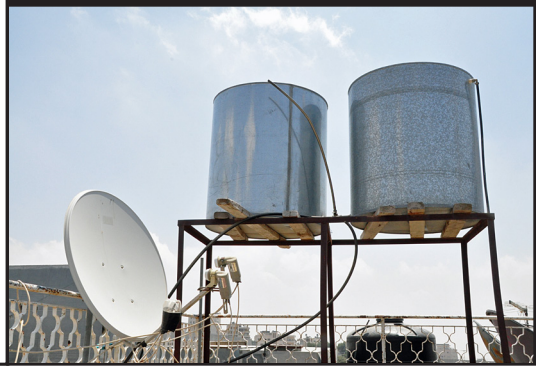
Water Quality in Aida Refugee Camp

Bethlehem, Palestine

Tufts University

Water: Systems, Science and Society

The Lajee Center



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Abstract

This report summarizes a water quality monitoring project conducted in Aida Camp, a Palestinian refugee camp in the West Bank. As part of the *Water: Systems, Science and Society* program at Tufts University, a practicum team of seven students and three instructors studied the water situation in Aida as applied research with a public service focus. The project was a collaboration with the Lajee Center, a community-based cultural and advocacy organization serving Aida Camp. In discussions with the Lajee Center, concerns were raised about the quality of the water supply and its effects on health in the camp. The Lajee Center invited the practicum team to help better characterize the problem. The project objectives included the assessment of water quality in the camp and the development of a water quality monitoring program to be operated by the local community. The equipment and supplies necessary for water sampling and the detection of total coliform and *Escherichia coli (E. coli)* bacteria were provided to the Lajee Center. Baseline water sampling and household health and water access surveys were completed during a May 13-18, 2012 field visit, culminating in a community meeting to present and discuss the initial results. During the field research, the Lajee Center staff, as well as groups of women and students from Aida Camp, were trained in sampling and analysis procedures in order to continue the testing program for twelve months to May 2013.

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Summary

For Aida Camp, a Palestinian refugee camp near Bethlehem in the West Bank, water is a contentious issue. In addition to the chronic water shortages experienced at the camp each summer, a community-based organization in Aida, the Lajee Center, has long been concerned about the quality of the camp's water supply. In cooperation with Lajee, students and faculty participating in a practicum in Tufts University's *Water: Systems, Science and Society* (WSSS) certificate program developed a water quality monitoring initiative to explore the state of water quality in Aida. After preparing the program and raising money in Boston, the practicum team spent a week at Aida to initiate the water testing, train community members to develop an ongoing water quality monitoring program, and conduct household health and water access surveys.

The practicum team arrived in Aida on May 13, 2012 and conducted sampling and surveys through May 17. The team provided Lajee with water sampling supplies and laboratory equipment to analyze samples for *Escherichia coli (E. coli)*, which is known to cause a variety of gastrointestinal illnesses, and other coliform bacteria. In order to continue the testing, the practicum team raised funds to employ a coordinator for the water quality monitoring program.

During the practicum team's trip to Aida, training was provided to the coordinator on the correct procedures for sampling and analyzing water samples, data management and oversight of volunteers.

Women and students were also educated on the connection between water quality and health, and trained in proper procedures for water sampling and bacteria analysis. On May 18, the initial results of the work were presented to the community in a public meeting. The Lajee Center and the program coordinator have continued gathering data since that time.

Practicum team members also conducted public health surveys with the help of local translators. The surveys were designed to assess possible connections between community health and drinking water quality, determine common practices for water storage and treatment, and elicit perceptions about the agencies responsible for addressing water quality and quantity concerns in the camp.

Evaluation was a final component of the program. Practicum team members completed daily activity logs designed to record all activities undertaken, as well as perceptions about which activities were succeeding and which were implemented differently than originally planned.

Summary

Key Findings

- Bacterial contamination of household water supplies in Aida appears to be widespread. The World Health Organization (WHO) standard for the membrane filtration technique is that no coliform colonies should be detected in drinking water. Our results showed that water samples collected from 35 out of 75 taps (47%) contained at least one total coliform colony per 125 mL water sample, and samples from 10 out of 75 taps (13%) contained at least one *E. coli* colony per 125 mL sample.
- There is no conclusive evidence of a connection between water quality and poor health in Aida. Nonetheless, illness is common in the camp, with 66% of 29 households surveyed reporting that at least one individual in the home had been ill in the two weeks prior to the survey.
- Residents are aware that poor water quality can cause illness, but most residents (>75%) believe that the color, smell, and taste of the water in their household is of normal to very good quality. They generally appear to assume their illnesses are due to non-water related causes (e.g., changes in the weather).
- Multiple agencies have some responsibility for water quality in Aida. But given the lack of consensus about the sources/causes of contamination, no agency has accepted the responsibility for making the changes necessary to fix the problem. Nor have officials worked with Lajee to identify what changes need to be made.

Recommendations

- The water quality monitoring program should continue to expand. Drinking water testing is a powerful tool for evaluating the spatial variability of harmful bacteria in Aida's water supply and for determining the sources and causes of this contamination. This will entail securing additional funding for supplies and payment of on-site personnel for the coordinator position.
- As testing continues, community members should be informed of the results so that steps may be taken to encourage safe water use, especially among the most contaminated households. Lajee can help by continuing to educate community members about the risks of contaminated water and methods of water purification.
- Lajee should strive to work with other agencies in the West Bank, such as the United Nations Relief Works Agency (UNRWA), in order to improve water conditions at the camp. This could lead to collaboration and information dissemination. However, Lajee should maintain independent control of the water sampling and analysis program, including all testing records.
- Lajee should give high priority to maintaining the trust and support of the community members in Aida so it can continue to work to improve the water situation.

Figure 1: Mural in Aida Camp

Introduction

The following study used several complementary strategies and techniques to address water quality concerns in Aida Camp, a Palestinian refugee camp on the northern side of Bethlehem.[1]

First, a water quality testing program was designed and implemented. The objective was to determine the bacterial content of household water both spatially and temporally in the camp, and to identify the locations of problematic aspects of the water system. This program included water quality testing training for community members. Funding was raised and provided to the Lajee Center, a community center in Aida, to ensure continued water quality monitoring for the following twelve months.

Second, a knowledge, attitudes, and practices (KAP) survey was designed and implemented to gather data on perceptions of water quality, methods of water storage, water treatment, and hygienic practices in the camp.

Third, a process evaluation of the project components was implemented during the project. One objective of this evaluation was to improve implementation of project components over the course of the study. An additional objective was to provide recommendations for improving the execution of fieldwork should there be further collaboration between Tufts University and Aida Camp.

This report provides contextual background to the current water conditions in Aida Camp and describes the rationale behind the project design and methods. It also presents the results of the testing and community surveying components and responses to the program from the community and water authorities. Lastly, the report documents modifications made to the program resulting from an improved understanding of the resources and conditions in Aida Camp and provides recommendations that might allow the program to better serve the community.

[1] Bethlehem is located in the West Bank. The naming of this region is a political and contentious issue. However, as our partners in this project refer to this region as Palestine, we will do so throughout this report, although it is under stood that this is not currently the name of a formally-recognized nation.

Background: Historical Background

The 1948 war that established the state of Israel also displaced an estimated three quarters of a million Palestinians into neighboring countries (Letter from the UN, 1949, cited in Fraser, 1980). The final status of these refugees is a crucial component in the Palestinian-Israeli conflict, a conflict that traces its roots to the late 1800s and remains unresolved today.

During World War I, several European governments issued statements — often blatantly contradictory — promising support for various political movements after the war in exchange for their support during the war. These were "products of wartime expediency" (Smith, 2007), but would later frame the policies of the British mandate in Palestine. Chief among these was the Balfour Declaration of 1917, which stated that the British government "favours the establishment in Palestine of a national home for the Jewish people… it being clearly understood that nothing shall be done which may prejudice the civil and religious rights of existing non-Jewish communities in Palestine" (Balfour Declaration, as cited in Fraser, 1980). The declaration bolstered the political prospects of Zionism, a movement to "support the quest by Jews to 'return to Zion'" (Caplan, 2010). At the time of the declaration, Palestine was still under Ottoman control.

After the fall of the Ottoman Empire in World War I, the British took control of territorial Palestine, which became known as Mandatory Palestine. The Mandate Period, from late 1917 to early 1948, was characterized by attempts to balance the aim of creating a Jewish state with the political aims of the region's Muslim and Christian inhabitants. With the increase in Jewish immigration, especially due to the rise of Nazism in Europe, the British government worked to assure each group that Britain supported their self-determination (Ovendale, 1985), even as the rhetoric on each side increasingly assumed the exclusion of the other. After bearing terrorist attacks from Zionists and Arabs (Primoratz, 2008), the British government announced in 1947 its intention to withdraw from Palestine the following year (Louis, 1984).

The British charged the UN General Assembly with solving the Palestine problem after their departure, and in 1947 a partition plan was approved for the region. The Zionists accepted the plan but Arab leaders objected, citing the large Arab populations living in the future Jewish state, and the fact that the majority of private land in all areas was still owned by non-Jews (Smith, 2007).

Without an agreed path forward, war ensued. It ended six months later, in May of 1948, with the establishment of the state of Israel and the exodus of Palestinians.[2] In 1949, armistice agreements with Egypt, Jordan, Syria, and Lebanon extended the frontier of the new state of Israel beyond those recommended in the UN partition plan to cover approximately 78% of the area of former Mandatory Palestine (Caplan, 2010).

[2] Referred to (in Arabic) as the Nakba, or "catastrophe" (Caplan, 2010).

Background: Historical Background

The Palestinians who fled from Israel — including those who founded Aida Camp — became refugees, united by their wish to return to their land after hostilities ended. However, Israel barred them from returning, despite the 1948 UN Resolution 194, which stated that “the refugees wishing to return to their homes and live in peace with their neighbours should be permitted to do so at the earliest practicable date.” This resolution has been reaffirmed almost yearly by the UN General Assembly (Masalha, 2010). Instead of returning, many refugees stayed near the border of Israel. They often lost most of their possessions, received no compensation for their land, and in their new environment they found “insufficient opportunit[ies]” for work. The influx of so many destitute families “aggravated” the already economically depressed regions they entered (Letter from the UN, 1949, cited in Fraser, 1980).

In response to the growing humanitarian crisis, the United Nations founded the Relief and Works Agency for Palestine Refugees in the Near East (UNRWA) to construct and operate refugee camps for “those unable to secure decent lodging in their host countries” (Husseini, 2010). Under this mandate, refugee camps were established in Jordan, Lebanon, and Syria. They were also established in areas of Jordan and Egypt that would become the West Bank and Gaza, respectively, after 1967 (Smith 2007).

After 1948, small-scale, intermittent periods of raids and retaliation between Israel and neighboring states were punctuated by large-scale wars. Israel and Egypt became adversaries in the 1956 war and this in turn provided a basis for the 1967 conflict, which resulted in Israeli occupation of the Sinai Penninsula, Gaza, and the West Bank. The military occupation gave Israel control over the region's water resources (World Bank, 2009) and enabled settlement construction in the West Bank to begin (Tessler, 2009). After the 1973 war, the 1977 peace agreement returning the Sinai to Egypt ensured that the largest regional Arab military force would not again engage with Israel.

After the First Intifada (intermittent from 1987-1993), Israel and Palestinian authorities signed Oslo 1 and 2 in 1993 and 1995 respectively, giving Palestinians political representation in the form of the Palestinian Authority (PA). The PA has limited governmental control over Areas A and B as stipulated in the Agreements, constituting roughly 30% of the West Bank (Smith, 2007). Though intended to last only five years, the Agreement has not been updated for nearly two decades and its implementation has become characterized by systematic violations, especially in the case of water withdrawals (World Bank, 2009). The failure to continue the peace talks was followed by the Second Intifada (intermittent from 2000-2005) and the construction of the Separation Wall. At the time of this writing, peace talks have not resumed.

Background: Historical Background

Aida Camp was founded in 1950 between the towns of Bethlehem and Beit Jala (UNRWA, 2012). In 1967, along with the rest of the West Bank, it came under Israeli occupation and has been part of the evolving history on the ground. The segregation of Palestinian refugees strengthened Palestinian nationalism and identity (Gelvin, 2007) and Aida residents are vocal in demanding rights, as witnessed during the course of this study. UNRWA currently operates 58 refugee camps, housing 1.4 million people — or roughly one third of the registered Palestinian refugees (UNRWA, 2012).

The question of what to do with these refugees remains today, over a half century later. The UN has been clear in its rulings regarding the Right of Return, enshrined in Resolution 194, but UN General Assembly resolutions are non-binding and thus unenforceable. This is one of the most intractable issues in the conflict, since the refugees and their descendants affirm the Right to Return (Daoudi, 2011), while the Israelis argue that incorporating so many Palestinians into Israel would mean the end of the Jewish State (Peters, 2011).

Figure 2: Youth With Kites
Refugee youth fly kites over the Israeli security wall during an annual Lajee Center-sponsored kite festival.

Background: Governance and Water Resources in the West Bank

Since the formation of the Palestinian Authority (PA) in 1994, Palestinians have lived under "transitional democracy" where Israel continues to control key elements of Palestinian life. Palestinians can elect members of the PA, including the president, but the democracy has been called "far more impressive in theory than in practice" (Brown, 2005). As the Palestinian democracy continues to develop, it encounters many obstacles, including its inability to negotiate with Israel as an equal (Salem, 2011).

The West Bank is under Israeli military occupation, meaning its government has limits over its own autonomy. To further complicate the situation, many foreign donors coordinate haphazardly to provide services (World Bank Report, 2009). Thus, it is not always clear to Palestinians who can help them or whether they can be helped at all.

Water distribution in the West Bank is notorious for not meeting demand, especially in the summer, but Palestinians are not permitted to drill more wells or to access the Jordan River because of Israel's military occupation (World Bank Report, 2009).

The World Health Organization has said that "neither personal hygiene nor public health" would require water for domestic consumption greater than 100 liters per capita per day (Kirke, 1984).

Residents of the United States use an average of 69.3 gallons, or 262.3 liters, per capita per day (l/c/d) for indoor use, and 100.8 gallons, or 381.6 l/c/d, when including outdoor use (Water Research Foundation, 1999).

Data for Israeli water consumption are somewhat divergent. Estimates range from 137 l/c/d for rural residents and 190 l/c/d for urban residents (indoor water use only) to 250 l/c/d for overall domestic use (Netanyahu, 2011).

Figure 3: Map showing location of Aida Camp in the West Bank

Background: Governance and Water Resources in the West Bank

According to the Israeli Information Center for Human Rights in the Occupied Territories (B'tselem), which also cites the Israeli Water Authority, Israeli urban domestic consumption is 242 l/c/d and rural consumption is 211 l/c/d (B'tselem, 2012).

The Palestinian Water Authority (PWA) estimates that residents of the Bethlehem governorate have a consumption rate of 102 l/c/d (PWA, 2012). This quantity is just above the WHO standard for personal hygiene and public health (Kirke, 1984). The actual quantities vary throughout the governorate. Some of the rural areas are connected to the same pipe networks that supply the Israeli settlements and have consistent access (Galaitsis, 2012). This raises the average for the governorate.

The Bethlehem governorate, like most governorates in the West Bank, obtains water subject to numerous constraints. Approximately 37% of Bethlehem water comes from its own well resources, and the remaining 63% is purchased from Mekorot, the Israeli water company, which supplies a limited amount of water to the Palestinian territories (PWA, 2012). Piped water in the Bethlehem governorate is delivered to homes irregularly, and residents have adapted by storing large volumes of water for the periods when the water is not flowing.

Located on the border of Bethlehem and the town of Beit Jala, Aida Camp has an area of 0.71 square kilometers.

Estimates of the camp population vary. UNRWA's official statistic is that "over 4,700 registered refugees" reside in Aida (UNRWA, 2012). The camp is connected to municipal water and electricity grids; however, the "poor sewage and water networks" constitute one of the camp's major problems (UNRWA, 2012).

The camp sewer lines were installed in the mid 1990s and this process damaged several branches of the water piping distribution network. Water mains were replaced several years later (Al Azraq, 2012). The Tufts Practicum was unable to obtain maps showing the extent and location of water lines. However, it is our understanding that, at present, two water mains extend from the storage area to service the entire camp (Al Azraq 2012).

Water enters Aida at a distribution location containing a large water storage tank that was installed in the 1990s. The camp's original tank is also located in the distribution area but is no longer used to store water. This tank now houses the camp's distribution pumps. The distribution area also houses a generator and chemical mixing facility for chlorination and fluoridation. When water is delivered to the community, the new tank is first filled with water; then water is pumped to households via the camp's piping network. A community tap supplied by this tank is a few feet outside the fenced-in distribution center. The water at this tap is available to all camp residents (Al Azraq, 2012).

Figure 4: A view of metal and plastic rooftop tanks used for storing water
Photo: Stephanie Galaitsis.

Figure 5 (above): View of water meter and piping

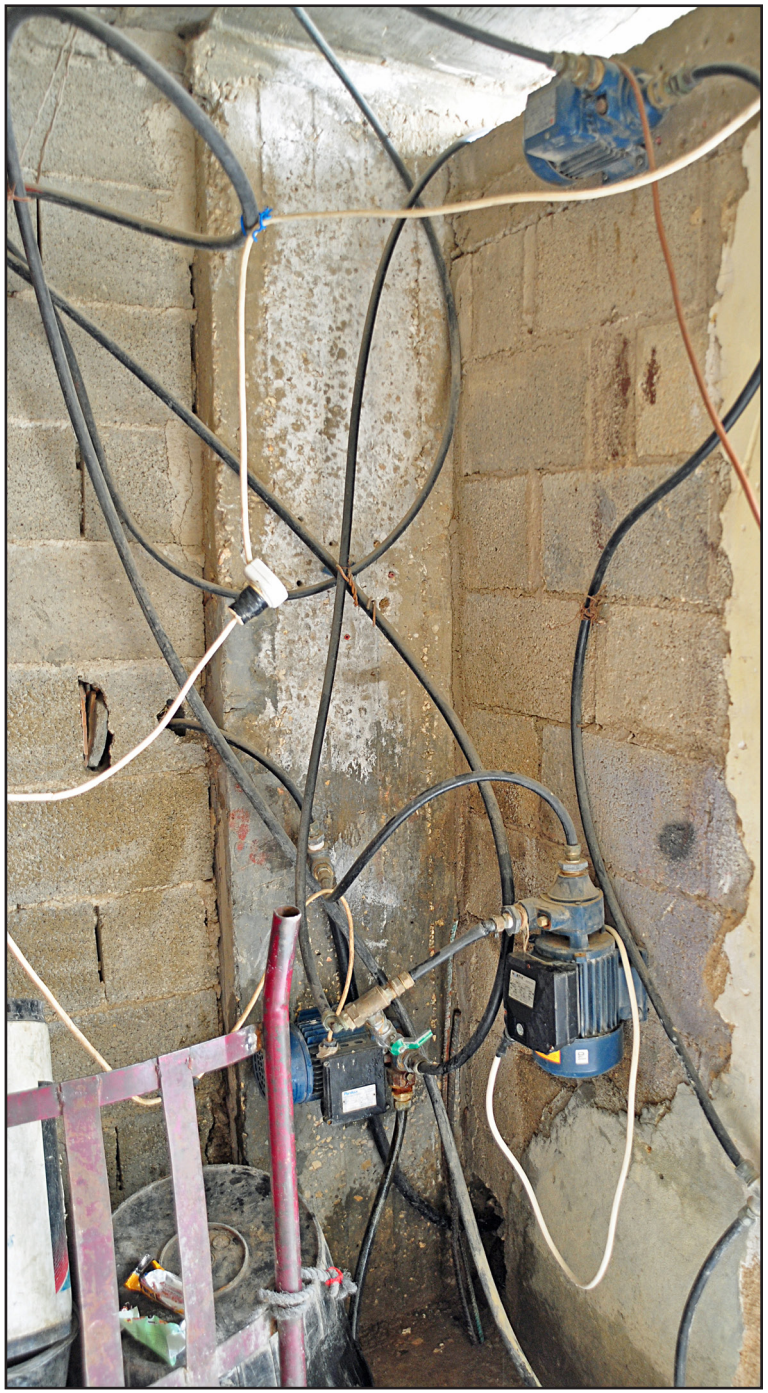

Figure 6 (right): View of household water pumps, piping, and electrical wiring
When water is delivered to the camp, electric pumps are used to lift water from street-level pipes to rooftop tanks.

Background: Water Distribution System in Aida Camp

Typically, water is delivered to the camp every two weeks. However, in some instances (most notably in the summers of 2008 and 2012), water was not supplied to parts of the network for over a month (Al Azraq, 2012). To cope with long periods between water deliveries, residents have installed large rooftop storage tanks.

The practicum team was unable to obtain maps documenting connections between water mains and individual homes. However, most homes or groups of homes have electric pumps that provide the necessary pressure to fill the rooftop tanks via household pipes and hoses.

Even with rooftop tanks, there are times when families do not have even the minimum quantity of water to address daily necessities. When household water runs out, residents can buy small amounts of very expensive bottled water, large amounts of relatively expensive tanker water, or collect water from the community tap, which rarely runs dry. Since the community tap is located just outside the camp, this can be a considerable hardship for households, especially those that are located farthest from the tap.

In addition to complications stemming from limited water supply, Aida lies on a hill and the resulting pressure gradients cause houses at higher elevations to receive water after those at lower elevations.

Those households at a higher elevation therefore have a shorter time to fill their storage tanks, often receive less water, and run out of water earlier. Even a small elevation difference can greatly affect a system with weak pressure. An map showing the change in elevation across the camp is provided on the following page.

Figure 7: Community water storage tank and tap
Water piped into Aida Camp fills the new storage tank (on the right) before homes are provided with piped water. Camp residents use the community tap when household tanks are empty.

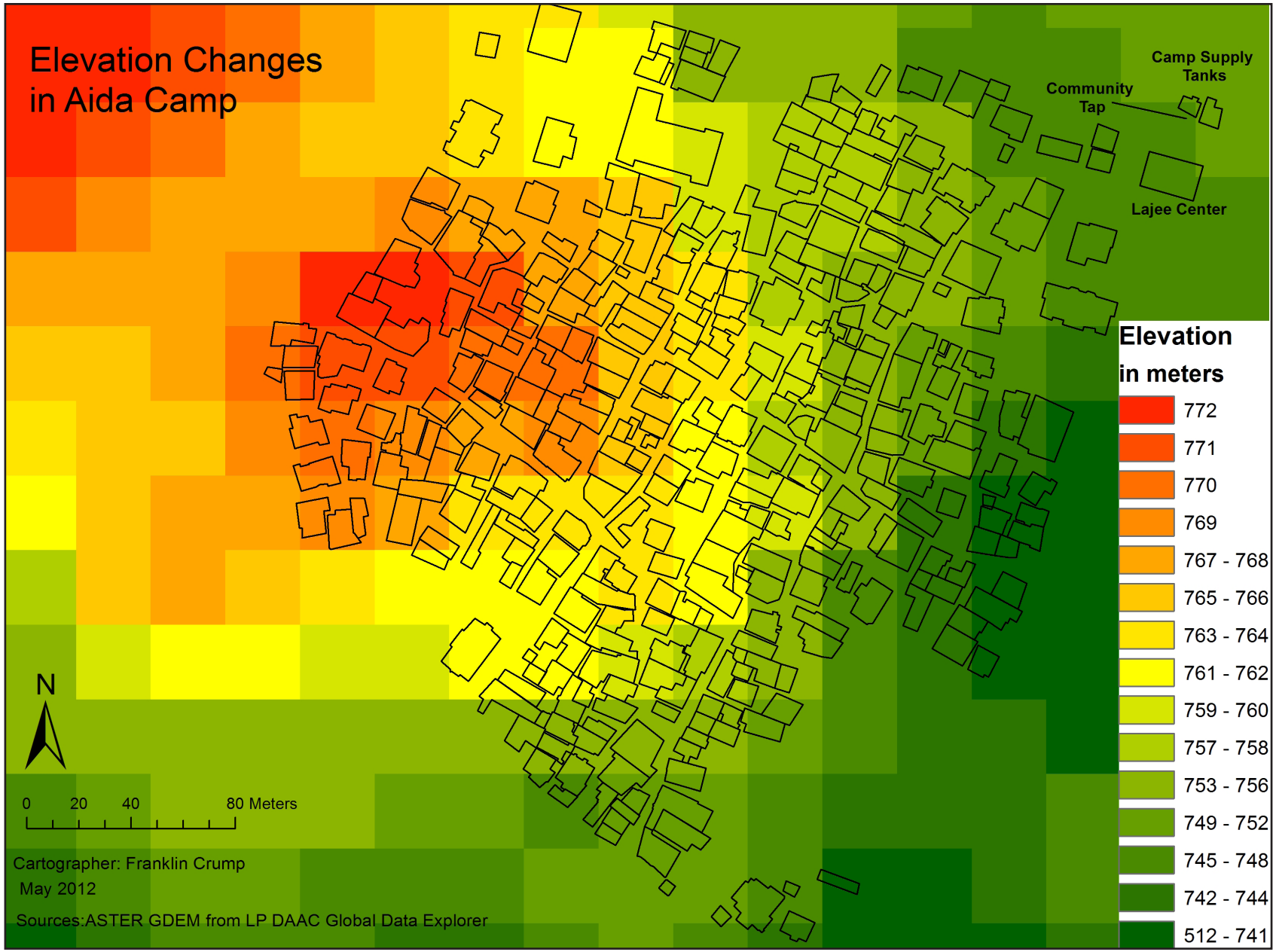

Figure 8: Map showing elevation changes in Aida Camp
Resolution of elevation map is 30 meters by 30 meters.

Background: A Review of Related Research

Many studies have been published on water quality, resultant health concerns, and potential interventions in refugee camps and developing countries. While most of this literature covers significantly different situations from those in Aida, several studies are relevant to the work of the practicum team and Lajee.

Trevett et al. (2004) conducted interviews to establish baseline knowledge of household water practices in rural Honduras. These interviews were followed by the collection of water samples, with 79% of the households retested at least once over a two-year period (Trevett et al., 2004). Studies of camps in Malawi (Roberts et al., 2001) and Liberia (Doocy, 2006) gathered baseline data in a similar way, but in each of these cases additional interviews were conducted along with resampling. These studies suggest that pairing interviews with the collection of water samples is an effective way to evaluate the quality of community drinking water supplies, and to assess household water practices in developing countries and refugee camps.

Contaminated water is a main cause of diarrhea (Zwane and Kremer, 2007; Pruess-Uestuen et al., 2008), which is responsible for an estimated 2 million deaths and 4 billion episodes of sickness worldwide each year (WHO, 2007). Additionally, chronic or recurrent diarrhea can cause under-nutrition because of increased nutrient losses in the affected individual (CDC, 2011).

Escherichia coli (E. coli) is a type of coliform bacterium known to cause gastro-intestinal illnesses. Other coliforms, while not dangerous themselves, may indicate the presence of other disease-causing bacteria. The Palestine Standards Institute, a branch of the International Organization for Standardization, established drinking water quality standards based on those of the WHO. These standards state that the sum of *E. coli* and other coliform colonies (the Total Coliform Count, or TCC) in any 100 mL sample must not exceed zero when membrane filtration is used, and that “free residual chlorine should not be less than 0.2 mg/L and is preferably not more than 0.8 mg/L at the consumers’ premises” (WHO, 2006).

An investigation of patients in Gaza visiting Primary Health Care Centers for diarrhea found that “the lack of public water access was independently predictive of diarrhea” (Abouteir, 2011). While the situation in Gaza is different in many ways from that in Aida camp, water access is a common problem. Lack of water for personal hygiene also increases the risk of such diseases as ringworm, lymphaitic filariasis, hookworm, lice, trachoma, and dental caries (cavities) (CDC, 2009).

Background: A Review of Related Research

Much of the literature about the quality of drinking water in refugee camps and the developing world focuses on post-collection contamination (Walden, 2005). This is because of the frequency with which "drinking-water that is of acceptable quality at the point of supply becomes microbiologically contaminated during the distinct processes of collection, transportation, and household storage" (Trevett, 2008).

Post-collection contamination can occur in a number of ways, but unclean collection/storage containers and unhygienic household/collection practices are often the source of the problem.

Many refugee camps have only central taps from which water is carried to households by hand. This situation is relatively common in Aida as well, especially when rooftop water tanks are dry. At those times, potential means of contamination are as described in the literature: dirty containers, unwashed hands, individual faucets, etc. (Walden, 2005).

Even when Aida residents have water flowing from their taps, post-delivery contamination is a concern. The WHO guidelines for storage containers recommend that they "have a secure, tight fitting lid" and be "easy to fill and clean" (WHO, as cited in Trevett, 2008).

Figure 9: Water collection from the communal tap in Aida

Background: A Review of Related Research

Many of the tanks in Aida fail on the first count, and virtually all of them fail on the second. These failures, combined with their sitting in the sun, create a warm, dark and wet environment in the tanks that is highly conducive to bacterial growth. In addition, there exists the potential for the aging sewer system to contaminate the water network. Although the degree of this risk is unknown, it is a concern among camp residents (al-Azraq, 2012).

Regardless of the specific situation, treatment alone is rarely sufficient to solve the problem of contaminated water. Hygiene education is vital to improving health outcomes in communities with insufficient access to clean water (Roberts, 2001; Doocy, 2006).

Because post-delivery contamination is so common, point-of-use treatment is often a recommendation for contaminated water in the developing world. For short-term treatment, chlorine and solar disinfection are the cheapest ways to effectively treat contaminated drinking water (Crump, 2004). However, the effectiveness of chlorine is reduced in water with a high concentration of organic material because chlorine binds to the organics before it can kill all of the microbial contamination (Doocy, 2006).

Some studies have shown that a combination flocculant-disinfectant can effectively remove organic materials, bacteria, viruses, and heavy metals from turbid water (Crump, 2004).

Flocculant-disinfectants are commercially available and are sold at cost to relief agencies. Annually, the cost of providing flocculant-disinfectants would be $3.83 per person (Doocy, 2006).

Other kinds of education are important as well, including learning how to monitor water quality. This knowledge, combined with an understanding of the political system, can provide leverage to advocate for the socioeconomic changes ultimately necessary to address the problem of insufficient water in refugee camps (Trevett, 2008; Abouteir, 2011).

Figure 10: Plastic bottle purchased in Aida
This type of clear plastic bottle can be used for solar disinfection of water.

Project Components: Water Quality Testing Program

In the spring of 2012 the practicum team developed a plan to establish a water quality monitoring program in Aida. This plan, consisting of two distinct components, was formalized in a Memorandum of Understanding (MOU) signed by the practicum team and by Lajee Center. The project components included a water quality testing program for drinking water and a household health and water access survey. A process evaluation was added as a third project component. Details regarding the objectives of and rationale for these project components are provided below.

The goals of the water quality testing program were to:

- Develop a water quality monitoring program for the detection of sewage indicator bacteria in Aida drinking water, including *Escherichia coli (E. coli)* and total coliform bacteria; and
- Create and implement a volunteer-operated water quality monitoring program for Aida Camp to be directed by a paid program coordinator designated by Lajee.

Coliform bacteria were selected as the contaminants of concern for a number of reasons. First, these bacteria can be addressed relatively easily compared with other sources of water contamination. Also, the equipment and supplies needed to sample and test for total coliform and *E. coli* were more cost-effective and transportable than those for testing for other contaminants.

This combination of low cost and transportability allowed Tufts to furnish Lajee with a water quality testing laboratory. Testing for coliform bacteria is a relatively simple process that can be taught to individuals with little or no water testing experience. The low cost and transportability of laboratory and sampling equipment and supplies, as well as the straightforward training, made the continuation of a testing regimen more feasible. In addition, coliform bacteria are common sources of water pollution in communities with inadequate water and wastewater infrastructure. Analytical results of the water quality testing program are included in **Appendix A**.

Training Aida community members in the methods of water quality sampling and analysis was an integral part of this program. The training of a paid program coordinator was necessary to ensure that testing would continue after the practicum team's departure from Aida. Volunteers were trained to provide support for the program coordinator and also to empower women and youth to get involved in water quality issues in their community.

Project Components: Household Health and Water Access Survey

The household health and water access survey was designed to increase the practicum team's understanding of the community's knowledge, attitudes, and practices regarding water. It was also intended to increase the practicum team's understanding of the composition of a typical household in Aida and to investigate potential links between water quality and health.

More specifically, the goals of the survey were to:

- Assess potential health consequences related to clean water access and availability;
- Determine common practices and perspectives of camp residents related to water usage and storage; and
- Establish a baseline understanding of attitudes and practices within the camp community.

The survey was designed to conform to Tufts University Institutional Review Board (IRB) standards. The IRB implements federal regulations designed to prevent harm to human subjects as a result of academic research. Because Palestinian refugees fit the definition of a vulnerable population, the IRB requirements were particularly stringent. Copies of the survey in English and in Arabic, as well as documentation of survey methods and protocols were distributed by the practicum team.

Documents explaining the purpose of the research, potential risks and benefits of participation and other information pertinent to the participant were also submitted. The survey template and associated IRB documentation is included in Appendix B.

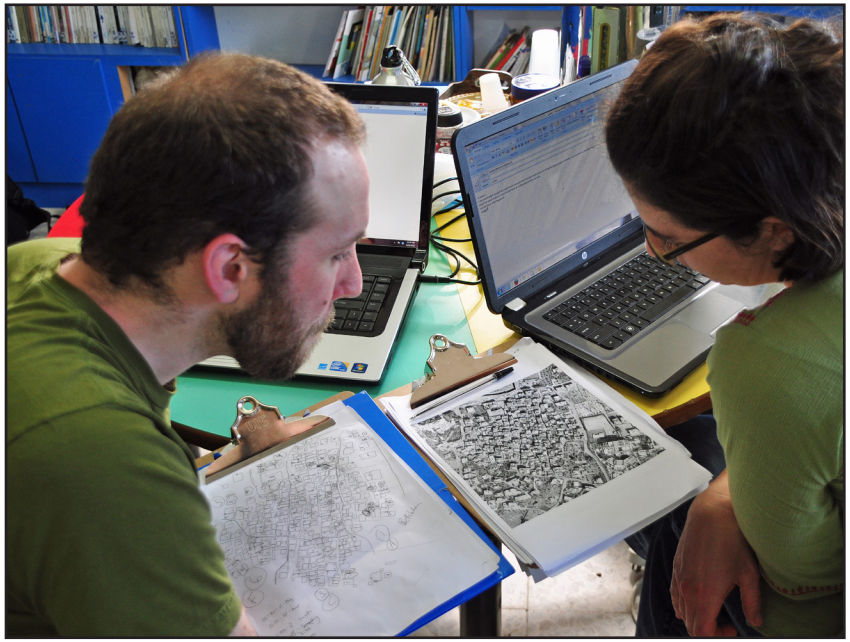

Figure 11: Comparing maps to ensure that all neighborhoods in the camp were surveyed

Project Components: Program Evaluation

A program evaluation helps to identify strengths and weakness of a program and inform future interventions. The practicum team decided that an evaluation conducted concurrently with the other project components could also improve implementation on a daily basis. The evaluation was added as a program component relatively late in the planning process. While the perspectives of Lajee staff and Aida residents would have greatly enriched an assessment of the program's success, the additional input from a vulnerable population might have jeopardized IRB approval of the entire project. Therefore, the evaluation of the program in process was solely a self-assessment. Nonetheless, this involved daily documentation of each team member's activities and perspectives on the strengths and weaknesses of program implementation. It was thought that this would allow for incremental improvements over the course of the week.

More specifically, the goals of the program evaluation were to:

- Clarify exactly what the practicum team did while in the West Bank — how much time was spent on each programmatic element, as well as on planned and impromptu social activities;
- Gauge the success of activities and preparations undertaken for the water quality monitoring program and public health survey, as perceived by the practicum team; and
- Provide recommendations for improvement, both for the team and for potential future collaboration between Tufts and Lajee.

A daily activity log was used to conduct the program evaluation (attached in **Appendix C**). Practicum team members agreed to complete an activity log each day. The log was designed to record both quantitative and qualitative information about the day's activities, to be used both for improving outcomes on subsequent days and for increasing the operational efficiency of potential future WSSS programs in the West Bank.

Methods: Water Quality Testing

The Lajee Center selected a community member prior to the practicum team's arrival to serve as the water quality program coordinator. This part-time position is funded for one year by WSSS under terms detailed in an MOU dated March 31, 2012, attached in **Appendix D**. Responsibilities of the program coordinator include coordination of water sampling, sample analysis, management of data, and training of volunteers.

The program coordinator participated in a 3-day training program with Tufts faculty member Dr. John Durant and Tufts students. Training began with sample collection procedures including proper labeling and documentation of sample containers in the field. The program coordinator accompanied Tufts students to households for sample collection to obtain field experience and later led a team of volunteer samplers (see below for information on volunteer training), with oversight from the practicum team. Training continued with bacteria analysis procedures, including sample plating and counting.

After the initial training, the program coordinator completed the bacteria analysis with the oversight of the practicum team and was able to train volunteers in proper procedures. The program coordinator was also trained in data management, documentation, and reporting procedures.

In addition, the practicum team conducted training workshops for volunteer water samplers. The workshops were intended to serve as educational and awareness-raising tools for the community, to spark the community's enthusiasm and interest in the sampling program, and to support the continuation of the program after our field work ended. One workshop was conducted for women from Aida Camp; a second workshop was conducted for university students from Aida Camp and nearby refugee camps. Five women and nine students attended the respective workshops.

The practicum team expected to encounter language barriers during the workshops and arranged to have a translator available. With one exception, all volunteers spoke English. One woman who did not speak English asked another participant in the volunteer training workshop to translate.

Each workshop consisted of two sessions. The first session began with a discussion of the principles of water quality, the Aida water system, and the pathways through which local water could become contaminated. Volunteers were encouraged to share their opinions about water quality at Aida and in their homes. After the introduction to water quality issues, volunteers were trained in the Volunteer Sampling Protocol and the Bacteria Analysis Protocol. These protocols are included in **Appendix E**.

Methods: Water Quality Testing

The volunteers then completed field training in proper water sampling techniques. After collecting water samples, they returned to the center to learn how to plate samples. The second session occurred on a subsequent day, allowing the samples sufficient time to incubate. During this session, volunteers were trained to count bacteria colonies in petri dishes.

Prior to traveling to Aida, the practicum team drafted a Volunteer Sampling Protocol and Bacteria Analysis Protocol (**Appendix E**) to serve as training guides and references for the program coordinator and volunteers. The team also drafted a Water Quality Data Sheet and Household Data Sheet for sample documentation and recordkeeping. The Water Quality Data Sheet and Household Data Sheet are included as **Appendix F**.

Throughout the week, the practicum team worked with the program coordinator to modify protocols to fit the constraints of Aida. For example, in laboratory settings it is standard practice to use distilled or de-ionized water and filtered water to clean sampling equipment and prepare quality control samples. However, due to the lack of availability of water and supplies in Aida, this method was deemed unsuitable.

The use of bottled water was determined to be a viable alternative (a commonly-available bottled water brand was tested for bacteria by the practicum team and found to be uncontaminated).[3]

Methods prescribed in these protocols are based on the American Public Health Association (APHA) Standard Methods for the Examination of Water and Wastewater (APHA, 1995).

At this time, there is no plan to translate the Volunteer Sampling Protocol, Bacteria Analysis Protocol, Water Quality Data Sheet, or Household Data Sheet into Arabic. The program coordinator speaks fluent English, as do most of the volunteers.

The laboratory technique utilized for this program is Millipore single filtration membrane technique for fecal coliform (m-FC). This technique tests for fecal coliforms, such as *E. coli,* as well as for other coliforms. Water samples of 125 mL were collected from various locations in the camp and tested using membrane filtration. The samples were collected primarily from kitchen taps, as these were most often identified as the source of the resident family's drinking water. In some households, the kitchen tap was unavailable, so samples were collected from other taps, such as the bathroom or entryway tap. Other sampling locations included household taps, a community tap, the youth center, and the Lajee Center itself.

[3] In the future, the program coordinator should purchase a large supply of the branded water bottles for testing. The bottles should be purchased on the same day and from the same store to increase the likelihood that bottles were filled at the same time and from the same source. This water should be tested before use in cleaning or quality control. This process should be repeated for every batch of water purchased.

Methods: Water Quality Testing

Each pre-cleaned collection bottle was labeled, triple rinsed with tap water, then filled, and the sample number and location were logged in a field notebook. The samples were usually tested within two hours after collection. In cases when prompt testing was not possible, the samples were stored in the Lajee Center refridgerator until the water could be run through the filter.

The samples were filtered using a hand-operated vacuum filtration apparatus. Each filter was then placed in a Petri dish with growth media (plastic ampules of m-FC broth with rosolic acid) to feed any coliform bacteria present during the 22 ± 2 hours of incubation. This time period allows the bacteria to grow to the extent that colonies are visible to the naked eye. After incubation, Petri dishes were examined for coliform colonies.

Figure 12: Water sample bottles and laboratory equipment
A bacterial analysis laboratory setup in the Lajee Center library.

Blue spots indicate the presence of *E. coli* colonies. Glossy red spots indicate other coliforms. Total coliform is found by adding together the number of blue and red colonies.

E. coli indicate recent fecal contamination. They are disease-causing bacteria and render drinking water unsafe (WHO, 2004). The severity of the *E. coli* infection depends on the bacterial strain, but stomach illness and diarrhea are common symptoms that are especially dangerous for young children. While other coliforms are not necessarily harmful on their own, they are indicator bacteria, appearing in water that has been subject to some type of bacterial contamination. Some of the bacteria that live and die on the same time scale as coliform are harmful, and thus the presence of coliform serves as a warning that the water may be unsafe to drink (WHO, 2004).

A total of 65 water samples and one duplicate sample were collected from May 13-16, 2012.[4] The program coordinator oversaw the collection of an additional 28 water samples on May 24 and June 2, 2012, so that a total of 93 water samples and one duplicate sample had been collected by the end of June. Sample collection has continued since June, but this data is not included in this report.

[4] A duplicate sample is a quality control measure to ensure that the testing delivers precise results.

Methods: Public Health Survey

The public health survey was administered during our week in Aida with the assistance of Arabic translators. Individuals from 29 households were interviewed about public health concerns relating to drinking water quality, including water procurement and storage practices, perceptions of water quality in the camp, and health issues experienced by members of the household in the past year.

The interviews included the completion of an 18-question public health survey, which was developed based on common health issues related to bacterial contamination of drinking water. Two bilingual translators independently translated the survey into Arabic, and the two resulting translations were then integrated in order to avoid ambiguities and discrepancies in wording. An English version of the survey is attached in Appendix B.

Before surveying began, Arabic language translators were briefed on best practices for maintaining consistent and reliable communication with respondents. These included asking the questions in the same order and same way each time, not reacting to any answer given by a respondent, and not probing to look for a specific answer from the respondent.

Due to time constraints, it was decided that convenience sampling was the only feasible approach to data collection. The local translators were told that surveys needed to be conducted in each neighborhood of the camp. With this in mind, the translators chose potential respondents based on the likelihood that they would be at home and willing to participate.

Survey teams of two or three individuals, including at least one trained research assistant and one English-Arabic translator from the local community, visited individual households. When possible, survey teams included at least one male and one female in order to avoid response bias based on gender. In all cases, at least one female was present.

The survey teams conducted house visits during times of day when the heads of household were most likely to be present and available (typically in the afternoon and early evening). Potential participants were given a brief description of the study being conducted, followed by an opportunity to read an IRB-approved Consent Form in its entirety in Arabic and to voice any questions or concerns.

If verbal consent to participate was given, the survey team proceeded with the public health survey. The survey process generally took 15 to 30 minutes. After the questionnaire was completed in accordance with the established protocol, participants were allowed to discuss related topics with the survey team. Notes from these conversations were recorded in the teams' field notebooks.

Methods: Program Evaluation

The instrument used to conduct the program evaluation was a daily activity log (**Appendix C**) that practicum team members had agreed to complete. The log was designed to record both quantitative and qualitative data about a day's activities, to be used both to improve outcomes on subsequent days, and increase the operational efficiency of potential future WSSS programs in the West Bank.

The five-day period spent in the camp presented a tight timeframe in which to accomplish all components of the program. The daily activity log was intended to be completed by practicum team members in their spare time. The log was designed to document objective details and sequencing of all activities undertaken by team members. It also recorded subjective perceptions of which activities were succeeding and which were being implemented differently from the design plans. The front of each log sheet contains a blank area on which team members recorded daily activities, including the time, location, others who participated in the activity, and comments. The back of the sheet poses qualitative questions about the activities and prompts suggestions for improvements.

Some practicum team members kept a log sheet with them throughout the day and recorded activities as they happened, while others chose to fill them out from memory at the end of the day. Each morning, completed logs were collected and blank logs were distributed. Daily tabulation of data that could be quantified allowed for a more accurate account of the team's actions, while daily reflection on the efficacy of programmatic elements increased the adaptive potential of the project.

Figure 13: Conducting a workshop with women from Aida

Results: Water Quality Testing

Although the water quality monitoring program has been ongoing for six months as of this writing, only data collected between May 13 and June 2, 2012 is included in this report. A total of 93 water samples and 1 duplicate sample were collected during this period. Results were not obtained for 3 of the 93 samples; one sample was dropped and two samples had inconclusive results due to high particulate matter in the sample. A Summary of Sample Collection is presented in Table 1.

For this section of the report, the term "household" includes samples collected from households as well as the community tap, the Lajee Center, and commercially bottled water. The term "tap" extends to samples collected from bottled water and directly from water tanks.

Ninety water samples were collected from 71 seperate households. In four of these households, water samples were collected from multiple taps, resulting in a total of 75 taps being sampled. In two of the four, samples were collected on the same day from both an interior tap and an exterior tap. In the third, also on the same day, one sample was collected from a first-floor tap and the second was collected from a second-floor tap, both of which used water from the same tank.

In the fourth household, the practicum team collected a sample and returned to the house to collect an additional sample the following day to confirm results, but insufficient water could be collected from any of the faucets. Instead, water was sampled directly from the roof-top tank. A summary of the number of households and taps sampled is presented in Table 2 on the following page.

Table 1: Summary of Sample Collection

Sample Date	No. of Samples	No. of Results	Notes
5/13/12	15	14	sample dropped
5/14/12	25	24	inconclusive result
5/15/12	9	8	inconclusive result; plus 1 duplicate
5/16/12	16	16	
5/24/12	15	15	
6/2/12	13	13	
Total	**93**	**90**	
by WSSS	65	62	
by Lajee	28	28	

Results: Water Quality Testing

Table 2: Number of Households and Taps Sampled

No. of Samples Collected Per Household	No. of Households	No. of Samples Collected from Individual Taps	No. of Taps
1	59	1	65
2	8	2	8
3	2	3	0
4	1	4	1
5	1	5	1
Total	71	Total	75
No. of Households Re-Sampled	12	No. of Taps Re-Sampled	10

* More households were resampled than taps because two households were re-sampled from different taps.

Total coliform colonies were detected in 42 water samples (47%) and *E. coli* colonies were detected in 13 water samples (14%). As noted above, the WHO standard is zero — that is, that no coliform colonies, including *E. coli,* should be detected in drinking water samples. More than 10 total coliform colonies were detected in 16 water samples (18%) and more than 10 *E. coli* colonies were detected in 5 water samples (5.6%). See Table 3 for a Summary of Results.

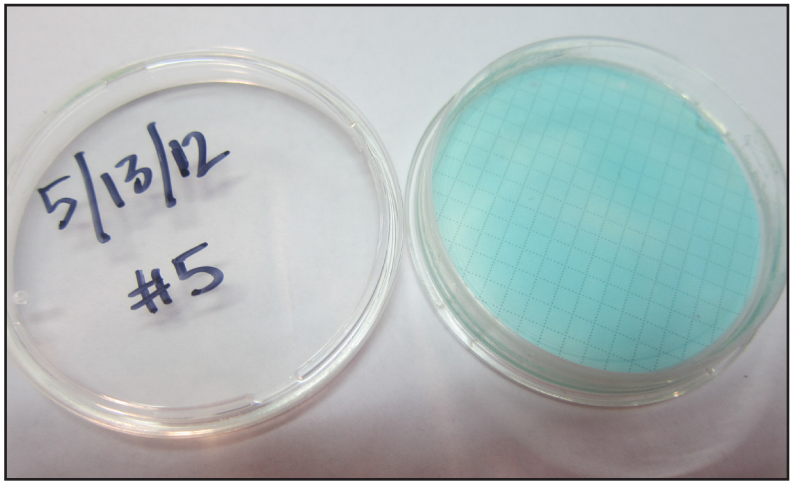

Figure 14: Petri dish containing no E. coli or other coliform bacteria colonies

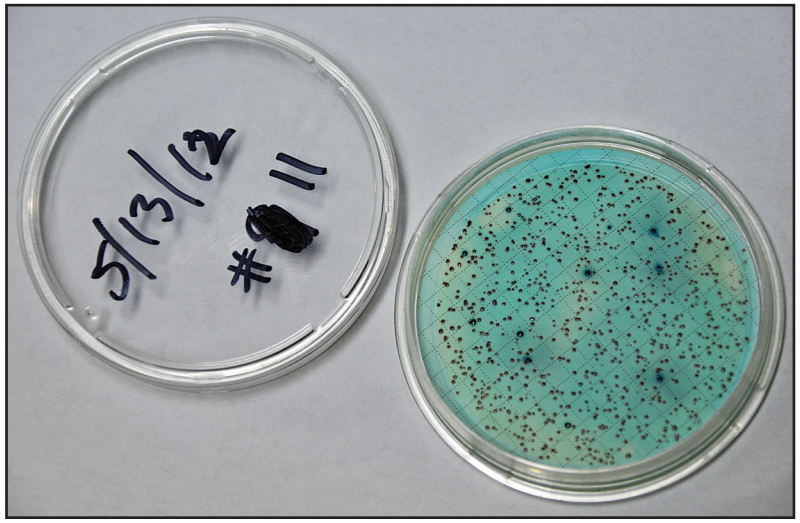

Figure 15: Petri dish with E. coli (blue dots) and other coliform bacteria colonies (red dots)

Results: Water Quality Testing

Table 3: Summary of Results

No. of Colonies	No. of Samples with Bacteria Growth			
	Escherichia coli		Total Coliform	
0	77	85.6%	48	53.3%
>0	13	14.4%	42	46.7%
1-10	8	8.9%	26	28.9%
>10	5	5.6%	16	17.8%
>50	3	3.3%	7	7.8%
TNTC	0	0.0%	4	4.4%
No. of Colonies	**No. of Taps with Bacteria Growth**			
	Escherichia coli		Total Coliform	
0	65	86.7%	40	53.3%
>0	10	13.3%	35	46.7%
1-10	6	8.0%	23	30.7%
>10	4	5.3%	12	16.0%
>50	3	4.0%	5	6.7%
TNTC	0	0.0%	2	2.7%

TNTC = Too Numerous To Count
Total number of samples collected = 90
Total number of taps sampled = 75

Water samples were collected from the community tap (Sample Location No. 8) on May 13, May 15, May 16, and May 24. On May 15, a water sample collected from the community tap had no coliform colonies, but a duplicate sample collected at the same time had one coliform colony. One coliform colony was detected in the water sample collected from the community tap on 2 out of the 4 days it was sampled. Table 4 on the following page summarizes the results from the taps that were sampled multiple times. It is notable that new water was pumped into the camp from Bethlehem governorate on the afternoon of May 15.

During the summer of 2012, Aida Camp endured an unusually long (71-day) period without piped water. The program coordinator decided not to request water samples from residents facing extremely low water supplies. Sampling resumed after new water was delivered.

Results: Water Quality Testing

Table 4: Summary of Results from Taps Sampled Multiple Times

Sample Location No.	Parameter	Results (No. of Colonies) By Sample Date					
		5/13/12	5/14/12	5/15/12	5/16/12	5/24/12	6/2/12
6	*E. Coli*	0			1		
	Total Coliform	10			15		
8	*E. Coli*	0		0	0	0	
	Total Coliform	1		1	0	0	
11	*E. Coli*	10	27	69	8	0	
	Total Coliform	TNTC	TNTC	TNTC	44	0	
12b	*E. Coli*		2	0			
	Total Coliform		8	0			
13	*E. Coli*	0	0				
	Total Coliform	19	48				
18a	*E. Coli*		4			0	
	Total Coliform		14			0	
29	*E. Coli*		0		0		
	Total Coliform		41		9		
31	*E. Coli*		0			0	
	Total Coliform		0			0	
32	*E. Coli*		4		0		
	Total Coliform		10		0		
54	*E. Coli*					0	0
	Total Coliform					9	0

TNTC = Too Numerous To Count

Sample location = Each sampled household is assigned a number. If multiple taps are sampled from the household, each tap is identified by the household number and a letter.

Results: Public Health Survey

Households in Aida generally consist of multiple generations of family members living in the same home. Branches of extended family members often live in the same building as well; historically, as families have grown in number, additional rooms or floors have been added to buildings to allow the additional family members to live in the same ground footprint.

Table 5: Household Information

Description	Mean (SD*)
Household Size	8.0 (4.95)
Number of Children Under 5 per Household	1.3 (2.04)
Total Water Tanks per Household	5.8 (3.93)
Metal Tanks per Household	3.2 (3.70)
Plastic Tanks per Household	2.6 (1.74)

**SD* = Standard Deviation

Of the 29 households that completed the survey, 66% reported that at least one individual in the home had been ill in the previous two weeks. Among these households, 47% reported that a child under the age of five had been ill and 16% reported that a family member over the age of 70 had been ill.

Furthermore, when the time period was extended from two weeks to six months, 83% of households reported that at least one person in the home had been ill.

Of those homes where at least one resident had been ill in the last six months, 54% reported that a child under the age of five experienced illness and 13% reported that the illness involved a family member over the age of 70.

When participants were asked what they believe caused these illnesses, the majority (63%) of respondents stated that they believed the weather was the cause, while only 13% thought that water quality might be at fault.

Figure 16: Conducting a public health survey

Results: Public Health Survey

A majority of survey respondents considered the quality of their drinking water to be "normal" in terms of smell, color and taste.[5] No one considered their water "very bad" in any of these categories.

Every household reported storing water in metal or plastic tanks, usually located on the roof of their homes. The majority of households (86%) reported that they do not take any measures to improve the quality of their water before it is consumed. The majority of respondents (90%) said that they clean their storage tanks. However, many noted that it is a very difficult and sometimes dangerous task, because the tanks are located on crowded rooftops, and the tank openings are small and difficult to access.

Table 6: Opinion of Quality of Household's Primary Water Supply

Water Quality	Respondent Percent*
What is the quality of the water's smell?	
Very Bad	0%
Bad	12%
Normal	60%
Good	16%
Very Good	12%
What is the quality of the water's color?	
Very Bad	0%
Bad	16%
Normal	56%
Good	24%
Very Good	4%
What is the quality of the water's taste?	
Very Bad	0%
Bad	23%
Normal	54%
Good	19%
Very Good	4%

A total of 29 individuals were surveyed. Percentages in this table represent the number of those who chose a given answer out of the total of surveyed individuals.

[5] "Normal" was not specifically defined in the questionnaire, and was therefore open to interpretation by the respondent.

Table 7: Household Water Cleaning Habits -- Questions

Question	Sample percent
Do you ever take measures to clean your water? If so, how?	
No	83%
Yes - Boil	7%
Yes - Filter	7%
Yes - Chlorine	3%
Do you clean your water storage vessels? If so, how?	
No	10%
Yes - Scrub with water	28%
Yes - Scrub with soap and water	31%
Yes - Scrub with chlorine, bleach or other chemical	31%

The amount of time required to fill household tanks varied greatly, ranging from three hours to three days, depending on the location of the home. Nearly every family (90%) reported having run out of water at least once in the previous year. The three households that had not run out of water were those that had high-volume subterranean water storage pools to allow their supply to last when water delivery to the camp was infrequent. Of the 26 families that reported running out of water on a regular basis, 50% had purchased water after their personal supply ran out. The most common way to do this was to schedule delivery by a water truck from nearby Bethlehem. The cost was between 200 NIS[6] (51.89 USD)[7] and 500 NIS (129.74 USD) and the quantities purchased for this amount varied from 6 cubic meters to the contents of an entire large tanker truck.

[6] Israeli New Shekel.

[7] United States Dollar.

Results: Public Health Survey

Interviewees also were asked what agency they would notify if a problem were discovered with their drinking water. In addition, interviewees were asked who they believed would actually take steps to fix the problem. Responses to both questions varied greatly, and there was no clear consensus regarding which entities were responsible for ensuring that residents had access to clean drinking water.

Figure 16: Orphan mural
The orphan is a common symbol in Aida. The child always has his back to the viewer, a reminder that the world has turned its back on the refugees.

Table 8: Accountability for Water Quality

Question	Percentage*
If a water quality issue were identified, to whom would you go with your complaint?	
United Nations Refugee Works Agency	45%
Palestinian Water Authority	21%
Palestinian Health Ministry	28%
Bethlehem Consulate	12%
Lajee Center	3%
Camp Manager	3%
No One	14%
God	3%
Who would you expect to deal with it?	
United Nations Refugee Works Agency	28%
Palestinian Water Authority	21%
Palestinian Health Ministry	17%
Bethlehem Consulate	3%
Community Members	7%
Plumber	3%
Other Government/Responsible Persons	7%
No One	31%

* Percentages do not add up to 100% because some respondents gave multiple answers for each question.

Results: Program Evaluation

Each of the seven students in the practicum team agreed to fill out a daily activity log each day, but only 22 completed logs were submitted for the 6 days that the team was in the West Bank — from a high of 8 on the first day to just one on the last day. Because there was no strict prepared schedule, practicum team members engaged in a variety of activities at any given moment. In short, quantitative data was insufficient to provide an accurate profile of the team's activities, especially toward the end of the trip.

However, the qualitative data collected provided significant insight into the strengths and weaknesses of project planning and implementation. This understanding, bolstered by knowledge gleaned from the quantitative data, could greatly improve the efficiency and efficacy of future practica in the West Bank.

Overall, students in the practicum team felt that the project went quite well. Many log entries mentioned the central role that Lajee staff played in making sure that things ran smoothly. Their knowledge of pertinent cultural and political issues, deep connection to the camp community and enthusiasm for our joint project were essential.

Practicum team members made special note of our initial meeting with Lajee staff and the brief tour of the camp, which ended with a discussion on the roof of one of the higher buildings, as a great introduction to the research site.

Also mentioned multiple times was the fine job that Lajee did in recruiting volunteers or in encouraging those most interested to participate. The interest and competency of the women and student volunteers ensured that the training process was less challenging than anticipated.

The food was unanimously praised. The team ate lunch daily in the home of a camp resident hired to cook for us, joined by various friends and relatives. Several logs mentioned discussions over lunch, noting that interacting with Lajee staff and camp residents in informal settings helped us to deepen connections with the community. The practicum team, including Lajee representatives, also ate dinner together every night, always in restaurants outside of the camp. This helped to strengthen the group's cohesion, while providing the distance necessary to gain perspective on the day's work.

Unplanned social events and other activities not directly related to specific project components were also considered important by team members. A kite competition, a march/vigil and a field trip were all mentioned in logs as events that strengthened our bonds to each other and the camp community, reminded us of our purpose, provided broader social and political perspective, and helped us to work together more effectively.

Results: Program Evaluation

Flexibility, such as the lack of a regimented schedule, the willingness and ability of team members to take on different roles, and the ability to adjust the previously written protocols, was usually an asset when working in Aida. This increased the team's adaptability to situations on the ground. On the other hand, some practicum team members reported periods of unproductive down-time due to lack of scheduling.

A related concern was that, at times, there were "too many cooks in the kitchen." The roles and responsibilities laid out in the MOU were largely ignored, leading to inefficiency and, as the week progressed, some inter-group tension.

The most significant shortcomings reported in the logs were the result of oversights by the practicum team in preparation for the project. For example, there was no protocol in place for documenting and organizing data collected simultaneously by multiple groups. This wasted time retroactively designing such a system, while dealing with samples and photographs bearing duplicate numbers. Another example of a failure that could be easily avoided in the future was the lack of small latex gloves for the women volunteers. This led to breaches of protocol designed to prevent sample contamination.

Figure 17: Last minute planning

Figure 18: Systematic organization of the water sample records
A sample and sample location numbering system was not established prior to the field trip, causing some confusion and loss of time.

Results: Limitations

Data presented in this report and the conclusions drawn from the data are based on samples and surveys collected over the week of May 13-18, in addition to sampling overseen by the program coordinator between May 24 and June 2. This period included Nakba Day, which occurs annually on May 15 to mark the events that resulted in the displacement of Palestinians in 1948. Camp activities on Nakba Day prevented the practicum team from collecting water samples.

On May 17, the team travelled to Ramallah to meet with the Palestinian Agricultural Relief Committee (PARC) and to Nablus to visit the Balata Refugee Camp.[8] While these activities were fruitful and informative, they precluded the collection of any samples or surveys on that day.

Lack of housing and demographic data within the camp prevented the randomization of the public health survey. The convenience sampling methodology that we used in this survey could give rise to exclusion bias. That respondents often knew the translators created the potential for response bias. Finally, the relatively small sample size did not yield statistically significant results. As a result, the survey may not be truly representative of the Aida community.

Lajee staff members reported that the public health survey process was a useful addendum to the water quality data and expressed an interest in continuing this survey in the coming year. This would add to the robustness of understandings gained from the survey process.

Figure 19: Placing bacterial growth media on a Petri dish
A woman from the camp is learning how to use the laboratory equipment, but the gloves are too big for her hands.

[8] Balata is the West Bank's most populous refugee camp, with over 23,000 registered refugees.

Community Response: Sampling and Surveys

The reactions of community members to the water quality sampling and public health survey were generally positive. It is highly probable that this was in part due to selecting trusted community members to serve as liaisons and translators. Nonetheless, most residents appeared happy to invite practicum team members into their homes and many seemed genuinely interested in our work.

The most important limiting factor in the sampling and survey process was time. Practicum team members were often asked to stay and have tea for an additional 10 to 15 minutes. Also, the hours available for sampling and surveying were limited by our effort to maintain a culturally appropriate schedule in the camp. This meant avoiding meal times and hours when men were likely to be out of the house.

Students and women who attended the water sampling and bacteria counting workshops were enthusiastic and inquisitive — fast learners who, when given an explanation, were quick to understand the potential pathways for water contamination.

The Lajee Center was an enthusiastic supporter of the sampling and surveying program. Volunteers and center staff provided practical advice and recommendations that were essential to the successful implementation of the training program.

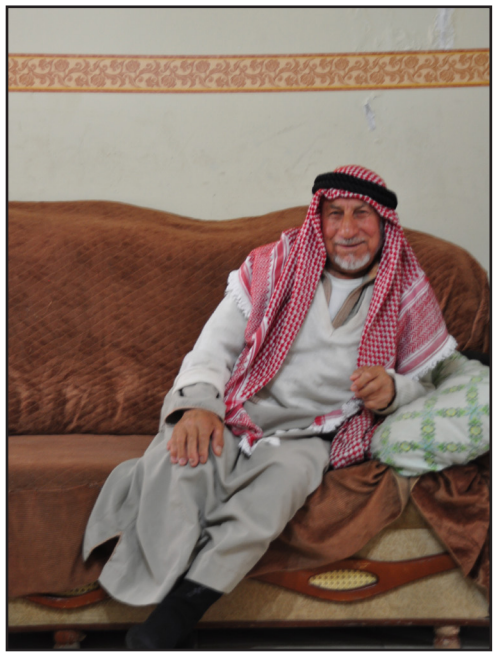

Figure 20 (top): Women in Aida quickly learned laboratory procedures

Figure 21 (right): Aida hospitality
Camp residents almost always insisted that Practicum team members stay for tea after collecting a water sample.

Community Response: Presentation of Results

Lajee organized a community meeting so that the research team could discuss its findings with camp residents. Approximately 30 community members, as well as representatives from UNRWA, the PWA and other Palestinian refugee camps, attended the meeting. The presentation was given by a Tufts student and translated by an Aida Camp resident. The presentation included an overview of the water quality monitoring program's objectives, a description of the potential health effects from consuming water containing *E. coli*, and an explanation of the Palestinian and WHO water quality standards. Sampling and analysis methodologies, and findings were then reviewed. Attendees were informed of potential water treatment options that are known to reduce or eliminate bacteria in drinking water.

Figure 22: Concerned citizens listen intently to the presentation

Results of the Public Health Survey were not included in the presentation. This decision was made for a number of reasons, including time constraints, the density of data relating to the testing itself, the desire to focus on water quality (the central health issue), and the preliminary state of the survey results. Presentation slides are included in this report in **Appendix G**.

Figure 23: The presentation was followed by a lively discussion

The camp residents were concerned by the findings. In response, an UNRWA representative stated that his organization was very interested in the study and wished to be involved in future testing. However, he also insisted that the contamination was not the responsibility of the UN.

Conclusions: Water Quality and Sources of Contamination

The UNRWA website states that the Aida Camp's pipe networks for both water and sewage need to be rehabilitated (UNRWA, 2012). But it says nothing explicit about about the potential health implications of this poor infrastructure.

Water delivery by the Bethlehem water utility is governed by specific water quality standards, including those addressing bacterial growth (WHO, 2006) and residual chlorine (Informal discussion with an UNRWA representative inquiring about the practicum team's work, 2012). Water from the community tap was tested five times, with each of two results indicating one coliform colony. This may be the result of contamination in the tank or between the tank and the community tap. Continued sampling of the community tap, as well as a more detailed understanding of the pipe network, is necessary to draw any definitive conclusions. However, the community tap tested clean most of the time and the levels of coliform, when detected, were very low (one coliform colony, and no *E.Coli* colonies, detected). It is worth noting that the water is chlorinated before being pumped to the camp. In fact, 53% of taps sampled in the camp had clean water. We therefore conclude that, based on our data, water entering the camp is generally free of sewage indicator bacteria.

One potential source of contamination is the camp's water and sewage networks, including the water mains and connections from those mains to neighborhoods and individual homes.

At least one instance has been noted of cross-contamination between the sewage and the water supply networks (this was mentioned by several residents during informal discussions about the camp water and sewage systems).

During the course of our work, UNRWA carried out an independent investigation and shared the results of the five houses it tested for residual chlorine, four of which we had previously sampled. All five had adequate levels of residual chlorine in the connection pipes from the underground network. However, when UNRWA tested samples from the house taps, they found that three of the houses did not have enough residual chlorine in their water to ensure that it was safe to drink. This indicates that the contamination for at least these three houses is occuring between the connection pipes and the household taps, such as the rooftop tanks or household pipes.

A potential source of water contamination in these cases is the household water tanks, almost all of which are located on rooftops. Many tanks lack tightly fitted covers, allowing the entrance of foreign contaminants. Team members observed organisms swimming in one tank and were told by a resident of a dead bird found in another. The water in these tanks sits for days or weeks in the sun before it is consumed, and the warm and dark conditions are ideal for bacterial growth.

Conclusions: Water Quality and Sources of Contamination

Many camp residents stated that they are unable to clean their tanks properly. The space on the roofs is crowded and it can be a dangerous area in which to walk, let alone to fill or wash a tank. There have been at least two cases of serious injury in Aida (one case of multiple fractures, and one case of brain trauma) resulting from falls while checking or cleaning water tanks (Al Azraq, 2012).

Figure 24: Cleaning the inside of rooftop tanks can be difficult and dangerous work

Conclusions: Community Health and Perceptions of Organizational Responsibility

Identifying a causal connection (or even correlation) between community health and water quality is beyond the scope of this study. With that caveat, it is worth noting that the results indicate that 47% of sampled water taps contained coliform bacteria, and 66% of households surveyed experienced some illness within the previous two weeks.

We were unable to collect enough water samples or conduct enough surveys to draw any definitive conclusions from these data. Nonetheless, the scientific relationship between contaminated water and poor health is well understood, and the data from Aida is suggestive.

Our survey of Aida residents indicates that the connection between water quality and health is generally not well understood. Despite the high incidence of illness, 83% of households surveyed stated that they believe their water to be of normal or good quality. Of course, as stated earlier, a limitation of this study is that it is not completely clear what residents assumed “normal” water to be.

Surveying indicates that residents have little faith in the several organizations officially responsible for various aspects of water quality and water conveyance. UNRWA appears to be the organization to which most residents would address their complaints about the water system. Nevertheless, only 38% of respondents believe the agency would actually take steps to fix the problem.

In informal discussions with the practicum team and at the presentation of results to the community, UNRWA accepted responsibility for the two water mains that it had constructed. However, the team was unable to identify any agency or organization responsible for infrastructure or water quality issues after water leaves the main. This means that household water tanks and all associated pumps, hoses, and piping — which are critical aspects of the camp water infrastructure and potential sources of bacterial contamination — benefit from no organizational oversight.

Figure 25: Discussing water quality with UNRWA representatives

Recommendations

Given administrative complications and organizational distrust, solving the water contamination problem will be difficult. However, we believe that concrete steps can be taken that will improve health outcomes in the short term, and potentially in the long term as well.

We recommend that the Lajee Center make an effort to educate camp residents about the potential illnesses resulting from the consumption of contaminated water, and provide information on treatment options for drinking water. It is important to inform residents that untreated water may still be used for bathing, washing clothes, and other household tasks with little risk to health. This knowledge may help residents to decide which treatment options are best for them, given individual family circumstances. Tufts, with the help of the Lajee Center, has written a brief educational piece that can be used for this purpose (attached to this report in Appendix H). Lajee may find additional value in seeking other options available to Aida Camp residents, or in cooperating with NGOs concerned with water quality and water treatment.

We recommend that the Lajee Center expand the water quality testing program. The results presented in this report account for water quality in only a small percentage of camp households during a period of less than a week. Given the small sample size, and the considerable variability in these analytical results both spatially and over time, it is clear that further testing is necessary to better understand the factors influencing water quality in Aida Camp. Comprehensive testing should also identify the sources of water contamination in the camp — whether rooftop storage tanks, failing infrastructure, or as yet unknown elements.

We recommend that the Lajee Center maintain independent control over the water sampling and analysis program, as well as the related records. However, despite the distrust between Lajee and UNRWA, cooperation and information sharing could be advantageous to both parties.

Figure 26: Sharing a laugh in the Lajee water quality analysis lab

Recommendations

Outreach by Lajee may also serve as a catalyst for developing inter-organizational trust. However, information sharing does not mean ceding control of the program or its records. By maintaining independent control over the water quality program, Lajee remains free to partner with other organizations, or to work alone, if collaboration with UNRWA proves to be impractical or counterproductive. Independent control of the program also protects Lajee from being perceived as a victim of co-option by an agency that lacks legitimacy in the eyes of many in the Aida Camp community.

We also recommend that the Lajee Center consider future collaboration with research teams from Tufts. As the water quality monitoring program continues, Lajee may discover that new research questions, not considered in this study, arise. Tufts University and the WSSS program seek further opportunities to address complex water problems of the type seen at Aida Camp. We look forward to the possibility of mutually beneficial work with the Lajee Center in the future.

Opportunities for future collaboration include:

- Performing statistical analysis of data collected throughout the year to map trends and patterns in water quality.
- Increasing participation in the community survey in order to develop a baseline that is statistically significant and descriptive of other populations.
- Using the same learning tools and methods to develop water quality testing programs in other refugee communities.
- Testing for other potential drinking water contaminants, including the plastics and metals that are present in the roof-top tanks.
- Studying institutions responsible for the maintenance of water quality in Aida Camp.

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Appendix A: Water Quality Results

Note: Household names were expunged from the attached water quality data sheets for reasons of privacy and security. The households associated with each sample are known by Lajee.

Water Quality Data Sheet

Sampler's Name: WSSS Practicum Team

Date: 5/13/2012

Sample No.	Household Name	Sampler's Initials	Volume Plated (mL)	Time Put in Incubator	No. of Colonies		
					Other Coliforms (red)	*E. coli* (blue)	Total Coliform (red + blue)
1		jd	125 ml	17:15	7	0	7
2		jd	125 ml	17:15	0	0	0
3		jd	125 ml	17:20	1	0	1
4		jd	125 ml	17:20	1	0	1
5		jd	125 ml	17:25	0	0	0
6		jd	100 ml	17:25	10	0	10
7			125 ml	17:30	4	0	4
8			125 ml	17:30	1	0	1
11		km	125 ml	17:35	tntc	10	tntc
12a		km	100 ml	17:35	8	0	8
13		km	125 ml	17:40	19	0	19
14		km	100 ml	17:40	no results	no results	no results
15		km	85 ml	17:45	0	0	0
16		km	125 ml	17:45	0	0	0
17		km	125 ml	17:50	2	0	2
							0
							0
							0
							0
							0
							0
							0
							0
							0

Water Quality Data Sheet

Sampler's Name: Practicum Team

Date: 5/14/2012

Sample No.	Household Name	Sampler's Initials	Volume Plated (mL)	Time Put in Incubator	No. of Colonies		
					Other Coliforms (red)	*E. coli* (blue)	Total Coliform (red + blue)
9			125 ml	11:50	0	0	0
10			125 ml	12:12	1	0	1
11			125 ml	12:20	tntc	27	tntc
12b			125 ml	12:20	6	2	8
13		km	125 ml	12:20	48	0	48
18			125 ml	12:40	10	4	14
19			125 ml	12:30	2	0	2
20a			125 ml	12:30	0	0	0
20b			125 ml	12:40	1	0	1
21		km	125 ml	17:15	4	0	4
22		km	125 ml	17:15	no results	no results	no results
23		km	125 ml	17:30	2	0	2
24		km	125 ml	17:30	0	0	0
25a		km	125 ml	12:00	0	0	0
25b		km	125 ml	12:31	0	0	0
26		km	125 ml	12:25	0	0	0
27		km	125 ml	12:15	0	0	0
28		km	125 ml	12:05	tntc	0	tntc
29		km	125 ml	12:35	41	0	41
30		km	125 ml	12:40	2	0	2
31			125 ml		0	0	0
32		km	125 ml	18:30	6	4	10
33		km	125 ml	18:25	2	0	2
34		km	125 ml	18:20	0	0	0
41		km	125 ml	18:35	0	0	0
							0

Water Quality Data Sheet

Sampler's Name: WSSS Practicum Team

Date: 5/15/2012

Sample No.	Household Name	Sampler's Initials	Volume Plated (mL)	Time Put in Incubator	No. of Colonies		
					Other Coliforms (red)	*E. coli* (blue)	Total Coliform (red + blue)
8		eh	125 ml	17:40	0	0	0
8		sg	125 ml	early PM	1	0	1
11		eh	125 ml	17:40	tntc	69	tntc
12b		eh	125 ml	17:40	0	0	0
35		sg	125 ml	early PM	no results	no results	no results
36		sg	125 ml	early PM	0	0	0
37		sg	30 ml	early PM	0	0	0
38		sg	125 ml	early PM	1	0	1
39		sg	125 ml	early PM	46	0	46
40		fc	125 ml	early PM	0	0	0
							0
							0
							0
							0
							0
							0
							0
							0
							0
							0
							0
							0
							0

Water Quality Data Sheet

Sampler's Name: Practicum Team

Date: 5/16/2012

Sample No.	Household Name	Sampler's Initials	Volume Plated (mL)	Time Put in Incubator	No. of Colonies		
					Coliforms (red)	*E. coli* (blue)	Total Coliform (red + blue)
6		fc			14	1	15
8		fc	125 ml		0	0	0
11		fc			36	8	44
18b		fc			0	0	0
29					9	0	9
32		sg	125 ml		0	0	0
43		sg	125 ml		0	0	0
44		sg	125 ml		0	0	0
45		sg	125 ml		0	0	0
46		sg	125 ml		1	0	1
47		sg	125 ml		0	0	0
48		sg	125 ml		1	0	1
49		sg	125 ml		0	0	0
50		fc			0	0	0
51		fc			15	0	15
52		fc			0	0	0
42					no results	no results	no results
							0
							0
							0
							0
							0
							0
							0
							0

Water Quality Data Sheet

Sampler's Name: Mohammed Alazraq

Date: 5/24/2012

Sample No.	Household Name	Sampler's Initials	Volume Plated (mL)	Time Put in Incubator	No. of Colonies		
					Other Coliforms (red)	*E. coli* (blue)	Total Coliform (red + blue)
53		mq	125	14:00	0	0	0
54		mq	125	14:00	9	0	9
55		mq	125	14:00	0	0	0
56		mq	125	14:00	0	0	0
57		mq	125	14:00	6	1	7
58		mq	125	14:00	0	0	0
59		mq	125	14:00	5	0	5
60		mq	125	14:00	0	0	0
61		mq	125	14:00	0	0	0
62		mq	125	14:00	0	0	0
63/11		mq	125	14:00	0	0	0
64		mq	125	14:00	0	0	0
65/8		mq	125	14:00	0	0	0
66/31		mq	125	14:00	0	0	0
67/18a		mq	125	14:00	0	0	0
	Sun A	mq/km	1500		64	1	65
	Sun B	mq/km	1500		14	6	20
	Dark A	mq/km	1500		tntc	47	tntc
	Dark B	mq/km	1500		tntc	60	tntc
							0
							0
							0
							0
							0
							0
							0

Water Quality Data Sheet

Sampler's Name: Mohammed Alazraq

Date: 6/2/2012

Sample No.	Household Name	Sampler's Initials	Volume Plated (mL)	Time Put in Incubator	No. of Colonies		
					Other Coliforms (red)	*E. coli* (blue)	Total Coliform (red + blue)
68		mq	125	15:00	0	0	0
69		mq	125	15:00		0	0
70		mq	125	15:00	0	0	0
71		mq	125	15:00	28	0	28
72		mq	125	15:00	6	1	7
73		mq	125	15:00	0	0	0
74		mq	125	15:00		0	0
75		mq	125	15:00	0	55	55
76/54		mq	125	15:00	0	0	0
77/54		mq	125	19:00	0	0	0
78		mq	125	15:00	36	50	86
79		mq	125	15:00	0	0	0
80		mq	125	15:00	0	0	0
81		mq	125	15:00	5	60	65
							0
							0
							0
							0
							0
							0
							0
							0
							0

Appendix B: Survey and IRB Documents

Tufts UNIVERSITY

OFFICE OF THE VICE PROVOST

Social, Behavioral, and Educational Research
Institutional Review Board
FWA00002063

May 9, 2012 | Notice of Action

IRB Study # 1203014 | Status: ACTIVE

ATTENTION: BEFORE CONDUCTING ANY RESEARCH, PLEASE READ THE ENTIRETY OF THIS NOTICE AS IT CONTAINS IMPORTANT INFORMATION ABOUT PROPER STUDY PROCEDURES.

Title:Democratizing Water: Engaging Youth and Women in Improving Water Systems in the West Bank

PI: John Durant
Study Coordinator: Franklin Crump
Co-Investigator(s): Annette Huber-Lee, Stephanie Galaitsis, Elliot Hohn, Margaret Holmes, Kathryn McMahon, Jessica Morrison, Adam Weinberg

The PI is responsible for all information contained in both this notice of action and on the following **Investigator Responsibilities Sheet.**

Only copies of approved stamped consent forms and other study materials may be utilized when conducting your study.

This research protocol now meets the requirements set forth by the Office for Human Research Protections in 45 CFR 46 under Expedited .

Reviewed 5/7/2012 – Expires 5/6/2013

- Approved for 60 participants for the duration of the study.

Protocol Management:
- For all changes to the protocol, submit: *Request for Protocol Modification* form
- All Adverse Events and Unanticipated Problems must be reported to the Office of the IRB promptly (no later than no later than 7 calendar days after first awareness of the problem) using the appropriate forms.
- Six weeks prior to the expiration of the protocol on 5/6/2013, investigators must submit either a *Request for Continuing Review* or a *Request for Study Closure*
- All forms can be found at: **http://www.tufts.edu/central/research/IRB/Forms.htm**

IRB Administrative Representative Initials: ___

20 Professors Row, Medford, MA 02155 | TEL: 617.627.3417 | FAX: 617.627.3673 | EMAIL: SBER@tufts.edu

IN THE KNOW

BULLETIN OF THE TUFTS SBER IRB MEDFORD CAMPUS

COMMUNICATION

NOTICE OF ACTION IS THE NEW FORMAT FOR COMMUNICATION

The Office of the IRB has been sending letters to notify you of committee decisions. You will no longer receive letters from our office. Instead, you will receive a *Notice of Action*. This new format is less wordy and more precise. With only one quick glance you will be able to see the status of your application – refer to the table below for an explanation of the four statuses that will be used most often.

STATUS	EXPLANATION
EXCLUDED	The proposed study does not require review by the IRB – it is excluded on the basis that it does not meet either the federal definition for *Research* or the federal definition for *Human Subject Research* in 45CFR46.102 d or f.
EXEMPT	The proposed study meets the criteria for one (or more) of the six categories of exemption as defined in 45CFR46.101 b.
PENDING	You may not begin conducting research. The protocol has been reviewed by the IRB but there are certain conditions that need to be met before obtaining full approval. The conditions and instructions for meeting the conditions are detailed in the *Notice of Action*. Your study may not commence until you have received a *Notice of Action* on which your status is reflected as ACTIVE.
ACTIVE	Your proposed study has obtained full approval and you may begin conducting research. The *Notice of Action* specifies if the study has been approved by the convened IRB (full review) or by means of an expedited review and the applicable expedited category. The expiry date is clearly visible, and for ease of reference, the *Notice of Action* also details the number of participants that have been approved for your study. For continuing reviews the *Notice of Action* will also detail the number of participants that have been enrolled.

Please bear in mind that just as with the letters, the *Notice of Action* will only be sent to the Principal Investigator, the Study Coordinator (if applicable) and the Faculty Advisor (if applicable). We do not send notifications to Co-Investigators.

Tufts University Office of the Vice Provost
Social, Behavioral, and Educational Research Institutional Review Board (SBER IRB)
Program for the Protection of Human Participants in Research

Investigator Responsibilities

Research involving human participants involves a myriad of responsibilities.

General Responsibilities:

- To comply with the Code of Federal Regulations regarding the protection of human subjects http://www.hhs.gov/ohrp/humansubjects/guidance/45cfr46.htm
- To protect the rights and welfare of all human subjects and to conduct all research according the IRB approved protocol.
- To retain all data and signed consent documents for at least 3 years beyond the completion of the research.

Consent Responsibilities:

- To ensure that each potential participant understands the nature of the research.
- To ensure that the correct procedures are followed to gain *informed* consent from each person prior to participation.
- To provide each participant with a copy of the IRB approved consent document unless waived by the IRB.

Education Responsibilities:

- To ensure that all researchers, research assistants and faculty advisors have completed the required CITI training and that the certification is current. Certification is valid for a period of 5 years.

Procedural Responsibilities:

- When submitting to the SBER IRB, be sure to only use the most updated version of the required forms. They will always be posted on the website under 'forms'.
- To not initiate any changes to the protocol without IRB review and approval, unless it is necessary to eliminate an immediate hazard. Submit the *Request for Protocol Modification* form.
- To submit to the IRB for continuing review (*Request for Continuing Review* form) at least 6 weeks prior to the expiration date of the protocol if the research is going to continue past the expiration date.
- To promptly report any unanticipated problems to the IRB. Submit *Unanticipated Problem Report* form.
- To promptly report any adverse events to the IRB. Submit the *Adverse Event Report* form.
- To officially close the study once completed. Submit the *Request for Study Closure* form.

Please refer to the website for additional information:
http://www.tufts.edu/central/research/IRB/main.htm

Feel free to contact us at SBER@tufts.edu or 617-627-3417 for any assistance.

Revised July 2010

Tufts University Office of the Vice Provost
Social, Behavioral, and Educational Research Institutional Review Board (SBER IRB)
Program for the Protection of Human Participants in Research

Faculty Advisor Responsibilities

All faculty advisors who oversee undergraduate and graduate student research have the following responsibilities:

- To complete the required CITI training.
- To ensure that the principal investigator and additional research staff abide by the *Investigator Responsibilities*.
- To meet with the principal investigator to monitor study progress and ensure that the procedures outlined in the IRB protocol are followed.
- To be available to the principal investigator to supervise and address problems should they arise.
- To arrange for an alternate faculty advisor to assume these duties when unavailable (vacation or sabbatical).
- To oversee the prompt reporting of any adverse events or unanticipated problems to the IRB.

Please refer to the website for additional information:
http://www.tufts.edu/central/research/IRB/main.htm

Feel free to contact us at SBER@tufts.edu or 617-627-3417 for any assistance.

Revised July 2010

Household Survey Recruitment Rubric

When the house is approached for survey the following will be read to the adult who comes to the door:

Hello. We are members of a group of students working with the Lajee Center on a project about water in your community. The Lajee Center is an organization in Aida Camp which provides refugee youth with cultural, educational, social and developmental opportunities. Would you be willing to spend about 30 minutes with us answering some questions about your personal experiences with water? The questions are about general health, water storage, and supplies in your household.

APPROVED
MAY 0 9 2012
Tufts SBER IRB

EXPIRES
MAY 0 6 2013
Tufts SBER IRB

Lajee Center Script - Notification to the Community

A group of students from Tufts University in the United States will be working with the Lajee Center on a project about water in our community. They will be visiting households May 12-16, 2012, asking residents to talk about their personal experiences with water in Aida Camp. The questions are about general health, water storage, and supplies in your household.

APPROVED
MAY 0 9 2012
Tufts SBER IRB

EXPIRES
MAY 0 6 2013
Tufts SBER IRB

Verbal Consent Script

Background and Purpose: You are being asked to participate in a research project organized by a group of Tufts University students and professors in the Water: Systems, Science and Society (WSSS) program. Tufts is a research university located near Boston in the United States. The purpose of the project is to provide members of the Aida Camp community with the skills and equipment necessary to test water quality in Aida Camp, and to investigate a possible connection between water quality and health problems there. As a member of the community, you are in a position to provide insight into water quality at the camp. I would appreciate it if I could ask you some questions, in the form of a survey, about these issues.

Procedures: If you agree to participate, one of our group members, through a translator, will ask you some questions. Our survey should take about thirty minutes. One of my colleagues will take notes.

Risk and Confidentiality: There are no physical risks arising from your participation in this project. . We will not record your name, and have designed the questions to avoid obtaining information that can be used to identify you. Please be aware that, although your responses will be maintained in complete confidentiality, there is a chance that someone may discover that you participated in this study.

We believe that the risk of harm to you and your family by participation in this survey is minimal. However, you should consider whether you want to be associated with this study prior to providing your consent.

Voluntary Participation: Participation in this project is strictly voluntary – there are no consequences if you do not wish to be surveyed. Furthermore, if you decide at any time during the survey that you no longer wish to participate, you may withdraw your consent without consequence and we will not incorporate any of your responses into our research.

Benefits: There are no direct benefits to you for participation in the project. However, your participation will help to determine whether or not there may be a link between health issues and water quality in Aida Camp. This information may assist future efforts to improve water quality in the camp, and may provide a framework for future projects conducted at the camp by other students and faculty from Tufts University.

Request for More Information: If you have any questions or concerns about the project or your participation in it, do not hesitate to contact Stephanie Galaitsis at Stephanie.Galaitsis@tufts.edu or 0592150103. If you have any questions or concerns about your rights as a participant, you are encouraged to contact the Institutional Review Board (IRB) Administrator, Lara Sloboda (in the USA) at: +1 617 627 3417. We will provide you with an Information Sheet with this contact information to keep after we leave.

Permission: Now that I've explained the purpose of the survey, would you be willing to participate in it?

Signature: I confirm that the purpose of the research, the study procedures, the possible risks and discomforts as well as benefits have been explained to the participant. All questions have been answered. The participant has agreed to participate in the study.

Signature of Person Obtaining Consent _____ Date _____

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Tufts University

Medford, MA 02144

USA

Participant Information Sheet

Democratizing Water:
Engaging Youth and Women in Improving Water Systems in the West Bank

Purpose of the Study:

The purpose of the Study is to provide members of the Aida Camp community with the skills and equipment necessary to test water quality in Aida Camp, and to investigate a possible connection between water quality and health problems there.

Contact information:

- If you have any questions or would like to receive a report of this study (or a summary of the findings) when it is completed please contact us.

Researcher: Stephanie Galaitsis

- E-mail: [redacted]
- Telephone while in Aida Camp (May 12 – May 19) : 0592150103

Faculty Advisor: John Durant

- E-mail: John.Durant@tufts.edu
- Telephone (in the USA): [redacted]

- If you have concerns about this study or your rights as a participant, you are encouraged to contact the Institutional Review Board (IRB) Administrator, Lara Sloboda, PhD (in the USA) at: +1 617 627 3417

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Survey/Interview Guide

1. INTERVIEW PLANNING

1a. Select the Team - preparation and planning
Conducting interviews requires a trained interviewer and a trained translator. A second person may serve as a note-taker but is not necessary. The interviewer, with the assistance of the translator, will: conduct informed consent, complete interview survey, and write up the Interview summary following the interview.

1b. Decide on the time and location
Interviews are expected to last approximately 30 minutes. The team will randomly select homes within the camp for in-person surveys. The time of day during which the surveys will be conducted will be varied so as to avoid selection bias. In the instance that no one is present at the randomly selected residence, the surveyor will approach the residence immediately adjacent. This process will continue until a residence with an eligible and consenting individual is found, and the survey will be completed at that location, thereby starting the random selection process over again. The location of the home will not be recorded in any way that could connect the survey to any specific home. An Arabic-speaking translator will be present at all times. Surveying should be conducted in the most comfortable setting possible for the individual being surveyed (i.e. in the home, in front of the home, etc.).

Eligibility Criteria:

Inclusion criteria: Participants of interviews will be long-term residents of Aida Camp (defined as having lived in the camp for greater than twelve contiguous months), aged 18 years or more, and who provide informed consent to participate in the interview.

Exclusion criteria: Individuals will be excluded from participating in the interviews if they do not provide verbal consent to participate, are less than 18 years of age, or if the study team and/or implementing partners determine that participation may cause harm to the participant.

2. INFORMED CONSENT
Consent scripts will be developed to provide information on project objectives and activities, risks and benefits associated with participation, and study contact information. Before data collection begins, the appropriate consent script should be read aloud to each participant by the interviewer and communicated to the potential participant by the trained translator. The potential participant should be asked if he/she has any questions or concerns about participation. They may be reminded that they can chose not to answer any question they do not wish to answer, and that they can end their involvement in the interview at any time. Their decision to participate or decline participation in the interview will not influence services they receive from any affiliated programs in any way. If there are no further questions, the participant will be asked if he/she gives verbal consent to participate- **no signature, name, or identifying information should be collected on the consent script.**

All participants will receive a unique, Participant identification number (Participant ID) at enrollment when consent is provided. This number will be generated sequentially and agreed between team members conducting simultaneous interviews. These interview numbers will be used (with the date) on all study documents.

This study uses Oral Consent Scripts- this method further ensures the confidentiality of the participant because no participant is required to sign their name for consent but must provide verbal agreement. **It is important to note that although signed consent is waived, the consent process is still required and the interviewer/translator is responsible for documenting that consent was obtained.** Consent will be documented by entering the following information: participant ID, date, and whether informed consent was provided by the participant.

3. CONDUCTING THE INTERVIEW

4a. Roles and Responsibilities of Interviewers and Notetakers:
- Bring all materials needed (surveys, notebook, pens, interview guide, consent scripts)
- Keep participants focused, engaged, attentive and interested
- Monitor time and use limited time effectively
- Use prompts and probes to stimulate discussion
- Be prepared to explain or restate questions- a list of key phrases or local/commonly used terms may be helpful
- Ensure confidentiality

4b. Leading the discussion

Establish rapport Often participants do not know what to expect from survey questions and interview discussion. To set the participants at ease, the interviewer should describe the purpose and format of the discussion at the beginning of the session. Participants should be told that the survey questions are standardized, and that discussion is informal. Participants are not required to provide their *personal experiences*. Participant should be reminded that they are sharing their expertise and opinions, so there are no right or wrong answers.

4c. Protecting participants during interview and discussions
It is important that project staff remember the communities in which participants reside are small, people often know each other, and unintentional disclosure of participation or experience can place a participant at social or physical risk. The interviewer/coordinator should develop a contingency plan to prevent unintentional disclosure of the individual's participation. The contingency plan should include 1) a topic to which the interview should change to if someone enters the room during the interview and 2) fake name(s) and/or title(s) of the interviewer/translator. It is the responsibility of the project team to continuously assess the environment and stop project activities to avoid placing the participant and/or project team at risk.

Public Health Survey

GOALS

- To assess whether noticeable disease occurrence can be linked to the following:
  - Rust contamination on days when water is turned on
  - Lowered capacity for hygienic practices due to water restrictions
  - Issues due to constant presence of contaminants in the water supply
- To identify potential confounding factors in linking waterborne illness through mapping real-time availability of services for individuals who do get sick.

HEALTH OF HOUSEHOLD

1. How many people live in this household?

2. How many are children under the age of 5?

3. a) Has anyone in your family been sick in the last 15 days (2 weeks)?
   b) In the last 6 months?
   c) Who? (no names- categorize by age group and gender)
   d) What was the nature of the illness?
   Check all symptoms associated with illness:
   - o Diarrhea
   - o Vomiting
   - o Fever
   - o Intestinal Discomfort
   - o Coughing
   - o Runny Nose
   - o Other _____

4. How frequently does an illness like this occur in your household?
   - o Less than once/year
   - o 1-2 times year
   - o More than twice/year

5. Are there types of illness that happen at specific times of year in the camp? If so, what are they and when do they occur?

6. What caused the sickness described above?

WATER USAGE AND STORAGE

7. How do you store your water?
   - o Tank Quantity:_____ Type/Material:_____
   - o Cistern Quantity:_____
   - o Dubba Quantity:_____
   - o Other Quantity:_____

8. Do you ever take measures to clean your water? What are they? (check all that apply)
   - o Boil
   - o Filter
   - o Refrigerate
   - o Other_____

9. Do you clean your water storage vessels and how?
   - o Yes How?_____
   - o No

10. How much water did your family use in the last week?

11. Do you know your monthly water usage?

12. How does usage vary between the dry season and the wet season?

13. How often does your primary water supply run out (wet and dry season)?

14. Do you ever buy water?
   - o Yes
   - o No

   a. How much does it cost?
   b. Where do you get it?
      - o Water truck
      - o Water Bottles or other water based drinks
      - o Other_____

15. How long does it take to fill one tank when water is running from the public supply? (mark tank size)

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WATER QUALITY

16. What do you think of the quality of water delivered (taste, smell, color, primary and secondary supply)?

Primary Supply

a) Taste
- o Very bad
- o Bad
- o Normal
- o Good
- o Very Good

b) Smell
- o Very Bad
- o Bad
- o Normal
- o Good
- o Very good

c) Color
- o Very bad
- o Bad
- o Normal
- o Good
- o Very good

Secondary Supply

a) Taste
- o Very bad
- o Bad
- o Normal
- o Good
- o Very good

b) Smell
- o Very bad
- o Bad
- o Normal
- o Good
- o Very good

c) Color
- o Very bad
- o Bad
- o Normal
- o Good
- o Very good

17. Is your household connected to a sewer?
- o Yes
- o No

18. a) If a water quality issue were identified, who would you go to with your complaint?
- o UNRWA
- o PWA
- o Mekorot
- o Other_____

b) Who would you expect to deal with it?
- o UNRWA
- o PWA
- o Mekorot
- o Other_____

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Appendix C: Daily Activity Log Template

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Daily Activity Log

Name:
Date:

Activities: Note how much time was spent on each, where the activity occurred, and who was involved (omitting IRB sensitive information). *We're trying to determine how expectations of our work in Aida align with the reality on the ground and the rhythms of the community. Therefore please record not only the formal activities we've agreed to undertake, but also those which are improvised in reaction to unforeseen circumstances. Whatever you have done during the day is important information for us.*

Time	**Activity**	**Location**	**With whom**
Comments:			
Comments:			
Comments:			
Comments:			
Comments:			
Comments:			
Comments:			
Comments:			
Comments:			

Daily Program Evaluation

To what extent were the formally planned activities implemented according to our designs? For those with implementation different from our designs, what made changes necessary?

Which activities, planned or not, worked well, and why?

Which did not work well, and why?

What might you do differently during the rest of the week?

Additional thoughts, insights, comments...

Appendix D: Memorandum of Understanding

MEMORANDUM OF UNDERSTANDING

between

TUFTS UNIVERSITY, WATER: SYSTEMS, SCIENCE AND SOCIETY CERTIFICATE PROGRAM

and

LAJEE CENTER

I. Introduction

This Memorandum of Understanding (the "MOU") summarizes the scope of work, work product(s) and deliverables, timeline, work processes and methods, and lines of authority, supervision and communication relating to the project described below (the "Project"), as agreed between (1)(a) the Tufts University graduate students enrolled in the WSSS Research Practicum course (UEP-294-11) during the spring semester, 2012 (the "Course") offered by the Tufts University Water: Systems, Science and Society ("WSSS") graduate Certificate program and (1)(b) faculty of Tufts University, Medford, Massachusetts, USA, who are directing the Course and its key component, the Project, more completely described below; and (2) the Lajee Center, a social justice organization based in Aida Refugee Camp, Bethlehem, Palestine, further identified in Paragraph II(2) below ("Lajee" or the "Client").

II. Information about the Parties

(1) The team of Tufts University graduate students and faculty (the "Practicum Team") working on the Project consists of the following individuals:

1. Franklin Crump email address: [redacted]
2. Stephanie Galaitsis email address: [redacted]
3. Elliot Hohn email address: [redacted]
4. Margaret Holmesheoran email address: [redacted]
5. Kate McMahon email address: [redacted]
6. Jessica Morrison email address: [redacted]
7. Adam Weinberg email address: [redacted]
8. Annette Huber-Lee* email address: [redacted]
9. John Durant* email address: [redacted]
10. Robert Russell* email address: [redacted]

*Tufts Faculty Advisor

(2) The Client's contact information is as follows:

Client name: Lajee Center
Key contacts: Mr. Salah A.M Al Ajarma (Director of Lajee Center)
Mr. Rich Wiles (Coordinator of International Relations)
info@lajee.org
Telephone: [redacted]
Address: Lajee Center
Aida Refugee Camp, Bethlehem, Palestine
Web site: www.lajee.org

III. Project Goals

Drinking water quality has been identified as an environmental issue of importance to the community of the Aida Refugee Camp. Lajee Center and the Practicum Team have developed goals for the Project that will benefit both parties, including the research interests of the Practicum Team and the educational and advocacy goals of Lajee Center and their constituent communities. Generally, the Project is designed to raise awareness of water quality issues in Aida Refugee Camp by gathering and analyzing scientific data about water quality there, developing a citizen-directed water quality testing program, and increasing citizen awareness of potential issues that relate to local water quality.

The Project fulfills the requirements of the Course. The Course enables Tufts University graduate students enrolled in the Practicum Track of the WSSS Certificate Program to perform field research in a small group setting on a case study involving the integrated assessment of a water resources problem. A goal of the Project is to expose students to the techniques and thought processes of integrated water resources assessment to advance their training as researchers and professionals.

The contaminants which are the subject of analysis by the Project are sewage indicator bacteria – E. coli and, more generally, fecal coliform. Sewage indicator bacteria were selected as the contaminants of concern because they are common sources of water pollution in communities with inadequate water and wastewater infrastructure. Another advantage of analyzing sewage indicator bacteria is that these pathogens can be treated relatively easily compared with other sources of water contamination.

A central goal of the Project is to provide Lajee Center with an opportunity to develop the expertise necessary to develop a water quality monitoring program for the Aida Refugee Camp. The training, training materials and initial equipment procured for Lajee Center (described in detail below) will allow Lajee Center to maintain a program to analyze water quality samples for the residents of the camp. However, the consumable supplies required for sampling and sample analysis will require periodic augmentation.

While fulfilling its academic goals, the Practicum Team will work with Lajee Center in a relationship that parallels and draws upon the consultant-client model. It is our goal that this relationship provides tangible benefits to both parties, and that incentives are created to identify and act upon opportunities for future collaboration.

IV. Specific Project Components

1. Water Quality Testing

The goals of water quality testing are to:

(1) Develop a water quality monitoring program for the detection of sewage indicator bacteria, including E. coli and fecal coliform in drinking water;

(2) Provide water quality training to the Lajee Center and volunteers from Aida Refugee Camp; and

(3) Create and implement a volunteer-operated water quality monitoring program for Aida Camp to be directed by a water quality leader designated by Lajee Center. Lajee Center will oversee the program on an ongoing basis and keep records of the data the volunteers collect.

WSSS students will provide materials to the Lajee Center so that a water quality monitoring program can be implemented at the camp. Activities to achieve this objective will include developing an initial sampling plan for Aida Camp, preparing a Water Quality Monitoring Manual/Quality Assurance Plan (QAP), and developing a Volunteer Training Manual. These documents will be prepared in English and made available to Lajee Center prior to the WSSS students' arrival at Aida Camp.

Upon arrival in Aida Camp, the Practicum Team will coordinate and participate in a presentation designed to raise community awareness about the volunteer water sampling training program. The Practicum Team will be available to work with the Lajee Center's Media Unit to document water quality training and to help create a training video for future use by Lajee Center. Additional video documentation may be desirable to develop promotional materials for the purpose of fundraising by Lajee Center and the WSSS program. The Practicum Team will work towards procuring a year's funding for an individual based at the Lajee Center to direct the water quality testing program at the Aida Refugee Camp (the "Water Quality Leader"). All necessary laboratory equipment -- including a water sample incubator, vacuum filtration apparatus, graduated cylinders, beakers, and pipettes will be provided by the Practicum Team. The team will also provide a year's supply of sampling and analysis materials, including latex gloves, sample bottles, sample filters, petri dishes with absorbent pads, and sterilizing solution.

Testing methods for analyzing water samples for sewage indicator bacteria have been chosen to meet the following criteria: accuracy, ease of use, and budget parameters. The Practicum Team, assisted by volunteer sampling trainees, will collect water samples from the Aida Refugee Camp water supply, consistent with the initial sampling plan. Water samples will be filtered and plated in indicator bacteria-specific growth media. The plates will be incubated and the bacteria colonies, which indicate the presence and concentration of bacteria, will be counted. The results of the water quality analysis will be recorded and given to the Lajee Center, thus providing the Aida Refugee Camp with the beginnings of a water quality database.

All testing results will be made available to Lajee Center and the general public. The intent is to raise community awareness of the importance of water quality and the potential health effects of

consuming water of poor quality. The Practicum Team will provide training to water quality volunteers on proper sampling techniques. The critical training component will be to conduct thorough training for the Water Quality Leader and a Lajee Center volunteer on the specifics of the water quality monitoring manual; proper sample collection, transport and storage; sample analysis; the use and maintenance of analytic equipment; documentation; and data management

Responsibilities of Lajee Center include:

1. Designating a Water Quality Leader;
2. Working with the Water Quality Leader to identify volunteers who can conduct water quality monitoring, training the volunteers and establishing a location to test the water samples for indicator bacteria;
3. Maintaining the water quality database; and
4. Expanding the water quality monitoring program to other communities.

Responsibilities of the Water Quality Leader include:

1. Working with Lajee Center to identify volunteers who can conduct water quality monitoring, setting up the training program and establishing a location to test the water samples for indicator bacteria;
2. Providing water quality training to additional volunteers after the Practicum Team has departed;
3. Conducting water quality sampling with volunteers;
4. Analyzing water samples for indicator bacteria; and
5. Entering sampling results in the water quality database.

Responsibilities of the volunteers include:

1. Attending training sessions conducted by the Practicum Team on water quality samplin
2. Obtaining samples, under the direction of the Water Quality Leader; and
3. Transporting samples to the Water Quality Leader (or to a designated site) for analysis.

The Practicum Team and affiliated Tufts faculty will be available during the year to provide reasonable back-up support – in the form of email and telephone communication – for the wate quality testing effort conducted by Lajee Center. The point of contact for this support is John Durant.

2. Household Health and Water Access Survey

The goals of the health and water access survey are to:

(1) Assess potential health consequences related to clean water access and availability; and

(2) Empower the refugee community in Aida Camp to more effectively advocate for access to healthy drinking water.

The Practicum Team will conduct surveys of randomly selected households in Aida Camp (the team's goal is to survey up to 60 households). Surveys will be conducted door-to-door with the aid of a translator provided by Lajee Center and paid for by WSSS. Results of the collected data will be provided to Lajee Center within 6 months of its collection. Based on information from this research, the Practicum Team will recommend any potential interventions that can be taken to improve water treatment, health and hygienic water practices.

V. Project Deliverables/Outcomes

The Project deliverables (the "Work Product") and outcomes to be provided by the Practicum Team to the Lajee Center consist of:

(1) Water Quality Monitoring Manual/Quality Assurance Plan (QAP);

(2) Volunteer Training Manual;

(3) Volunteer Training Presentation;

(4) Training of community volunteers in sample collection and the importance of water quality;

(5) Training of a Water Quality Leader capable of correctly analyzing water samples, directing the water quality monitoring program, maintaining a database of water quality data and providing trainings for future volunteers;

(6) Documentary evidence of overall community water access, water treatment, health and hygiene practices, and water-related illness; and

(7) Access to resources and training on how to mitigate identified health risks from water borne illnesses.

VI. Practicum Team Responsibilities/Task Groups

Below are the key contacts for each component of the Project. These task groups are responsible for coordination and implementation of the listed component.

Water Quality Testing and Training

Jessica Morrison
Adam Weinberg

Citizen Awareness, Education and Outreach

Kate McMahon
Stephanie Galaitsis

Social Surveying

Elliot Hohn
Maggie Holmes

Report of Social Survey Results

Franklin Crump
Adam Weinberg

Faculty Coordinators

John Durant
Annette Huber-Lee
Robert Russell

VII. Additional Representations and Understandings

A. The Practicum Team is undertaking the Course and the Project for academic credit and therefore compensation (other than reimbursement of Project-related expenses) may not be provided to team members.

B. Because the Course and the Project are part of an academic program, it is understood that the Work Product – either in whole or in part – may be shared with others inside and beyond the Tufts community. This may include, without limitation, the distribution of the Work Product to other students, faculty and staff; release to community groups or public agencies; general publication; and posting on the Web. Tufts University and the Practicum Team may seek and secure grant funds or similar payment to defray the cost of any such distribution or publication. It is expected that any issues involving Client confidentiality or proprietary information that may arise in connection with the Project will be narrow ones that can be resolved as early in the spring 2012 semester as possible by discussion among the Client, the Practicum Team and a Tufts instructor directly responsible for the Course (or his or her designee).

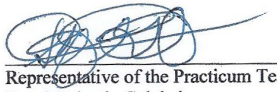
C. Lajee Center will have access to all research data from the Project, including raw data from water testing, with one exception: Consistent with Tufts University policy, the Practicum Team will not provide to Lajee Center or any third party raw data (i.e., data with personal identifiers) from any interviews, surveys, or the like that it conducts related to the Project.

D. Lajee Center may not alter any aspect of the Work Product, unless: (1) advance written consent thereto is given by either (i) at least three-quarters of the graduate students on the Practicum Team, or (ii) a Tufts faculty member acting on behalf of the WSSS program, or (3) Lajee Center removes reference to the Practicum Team or any member(s) thereof as an author of the Work Product (although, in this event, Lajee Center will acknowledge the assistance of the Practicum Team). Otherwise, the Work Product will refer to each member of the Practicum Team by name, and his or her academic affiliation. Collectively, the author will be referred to as the "2012 Tufts University WSSS Practicum."

E. It is understood that this Project may require review and approval (through exclusion, exemption, or full review) by the Tufts University Institutional Review Board (IRB). This process is not expected to interfere with timely completion of the project.

VII. Signatures

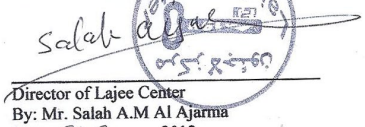
For the Practicum Team:



Representative of the Practicum Team
By: Stephanie Galaitsis
Date: 03/27/ 2012

Tufts WSSS Faculty Representative
By: John Durant, Ph.D., Associate Professor, Tufts University
Date: 27 March 2012

For the Lajee Center:



Director of Lajee Center
By: Mr. Salah A.M Al Ajarma
Date: 31.3. 2012

Appendix E: Volunteer Sampling and Bacteria Analysis Protocols

VOLUNTEER SAMPLING PROTOCOL

PURPOSE

The purpose of this Volunteer Sampling Protocol is to briefly describe the procedures for water quality sampling in Aida Camp. Volunteers should review this protocol and familiarize themselves with these procedures before each sampling event.

SAFETY CONSIDERATIONS

Sampler safety is of utmost priority to Lajee Center. Please read the following *safety precautions* carefully:

- Only sample from private homes after gaining permission from the family.
- Be careful when accessing sampling sites, especially if collecting samples from a rooftop – don't hurt yourself just to get a sample!
- Always wash your hands thoroughly with soap and water before and after sampling.

VOLUNTEER SAMPLING PROTOCOL

Prior to Sampling

1. Determine sample locations for the day.
2. Inform Water Quality Leader a minimum of 24 hours in advance that you will be sampling.
3. Assemble and pack all sampling equipment:
    a. Field notebook
    b. Sterile 125 mL sample bottles (one per site)
    c. Permanent marker (for labeling bottles)
    d. Pen or pencil (for data sheets and field notebook)
    e. Labeling tape
    f. Cooler
4. Put fresh labeling tape on the bottles. It is best to wrap the labeling tape all the way around the bottle so the labeling tape doesn't come off the bottle when the tape gets wet.

At Each Sampling Site

1. Write the sample location, date, time, and sampler's initials on the labeling tape. Make sure to label the bottle before you collect the sample so that you have a dry surface to write on. *Note: Labels may be completed prior to sampling.*
2. Remove the cap and put 10 mL of water into the bottle from the tap of the water source. Cap and shake the bottle vigorously for 2 seconds. Pour out the water. If you are sampling directly from a tank, pour rinse water outside the tank.
3. Repeat Step 2 two more times. This step ensures residual disinfectant is removed from the bottle.
4. Fill bottle with water from the source (tap or tank). A little air space (5 to 10 mL) is OK. Make sure that the sample water does not touch your hands. If it does, dump out the sample water and fill again. If there is excessive debris in the sample bottle, empty it out and collect a new sample.
5. Cap the bottle and put into sample cooler.
6. Fill out field notebook. Remember to enter the sampler's name, date, time sample collected, sample location, water source (kitchen tap, bathroom tap, outside tap, tank) and observations/comments. Observations and comments may include unusual odors or colors, date water was last delivered, or any exceptions from this protocol.
7. Bring the sample to the lab as soon as possible, but no later than 3 hours after collecting the sample.

BACTERIA ANALYSIS PROTOCOL

for the Lajee Center, Aida Refugee Camp, Bethlehem

prepared by the Water: Systems, Science and Society graduate program, Tufts University

PURPOSE

The purpose of this Laboratory Analysis Protocol is to describe the procedures to analyze water samples in Aida Camp for total coliform bacteria and *Eschericia coli* (*E. coli*). The method described in this protocol is a membrane filtration (MF) technique.

MATERIALS AND SUPPLIES NECESSARY FOR ANALYSIS

- Water samples (see Water Sampling Protocol for details)
- Petri dishes with absorbent pads (1 dish and pad combination per water sample)
- Permanent markers
- Media – 2 mL plastic ampoule of m-Coliblue24® Broth (1 per sample)
- Filters (1 per sample)
- Box of gloves
- Plastic pipettes for dilutions if necessary
- Plastic filtration unit and syringe
- Chlorine disinfectant (bleach)
- Tweezers
- Buckets (1 for disinfecting the sample bottles and filtration unit and 1 for rinse water)

MEDIA INFORMATION

Shelf life of media is 12 months from date of manufacture. Media should always be stored in a refrigerator when not in use. A standard kitchen refrigerator maintained at <4 ºC is sufficient. Media stored in this way will not harm or be harmed by the other contents of the refrigerator. Ampoules should be stored in plastic bag or container to keep them separated from other items in the refrigerator.

QUALITY CONTROL

Quality control samples are analyzed to ensure the consistency and quality of the data. Quality control samples are prepared and processed with the water samples being tested for bacteria.

Negative Control – A negative control is used to ensure that bacteria are not present in the materials used to prepare the samples for placement on petri dishes ("plating"). For the Aida Camp Water Quality Monitoring Program, a negative control should be performed each day of analysis using water from a trusted source (the best source would be bottled water purchased at a store). For the best results, use the same source of water (e.g., same brand of bottled water). No colonies should be found in this water. If colonies are found in the negative control samples, document the results and re-test. If colonies are found in the re-test sample of the negative control sample, contact John Durant at Tufts (john.durant@tufts.edu).

Positive Control – A positive control ensures that coliform bacteria will grow in the media under the incubation conditions if bacteria are present. This may become an issue as the media ages and nears its expiration date. Positive controls should be routinely completed. The positive control would be processed with the group of water samples to be analyzed. Water for this sample should be collected where total coliform and *E. coli* bacteria are known to be high (*e.g.*, toilet water after someone has used the toilet). After defecating, flush the toilet once and then, wearing clean latex gloves, collect your sample from the toilet bowl as you would with any other sample. Begin by triple rinsing your bottle, dumping the rinse water in the sink. Then collect your sample from the toilet bowl. Plate 1 mL of positive control water diluted with tap water from the Lajee Center for a total of 100 mL of liquid. The positive control should be the last sample of the day to minimize the potential for cross-contamination, as it will likely have the highest concentrations of coliform bacteria. If there is no growth on the positive control filter, it likely means that 1 mL of toilet water was not enough. Rerun the positive control the next day using 5 mL from a new positive control sample. Sometimes the growth on the positive control will be pink, most likely because the bacteria are too numerous for the volume of media. If this occurs, the positive control water sample should be run again using a higher dilution.

If problems with the controls persist, contact John Durant at Tufts (john.durant@tufts.edu).

ANALYTICAL PROCEDURES

It is imperative that analysis procedures in the lab be performed the **same way each time** to ensure consistency of the results.

Plating the Samples

1. Plating should begin as soon as the samples arrive in the lab. No sample should be plated more than 6 hours after the sample was collected. Samples should be placed in the refrigerator until plating begins.

2. Turn on the incubator. Set to 35 °C.

3. Put on rubber gloves.

4. Sterilize the upper chamber of the filtration unit and tweezers in a bucket of water with chlorine bleach. Use 1 capful (~10 mL) of bleach per four liters of water (approximately ½ bucket). Soak in bucket for at least 30 minutes. Thoroughly rinse with tap water from Lajee Center. After rinsing, there should be no chlorine odor on the sample bottles or equipment. If the sterilized filtration equipment touches any unclean surface, re-sterilize.

5. Label both sides of each Petri dish in permanent marker with the location and date of each sample. Label one dish per sample.

6. Place the Petri dish on the table with the side that says "Millipore" face down.

7. Remove the cap from the media ampoule. Remove the cover of the Petri dish, holding it only by the outer edge. **Do not** place the Petri dish cover on the table. Squeeze the media evenly over the pad inside of the Petri dish without touching the pad. Place the Petri dish cover back on.

8. Remove the upper chamber of the filtration unit and place it on a clean surface such as a cleaned area on the table or sheet of paper.

9. Take a filter and open the packaging, being sure to touch only the outside of the package. Using your sterilized tweezers, gently separate the blue cover from the white filter. Try to touch only the edge of the filter with the tweezers. Remove the filter from the sterile packaging. Center the filter, grid side up, on the white pad on the base of the filtration unit.

10. Place the upper chamber of the filtration unit on top of the filter, and snap into place. Be sure to push the top on tightly, so that there is no leakage once the sample is poured into the upper chamber.

11. Attach the vacuum pump (syringe) to the side spout of the filtration unit.

12. Pour the entire water sample (125 mL) into the upper chamber of the filtration unit.

13. Slowly pull the plunger back so that the sample water drips through the filter. As needed, detach the syringe, push the plunger back in, and reattach the syringe to the spout. Pump until all of the water has dripped into the bottom of the filtration unit.

14. Remove the vacuum syringe from the filtration unit.

15. Remove the upper chamber of the filtration unit and place it upside down on a clean surface.

16. Secure the edge of the filter with the tweezers and lift the filter off of the filtration unit. Be careful not to tear the filter or touch the center of the filter.

17. Remove the lid of the Petri dish and gently lay the filter flat -- grid-side up -- and centered on the pad inside the Petri dish. Place the Petri dish cover back on the dish.

18. Place the Petri dish in the incubator, keeping the "Millipore" side up, and incubate for 22 ±2 hours.

19. Sterilize equipment, including tweezers, between each sample by placing the equipment in a bucket of water with chlorine bleach. Use 1 capful of bleach per four liters of water (approximately ½ bucket). Soak bottles in bucket for at least 30 seconds. Rinse with tap water from Lajee Center. If sampling equipment becomes unclean again, re-sterilize.

20. Repeat steps 5 through 19 for each remaining sample.

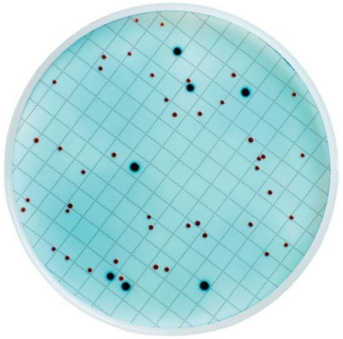
21. Refrigerate remaining ampoules of media. Clean up and put all other materials back where they belong.

22. Place the sample bottles and caps in the bucket containing the chlorine bleach and let soak for 24 hours before rinsing.

Counting the Bacteria Colonies

1. Remove the Petri dishes from the incubator after 22 ±2 hours.

2. Count the blue (*E. coli*) and red (other coliforms) colonies. Total coliform is the sum of the blue and red colonies. Use the grids on the filter to keep track of which colonies you have already counted. For example, you can count all colonies above a line (including the ones directly on the line) and continue this as you move from top to bottom. Remember the three key things to look for when counting colonies – **color and shine**. The colonies should be dark red or blue in color and exhibit a shine. Observing the colonies under direct light or sunlight can help determine if the colony exhibits shine. Colonies will look similar to the following:



Source: Millipore m-ColiBlue24® Broth website
http://www.millipore.com/catalogue/item/m00pmcb24

Recording the Data

1. When colonies for each sample are counted, the results should be recorded on the corresponding data sheet. (** do we talk somewhere about what the data sheet is and what "corresponding" means?)

2. If you make a mistake on a data sheet, cross out the mistake and write the correct text next to it. Do not erase anything.

3. If any data needs to be discarded, write the reason why the data is being discarded on the data sheet. Some examples of reasons to discard a sample are: analytical errors, the filter turned pink because there was not enough media in the Petri dish, and power outages that shut off the incubator for more than 30 minutes.

4. After completing all water quality data sheets, record the results for the household on the corresponding Excel worksheet on your computer. Note that these records should be backed up (and shared with Tufts) on a frequent basis.

5. Filters and Petri dishes can be thrown out in the trash. First place them in a plastic bag so that no one comes in direct contact with the dirty filters.

Appendix F: Water Quality and Household Data Sheet Templates

Water Quality Household Data Sheet

Sample No.:

Household Name:

Sample Date	Sample No.	Collection Source	Observations	No. of Colonies: Other Coli-forms (red)	No. of Colonies: *E. coli* (blue)	No. of Colonies: Total Coli-forms (red + blue)
						0
						0
						0
						0
						0
						0
						0
						0
						0
						0
						0
						0
						0
						0
						0
						0
						0
						0
						0
						0
						0
						0
						0

Water Quality Data Sheet

Sampler's _____ Date: _____

Name:

Sample No.	Household Name	Sampler's Initials	Volume Plated (mL)	Time Put in Incubator	No. of Colonies: Other Coli-forms (red)	No. of Colonies: *E. coli* (blue)	No. of Colonies: Total Coliform (red + blue)
							0
							0
							0
							0
							0
							0
							0
							0
							0
							0
							0
							0
							0
							0
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							0
							0
							0
							0
							0
							0
							0
							0
							0

Appendix G: Presentation Slides

Aida Camp Water Quality Monitoring Program

Lajee Center and WSSS Program, Tufts University
May 18, 2012

Outline

1. Program Objectives
2. Health Effects
3. Methods
4. Results
5. Solutions

Project Objectives

1. Collect and analyze water quality samples
2. Train Lajee staff to sample and analyze water
3. Develop water quality monitoring program for Aida Camp

Health Effects

Coliform bacteria, including *E. Coli,* in drinking water can cause:

- Intestinal discomfort
- Diarrhea
- Infections
- Rash

Health Effects

Palestinian and World Health Organization drinking water standards:

- **Total coliform bacteria**: **0 colonies**
- **E. Coli**: **0 colonies**

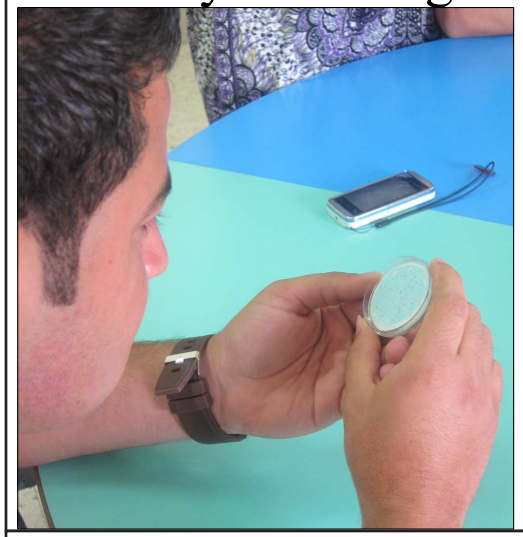
Source: World Health Organization. *A Compendium of Drinking Water Standards in the Eastern Mediterranean Region*. 2004.

Methods: Sample Collection

Methods: Filtration

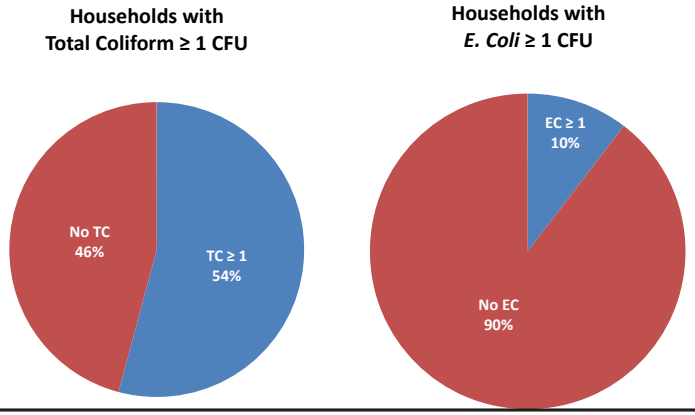
Methods: Incubation

Methods:
Colony Counting



Results

- 26 out of 48 households had total coliform
- 5 out of 48 households had *E. coli*



Solutions

Harmful bacteria can be treated by:

- Heat (boiling)
- Solar disinfection
- Chemical disinfection (chlorine tablets)
- Filtration

Other solutions:

- Use water from communal tap
- Use bottled water
- Clean water tanks

Solar Disinfection

Place clear PET bottles of water in direct sunlight for at least 6 hours.

Chemical Disinfection

Add chlorine tablets to water
(follow instructions)

Filtration

Use carbon filters
Replace periodically (follow instructions)

Next steps

Lajee will continue the monitoring program for at least 1 year

- Weekly monitoring and retesting as necessary
- Weekly reporting to Aida Camp
- Provide advice to reduce bacteria in drinking water

Tufts University will continue to provide Lajee funding, materials and supplies, and technical support for 1 year

Acknowledgements

Translators

Volunteers:

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Appendix H: Educational Water Treatment Sheet

مياه صالحة للشرب

خطوات من الممكن إتخاذها الآن

من حقنا أن نحصل على مياه صالحة للشرب . و لكن في كثير من الأحيان لا نستطيع أن نكون على يقين من أن مياه الشرب في مخيم عايدة خالية من البكتيريا الضارة. ماذا بالإمكان ان تفعل إذا إكتشفت بأن المياه الخاصة بك غير آمنة للشرب؟

يجري مركز لاجئ هذا العام من خلال فريق تم تدريبه على فحوصات ميدانية و مخبرية في مخيم عايدة على مياه الشرب و الذي بدوره اكتشف بعض الحالات في المخيم التي تحتوي على كميات بكتيريا عالية. لذلك يوصي المركز باتخاذ هذه التدابير الثلاث المجانية او المنخفضة التكلفة لتنقية المياه المستخدمة للإستهلاك البشري مثل الشرب و غسل الفواكه و الخضراوات و غيرها من الأطعمة و الأشربة الغير مغلية.

ملاحظة: حتى لو كان الماء يحتوي على بكتيريا لا يزال من الممكن استخدامه لجميع الأشياء ما عدا الاستهلاك البشري المباشر. فمثلا , يمكنك استخدام المياه المحتوية على البكتيريا للاستحمام و غسل الملابس و سقي النباتات , و حتى الطبخ , خصوصا اذا تم غلي المياه لمدة لا تقل عن دقيقتين .

التدابير الوقائية :

1 - كلور سائل : اضافة قطرتين من الكلور السائل لكل لتر من الماء و تركها لمدة لا تقل عن نصف ساعة قبل الاستخدام . يمكنك استخدام الكلور المتوفر في الأسواق .
تعمل هذه الطريقة بفاعلية لكميات المياه القليلة ما يقارب العشرة لترات في اليوم ليتم استخدامها للشرب و غسل الفواكه و الخضروات . يمكن لهذه الكمية من المياه ان تبقى صالحة للشرب لمدة يومين أو ثلاثة أيام اذا تم تغطية المياه بشكل جيد و تركها داخل البراد . هذه العملية تبقي فاعلية الكلور و تبطء نمو البكتيريا .

-2 غلي المياه : يمكنك غلي كميات قليلة من المياه مدة لا تقل عن الدقيقتين . هذه العملية تجعل المياه المحتوية على بكتيريا صالحة للشرب لمدة يوم أو يومين . يجب ترك المياه في البراد بعد غليها .

-3 المياه من المصدر الرئيسي في المخيم , (المضخة) : لقد تم اختبار هذا المصدر للمياه و التأكد من خلوه من البكتيريا الضارة . هذه المياه صالحة للشرب لمدة يومين او ثلاثة ايام اذا تم اغلاق العبوات و وضعها في البراد .