Water Safety Plan: Dadaab Refugee Camps

Prepared for:
UNHCR

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- Timothy Nguyai, CARE;
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ACRONYMS

CDC	US Centers for Disease Control and Prevention
CMR	Crude Mortality Rate
FCR	Free Chlorine Residual
GTZ	German Technical Cooperation
KAP	Knowledge, Attitudes, and Practices
NRC	Norwegian Refugee Council
PoUWT	Point-of-Use (or POU) Water Treatment
RtD	Relief to Development Continuum
UNHCR	United Nations High Commission for Refugees
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
WatSan	Water and Sanitation
WHO	World Health Organization
WSP	Water Safety Plan

1 INTRODUCTION

1.1 Dadaab Refugee Camps

Dadaab refugee camps are located in Dadaab Division, Garissa District, North Eastern Province, Kenya. The camps are about 80 kilometers from the Somalia/Kenya border and 500 kilometers from Nairobi. The three camps – Ifo, Dagahaley, and Hagadera – were established in 1991/1992 following the fall of the Said Barre regime and onset on inter-clan conflict in Somalia. The vast majority of refugees are Somalis from Central and Southern regions of Somalia, with the remainder from Sudan, Ethiopia, Eritrea, Uganda, Democratic Republic of Congo, Rwanda, and Burundi. The populations in the camp remained relatively stable from 1994 to December 2006, when approximately 177,000 refugees were hosted in Dadaab refugee camps. Further political changes in 2006 and 2007 in Somalia led to increased populations seeking asylum. As of December 2008, Dadaab refugee camps had grown to approximately 240,000 refugees, representing nearly 40% growth in 2 years. Dadaab is now the largest refugee camp in the world.

Dadaab refugee camps have experienced recurrent outbreaks of diarrheal disease, including cholera, in the last decade. The most recent cholera outbreak was in 2007, with 187 cases in Hagadera. Although the outbreaks are generally attributed to influxes of new refugees, the water supply and sanitation conditions in the camps have been of concern. The high number of new arrivals in 2008 has contributed to congestion, decreased water supply, and decreased access to sanitation facilities. On January 28-29, 2009 two suspect cases of cholera were identified. Specimens from each case were sent to CDC-Kenya for testing, and one, from a 7-year old girl, grew *Vibrio cholera, Inaba* strain. The child arrived in the camp on January 27, 2009 and onset of illness was January 28, 2009. Another 23 cholera cases (over age 2) were identified through March 9, 2009 in Hagadera, six cholera cases (over age 2) were identified between February 18th and March 5th in Dagahaley, and five cases were identified between March 3rd and March 5th in Ifo.

1.2 Early 2009 CDC TA Trips

The United Nations High Commission for Refugees (UNHCR) invited Centers for Disease Control and Prevention (CDC) staff to Dadaab to investigate: 1) the risk factors for cholera; and, 2) the water and sanitation situation. The Terms of Reference for the technical assistance visits included:

1) Conduct a case-control study to determine risk factors associated with illness. Investigation should include case ascertainment, assessment of case definitions, control selection, risk factor evaluation;
2) Review the existing water and sanitation conditions in Dadaab to establish the quantity and quality of water supplied and stored and identify aspects of water supply chain where water quality may be compromised;
3) Evaluate latrine construction, locations, coverage and use and hygiene promotion interventions in schools and at household level;
4) Work with local partners in Dadaab refugee camp, including, but not limited to: UNHCR, IRC, GTZ, CARE and NRC;
5) Assist with training health care workers, including community health care workers as needed;
6) Provide ongoing consultation regarding recommendations as needed;
7) Liaise with the Ministry of Public Health and Sanitation and WHO as appropriate;

8) Debrief partners and health officials of activities and major findings prior to departure from Dadaab and Kenya; and,
9) Provide written report of findings within 60 days of completion of visit.

A cholera response team was dispatched from February 25th – March 11th to complete activities 1 and 5, as well as work on activities 4, 5, 7, 8, and 9. They completed their debrief on March 10, 2009, and their report is anticipated. A water and sanitation investigation team was in Dadaab from March 23rd through 30th, and completed activities 2 and 3, as well as work on activities 4, 6, 7, 8, and 9. Partners in Dadaab were debriefed on March 30th, and partners in Nairobi were debriefed in March 31st. This water safety plan (and the associated PowerPoint file) serves as the trip report for the water and sanitation investigation team. The water and sanitation investigation team is available for ongoing consultation and can be contacted at dlantagne@cdc.gov, kpezzi@cdc.gov, and amahamud@yahoo.com. Rachel Eidex, based at CDC/Nairobi, can also be contacted at reidex@cdc.gov.

1.3 Decision to develop a 'Water Safety Plan'

During information gathering activities conducted prior to arrival in Dadaab, the WatSan Team was struck by the large volume of information, data, and reports on the water and sanitation situation in Dadaab already available. Rather than conduct another independent evaluation, the team determined that a more useful endeavor for all partners would be to review, analyze, and collate the disparate information and recommendations already existing into one document that could be used by all partners as a working document from with which to more forward. The WatSan Team determined that an appropriate way of organizing the information and developing a strategy for moving forward would be to follow Water Safety Plan (WSP) methodology supported by the World Health Organization (WHO) and outlined in the *Guidelines for drinking-water quality: 3rd Edition (WHO, 2004c)* and subsequent implementation manuals (WHO)

"The most effective means of consistently ensuring the safety of a drinking-water supply is through the use of a comprehensive risk assessment and risk management approach that encompasses all steps in water supply from catchment to consumer. In these Guidelines, such approaches are called water safety plans (WSPs)" (Bartram, 2009).

The aim of a WSP is: "To consistently ensure the safety and acceptability of a drinking water supply." *(Bartram, 2009).*

The development and implementation of the WSP approach for each drinking-water supply is as follows:

1) Set up a team and decide a methodology by which a WSP will be developed;
2) Identify all the hazards and hazardous events that can affect the safety of a water supply from the catchment, through treatment and distribution to the consumers' point of use;
3) Assess the risk presented by each hazard and hazardous event;
4) Consider if controls or barriers are in place for each significant risk and if these are effective;
5) Validate the effectiveness of controls and barriers;
6) Implement an improvement plan where necessary;
7) Demonstrate that the system is consistently safe;
8) Regularly review the hazards, risks and controls;
9) Keep accurate records for transparency and justification of outcomes *(Bartram, 2009).*

The WatSan Team determined to develop a working document WSP for presentation to the partners (Activity 1); completed a literature review and on-site investigations describe the water supply system (presented in Section 2); identified hazards and risks within the system (Section 2.8.4); and recommended control strategies to address the risks (Section 5). One modification to the standard WSP methodology included within this report is sections on sanitation (Section 4).

It is our sincere hope that this WSP working document can serve two functions: 1) it can be a useful tool for all partners to understand the work that has been completed to date on assessment in the watsan sector; and, 2) it can be a working document adopted by the partners as a tool for water and sanitation planning in Dadaab. The authors of this report explicitly grant the right to future authors to adapt this report to suit the needs of the time, and simply request that the current authors are credited for any work they have completed. To this end, this working document copy of this Water Safety Plan (after presentation to the partners in Dadaab and Nairobi) will be distributed via email to all partners in Dadaab and Nairobi, as well as to all individuals that have conducted reports that were identified in the literature review.

1.4 Literature identified and field sampling completed

During the literature review stage of the investigation (conducted prior to and throughout the field time), the following report information and reports were collected:

Table 1: Literature identified and reviewed

	Report Name and Date	Reference
CARE	- Well pumping data, aquifer monitoring data, lead data (March 2009) - CARE Internal KAP reports - KAP Survey Report on Hygiene Promotion in Dadaad (sic) Refugee Camp (2008) - Report on Water Quality in the Refugee Camps in Dadaab, Under CARE/Kenya (2008, 2007) - Follow-up report on water supply in Hagadera camp, Dadaab, Kenya (July 2008). - UNICEF Kenya Country Office, Study of the Merti Aquifer, Final Report (April 2004) - Dadaab Water System Turnover Document (1994)	(CARE, 2009) (CARE, 2008) (Simon, 2008) (MENR, 2007; 2008) (Fewster, 2008) (GIBB, 2004) (UNICEF/CARE, 1994)
NRC	- Latrine coverage data from Hagadera (January 2009), Ifo (January 2009), and Dagahaley (March 2009) camps	(NRC, 2009)
UNHCR	- Mission Report: Water and Sanitation; Dadaab, Kenya; October 08-13, 2008.	(Shrestha, 2008)
Oxfam	- Assessment of the ability of the populations of Ifo, Hagadera and Dagahaley refugee camps to access adequate water and sanitation facilities (March 2009)	(Oxfam, 2009)
CDC	- Water and Sanitation Data Analysis from Cholera Outbreak Investigation (March 2009) - Cholera Outbreak Investigation - Hagadera and Dagahaley Camps (Feb 25-Mar 10 2009) - Trip Report, Visit to Hagadera Camp, Dadaab Kenya, Assessment of urinary schistosomiasis / drinking water quality (June 30 – July 6, 2008) - Field Visit to Dadaab Refugee Camp Regarding the Cholera Outbreak (May 22-23, 2007)	(Pezzi, 2009) (Mitchell, 2009) (Handzel, 2009) (O'Reilly, 2007)

After reviewing this data, the WatSan Team conducted one day of water quality sampling, household surveys, and information verification and gathering in each of the three camps and their associated host communities. The results from this field investigation are presented throughout this report. The sampling protocol was qualitative and included:

- Visiting 2-3 boreholes in each camp and testing free chlorine residual (FCR), turbidity, pH, and conductivity;
- Following the lines of the boreholes and measuring FCR at five tapstands;
- Visiting five households in each camp and testing FCR and conducting a household water use survey;
- Visiting businesses in each camp, including ice making facilities, restaurants, and brick making facilities;
- Visiting NRC slab production sites;
- Visiting the CARE office in each camp and obtaining data only available on camp-based computers; and,
- Conducting general observation of the camps to verify/confirm/deny observations seen in reports.

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2 Dadaab Water Supply System

In this section, the WatSan Assessment team fully describes the information available to us about the Dadaab Refugee Camps water supply situation. First, we discuss the health needs of refugees in camp situations (Section 2.1) including a section on cholera, followed by a discussion on the Sphere Standards (2.2). Then, we describe the water supply system in Dadaab (2.3), and the state of the system in the 1994 handover from UNICEF (2.4), to CARE. We summarize the current production rates in the camp (2.5), results of a comprehensive aquifer study on the Merti aquifer (2.6), discuss water quality testing results (2.7), and summary information on water use and knowledge, attitudes, and practices around water of the refugees (2.8). This information is then used to discuss the risks to the system in Section 2.8.4.

2.1 Health needs in refugee camps

In the early to mid-1990's the use of crude mortality rates (CMR) and excess mortality became widespread as indicators of health in refugee camps (Toole, 1990). Responders developed nomenclature to help characterize the prevailing circumstances and health conditions based on the fact that a CMR of 1/10,000/day was, at the time, double the background level in sub-Saharan Africa. The '*emergency phase'* was thus defined as when CMR exceeded 1/10,000 people/day, and the '*post-emergency phase'* was when mortality rates returned to background rates. Measles, diarrheal diseases, and acute respiratory tract infections were identified as the major causes of death in the emergency phase, accounting for 50-95% of deaths. In established refugee camps, the major causes of death were identified as diarrheal diseases and acute respiratory infections. According to Toole and Waldman (1990), "most excess mortality in refugee populations has been caused by measles, diarrheal diseases, undernutrition, acute lower respiratory tract infections, and malaria, the same diseases that affect nonrefugee [sic] populations" and "thus it is not the *type* of illness but rather the *incidence* and *high mortality rates* that make these populations remarkable". Toole and Waldman (1990) recommended providing: food, clean water, interventions to prevent communicable diseases, curative programs, and health information systems as soon as possible to reduce the disease burden in refugee camps.

The progression of disasters as described by Toole and Waldman has been adapted and is known as the relief-to-development (RtD) continuum (Burkholder, 1995). Burkholder *et al*. describe three stages of an emergency. The *'acute emergency phase'* is "chaotic as thousands of persons seek refuge after physical or emotional trauma"; the response is "complicated by security concerns, logistic and resource constraints, and lack of coordination". The *'late emergency phase'* focuses on "public health programs rather than acute needs". The *'post-emergency phase'* is when "the health profile of the refugee camps begins to mirror that of a typical village". At this point "the emphasis of humanitarian assistance shifts from relief to development". These early 1990's papers remain the basis of refugee health literature and intervention strategy even today.

A more recent analysis, investing 51 post-emergency phase camps in seven countries, found that lower CMRs were associated with: older camps, those with more health workers per person, those camps a further distance to the border, and with less time to the referral hospital (Spiegel, 2002). Lower under-5 CMRs were associated with older camps, those with more health workers per person, increased (over 20 Liters per person per day) water quantity, and less diarrhea.

2.1.1 Diarrheal diseases and cholera

As diarrheal disease is one of the main causes of morbidity and mortality in refugee camps, it is of high public health concern. Diarrheal disease can be 'sporadic', when the infection appears and disappears, likely due to external inputs; 'endemic', when the infection is maintained in the population without the need for external inputs and is in a steady state; or an ‘outbreak’, when the disease is increasing. Diarrhea is generally categorized and recorded as either ‘watery’ or ‘bloody’ (dysentery).

In contrast to sporadic or endemic disease, “A disease outbreak is the occurrence of cases of disease in excess of what would normally be expected in a defined community, geographical area or season. An outbreak may occur in a restricted geographical area, or may extend over several countries. It may last for a few days or weeks, or for several years” (WHO, 2008a). Common waterborne disease outbreaks include cholera, typhoid fever, shigellosis, dysentery, and hepatitis A and E. Cholera is a serious epidemic disease requiring notification to the WHO under the International Health Regulations (WHO, 2008b), and recent data shows that cases of cholera are increasing, particularly in Africa. In 2007, a total of 177,963 cholera cases, including 4,031 deaths (case fatality rate of 2.3%) from 53 countries were reported to the WHO (WHO, 2008b). This represented a 46% increase in the mean number of cases reported in 2002-2005. Cases in Africa accounted for 93.6% of the global total. In addition, countries in Asia reported cases for the first time since 2000, accounting for 6.4% of global cases. Despite the increases seen over time, these figures likely represent only a small fraction of the cholera disease burden, as WHO estimates that only 5-10% of cholera cases worldwide are reported, due to inadequate surveillance systems and under-reporting motivated by fear of trade sanctions and lost tourism. Particularly concerning is the fact the incidence rate (166 cases/1,000,000 population) and case fatality rate (1.8%) in Africa is much greater than in Asia (1.74 cases/1,000,000; 0.6%) or Latin America (0.01/1,000,000; no deaths) (Gaffga, 2007).

Cholera is a major concern in refugee camps, and large and small outbreaks have occurred in camps. The largest outbreak occurred in 1994, when in five days in July, approximately 850,000 Rwandan refugees crossed into Goma, DRC. The capacity of the agencies present in Goma was quickly overwhelmed. Within one month, approximately 50,000 refugees died as a result of cholera, dysentery, dehydration and violence (Borton, 1996). Despite the efforts made, the relief community was highly criticized for inappropriate response (such as bottled water importation), poor case management (such as antibiotics and IV solution instead of rehydration for treatment of non-severe cholera cases), and delay in establishing water supplies (Eriksson, 1996; GROUP, 1995).

A small outbreak occurred in Mae La Refugee Camp in Thailand in 2007. An example epidemiologic curve from that cholera outbreak investigated by CDC is shown below (Figure 1). An epidemiologic curve from a large population based outbreak in Angola is presented on the next page (Figure 2).

Figure 1: Cholera Outbreak in Mae La Camp, Thailand, 2007 (source: Mike Lynch, CDC)

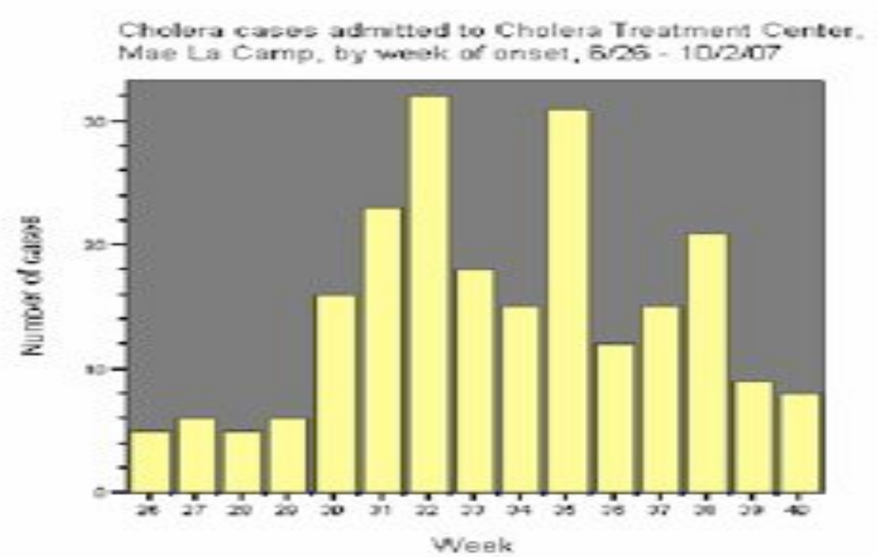
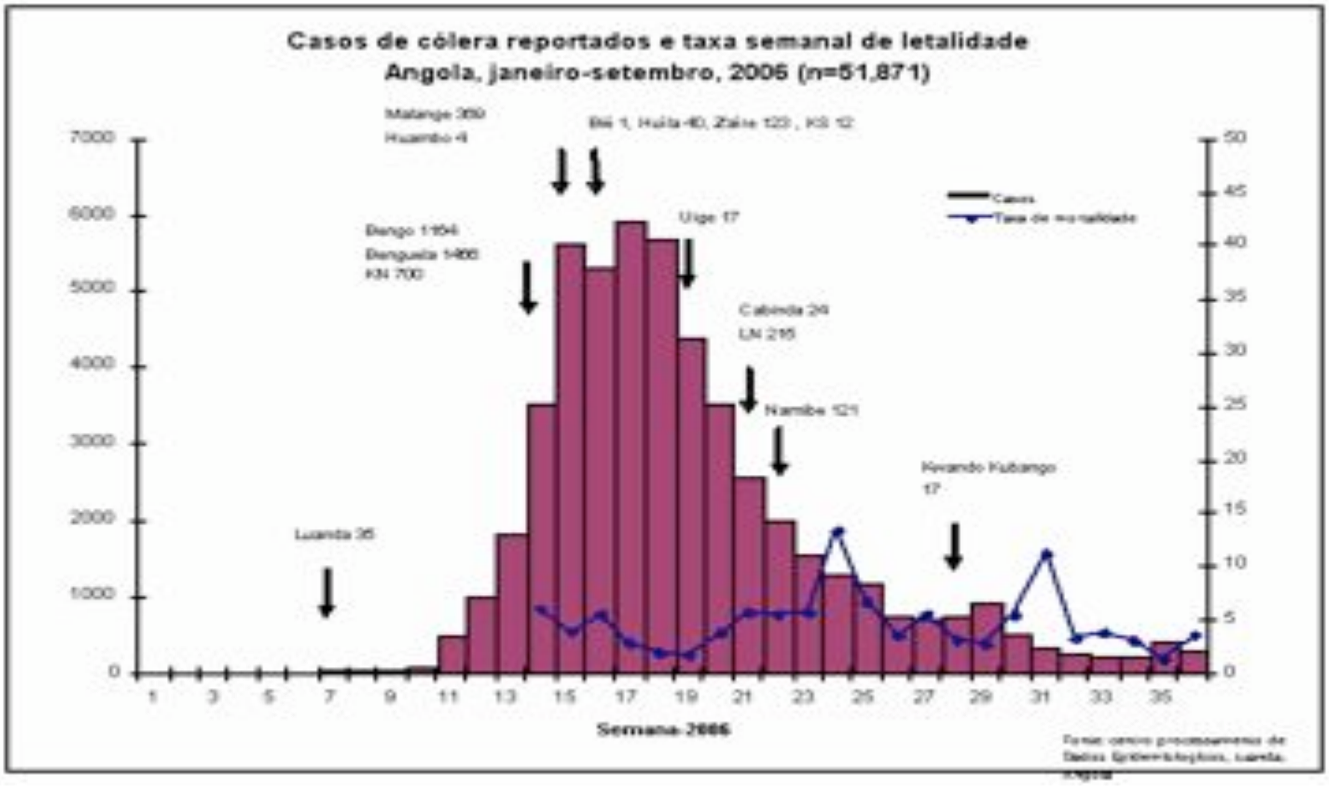


Figure 2: Cholera Outbreak in Angola, 2007 (source: Niko Gaffga, CDC)



The WHO maintains extensive documentation on cholera response management strategies on the cholera control web site: www.who.int/cholera. Those interested in learning about cholera response strategies are referred to that web site and to the documents referenced in this sentence (WHO, 2004a; b; 2008a).

2.2 The Sphere Standards

In response to critiques of NGO response during the Goma refugee crisis (Griekspoor, 2001; GROUP, 1995), a group of emergency NGOs and the Red Cross and Red Crescent societies gathered together to form the "Sphere Project" and develop minimum standards for NGOs in disaster response (SPHERE, 2004). The "Humanitarian Charter and Minimum Standards in Disaster Response" (Sphere) handbook was drafted in 1998, published in 2000, and revised in 2004. Over 400 organizations in 80 countries have contributed to its development. The Sphere Handbook provides a humanitarian charter, standards, key indicators, and guidance notes in five key sectors (water and sanitation, nutrition and food security, shelter, settlement and non-food, and health services) and addresses seven cross cutting issues (children, older people, disabled people, gender, protection, HIV/AIDS, and the environment) in all sectors. In the water supply and sanitation sector the standards are: 1) access and water quantity; 2) water quality; and, 3) water use facilities and goods (Table 2).

Table 2: Sphere water supply standards and key indicators

Water supply standard	Key Indicators
1: access and water quantity	- a minimum of 15 liters of water per person per day; - a minimum flow of 0.125 liters/second at water collection points; - a maximum of 250 people per water point; and, - a maximum distance to water point of 500 meters
2: water quality	- no more than 10 fecal coliforms per 100 mL at the point of delivery for undisinfected supplies; - low sanitary survey risk; - residual chlorine levels of 0.2-0.5 mg/L for populations over 10,000 of populations at risk of a diarrhea epidemic; - a total dissolved solids level below 1,000 mg/L and palatable water; and, - no significant negative health effect from short term use or planned time of use of the water supply.
3: water use facilities and goods	- each household has two water collective vessels of 10-20 liters, plus storage vessels of 20 liters, all with narrow necks and/or covers; - 250g of soap per person per month; - appropriate communal bathing facilities; and, - appropriate communal laundry facilities.

Despite the successes of Sphere, there has been criticism of the Handbook, including that: 1) the indicators are not evidence-based; 2) the Handbook has not been fully accepted by the UN, is informal, and provides only recommended guidance; and, 3) the indicators apply more easily to ideal conditions in refugee camps, and not to complex situations, which could foster unrealistic expectations in more complex emergencies (Griekspoor, 2001; ODI, 2005). The key Sphere water indicators were developed based on perceived wisdom of acknowledged experts and working group members, as opposed to more formal research. Investigation of this unvalidated perceived wisdom was identified as one of the key research needs during the recent WASH Evidence Base / Knowledge Base in Emergencies workshop (Lantagne, 2009). Although the Sphere Standards and Indicators represent the more accurate summary of knowledge to date, seeking only to meet the standards without understanding the specific circumstances of each emergency is not recommended.

2.3 The water supply system in Dadaab Refugee Camps

The Dadaab Refugee Camps include three sites: Ifo (6 kilometers north of Dadaab), Dagahaley (18 km north of Dadaab), and Hagadera (15 km south of Dadaab). Water exploration, drilling, and supply began during WWII (when the aquifer was identified) and then development of the aquifer was only minor (15 wells drilled) until the 1970's, when a Ministry of Livestock Development/USAID project drilled 50 wells in the aquifer (GIBB, 2004). The National Oil Corporation of Kenya also has drilled exploratory wells in the Merti aquifer over time. Further use of the aquifer and drilling began to supply the refugee camps, which were initially settled in the time period 1991-1994. From 1994-2006, the camps remained (relatively) stable in population. A second large influx of refugees began again in late 2006, and continues through the current time of March 2009. This second large influx has overwhelmed camp services and strained the water supply severely.

A borehole site in the camps

2.4 1994 handover of water supply

UNICEF oversaw the initial development of the water supply systems in the three camps, and supervised the drilling, between 1991 and 1994, of the majority of the boreholes still in use today. The boreholes were drilled to an average depth of 140 meters from the Merti Aquifer, which sits underneath the camps and is discussed in detail in the next section (Section 2.5). At the time of the water supply system handover from UNICEF to CARE in 1994, 91,305 refugees were present in the three camps, and an average 24 L/person/day was provided (Table 3). At this point in time, there were dedicated boreholes for livestock, and boreholes in Dadaab and in Alunjagal.

Table 3: 1994 Statistics

	Ifo	Dagahaley	Hagadera	Total
Population	35,463	24,550	31,292	91,305
Number boreholes	6	4	4	14
Production	779 m^3/day	677 m^3/day	761 m^3/day	
L/person/day	22.0	20.5	24.3	
Hours of pumping	16.7	12.5	11.1	
Additional boreholes	1 capped	1 w/ no pump	1 capped	00

The report discussed the potential for the water supply system to accommodate additional refugees, and stated: "The extent to which existing water supply infrastructure can accommodate additional influxes varies from camp to camp and is discussed in detail in following camp summaries. On the basis of the planning figures provided, the general consensus was that Dagahaley and Hagadera could easily accommodate an extra 3,000 people each. Ifo is slightly more complex, and UNHCR will be carrying out a more detailed survey, but evidence suggested that 5-10,000 might be accommodated within currently unsettled secure areas if use is made of some 'green' areas. With the policy of a dedicated livestock borehole per camp, if irrigation can be kept under control, the additional influx can be accommodated within reasonable pumping hours. Probably the most effective way of controlling irrigation will be to limit pumping such that 15 L/cap/day is supplied against an accurate head-count figure."

Finally, it was recommended by UNICEF to CARE that regular monitoring occur for bacteriological indicators, free chlorine residuals, and chemical sampling, at a rate of six samples every two weeks "taken at taps at the extremities of the pipeline", daily at the taps (six samples per day), and twice per year in Nairobi, respectively.

2.5 2004 aquifer study

In 2004, GIBB (Eastern Africa) Ltd, was commissioned by UNICEF/Kenya to complete a study of the 'Merti Aquifer', which, at the time, supplied approximately 2.5 million cubic meters (40% for refugee use) of water per year for refugee camps, rural centers, and livestock (GIBB, 2004). The objectives were to:

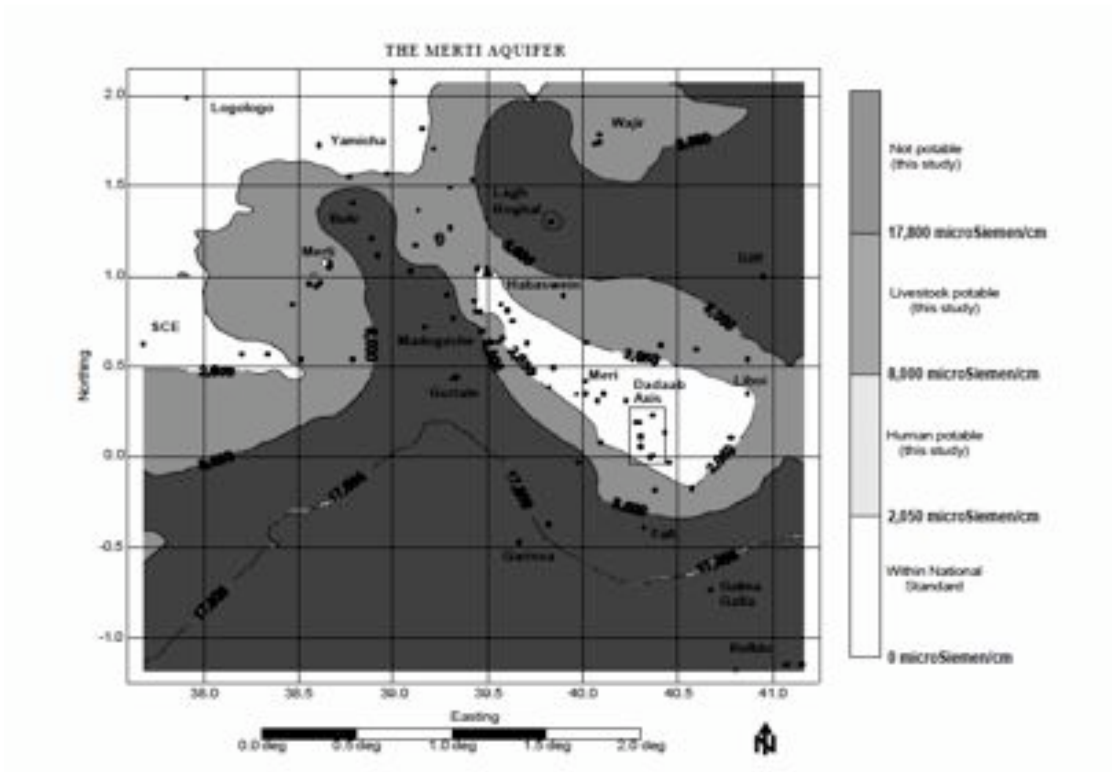
- identify and map the extent of the Merti Aquifer;
- identify and quantify recharge sources to the aquifer;
- determine the water quality characteristics of the aquifer, and consider the long term implications of these to aquifer use;
- determine the current level of abstraction and its effect on the aquifer; and,
- recommend a sustainable development and management plan for the aquifer.

The aquifer study completed an extensive and exhaustive review of existing data, compiling information and creating databases to answer the above questions. The reader is referred to the actual study for a comprehensive description of the results. Herein, only the key points for each objective are presented.

2.5.1 Identify and map the extent of the Merti Aquifer

The authors of the study decided to define and map the extent of the Merti Aquifer by its main use, provision of human and animal water supply. Much of the aquifer is, naturally, highly mineralized and salinized, and as such not suited for consumption. The authors created a map of the aquifer based on the easily-measurable water quality parameter of conductivity, and created four categories: 1) within the national standard (<2,050 μS/cm); 2) human potable based on acceptability drinking water taste to the local population (2,050 μS/cm – 8,000 μS/cm); 3) livestock potable (8,000 μS/cm – 17,000 μS/cm); and, 4) not potable (>17,800 μS/cm).

Figure 3: Map of potability in the Merti aquifer



2.5.2 Identify and quantify recharge sources to the aquifer

A key consideration in sustainable use of an aquifer is the amount of recharge (water flowing into the aquifer). Sustainable use of an aquifer can be considered withdrawing less volume of water than is being recharged. There is considerable debate over the nature of recharge in the Merti Aquifer, which is extensively covered in the GIBB report. The authors concluded that the major recharge to the Merti Aquifer is from the Lagh Dera area during large flooding events, at a rate of ~30,000,000 m^3 per event. The authors qualified the exact amount of recharge conclusion is based on weak data and could be questioned but is the best recharge estimate we have to date. The last large flooding event was the el nino floods in 1997.

2.5.3 Determine the water quality characteristics of the aquifer, and consider the long term implications of these to aquifer use

The study extensively reviewed and testing water quality throughout the aquifer. The key results relevant to the refugee camp water supply include:

- Many parts of the aquifer are mineralized and not potable. Mineralization increases with aquifer depth, and abstraction could bring up this deeper water to decrease the water quality of the aquifer.
- The aquifer thickness is greater than expected, and can be estimated at 300-500 meters of saturated waters.
- Trace ion heavy metals were analyzed, and high arsenic, cadmium, nickel, lead, mercury, and boron levels were noted. It was recommended that regular testing of arsenic, cadmium, nickel, and lead testing, the most serious contaminants, be undertaken on an occasional basis to ensure that no water supply systems

are seriously jeopardized because of declining water quality. Reported mercury concentrations exceed potable water standards 10 to 20 times.

2.5.4 Determine the current level of abstraction and its effect on the aquifer

Given the physical nature of the Merti aquifer, the distribution of mineralized waters (towards the aquifer periphery), and the likelihood that total dissolved solids increase with depth, there are two possible impacts of over-abstraction: 1) aquifer depletion as measured by declining aquifer level; and, 2) a decline in water quality as mineralized waters are drawn up and into the freshwater sections of the aquifer. These impacts could be particularly noticed in the refugee areas, where abstraction is intense, and increased from 250,000 m^3/year in 1992 to 930,000 m^3/year in 2002.

Based on an analysis of the data, a decline in aquifer level of 1.5 meters over the 11-year pumping period was calculated and increased mineralization of the aquifer was noted. Data and trends presented in the GIBB report: "support our assertion that a degree of mineralization occurs in the wake of abstraction". The report concludes: "that abstraction has had a measurable impact on the Merti aquifer: water levels have declined in Dadaab Axis boreholes, and very likely elsewhere at Centres where abstraction is intensive (Habaswein is a likely possibility). Water quality has deteriorated measurably in many boreholes for which data exist, and probably at a number of unmonitored boreholes as well."

However, the report continues by stating that: "water level decline should be considered in the proper perspective. Gross aquifer depletion of less than 1.5m over an 11-year pumping period and this only in one comparatively small area is barely significant (Dagahaley)." However, "water quality deterioration is perhaps more significant, and is probably more widespread than depletion. Water quality deterioration apparently pre-dates groundwater development in the Dadaab Axis though has accelerated slightly under the influence of abstraction. While measurable deterioration has occurred, we do not consider this to be significant in terms of local perceptions regarding water quality. Current rates of deterioration are unlikely to lead to catastrophic water quality decline except over several decades."

"The findings of this study strongly suggest that the Merti aquifer as presently exploited runs a risk of deteriorating to a point where water quality becomes marginal. We accept that if this occurs it is likely to take place over decades to centuries, though areas of intensive abstraction will likely deteriorate at a faster rate."

2.5.5 Recommend a sustainable development and management plan for the aquifer

Based on the aquifer depletion and water quality data, the following recommendations for aquifer management were presented:

- complete additional studies on the aquifer;
- continue defining the aquifer by zones of potability – fresh, human, livestock, non-potable;
- pump no more than 60% of tested discharge from each well for 10 hours a day as in the permits from the responsible authority;
- develop no new host community boreholes with 12 kilometers of existing boreholes to protect the environment from degradation from livestock, and no new refugee wells within 800 meters of a well to protect the aquifer from significant drawdown in a localized area;
- site livestock wells in livestock potable (not human potable) areas of the aquifer; and,
- monitor aquifer static water levels at wells and abstraction rates, and locate and monitor the three 'monitoring wells' dug specifically in the region in non-pumping areas to monitor aquifer level.

2.5.6 Other points

The study noted significant difficulties and limitations with the aquifer and water quality monitoring data collected by organizations working in the camp, including quality, consistency, and lack of evaluation of the data to respond (in a timely manner or at all) to abnormalities. It was recommended the deficiencies in data collection be addressed, and noted that previous studies had "recommended strongly that data collected should be evaluated in the field as soon as it is collected, even if only at a preliminary level."

2.6 Current water supply

Currently, 18 boreholes in the three camps pump at a total of 4,851 m^3/day (1.77 million m^3/year) to provide the refugees water (Table 4). Many of the original boreholes are still on line, although some flux has occurred, such as one borehole has been decommissioned because the pump fell into it, and an additional three have been drilled and commissioned. This represents a significant increase over pumping rates documented in the 2004 aquifer study (Figure 4) and a decrease in the per capita water supply since 1994 (due to the increased population) (

Figure 5). The current rates of pumping significantly exceed the recommended pumping rates in the aquifer study and the permitted use of the water. The liters/capita/day calculation is based on aggregate camp data, and assumes that all water extracted is delivered to the refugees and does not account for water that is used in institutions, economic productivity activities, losses in the system, and animal use of the water.

Each borehole has an in-line chlorinator at the pumping site to dose chlorine into the system, after which water sometimes flows into a tank and then tapstands and sometimes directly to tapstands. Water flows (roughly) for three hours in the morning and three hours in the afternoon to the camp populations. A tapstand monitor nominated by the community monitors and allows access to the taps.

An automatic chlorinator and the 1% chlorine solution that feeds the chlorinator

Table 4: Borehole production data as of 25/3/09 (CARE, 2009)

Borehole Number	Yield (m^3/hr)	Daily running hours	m^3/day	Fuel used/day (liters)
Ifo				
1	10.91	19	207	65
2	18.56	17	316	80
4	18	18	324	90
5	19.28	16	308	80
6	18.48	17	314	95
7	28.5	12	342	70
Total	113.73	99	1,811	480
Dagahaley				
1	9	16	144	72
3	18.4	19	350	105
4	0	9	0	27
6	10	19	190	76
8	26	20	520	156
9	15.78	19	300	110
Total	79.18	102	1504	546
Hagadera				
1	9	11	99	70
2	16.22	18	292	103
3	14.68	16	235	96
4	18.8	15	282	103
6	21.16	18	381	127
7	22.45	11	247	72
Total	102.31	89	1,536	571
Regional Total	**295.22**	**290**	**4,851**	**1597**

Figure 4: Extraction rate (per year) over time

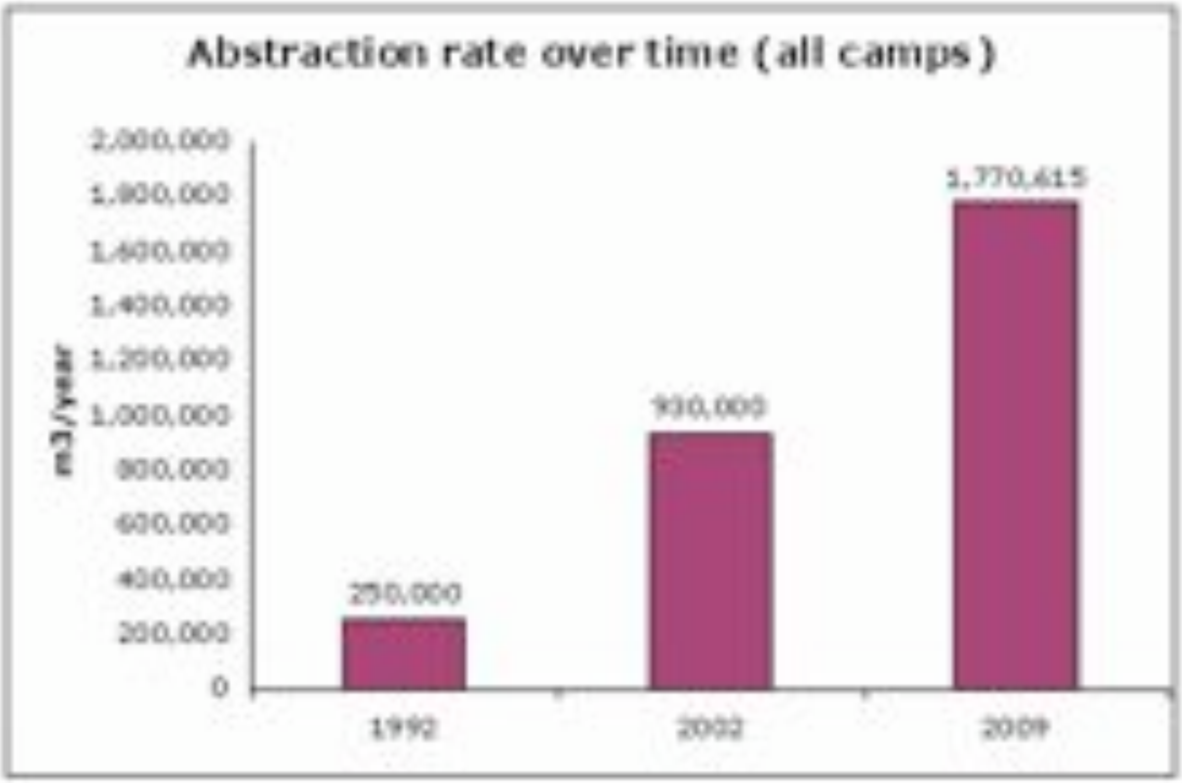
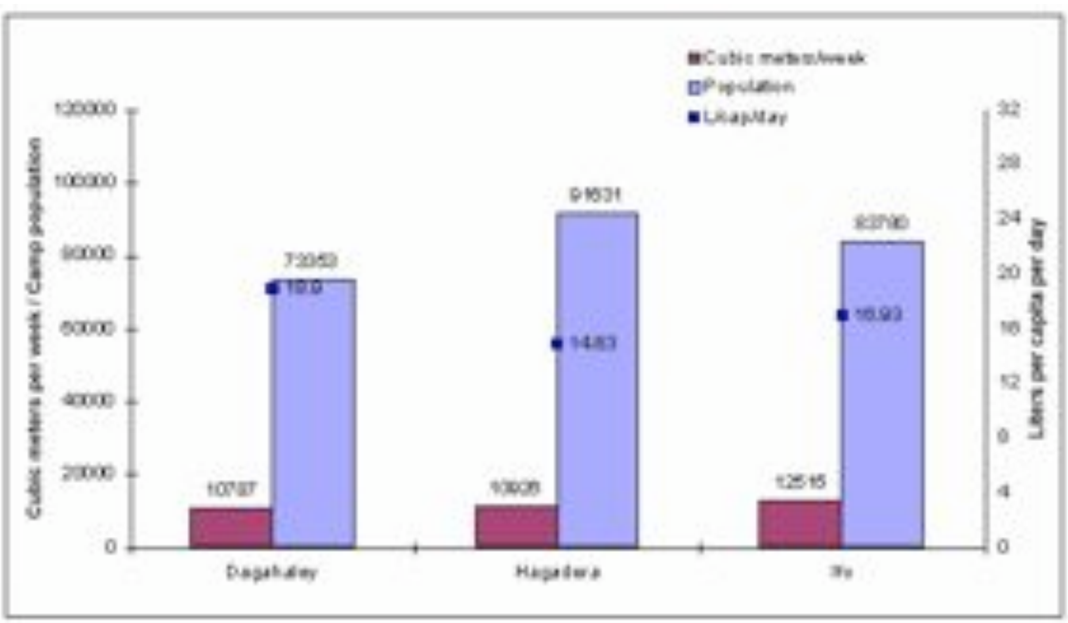


Figure 5: Amount of water produced and L/person/day (as reported by CARE to UNHCR 25-3-09) Errors in calculation included



2.7 CARE water quality testing results

CARE completes: 1) chlorine residual monitoring on a daily basis; 2) aquifer monitoring on a weekly, tri-monthly, or monthly basis; 3) water quality monitoring of borehole water at the Kenyan Ministry of Environment and Natural Resources yearly; and, 4) household water use questionnaires monthly.

2.7.1 Chlorine residual monitoring

Free chlorine residual (FCR) is tested with Lovibond color comparator kits that measure 0.0-1.0 mg/L FCR at increments of 0.1 and, if needed, a pool test kit that measures a higher range. The accuracy of the pool test kit is low. As of February 2009, five samples were taken per camp per day and recorded on data sheets, and there are plans to hire five incentive workers to measure chlorine residual along each borehole line in each camp. The values on the data sheets ranged from 0.4-0.8. These values are averaged per camp per week and submitted to UNCHR in the weekly reports. At only one camp, Ifo, was it stated if a problem is noted in the FCR that there is responsiveness to the data in adjusting the chlorinator. Staff at Ifo requested better equipment to measure above 1.0 mg/L FCR accurately. It was noted in observing staff completing the monitoring that errors were made in testing, such as filling the tube completely instead of only to the 10 mL line, so that the color will be over-diluted, and an under-reading of the FCR concentration recorded.

CARE staff testing FCR

2.7.2 Aquifer monitoring

Aquifer monitoring with a dipper is supposed to be collected on a weekly basis and recorded in data kept at the camp. The weekly reports to UNHCR only include the fact that aquifer monitoring was completed. The WatSan Team was able to collect aquifer monitoring data from CARE WatSan office computers in each of the camps. In Hagadera, the water quality team noted the readings were always similar, so moved to only monthly testing. In Ifo and Dagahaley, the monitoring is occurring on a tri-monthly, bi-weekly, or weekly basis, somewhat sporadically. To conduct aquifer monitoring, the camp staff measure the aquifer depth at the beginning of pumping in each well, pump for 11 hours, and then measure the aquifer depth at the end of the 11-hour pumping period. All aquifer data that could be obtained was graphed, by camp (Figure 6, Figure 7, Figure 8).

Please note that this data should be interpreted with extreme caution, for the following reasons:

- staff noted that although there is supposed to be one dipper per camp, there have been problems with the dippers to measure aquifer depth and the dippers are shared by camps and not always available;
- the data has been extremely sporadically taken;
- there are inconsistencies in the data set that raise questions as to its accuracy, including:
    - the 'spikes' in the data in August-October 2006 in Dagahaley; and,
    - the fact the aquifer varies in depth by over six meters within the small area of Hagadera;
- upon review of the reports, it was noted that identical data was reported for months at a time, and it is highly unlikely that the data would be the same each sampling time to an accuracy of $1/100^{th}$ of a meter;
- very few years of aquifer monitoring data were able to be collected (Hagadera only 2008; Ifo from August 2008 to the present; and Dagahaley some point in 2006 and 2007 and a large break in sampling until 2009)

and the value of aquifer monitoring data is in sampling over long periods of time, and that was not completed here.

Nonetheless, there are some general trends that this data shows, including:

- there is significant drawdown in some of the Ifo boreholes; and,
- there appears to be little aquifer drawdown recently, although this data should be compared to the long-term aquifer data, which will be completed by GIBB.

Figure 6: Aquifer monitoring and drawdown in Ifo Refugee Camp (in meters)

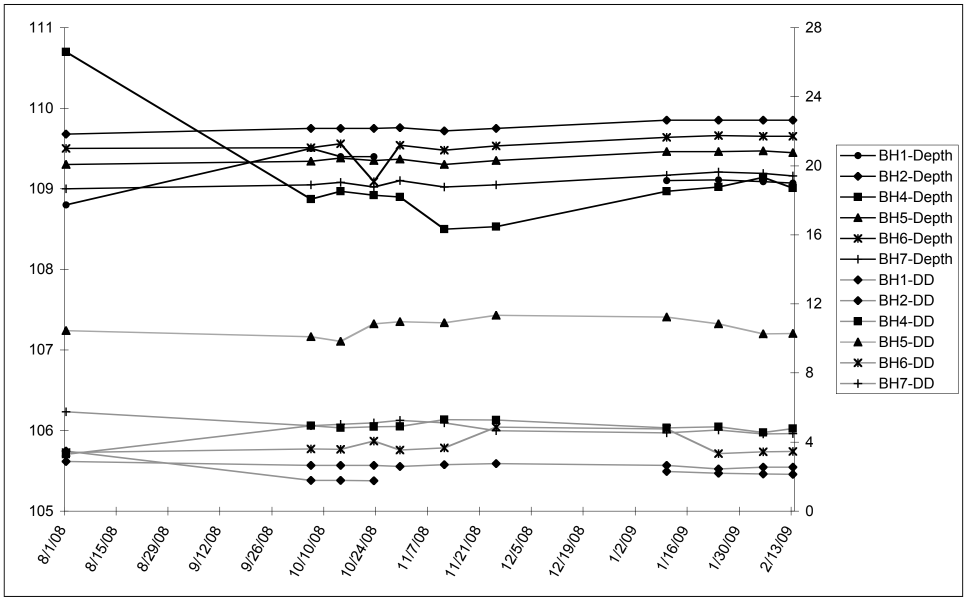


Figure 7: Aquifer monitoring and drawdown in Dagahaley Refugee Camp (in meters)

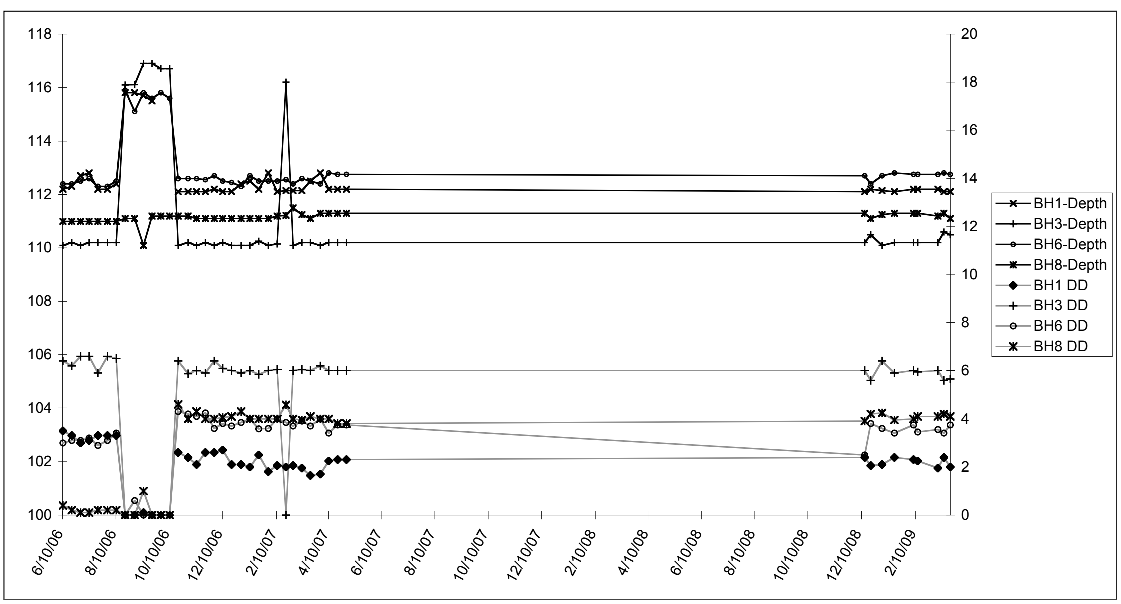
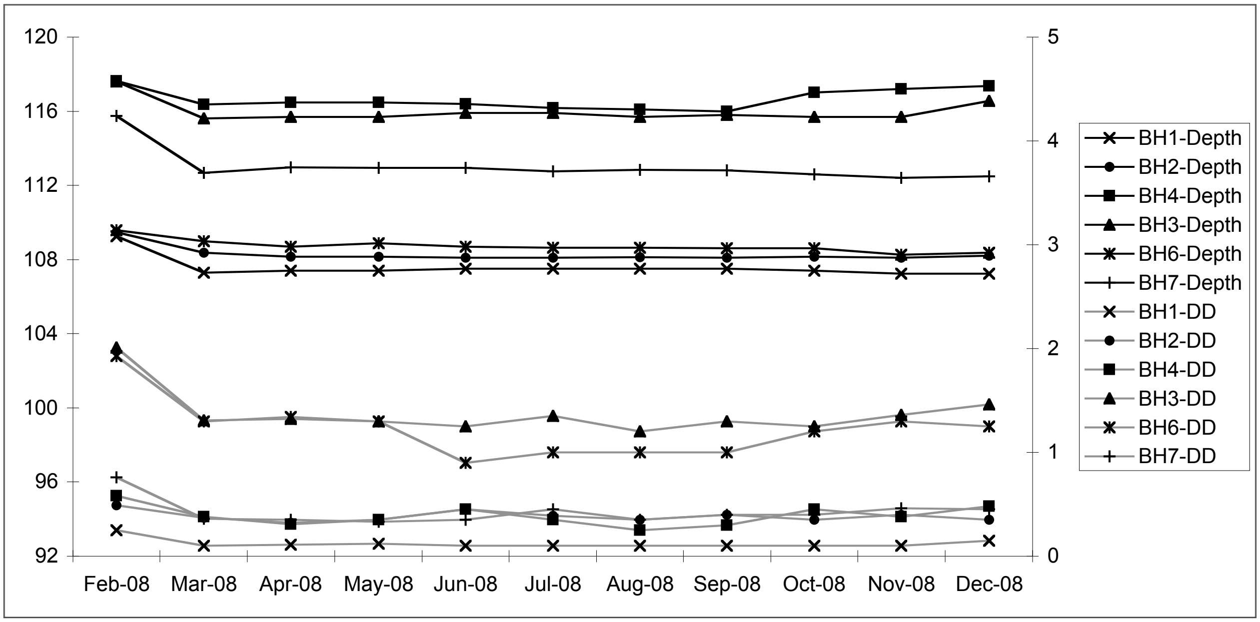


Figure 8: Aquifer monitoring and drawdown in Hagadera Refugee Camp (in meters)



2.7.3 Borehole water quality monitoring

As part of routine monitoring, each borehole is tested for chemical and physical parameters once per year. During the past two years, the water quality monitoring has been conducted at the Ministry of Environment and Natural Resources (MENR, 2007; 2008). Data was not easily available for previous years, although likely could be obtained. Sixteen wells were tested in 2007 (D-1,3,6,8; I-1,2,4,5,6; H-1,2,3,4,6,7; UNHCR), and 17 in 2008 (D-1,3,6,8,9; I-1,2,4,5,6,7; H-1,2,4,6,7; UNCHR). Note that the same wells were not tested each year.

The water quality data that is being collected could, and should, be used for four independent purposes: 1) to measure the treatability of the water; 2) to monitor aquifer health over time; and, 3) to measure the potability of the water; and, 4) to ensure that there no contaminants in the water are human health risks. It does not appear that any analysis is conducted on the data aside from noting whether MENR considers the water potable (as measured by acceptability) or not. MENR uses WHO and Kenya National Standards for potability of water, and is not completing analysis of the data for long-term trends in aquifer health, water treatability, or human health risks. Parameters related to human health risks, as recommended in the aquifer study, are not measured.

The water quality data for 2006 and 2007 were input by the WatSan team and analyzed to the extent that is possible. In terms of water treatability, pH and turbidity are indicators of appropriateness for chlorination. The WHO recommends a pH of below 8 and a turbidity below 5 NTU for effective chlorination. During 2007, all pH values were above 8, indicating that the contact time for chlorination should be higher in these waters (60 minutes instead of 30 minutes of contact time to ensure appropriate disinfection). In borehole lines in Dadaab with a tank, this contact time will be easily achieved. In boreholes pumping directly to the tapstands, the contact line might be less, although will be met during storage at the household. However, it is unclear why such large difference in pH between years, and this could be a laboratory error.

In terms of aquifer health, the data set (alkalinity, calcium, magnesium, sulphate, chloride, total hardness, total dissolved solids) is generally consistent with the aquifer study data, and indicates the water is slightly mineralized and 'tasty' (sometimes above the recommended WHO or Kenya standards, but not above the taste acceptability of the local population). Thus the water remains potable. The conductivities are slightly lower than noted in the aquifer study, which is an indicator the aquifer is not mineralizing around the extraction boreholes.

In terms of human health:

- Fluoride in small amounts promotes healthy teeth, and in high levels can cause fluorosis of the skeleton. The WHO recommends between 0.50-1.00mg/L for healthy teeth, and no greater than 1.5 mg/L to prevent fluorosis. No sample exceeded the 1.5 mg/L maximum in either year, and the majority were in the appropriate range for teeth health (9/16 (56%) in 2007; 11/17 (65%) in 2008).
- The maximum recommended nitrate level is 50 mg/L to prevent methaemoglobinaemia in children. One sample exceeded that level in 2007.
- Of concern is that lead levels exceeded the WHO recommend maximum of 0.01 mg/L in 14/16 (87.5%) in 2007 and 16/17 (94.1%) of samples in 2008. The Kenya standards are less strict, at a limit of 0.05 mg/L, and 4/16 (25%) of samples in 2007 and 1/17 (5.9%) of samples in 2008 exceeded the Kenya standards. Follow-up testing was completed based on these high results. The average lead concentration in the 33 samples as 0.029 mg/L, with 26/33 (78.8%) wells exceeding the WHO standard, and 3/33 (9.09%) exceeding the Kenya standard. Soil samples showed high rates of lead, from 4.8-22.6 mg/L (average 12.82), indicating the lead is leaching from the soil into the water.
- Of high concern is that the other contaminants noted that were high in the aquifer study – arsenic, cadmium, nickel – have not been analyzed as recommended.

There are some concerns with the quality of the data obtained from MENR, including:

- The data set is more meaningful in a time series analysis to determine trends in aquifer health.
- The large difference in pH between the years is unexplained.
- It is not possible for fecal coliform levels to be higher than total coliform levels, as fecal coliform is a subset of total coliform. The fecal coliform levels thus indicate contamination in the laboratory.
- One turbidity sample of 88 NTU in 2007 is a highly questionable laboratory result.

2.7.4 Household water use questionnaires

Each month, a certain number of households are visited by CARE, and a water use questionnaire is completed. CARE staff counts the number of jerry cans of different sizes, people, and animals of various types in the home. A calculation of water use per family per day is made by assuming all jerry cans are filled on a daily basis, and subtracting a certain amount of water per animal. A review of the data maintained in hard copy in CARE offices indicates that not many families report owning animals, families own a large number of jerry cans, and the average water use is above 20 L/person/day.

Table 5: Water quality results from CARE 2007 and 2008 testing

	2007 average (n=16) (min, max, stdev)	2008 average (n=17) (min, max, stdev)
PH	8.83 (8.56, 9.16, 0.17)	7.70 (7.19, 8.13, 0.33)
Conductivity (micros/com)	1045 (795, 1359, 202)	914 (649, 1280, 200)
Alkalinity (mg CaCO3/L)	435 (388, 512, 41)	434 (392, 508, 40)
Calcium (mg/L)	40.12 (13.50, 76.00, 21.05)	41.47 (9.92, 75.12, 21.00)
Sodium (mg/L)	148 (78, 247, 67)	143 (71, 245, 68)
Magnesium (mg/L)	15.8 (6.0, 23.0, 5.8)	18.3 (5.5, 28.1, 6.6)
Sulphate (mg/L)	17.1 (3.6, 29.0, 7.9)	26.6 (1.1, 62.3, 15.3)
Chloride (mg/L)	72.3 (17.0, 361.0, 82.3)	52.7 (19.0, 122.0, 32.6)
Fluoride (mg/L)	0.78 (0.42, 1.40, 0.28)	0.67 (0.33, 1.03, 0.19)
Total Hardness (mg CaCO3/L)	146 (56, 236, 63)	96 (6, 172, 55)
Iron (mg/L)	0.32 (0.09, 0.84, 0.21)	0.06 (0.00, 0.25, 0.08)
Turbidity (NTU)	0.54 (0.00, 2.35, 0.70)	0.00 (0.00, 0.00, 0.00)
Nitrate (mg/L)	19.35 (1.95, 68.64, 16.59)	6.00 (0.28, 21.90, 5.10)
Lead (mg/L)	0.05 (0.00, 0.12, 0.03)	0.03 (0.01, 0.06, 0.02)
Total Dissolved Solids (mg/L)	648 (493, 843, 126)	567 (402, 794, 124)
Dissolved Oxygen (mg/L)	6.17 (5.94, 6.81, 0.24)	9.29 (8.50, 10.70, 0.71)
Total Phosphorus (mg/L)	0.50 (0.22, 0.79, 0.18)	0.91 (0.00, 7.84, 2.06)
Fecal Coliform (colonies/100 mL)	0.31 (0.00, 5.00, 1.25)	7.71 (0.00, 101.00, 24.91)
Total Coliform (colonies/100 mL)	11.00 (0.00, 83.00, 21.22)	0.06 (0.00, 1.00, 0.24)

2.8 Camp knowledge, attitudes, and practices (KAP) around water

Up until this point in the report, we have only discussed the hardware components of the Dadaab Refugee Camp water supplies, and we have not discussed any of the software components of how users actually use the water, and user perceptions and knowledge, attitudes, and practices around water supply in the home. The user perspective is vital to understand a water supply system, and to this end surveys have been conducted in the camp to understand user perception. Three surveys are described herein: 1) the EcoSARD KAP commissioned by CARE; 2) the water and sanitation data collected during the CDC cholera response activity in early 2009; and, 3) data collected by the respondents during informal interviews during site visits in each camp. In addition, CARE completed an internal KAP not released at the time whose results are summarized herein as well.

2.8.1 EcoSARD KAP survey (2008)

In 2008, EcoSARD was contracted by CARE to conduct "a Knowledge, Attitude and Practice (KAP) survey on hygiene promotion to determine the extent of program implementation achievements, defining the existing gaps and setting benchmarks for further action" (Simon, 2008). A survey was developed and administered to 2,821 families in the three camps, and states that a 95% confidence interval was obtained with a confidence interval of 1.8%. Unfortunately, data analysis was quite limited as the report: 1) does not present data associated with all the questions asked; 2) does not complete statistical analysis at all; 3) does not segregate data by camp; and, 4) recommendations do not appear to be linked to the data. Overall, the quality of the data analysis was poor, and it is recommended that further analysis on the raw data set be completed to understand the results.

In terms of water supply, the survey reports that over 50% of Hagadera residents have access to over 5 jerry cans per day (not divided by user) and that rolling jerry cans in Hagadera leads to contamination.

However, the report concluded that: "The lack of fully (sic) adoption of appropriate hygiene practices were attributed to lack of materials such as soap for hand washing, sanitation tools e.g. wheelbarrow and rakes and few latrines shared between any families". The need to focus on few hygiene messages for some time, integration of the hygiene promotion program with the hardware components and increased involvement of the community at the block levels would go a long way to improving the hygiene standards in camp". The report recommended increasing campaigns among minority group blocks, providing more latrines (especially in schools), establish soap distribution, increase tapstands to prevent recontamination at the household level, and discourage transportation of water containers by rolling.

2.8.2 KAP information gained during cholera outbreak investigation (2009)

During the survey 82 individuals were interviewed, including 26 suspect cholera/severe watery diarrhea cases (31.7%), 26 matched controls (31.7%), and 30 unmatched controls (36.6%). Interviews were conducted in two refugee camps, with 18 interviews (21.9%) in Dagahaley and 64 interviews (78.1%) in Hagadera.

2.8.2.1 Water Supply

The majority of the individuals surveyed (80, 97.6%, n=82) obtained their household water from a communal tap. A moderate number of households (16, 19.5%, n=81) purchase water from the donkey carts. Very few survey respondents (8, 10%, n=80) reported collecting surface water, defined as stagnant water collected from around the tap, for household use. A small number of households (5, 6.3%, n=80) reported using water from Lake Hagadera.

Nearly every individual interviewed reported having problems with the water supply in the camp (77, 95.1%, n=81). The most common reasons for problems with the supply were: the line for water was too long (77, 100.0%, n=77), the tap was not working (18, 23.4%), the water pressure was too low (74, 96.1%, n=77), and the water was not on at the tapstand for long enough during the day (75, 97.4%, n=77). In addition, individual respondents reported the following problems with water supply: the water officer is corrupt, the tap is far away, there are reduced numbers of taps and nozzles, and one household was prevented from fetching water from any of the tapstands because they were recent camp arrivals.

2.8.2.2 Household Water Consumption

The majority of the households (78, 96.3%, n=81) used water from the communal tap for drinking. Also, nearly all households use tap water for other domestic purposes such as cooking, washing, bathing, laundry, and animals (80, 98.7%, n=81). The majority of households (n=80) surveyed fetched water from the communal taps once a day (41, 51.3%). A substantial number of households fetched water from the taps less frequently than every other day (25, 31.3%). A small number of households used the communal taps more than once a day to get water (8, 10.0%) and almost the same number of households fetched tap water every other day (6, 7.5%). The average time a household spent waiting to get water from the tapstands was 3.2 hours (min=0.05 hours, max 12.0 hours, stdev=2.64, n=74).

Of the eight households who reported collecting surface water, only one household (12.8%) replied that they use surface water for drinking purposes. Six of the households, 75%, answered that they use surface water for other domestic uses such as cooking, washing, bathing, laundry, and animals).

None of the survey respondents reported drinking water from Lake Hagadera. Of five the respondents who had answered they collected water from Hagadera, all five (100.0%) used the water for household purposes such as washing, cooking, or animals.

On average, households collected 16.1 jerry cans a week (min=4, max=84, stdev=11.2, n=82). The calculated average of water used per person per week is 5.6 L (min=1.1, max=40, stdev=5.5, n=82). The average number of people sharing water was 9.9 people per household (min=2, max=25, stdev=4.7, n=82).

2.8.2.3 Household Water Storage

The majority of households surveyed used jerry cans to collect and store water (74, 90.2%, n=82). Some households also used drums to store water in the home (48, 58.5%. n=82). No individuals reported using clay pots or buckets (0.0%, n=80).

Most households (66, 80.4%, n=82) stored water in the home for less than a day after it was collected. Fewer households (10, 12.2%, n=82) stored collected water in the home for 1-2 days. Six households (7.3%, n=82) responded that they don’t usually store water in the home.

Most respondents reported pouring water out of containers (57, 69.5%, n=82) and/or using a cup to dip water of a container (45, 54.9%, n=82). A very small number of respondents (4, 5.0%, n=80) reported using a spigot to get water out of storage containers and only two households (2.5%, n=82) reported using hands to scoop water from storage containers.

Very few households (3, 3.7%, n=81) reported treating their drinking water before consumption. Of the three households who responded that they treated their water (3.7%, n=3), two of the households (66.7%, n=3) boiled the water to treat it. The third household did not list a treatment method.

2.8.2.4 Direct Observation

The average number of jerry cans directly observed at each household (n=82) was 5.8 (min=1, max=24, stdev=3.6). Lids were available for all jerry cans in 37 households (49.3%, n=75); 21 households (28.0%) had lids for some jerry cans and not others, and 17 households (22.7%) had no jerry can lids. The average number of drums per household was 1.2 (min=1 max=3 stdev=.5, n=42). Of the 40 drums observed in compounds, 87.5% had lids. The average number of buckets per household was 1 (min=0, max=4, stdev=0.6, n=76). No families reported having clay pots.

Of the 75 households where storage containers were available for observation the following degrees of cleanliness were observed: in 13 homes (17.3%) the containers were very clean (no dirt visible), in 48 homes (64.0%) the containers were clean (defined as very little visible dirt), and in 14 homes (18.7%) the containers were dirty. Thus, a total of 81.3% of containers were considered clean.

For 75 households the distance to the closest tapstand used for fetching water was measured (measured in minutes walking). The average distance was 4.0 minutes (min.1, max=12, stdev=2.5). The majority of the taps that were observed were in working condition (64, 91.4%, n=70) and were shared by more than one block (68.4%, n=72). On average there were 80.8 jerry cans waiting at the tap stands observed (min=1, max=220, stdev=56.6, n=62). Water pressure was observed to be adequate (as defined by the community health worker present, not measured according to the Sphere Standards) at 50 tapstands (74.6%, n=67).

2.8.2.5 Limitations

The design of this case control study resulted a disproportionate sampling of the population who had experienced severe diarrhea (31.7%), so this may mean the study oversamples the most vulnerable population. Also, the survey asked refugees about a time period that had occurred roughly a month prior to the survey interview; education, hygiene promotion, and sanitation campaigns taking place in the intervening month had resulted in some substantial changes to households, particularly in the households with suspected or confirmed cholera cases. These changes included distributing soap in the camp, addition of private latrines, and increased chlorine levels in the tap water.

2.8.3 Informal survey during site assessments

As mentioned previously, the WatSan Assessment Team felt that, because of the significant amount of data already available, an additional survey was unnecessary in order to create this report. However, one gap we identified in the data was understanding actual and desired water use in the home. Thus, during the day of site assessment at each camp, five households in each camp were visited and asked: 1) what they used their water for?; 2) what they would use water for if they had access to more water?; and, 3) in Ifo and Dagahaley only, how many jerry cans of water were collected per day and family size to calculate water usage rate? Respondents were not prompted in any way for answers – they provided a list of what they use or would like to use water for.

Respondents identified the main current uses of water in the home as: cooking (93%), bathing (87%), laundry (80%), and ablution (93%) (Figure 9). Drinking (60%), washing utensils (53%), watering animals (20%), and other cultural/religious reasons (ritual bathing (20%), after toilet (20%)) were also noted as uses of water. It is of note that families knew exactly how much water they had access to (in terms of jerry cans per day), and many families, unprompted, were able to tell us the number of liters of water they used for each activity, such as 10 liters each for cooking breakfast, lunch, and dinner, etc.

When asked what they would use water for if they had access to additional water, one family replied she could only carry four jerry cans a day and thus could not use more. Thus, the number of respondents for this answer is 14. The majority of the 14 respondents noted three answers for using more water: wash clothes more (100%), bathe more (86%), and wet the ground (93%). Economic uses of water trees (29%), watering animals (50%), and brick making (21%) were also desired. Religious/cultural uses, such as ablution, ritual bathing, and gift to travelers were not noted strongly (7% each), indicating users are prioritizing these reasons for water use of their existing water. One respondent indicated she planned marital acts for when she had enough water to complete the prescribed ritual bath afterward.

The average L/person/day in nine households of respondents in Dagahaley and Ifo was 8.21 (min=4, max=20, stdev=5.1). When the high outlier was removed, the average became 6.7 L/person/day (min=4, max=12, stdev=2.5). One respondent indicated she felt 13 jerry cans every other day would fulfill her families water needs, which is equivalent to 20 L/person/day. Currently, she has access to 3 jerry cans every other day.

Figure 9: Actual water use in 15 households interviewed

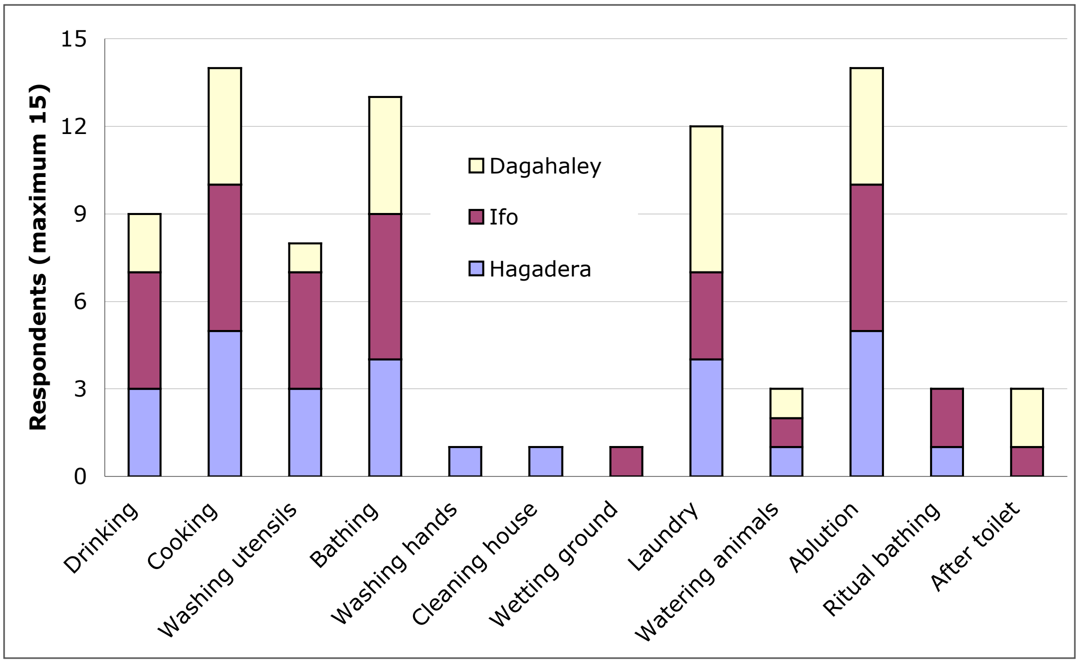
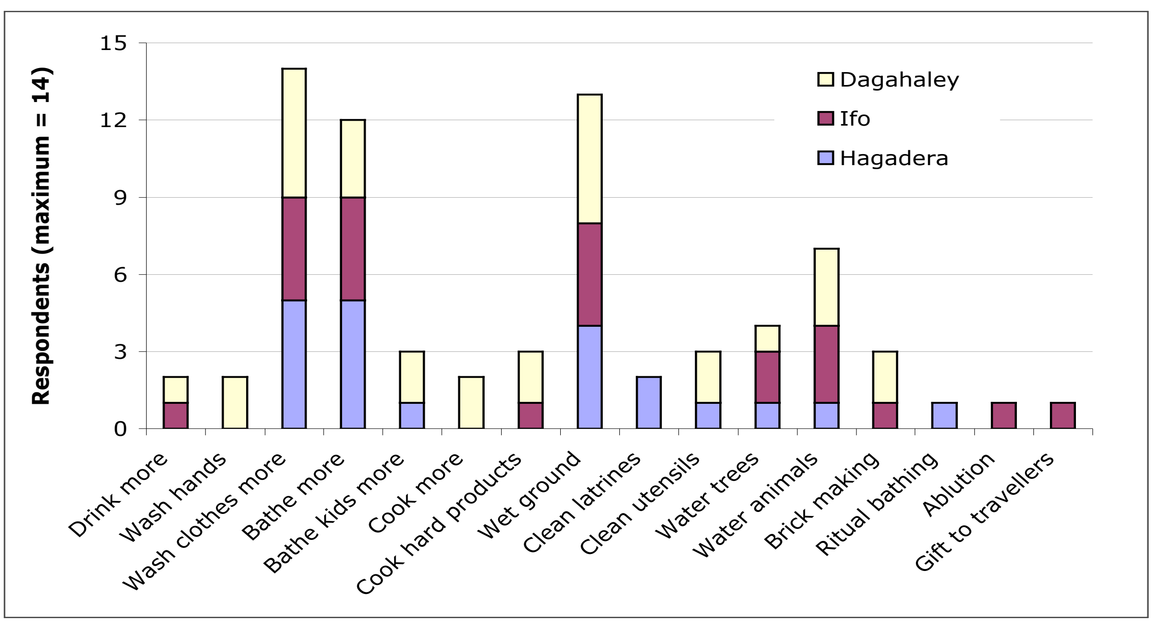


Figure 10: Desired water use in 15 households interviewed



2.8.4 CARE internal KAPs

During 2008, CARE conducted KAP surveys in each camp to serve as baseline indicators for the follow-up which was conducted by EcoSARD (CARE, 2008). The survey focused exclusively on hygiene indicators, not on water supply, but each of the survey results noted the majority of people rolled their water containers to fetch water and many were dirty.

Rolling jerry cans for water transport

Wetting the ground to keep dust down in homes

3 Identification of hazards and risk in system

The next stage in development of a water safety plan is to identify the hazards and risks in the water supply system described in the previous section. Based on the data presented in the previous section, and additional information that will be presented in this section, the following 10 hazards are identified in the current water supply system in Dadaab Refugee Camps:

- Population growth
- Diarrheal disease outbreak
- Low per capita water supply
- Aging infrastructure
- Aquifer depletion/mineralization
- Inconsistent chlorine residual
- Unsafe storage of water in the home
- Inequitable water distribution
- Low quality monitoring
- Lack of technical capacity and coordination on the ground

At the end of this section, these hazards are detailed in a table comparing their likelihood, severity, and current risk ratio. In addition to the risks identified above, there is a risk (not related directly to the water system) of flooding, as occurred in 1997 and 2006/7, in the camps inundating households and boreholes. As there are large flooding events in the region on a somewhat regular basis (and in fact these events are what recharge the aquifer providing the water supply) this is an issue that those involved in running the camps need to be aware of.

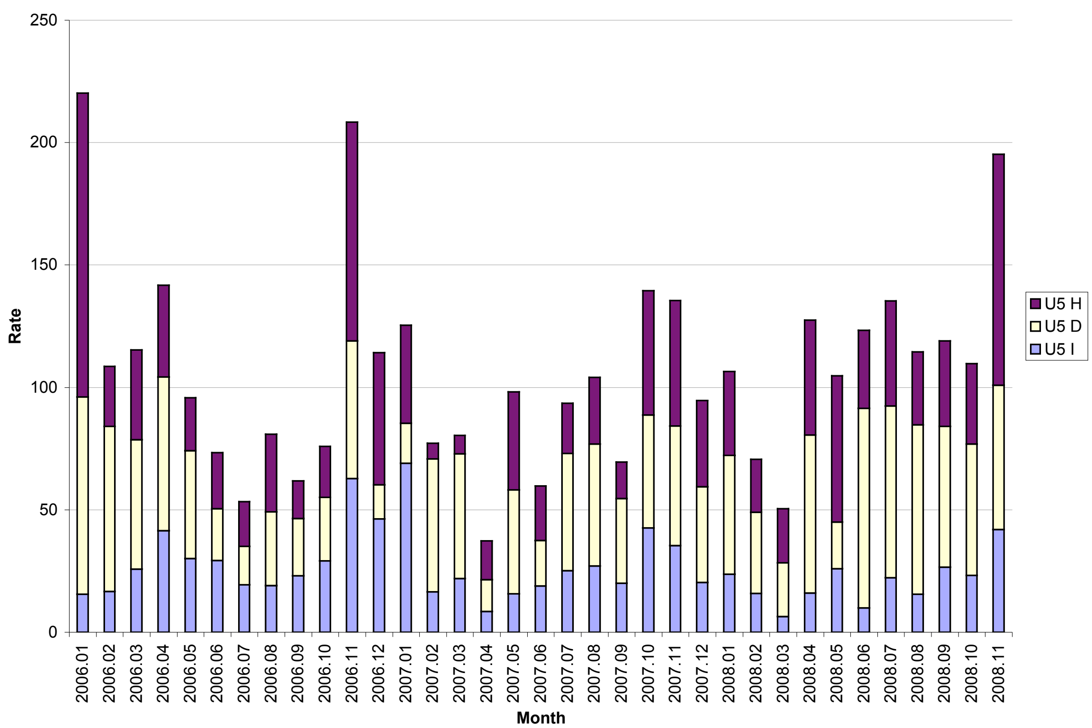
3.1 Hazard 1: Population growth

The water system in the three Dadaab Camps was designed for the 1994 population of 91,305, and when UNICEF turned the system over to CARE it was estimated the 14 wells in operation could safely provide water to an additional 3,000 people in Hagadera, 3,000 in Dagahaley, and 5-10,000 in Ifo. This estimate was based on actively discouraging livelihood and development activities, such as community gardens, in the camp that utilized water. The system has not significantly improved or expanded since 1994, and as of March 2009, 18 wells are providing water to 264,069 people. This population is approximately three times the population served in 1994, and 2.5 times the estimated maximum number of people the system could safely provide water to in 1994. In addition, 10,000 refugees per month are currently arriving into the camps, and it is not estimated this influx will decrease in the near term. The existing water supply system was not built to, nor can it safely provide water to, this many refugees on a long-term basis. As stated in the Oxfam report: "The rapid increase in population is eroding the capacity of the agencies providing services to the camps to maintain adequate levels of basic service and overloading the water, sanitation and primary health care infrastructure that were originally designed for less than half the current population. It is also reducing the ability of the established refugee populations to access existing basic services, significantly reducing standards of living. The camp populations have increased by 37% from a total population of 171,870 at the beginning of January 2008. The average monthly increase in population of 2.65% per month over the last year has far outpaced the expansion of the accommodation blocks and has resulted in serious overcrowding." In order to accommodate the increased population more camps are needed to distribute the population and increase hygiene, and more wells are needed in each camp to increase the water supply.

3.2 Hazard 2: Diarrheal disease outbreak

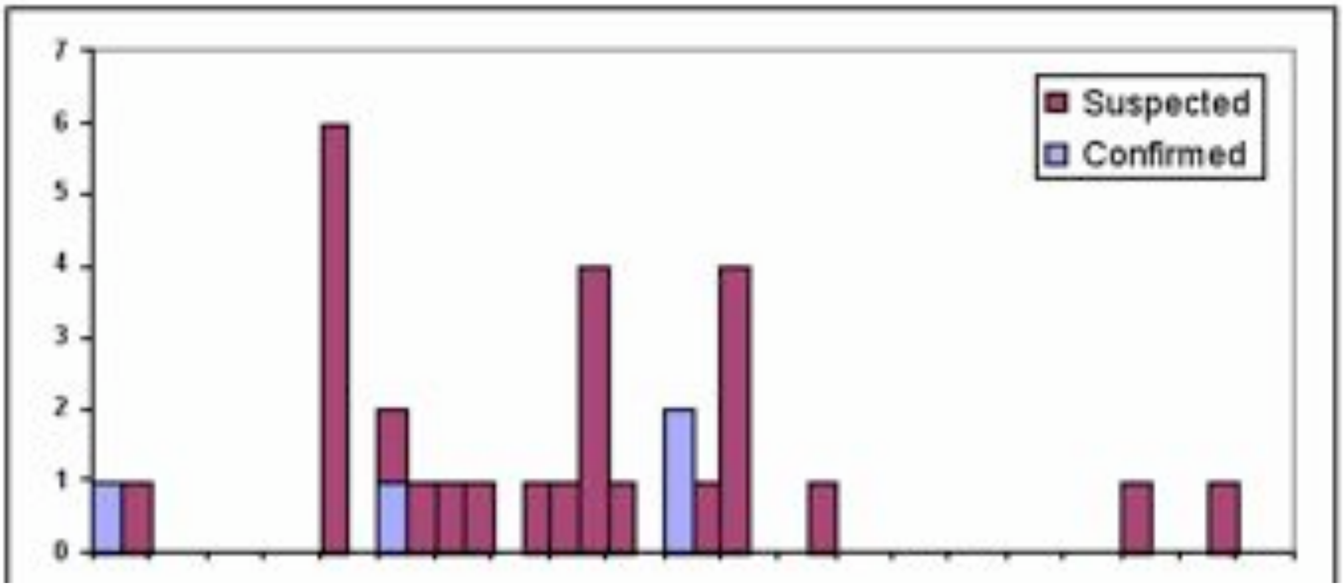
One potential consequence of poor water and sanitation systems is an increase in cases of sporadic, endemic, or outbreak diarrheal disease. Sporadic and endemic diarrheal disease rates are captured in reporting from health posts. Each refugee camp has a system of health posts located in the camps that serves certain sections. These posts fill out weekly surveillance reports on the illnesses they treat and these reports are entered in UNCHR's Health Information System (HIS). The CDC cholera investigation and WatSan teams accessed the HIS data in order to generate reports for the last three years (as far in the past as data was available) on the rates of watery diarrhea within the camps. The HIS data obtained by CDC contained two rates for watery diarrhea, an under 5 rate and a crude rate. Rates were obtained for each camp between January 2006 and December 2008 (Figure 11). The data displays a strong seasonality trend, with an increase in the number of watery diarrhea cases reported in November of 2006, 2007 and 2008. The increase in the rates over the year 2008 (the flatness of the data between April and November 2008 instead of a dip that we would expect due to seasonality) could indicate a potential overall increase in the rate of watery diarrhea in the camps but there is currently not enough data to draw a firm conclusion. The results of this data indicate a need for such monitoring to be continued to determine if the baseline rate of watery diarrhea is significantly increasing over time.

Figure 11: Water diarrhea rates in all three camps



In addition to sporadic and endemic diarrheal disease, there have also been outbreaks of cholera in Dadaab Camps. CDC helped to investigate an outbreak (which at the time of the investigation had 129 cases and 4 deaths) in May 2007 (when the population was 170,000 people) and found no free chlorine residual in "samples tested from housing blocks with the highest concentration of cholera cases, indicating that chlorination was inadequate in water supplied to these households" (O'Reilly, 2007). The investigation recommended "latrines and education, specifically for Bantu population, as well as surveillance and a case control study." In the CDC epidemiological investigation of cholera in February 2009, the epidemiological curve shows that, unlike the Angola and Mae La outbreak shown in Figure 1 and Figure 2, that the 2009 cholera outbreak never became a full-blown outbreak with exponential increase in cases (Figure 12).

Figure 12: Epidemiologic curve from 2009 cholera outbreak in Dadaab (from Mitchell, 2009)



The hazard of all types of diarrheal diseases, and a large-scale exponential cholera outbreak, is increasing due to "the potentially poor health condition of new arrivals from Somalia, due to the effects of the protracted conflict that they are fleeing, risks introducing communicable diseases into the camps and compromising the health status of the existing populations. This risk is exacerbated by the crowded conditions leading to enhances diseased (sic) transmission; lack of access to sufficient water and sanitation to moderate disease transmission; and the reduced capacity of the primary health services, in relation to the size of the population, to effectively deal with large outbreaks" (Oxfam, 2009).

As the water and sanitation systems are further strained by population growth, the hazard and risk of a large diarrheal disease outbreak increases. One hazard associated with a large outbreak is that surveillance systems in the camp might not be able to recognize, identify, and verify with laboratory testing outbreaks at an early stage when response would be easier and the outbreak might be able to be contained. For example, there is a time delay of a few weeks before HIS data is submitted to UNHCR. There is also a delay in giving feedback to the clinicians in the health posts resulting in a problem in linking information to action. Because the risk of a large diarrheal diseases outbreak is high under the current situation, attention need to focus on continuous training of the medical staff and the community health workers on the case definition, surveillance, and management of diarrheal diseases like cholera. In the UNHCR report, it was recommended to improve surveillance systems in order to capture potential outbreaks at an earlier stage.

3.3 Hazard 3: Low per capita water supply

Currently, the amount of water available to each refugee per day is calculated by CARE using two equations: 1) by dividing the aggregate production in the camp (adjusted by a factor of 10%, 12%, and 10% for institutional use, leakage, and animal use, respectively) by the number of people in the camp; and, 2) by counting the jerry cans in the household at household visits, assuming that all jerry cans are filled each day, subtracting out a certain amount for animal consumption based on the number of different animals the family owns, and then dividing the remaining water by the number of people in the household.

There are severe inaccuracies in both of these calculations. In the first calculation, the adjustment factors are estimated, and it is unknown whether: 1) 10% is an accurate representation of institutional use (such as schools, hospitals, NGO compounds, Norwegian Refugee Council (NRC) slab production facilities, businesses in the camp, the GTZ tree growing facility, etc..); 2) 12% is an accurate indication for leakage, as almost all taps observed leaked; and, 3) whether 10% is an accurate portrayal of animal use in the camps. There are plans by CARE to install flow meters at public institutions and by Oxfam and UNHCR to study water availability at schools and hospitals in hopes of better understanding the institutional uses of water in the camp.

Other water uses in the camp, including (clockwise from top left):

brickmaking, animal watering, making mud for house construction, and ice/juice making

Currently, the water availability numbers reported by CARE generally meet the Sphere Standards. The data obtained from method 1 was presented in

Figure 5, and shows current water availability as reported by CARE on 25-3-09 in their weekly report to UNHCR, and obtained by the WatSan Team from UNHCR. However, this data does not appear to be calculated consistently or according to the calculation provided.

Every week, CARE reports to UNHCR a weekly abstraction rate in cubic meters, a camp population, and a L/cap/day. These three figures are presenting in the second, third, and fourth columns in Table 6. However, the CARE L/cap/day reported does not equal the number of liters abstracted per day (calculated by multiplying the cubic meters by 1,000 and dividing by the population) divided by the population and adjusted by factors of 10%, 12%, and 10% for institutional use, leakage, and animal use. For Dagahaley, the L/cap/day reported is equal to the liters abstracted divided by the population and reduced by 10%. For Ifo, the L/cap/day reported appears to be equal to the liters abstracted divided by population and reduced by 10% and then 10%, although the calculated number is not exactly equal to the reported number. It is unclear how the Hagadera number was obtained. In the fifth column, the L/cap/day as calculated with no factors (liters abstracted divided by population) by CDC is presented. In the sixth column, the L/cap/day as calculated by CDC with the three percentage reductions are presented. As can be seen, there are significant errors in the current CARE calculations. It is imperative that a method for calculation be agreed upon and aligned for moving forward in the future, as the values currently presented are not comparable or accurate, and if the factors are included the L/cap/day is significantly lower than reported.

Table 6: Discrepancies in CARE L/cap/day reporting (25-3-09 to UNHCR)

	CARE data: Abstracted m^3 reported (/week) calculated (/day)	CARE data: Population	CARE data: L/cap/day (reported)	CDC calculation: L/cap/day (no factors)	CDC calculation: L/cap/day if 10%, 12%, 10% factors are included (CORRECT)	Discrepancy
Hagadera	10,926/week 1,561/day	91,631	14.83	17.0	11.58	Unclear
Dagahaley	10,787/week 1,541/day	73,353	18.9	21.0	14.29	Deducting 10% from total
Ifo	12,515/week 1,789/day	83,780	16.93	21.3	14.51	Deducting 10% and then 10% from total

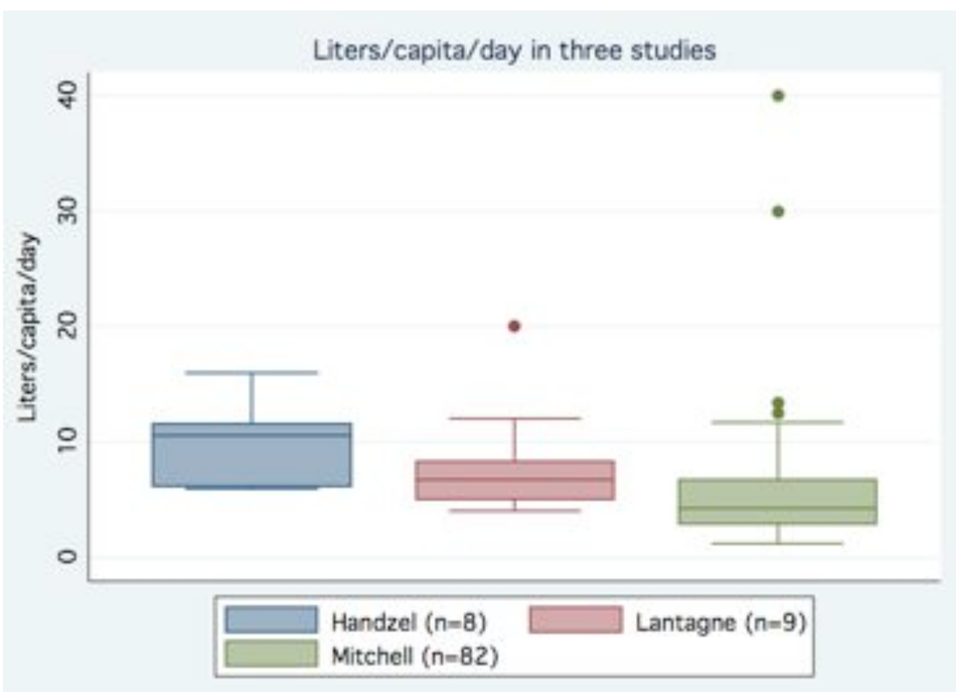
A review of the household survey records kept by CARE in the camp-based offices showed an average water availability of approximately 20 L/cap/day. However, we know from the cholera survey that families have significantly more jerry cans in the home (average 5.8/house) than they are able to fill each day (average filling of 16.1/week or calculated 2.3/day), and thus this is an inaccurate assessment (Section 2.8.2 on page 26).

A more accurate way of measuring household water availability than either of these methods is to conduct household surveys and ask families how much water they collect each day (in jerry cans) and how many members are in the household. To our knowledge this type of survey has been conducted three times: by Handzel in July 2008; Mitchell in February 2009; and, during the WatSan Assessment teams household visits in March 2009. As can be seen in Table 7 and Figure 13, the average available L/cap/day found in these surveys is significantly lower at the household level than reported by CARE – with a mean of 9.79 Liters per person per day found in the Handzel study, 5.57 L/cap/day in the Mitchell study, and 8.21 L/cap/day in the WatSan Assessment team work. Please note the Mitchell survey included 31 families with cholera in this data, and so families with low water availability, and hence more susceptible to diarrheal disease, may be oversampled in this survey. Although none of these three surveys were statistically significant on their own, they do represent a sample of 99 families and show a consistent trend of significantly lower water availability at the household level than reported. The discrepancies between the reported water availability and actual availability at the household can be attributed to higher institutional use, leakage, and animal use than accounted for. If statistically significant data on actual water usage is desired, a randomized household survey of 200 families per camp asking questions on socio-economic status, water use, desired water use, and family size could be developed. The population, as we noted in our survey, is well able to answer specific questions (including how many liters per day they use for each water use) about their current and desired water use practices.

Table 7: Per capita water availability as measured during household surveys

Study	Handzel	Mitchell	WatSan Assessment Team
Camps	Hagadera	Hagadera, Dagahaley	Dagahaley, Ifo
Date	July 2008	February 2009	March 2009
Sample size	8	82	9
Average L/cap/day	9.79	5.57	8.21
Minimum	5.88	1.14	4
Maximum	16	40	20
Standard deviation	3.57	5.47	5.02

Figure 13: Per capita water availability as measured by household survey



It is of note that the L/cap/day number all align around a bit less than 10 L/cap/day if you:

- Assume a 50% use of the water in leakage, institutional use, and animal use, which is likely a more accurate representation.
- Assume only half the families jerry cans are filled each day, as was seen in the recent survey done in the CDC cholera response, and divide the number of jerry cans by two in the CARE household visit calculation to change to an average of about 10 L/cap/day.
- Look at the household survey data, and understand the Mitchell data might be slightly low because of oversampling of at-risk, cholera families.

Overall, the data presented strongly indicates that currently, the population in the camp is receiving less than 10 L/cap/day. It is critical that the calculations for determining L/cap/day be both consistent and realistic, and as such it is recommended that the L/cap/day calculations be revised.

3.3.1 Limitations of Sphere Standards in Dadaab context

The Sphere Standards provide a vital tool in assisting organizations to attain minimum standards for emergency response. However, there are limitations when using the 15 L/cap/day indicator for planning water supply provision in the Dadaab context, including:

- 15 L/cap/day is meant as a minimum amount provided for emergency situations, and does not take into account the needs of a population living long-term in camps, such as livelihood activities and animal consumption;
- the 15 L/cap/day minimum standard does not include water for the cultural/religious practices of the majority of the Dadaab refugees, such as ablution and ritual bathing, which we know from the survey are one of the main water uses of the population; and,
- the amount does not take into account that in the extreme high temperatures in Dadaab a minimum of three liters of drinking water per day is recommended to avoid nephrolithiasis (kidney stones).

3.3.2 Violence directed at water system

During three days time the WatSan Assessment team spent in the camps, we noted numerous instances of refugees interfering with the water distribution system, including cutting lines and tapping pipes, in order to obtain water. In addition, when a tap broke at a borehole and water flowed freely onto the ground, a crowd collected and asked for the water. However, when a hose was added to the tap, the crowd fought over the hose and the supply was discontinued. These events highlight both: 1) the high level of dissatisfaction with the amount of water being provided; and, 2) the difficulties in completing normal operations of maintenance of a system when the staff is responding to emergency situations on a regular basis.

3.3.3 Host community borehole supplements to water supply

During each visit to the camp, the WatSan Assessment team visited the host community borehole. In Dagahaley, the team was denied access to the borehole, however, water quality testing was completed on host community boreholes in Hagadera, Ifo, and Dadaab. No host community borehole had an automatic chlorinator or any presence of free chlorine residual in the water. The Hagadera and Ifo community boreholes both sell water to the refugees. At the Hagadera community borehole, which was noted to be extremely active and busy with people, animals, a watering trough, and donkey carts, the community estimated that 400 donkey carts of 20 jerry cans each (160,000 liters or 160 m^3/day) were sold to the community, at a cost of 4 KSH/jerry can, every day. As the average production of the six refugee boreholes is currently 256 m^3/day), the amount provided into the camp from the community borehole is the equivalent of 63% of a refugee borehole. In Ifo, the community estimated they sold 100 jerry cans (2,000 liters or 2 m^3/day) to the refugees, at a cost of 4 KSH/jerry can. The reason for the high use of the community borehole in Hagadera is that the densest area and the market are furthest away from the camp boreholes (with concurrent low pressure in the tapstands) and near to the community borehole. An ice manufacturer and restaurant visited in Hagadera reported buying 250 and 300 jerry cans, respectively, from the community well; in Ifo an ice manufacturer and restaurant both purchased their water from the CARE tapstands. The income generated from these commercial purchases funds hygiene education in the market. No chlorine residual was seen in the ice manufacturer and restaurant in Hagadera, or the ice manufacturer in Ifo; however, chlorine residual was seen in the water served in the restaurant in Ifo. A combined restaurant/ice manufacturer in Dagahaley purchased 100 jerry cans per day from the community borehole, and no chlorine residual was seen in this water. Based on these observed uses of the community boreholes for camp water supply, it is recommended that the community boreholes be chlorinated.

The Hagadera community borehole and donkey carts bringing water in to the camp

3.4 Hazard 4: Aging infrastructure

It was clear during the WatSan Assessment team's visit to the camp that the state of the water supply system is in disrepair. We noted broken flow meters, the fact the majority of taps were leaking, and leakages in the piped network – all things indicating that the water supply system is in need of repair. In fact, this issue was noted as the most important issue in water supply in the camp in the recent UNHCR report: as the "**Need for improved efficiency of water supply system** was identified as the top-most priority among the "top 3" gaps during strategic planning exercise. **Poor and aging infrastructures** are in the process of being rehabilitated or replaced and there is a good system of record keeping in the pump-house. Currently, efforts are also underway to upgrade system to cater new influx through construction of additional capacity/facility, extension of services, and improvements in the existing infrastructures. Vandalism of distribution pipelines has been experienced in some sections, water tap-stands in many cases were found to be poorly-drained and not well maintained, and low pressure head at some water points" (Shrestha, 2008).

The issue of maintaining and improving this system is not new. In both 2007 and July 2008, a visit was made to the camps by an expert in water supply systems from Bushproof (Fewster, 2008). In 2007 and 2008, he recommended such improvements as changing pump sizes to increase capacity, fitting pump shrouds to prevent motor burnout, rehabilitating the one well where the pump had fallen in and the well was decommissioned, fixing the capacity in Hagadera0BH6, identifying and fixing the low broken flow meters, fixing broken taps, and optimizing tank, pipe, and distribution network design. He developed a master plan for the system based on available data, and an Excel worksheet to calculate how to add new nozzles to the system and maintain the correct pressures and obtaining increased water volume using pumping schedules, cross-pumping, increased pumping hours, and increasing the efficiencies of boreholes. In the report from 2008, the consultant stated: "It is clear that no one in CARE is responsible for design work. The master planning document created in 2007 had not been utilized since then. This situation needs to change if CARE is going to make professional progress in water supply provision in the camps while being able to have a basis to argue and reason with UNHCR."

No member of this WatSan Assessment team is an expert in the details of maintaining a water supply system, and as such, we did not complete a full evaluation of the state of repair (from flow meters to chlorinators to pipes to tapstands to taps to pressure to tanks to pumping schedules, etc) of the system. It is highly recommended that an expert in the operation and maintenance of water supply systems be deployed long-term to assist in rehabilitating the water supply systems in the three camps, to optimize and increase capacity in the current network until new boreholes can be installed.

A (working) flow meter and a very leaky tap

3.5 Hazard 5: Aquifer depletion/mineralization

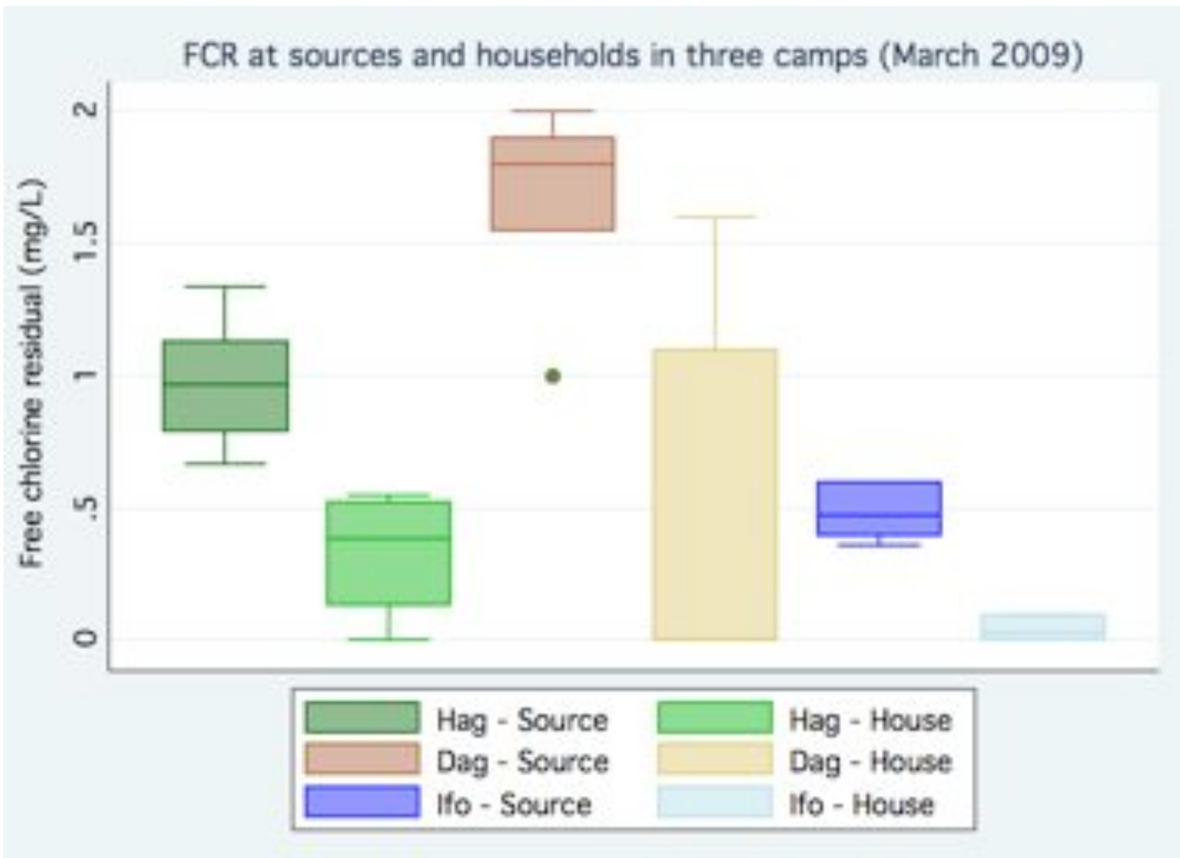
Although aquifer depletion and mineralization is a strong concern of the Kenyan government and host population, the best evidence we have to date indicates that there are only minor effects of the pumping from the refugee boreholes on the aquifer both in terms of aquifer drawdown and mineralization. Continued monitoring is needed to ensure that the aquifer does not begin to significantly degrade. It is of note that having a more dispersed refugee population, with fewer wells in each camp, would minimize local drawdown effects on the aquifer compared to having many wells in one location.

3.6 Hazard 6: Inconsistent chlorine residual

The need to consistently chlorinate the system has been noted in numerous reports (Fewster, 2008; Handzel, 2009; O'Reilly, 2007; Shrestha, 2008). CARE has moved from an inaccurate chlorination scheme of using an IV drip bag with chlorine solution to drip into the tanks to an in-line chlorination system. Problems with the system (including clogging due to use with non-settled HTH powder made chlorine) are being addressed and are beginning to improve.

During the WatSan Assessment teams time in the camp, we, as many others have done, collected borehole/tapstand and household level free chlorine residual samples. When we tested for FCR at the boreholes and tapstands, we found that in Hagadera the median FCR was approximately 1.0 mg/L, with a medium range of residual levels; in Dagahaley the median was about 1.75 mg/L, with a medium range; and, in Ifo, the median was approximately 0.5 mg/L, with a tight range. These data indicate that, at each camp, the tapstands can be reliably chlorinated to a fairly accurate range. However, the median was very different at each camp. When we took FCR samples at the household level, however, we found a very different picture. It is normal for chlorine to degrade over time in storage, and as many people do not have access to the tapstands every day (Section 2.8.2) people are storing their water for 24-48 hours and the chlorine is degrading. In Hagadera, when the median at the tapstand/boreholes was 1.0 mg/L, there remained a nice level of around 0.2-0.5 at the household level. In Ifo, when the median at the tapstand/boreholes was 0.5 mg/L, there remained very little chlorine residual at the household level. In Dagahaley, we think the team specially chlorinated for us that day, as the median was high at the tapstands/boreholes, but the household results were either very high (because they collected that morning) or very low (because they collected the day before). The data strongly indicates that a FCR of 1.0 mg/L at the tapstand will maintain a good chlorine residual in the household.

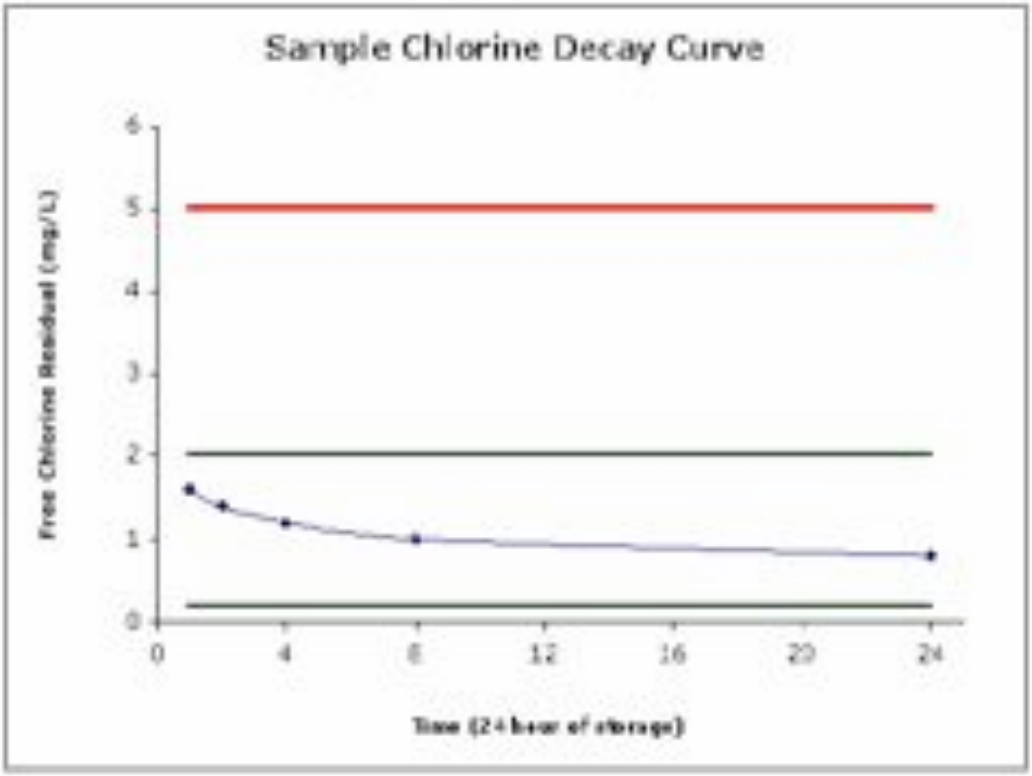
Figure 14: FRC at sources and household in three camps (March 2009)



There is significant misunderstanding and debate about the appropriate FCR residual levels recommended by WHO for chlorination. The maximum allowed level is 5.0 mg/L, as that has been the maximum dose tested in laboratory studies (WHO, 2004c). Even though no adverse effects were noted when drinking water at 5.0 mg/L, the WHO has established is as their maximum, and states that very few people will be willing to drink water at this level due to the poor taste. WHO recommends that, in infrastructure systems that deliver water continuously, a level of 0.2-0.5 mg/L be maintained. In cholera or outbreak situations, an FRC of 1.1 mg/L is recommended. However, WHO does not make a recommendation when infrastructure water is not continuous and people store their water in the home. CDC promotes household water treatment with chlorine in over 30 countries, and has completed dosage testing in all program countries, and determined that a dose of 2.0 mg/L in water is appropriate to treat the water and maintain more than 0.2 mg/L FRC for 24 hours of storage (Lantagne, 2008). A dose of 2.0

mg/L does not exceed the taste acceptability of most people in Africa. Because the water in Dadaab is so pure, it does not have excessive chlorine demand, and so a dosage of 1.0 mg/L has been shown (in the above data) to maintain residual and continue to protect the water in the household for the 24-48 hours that people store their water after collecting it from the tapstands.

Figure 15: Chlorine decay and WHO standards at the household level



3.7 Hazard 7: Unsafe storage of water in the home

As indicated in the previous section, if chlorine residual is maintained at an average of 1.0 mg/L at the tapstand and borehole level, there remains sufficient chlorine residual in the household water, even though the jerry cans might be dirty and the water is being stored in the home for up to 48 hours. Jerry cans are, in and of themselves, a safe storage container, as they are sealed to prevent the chlorine from escaping and you must pour water out of them (and not reach in) in order to access the water.

In the 1998 KAP survey results commissioned by CARE, much was made of the dangers of rolling jerry cans, and it was recommended in the conclusions that rolling should be discouraged because it can contaminate the water inside the can and the whole can needs to be washed before the water is safe inside (Simon, 2008). In reality, only the part of the can that touches the water (the inside and the spout) needs to be clean, and rolling is actually a culturally appropriate and locally appropriate method to transport the jerry cans to the households, as unlike Kenyans, Somali's do not transport water on their heads. Thus the circular jerry cans are highly desired because they can role in the sand present in the camps and over half of respondents (those who couldn't afford donkey carts and didn't have a wheelbarrow) roll their jerry cans homes.

At this point in time, given the fact that families have more jerry cans available in the home than water to fill them (Section 3.3), we cannot recommend the distribution of additional safe storage containers as an option to reduce risk. In addition, families do not have access to enough water per day to justify distributing larger containers (and assuming the concurrent risk of recontamination of water during storage or by dipping into tanks) such as 100-liter tanks to the household. Lastly, given the low risk inherent in rolling, we cannot recommend discouraging rolling or encouraging users to use the little water supply available in cleaning the whole jerry can. Although rolling does reduce the life span of the jerry can due to damage to the plastic over time, many innovations (such as wrapping extra plastic around, etc) were noted in the camp to deal with this issue.

3.8 Hazard 8: Inequitable water distribution

Numerous reports reviewed identified inequitable water distribution as a key hazard in the camps. The UNHCR report noted "In some blocks while there were overcrowding of people fetching water and even reported conflicts, in others the water points were found to be less crowded and supply was plenty implying **widespread inequitable distribution of supply**." The Oxfam report noted tapstand monitors charging people for water and year round shortages of water that lead to conflict. One respondent in the cholera survey noted they could not access water because they could not afford to pay/bribe the tapstand monitor. In the WatSan Assessment Teams time in the camps, we spoke to new arrivals who told us they were not allowed to access any tapstands, to tapstand monitors who had a list of who was allowed to access water in the morning time and in the afternoon time, and to many people who approached us at every tapstand saying there was not enough water. We also witnessed fights over water when the tap broke on the borehole site. UNHCR recommends that this "observed disparity in the distribution of water supply should be corrected through adjustments in the distribution system, storage facilities and extension of network to newly populated areas".

Children collecting run-off water from a tapstand

At this point, although inequities have been noted in numerous reports anecdotally, there is no solid data from the camp showing the number of people per tapstand or the practices of the different tapstand monitors in order to systematically identify the areas of the camp that are in need of additional water. In addition, there is no solid data on time in the camp or ethnicity as factors influencing inequitable supply. It is recommended that the number of people per borehole be calculated, and tapstands installed in underserved areas.

3.9 Hazard 9: Low-quality monitoring

Currently, CARE completes four types of monitoring: 1) free chlorine residual monitoring daily; 2) aquifer monitoring weekly; 3) yearly chemical and physical monitoring of borehole water; and, 4) household water use survey monitoring. The WatSan Assessment team was able to obtain data from CARE on all these types of monitoring, and noted that improvements could be made in all four monitoring procedures.

At this time, chlorine residual monitoring is being completed with Lovibond test kits (for 0.0-1.0 mg/L) and pool test kits (up to 4 mg/L) in each camp by one person who measures five-six samples per day. The results are recorded in a notebook (since February) and they are available. CARE is planning to hire incentive workers to complete testing on each line every day. This testing protocol is comprehensive. One of the CARE staff noted problems with the test kits, as the pool test kits are hard to read and he would prefer a test kit like the Lovibond color-wheel kit that goes higher than 1.0 mg/L. Upon observing him testing it was noted there were minor errors in how the testing was being completed, as the tube was filled completed instead of only to the volume line, diluting the color of the sample; and the tube was left full after sampling, potentially staining the tube. There are color-wheel test kits from Hach available for 40-80 USD that are accurate in a range of 0-0.7 mg/L or 0-3.5 mg/L that might be a better option for testing free chlorine residual in the camp. It is not recommended to use colorimeters to measure extremely accurately free chlorine residual due to the expense, the difficulty in training, and the fact that both CDC meters that were taken to the camp broke down in the conditions.

Chlorine test kits (with minor errors)

The aquifer monitoring has been completed sporadically, and it is recommended that: 1) aquifer monitoring be conducted at least two times per month, regularly, at every borehole in each camp; 2) that each camp have the equipment necessary to complete the testing on site and not have to share; 3) that the data is recorded in an Excel file in each camp; 4) that any monitoring well that was previously installed that can be rehabilitated (one was lost, one was vandalized, and one was destroyed by the host community) be reconditioned so the aquifer can be monitored at a well that is not a pumping well. GIFF could be contacted for assistance on this topic.

In the yearly laboratory testing for chemical and physical parameters of the borehole water, it is recommended that: 1) arsenic, mercury, and cadmium be added into the parameters tested for; and, 2) the data be analyzed across the years to identify if there are any trends indicating aquifer depletion or water quality degradation in the boreholes.

In the household surveys that calculate water availability it is recommended that, as discussed in Section 3.3, the surveyors ask how many jerry cans the family is able to fill every day, and not use how many jerry cans the family owns to calculate the volume as currently being done.

It all this monitoring, it is recommended that the data be evaluated immediately to adjust for problems or adjust chlorine dosage, and that the data be analyzed over the long term for trends.

3.10 Hazard 10: Lack of technical capacity and coordination on the ground

In the UNHCR report, it was recommended that the "knowledge and expertise of sizeable technical staff available on the ground among partners should be capitalized to resolve range of deficiencies observed in engineering, public health and environmental sectors through convening regular inter-action programmes on important and urgent technical issues faced by the Operation. In view of the scope and size of WatSan activities, under-performance by IPs and observed short comings of having experts deployed under standby arrangements, its is essential to have a WatSan expert exclusively available for long-term based at SOD to ensure effective and optimal delivery of related technical activities in this Operation". The WatSan Assessment team agrees with this recommendation, and hopes that by summarizing the existing data in this Water Safety Plan that we have assisted in the process of summarizing technical knowledge to address deficiencies. Another point noted in the UNHCR that was validated by the WatSan Assessment team was the lack of involvement an ownership of the system by the refugee population, and UNHCR recommended thinking of ways to transfer ownership of the system (over the long-term) to the population instead of the national and ex-pat staff.

3.11 Development of risk ratios from hazard assessment

Based on the currently available information discussed in the above section, and the literature review in the previous section, the WatSan team has developed a risk ratio scale (presented in Table 8) that represents our best estimates of the likelihood (measured as 1 least likely to 5 most likely) and severity (measured as 1 least severe and 5 most severe) of each of the hazards. A risk ratio for each hazard has been calculated by multiplying the likelihood by the severity. The WatSan Assessment team looks forward to the partners on the ground revising and refining these risk ratios in a collaborative process to develop strategies to move forward with risk-based planning for water supply provision in Dadaab Refugee Camps. Our recommended actions to reduce these risks are presented in the next section.

Table 8: Hazards to water supply and risk ratio development

Hazards	Likelihood (1-5 scale)	Severity (1-5 scale)	Risk Ratio	Effect
Population growth	5	5	25	Increase demand on system, increase crowding and risk of disease transmission, decrease hygiene.
Diarrheal disease outbreak	4	4	16	Lack of ability to identify and respond to outbreaks in a timely manner.
Low per capita water supply	5	5	25	Inability of families to access enough water for basic purposes and violence over water.
Aging infrastructure	5	4	20	Inability to efficiently abstract and deliver water.
Aquifer depletion/mineralization	1	5	5	Loss of single water source.
Inconsistent chlorine residual	5	4	20	Inadequately treated water.
Unsafe storage of water in home	2	4	8	Loss of chlorine residual in house.
Inequitable water distribution	5	4	20	Inability of certain families to access water and subsequent violence/cost.
Low-quality monitoring	5	3	15	Lack of ability to identify and respond to problems.
Lack of technical capacity and coordination	5	2	10	Inability to coordinate efforts on the ground and make informed technical decisions.

4 Determine control measures, prioritize risks

Now that the hazards and risks have been identified and discussed, the WatSan Assessment Team has developed preliminary recommendations for prioritizing these risks and developing control measures to ameliorate these risks. The WatSan Assessment Team looks forward to the water and sanitation partners in Dadaab refining these recommendations.

4.1 Ideal situation

While the WatSan Assessment Team understands that the 'ideal situation' is not attainable immediately, or perhaps ever, we believe that defining the ideal situation is useful to understand goals. Based on the information presented and discussed above, we believe an ideal situation for the water and sanitation situation in the Dadaab Refugee Camps would be to have:

- Camps of a population of less than 50,000 persons each to have enough room for each person to have adequate space for hygiene
- A household water supply of 20 L/cap/day
  - And enough water for institutional, economic, and animal uses of water, which would be an aggregate camp level water supply of 40 L/cap/day
- Water quality monitoring that is both used for immediate response (such as noting low chlorine levels and adjusting the dozer) and analyzed over time to detect trends (such as depletion of the aquifer), including:
  - Free chlorine residual monitoring daily
  - Weekly aquifer monitoring
  - Yearly water quality testing
- Maintenance of a free chlorine residual of 0.5 mg/L at all tapstands, which will allow for maintenance of 0.2-0.5 mg/L at the household level, because people would not have to store their water for long
- Provision of a household latrine slab for each family who can provide superstructure and dig a pit
  - Provision of latrines with superstructure for those in need (new arrivals, etc)
- Hygiene education, particularly among at-risk minority groups

4.2 Reality

Unfortunately, the ideal situation will not be obtained for the refugee population in the near term. Thus, the question before us now is: What actionable, doable items can we do now to improve the situation in Dadaab Refugee Camps and reduce the potential risk from waterborne disease? Recommended doable actions are presented in Table 9 using the risk ratios developed in the previous section.

Table 9: Working document recommendations for actions to address hazards

Hazards	Risk Ratio	Doable Actions
Population growth	25	Support the development and exploration of new camps Support additional drilling of wells in existing camps
Diarrheal disease outbreak	16	Improve surveillance systems Complete hygiene education among minority groups
Low per capita water supply	25	Calculate institutional and economic uses of water (flow meters) Analyze CARE raw data set from KAP survey Complete water use household questionnaire Understand limitations of Sphere Standards Replace current L/cap/day calculations Understand there currently is not enough water for hygiene purposes, and prioritize water supply interventions at this time
Aging infrastructure	20	Have consultant complete systems analysis Conduct repair and maintenance
Aquifer depletion/mineralization	5	Continue to monitor aquifer levels
Inconsistent chlorine residual	20	Stabilize FRC at 1.0 mg/L across all tapstands Chlorinate the community wells
Unsafe storage of water in home	8	Understand that rolling probably is not a large issue Users have safe storage, although FRC needs to be 1.0 mg/L at tap
Inequitable water distribution	20	Map out water access and use water supply calculations to determine how to provide additional tapstands to underserved populations
Low-quality monitoring	15	Include human health contaminants in yearly chemical sampling Improve FRC testing with improved test kits and training Improve aquifer monitoring (purchase dippers for each camp) Complete immediate responsive and time-series data analysis
Lack of technical capacity and coordination	10	Have additional water systems and management expertise on site Work to develop strategies to need less repairs/maintenance Maintain one NGO as coordinator for WatSan Have WSH sector meetings

In summary, the WatSan Assessment Team is pleased to present this document as a working Water Safety Plan and risk assessment for the agencies involved in water and sanitation provision in the Dadaab Refugee Camps. We hope that this document is useful, and look forward to receiving feedback, refining the analyses, and further the developing this risk-based analysis to improve the water and sanitation situation in Dadaab.

If you have any questions on this documents, please feel free to contact the WatSan investigation team for ongoing consultation at dlantagne@cdc.gov, kpezzi@cdc.gov, and amahamud@yahoo.com.

5 Sanitation and hygiene

Although Water Safety Plans do not generally include assessments of sanitation and hygiene risks, the WatSan team was asked in the Terms of Reference to include information on distribution and coverage of latrines in the three camps. In this section we summarize the Sphere Standards for sanitation, describe the existing situation in the camps, present the data from the water and sanitation assessment, describe future plans for latrine construction in the camp, and summarize recommendations.

5.1 Sphere Standards for Sanitation

The Sphere Standards for sanitation include the following indicators:

- a maximum of 20 people use each toilet;
- use of toilets is arranged by household(s) and/or segregated by sex;
- separate toilets for women and men are available in public places (markets, distribution centres, health centres, etc.);
- shared or public toilets are cleaned and maintained in such a way that they are used by all intended users
- toilets are no more than 50 metres from dwellings;
- toilets are used in the most hygienic way and children's faeces are disposed of immediately and hygienically.

5.2 Existing situation

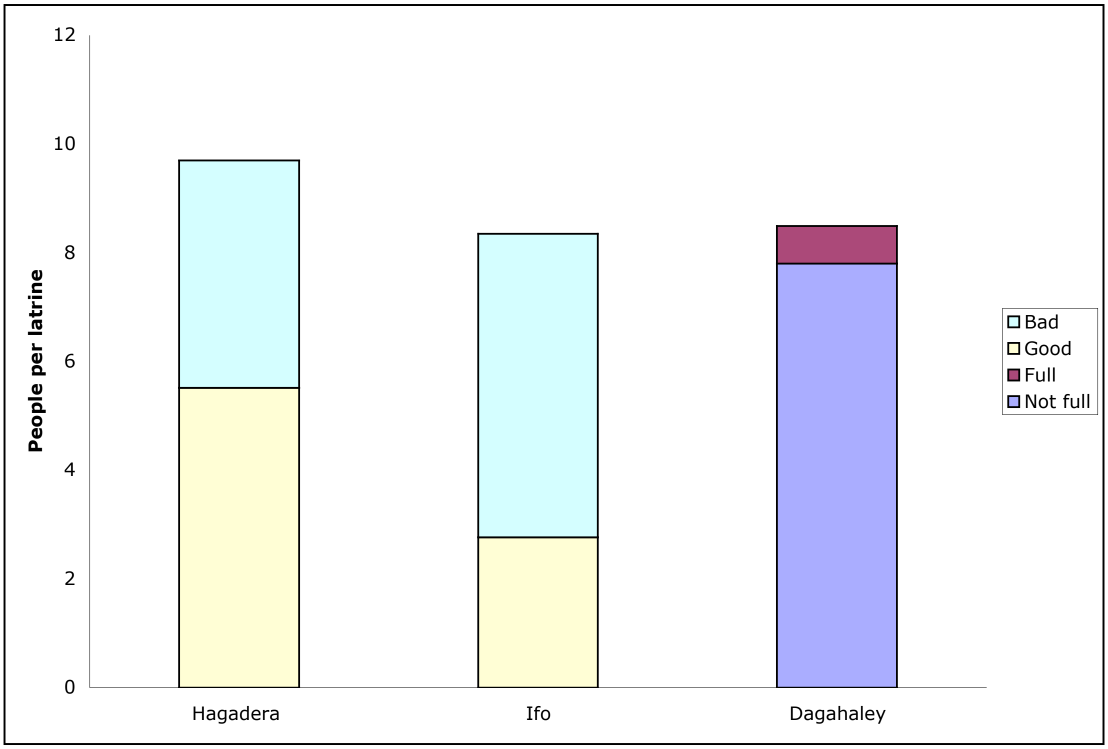
The Norwegian Refugee Council (NRC) recently conducted a latrine survey to provide baseline indicators for their new sanitation program (January-March 2009). This data was shared with CDC, and used by CDC to calculate latrine coverage statistics, which are presented herein. Please note that between 2008 and 2009 the data reporting on latrines changed due to the transition in latrine management from CARE to NRC, so latrine coverage statistics calculated by CDC will not be comparable with those previously calculated by CARE.

5.2.1 Overall situation

The data for Hagadera and Ifo camps included whether the latrines were in 'good' or 'bad' condition, and also whether they were household or community latrines. Note that a 'bad' condition latrine does not indicate that the latrine is unusable, only that the superstructure might not be in perfect condition, or that the latrine might not be clean. The data for Dagahaley included whether the latrines were full or not full. Full latrines are not usable.

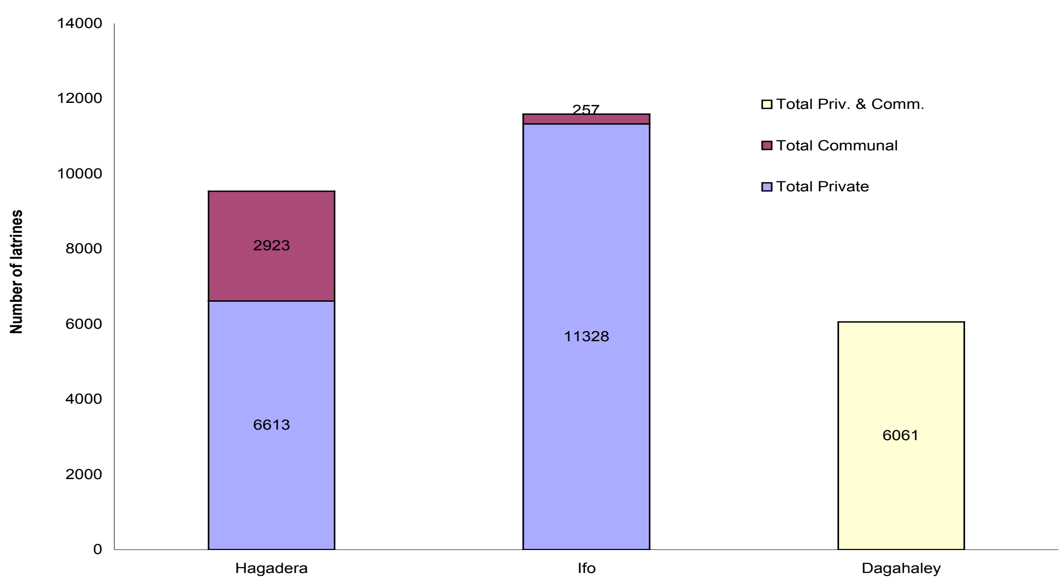
- Of the latrines in Hagadera, 5,419 (56.8%, n=9,536) are in use and in good condition. The remaining latrines are in need of maintenance but are mostly still usable. Including both latrines in good and bad condition, Hagadera has a camp-wide average of 9.7 people per latrine.
- The NRC listed 3,827 latrines in Ifo as being in good condition (33.0%, n=11,585). The rest of the latrines are in need of maintenance, although they are not necessarily unusable. Ifo has an camp-wide rate of 8.4 people per latrine.
- Dagahaley contains a total of 6,061 latrines; there was no data available on the numbers of household and communal latrines. Of those 6,061 latrines, 494 (8.2%) are full and unusable, leaving 5,562 usable. The camp-wide number of people per usable latrines in Dagahaley is 9.2 (this number only includes the usable, non-full latrines). The camp-wide number of people per all latrines is 8.5.

Figure 16: People per latrine in all three camps



In both Hagadera and Ifo the number of household latrines is far greater than the number of communal latrines. Similar data on Dagahaley's latrines was not available at the time of this report. As of January 2009, Ifo contained 11,585 latrines, 11,328 of which were household (97.8%). Hagadera contained 9,484 latrines, 6,795 of which were household (71.6%).

Figure 17: Number of latrines per camp



5.2.2 Data by Section

When the data was separated by Section within each camp, it is clear that there are inequities in latrine distribution, with some sections having more latrines per person than others in all three camps (Figure 18, Figure 19, Figure 20)

Figure 18: People per latrine, by section in Ifo

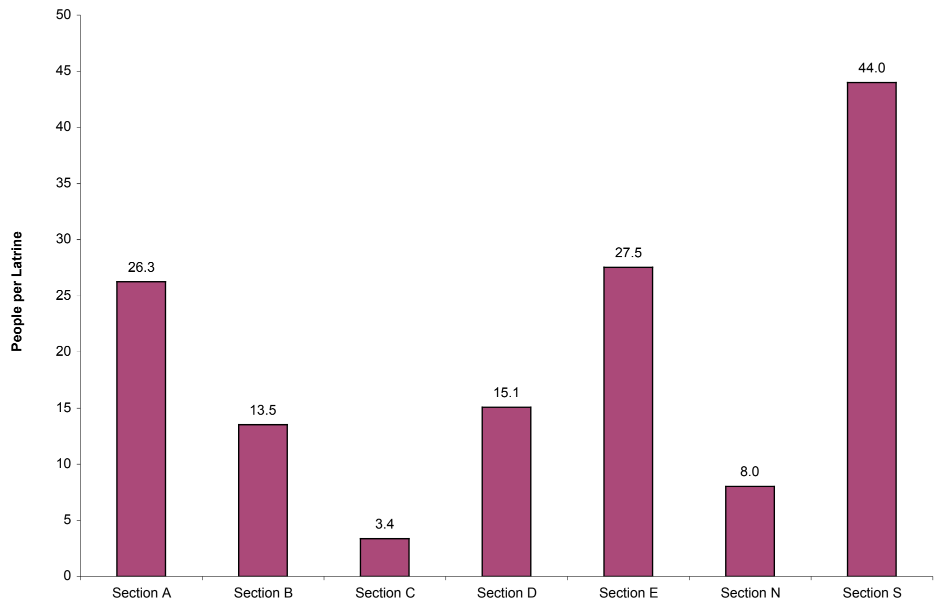


Figure 19: People per latrine, by section in Dagahaley

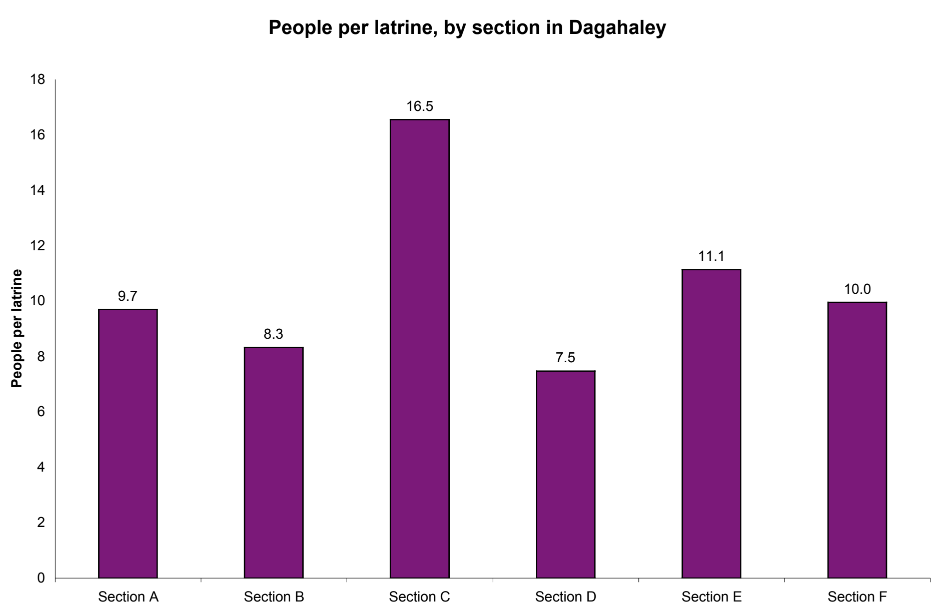
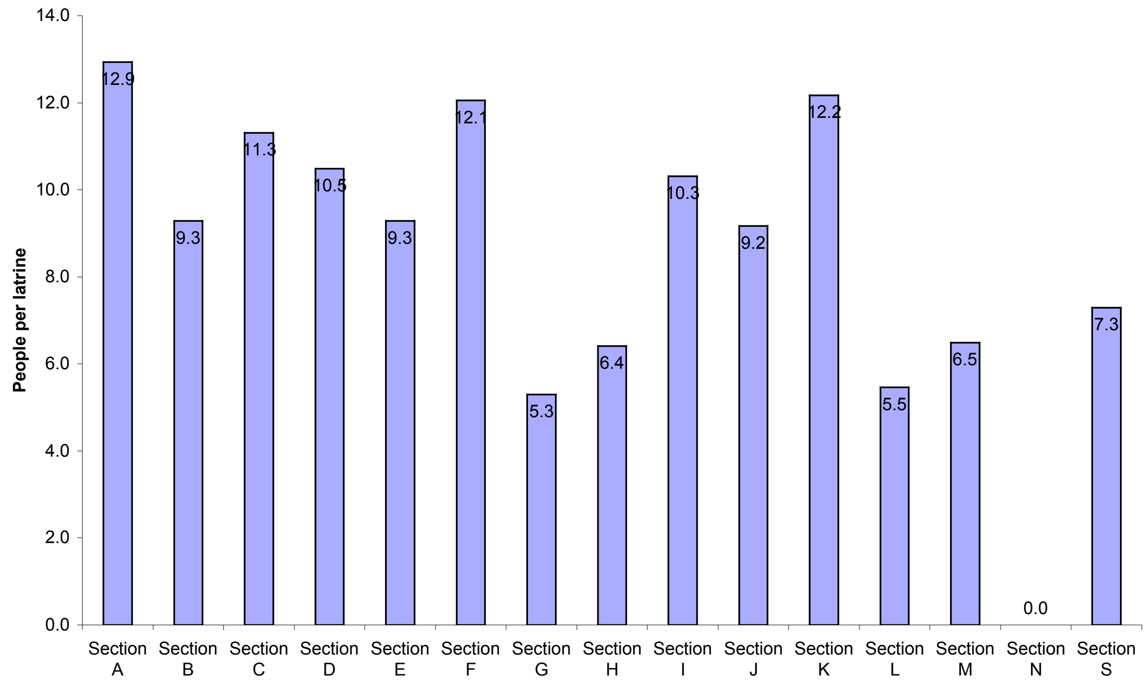


Figure 20: People per latrine, by section in Hagadera



5.2.3 Limitations of data

While the data from NRC is quite high quality, there were some limitation seen in the data, including:

- In some sections, which may be some of the worst latrine coverage sections because they are new arrivals, latrines were not counted by NRC
- Population data was obtained from UNHCR to match the latrine statistics and may not be exact populations at the time of counting the latrines.

However, what is important to remember is that, despite these data limitations, latrine coverage across the camps generally meets the Sphere Standards, and the challenge now with latrine provision is to address inequities, and reach those currently not reached.

5.3 Results from CDC cholera investigation survey

During the cholera case control study conducted in Hagadera and Dagahaley in early March, survey respondents were asked questions to determine condition of their latrines. These latrines were also observed and evaluated by the surveillance teams.

The majority of individuals surveyed had latrines available for use (73, 89.0%, n=82), although nine people (11.0%) reported that they did not have access to a latrine. Of the respondents that had access to latrines, 43 (58.9%, n=73) had a household latrine and 33 (45.2%) had access to a communal latrine. Six individuals surveyed (8.2%) had access to a latrine at school. Some of the individuals surveyed had access to more than one type of latrine so the total exceeds 100%.

Of the 43 household latrines identified in the survey, 36 (83.7%, n=42) were considered clean by the respondents using them, 24 (55.8%, n=41) were covered, 22 (59.5%, n=37) latrines had superstructures in good condition, and 36 (92.3%, n=39) household latrines were reported to be usable. Respondents reported that 18 (45%, n=40) household latrines were full.

Of the 33 communal latrines, 26 (78.8%, n=33) were considered clean by respondents using them, 18 (54.5%) were covered, 16 (48.5%) were reported as being full, 31 (93.9%, n=32) were considered usable, and 20 (62.5%, n=32) had superstructures in good condition.

Wastewater from a communal latrine

Of the 6 respondents who reported using a school or work latrine, only four completely answered questions regarding latrine condition. All four respondents (100%) reported that his or her school/work latrine had a superstructure in good condition. Three of the individuals (75%) reported that the school/work latrines they used were clean; one person (25%) said that the school/work latrine they used was not clean. Only one of the school/work latrines was covered (25%) and 2 of the latrines were reported as full (66.7% - one respondent didn't answer this question). Also, only three people (100%) responded that their school/work latrines were usable – the fourth person did not answer this question.

The majority of all respondents (47, 58.0%, n=81) surveyed reported that they always used the latrine every time they needed to go to the toilet, day or night. For the cases/controls interviewed who were under the age of five, only 15 (34.9%, n=) were trained to use the latrine at the time of the interview. If a child did not use the latrine, they used the following alternatives (n=31): open ground outside (18, 58.1%), a baby potty (11, 35.5%), a jerry can (1, 3.2%) or the ground inside a structure (1, 3.2%). Almost all of the adults (78, 92.9%, n=82) reported that they used the latrine every time they needed to go to the toilet, day or night. Of the four adults that did not always use the latrine, three (75%) used bushes and one (25%) used an open jerry can when they needed a toilet.

Of the 78 households surveyed who had children <u>other</u> than the child interviewed as a case or control, only 38 (48.7%, n=78) of the households reported that all the children over the age of two used the latrine every time they needed to use the toilet. The remaining 40 children (51.3%) used the following alternatives: 18 children (47.4%) went outside, 19 children (50.0%) used a baby potty, one child (2.6%) used a jerry can and two respondents (5.0%) did not specify what alternatives they used.

5.3.1.1 Direct Observation

The latrines in the households chosen for the surveys were directly observed during the visit to the compound. At the time of the interview most compounds had a household latrine (63, 76.8%, n=82). For the compounds that used a communal latrine the average walking time to the latrine was 1.1 minute (min=0, max=2. stdev=0.51, n=30).

Of the latrines observed, only 18 were full (25.0%, n=72) and 58 latrines were deep (79.5%, n=73). Less than half of the latrines were judged to be clean by the observers (46, 56.8%, n=81). Only 33 latrines were covered (41.2%, n=80) and 70 latrines were considered usable (87.5%, n=80). Most latrines had superstructures in good condition (58, 71.6%, n=81). Water for handwashing was observed in only 8 of the latrines visited (10.0%, n=80) and soap was observed in 22 latrines (27.5%, n=80). Feces was observed on the ground in 19 compounds (24.4%, n=78).

5.3.1.2 Hygiene

Individuals surveyed during the case control survey conducted by CDC in March 2009 were asked questions about the availability and use of the soap and water for hand hygiene.

Most individuals surveyed (55, 68.8%, n=80) did report having always having soap in the home. Of the remaining respondents, 25 (31.3%, n=51) said they didn't always have soap in the home. For those who did have soap available at home, 47 individuals had obtained the soap through camp distribution (92.2%, n=51) and 45 respondents had purchased the soap themselves (71.4%, n=45). Respondents were also questioned about their hand-washing practices; 69 individuals (90.9%, n=76) reported always washing their hands before eating, 73 (96.1%, n=76) always washed hands after eating, and 62 (81.6%, n=76) always washed their hands after visiting the toilet. Respondents were also asked if they always washed their hands after cleaning the baby's bottom. This question was only answered by/applicable to 38 individuals; of those, 36 (94.7%, n=38) always washed hands after cleaning the baby's bottom. Individuals were also asked if they felt like they always had enough water to wash their hands as often as they would like; 34 people (43.0%, n=79) said they did have enough water, the other 45 (57.0%) said they did not have enough water to wash hands as often as they wanted. Soap was directly observed in 49 homes administered the survey (62.0%, n=79).

When questioned about the method of washing hands, all 80 people who responded to the question washed their hands with water poured from a jerry can or jug (100%). People reported using more than one method to wash hands; two individuals (2.5%) also reported they washed hands under running water and four people (5%) washed hands from water sitting in a basin.

Individuals were also asked if they always used soap when they washed their hands; 48 (63.2%, n=76) people reported always using soap. Those who didn't always use soap were asked what alternatives they used to soap; 15 people provided responses. Of the 15 respondents, 7 (46.7%, n=15) used ash, 5 (33.3%) used sand, and 3 (20%) used plain water.

5.4 2009 Plans

The CDC WatSan assessment team was able to meet with the Norwegian Refugee Council (NRC) to review the latrine status in the camps and were also able to observe a slab production facility in Ifo camp. The NRC took over latrine management in the camps from CARE in 2009. Upon assuming management of latrines, NRC conducted a survey of the latrines conditions in all three camps to develop accurate baseline data. They update the survey on a monthly basis. Although latrine management was not fully turned over to NRC until 2009, NRC had been working with latrines in Ifo since May of 2007, when they built 500 latrines in section N to assist with the relocation efforts for the refugees displaced during the spring 2007 flooding. In 2008, NRC constructed 2,700 new communal and household latrines in the camps, maintained 300 latrines, and backfilled 300 pits.

NRC slab production

NRC has three production facilities, one at each camp, which are producing slabs at a rate of 120 slabs/day. Current production levels by camp are: 20 slabs/day at Ifo, 30 slabs/day at Dagahaley, and 80 slabs/day at Hagadera. NRC has a goal of producing a total of 7,200 complete latrines and 7,700 slabs in 2009. These slabs will be distributed to the families who can dig their own pit and provide their own superstructure with the following breakdown (for the UNHCR funding) by camp: 900 slabs to Ifo; 3,600 slabs to Dagahaley; and, 3,200 slabs to Hagadera. In addition, NRC has a goal of constructing 1,500 new complete household latrines with superstructures in 2009 (150 in Ifo, 750 in Hagadaley, and 600 in Dagahaley). The slabs are checked for quality during the production process. Adding the latrines funded by other donors, the total number of latrines planned for 2009 include: 6300 household latrines (Ifo: 1,050, Dagahaley: 2,800, Hagadera: 2,450); and, 687 new communal latrines (Ifo: 7; Dagahaley: 230, Hagadera: 350 + 250 to be maintained).

During CDC's visit to the slab production facility team members were able to observe slabs in production as well as slabs curing before distribution. The operation appeared well organized and efficient. NRC stated that they are continuing to increase their slab-building capacity by hiring and training additional incentive workers, but their storage facilities are a limiting factor. Also, slab production requires not-salty water to mix the cement, so water supply is also an issue that limits production. The current pressure in the pipes and taps is not enough to support an increase in production, and NRC has built concrete tanks to hold water that fill in the evening. If NRC obtains more land for slab production and warehouse facilities the capacity could be doubled, since more workers are currently trained than can be utilized to produce slabs.

Based on the survey results and observations from early 2009, NRC set a goal to rehabilitate old latrines as well as to add new households latrines. Rehabilitating a latrine consists of digging a new pit and moving the slab and superstructure from the old pit to the new. Household latrines are preferred to communal latrines because they are: less expensive to dig than communal latrine; generally better maintained by the refugees; and, pits are dug by the household at no cost (as opposed to communal latrines where the pit is completed by NRC). A new slab is given to the households after the pit excavation has been completed.

NRC stated that ideally the ratio of good quality latrines in each of the camp should be one latrine for every 7-8 people, and there should be 28 communal latrines per block. However, to reach this goal, latrines in poor condition will need to be maintained and rehabilitated. A funding gap currently exists for rehabilitation of latrines, although maintaining an existing latrine is cheaper than building a new latrine. This means that the goal ratio of 1:7 latrines to people will probably not be met in 2009 and will require more funding. The current cost of making a 5 cm thick, 225 kg slab is 2,400 KSH (30 USD), while the cost of a building a new latrine with superstructure is 15,000 KSH (190 USD). The cost of moving an existing latrine is 5,000 KSH (62.5 USD)

Different donors have provided funding to NRC to produce slabs and latrines for 2009. The following table summarizes the partners and production goals for the allocated funds.

Table 10: Latrine production plans for 2009

Partner	Dagahaley	Hagadera	Ifo
UNHCR	600 complete household 3,600 slabs	750 complete household 3,200 slabs	150 complete household 900 slabs
ECHO	2,200 complete household 230 complete communal	1,700 complete household 100 complete communal	900 complete household 70 complete communal
BPRM		250 complete household 250 complete communal 250 maintenance	
NCCK	Constructing 2,000 latrines, but may expand to construct more depending on funding (funding from UNHCR)		

Institutional latrines are also present in the camps. In the three camps combined, there are: 1) 240 semi-permanent latrines, consisting of 30 blocks of 8 latrines with wash basins; and, 2) 248 latrines, consisting of 31 blocks of 8 at the schools; 48 double latrines, 10 showers, and 3 single latrines at hospitals and health posts.

There are currently 3,000 plastic slabs in use in the camps that were distributed in 2008. These slabs are not popular among the refugees because they grow soft in the heat and collect water. NRC plans to replace these plastic slabs with concrete slabs as the pits fill up. There is also a new design for fiberglass slabs being developed by UNHCR.

5.5 Recommendations

Based on the above data, the following recommendations are presented for improving the sanitation and hygiene conditions in the camps (Table 11). It is important to remember that, overall, the camp meets and exceeds Sphere Standards for latrine coverage, and that improving the latrine situation is now a matter of addressing inequities, targeting certain specific details, and continuing to ensure the latrine situation improves; rather than a system-wide problem, such as seen with the water supply issue.

5.5.1 Keep installing latrines with NRC/NCCK

Currently the coverage in the camps is good, and there are significant programs in the camp to increase coverage this year. Additional latrines should be targeted to areas with low latrine coverage. In addition, during the WatSan assessment teams time in the camp, we noted many pits that were dug by refugees, ready for slab installation, indicating a willingness to dig a pit and demand for the "dig a pit and build the superstructure and receive a slab program".

A refugee-dug pit ready for slab

5.5.2 Provide lids to all latrines without lids

Many of the latrines seen during the WatSan assessment, and 30.8% of latrines in the CARE KAP survey in Hagadera and 40% in Ifo did not have lids in use at the time of the survey. For hygiene purposes, and for prevention of water entering the latrine from rainfall or washing and filling the latrine prematurely, it is recommended that lids be provided to all latrines without lids.

A latrine without lid

5.5.3 Deemphasize the use of community latrines whenever possible, and set up a system for cleaning if they are necessary

Communal latrines on camp border for new arrivals

People in the camps prefer household latrines for privacy, gender, and hygiene issues; and, to the extent possible, it is recommended that household latrines be prioritized. Where communal latrines are necessary, such as in institutions or new refugee areas, it is recommended, as per the Sphere Standards, that a system for regular cleaning and maintenance of communal latrines be implemented. Currently, there is no formal system in place for cleaning and maintenance, and the lack a system means that communal latrines become dirty and unusable rapidly.

5.5.4 Provide gender-specific latrines at institutions

At this point in time, the majority of the communal latrines available in public places in the camps are not gender segregated. This is particularly an issue for cultural reasons, and the Sphere Standards recommend that there be gender-segregated latrines for men and women in public places are not met. The camps should be assessed to determine where gender-segregated latrines are needed, and then these should be built.

5.5.5 Consider alternate methods for waste disposal in locations that are difficult for latrines

There are two soil conditions in Hagadera that limit the effectiveness of latrines: 1) they can only be built to 3 meters deep because the bedrock is high, and thus they fill quickly; and, 2) the sand is not stable, and so the pits need be dug with a greater diameter and lined with sand bags for stabilization. Due to these difficulties, it might be worth considering some alternative water strategies in Hagadera, such as: 1) a night-soil collection system, such as in the city of Wajir, where staff collect solid waste daily from households, and dispose in a central location; 2) emptying the latrines with a "gulper" and disposing of the solid waste elsewhere; or, 3) building latrines up with a cement or brick structure to make the pit deeper by elevating the superstructures.

5.5.6 Educate on not letting water from bathing flow into latrine

Latrines in the camp are filling faster than necessary because people are using latrines as private spaces, and wash water is running into the latrine. This can be prevented if: 1) latrines have lids; and, 2) people are educated to let the washwater flow down the sloped slab outside of the latrine instead of into the pit.

5.5.7 Consider providing soap

In many refugee situations, soap for handwashing is distributed along with other NFIs in the distributions. In these camps, soap is only normally distributed during outbreak situations. As the practice of handwashing and ablution is well established in this population, it is recommended to consider regular soap distribution.

Table 11: Recommendations for sanitation/hygiene provision in the camp

Sanitation	Keep moving on installing household latrines with NRC/NCCK, particularly in underserved areas Educate on not letting water from bathing flow into latrine Provide lids to all latrines without lids Deemphasize the use of community latrines whenever possible, and set up a system for cleaning if they are necessary Provide gender-specific latrines at institutions Consider alternate methods for waste disposal in locations that are difficult for latrines Consider providing soap

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