HOUSEHOLD WATER USE AND HEALTH ASSESSMENT
SPANISH TOWN, JAMAICA WATER SAFETY PLAN

Background

In 2006-2007, through a collaborative effort between the Government of Jamaica, the Centers for Disease Control and Prevention (CDC), the U.S. Environmental Protection Agency (EPA), and the Pan American Health Organization (PAHO), a Water Safety Plan (WSP) was implemented in Spanish Town, Jamaica. A Water Safety Plan is a methodology developed by the World Health Organization (WHO) to assess critical control points for water quality in the watershed, the water treatment plant and the distribution system. It provides recommendations for system and operational improvements with the goal of improving drinking water quality and service.

The Water Safety Plan (WSP) methodology aims to identify hazards to drinking water quality that can be introduced at multiple points from "catchment to consumer." However, it does not traditionally provide for identifying hazards that could compromise drinking water quality after it reaches the household, such as contamination associated with water acquisition, storage and treatment practices within the home. This household water use and health assessment was therefore conducted as part of the Water Safety Plan undertaken for Spanish Town, Jamaica in order to understand water use and storage practices within households, identify potential health hazards that can occur from the tap to the point of consumption and to understand issues in water provision from the perspective of the consumer.

This assessment consisted of a randomized household survey and the collection and testing of drinking water samples from sources (household tap, public standpipe, rainwater, etc.) and household storage containers. The assessment also looked at consistency of water provision as well as consumer perceptions and practices concerning water service and quality that could affect customer satisfaction and the safety of drinking water within the home. Results will provide information to the St. Catherine Parish Health Department and the National Water Commission of Jamaica (NWC) about potential problems with service delivery or the need for public awareness and education regarding the handling of water at the household level. CDC provided technical assistance to the St. Catherine Parish Health Department and the Jamaica Ministry of Health for the assessment, which was conducted from April 28th to May 5th, 2007.

Objectives

Specific aims of the assessment were the following:

1. to determine the quality of household water at the point of collection and at the point of consumption to determine if deterioration of water quality occurs due to storage and handling practices within the household
2. to describe water use practices at the household level, degree of user satisfaction with the water supply system, and perceptions of water quality by consumers

3. to estimate the prevalence of gastrointestinal illness in the population served by the water system, to describe health-seeking behaviors, and to estimate the sensitivity of the existing sentinel surveillance system for gastrointestinal illness
4. to identify subpopulations or specific areas of the city that experience daily or seasonal interruptions in service or pressure and may therefore require alternative or supplemental services

Methods

Prior to conducting the assessment, information was collected from the St. Jago Health Center and Spanish Town Hospital concerning principal health problems in the area, especially diarrheal disease, and the types of surveillance data collected in Spanish Town. Informal discussions were also held with community health workers regarding health issues in their particular communities. In addition discussions were held with the St. Catherine Health Department and the NWC in order to determine what communities in Spanish Town should be included in the assessment.

Sampling frame and sample selection

The assessment was conducted in communities principally served by the Spanish Town water treatment plant which draws from the Rio Cobre River (Figure 1). The water treatment plant uses conventional treatment methods including pre-chlorination, flocculation/sedimentation, rapid sand filtration and disinfection. The distribution system is also connected to a series of deep wells within St. Catherine Parish. Water from these wells is often mixed with water from the treatment plant, especially during periods of high turbidity in the Rio Cobre when the plant is forced to shut down. Some communities in Spanish town receive water only from the deep wells. These communities were not included in the sampling frame as they did not receive water from the water treatment plant. (See also Figure 5 in the document "Water Safety Plan, Spanish Town Water Supply, St. Catherine, Jamaica, October 2007" for water supply service areas.)

Population data for each community was provided by NWC and was cross-checked by the St. Catherine Health Department. A total of 20 communities were included in the assessment, including central Spanish Town and communities to the west and south (Figure 2).

The sample size was based on population data provided by the National Water Commission (NWC) and data from the national census covering the NWC service area. The outcome variables of interest included the percent of households with interruptions in service, percent living in informal settlements and the prevalence of diarrhea among consumers of the Spanish Town water supply. With an estimated diarrhea prevalence of 8%, an acceptable error of 3% and a confidence level of 95%, a sample size of 313 was calculated. The sample size was increased to 400 in order to account for potential missing households and refusals as well as permit additional analysis for risk factors for diarrheal illness.

The number of households visited in each of the 20 communities was proportional to the population size of that community such that each household in the sampling frame had an equal chance of selection. Selection of households within a community was based on systematic random sampling. The total number of households was divided by the sample size to produce a sampling interval. The assessment team randomly selected a number between 1 and the sampling interval to select the initial household and conduct the first interview. The team then systematically walked through the entire community selecting every n^{th} household for inclusion in the assessment. If no one was home at a selected household, the interviewer would leave a notice with the date and time of a planned revisit later that day or on a subsequent day, for up to three attempts. If no adult was home on the third visit, or if the home was abandoned or unoccupied, the next closest house was visited.

At each selected household, after verbal consent was obtained, a questionnaire was administered and water samples were collected and tested for free residual chlorine. In a subset of households with no or trace levels of residual chlorine, additional water samples were collected for microbiological testing.

Health data

To attempt to estimate the prevalence of diarrhea in Spanish Town, preliminary health data were gathered from the St. Catherine Parish Health Department. Data on diarrhea incidence were also obtained from two sentinel sites, the Spanish Town Hospital and St. Jago Hospital. Data from these sources is assumed to provide an underestimate of diarrhea prevalence as most mild illnesses would be treated at home. In addition, patients who were seen at private medical offices or public clinics would not be included as diarrhea incidence is not routinely recorded at those facilities. Also, patients who were seen at hospitals outside of the Spanish Town area, such as the Kingston Pediatric Hospital would not be identified in the surveillance system as being from Spanish Town. Formal discussions were also held with community health aides to understand their perceptions of diarrhea prevalence in the community. Community health aides were also asked to report anecdotally on diarrhea incidence that they encountered in the community in the weeks prior to the assessment in an attempt to determine the amount of diarrhea in the community that goes unreported or does not present at a health care facility.

The assessment dates were selected so that they would not coincide with the frequent annual spike in rotavirus cases (usually between December and March). Rotavirus may be transmitted through multiple routes, so a large number of cases of diarrhea that may not be attributable to drinking water could complicate efforts to demonstrate a link between water quality and diarrhea.

Questionnaire

A household questionnaire was administered to collect information about household demographics, sources of water, access to water, frequency of water service interruptions, possession of a storage tank or water meter, handwashing practices, sanitation, water storage and treatment practices in the home, diarrhea incidence and health seeking

behaviors for diarrhea. Several questions were aimed toward understanding perceptions of community members concerning water quality, water safety and health concerns.

Diarrhea was defined as having three or more loose or watery stools in a 24-hour period. Two-week recall data were used to estimate diarrheal prevalence. In addition, because it was suspected from available information that diarrhea incidence might be low in this area, the questionnaire also asked about diarrhea incidence since the beginning of the year (approximately 4 month recall at the time of the assessment) in order to capture more information about health-seeking behaviors.

Questionnaires were reviewed and checked for clarity and cultural appropriateness through question-by-question review by interviewers before and after pilot testing. Completed questionnaires were reviewed for accuracy and completeness on a daily basis.

Water testing

In addition to the questionnaire, a small amount of water was collected directly from the household tap, yard tap or standpipe and tested for free residual chlorine. If household water storage tanks and household water storage vessels were in use, additional samples were also collected from them to determine if changes in water quality occurred as a result of storage.

Each sample was tested on site for free residual chlorine using the N,N – diethyl-P-phenylendiamine (DPD) method and portable colorimeters (Hach Co., Loveland, CO). A small number of tap and stored water samples from households with no or trace amounts of chlorine were collected for microbiological analysis. Samples were collected in sterile glass bottles containing sodium thiosulfate, and transported in coolers with ice to the Ministry of Health Laboratory in Kingston for processing within 12 hours of collection. Water samples were analyzed for total and fecal coliforms and E. *coli* using the multiple tube fermentation method.

Data analysis

All questionnaire and water sampling data were entered into an Epi Info™ database (Centers for Disease Control, version 3.3.2) and checked for data entry errors. Data were cleaned and analyzed using SAS (© 2002, SAS Institute, Cary NC, version 9.1).

Results

Demographics

A total of 376 households were included in the assessment which covered 20 communities in the Spanish Town area (24 houses from the original sample size of 400 were absent or missing). Twenty-two percent of the households were from central Spanish Town. Slightly over half of the homes were owned (53.9%), with 106 (28.3%) rented and 21 (5.6%) classified as rent-free (including homes occupied by family members or caretakers) (Table 1). There were 45 households (12%) classified as informal, or squatter, settlements. Seven of the 20 communities contained one or more informal settlements (Table 2).

Seventy-five percent of the respondents were women and 83% were over 30 years of age. Approximately 70% had completed secondary school, vocational school or university.

The average family size was 3.9 persons (range 1, 12). According to respondents there were a total of 173 children under five years of age or 11.9% of the total population.

Water sources and access

A total of 372 of 376 (98.9%) of households had access to the piped water supply. Of these, 78% had an in-house water tap with 19% having a tap in the yard. Only 2% collected water from a public standpipe. Those households collecting from public standpipes were located in Homestead, Duncan's Pen, Tawes Pen and one household in Central Spanish Town. Two respondents, both living in Homestead, said they received tankered water. Eleven percent said they used bottled water. Thirteen households (2.8%) said they also collected from surface or rainwater sources.

Low water pressure and disruptions in service were fairly common. Thirty-seven percent of households reported not having 24-hour-a-day water service. The median time for not having water was 6 hours per day according to the respondents. Over 90% of households said that they had low water pressure during most days. Approximately one quarter of all households said they experienced several days without water during the year. When asked what they do during these periods of water outages or shortages, 75% responded that they used stored water from drums, tanks or buckets, 8% purchased bottled water, and 22% said they simply waited for the water to return.

Approximately one quarter of all households (26.1%) routinely stored water in a tank. Most of these (73.5%) were elevated tanks and one half were reported to have been cleaned within the last year. Approximately 13% of tank owners said they added chlorine to the tank, although in most cases (77%) this had been done more than one month earlier.

Storage of drinking water in the home was high in all communities: 94% of respondents said they stored their drinking water (as opposed to obtaining it straight from the tap), and nearly all of these (95%) stored the water in a closed, narrow-necked container.

Sixty-five percent of respondents said that they had a water meter and 23% of respondents did not pay for their water. The mean monthly payment for water was $30 US (median, $15 US) for those with a meter, and $12 US (median $0) for those without a water meter. Ninety-nine percent of those who did not pay did not have a water meter. These include people with unauthorized connections and those living in informal settlements.

Access to and problems associated with water and sanitation services varied by community and type of housing (Tables 2 and 3). Informal settlements tended to experience greater problems with interruptions in water supply, had a slightly lower mean residual chlorine concentration at the tap and had lower levels of sanitation.

Levels of chlorine residual in tap and stored water

Chlorine residual in tap water was tested from 297 (79.0%) of all study households. Overall, 94% of the samples were positive for free chlorine residual. Among samples taken directly from the tap, 80.1% had a free residual concentration of ≥0.5 mg/L (WHO minimum target standard), and 92.6% had a free residual concentration of ≥0.2 mg/L (detection level used for Jamaica early warning system for emergency monitoring). (Note that Interim Jamaica Standard [IJAM] is a qualitative standard and indicates only "presence".) Forty-five percent of the samples had a free residual concentration between 0.5 mg/L and 1.0 mg/L, and 35% had a free residual concentration of greater than 1.0 mg/L. The maximum concentration measured was 2.5 mg/L. Nineteen of 297 tap samples (6.4%) were negative for chlorine.

The overall mean residual concentration for tap water samples was 0.86 mg/L and the median was 0.8 mg/L (Table 4). Samples that were negative for chlorine residual were collected from Hampton Green, Highfield, Homestead, Irish Pen, Central Spanish Town, Sunnyside, Tawes Pen and Willowdene. Chlorine residual levels varied little by the type of settlement. Among informal settlements the mean concentration was 0.71 mg/L while among those who owned or rented their house the residual levels were 0.88 and 0.89 respectively.

Water stored in tanks tended to have slightly lower concentrations of residual chlorine. Water that passed through an elevated household tank connected to the tap was tested from 23 households. Eighty seven percent of these samples were positive for chlorine residual (≥0.2 mg/L) with mean and median concentrations of 0.6 mg/L and 0.5 mg/L respectively. The proportion of samples with a residual concentration at or above 0.2 mg/l declined from 93% of tap samples to 62% of tank samples.

Water taken from freestanding tanks, where tanks were not connected to the municipal water system or a tap, (generally reserved for use when there was no tap water or when pressure was low) had lower levels of free chlorine. Eleven of 28 samples (39.3%) were negative for chlorine residual, with a mean and median of 0.5 and 0.4 mg/L respectively.

Finally, water from the drinking water container in the home was tested in 321 households. Twenty-four percent of stored water samples tested did not contain any chlorine residual with an overall mean concentration of 0.5 mg/L. The negative chlorine residual results for stored water are partly explained by boiling practices. Ten percent of the stored water samples had been previously boiled. Of these, 69% did not contain detectable levels of residual chlorine.

Microbiological testing of tap and stored water

Testing for total and fecal coliforms was done on a sub-sample of 31 water samples that had no or minimal levels of chlorine residual (< 0.2 mg/L). This included seven samples taken directly from the tap, three directly from a storage tank (two were from tanks filled with tap water and one with trucked water), and 21 from a household drinking water vessel (20 were filled with tap water and one with rain water) (Table 5).

Two of the seven chlorine-negative tap samples (28.6%) tested positive for both total and fecal coliforms. The remaining five samples were negative for both.

Of the tank samples of tap water, one was positive for both total and fecal coliforms and the other was negative for both. *E. coli* was also cultured from the fecal coliform-positive sample. The tank sample of trucked water was positive for both total and fecal coliforms.

Stored drinking water samples that that had low or no chlorine residual were more likely to be positive for coliforms. Fourteen of 20 (70%) stored water samples were positive for total coliforms and 10 (50%) were positive for fecal coliforms. One of the samples (5%) was also confirmed as *E. coli*.

Public perceptions

When asked about the biggest problems in their community, the main concerns identified were unemployment (20%), roads/infrastructure (18%), water quantity/quality (16%), and violence/crime (14%). When asked specifically about health, over three quarters of respondents said there were no major health concerns in their community. Malaria and mosquito-related diseases were mentioned by 11% of respondents, followed by chronic diseases including hypertension and AIDS (5%), and respiratory disease (3.5%). Only two respondents (0.5%) mentioned diarrhea as an important health concern.

More than half of respondents (53%) stated that the water shortages posed no problem, while 26% perceived them to be a significant problem, and the rest (20%) perceived them to be somewhat problematic. Two thirds of respondents (68.1%) said they were satisfied with the quality of their tap water. Among those who were not satisfied, 65% said it was due to the cloudiness or 'dirtiness' of the water, and 41% said the water had a bad taste, including too much chlorine. Fewer than 2% said it was due to health reasons. Sixty-nine percent believed their water was safe to drink. Of those who believed it was unsafe, 59% cited the dirty or cloudy appearance of the water, and 19.8% said the chlorine concentration was too high. Nearly 10% said it made them feel ill.

Eighty-one percent said they drank their tap water untreated. Among those who did treat their tap water, most boiled (78%), filtered (21%) or added chlorine to their water (11%).

Diarrheal illness

A total of 12 diarrhea cases were reported for the two weeks prior to the assessment (Table 6). This corresponds to a two-week prevalence of 1.7% for children under five years of age and 0.7% for older children and adults.

Since January 1st, a total of 50 cases of diarrheal illness were reported, 11 (22%) among children under five years of age. For those individuals who reported having an incident of diarrhea since January 1st, 25 (50%) went to a health facility (15 to public and 10 to private facilities). Eighteen (36%) used home remedies or purchased medicines at a local pharmacy. Seven (14%) took no action in response to their illness. Thus, of the 50 cases of diarrhea reported here, 15, or 30%, went to a public health facility and would have been included in the monthly surveillance reports. The remaining cases would have not

been captured in surveillance reports suggesting that the true incidence of diarrhea in the community may be significantly underestimated in monthly surveillance reporting.

Sanitation

Over 90% of households used a flush toilet. Most of these used septic tanks with a smaller number (16.8%) connected to a sewer. Thirty-five respondents (9.3%) said they used a pit latrine. Pit latrines were more concentrated in the informal settlements (37.8% of households in the informal settlements reported using pit latrines) and rent-free housing (19.1%) as opposed to those owning their home (3.1% used a pit latrine). Most of the households with pit latrines were in Central Spanish Town, Homestead and Irish Pen.

Discussion

In completing this assessment, nearly 400 households were visited, covering 20 communities in the Spanish Town area. In addition, nearly 300 tap water samples were collected and tested for residual chlorine. The results of this assessment provide a snapshot of water use practices and user perceptions and serve as a complement to the water safety plan conducted in the same area.

Water quality of tap water

Overall, the quality of tap water in terms of residual chlorine was relatively high during the period of this assessment with 93% of samples having a residual equal to or greater than 0.2 mg/l. However, two of seven piped water samples with no residual chlorine tested positive for fecal coliforms. This indicates that microbial contamination of the piped system occurs and highlights the importance of maintaining a constant and adequate concentration of chlorine throughout the distribution system.

Water quality and storage

This assessment also demonstrated that water quality in terms of chlorine residual deteriorated during storage and handling. This was true of water stored in large tanks during periods of water outages, as well as in household storage vessels. There was a trend for decreasing levels of chlorine residual with storage – from tap samples (93%) to tank samples (87%) to drinking water container samples (76%) and for a corresponding decrease in mean chlorine concentrations (Table 4). Storing water in a secondary vessel such as a tank, open drum or drinking water container leads to loss of chlorine residual over time and an increased opportunity for introduction of contaminants as compared to water taken directly from the tap

Nearly one quarter of stored household water samples had no or minimal levels of residual chlorine. One half of the stored water samples with minimal chlorine levels were positive for fecal coliforms indicating contamination of the stored water after collection.

Water is stored either in tanks or containers because of the interruptions in flow in many parts of Spanish Town. This in turn leads to loss of disinfectant and possible entry of pathogens into the stored water. This may become less of a problem once the

rehabilitation of the water treatment plant is completed. However, an education program aimed at cleaning and disinfecting tanks as well as the importance of safe water storage is an immediate step that can be taken to improve water quality in Spanish Town.

Water quality and housing type

Access to and quality of services varied according to type of housing. Informal settlements experienced the most inconsistent service, with the highest number of residents who received no water for several hours per day and for several days per year. Informal settlement also had the highest proportion of families using pit latrines as opposed to flush toilets.

The highest number of informal settlements was found in the communities of Irish Pen, Tawes Pen, Sunnyside, Homestead, and Central Spanish Town. These settlements are characterized by predominantly small, one-room houses make of wood, corrugated metal, and other semi-permanent materials or tenement buildings in poor condition. Residents of informal or "squatter" communities did not have water meters and water and electricity connections were mostly unauthorized.

These unauthorized connections may increase the opportunity for contaminants to enter the distribution system especially during interruptions in service when negative pressure in the system may occur. However, access to and control of water connections by NWC is challenging in these areas because of crime and gang activity. NWC officials had previously stated their inability to enter these areas or to mitigate losses from illegal connections due to physical risks to employees.

Public perceptions and customer satisfaction

Respondents in general did not perceive health problems to be a major concern in their communities, citing unemployment, poor infrastructure, and violence as major concerns, typical of a densely populated urban area. Water quality was mentioned among the top three community problems, but not among health concerns, suggesting that these perceptions may largely reflect dissatisfaction with taste, appearance, and availability factors, rather than health characteristics of the water.

Most respondents stated they were satisfied with the quality of the water they received and believed it was safe to drink from the tap. Most people reported drinking their tap water untreated. Those who were not satisfied most often cited a cloudy or dirty appearance or a bad taste, including too much chlorine.

The most important problem with respect to the water supply according to the respondents was the unreliability of the water supply and the frequent outages. One quarter of respondents said that they experience several days at a time without water at some points during the year. This could not be confirmed due to the short period in which the assessment was conducted. Furthermore more than one third said they had no water for several hours per day and nearly all complained of low water pressure.

When asked specifically about health concerns, diarrhea was only mentioned by two respondents, suggesting that diarrhea from water or other sources is not a major concern. The health concern most frequently mentioned was malaria, reflecting the recent publicity and door-to-door case-finding survey carried out by the Ministry of Health following a malaria outbreak in the western part of the island. Other top concerns were chronic diseases such as AIDS and hypertension, and respiratory disease. Since chlorine residual was present in most of the samples it is not surprising that acute water-related illness was not a concern in this community.

Health

The overall and under-five prevalence of diarrhea was low in Spanish Town. This is in agreement with information gained from discussions with community health workers and staff at the St. Catherine parish health department. The number of cases was not large enough to see if particular areas or groups, such as those living in informal settlements, had higher rates of illness. It is possible that the assessment was conducted during a period when there was little illness in the community. However, the high levels of chlorination and access to sanitation found in this urban environment likely contributed to low levels of gastrointestinal illness.

Limitations

This assessment faced several limitations. Many of the concerns expressed by respondents in this assessment were related to periods of water shortages which occur at unpredictable times during the year. Due to the short time period covered by this assessment it was difficult to capture these events. Water quality and availability during these events can only be reported as described by the respondents. It would be useful to monitor water quality during one of these periods of water shortage.

Due to logistical problems with the laboratory, far fewer water samples were analyzed for microbial indicators than originally planned. Describing the microbiological quality of the treated water at the tap and after a period of storage in the home was constrained by the limited number of samples analyzed.

This assessment did not include any laboratory analysis for pesticides or other chemicals that may be present in the water supply. The main focus was on the risk of microbial contamination as this assessment was conducted prior to completion of the Water Safety Plan. It may also be useful to test for particular contaminants related to concerns regarding chemical contaminants raised in the Water Safety Plan.

Conclusions

1. The results from this assessment indicate that while there is some room for improvement of water quality, issues such as reliability of service for improved convenience and quality of life are of greater importance to consumers. The main water-related concerns of consumers were lack of service and low pressure, not health.

2. Overall, the residual chlorine level of water delivered by the community water system in Spanish Town was good at the tap (with 93% having chlorine residual ≥0.2 mg/L), but water quality decreased with storage in both tanks and in household water storage vessels.

3. The prevalence of diarrhea among both children and adults was low among households included in this assessment. This supported information from informal interviews that diarrhea rates were generally low. Most diarrhea cases are probably not picked up by the surveillance system as they are often treated at home or the patient is taken to a private clinic.

4. Due to inconsistent service or low pressure, most households store water in tanks or secondary containers. The quality of the stored water showed some deterioration during storage.

5. Quality of services in the informal settlements was poorer than in other types of housing in Spanish Town. Residents in these areas suffered more frequent water outages and low water pressure. They were also less likely to have meters or to pay for water.

Recommendations

1. Storage of drinking water in household tanks and secondary containers leads to lower chlorine residual levels and increased handling of drinking water, creating opportunities for contamination. Providing consistent service of high quality water would therefore improve the quality of drinking water by eliminating the need for household storage that creates these additional risks. Health education about proper use and storage of water within the household could also help to reduce risks from these practices. This health education could also incorporate information about the benefits of water chlorination in order to help counter negative public perceptions related to chlorine affecting the taste of water.

2. Water quality monitoring should be done more frequently; and given the variation in chlorine levels observed by area, should be done in more locations along the distribution system.

3. Based on results of the Water Safety Plan it may be useful to test for other contaminants in the raw and treated water, including chemicals as well as other microbiological parameters such as *Giardia* and *Cryptosporidium*.

Figure 1: Spanish Town Drinking Water System

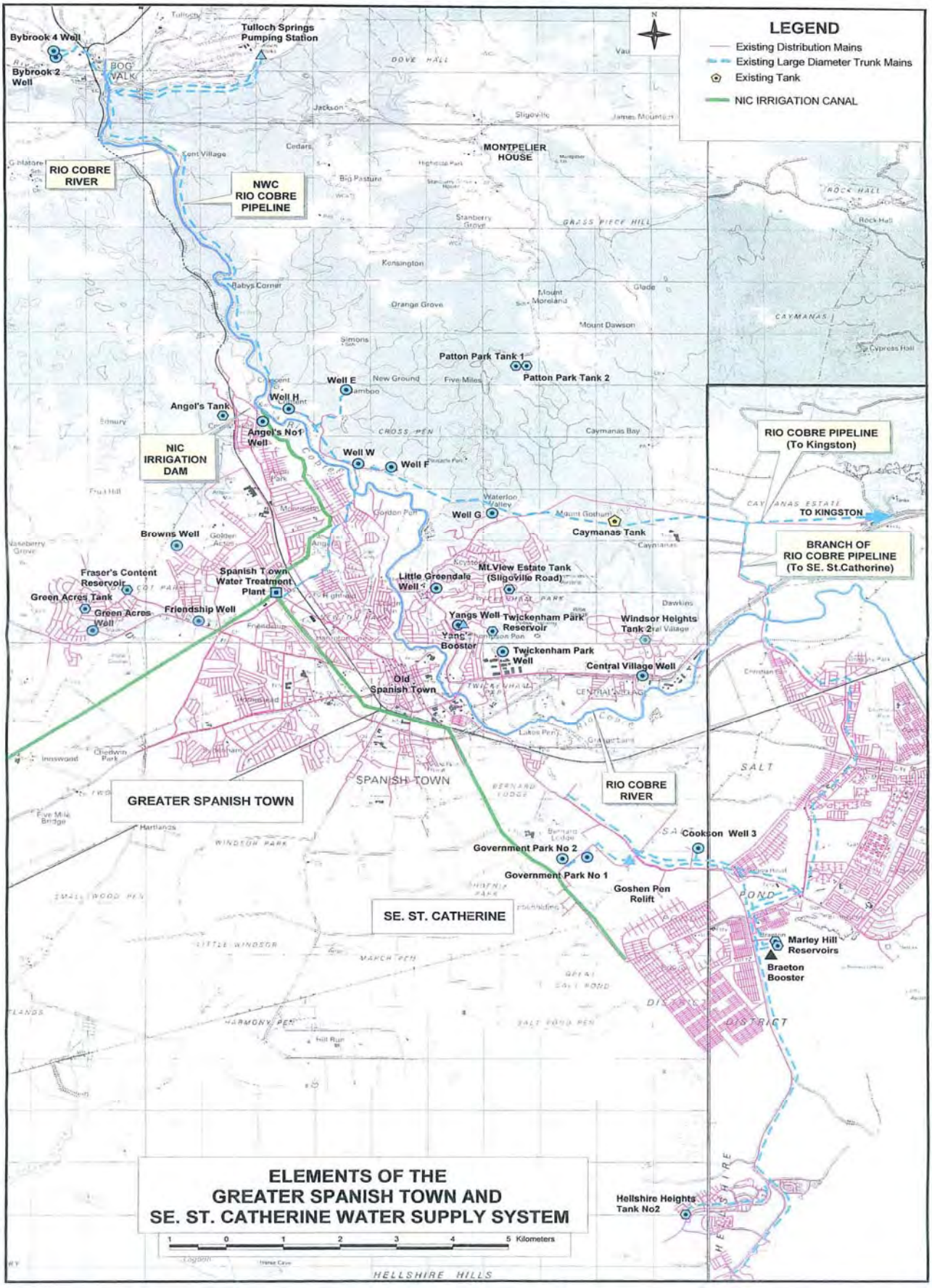
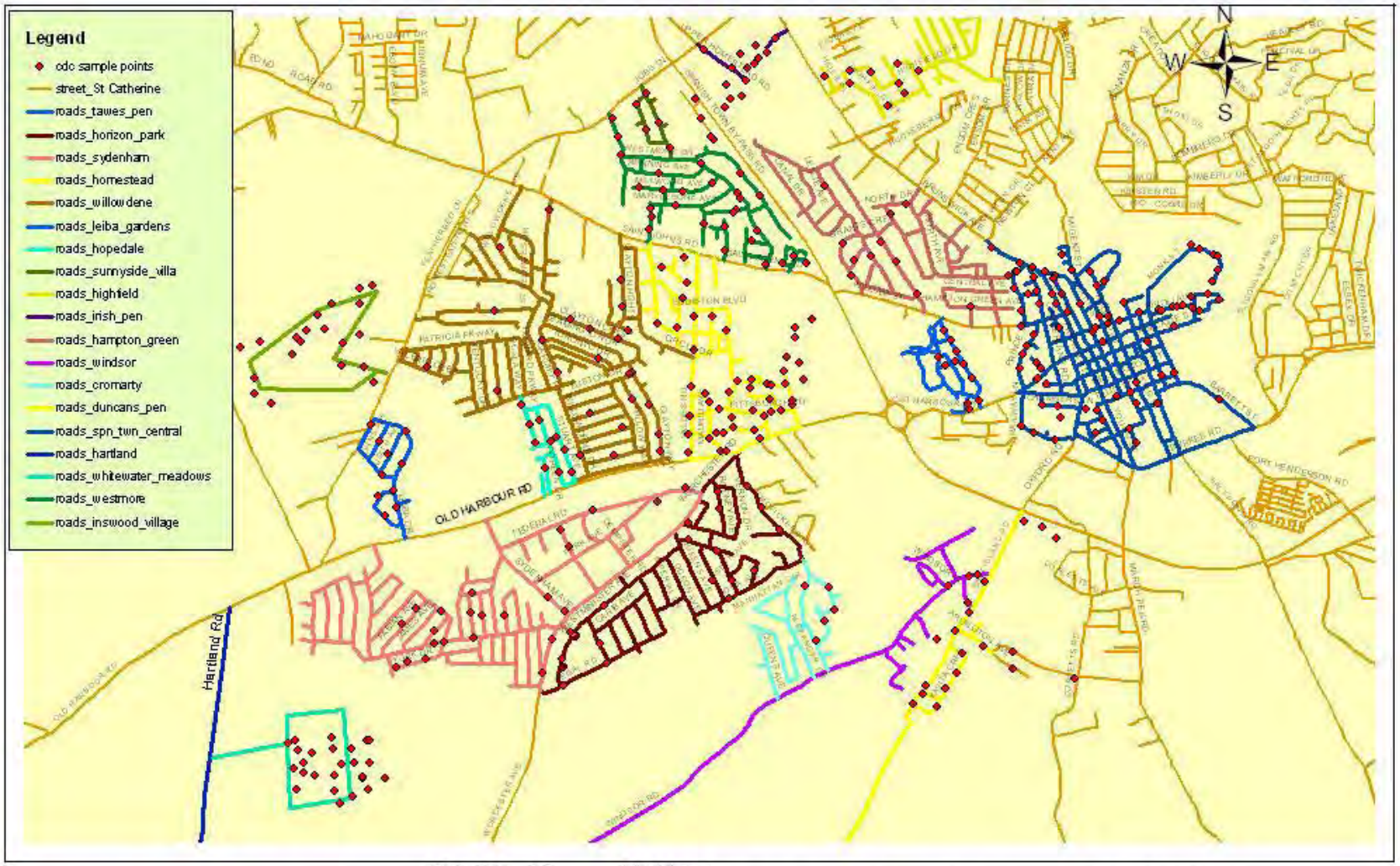


Figure 2: Households Sampled in Household Water Use and Health Assessment



Grid	Jamaica Metre Grid
Projection	Lambert Confromal Conic
	One Standard Parallel (18 degrees north)
Datum	WGS 84
Unit of Measure	Metre
Meridian of Origin	77 degrees west of Greenwich
Latitude of Origin	18 degrees north

Table 1: Descriptive data on demographics and water use practices in households in Spanish Town

Variable	No. (%)
Level of education of female head of household	
University	51 (13.6%)
Vocational	36 (9.6%)
Secondary/Technical	174 (46.3%)
All age	55 (14.6%)
Primary	47 (12.5%)
Basic	7 (1.9%)
Other or don't know	6 (1.6%)
Type of housing	
Owned	202 (53.9%)
Rent/lease	106 (28.3%)
Rent free	21 (5.6%)
Informal	45 (12.0%)
Other	1 (0.3%)
Source of household water (may use more than one source)	
Household tap	293 (77.9%)
Yard tap	71 (18.9%)
Standpipe	8 (2.1%)
Bottled water	52 (13.8%)
Tankered water	5 (1.3%)
Surface water	6 (1.6%)
Rainwater	7 (1.9%)
Other	14 (3.7%)
Do you believe your water safe to drink?	
Yes	260 (69.3%)
No	88 (23.5%)
Don't know	27 (7.2%)
What type of water do you use for drinking?	
Tap direct, no treatment	303 (80.0%)
Tap, treated	51 (13.6%)
Bottled water	19 (5.1%)
Other	2 (0.5%)
Type of household water storage vessel used	
Closed container	331 (95.4%)
Open container	9 (2.6%)
Other	7 (2.0%)
Where do you go if family member is ill with gastrointestinal illness?	
Go to hospital/health center/public clinic	146 (44.0%)
Go to private clinic	59 (17.8%)
Go to pharmacy	32 (9.6%)
Treat at home	87 (26.2%)
Other	8 (2.4%)

Table 2: List of communities in Spanish Town covered by assessment and indicators of access to water and sanitation services

No.	Community	Estimated Population	# Households	Informal settlement N (%)	Have water 24 hrs/day N (%)	Several days/year w/o water N (%)	Negative Cl_2 residual (n=297) N (%)	Use pit latrine N (%)
1	Cromarty	1718	5	0	3 (60.0)	0	0	0
2	Windsor		5	4 (80.0)	1 (20.0)	3 (60.0)	0	1
3	Duncan's Pen	2000	17	0	6 (37.5)	7 (43.8)	0	2 (12.5)
4	Hampton Green	1821	12	0	11 (91.7)	2 (16.7)	2 (20.0)	0
5	Heartland	300	4	2 (50.0)	2 (50.0)	4 (100)	0	2 (33.3)
6	Highfield	1566	10	0	8 (80.0)	2 (20)	2 (28.6)	0
7	Homestead	5756	47	8 (17.0)	21 (44.7)	19 (41.3)	6 (16.7)	9 (19.2)
8	Hopedale	2752	10	0	2 (20.0)	6 (60.0)	0	0
9	Leiba Gardens		10	0	8 (80)	5 (50.0)	0	0
10	Horizon Park	2341	18	0	14 (77.8)	0	0	0
11	Innswood Village	3250	20	0	17 (85.0)	1 (5.0)	0	0
12	Irish Pen	1954	14	12 (85.7)	7 (50)	6 (42.9)	3 (27.3)	5 (35.7)
13	Spanish Town Central	12,674	82	6 (7.3)	48 (59.6)	14 (17.3)	3 (6.1)	14 (17.1)
14	Sunny Side Villa/ Westmore	5237	37	6 (16.2)	30 (81.1)	3 (8.8)	1 (3.9)	2 (5.4)
15	Sydenham	3252	24	0	18 (75.0)	2 (8.3)	0	0
16	Tawes Pen	1815	11	7 (63.6)	3 (27.3)	6 (54.6)	1 (16.7)	0
17	Whitewater Meadow	3520	24	0	23 (95.8)	0	0	0
18	Willowdene	3258	24	0	15 (62.5)	9 (40.9)	1 (4.4)	0
	Summary	**53,214**	**376**	**45 (12.0)**	**237 (63.2)**	**89 (23.9)**	**19 (6.4)**	**35 (9.3)**

Table 3: Access to water and sanitation by type of housing

	Type of Housing				
Variable	**Own (N=202)**	**Rent/Lease (N=105)**	**Rent free (N=21)**	**Informal (N=45)**	**Total (N=374)**
Have water 24 hrs per day	141 (69.8%)	64 (61.0%)	14 (66.7%)	17 (37.8%)	236 (63.1%)
Have several days without water	42 (21.0%)	24 (22.9%)	5 (23.8%)	18 (40.9%)	89 (24.0%)
Water shortages are large problem	51 (25.4%)	20 (19.2%)	2 (9.5%)	25 (55.6%)	98 (26.3%)
Have a water meter	155 (77.5%)	72 (68.6%)	12 (60.0%)	0 (0%)	240 (64.9%)
Amount paid per month (mean)	J$ 1897 (USD 27)	J$ 1648 (USD 24)	J$ 1145 (USD 16)	J$ 491 (USD 7)	J$ 1612 (USD 23)
Mean free chlorine concentration at tap	0.88 mg/L	0.89 mg/L	0.76 mg/L	0.71 mg/L	0.86 mg/l
No chlorine residual at tap	12 (7.1%)	3 (3.7%)	1 (5.6%)	3 (10.3%)	19 (5.1%)
Type of Sanitation					
Sewer or septic system	196 (97.0%)	98 (92.5%)	17 (81.0%)	27 (60.0%)	339 (90.6%)
Pit latrine	6 (3.0%)	8 (7.6%)	4 (19.1%)	17 (37.8%)	35 (9.4%)
Households reporting diarrhea among any member during previous two weeks	9 (4.5%)	2 (1.9%)	0 (0%)	1 (2.2%)	12 (3.2%)

Table 4: Concentrations of free residual chlorine in water samples collected for locations within the home

HH water source	Total Cl_2+ (≥0.2 mg/L) N (%)	Mean Cl_2 concentration mg/L	Median concentration mg/L
Tap (N=297)	275 (92.6)	0.86	0.80
Tank, connected to tap (N=23)	20 (87.0)	0.65	0.50
Tank, independent system (N=28)	17 (61.7)	0.46	0.35
HH drinking water container (N=326)	239 (76.0)	0.54	0.50

Table 5: Results from National Public Health Laboratory. Samples tested for total and fecal coliforms in tap and stored drinking water samples (31 samples tested with residual chlorine < 0.2 mg/l). Samples positive for fecal coliforms were further characterized to determine presence of E. coli

Source of water sample	No. tested	Total Coliforms + N (%)	Fecal Coliforms + N (%)	E. coli + N (%)
Direct from tap	7	2 (28.6)	2 (28.6)	-
Storage tank – tap water	2	1 (50.0)	1 (50.0)	1 (50.0)
Storage tank – tanker truck water	1	1 (100)	1 (100)	-
Household drinking water container – tap water	20	14 (70.0)	10 (50.0)	1 (5%)
Household drinking water container – rainwater	1	1 (100)	1 (100)	-
Total	31	19 (61.3%)	15 (48.4%)	2 (6.5%)

Table 6: Two-week prevalence of diarrhea by age group

	Total	**No. ill (%) previous 2 weeks**	**No. ill (%) since January 1 (~4mo. Recall)**
< 5 years	173	3 (1.7)	11 (6.4)
≥ 5 years	1277	9 (0.7)	39 (3.1)
Total	1450	12 (0.8)	50 (3.4)