstorm funding organizations. Begin by listing those organizations that fund research in your field. These may be international organizations. These may be your own government, such as the Higher Council for Science and Technology or one of the Ministries. These may be organizations of a foreign government, such as the U.S. National Science Foundation. Funding may come from businesses, though this is less likely in the case of basic research. Funding may come from foundations and other non-profits. Examples include the Gates Foundation and economic development organizations.

Once organizations have been identified, the next task is to identify opportunities. Grantors should have databases that can be searched online. Personal contacts and professional associations are also great sources of funding opportunities. At NSF, the first stop for locating funding opportunities is to search its website at http://www.nsf.gov/funding/. Opportunities can be searched by keyword or program area. For example, the Energy for Sustainability program is under the Engineering directorate. Many research projects are funded from more than one program, so be sure to search for all applicable programs. Another point is to review the NSF-wide and Cross-cutting programs for areas of special emphasis.

The next task is to evaluate each opportunity. After developing a long list of interesting opportunities, narrow down the list based on some criteria. Are you eligible/ qualified to apply? What other application criteria are there? What are the restrictions? Are there restrictions on the outcomes or research? What about intellectual property rights? Understand those things that would eliminate the researcher's proposal from consideration. Also, understand those circumstances under which the researcher would self-eliminate. Proposal writing and preparation is a significant investment of time and energy and it is important to understand the chances of success before moving ahead. The Foundation Center has developed a "Prospect Worksheet" to help evaluate potential sources of funding.[20] This tool assists with the collection of basic information, but also helps to evaluate whether the organization is a good match for the researcher's goals.

After arriving at a short list of funding opportunities, the last task is to contact each of the organizations to express interest. After some discussion with the funding organization, the researcher should understand whether he or she is qualified and what the probability is of

[20] It is available at <http://foundationcenter.org/findfunders/wrksheet/prospect_worksheet.pdf>.

being awarded funding. For example, the researcher may be qualified, but the submission deadline has already passed. Perhaps, the submission deadline has been extended. In the case of NSF, it is strongly emphasized that the researcher contacts the program officer in charge of the program of interest. If there are multiple programs, contact each appropriate officer.

At the end of this step, the researcher should have a very short list of funding opportunities. Perhaps there is just one on the list. This is the funding opportunity the researcher plans to pursue and develop a proposal.

STEP 3: UNDERSTAND THE REQUIREMENTS

The next step in proposal writing is to understand the proposal requirements. The requirements will be spelled out in the solicitation. The solicitation may also be called a Request for Proposal (RFP) or some other term. In any case, items as mundane as font and spacing, page limits, and number of copies will be listed. It will advise the researcher when, where, and how to submit the proposal. It will instruct what sections to include. It will inform the researcher how the proposal will be evaluated.

The NSF uses several methods for encouraging proposals. Program Descriptions and Program Announcements are the two primary methods. Program Descriptions are found doing a search on the NSF Funding website. Program Announcements are more formal communications about a program. Both use the general criteria in the agency proposal guide. A Program Solicitation is a formal communication, but has additional specific criteria. A Dear Colleague letter provides information of a general nature.

There are three tasks in this step. The first task is to carefully review the solicitation. Use a highlighter to note key requirements. Understand the requirements for both the technical content and formatting. Look for deadlines. Comprehend how the proposal will be evaluated. This will help determine where to put the emphasis in the proposal. Write down questions to later ask the funding organization.

The next task is to develop a compliance matrix as described in Section 2. Take all of the proposal requirements from the solicitation and list them in a table or spreadsheet. Formatting requirements are usually not necessary, except for page limitations. In the case of NSF, the requirements will be in both the Program Description and the Grant Proposal Guide (NSF 09-29). NSF's proposal checklist is included in Appendix 1.

NSF has two standard review criteria: intellectual merit and broader impact. They are defined in Section 5. Because these criteria are broad, they are not going as easy to tackle in a compliance matrix, but include them nonetheless. The aims of the two review criteria are:

- Intellectual merit
  - Importance in advancing understanding in a field
  - Creativity and novelty of approach
  - Qualifications of investigators
  - Completeness of research plan
  - Access to resources
- Broader impacts
  - Promotion of teaching and training
  - Inclusion of underrepresented minorities
  - Enhancement of infrastructure and partnerships

- Dissemination of results
- Benefits to society[21]

The next task is to develop a proposal plan. This is a plan for how to build the proposal. In Step 1, a research strategy is developed—the approach to executing the research. The proposal plan is the approach for executing the proposal. Who is going to write the proposal? Will you write the entire document, or request help for certain sections, such as budget? How will you involve your research team in writing the proposal? How long will it take to write the proposal? What are the timelines, milestones, and deadlines? Who will review the proposal and when? What other items are needed to complete the proposal? This is the researcher's strategy for getting to a completed, ready-to-submit proposal.

At the conclusion of this step, the researcher should have the foundation for the proposal. He or she understands what is required; has catalogued the requirements in a compliance matrix; and has developed a proposal plan. All of this preparation should make the remaining steps go smoothly and seem less overwhelming. In the next step, the researcher will begin to execute the proposal plan.

STEP 4: DRAFT THE PROPOSAL

The fourth step in proposal writing is to draft the proposal. The focus of this step is on content and writing. This step in the process could take a significant amount of time. Fortunately, some content has already been drafted in the earlier steps, such as the background and research strategy. There are three tasks in this step.

The first task is to locate necessary proposal templates. Proposal templates will provide the basis for the proposal outline. For example, the department or university may have a proposal template for research grants. The funding agency may also have a proposal template. Proposal templates may also contain the standardized text (also known as boilerplate) for certain sections. An example with regard to NSF proposals is the proposal certifications.

The National Science Foundation requires a specific organization in proposals. All of the following items are required to be in a proposal.

1. Cover Sheet
2. Project Summary
3. Table of Contents
4. Project Description
5. References Cited
6. Biographical Sketch(es)
7. Budget[22]
8. Current and Pending Support
9. Facilities, Equipment and Other Resources
10. Special Information and Supplementary Documentation
11. Appendices (GPG II-4-19)

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[21] Prentice 72.

[22] United States Environmental Protection Agency, "Tips on Writing a Grant Proposal," <http://www.epa.gov/ogd/recipient/tips.htm> has a number of budget examples. NIH also has some budget resources at <http://www.niaid.nih.gov/ncn/grants/cycle/part06.htm> and <http://deainfo.nci.nih.gov/EXTRA/EXTDOCS/gntapp.htm>.

Descriptions of each section can be found in the Grant Proposal Guide (NSF 09-29). There is one section of particular interest, Budget. Preparing a budget for a proposal requires some different competencies than writing a proposal, so it has not been covered in detail in this workshop. There are many good resources, including an online tutorial by the Foundation Center called "Proposal Budgeting Basics."[23]

The budget will drive the amount requested for the grant. There are two main components of a budget: direct costs and indirect costs. The main categories of direct costs are salaries and wages, fringe benefits, equipment, travel, participant support, and other direct costs. Other direct costs include materials, publication, consultants, computer services, subawards, and miscellaneous. Indirect costs are facilities and administrative costs. Unallowable costs cannot be included with direct or indirect costs (GPG II-10-17).

The next task is to develop a proposal outline. If a template is required, developing an outline will be simplified. Adjust the outline to the specific research proposal and insert additional levels of detail. If a template is not required (or provided), the researcher may find that searching for a template will be easier than starting with a blank sheet. It is likely that the researcher will still need to cover much of the material highlighted in the NSF proposal template, so it may be helpful to use it as the basis for the outline.

The proposal outline needs to include enough detail to make the writing straightforward. This is especially true if there are multiple writers, who will need guidance. Add subheadings to the main headings. Add topic sentences and examples. Add references and other resources. Add ideas for tables and graphics. Refer to the compliance matrix to make sure there is a place to include all the necessary material.

The last task is to draft the content of the proposal. As was already mentioned, some of the content should have been already drafted while the researcher was considering the merits of pursuing a research grant. Now is the time to review and revise those sections. For the sections where there is not existing material, begin writing according to the outline. The planning and outlining to this point should make the writing a less daunting task.

If this is the first time for writing a proposal, seek help from all available sources. Use the grant making organization's proposal guide. Look to successful proposals for exemplars. Seek out the advice of colleagues. Turn to writing guides and style guides. Attend workshops online or in person. Other sources of proposal writing support include the current and former Program Officers, previous panelists, and mentors. Serving as a reviewer is a wonderful window into proposal writing.[24]

The researcher must consider the audience when drafting the proposal. The audience is the reviewers empanelled by the funding organization. The reviewers will provide their evaluation according to the guidance they are provided, but they will be looking for some key items. "Reviewers want to know four things:

- What is it about (the research objective)?
- How will you do it (accomplish the objective)?
- Can you do it (you and your facilities)?
- Is it worth doing?"[25]

[23] <http://www.foundationcenter.org/getstarted/tutorials/prop_budgt/index.html>.

[24] "Proposal Preparation."

[25] George Hazelrigg, National Science Foundation, "Research Program Development Workshop," Briefing, 07 January 2007, pp. 14, <http://www.nsf.gov/eng/cmmi/conferences/2008/rpdpresentation.pdf>.

Some thoughts about writing: Select and use a writing style guide. There are many formats, some general like APA, MLA, and Chicago, and some geared to science writing.[26] Use your best writing skills. Write clearly and concisely. Use active, not passive language. Use topic sentences and transitions.[27] Tell a compelling story. The proposal is a chance to sell the research idea. Be persuasive in doing it.

The end result of this step is the first draft of the proposal. The time spent finding the template, expanding the outline, and developing the content should codify the research idea and the research strategy. The next step will fine tune the proposal and ensure that the research idea and strategy are effectively communicated.

STEP 5: REVIEW THE PROPOSAL

The penultimate step in proposal writing is to review the proposal. This is a critical step, so do no skip it! In order to have a coherent and cohesive story come through the proposal, review and revision are necessary. No one gets it perfect on the first try. There are two tasks in this step.

The first task is for the proposal writer to review the proposal, i.e., self-review. Do this with a fresh set of eyes, not after laboring over it for many hours. Set the proposal aside for a period of time and come back to it. Ask the following questions of the document:

- Is the research idea clearly expressed?
- Is the research strategy effectively communicated?
- Is there a sense of excitement and importance about the research and results?
- What will stand out for the reviewers?

In addition to getting the main messages across, the review will also need to check for format. The proposal writer should check for errors in grammar and inconsistencies in style. Check for spelling errors, going beyond what spell-check will find. Check references to sources, to figures and tables, and to other sections of the proposal. Check for jargon and make sure acronyms are defined.

Most importantly, the proposal writer should check for compliance with the requirements of the solicitation. Go back to the compliance matrix or checklist to make sure the proposal has covered all the necessary items. Are all the required sections and documents included? Are page limits observed?

An NSF Program Officer highlights the following pitfalls to avoid:

- “Failure to establish significance of your work
- Too much text devoted to complex details or past accomplishments
- Failure to construct testable hypotheses
- Constructing too many hypotheses
- Too ambitious for time/money
- Inadequate skills or credentials for proposed task

[26] There are many science and technical writing resources at the following website: University of Chicago Library, “Science Writing and Style Guides,” <http://www.lib.uchicago.edu/e/su/chem/science_writing.html>.

[27] There are many more writing tips at: National Institute of Allergy and Infectious Diseases, “NIH Grant Cycle, Part 4. Target Your Audience,” <http://www.niaid.nih.gov/ncn/grants/cycle/part04.htm>.

- Poor experimental design
- Bad analytical or statistical methods"[28]

The second task is to have a colleague review the proposal. It may be appropriate to have more than one colleague review the proposal if the researcher would like to get various perspectives. Be specific in the feedback requested. It is helpful if the researcher provides a list of items for feedback. "Please look for style or format." "Please look for inconsistencies." "Please review for compliance." The proposal writer should evaluate the feedback and decide how to incorporate it into the proposal.

Self-review, review by a colleague, and revision will be an iterative process. It may take one, two, or more reviews, but each is an investment in the proposal outcome. At the conclusion of this step, the proposal is complete and ready for submission to the grant making organization.

STEP 6: SUBMIT THE PROPOSAL, GRANT AWARD, AND REVIEWER FEEDBACK

The final step in proposal writing is to submit the proposal, acknowledge the award outcome, and absorb reviewer feedback. This step has multiple components, providing closure to the proposal writing process. There are three tasks in this step.

The first task is to submit the proposal. While it may be obvious, the researcher should follow the submission guidelines in the solicitation. Allow ample time to submit whether in hard copy or electronically. NSF uses an electronic system called FastLane, but proposals can also be submitted via the U.S. government-wide Grants.gov. FastLane is a key interface between NSF and potential and current researchers.

From the perspective of the proposal writer, the second task is to acknowledge the award outcome. The proposal review process, discussed in the following section, comes between the first and second tasks and is part of the larger grants cycle (refer to Figure 6). The researcher will want to know the results of his or her hard work and diligence in putting together the proposal. If the outcome is positive and the researcher has been awarded funding, he or she will be entering the new process of managing the grant. If the outcome is negative and the researcher has not been awarded funding, he or she will want to understand the rationale for the decision.

The last task is to absorb reviewer feedback. This is important irrespective of the award outcome. Reviewer feedback is constructive criticism to help the researcher improve his or her current research proposal, as well as future research proposals. It is not necessary to agree with each comment or every reviewer, but take away the most helpful points raised and learn from them.

At the conclusion of this step, the researcher has completed the proposal writing process. Depending on the award outcome, he or she will be moving on to managing an award or considering whether to resubmit the proposal. The following exercise will bring together some of the main points in the proposal writing process.

Exercise 4: Select a renewable energy technology that needs funding. Answer the following questions:

- *What is the key scientific question?*
- *What would be an effective research approach?*

[28] Prentice 183-184.

- *What are several funding organizations?*
- *How would you manage the proposal effort?*
- *What would be some key points to include in the proposal?*
- *What would be a mistake to avoid?*

GRANTOR PROPOSAL REVIEW PROCESS

The funding organization that receives the proposal will have to review and evaluate the proposal, as well as all the others it receives in response to the solicitation. This section is designed to give some insights into the proposal review process. The discussion is framed from the standpoint of the funding organization and reviewers. The researcher will develop a better understanding of the process and timeline. The researcher will also gain insights on how the review process can strengthen his or her proposal writing.

The funding organization will have a standard process for evaluating proposals. Figure 9 illustrates the basic steps. The proposal is received at the funding organization, either electronically or in hard copy. Many organizations have an electronic system for managing proposal processing and all of the steps will be managed and executed through this system. For example, NSF's system is called FastLane. The proposal is then assigned to the appropriate office within the funding organization and a program officer is assigned to monitor and direct the proposal through the review. The program officer will provide an initial review to make sure the proposal is complete, relevant to the office/program, and meets the requirements of the solicitation.

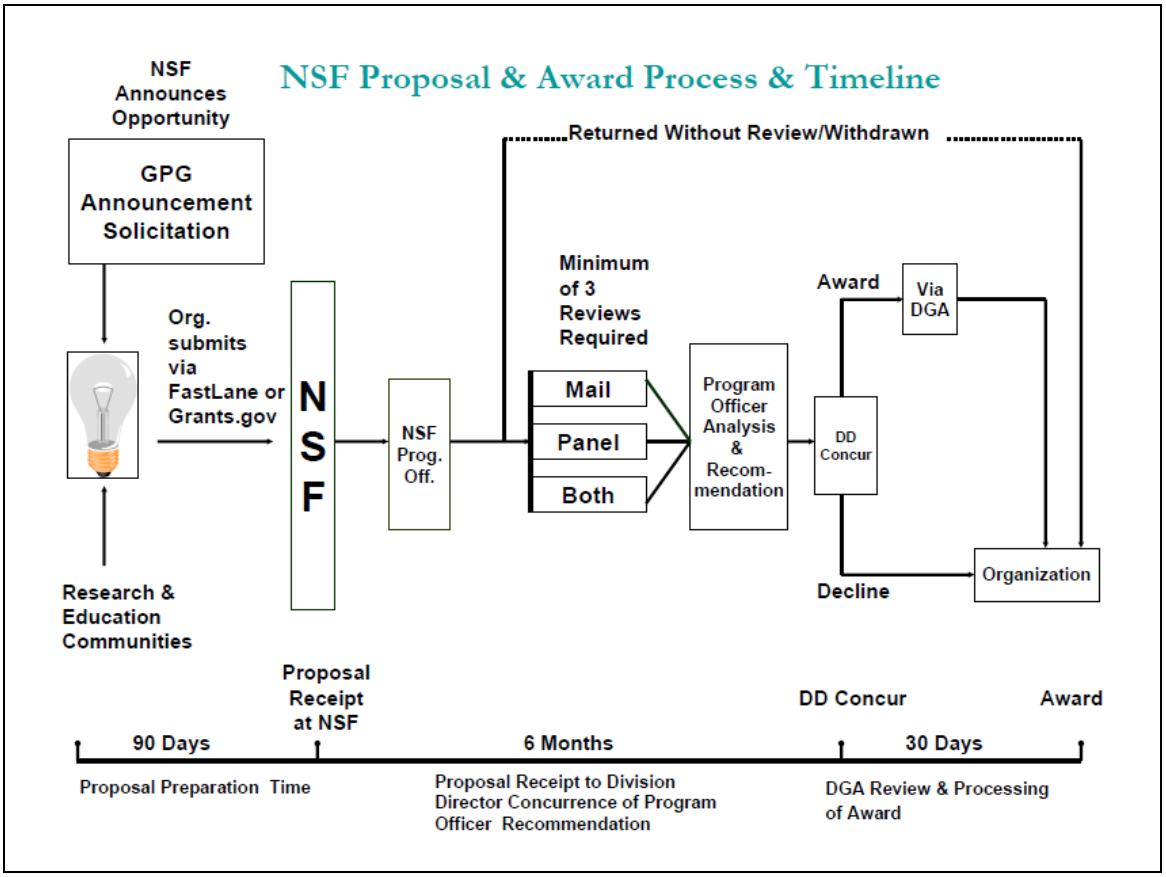
The program officer will begin to coordinate the peer review process. If the researcher has provided a list of suggested reviewers, the program officer will use this and other resources to empanel a group of reviewers from the proposal's field of research. The review format and criteria are discussed below. The results of the review are returned to the program officer. A recommendation is made to either award or decline the research proposal.

Figure 9 Grantor Proposal Review Process

NSF has a four step process for proposal review. First, reviewers are selected based on their knowledge and expertise within the field of research. The program officer strives to select a diverse group of three to ten outside reviewers. Then, the peer review is conducted where each reviewer evaluates the proposal according to NSF's intellectual merit and broader impact criteria. Additional criteria may be applied if indicated in the solicitation. Next, the program officer makes a recommendation to the division director based on the

results of the peer review. Last, the division director makes the final decision whether to award or decline funding and the researcher is notified of the outcome.[29] Figure 10 is a diagram of this process.

Figure 10 NSF Proposal & Award Process & Timeline (GPG III-5)



The final point about NSF's process is that it can take close to a year. The agency estimates 90 days for proposal preparation. That means steps 3 through 6 in the proposal writing process. The agency estimates 6 months or longer depending on complexity to conclude the proposal review process and reach an award decision. It then takes another 30 days to process and finalize the award.

REVIEW CRITERIA

Each funding organization has its own review criteria, but typically center on scientific merit. NSF uses two review criteria: intellectual merit and broader impacts. NSF's definitions are cited below.

> *What is the intellectual merit of the proposed activity?*
>
> *How important is the proposed activity to advancing knowledge and understanding within its own field or across different*

[29] National Science Foundation, "NSF Proposal and Award Process," <http://www.nsf.gov/bfa/dias/policy/meritreview/mr508.pdf>.

fields? How well qualified is the proposer (individual or team) to conduct the project? (If appropriate, the reviewer will comment on the quality of prior work.) To what extent does the proposed activity suggest and explore creative, original, or potentially transformative concepts? How well conceived and organized is the proposed activity? Is there sufficient access to resources?

What are the broader impacts of the proposed activity?

How well does the activity advance discovery and understanding while promoting teaching, training, and learning? How well does the proposed activity broaden the participation of underrepresented groups (e.g., gender, ethnicity, disability, geographic, etc.)? To what extent will it enhance the infrastructure for research and education, such as facilities, instrumentation, networks, and partnerships? Will the results be disseminated broadly to enhance scientific and technological understanding? What may be the benefits of the proposed activity to society? (GPG III-1)

Examples of intellectual merit and broader impacts can be found by researching recent awards and reading the abstracts at http://www.nsf.gov/awardsearch/. NSF also provides some examples in the following document: National Science Foundation, "Merit Review Broader Impacts Criterion: Representative Activities," July 2007, <http://www.nsf.gov/pubs/gpg/broaderimpacts.pdf>.

REVIEW FORMAT

The peer review format can vary depending on the funding agency. Typically, the panel of reviewers will meet to discuss their evaluation of each proposal. The panel may also meet virtually to discuss the evaluations. Regardless of the format, each reviewer will review the proposal and perform an evaluation. Reviewers will be given instructions on how to conduct the review. See the instructions for NSF reviewers in Figure 11.

The following items from the review will be made available to the researcher:

- Description of the context in which the proposal was reviewed;
- Copies of all reviews used in the decision (with any reviewer-identifying information redacted);
- Copy of panel summary, if the proposal was reviewed by a panel at any point in the process; and
- Site-visit reports, if applicable (GPG III-4).

Figure 11 NSF Reviewer Instructions

• Comment in detail on the quality of the proposal

• Provide an overall rating of the proposal

• Identify the proposal's strengths and weaknesses for each NSF Merit Review Criterion:

–What is the intellectual merit of the proposed activity?

–What are the broader impacts of the proposed activity?

• Provide a summary statement that includes the relative importance of the two criteria in assigning your rating. (You do not have to weigh the criteria equally.)

• Indicate any potential conflicts of interest that you might have in evaluating the proposal (optional if no conflict of interest exists).

• Recommend any other qualified reviewers for this proposal (optional).

Source: National Science Foundation, FastLane, "Proposal Review Introduction," < ttps://www.fastlane-beta.nsf.gov/NSFHelp/flashhelp/fastlane/FastLane_Help/fastlane_help.htm#proposal_review_introduction.htm>.

At the conclusion of this section, the researcher should have an appreciation for the detailed review a proposal receives by the funding organization. It is important to apply these insights to the proposal writing process. With an understanding of what reviewers look for, the following exercise will put that into practice.

Exercise 5: Critique the following sections of a renewable energy proposal.

- *Identify the proposal's strengths and weaknesses for each NSF Merit Review Criterion:*
  - *Intellectual merit*
  - *Broader impacts*

This proposal is for a project to investigate the integration of green roofs and solar panels. Professor Carl Wamser of Portland State University is one of the investigators and was awarded $315,000 from the NSF Energy for Sustainability and related programs for a three-year project started in April 2009.

Award #0853933 Integrating Green Roofs and Photovoltaic Arrays for Energy Management and Optimization of Multiple Functionalities.

> *Intellectual Merits: In this proposal we present a plan to study the combination of green roof and photovoltaic arrays in the urban roof-top environment of Portland, Oregon. Green roofs and roof-top photovoltaic arrays are two important strategies for enhancing the environmental sustainability of the built environment. Green roofs have increased in popularity because of their favorable impact on building energy utilization, local heat island effects and*

storm water control. Manufacture and installation of solar photovoltaics is rapidly growing based on improving economics and their preeminent role in generating renewable, carbon-free energy. Despite the promise of these green technologies, there have been relatively few quantitative studies of the interactions between green roofs and roof-top mounted photovoltaic panels under actual field conditions. Prior studies indicate that green roofs thrive better with partial shading and that silicon solar cells operate at higher efficiency at cooler temperatures, suggesting that the combination of these two systems in the rooftop environment may have favorable reciprocal effects. In this proposal we present a research plan focused on addressing the fundamental question: Can green roof design and/or management be altered to enhance both photovoltaic energy production and green roof function in a combined technology system?

This project will use the PSU Photovoltaic Test Facility as the site for studying interactions between green roof systems and photovoltaic arrays. The current design of the Photovoltaic Test Facility consists of nine different arrays totaling 11 kW of peak power generation. It will be a demonstration and test site for comparing different types of solar technologies that are currently available to homeowners and businesses in Oregon. The goal is to provide information that will be useful and engaging for a wide range of audiences, including students, educators, researchers, manufacturers, installers, policy-makers, and the general public. This project will significantly expand the research capabilities of the facility, specifically investigating the effects of installing a variety of green roof systems under selected (otherwise identical) solar arrays. We will establish a suite of experimental green roof microcosms to test hypotheses examining the relationship between green roof properties (species composition and evapotranspiration) on photovoltaic energy production and roof carbon gain. In addition, we will examine how these technologies (separately and in combination) impact building energy consumption and the development of the urban heat island effect.

Broader Impacts: The long-term goal of this project is to provide data that will advance our ability to design integrated green roof-photovoltaic array systems that can be optimized for multiple purposes on urban rooftops. We believe this integrated approach to green engineering will be an important strategy for promoting environmental sustainability in the urban environment. Although results are expected to help guide the planning for future large-scale installations in Portland, the concepts and results generated will be broadly applicable to any urban system, based on this project's proposed modeling efforts. Direct use and implementation of our results will build upon collaborations with the City of Portland Bureau of Environmental Services, Portland General Electric, Oregon BEST (Built Environment and Sustainable Technology Center), Gerding Edlen Development, and GreenWorks, with planned outreach components with the Oregon Museum of Science and Industry. Further, this project will establish a research facility capable of hosting a wide range of future studies.

The project will provide interdisciplinary research training for 8 to 10 undergraduate research assistants and three graduate students at Portland State University (PSU). Undergraduates at PSU, an urban university, include a high proportion of financial aid students, students who are the first members of their families to attend college, and non-traditional re-entry students. Through development of a senior capstone course, engineering students will participate in key design and development aspects of this proposed work. Finally, it is noted that this research will support an emerging collaborative

relationship between faculty members in multiple departments at PSU; such collaborations, across disciplinary boundaries, are fundamental to encouraging innovative research progress in environmental sustainability.[30]

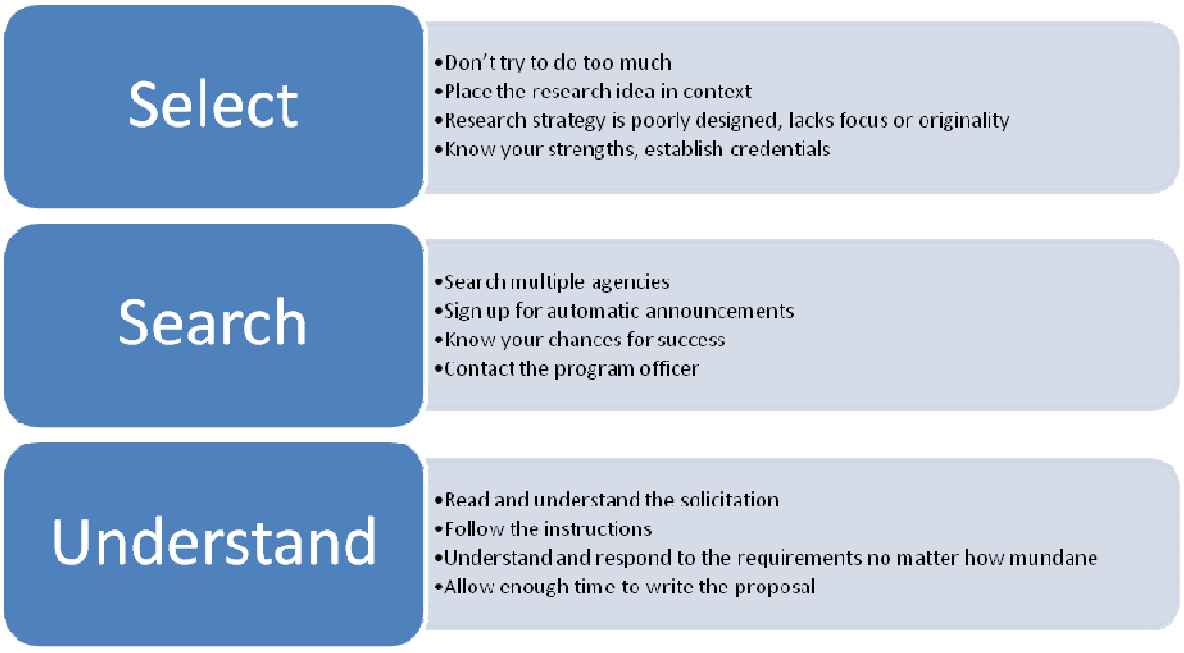
PROPOSAL WRITING TIPS AND TECHNIQUES FROM EXPERIENCED WRITERS AND REVIEWERS

With an understanding of the grants process, the proposal writing process, and the review process, what other ways are there to improve the grant proposal? Learn from experienced proposal writers and reviewers. Reviewers and program officers see tens and hundreds of proposals that are bad, good, and great. They have seen common mistakes as well as beautiful prose. Experienced proposal writers have learned hard lessons about what works and what doesn't. This section is a compilation of the hints, tips, and techniques shared by seasoned writers and reviewers.

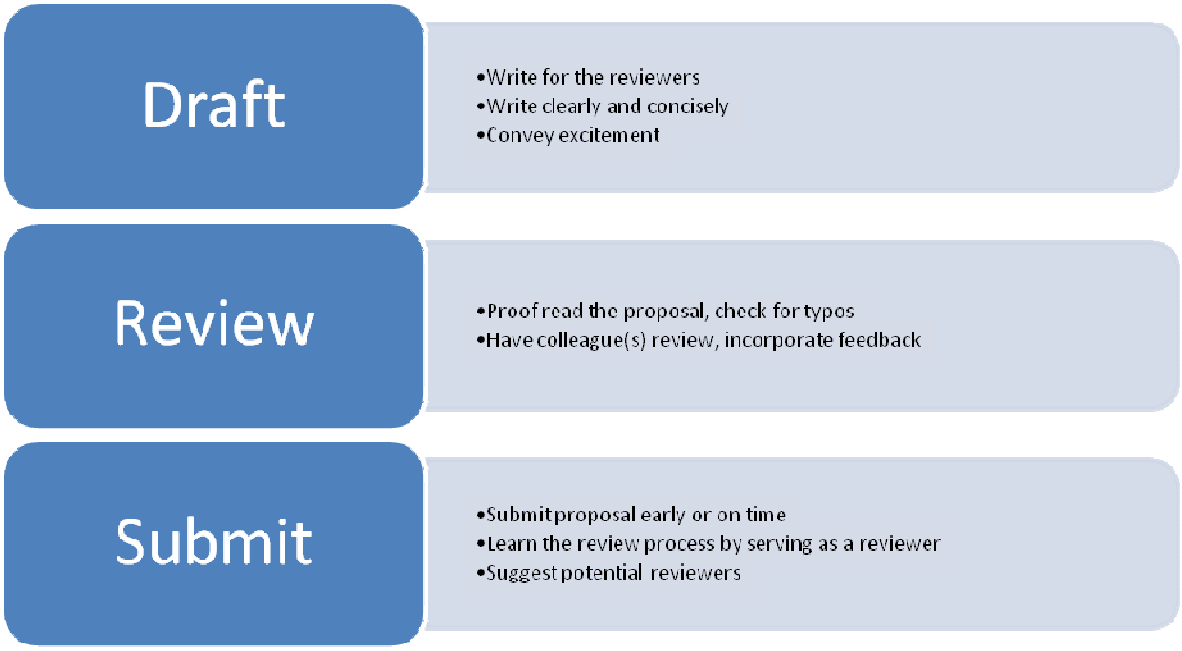
Some of the tips and techniques have been mentioned in previous sections. Some are embedded in the proposal writing process. Some of the tips seem obvious, but can often be overlooked in a rush to complete. Other tips are based on tacit or implied knowledge, which is difficult to document.

In the course of research for this document, numerous tips and techniques were collected. Without listing the over 200 suggestions, a brief analysis was conducted to extract themes. Figure 12 illustrates the themes as they relate to each of the proposal writing steps. Sources of the tips and techniques are listed in Appendix 2.

Figure 12 Themes from Tips and Techniques



[30] Carl Wamser, Portland State University, "Integrating Green Roofs and Photovoltaic Arrays for Energy Management and Optimization of Multiple Functionalities," Email, 11 September 2009.



Overall, proposal writers and reviewers suggest that proposal writing not take place in a vacuum. While the actual writing can be a solitary activity, involve others. Ask for feedback at any of the proposal writing steps. There are resources at every step of the way and people that are willing to assist the researcher in his or her endeavor. Implementing these suggestions can help increase the probability of a successful proposal.

CASE STUDIES

Case studies are an important learning tool when it comes to proposal writing. They offer the opportunity to learn from the experiences of proposal writers and proposals themselves. Proposal writers can share their insights into the proposal writing process. Successful proposals and reviewer feedback can point to those positive and negative features for future improvement. The case study will present some key facts about the proposal, the proposal writer's assessment, and excerpts from the proposal.

CASE STUDY: BIOSOLIDS PROPOSAL

This case study is about a Jordanian researcher working with an American collaborator in the area of wastewater management. Dr. Nisreen Al-Hmoud of the Environmental Research Center at the Royal Scientific Society developed a working relationship with a researcher at the University of Arizona (UoA), while UoA was conducting experiments in Jordan. The first project accomplished was "aimed at assessing the feasibility of utilizing generated dewatered bio-solids for improving soil fertility and crop production in Jordan." The second project and subject of this case study "will investigate the feasibility of the combined reuse of reclaimed wastewater and bio-solids for improving soil fertility and crop production in addition to studying the fate of pathogens when Type I bio-solids is rewetted with treated effluent." Figure 13 summarizes the proposal.

Figure 13 Biosolids Proposal Summary

Proposal Overview

Proposal Title	"Sustainable Development of Dry Lands in Asia and the Middle East—Jordan Component"
Objective	Study the feasibility of using bio-solids and treated effluent for improving soil fertility and crop production in Jordan
Proposer	Dr. Nisreen Al-Hmoud, ERC, RSS -Submitted proposal via Jordan Badia Research and Development Center (BRDC)
Funding Organization	United States Agency for International Development (USAID) via International Arid Lands Consortium (IALC)/ University of Arizona(UoA) collaboration
Start Date	April 2007
Proposed Funding	$57,710 USD

About the Proposal

1. What program description, solicitation, or RFP did you respond to?	There was not a formal solicitation. Dr. Al-Hmoud submitted a proposal to UoA (through BDRC) for the ERC portion of the research.
2. Could you provide your project summary and/or project description?	The proposed project will investigate the feasibility of the combined reuse of reclaimed wastewater and bio-solids for improving soil fertility and crop production in addition to studying the fate of pathogens when Type I bio-solids is rewetted with treated effluent.
3. What features of your proposal made it a winning proposal?	The relationships amongst the various parties were already established.

About the Proposal Process

4. What steps did you follow in your proposal writing process?	Dr. Al-Hmoud and her UoA collaborator focused on the problem and solution in the 2005-2006 timeframe. They spent a lot of time brainstorming. She then wrote the proposal herself.
5. What were the challenges in developing the proposal?	One of the challenges was working through many intermediary organizations. Another challenge was working with a funding organization (USAID) that is not research oriented. It doesn't understand the length of time to get results from research. This proposal was easier to write than proposals for other funding organizations, because it did not call for the involved proposal requirements and justifications that are typical of other funding

	organizations.
6. What advice would you give to other proposal writers?	-Spend your time thinking, not writing. Proposal writing is a learning experience. Allow 6 months or more for proposal writing. It may 2 years before a contract is in place. -Start dialogue early with the funding organization. Building trust with the funding organization over time and over multiple proposals makes proposal writing easier. -Submit the proposal in the best shape possible, not a half-hearted attempt. -Stick to the format.

Excerpts:

1. <u>INTRODUCTION</u>

The reuse of treated wastewater and bio-solids is a concept that is being increasingly accepted in most regions of the world, both in industrialized and developing countries, but one which will dramatically increase in global importance over the coming decades. The reason for this is as simple as it is stark: the number of people living in water-stressed and water-scarce countries is increasing at a rate much greater than that of the number of people in the world, hence, the need for water and food is continuously increasing (Mara, 2006) and (Kretschmer et al, 2002).

Recent changes in regulations concerning municipal wastewater treatment in Jordan have resulted in a significant increase in treated domestic wastewater production and, accordingly, bio-solids quantities. The majority of Municipal Wastewater Treatment Plants MWTPs in the country are of secondary type, achieving nutrient and pathogen reduction utilizing conventional and modified activated sludge processes. Treated effluent is either discharged to environment or reused in agriculture, while, generated bio-solids are usually thickened, and then dewatered utilizing drying beds.

In Jordan, the discharging of reclaimed wastewater from domestic wastewater treatment plants is an important component of water budget. About (94) Million Cubic Meters (MCM) in the year 2003, 101 MCM in the year 2004 and 107 MCM in the year 2005 were treated and discharged into various watercourses or used directly or indirectly for irrigation and other intended uses and it is expected to increase up to 262 MCM in the year 2020 (Uleimat, 2006).

Sewage sludge / bio-solids represents an increasing challenge all over the world. In Jordan, huge amounts of bio-solids are generated annually and unfeasibly transferred to dumping sites. In other words, none of the bio-solids is being reused or recycled. Bio-solids contain organic matter and nutrients that are essential to crops. Potentially, bio-solids can be used as fertilizer to enhance soil fertility and crop production. In this respect, the reuse of bio-solids in agriculture can be both economically and environmentally accepted (Amin and Sherif, 2001).

This proposed project is a continuing activity to a previously funded project by the International Arid Lands Consortium IALC / University of Arizona UoA that was executed by the Environmental Research Center ERC of the Royal Scientific Society RSS of Jordan over a period of two successive seasons. The previously funded project aimed at assessing the feasibility of utilizing generated dewatered bio-solids for improving soil fertility and crop production in Jordan. The proposed project will investigate the feasibility of the combined reuse of reclaimed wastewater and bio-solids for improving soil fertility and crop production in addition to studying the fate of pathogens when Type I bio-solids is rewetted with treated effluent.

2. CURRENT SITUATION, PROBLEM AND JUSTIFICATION

The expanding population and the climatic and topographical conditions in Jordan have exerted enormous pressure on the limited water resources and created a severe water supply-demand imbalance where the renewable water resources are amongst the lowest in the world, and is declining with time (Malkawi, 2003).

To ensure a nation-wide control of the wastewater quality, the first Jordanian Standard (JS) on treated domestic wastewater was published by the Jordanian Institution of Standards and Metrology (JISM) in 1994. Already in 1995 the standard was revised and the Standard Specification (Water - Treated Domestic Wastewater) No. 893 was published by JISM in 1995. This standard was valid until 2002 and was then replaced by the Standard Specification (Water- Reclaimed Domestic Wastewater) No. 893 of 2002 (Hussein, 2006).

Jordan has 23 wastewater treatment plants distributed throughout the country. The total discharge of all treatment plants in 2005 was 107 MCM (Uleimat, 2006). Since 2002, Jordan has the standard JS 893/2002 for the effluent (also called reclaimed water) from wastewater treatment plants that is released into streams, valleys (wadis) or water bodies and used for artificial recharge of groundwater aquifers that are not used for drinking purposes or used for restricted agriculture. Within the treatment plants and in their vicinity about 1.400 hectares are used for restricted agriculture, mainly fodder crops, cereals and trees. In the central and southern Jordan Valley diluted reclaimed water is used for unrestricted irrigation on about 11.000 ha (Vallentin, 2006).

With regard to bio-solids, a field survey carried out in 2005 by Royal Scientific Society (RSS) in cooperation with Water Authority of Jordan (WAJ) and the biosolids ad hoc committee revealed that about 300,000 m^3 of liquid sludge as well as 15,000 m^3 of dewatered bio-solids are generated annually in addition to 600,000 m^3 of sludge accumulated at As-samra treatment plant. Almost all generated sludge and bio-solids quantities are usually disposed of at near-by dumping sites with high transfer cost, in other words, there are no beneficial uses of sludge and bio-solids in Jordan (RSS report, 2005).

The Jordanian regulations for bio-solids reuse and disposal No. (1145/2006), a modified version of the previous standard No. (1145/1996), classify bio-solids according to some microbiological, chemical and physical aspects into three classes, class I is used as a fertilizer, class II is used as soil amendment and class III is to be disposed of in sanitary landfills.

Madaba wastewater treatment plant, where the proposed project activities will be carried out, started operation in (1988). The treatment system used to be of waste stabilization ponds type, and then later in (2002) it was changed to mechanical system (activated sludge). The treatment plant currently serves about (50,000) inhabitants. The influent to the treatment plant is 5,500 m^3/d (Tamimi and Freitas, 2006). The treated effluent amount is totally used to irrigate lands grown with forage crops within the vicinity of the treatment plant.

Treatment operations at Madaba treatment plant starts with screening and grease removal unit, the secondary treatment consists of an aeration tank, two secondary clarifiers and two polishing ponds. Sludge treatment units consist of two thickeners and (156) drying beds. Total amounts of dewatered bio-solids generated annually are about 900 m^3 (WAJ, 2005).

3. OBJECTIVES

The general objective of the proposed project is to investigate the feasibility of using bio-solids and treated effluent for improving soil fertility and crop production in Jordan. The specific measurable objectives are:

1. *To evaluate the impacts of applying bio-solids and treated effluent on soil properties and on crop yield and quality based on field-pilot experiments.*

2. *To recommend appropriate bio-solids application procedures and loading rates for fodder crops irrigated with treated effluent.*

3. *To determine the fate of pathogens in bio-solids when re-wetted with treated effluent under irrigation of fodder crops.*

4. SCOPE OF WORK AND METHODOLOGY

In order to evaluate the effect of irrigation with reclaimed wastewater in parallel with bio-solids fertilizing, field experiments during two growing seasons will be conducted on a piece of land kindly contributed from WAJ within the vicinity of Madaba WWTP. Maize and Sudan grass (summer crops) will be grown at the beginning of May/2007 and April/2008, respectively. Reclaimed wastewater and dewatered bio-solids from Madaba treatment plant will be utilized. Irrigation with reclaimed wastewater will be scheduled based on crops irrigation requirements.

The experiments will be established in Split Plot Randomized Complete Block Design (SPRCBD) with four replications in one row. The proposed dimensions of each plot are 7m X 7m. The treatments will be designed to study the combined effect of bio-solids application at different rates in parallel with irrigation with reclaimed wastewater, bio-solids will be applied at rates: 0, 2, 4, 6, and 8 ton/ha.

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APPENDIX 1

NSF PROPOSAL PREPARATION CHECKLIST (GPG II-28-29)

[ ] **General:**

[ ] Proposal is responsive to the program announcement/solicitation or to the GPG.

[ ] If a proposal has been previously declined and is being resubmitted, proposal has been revised to take into account the major comments from the prior NSF review.

[ ] Proposed work is appropriate for funding by NSF, and is not a duplicate of, or substantially similar to, a proposal already under consideration by NSF from the same submitter.

[ ] **Single Copy Documents:**

[ ] Information about Principal Investigators/Project Directors (except for the required information regarding current or previous Federal research support and the name(s) of the PI/co-PI, submission of the information is voluntary).

[ ] Authorization to Deviate from NSF Proposal Preparation Requirements (if applicable).

[ ] List of Suggested Reviewers, or Reviewers Not to Include (optional).

[ ] Proprietary or Privileged Information Statement (if applicable).

[ ] Proposal Certifications (submitted by the Authorized Organizational Representative within 5 working days following the electronic submission of the proposal.) (See GPG Chapter II.C.1e for a complete listing of proposal certifications.)

[ ] SF LLL, *Disclosure of Lobbying Activities* (if applicable). (One copy only, scanned as a single copy document.)

[ ] **Cover Sheet:**

[ ] Program Announcement/Solicitation No./Closing Date (If the proposal is not submitted in response to a specific program announcement/solicitation, proposers must enter “NSF Grant Proposal Guide.”)

[ ] Specific NSF program(s) identified (if known).

[ ] For renewal proposal, previous award number entered.

[ ] Related preliminary proposal number entered (if applicable).

[ ] Check Appropriate Box(es), and provide requisite information, if the proposal includes any of the items identified. Note in particular, proposals that include use of human subjects or vertebrate animals require additional information to be submitted with these types of proposals.

[ ] **Project Summary:**

Note limitation of one page, and the requirement that both merit review criteria be separately addressed within the body of the Summary.

[ ] **Project Description:**

[ ] Note limitation of 15 pages

[ ] Merit Review Criteria: Ensure both merit review criteria are described as an integral part of the narrative.34

[ ] Inclusion of Universal Resource Locators (URLs): PIs are advised that the Project Description must be self-contained and are cautioned that URLs (Internet addresses) that provide information necessary to the review of the proposal should not be used because reviewers are not obligated to view such sites.

[ ] Results from Prior NSF Support: Required only for PIs and co-PIs who have received NSF support within the last 5 years.

[ ] Human-resource information: Required for renewal proposals from academic institutions only.

[ ] **References Cited:**

[ ] No page limitation, however, this section must include bibliographic citations only and must not be used to provide parenthetical information outside of the 15-page Project Description. Each reference must be in the specified format.

[ ] **Biographical Sketch(es):**

[ ] Note limitation of 2 pages per individual; required for all senior project personnel. The required information must be provided in the order and format specified.

[ ] **Proposal Budget:** (cumulative and annual)

[ ] Budget Justification (Note limitation of 3 pages **per proposal**.)

[ ] **Current and Pending Support:** Required for all senior project personnel.

[ ] **Facilities, Equipment and Other Resources**

[ ] **Special Information and Supplementary Documentation:**

[ ] See GPG Chapter II.C.2j for the types of information appropriate for submission in this section, as required.

[ ] Any additional items specified in a relevant program solicitation.

[ ] **Special Guidelines:**

[ ] Note that GPG Chapter II.D contains special proposal preparation instructions for certain types of proposals.

APPENDIX 2

SOURCES FOR TIPS AND TECHNIQUES IN SECTION 6

American Astronomical Society, “Hints on Preparing Research Proposals,” <http://aas.org/grants/hints.php>.

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