Document 521
PRE-ASSESSMENT REPORT

CHAPTER: EWB-Oregon State University
COUNTRY: Kenya
COMMUNITY: Lela
PROJECT: Lela Community Water Project
TRAVEL DATES: 08 June - 01 July 2011

PREPARED BY
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13 February 2011

ENGINEERS WITHOUT BORDERS-USA
www.ewb-usa.org

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Pre-Assessment Report Part 1 – Administrative Information

1.0 Contact Information

Project Title	Name	Chapter Name or Organization Name
Project Leads	**Daniel Bailey**	**EWB - OSU**
President	**Jordan Machtelinckx**	**EWB - OSU**
Mentor #1	**Paul Berg**	**CH2M Hill**
Mentor #2	**Jack Istok**	**OSU**
Faculty Advisor (if applicable)	**Kevin Boston**	**OSU**
Health and Safety Officer	**Zachary Dunn**	**EWB-OSU**
Assistant Health and Safety Officer	**Jaynie Whinnery**	**EWB-OSU**
Education Lead	**Jaynie Whinnery**	**EWB-OSU**
NGO/Community Contact	**Charles Olang'o**	**Lela, Kenya**
NGO/Community Contact	**Wilson Olang'o**	**Nairobi, Kenya**

2.0 Travel History

Dates of Travel	Assessment or Implementation	Description of Trip
14 - 29 Dec 2009	Assessment	Initial community health and needs assessment

3.0 Travel Team:

#	Name	Chapter	Student or Professional
1	Jaynie Whinnery	OSU	Student
2	Zachary Dunn	OSU	Student
3	Miriam Goldade-Holbrook	OSU	Student
4	Don Moris		Professional

4.0 Health and Safety

The US Department of State's most recent travel warning for Kenya was issued on December 28, 2010 and remains in effect, due to terrorist threats and violent crimes. The restricted area includes the northeast portion of the country and along the Somalian border, up to 80 kilometers from the border in some areas. For this assessment, travel will be limited to the southwest corner of the country, west of Nairobi and south of Nakuru. The travel team will sign up for the Smart Traveler Enrollment Program (STEP) through the US Department of State.

The group will remain within reasonably close proximity to each other for travel and day to day activities. The team will carry a cell phone to remain connected with EWB-OSU and also carry walkie-talkies so that when sub-group splits become necessary while in Lela they can remain in constant contact.When there is a need to separate, groups will be no less than two persons. Translators or other capable communicators will be assigned to each group when separation is necessary. All team members will carry a small amount of cash for travel, a list of emergency phone numbers, and a calling card. A meeting place will be designated daily and schedules will be shared in order to facilitate communication should an emergency arise. Three members of the travel team will have current CPR and First Aid certification through the Red Cross and will remain in separate groups when the team is required to split.

All travel members will fill out the personal health and emergency contact form listing all medical conditions, treatments, location of medications, and relevant contact information such as emergency contacts, doctors, etc. Prior to departure all persons traveling will have received vaccinations and other preventative medications recommended by the Centers for Disease Control and Prevention. These include the following:

- Measles/mumps/rubella (MMR)
- Diphtheria/pertussis/tetanus (DPT)
- Poliovirus
- Hepatitis A & B
- Typhoid

- Yellow Fever
- Malaria prophylaxis (NOT chloroquine)
- Necessary prescription drugs

Precautions will be taken to prevent insect bites and stings including wearing long pants and sleeves whenever possible and using insect repellent in order to prevent other illnesses such as Dengue Fever. Schistosomiasis is present in Kenya and will be prevented by not swimming in fresh water sources. Avian influenza is a slight risk so the team members will avoid contact with birds, especially domesticated chickens and ducks. A health and first aid kit will be taken which contains basic emergency care supplies such as pain/fever relievers, minor stomach upset, band-aids, antibacterial ointment, and such to take care of minor injuries while in Lela.

Travel Insurance details
Travel insurance will be purchased through the Seven Corners portal on the EWB-USA website. In addition, trip cancellation insurance was purchased via a separate policy from Seven Corners. As a note to EWB-USA, it would be helpful to have a trip cancellation option available through the EWB-USA required plan so that chapters are not forced to purchase overlapping coverage at an additional expense.

Food and Water
The team will buy a few food provisions from an urban town as well as several jugs of water. Upon arrival to the village the team will offer to pay for food from the village but refusal is anticipated due to a culture of generous hospitality in Kenya. The team will not consume any unwashed or unpeeled vegetables and will boil or treat all water prior to use.

Local Customs
When meeting people it is polite to ask about their health and the wellness of their family. Seeking privacy and isolation may be viewed with concern as Kenyans generally do not share American ideals of privacy. Many Kenyans generally do not place importance on punctuality or timeliness. When eating around Kenyans, sharing anything will be greatly appreciated and they will most likely attempt to share what they have with the team. Bribery and corruption is seen as generally commonplace by locals but should be avoided when possible. However, it is preferable to spending hours in a Kenyan jail. When shaking hands with someone of the opposite sex you should only give a light touch, anything harder is sometimes recognized as a sexual advance.

Weather and Other Natural Hazards
Flooding is a concern in Western Kenya, but this trip will be during the dry season so flooding is unlikely. Overheating and dehydration will be a greater concern during this assessment trip. The travel team members will prioritize staying cool and consuming plenty of water, but are also trained in the necessary first aid skills should a heat related health issue arise.

Transportation

Upon arrival the team will be met at the airport by a member of the Olang'o family (either Wilson or Paul) and escorted while in Nairobi and until arrival at Lela. The team will take a taxi to a hotel the day of arrival, ride the bus to Migori, and take a taxi from Migori to Lela. Three days before departure, the team will ride the bus from Migori to Nakuru and stay in a hotel there. The day of departure, the team will take the bus from Nakuru to Nairobi and a taxi straight to the airport. All taxis will be arranged with trusted vendors through the Olang'o family or other Lela community members.

5.0 Budget

5.1 Cost

Expense	**Total Cost**
Airfare	**4 * 2,000**
Travel Insurance	**600**
On Ground	**4 * 500**
Water Testing	**300**
Materials	**100**
Other	**600**
Total	**11,600**

5.2 Donors and Funding

Donor Name	**Type (**company, foundation, private, in-kind**)**	**Account Kept at EWB-USA?**	**Amount**
Private Donors	private	no	All ($11,600)
Total Amount Raised:			**All ($11,600)**

6.0 Project Discipline(s): Check the specific project discipline(s) addressed in this report. Check all that apply.

Water Supply
__x__ Source Development
__x__ Water Storage
__x__ Water Distribution
__x__ Water Treatment
__x__ Water Pump

Sanitation
____ Latrine
____ Gray Water System
____ Black Water System

Structures
____ Bridge
____ Building

Civil Works
____ Roads
____ Drainage
____ Dams

Energy
____ Fuel
____ Electricity

Agriculture
____ Irrigation Pump
____ Irrigation Line
____ Water Storage
____ Soil Improvement
____ Fish Farm
____ Crop Processing Equipment

Information Systems
____ Computer Service

7.0 Project Location
Longitude: 34.398536
Latitude: -1.123123

8.0 Project Impact
Number of Persons directly affected: 400
Number of Persons indirectly affected: 3600

9.0 Mentor Resumes -
Please see Appendix B.

Pre-Assessment Report Part 2 – Technical Information

1.0 INTRODUCTION

The purpose of this document is to inform EWB-USA of EWB-OSU's intentions to travel to Lela, Kenya for a technical assessment trip in June of 2011. The goal of the trip is to assess the quantity and quality of water sources available for the Lela community. This will include the analysis of existing distribution systems as well as potential sources to be developed in the future. The cost and availability of suitable construction materials will be collected for future reference. The objective is to acquire enough data to determine appropriate solutions to address the issues for which Lela has requested assistance.

2.0 PROGRAM BACKGROUND

Lela is a village in the Migori district of southwestern Kenya, 50 kilometers from Lake Victoria. During the first assessment in December of 2009 it was found that the community is larger than previously thought, with 400 households and approximately 3600 people. There is great need for safe, readily available water in order to improve health and allow further educational and economic development. Health surveys were administered during the first assessment and positive relationships were established with the locals. The community of Lela has made many efforts to improve its local water availability. This includes the creation of the Lela Women's Group & Water Committee which initially contacted EWB requesting assistance. Various attempts to mitigate the problem have been made, such as digging several seven meter deep wells and the construction of a water dam to provide water for cattle. Although there is a borehole in Bondo village, this is about three kilometers away and much time and energy is required to collect significant amounts of water. The community was unable to purchase water pipes to connect to this system due to lack of monetary resources and the borehole does not have an electric pump.

3.0 OBJECTIVES OF SITE ASSESSMENT TRIP

3.1 GPS Mapping

Global Positioning System (GPS) units, supplied by the OSU College of Forestry, will be used to map locations of importance, especially in relation to water sources and infrastructure. The last assessment trip took GPS data but due to equipment failure all data was lost. During the next trip, the GPS information will be logged by two GPS units, as well as by hand in a journal. Coordinates will be taken several times a day, or at each location visited. A printed map will be updated daily with handwritten notes and drawings while in Lela, including important buildings, current water sources, and potential well and rainwater catchment placements. A more specific GPS data collection plan is included in the Data Collection & Analysis Section.

3.2 Groundwater Wells

One of the primary objectives of this site assessment trip is to determine if drilling one or more groundwater wells is an appropriate solution to water access in Lela. This is the solution which the Lela Women's Group & Water Committee has specifically requested. The Water Committee contacted the local Water Ministry to request information about boreholes prior to its partnership with EWB-OSU. During the assessment trip in December 2009, the travel team obtained information from the Water Ministry in Migori on pricing for a geotechnical survey ($500) and for drilling a well ($16,000). Also, Lela's existing well, implemented by an unknown NGO on an unknown date, was observed and found to be contaminated and non-functional due to a broken hand pump. During this trip more information will be collected about this well in order to determine if it can be repaired or retrofitted.

Parameters pertinent to well drilling include depth to water, well diameter, and maximum sustained flow rate. The nearest functional drilled well is approximately one kilometer away. The team will gather as much data as possible from this well. Additionally, a meeting will be scheduled with the Water Ministry in Migori to view past drilling logs and discuss previous drilling in the area including depth, flow rates, and trends in water. The team will find out what type of drilling equipment is available for use in Lela. The Water Ministry in Migori must be consulted to determine what the permitting process for well drilling entails. The contact for the Water District Manager Chairman, Mr. Tom Simbi, is (0)72-188-7403 (tomsimbi@yahoo.com). The team will also determine the types of pumps which are readily available and currently in use for wells in the area.

The team will work with the Lela Women's Group & Water Committee to determine appropriate locations for one or more potential wells based on convenience for the community, accessibility for drilling, location of potential contaminant sources (i.e. latrines, livestock), and location of closest surface water. The team will compile a map of the community showing local latrines (if they exist), local water sources, location of households, and other relevant information. During this process communication will be critical to ensure mutual understanding regarding the purpose of these discussions and measurements (i.e. EWB-OSU is not promising to drill any wells).

3.3 Rainwater Catchment

The local primary school is the main potential site for rainwater catchment. The school building has a metal roof which will work well for collecting rainwater. The team will measure roof dimensions, height, and slope, determine possible water storage tank sites, and set up a simple weather station. More importantly, the team will discuss with the Lela Women's Group & Water Committee the possibility of rainwater catchment and how the water would be distributed

equitably. This discussion is very important because this is not a solution requested by the community. The team will also note additional buildings appropriate for potential rainwater catchment.

In order to adequately assess the potential for a rainwater catchment system, basic meteorology data needs to be gathered from the village. Therefore, a simple station will be set up and several members of the Water Committee will be taught how to record data from it. We can then use these data to compare to meteorology data from Migori (about 12 km away) to determine average rainfall patterns.

3.4 Overland Piped Water

The team will visit the nearest river (2 km away) and the reservoir and borehole in Bondo (3 km away) to assess the potential for piping water over land to Lela. At each location GPS data points will be taken and water samples collected for quality testing. The team will discuss the possibility of piping water to Lela from these sources and gather information related to property rights and concerns, depending on whose land the pipes would cross and whether or not that would be allowed.

3.5 Water Treatment Research

There are various options for treatment of water to make it safe for human consumption including filtration, chlorination, and UV disinfection. Chlorination is known to be inexpensive and effective when properly implemented. Filtration is another method being investigated for material availability and cost, including minimal recurring expenses. The priority is to determine the feasibility of implementing a large distribution of point-of-use filters (one for each household, up to 400 filters) and/or community scale filtration and/or chlorination systems. The travel team will talk with locals to find out if any nearby communities are using these methods already and if so, what the results have been and what their perceptions are about these types of systems. If existing treatment systems are located, effluent water samples will be taken for testing (see water quality testing). Additionally, material availability and pricing information will be obtained for chlorination systems and filters. Purchasing pre-constructed filters will also be investigated.

3.6 Water Quality Testing

The water quality assessment plan is comprehensive to ensure consistent sampling and analysis for all water sources under consideration. Water samples will be gathered from the following locations:

- Existing wells in Lela and nearby communities (surface & drilled)
- Nearby river
- Bondo borehole

- Effluent from any water treatment systems located and currently in use
- Rainwater captured for human consumption

Analysis to be completed is prioritized to include only necessary data - metrics directly linked to human health which are also actionable if found to not meet standards set by the World Health Organization (WHO). Because pathogens are the primary human health concern and are likely to be present, all water sources will be analyzed for total coliform and fecal coliform (*e. coli.*) using Petrifilm plates. Some areas of Kenya are known to have fluoride concentrations which greatly exceed WHO recommendations causing fluorosis from prolonged consumption; the overall geology of the area near Migori (and Lela) makes it unlikely that high fluoride concentrations will be found, but testing the water is the only way to be certain. Another risk includes heavy metals, specifically arsenic. It is unknown if the water sources near Lela have fluoride or heavy metal contamination so a selection of samples will be taken to be analyzed at the Catholic Diocese of Nakuru's Water Testing Laboratory. The lab also has the capability to measure other parameters such as alkalinity, total dissolved solids (TDS), nitrate and nitrite, sulfate and sulfite, and chloride. These tests will be done on a sample-by-sample basis if deemed necessary (e.g if a water source is located near an agricultural area or concentrated livestock it should be tested for nitrate and nitrite). [1]

Turbidity is an indicator of the amount of total suspended solids in solution. A calibrated turbidity tube will be used to quantify this metric for any water samples with questionable transmissivity, such as surface wells and rivers. A baseline measurement of pH will be taken using pH strips for each water source as this is an inexpensive and simple procedure and can indicate other issues to investigate if the measurement is not neutral. Turbidity and pH values may be required later for the proper design of water treatment systems.

The team will take care when collecting samples to ensure they are representative of the source, and detailed reference notes will be taken for each sample. More than one sample will be taken at each location in order to make a better data set and to insure against possible contamination of the sample, particularly for samples being taken to Nakuru for analysis. See the Data Collection & Analysis section for additional information.

3.7 Infrastructure Ownership & Maintenance

A maintenance and responsibility plan needs to be agreed upon through discussions with the Lela Women's Group & Water Committee. This includes a plan for technical training and managing finances required for initial implementation, preventative maintenance and repairs for the life of the infrastructure, and ultimately infrastructure replacement at the end of its useful

life. This depends on how many people will be provided with water, how far away those people are from the sources, who will be performing maintenance and repairs, and how they plan to manage money to cover capital and maintenance costs. No implementation will take place during this assessment trip, but it is best to get the community discussing these issues now in preparation for a future implementation.

3.8 Materials Availability & Pricing

The team will visit local shops to gather information for the following materials needed for various design solutions:

General Tools & Materials for Various Designs

- Cement
- Blocks/bricks
- Sand (different particle sizes)
- Tools (hacksaw, hammer, shovel, hoe, drill bits, screens for sifting sand)
- Nails, screws, other fasteners (e.g. tape, rope)
- Pipes & fittings (variety of sizes)
- Chlorine/Bleach
- Pre-constructed Filters

Wells

- Pumps
- Drillers

Rainwater Catchment

- Plastic tanks (10,000-20,000 liters)
- Gravel
- Sand
- Rebar
- Gutters
- Roofing materials (lumber, sheet metal)
- Barrels

Biosand Filters

- Machine shop to deliver steel mold
- Plastic drums
- Buckets
- Splash stones (flat stone)

3.9 Review of Existing Water Infrastructure

The Friends of Kenya Schools and Wildlife organization, headquartered in Junction City, Oregon, has done several water related implementations in Kenyan communities. Some of the methods may be viable options for Lela including community scale filters, in-river hydraulic ram (hydram) pumps, and retrofitting broken well pumps with liners and rope-and-washer pumps [2]. Communities to visit include Molo and Gilgil, both of which are en route from Lela to Nairobi and will be combined with layover in Nakuru for water analysis.

Summary

A list of the planned tasks for the assessment trip for analysis for future implementations is provided in the list below.

1. Take GPS data points and make mapping notes at all landmarks, water systems and sources, and other pertinent locations.
2. Gather data at the nearest borehole (1 km away) and at Lela's current water sources.
3. Review well drilling logs with the Water Ministry
4. Discuss potential well locations with Lela Women's Group & Water Committee
5. Measure dimensions, height and pitch of the school roof and determine potential tank locations (take photos and measurements)
6. Set up weather station at the school, primarily to gather rainfall data.
7. Discuss rainfall patterns with community members (how many days out of each month and how much (heavy, light, etc.))
8. Take note of other structures with rainwater catchment potential (gather measurements and take photos of any buildings identified)
9. Visit the river and Bondo to assess potential for overland piped water and discuss potential systems with community members, including property rights (whose land would the pipes cross and would it be allowed)
10. Discuss water treatment options with the community and attempt to locate current systems nearby to gather data.
11. Water sampling & analysis
12. Have infrastructure and maintenance discussions with the Lela Women's Group & Water Committee
13. Gather material availability and pricing information
14. Review existing water infrastructure in Molo and Gilgil

4.0 COMMUNITY INFORMATION

4.1 Description of Community

Lela is a community of about 400 households, ranging in size from 1 to 30 people, scattered throughout a land area estimated to be between 10 and 35 square kilometers. The December 2009 household surveys revealed an average number of nine people per household for an estimated total population of 3600. Charles Olang'o functions as the leader of the village, although no formal elections seem to have taken place to elect him as such. Prior to contacting EWB, Lelans took it upon themselves to create the Women's Group and Water Committee to facilitate community development, including water infrastructure.

Dholuo is Lela's mother tongue and is spoken within the community. Swahili is also spoken and understood but not used as much as Dholuo. Children learn some English in primary school. The villagers are predominantly Catholic or Protestant, with five small churches scattered throughout. Most residents are small scale farmers of maize, tobacco, beans, sugarcane and vegetables. Some cattle and poultry are raised for subsistence. The average income is estimated at two US dollars per month per household, but this may be a low estimate depending on how much tobacco and other cash crops are being cultivated.

Lela does not have electricity except for one small solar panel on Charles' rooftop that powers two lights, a television, and a radio. Charles also has a small solar powered cell phone charger. Most households consist of two to six mud huts with either thatched or steel roofs and two or three granaries. The huts range in shape and size from 10 to 55 square meters.

Transportation to and from the community is done by taxi, motorbike, bicycle, or foot. Bondo town is about a 10 minute drive from the community over a narrow and very bumpy dirt road. In Bondo there is access to construction materials, a supermarket, and a Barclays Bank. A taxi ride from Bondo to Lela costs 1000 ksh or about $14 (Dec. 2009).

4.2 Community and Partnering Organization/NGO Resources and Constraints

During the first assessment trip (Dec 2009) community members helped EWB-OSU's efforts by fundraising, providing accommodation and food to volunteers, translating to Dholuo, providing free manual labor, collecting local building materials, and providing security and transportation services.

The government water ministry office in Migori is able to provide some assistance with locating licensed well drillers and has information on file about other wells near Lela. The water ministry also has specific requirements for drilling wells in Migori district.

There is a local Rotary Club chapter in Migori, but the first assessment team was unable to make contact with this club due to time constraints. One of the goals of this second assessment trip is to make contact with the Rotary Club and establish communication with it.

Other groups EWB-OSU has been in contact with include:
- Catholic Diocese of Nakuru, http://www.cdnwaterquality.co.ke/
- Friends of Kenya Schools and Wildlife, http://www.fksw.org/

4.3 Community Relations

EWB-OSU has made strong connections with the Olang'o family and the Lela Women's Group. Over 30 households were visited by the first assessment group during the survey of community health. EWB-OSU communicates with Lela weekly to update the community on our progress.

4.4 Community Priorities

The following list is a summary of the community's priorities that EWB-OSU has identified as those which EWB-OSU is able to assist Lela in meeting:
- Secure a local source of clean water for year-round use
- Build personal/community composting latrines
- Reforestation
- Primary school improvements

The following are priorities which EWB-OSU is not able to directly assist Lela in meeting due to either lack of resources or not being the focus of EWB:
- Malaria treatment and prevention
- Opportunities for economic development
- Food security

5.0 DATA COLLECTION AND ANALYSIS

5.1 Site Mapping

The information to be compiled during this assessment trip includes:
- An accurate and functional map of the area
- Locations of existing wells, water sources and systems, as well as potential community centers for water distribution
- GPS data points to create a geo-spatial topographical map
- Geotechnical information regarding local wells

In order to map the site projects in Lela, the team will use a hand held GPS system (available through OSU College of Forestry). In addition to latitude and longitude, altitude will also be recorded so that topographical analysis can be done to assess an overland piped distribution system. The river will also be marked out including elevations.

Upon return the information will be quickly turned over and added to the EWB OSU digital library on STAK for safe keeping and future reference.

5.2 Technical Data Collection

Pricing information from the Catholic Diocese of Nakuru Water Quality Lab is shown in Appendix A - Table 1. Samples collected during the two weeks spent in and around Lela will be taken to the water lab in Nakuru at the end of the trip for analysis. Because of this, EWB will perform microbiological analysis in the field immediately following sample collection. While not included in the table, the lab does have the ability to analyze arsenic using a digital arsenator from Wagtech. Also, the heavy metals testing capability is an upgrade which is planned for April 2011 and therefore should be available by this assessment trip. The cost for arsenic and heavy metals analysis is estimated at $4.00 per sample for planning purposes. The total budget for water quality testing is $250 as shown in Appendix A - Table 2.

The following is a comprehensive list of data to be collected during the assessment trip:

1. Site Map & GPS data points
    a. General Map of Lela Community
    b. Water Sources
    c. Current Water Systems
    d. Important Buildings & Structures
2. Water Quality Testing
    a. EWB will perform the following:
        i. Petrifilm plate sampling for fecal coliform and total coliform
        ii. Turbidity tube measurements
        iii. pH testing using pH strips
    b. Nakuru facilities will analyze (see pricing information below) the following:
        i. Fluoride
        ii. Heavy metals
        iii. Nitrate & Nitrite
    c. Samples to be gathered from
        i. River water and reservoir water, representative of potential piped water source locations
            1. 2 samples analyzed for total and fecal coliform

2. Turbidity measurement
3. 3 to 5 samples taken for analysis in Nakuru

ii. Wells, surface & drilled
1. 2 samples analyzed for total and fecal coliform (each well)
2. Turbidity measurement (each well)
3. 3 samples taken for analysis in Nakuru from each well (at least one surface well and one drilled well, if possible)

iii. Filter effluent – 2 samples analyzed for total and fecal coliform
iv. Rainwater – 2 samples analyzed for total and fecal coliform

d. Use of water testing data
i. Potential to be used as a water source for Lela
ii. Determination of appropriate treatment method for potential sources

3. Dimensions of school and other viable buildings in Lela
a. Measurements of exact dimensions, height, and pitch of roof for any building possibly large enough to collect water; a measuring tape will be used
b. Potential rainwater catchment tank locations adjacent to these buildings
c. Photos will be taken for reference to the dimensions
d. Use of dimensions
i. Depending on the amount of rainfall and surface area of the roof, the possibility of rain water catchment at the school and other buildings will be determined
ii. Locations for tanks will be determined

4. Well Drilling
a. Water Ministry Data
i. Exact distance from Lela to closest wells
ii. Nearby well data
1. distance from surface to water
2. well diameter
3. maximum sustained flow rate

b. Use of well data
i. This data will be very important in determining if a well is appropriate
ii. What type of well would be best
iii. Possible well locations

6.0 MONITORING

6.1 Monitoring of past-implemented projects

There are no existing or past implemented projects in the area of Lela, Kenya by EWB.

7.0 COMMUNITY AGREEMENT/CONTRACT

To date no infrastructure has been implemented with the assistance of EWB-OSU. Prior to any implementations a memorandum of understanding will need to be generated and agreed upon by the Lela Women's Group & Water Committee and EWB-OSU. This agreement will include operational, maintenance, financing, and ownership plans. Discussions during this assessment trip will serve to provide necessary information to construct a preliminary memorandum of understanding.

8.0 SCHEDULE OF TASKS

June 2011

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
			8 Fly to LAX	**9** Fly LAX - DXB-NBO	**10** Arrive NBO 7:05 PM	**11** Travel Nairobi-Lela
12 First day in Lela	**13** Women's Group Meeting	**14** Water Ministry Meeting	**15** Water source data collection	**16** Water source data collection	**17** Water source data collection	**18** Women's Group Meeting
19 Water source data collection	**20** Women's Group Meeting	**21** Water source data collection	**22** Water source data collection	**23** Materials Pricing	**24** Materials Pricing	**25** Women's Group Meeting
26 Last day in Lela	**27** Travel to Nakuru	**28** Water Analysis Visit Molo	**29** Water Analysis Visit Gilgil	**30** Travel to Nairobi		

9.0 PROJECT FEASIBILITY

During the previous assessment trip, it was determined that working with Lela is feasible and safe. This trip is focusing on the possibility of water infrastructure implementations as described throughout this document. General data has already been collected on local health and attitude, now detailed data is required to make technical decisions.

10.0 MENTOR ASSESSMENT

The basic draft of this pre-assessment report was prepared prior to my being selected as their technical mentor for the Lela community consequently the basics were developed by Scott Gerhardt (student) and then further developed by Project Lead Daniel Bailey and the rest of the traveling team: Jaynie Whinnery (PhD Student in Environmental Engineering) , Zachary Dunn (biological & environmental engineering student), and Miri Goldade student.

Because this is still in the investigative phase to determine the best course of action there have not been any prior studies of design done on this project outside of an earlier trip for a health assessment of the Lela community.

Project management tasks performed by the group were performed by Daniel Bailey and Jaynie Whinnery to coordinate all activities relating to the trip. Having grown up in East Africa and worked there for 14 years helping to develop rural water supplies I believe their plans are basically sound in my opinion.

Training conducted was to have two members of the team trained in CPR and First Aid so there is a backup. Prior to departure on the trip team members will receive training and practice in the use of GPS mapping as is proposed for this project. The team has also had a technical review from drilling mentors in the subject of borehole and shallow well drilling and the fixing of broken borehole water supplies. One of the technical mentors for this training has first hand experience with well drill and maintenance in Uganda.

I believe that this pre-assessment report adequately describes the objectives of the trip and what is to be accomplished. My initial reaction was the proposal was a bit overly optimistic when compared to a compressed time frame of only 2 weeks in March. I advised that the time would be further impacted by the long rainy season limiting access and working time. The time frame was then changed to June to provide a more adequate length of time of three weeks to accomplish the objectives.
In regard to the collection of GPS data for incorporating into a map of the Lela community it is import to in advance have hard copy of any maps both topographical of the Lela area and Google maps with references to an approximate scale. The Kenya Government must have good topographical maps available of the area but the contour level may be too great for a relatively flat area.

The nearby district township of Migoro has a meteorological weather station and as such has some 50 years of rainfall records for the area which is only 7 miles from Lela so would be representative. The average rainfall records indicate some rainfall varying from a low of 2.5 inches in January to a high 8.3 inches in April so rainwater collection appears to be a very viable alternative at least for the school with corrugated metal roofs.

In my opinion the emphasis on taking and evaluated water samples from existing water sources such as shallow wells for *e. coli.* contamination should be the focus of collection. Arsenic would be the principal item among minerals to be checked for. Since this is not a volcanic area the question of high fluoride content would be of lesser probability. Likewise only necessary to have a few samples for turbidity checks as there will be a high degree of variability between the dry and wet seasons.

It is important to measure the water levels in all the shallow wells. However trying to assess the yield will be more difficult as the depth may well be beyond the suction limit of most pumps and no electricity for a submersible pump. As for the borehole 3km away we should be able to get an accurate yield as presently constructed.

When evaluating the shallow wells attempts should be made to obtain a sample of the aquifer material if at all possible without endangering anyone.
Investigations should concentrate on any existing river drainages in order to locate sources of alluvial deposits for an aquifer.

If the shallow wells prove to be undependable because of excessive contamination, it will be harder to determine the adequacy of drilling a new well simply because it is not possible to predict the yield prior to drilling or the determination of where to drill. Given the distance from an existing borehole 3mk away would seem to be problematic because that area probably could use all its yield.

10.1 Professional Mentor Name

Donald L Moris PE

10.2 Professional Mentor Affirmation

I believe that the development of the assessment objectives as outlined in this Doc 521 Preassessment Report will provide sufficient investigative information to recommend a preferred course of action by EWB-OSU to best assist meeting the water requirements for the Lela Community in Kenya

11.0 References

[1] Mihelcic, J. R., L. M. Fry, E. A. Myre, L. D. Phillips, and B. D. Barkdoll. *Field Guide to Environmental Engineering for Development Workers*. American Society of Civil Engineers. Reston, VA, 2009.

[2] http://fksw.org/. 12 February 2011.

Appendix A - Tables

Table 1 - List of tests available in Nakuru

SINGLE ANALYSIS	COST(Ksh)	COST (USD)
Physical and Aggregate Properties		
Color	180	$2.22
PH	180	$2.22
Turbidity	180	$2.22
Electrical Conductivity	240	$2.97
Alkalinity	240	$2.97
Hardness	180	$2.22
Total Solids	330	$4.08
Total Dissolved Solids	410	$5.07
Settleable Solids	180	$2.22
Metals		
Calcium,Ca++	200	$2.47
Iron,Fe	410	$5.07
Magnessium,Mg	180	$2.22
Manganese,Mn	410	$5.07
Potassium,K	410	$5.07
Sodium,Na	330	$4.08
Inorganic Nonmetallic Constituents		
Chlorine,Cl_2	240	$2.97
Chloride,Cl^{--}	240	$2.97
Flouride,F-	100	$1.24
Nitrate(NO_3-) and Nitrite(NO_2-)	330	$4.08
Total Reactive Phosphorus,P	330	$4.08
Silica,SiO2--	410	$5.07
Sulfate,SO4--	330	$4.08

Table 2 - Approximate number of tests to be completed by travel team with costs

Source	Petrifilm (coliform) (assume 3 dilutions)	Turbidity	pH	Fluoride	Arsenic	Heavy Metals	Nitrate & Nitrite
Cost per Test	*$2.00*	*$0.00*	*$10.00*	*$1.20*	*$4.00*	*$4.00*	*$4.10*
Lela Surface Well (broken pump)	6	yes	yes	3	3	3	
Lela Open Well 1	6	yes	yes				3
Lela Open Well 2	6	yes	yes				3
Nearest Drilled Well (1 km away)	6	maybe	yes	3	3	3	
Nearby River	6	yes	yes				
Bondo Reservoir	6	yes	yes				
Water Treatment Effluent 1	6	no	yes				
Water Treatment Effluent 2	6	no	yes				
Water Treatment Effluent 3	6	no	yes				
Rainwater System 1	6	no	yes				
Rainwater System 2	6	no	yes				
Total # of Tests	66	N/A	N/A	6	6	6	6
Cost by Test	$132.00	$0.00	$10.00	$7.20	$24.00	$24.00	$24.60

Total cost = $221.80

Appendix B - Travel and Technical Mentor Resumes

Donald Moris - Travel and Technical Mentor (traveled in 2010 with EWB-Princeton)

I grew up Tanzania East Africa the son of a medical doctor, so am familiar with having to cope in a rural environment with difficult water problems.

I attended University of Washington graduating in 1963 with a BS in Civil Engineering and have a P.E. As an undergraduate I took as many courses I could get relating to hydraulics, water supply, and treatment. I went to work with the Corps of Engineers in Oregon. In their rotational training program I got to work on most of their multi-purpose dam projects on the Columbia River then worked on the construction of Cougar Dam on the McKenzie River which at the time was the world's highest rock fill dam and concrete Green Peter Dam at Sweet Home. After the 1964 flood of record knocked out our project for a year, I volunteered for a COE job in Anchorage, Alaska to assist with the restoration of waterways and harbors damaged by the big earthquake.

In 1966 I was recruited to provide technical assistance in the development of rural water supplies in Tanzania, East Africa, a job I had trained and hoped for from the start with a couple of non profit organizations but also as a Tanzanian employee and official. From 1966 to 1970 I worked as a civil engineer developing primarily gravity pipeline schemes and then as Regional Water Engineer for Arusha Region an area of over 25,000 square miles working with engineers and technicians & volunteers from many countries and a hard working and friendly Tanzanian staff of several hundred. Here water was a matter of life or death and the government made it a priority and very rapid development was made but much remains to be done. Most of our rural water supplies consisted of building & operating gravity pipeline schemes wherever possible primarily of GS, PVC, or Poly pipe most 4" size of smaller to storage tanks and water distribution points. We also operated pumped schemes, boreholes, and small town domestic water supplies. Later I joined the Masai Range Development Project and my job was the design and construction of new dam water supplies throughout rugged Masailand. We had to procure the dam building and water well drilling equipment, train the tractor drivers, build our own roads, construct, and then maintain the dams and equipment. In a span of span of only 5 years some 40 new dams were built or rebuilt . It was rugged work 6 days a week very long hours and difficult terrain and rough living conditions.

From 1977-1979 I joined the Texas A&M International Programs to assist development of water supplies consisting mainly of constructing new earthen dams on the large national ranches (200,000 + acres in size) and piped water supplies for dairies all over Tanzania during a very difficult time of food shortages and endemic cholera. I loved my time in Africa but my job was also to work myself out of a job.

My approach to work in developing countries is to make a point it is their project and not our project and they are the ones doing most of the work and responsible for it. First show them how to do it, then have them do it as soon as possible. Best to work in close cooperation with local authorities and not separately. Our job is to work ourselves out of a job as quickly as possible move on to help others in same way.

I returned to the States in fall of 1979 to Boise, Idaho and went to work with US Bureau of Reclamation initially in operation and maintenance where I got to inspect numerous dams operated all over the northwest. Moving over to construction I monitored the planning, design, and construction of more efficient piped irrigation schemes all over the Northwest assisting irrigation districts on the Rehabilitation and Betterment and Small Loan Projects. I was Project Engineer on the reconstruction of Soldiers Meadow Dam and oversaw the construction of both French Canyon Dam and the roller compacted concrete Galesville Dam. I have also been responsible for making a Planning & Design Report for Cabin Creek Dam in Washington.

Starting in 1990 I was our regional value engineer coordinator for ten years with responsibility to lead value engineering studies to obtain better value and more effective designs in every new major project we undertake. In

this period of time some $40m cost savings were accredited to the region. The focus was primarily on numerous Safety of Dams modifications to our dams to make the spillways safer to pass major floods and modifications to the embankments & foundations for potential earthquake forces and fish passage facilities. I have made several presentations to the International Save Conference for Value Engineers on the design of fish passage structures and the modification of dams.

Typically I led our value engineering studies which involved coordinating and leading the work of a team of small group of experts from various fields in a very concentrated 1 weeks time to discuss and come up with innovative better value solutions and publish and present our report (often up to 50 pages of documentation for the Value Engineer Report) documenting our brainstorming ideas, recommendations, proposal description, cost, and projected savings to management which is done on every project exceeding $1 million in value.

I have done preliminary studies on my own on how to best operate our dam storage facilities in Idaho to accomplish needed flow augmentation for fish passage or proposals to COE for modification of their Snake River dams to accomplish the same. I have also made a number of preliminary proposals for future generation of power for potential larger pump storage projects using BOR dams.

I have volunteered to assist on many of our national emergencies helping to restore public facilities such as water supplies, sewer systems, roads, levies damaged by floods and have been on almost a dozen details starting from Mississippi River and Missouri River floods in 1992, floods in California, Oregon, North Dakota, Kentucky, West Virginia and hurricanes Katrina and Rita. These details have totaled over 2 years work since that time and involved concentrated work 12 hrs day 7 days a week field surveys, evaluating damages, recommended restoration and working with local authorities to help restore public facilities from water supplies, sewage plants, earth slides, and roadways after floods & hurricanes or design of levee repairs or relocation (COE). This involved making hundreds of damage assessment reports to FEMA documenting the damages and recommended restoration and requests for funding of same for small communities or public entities.

During the last eight years I have been working primarily on the design of fish passage facilities at US Bureau of Reclamation dams and at irrigation diversions throughout the Northwest. I have enjoyed the creative opportunities to come up with new fish passage concepts and more natural like passages. I have often been called to provide prompt analysis of engineering problems which arise from breaks etc. or rush projects and much of my work has been to produce predesigns for outside entities or reviewing proposals in the John Day basin. One of the projects I worked on was on Chewuch River in Washington which in a new and effective concept for natural fish passage at existing structures. The biggest project recently has been the feasibility reports for the modification of Cle Elum and Bumping Dams Fish Passage.

I have found my work with BOR to be challenging and I felt a sense of accomplishment and enjoyed working with my coworkers, but would like to get back into helping people in developing countries get better safe water supplies.

If given the opportunity to be a part of this project, I would count it a privilege and do my best to help in any way I can and would offer a continued interest in the project. I believe in keeping things simple as possible and affordable seeking best value alternatives. No need to necessarily reinvent the wheel where type designs for structures or tanks are available, use them. I may have broad knowledge in a number of fields but I do not consider myself to be a structural engineer. I believe in the dependability of gravity water pipeline systems where feasible, or using hydraulic rams to power water to higher elevations for potable water use and combining the technologies of solar power for pumping & water sterilization and wind power, and small hydro power renewable resources to lesson dependence on other scarce & expensive sources of fuel or electrical power for rural communities.

For my recent August 2010 trip as mentor for EWB-Princeton University to Peru I put together a lot of background material from the internet relative to various water treatments from slow sand filters, simple drip chlorination, ultra violet UV water purifiers, hydraulic rams, solar power pumps & power sources, septic waste water systems, small

hydro development, pipeline materials & maintenance recommendations etc. for possible use.

I think it is very important to get active participation of the community in helping to making it their project and not our project and to give them pride in what they are doing. I believe it is important to make the project reliable and sustainable in the future.

I believe there are many challenges involved in this project for engineering students to get excited about in evaluating the most effective potable water supply options to meet the very real needs.

I am in good physical health and rarely ever sick. Although I am 70 years old I have been active in sports over the years (including rugby 66-79) until a knee replacement 2 years ago but hike & swim.

Paul Berg - Technical Mentor

Paul A. Berg

paul.berg@ch2m.com

CH2M HILL, Inc.

541-768-3413

Education

M.S., Civil Engineering (Environmental Engineering), Oregon State University, 1981
B.S., Civil Engineering, Oregon State University, 1977

Professional Registrations

Professional Engineer: Oregon, 1986, No. 13248
Oregon Certified Water Rights Engineer (CWRE): 1991, No. 266

Distinguishing Qualifications

- More than 25 years of experience in the planning and design of all aspects of water utilities—treatment plants, storage tanks, wells and surface intakes, pump stations, pipelines, and controls
- Project manager or design engineer for many treatment technologies: membrane, fine media filtration, activated carbon absorption, air stripping, ozonation, chlorination, ultraviolet disinfection, and slow sand filtration
- Managed or lead engineer for more than thirty water system master and facility plans
- Expertise in drinking water regulations, including a background with regulatory agency

Special Recognitions

- US Patent holder: “Portable Ultraviolet Water Treatment Apparatus,” issued July 2010, for a point-of-use water treatment product for the developing world.
- Recipient of the President’s Volunteer Service Award, President’s Council on Service and Civic Participation, by President Barak Obama, August 2010 (for volunteer work in 2009 and 2010)
- Best Paper Award, Regulatory Agencies Division, American Water Works Assoc.; for Journal AWWA Paper, "Assessing Unfiltered Water Supplies," March 1989
- CH2M HILL Certified Senior Project Manager, 2004

Relevant Experience

Mr. Berg is a senior project manager with CH2M HILL's Water Business Group in Corvallis, Oregon. He has more than 25 years of experience in the planning, design, and construction of all elements of municipal water treatment facilities –intakes, treatment plants, pipelines, reservoirs, and pump stations. He has managed more than 50 study and design projects for water utilities, with fees ranging from a few thousand to more than a million dollars. His experience includes alternative project delivery approaches such as construction manager-general contractor (CM/GC), design-build, and equipment pre-purchase procurement. He is experienced in water treatment studies and designs for filtration and disinfection processes.

Prior to joining CH2M HILL, he worked for the Oregon Health Division Drinking Water Program. In that role he performed surveys at approximately 100 public water systems and taught a number of training courses.

Representative Projects

International

Water Treatment Plant Operations Guidance, Amman, Jordan. Provided operations guidance for six months at Amman's 32-mgd conventional filtration plant. As the process control laboratory specialist, he was responsible for water quality at the plant and worked with operators in performing process and quality control testing.

Water System Planning and Design, Southeast Coast of Sri Lanka. As part of the reconstruction effort following the devastating December 2004 tsunami, Mr. Berg led the water system evaluation and design for a community of 30,000 people. The final system, which was designed by CH2M HILL and constructed with oversight from the firm, included a group of shallow, river-bank wells, followed by treatment for iron and manganese reduction.

Small Water Systems Designs for Villages, Hospitals, and Community Facilities, East Africa, August 2009-May 2010. Based in Kampala, Uganda, Mr. Berg led studies, designs, and implementation of potable water improvements in Kenya, Rwanda, Sudan, and Uganda including village wells and well rehabilitations, supply expansion and chlorination treatment for a rural hospital, evaluation of water system facilities for boarding schools, and design of water system facilities for schools and orphanages. He provided selection and oversight for employing a Ugandan firm to provide water, sanitation, and hygiene (WASH) training, and to establish local water committees among villages. He provided mentoring and review for interns. Additionally, his work included evaluation of a wastewater disposal system for a hospital and conducting field trials for a point-of-use ultraviolet disinfection unit among Ugandans connected to a municipal water utility.

Water Systems Designs and Implementation Projects, Mexico, Russia, and Brasil. Mr. Berg participated in short-term projects in each of these countries to evaluate and design water system improvements for cities, villages, and community facilities. In Mexico, as a volunteer with Water for People, he designed and installed a small chlorination system for a boarding school using an unprotected spring source. In Brasil, he provided on-site evaluations for water supply options, selected and designed a supply, and designed the distribution system. He also helped with surveying and percolation tests.

United States

Project Manager; Water System Master Plans. Managed water system master plans for Eugene Water and Electric Board, Medford Water Commission, Salem, Sandy, Central Point, The Dalles, Lebanon, Gresham, Warrenton, McMinnville Water and Light, and other Oregon utilities. These projects included water treatment plant assessments and expansion planning, distribution modeling, analysis of historical and projected demands, condition assessments, evaluation of intake facilities, review of water rights, establishment of design and construction standards, and preparation of CIP models and plans. (1990-2010)

Design Manager; UV Disinfection Improvements, Cordova, AK. Developed conceptual plan for addition of UV disinfection facilities in two separate locations for unfiltered supplies serving the City of

Cordova, with one facility designed to use medium pressure UV lamps and the other designed to accommodate either low or medium pressure lamps. One facility is in a new building and the other was retrofit into an existing facility.

Source Water—Water Quality and Security Evaluation and Conceptual Design, San Francisco, CA. Mr. Berg led the engineering analyses to examine water quality and security improvements for an open water supply impoundment that is one of the sources of potable water for the Bay Area.

Conceptual Design and Security Design Services for Large Reservoir Tanks, Syracuse, NY, and Philadelphia, PA. Developed conceptual design layout to ensure proper hydraulics and mixing to preserve water quality for an initial two tanks at 30 MG each and future five tanks of this size for the City of Philadelphia. Provided security evaluation and design recommendations for the project. Mr. Berg provided similar planning and design services for the two 32 MG tanks constructed for Syracuse.

Project Manager; Water Treatment Facility Plans, Joint Water Commission (west Portland, Oregon), McMinnville Water & Light (McMinnville, Oregon), Medford Water Commission (Medford, Oregon), and Lebanon, Oregon. Managed studies that examined treatment alternatives for both green-field and expansions of existing plants. Examined site conditions, demand and capacity needs, state-of-the-art treatment technologies, and costs. Used CH2M HILL's in-house water treatment evaluation software, CPES. Held numerous workshops with clients and presented findings to political members of communities. (2004-2009)

Lead Water Treatment Process Engineer; Water Treatment Expansion, McMinnville Water & Light, McMinnville, Oregon. Lead process designer for this major plant expansion, which include high-rate clarification, need deep-bed dual media filters, new chemical systems, and new facilities for waste flow handling.

Project Manager; Membrane Water Treatment Plant Designs, Warrenton, Youngs River Lewis & Clark Water District, Creswell, and Pendleton (all Oregon). Lead design of these treatment plants using pressure and vacuum low-pressure membrane filters. Project elements included reservoir tanks, intakes, coagulant and disinfection systems, and backwash waste handling facilities.

Project Manager; Water System Expansion Project, City of Boardman, OR. Managed major expansion of city's system, which included design and installation of a 10-million gallon per day radial collector well along the Columbia River (providing riverbank filtration), new on-site chlorination components, new high service pumping, and new finished water storage.

Project Manager, Water Management and Conservation Plans (WMCP) for several communities: Medford Water Commission, Joint Water Commission (west Portland area), Kernville Water District, Eugene Water & Electric Board, and others. Managed development of WMCPs to comply with the requirements of the Oregon Water Resources Department's Division 86 and 315 administrative rules and provide the communities with guidance on implementing conservation measures specific to their communities.

Project Manager; Water Supply Study; City of Astoria, OR. This study, completed in November 1996, included a review of the city's water rights, determination of reliable watershed yield, comparison

of water supply options, and recommendations for improvements to the city's existing dam and raw water storage reservoirs.
Water Supply and Water Rights; Kernville Water District, Pendleton, Creswell, Albany, Lebanon, Reedsport, and other communities. Provided expert supply and water rights evaluations and prepared documents for water rights certifications. Evaluated intake locations and provided design services for new river and lake intakes.

Security Designs and Senior Engineering for Large Portable Water Storage Tanks; Syracuse, New York, Philadelphia, Pennsylvania, and Joint Water Commission (west Portland area), Oregon. Provided evaluations and design services for these large prestressed concrete potable water storage tanks, ranging in size from 20 to 33 million gallons, each.

Project Manager; Potable Water Storage Tanks; Eugene Water & Electric Board, Clackamas River Water District (south Portland area), Central Point, Warrenton, The Dalles, Medford Water Commission, and other communities. Managed design and construction of the prestressed concrete, conventionally reinforced, welded steel, and bolted steel tanks for finished water storage. Project elements included a tank finished for a park setting with court areas on the roof, baffled tanks for chlorine contact, and rehabilitation of both small (0.5 million gallons) and large (10 million gallons) tanks.

Project Manager, Slow Sand Filtration Pilot Studies and Designs, Kernville WD, Lyons-Mehama WD, Astoria, and Reedsport (all OR). Led pilot studies for three of these communities to examine the effectiveness and suitability of using slow sand filtration for their municipal supply. The pilot study for Reedsport demonstrated that SSF was not the right treatment choice. Led designs for SSF plants for the other three communities, which have capacities ranging from 0.8 – 5 mgd.

Project Manager; Wicks WTP Clearwell; City of The Dalles, Oregon. Managed project to design and construct a 4.3-MG welded steel clearwell at the Wicks WTP. The two low bids and engineer's estimate were within 0.2 percent of one another, reflecting the high quality design. The tank provides improved disinfection contact time, enabling the city to comply with disinfection by-product regulations.

Publications

Guidelines for the Physical Security of Water Utilities, Lead author, by American Society of Civil Engineers, American Water Works Association, and the Water Environment Federation, December 2006.

Slow Sand Filtration, An International Compilation of Recent Scientific and Operational Developments, Contributing author, by American Water Works Association, 1994.

Slow Sand Filtration, Contributing author, by American Society of Civil Engineers, 1991.

Assessing Unfiltered Water Supplies, With Dave Leland, Journal American Water Works Association, January 1988. Winner of National Best Paper Award, AWWA, 1989.

Presentations

"A New Water Treatment Product for the Urban Poor in the Developing World," World Environment and Water Resources Congress 2010, May 2010, Providence, Rhode Island.

"What is Your Water Treatment Plant's Carbon Footprint?" Pacific Northwest Section AWWA, May 2009, Salem, Oregon.
Introduction to Zebra and Quagga Mussels and the Challenges they Present for Water Utilities," Pacific Northwest Section AWWA, May 2008, Vancouver, Washington.

"Pilot Studies of Membrane Filtration", Presented at the Pacific Northwest Section AWWA Conference, May 1998, Portland, Oregon.

"Innovations in Water Disinfection: Ozone", Presented at the Washington Environmental Training Center disinfection seminar, February 1997, Spokane and Seattle, Washington.

"Preparation of Water Supply Plans", Presented at the Oregon Water Resources Department Conference—Managing Limited Municipal Supplies, August 1995, Salem, Oregon.

Applying Bench Scale Testing to Ozonation Designs, Presented at the Pacific Northwest Section AWWA Conference, May 1995, Eugene, Oregon.

Evaluating Source Waters for Slow Sand Filtration, Presentation, AWWA National Conference, San Antonio, Texas, June 1993.

Updating a Small Water Treatment Plant (Dallas, Oregon), Presentation, Pacific Northwest Section, AWWA, May 1992.