Water Distribution at Marketplaces within Urban environments in Kenya

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ABSTRACT

In Kisumu, Kenya, there it is not a lack of water. There is not even a lack of safe drinking water. There is, however, a lack of affordable safe drinking water. The only safe drinking water available in Kisumu is bottled water, and the price of this is too high for the people of Kisumu to afford. To make investments on a private level is hard for the local people since most of them have a very limited economy. This is the reason why a new form of service is needed in Kisumu. A service that provides safe drinking water at a price that makes it economically accessible for the local residents. The service developed in this project consists of a ground water harnessing hand pump for public spaces. The pump has a visible water cleaning process, to make the people more aware and trust the water they consume. To access the water people pay a fee using sms. The service is owned by the 29 economical unions at the Jubilee Market and the fees paid are used by these unions to locally maintain the system. The most relevant keywords for this project are: waterdistribution, servicedesign, developing countries, Lifesaver systems and groundwater

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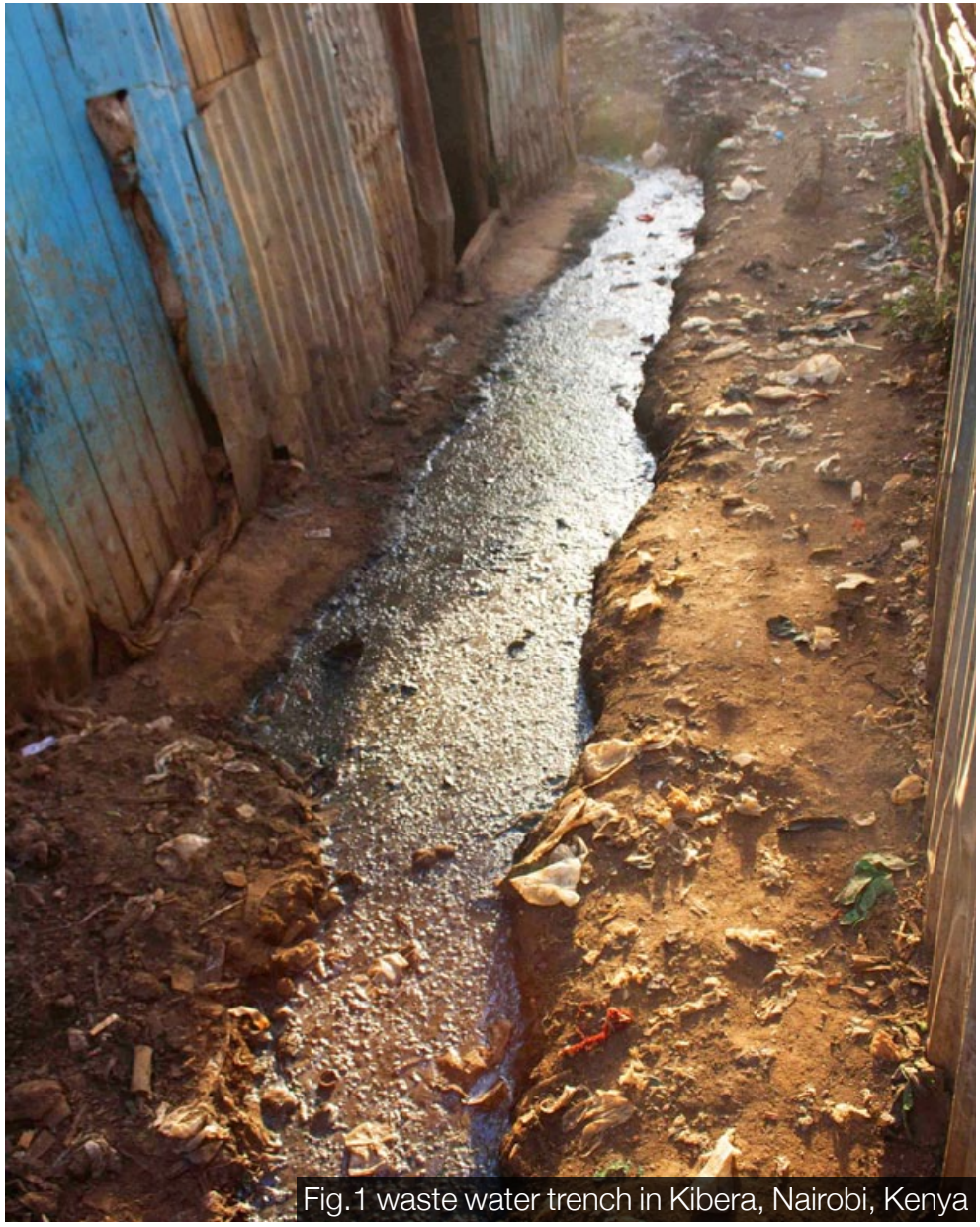


Fig.1 waste water trench in Kibera, Nairobi, Kenya

BACKGROUND

The background of this project could be divided into two categories. What is the background regarding my interest to execute this project on a personal level, and what is the background that created the topic of the project? Through working in a developing country I hope that I will earn a more holistic approach to the design profession on a cultural level than before. This is an important skill to have within my field and this is why I find this project interesting to work with. My initial topic: The flow of water in Kenya, Time scope 2030, was chosen because the lack of affordable safe drinking water is still a large issue in Kenya and it is an area where it is possible to compare Kenya to Sweden, thus to discover differences and similarities. Time scoping the project on the year 2030 makes it possible to create a suggestion to a significant change, instead of developing a solution that could be implemented faster and probably only contribute with a minor change in the Kenyan society.

PURPOSE AND OBJECTIVES

The purpose of this master thesis is to through a service design approach, investigate the water related infrastructure in the town Kisumu and work close to the local, urban population, to gain an understanding regarding water related routines in their everyday life in order to find opportunities for design related work. Kisumu will act as a case site but the research will be focusing on water distribution in urban environments in general. The main objectives ordered by level of importance are:

- To make clean water more accessible for the people of in Kisumu and Kenya in general, by creating or modifying a system or service and, if suitable, develop products needed within the service.
- To focus on the areas safety, health, sustainability, communication and efficiency throughout the project.
- On a personal level reach a higher level of knowledge regarding the development of systems/services and products within developing countries, thus creating the possibility to work with similar topics on a professional level in the future.

AIM AND RESULT

The result of this project will be a visualised and comprehensive service or system. If physical products are a part of the service or system these will also be visualized to clarify the project outcome.

The aim is that the service will be implemented and successful within Kisumu and that it will act as an example and be implemented on other locations within Kenya.

QUESTIONS AND METHODS

At this stage, since Kenya is unknown to me, there are questions in need of field studies to be answered. Initial research was conducted in the form of Kenyan census data collection regarding population demographics, education and other lifestyle patterns. Scoping down to the town Kisumu on a geographical level and investigating the specific needs and possibilities of this town will be conducted during the field studies. The methods used in this project can be divided into three categories:

<u>Research methods</u>
Cultural Probe
Character profile
Expert interviews
In context interviews
Observations

Personal inventory
Rapid ethnography
Survey

Analysis
Current situation maps
Sticky note manifesto
SWOT - Analysis

Suggestion
Macro map
Service implementation strategy
Money and material flow within service
Service map
Stakeholder map
User journeys
Emotional journey
Visualisations of service

TOPIC DEVELOPMENT

The starting point of the topic development in this project was the interest of working within a developing country. Later it came clear that Kenya and Kisumu would be the site for the field-studies. Initial research took place regarding a variety of topics related to this location. Eventually an interest in water related issues seemed relevant for this site since Lake Victoria is located so close. The marketplace is the heart of the town on many sites in Kenya, which means that it has a huge impact on the food that people consume and the sanitary questions regarding this. This is how the topic: “Investigation of the water related behavioural patterns among people withing homes and at marketplaces in urban Kisumu, Kenya” was developed. See the topic development in appendix 1.

Fig.2 Methane gas water heater, Kibera, Nairobi, Kenya

SERVICE DESIGN

Scope
Research stage
Analysis stage
Key findings
The design opportunity
Suggestion stage

Fig.3 Vessel retail, Jubilee Market, Kisumu, Kenya

GEOGRAPHICAL SCOPE - KENYA AND KISUMU

- From 1969 to 2009 the population of Kenya increased 354%[1]
- 67.7% of the population lives in rural environments and 32.3% lives in urban environments.[2]
- 2247071 students attends Pre-Primary school and 198119 attends the university. A drop of 91.2%[3]
- 3.6% of the households owns at least one computer[4]
- 63.2% of the households owns at least one mobile phone[5]
- In the rural environments the most common source of water is a well (42.6%)[6]
- In the urban environments the most common source of water is piped (38.4%)[7]
- Regarding human waste disposal the most common way is to use a pit latrine. In the rural environments 74.1% use this. In the urban environments 62.5% use this method.[8]
- In the rural areas the second most common method is to use the bush, 20.7% use this method.[9]
- Poor sanitary conditions impacts on prevailing and health standards of the local people, hence development in Kenya.[10]
- Kisumu used to be called Port Florence and was connected to the railway network for the first time in 1901.[11]
- Kisumu is the 3rd largest city in Kenya, located in the western region.[12]
- It has a population of approx. 355000 people and the east part of Kisumu is the 9th most populated region in Kenya.[13]
- Kisumu has a harbour in lake Victoria, which by area is the largest lake in Africa.[14]

Fig.4 Illustration of the location of Kenya

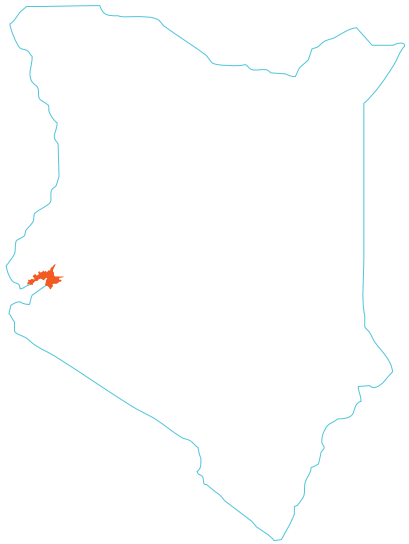


Fig.5 Illustration of the location of Kisumu

1 - 10. Kenyan Census Data 2009
11. http://www.scb.se/Pages/TableAndChart____26040.aspx 20111128 10.30
12. http://www.Kisumu.co.uk/History.htm 20111128 11.00
13. Kenyan Census Data 2009
14. http://www.lake-victoria.net/ 20111128 11.30

GEOGRAPHICAL SCOPE - JUBILEE

The marketplace is the heart of the city on many sites within Kenya. It creates an opportunity for people to arrange meetings, buy, sell and trade food and other items, thus make a living. Within Kisumu the geographical scope continues to the Jubilee Market. The Jubilee Market is suitable for the new service because of several reasons.

- It is located in the very centre of the city, which makes it a place where most of the people can afford to travel.
- Next to Jubilee Market there is a huge bus central. Which means that people will come through this area even though they might not have any purpose at the actual market. This makes it easy for these people to use the market to get water when they arrive or departure from here.
- There are facilities close to the market where the police has their training and accommodation. Within this compound there is also a centre where people can test themselves for HIV. A facility that might be more frequently visited if the area in general draws more people to it.
- The Jubilee Market is closed down and sealed of during the night. This might help minimize vandalism, theft and similar if the service somehow will be sensitive for this.

TIME AND USER SCOPE

To make a significant change within a large system takes time since it will change behavioural patterns and affect routines that people have been used to for a long time. This is why it is realistic to timescope the project on 2030 and look at how Kisumu will look when the service exists at this point in time. The user scope is focusing on the people who today can not afford clean water both young and old, female and male. To view the time and user scope see appendix 2 and 3.

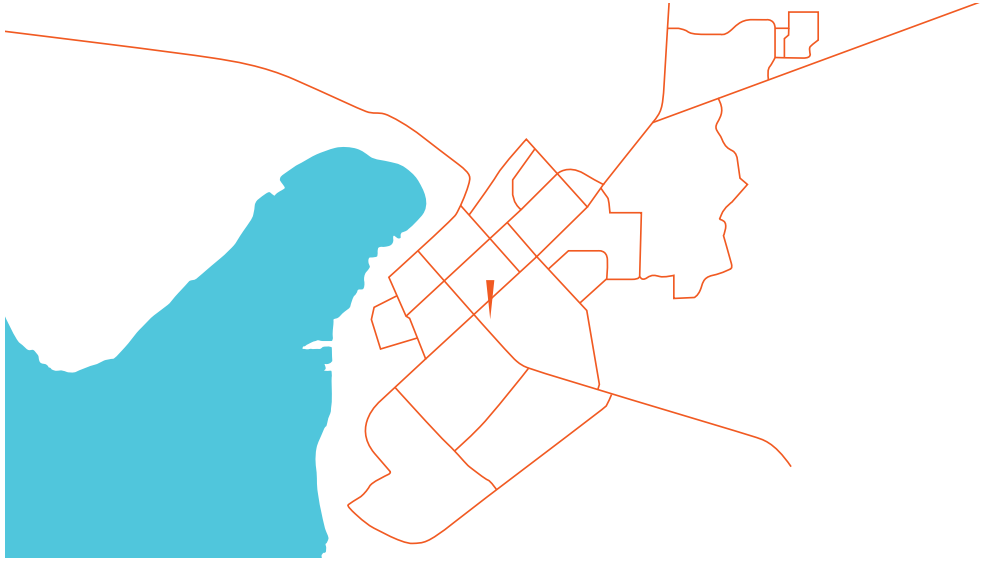


Fig.6 Illustration of the location of Jubilee Market

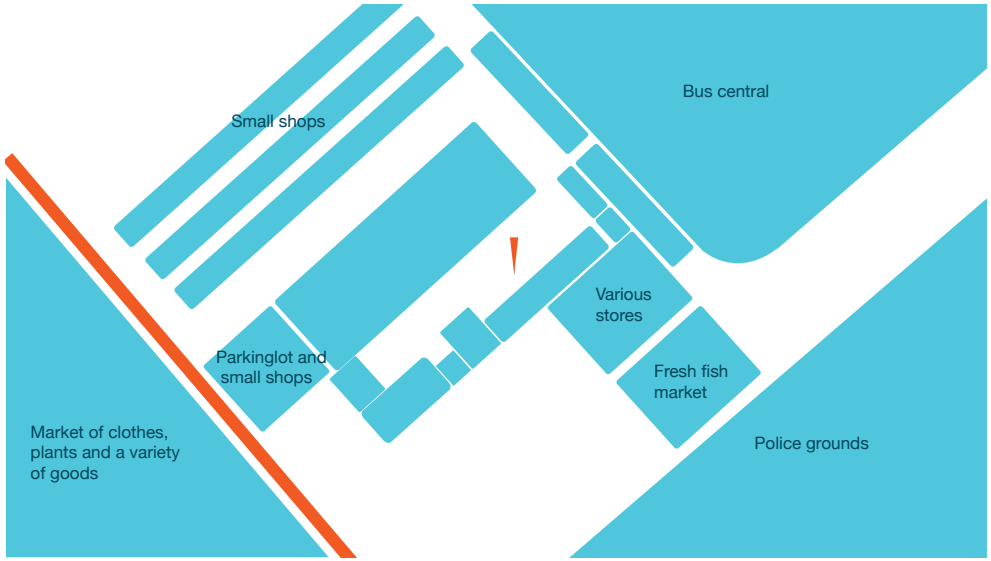


Fig.7 Illustration of the location of the new service

RESEARCH METHODS

Case studies
Cultural Probe
Character profiles
Expert interviews
In context interviews
Observations
Personal inventory
Rapid ethnography
Survey

Fig.8 Children carrying water in Kisumu, Kenya

CASE STUDIES

Waterwize is a Reality Studio project by Kristina Sahleström and Helena Norlén, Chalmers University of Technology 2009 and the most vital information found within this project was that there is a lack of communication and awareness regarding water in Kisumu, and that there is an interest from the people in the town to be more involved and informed regarding the water they consume.[15]
The design of a potable water distribution network in Kwarara on Zanzibar is a Master thesis project by Michael Magnold, Chalmers University of Technology from 2008. Michael went to Zansibar and investigated how the water distribution works there. Something that he found was that the people used to pay for the water but these days it was for free. However since this lead to a lack of maintenance on the water related infrastructure the government of Tanzania had decided that people should start paying for water again in 2008. Michael also discovered that neighbours help each other out by buying/selling water if someone has a well or a pump. This tells me that the society in Tanzania might be more open than the one in Sweden because people need to help each other out in a different way. He also found an interesting connection between religion and water distribution. Since water is needed in mosques and 98% of the population on Zansibar are Muslims, he investigated how/if the mosques could help distributing water and he also had a discussion regarding the people that are not Muslim. Would they be able to get this water just like everybody else or would the access of water depend on religion if this method would be used. Before I came to my site Kisumu I had already realized that the water distribution in these areas of the world demands several solutions and creativity to work as good as possible but that there are economical, cultural, traditional and political obstacles in the way of development.[16]

15.https://student.portal.chalmers.se/sv/studier/kursinformation/kurser/sidor/kursinformation.aspx?hp_id=6833&hp_view=handout&path=Assignments_and_workshops/Reports_Kisumu_2009/Waterwise&parsergrp=1 20120219 08.00
16. http://publications.lib.chalmers.se/cpl/record/index.xsql?pubid=92572 20120220 08.00

CULTURAL PROBE

In this case the cultural probe consisted of 20 weekly documentation kits, in which users could write down what ever they wanted regarding their everyday lives during one week. 3 of the users where also provided with disposable cameras to take pictures of things that they saw during this week. On the final page of the weekly documentation kit there was a short survey with water related questions. Since the cultural probe was handed out to people with different economical situations, religion and location of residence it is clear that there are huge segregational differences within Kisumu, based on what people documented that they where doing during their week. To summarize the outcome of this method it indicated that people in general are very hard working. They have very low salaries and the people which lives in the largest slum area in Kisumu: Nyalanda, are often feeling sick when they wake up.

Fig.9 Cultural probe kit

CHARACTER PROFILES

Name: Mary Raman Anyango[17]
Age: 49
Occupation: Bottle seller
Family situation: Lives with family and 5 children
Hobbies and interests: Tailoring. Wants to sell fruit instead of bottles
Attitudes towards health: Runs every morning to stay in shape
Key values: I believe in god the all mighty
Media interests: Watches news every morning
Strengths: Good at Swahili and at singing/dancing
Weaknesses: My friends are my weakness
A regular ritual: Preying
A source of pleasure: Buying and listening to CD:s, gospel music
A bad habit: Fighting too much with people around me

Fig.10 Mary Raman Anyango

Name: George Omondi Odongo[18]
Age:
Occupation: Motorcycle (pikipiki) driver
Family situation: Lives with wife and four children
Hobbies and interests: Wants to become a shopkeeper
Attitudes towards health: Tries to eat much fish and cabbage
Key values: God can open any door
Media interests: Listens to radio in the morning, local and global news
Strengths: Good at motivating people and make them feel better
Weaknesses: Sick often. Waking up in the morning and feeling weak
A regular ritual: Working every day
A source of pleasure: Reading the bible makes me happy at any time
A bad habit: Don´t know

Fig.11 George Omondi Odongo

17. In Context interview with Mary Raman Anyango 20120305
18. In Context interview with George Omondi Odongo 20120305

EXPERT INTERVIEWS

When it comes to Kenya it is common that people like to call themselves experts and it is sometimes hard to know who is actually educated in something and who is self educated. However I spent a lot of time with Edwin Watta, educated within chemistry at Moi University, Eldoret, Kenya. Watta has taken me to the Kiwasco water treatment plants. Both the one collecting water from Lake Victoria and the one collecting water from the river Kibos. He has also taken me to see the Kiwasco sewage plant, the Lagoon where water is treated in a biological process and the actual water inlets, both by Lake Victoria and the river Kibos.

The first visit at the main water treatment plant, that collects water from Lake Victoria, was a tour to look at the different steps of the cleaning process of the water. The tour was executed together with a group of students. During this tour another local resident was present. A man named Tom Mboya Adera. We (the sweidsh student group) where introduced to Tom when we came to Kisumu and he, as he describes it, is an expert in water hyacinth and ornithology. His occupation is to take students and tourists to different sites in Kisumu and share his knowledge. His knowledge is very impressive and a lot of his opinions are based on life experience, rather than coming from an educational or scientific point of view. However, during this visit at Kiwasco, he almost took over the tour that Watta was supposed to give us and from time to time it sounded like he was working for Kiwasco, which he does not. He made some remarks against Kiwasco and I could tell that Watta was annoyed by this. He claimed afterwards that he did it to give us students a real image of the situation, which I think is partly true but another fact is that Tom makes a living by providing people with information they think is interesting enough to pay him for. The next day I went back again, this time alone so I could have a longer talk with Watta. I was right about the fact that he had been annoyed the previous day. He told me that he almost called security and had Tom thrown out. I had started to do some mappings regarding the water distribution system of Kisumu that I showed Watta and he helped me to clarify a couple of things regarding the system. When I asked him about the cleaning process of the water plant he told me that what he was about to say could get him fired if anyone knew about it. He told me that he was educated in primary, secondary and tertiary water cleaning and that Kiwasco, at the moment, only has the primary step at the water plant. As Watta describes it he has the knowledge but he is missing the tools to use it. He feels that he is only using about two percentage of the things he learned during his education, and as he describes it most of the staff at Kiwasco has similar backgrounds. Watta continued with explaining that what they do at Kiwasco is to kill bacteria and make the water look clear. That´s it, and according to Watta it is not enough to classify the water as drinkable for anyone. They have different problems at Kiwasco compared with Göteborgsvatten in Sweden. For instance Kiwasco has to install water meters in every home they connect to their system and go there every month to read the meter manually so they can charge people. One of the reasons why people choose not to connect to Kiwasco is because they have to buy the meter, which many people can not afford. This is where the corruption within Kiwasco comes into the picture. If someone that works with installing these meters at Kiwasco knows someone or finds out that someone else needs a meter, the technician simply steals the meter and installs it somewhere else, and makes extra money. Of course not everyone working at Kiwasco has this state of mind but according to Watta it is a common phenomenon. Another problem they have to deal with from his point of view is that people sometimes tries to connect themselves to the pipe network to save the cost to hire Kiwasco to do this. The problem is that not all of them know what pipe to connect to, which leads them to take a chance and sometimes they connect their waste water pipe to the fresh water one. This is of course dangerous. A third problem for Kiwasco right now is that the other people that provides themselves with water in Kisumu, the vendor drivers, sometimes contaminates the

water system to increase their own business. A fourth problem for Kiwasco is the condition of Lake Victoria. According to Watta approximately 4.000 fishermen spends almost their entire day and night out on the lake, and they don´t have toilets on their boats. This is a problem for the lake and for Kiwasco. There are a lot more problems, but the last one mentioned here will be that the pipes in Kisumu are very old and rusty. According to Watta, even if Kisumu had a cleaning process like the one in Gothenburg, Sweden, they would have to exchange most of the pipes in their system to be able to guarantee safe drinking water to the people. I asked Watta what he thought about the future of Kiwasco and he showed me the Kiwasco plan for 2016 and they are planning to start a water bottling factory. When I asked him why they wanted to do this instead of focusing the resources on perfecting the cleaning process at their water treatment plants or maintenance on the piping system, he said that the bottling factory would generate money faster, which then would be used to perfect the existing cleaning process. Besides the visits mentioned in the beginning of this text I also went for a drive with Watta and some other of the Kiwasco staff to take water samples one day. These samples are taken from various locations within and around Kisumu. This tour is made two times every week, the samples are brought to the main water treatment plant then analysed to give Kiwasco an image of the water quality. To collect the water they use re - used PET water bottles and bottles made of glass.[19]

IN CONTEXT INTERVIEWS

Among other people in Kisumu I met a woman named Margaret Anyango. She has a restaurant and one of the waiters there is named Clinton Oluoch. This is an interview that took place with Clinton, and it gave me an image of what his life is like.

I went down to Margarets restaurant to pick up hers and Clintons

Fig.12 Kiwasco water sample

Fig.13 Kiwasco water samples

19. Expert interviews with water chemist: Edwin Watta, during the period 20120220 - 20120325

weekly journals that I handed out one week earlier. When I got there I didn´t see anyone I recognized at first but after only a few seconds Clinton showed up. He was really happy to see me and he showed me his journal. He had written a lot during each day of the week and also specified at what time he did what. I didn´t look into the journal at this point. Instead I had a long interesting conversation with Clinton about his life, my life, the future and so on. He is at the moment 18 years old. This Wednesday he got the results back from his high school finals and they where good. Now he can go to the university to study law, which is his dream, if he can save enough money to afford the tuition fees that is. He is a very hard working young man. Every morning he wakes up at 5.30 and prepares to go to the restaurant where he works besides his studies. He has to walk one hour to his job where he has a daily salary of 150KES, which is around 13 SEK/day. He works there until 6 in the evening. When he arrives at home he is responsible for the water supply of his family which consists of him, his mother and five siblings, since is father passed on because of malaria in 2010. He has to walk 250 meters, carry 40 litres of water back to his home, and then do the same thing one more time to collect the 80 litres of water they need every day. They have to let the water settle for a while since they often find sand and other particles in the water, then it needs to be boiled before used. He tries to save all the money he can right now and he is very aware of the fact that getting an education is his only option and way to a better life. He also plans to build a basic construction to breed chickens at home. It will be his business as he describes it, but his mother will run it from their home when he goes to the university. He is very good in history, in which he has a really high grade from his high school. He is a member of the Lou-tribe, and was born in a traditional Lou village, with round houses made from clay and wooden sticks. When I asked him who of his parents he had best connection with before his father passed on he answered “my father” without blinking. He also explained some things to me regarding HIV and AIDS. He says peer pressure is one of the reasons why so many young people gets infected. They get encouraged to have sex by their friends who often already have the virus, because they don´t want to be the only ones having it. In my opinion it is a very cruel thing to encourage friends into doing something that eventually will cost them their life. When I meet someone like Clinton and listens to his life story and situation and compares it with what it would be like to have the same conversation with an eighteen year old in Sweden I can´t help but feeling ashamed of my own background. Clinton never mentioned that anything was to hard for him or that he was unhappy in any way. He is one of the most impressive people I have ever met in my life. I couldn´t help feeling that I wanted to help him somehow. It would mean so much for his life and future if I would send him something like 100SEK/month. It is equal to one week of work for him. He was talking about buying a computer and also some software such as Microsoft excel and similar to use during his education. I told him how to download the software for free since this would take him about one month of work to buy otherwise. As for me every month I give 100SEK to UNICEF but I don´t know exactly where that money goes. I´m quite sure it goes to good things but if I could give it to my friend Clinton instead I would. He has no bank account and even if he did a transaction like that would cost more than 100SEK/month to transfer. I´m also asking myself if it is wrong interfering with his life on an economical level. He is used to his routines and to work hard for everything he wants in his life. To give him something for free might cripple him. He likes soccer like every other eighteen year old. His favourite team is Arsenal. He also likes to swim and to listen to gospel music and to watch movies. When talking about these things he feels like he could fit in on any other eighteen year old in the world, however when I got back to the hostel and read his journal he wrote that one of the days he had witnessed how a mob of people beat up a thief outside the restaurant where he works and that the day after this it was raining so he hurried home so he could take a bath using the cold rain water. It was an experience of a lifetime for me to be in Kisumu, but sometimes it

made me feel very small and helpless. However I will remember Clinton for ever. He is as I said before one of the most impressive people I have ever met in my life. Besides my talk with Clinton I executed similar interviews with several people in Kisumu during my stay there. This, however, was the most interesting one for me, which is why I wrote it here. I stayed in touch with Clinton during my stay in Kisumu. I went with him to his old high school and talked to the principal, who gave Clinton the information he needs to apply for a student loan. Something that Clinton didn´t know he could to. I also arranged for Clinton to open a bank account of his own, so he can write down his account number when he applies for the student loan. I opened an e-mail account for him and I am waiting for him to tell me how things are going regarding his educational situation. These things can really change his future for the better and together we arranged this without spending as much as one KES.[20]

20. In context interview with waiter: Clinton Oluoch, 20120226

OBSERVATIONS

When I fist arrived in Kenya I spent a few days in Nairobi before I travelled to Kisumu. Observations in Nairobi and Kisumu generated a lot of valuable information within the topic of my project that could not have been discovered without spending time in the field. Some of the most important ones are mentioned in this text.

While in Nairobi I visited the slum area; Kibera. At the moment Kibera has an estimated population of 2 million people. This number, however, shouldn´t be taken to seriously, since Kibera consists of unplanned residents that makes it hard to know exactly how many lives here.[21] The first topic related observation was a methane gas water heater developed by the locals. The people have constructed toilet facilities that collects the methane gas generated, which leads up to the second floor of the building, where people could bring water and heat it up using a gas heater. This to me is a clear sign that people are not only thinking but also acting regarding water related issues in Kenya. I asked the local initiators of this project, if they had any problems with vandalism or similar. The answer was no, because the people here doesn´t have much, so when an initiative like this is taken and developed people take care of it.[22]

People here live without access to any sewage system, and large parts of Kibera doesn´t even have electricity. A lot of people come here from rural areas to try and make a living in the city, but end up in the slum areas without any opportunities of work. However the water related issue here is the lack of a sewage system. There are some shallow trenches that allow human waste flow, but during the rain season these over flow, which is a common cause for the disease cholera to erupt in these areas.[23] The second observation to be mentioned here was that it is a common thing in Kisumu to drive cars down into Lake Victoria and have people wash the cars in the lake as a running business. Since the water from the lake is utilized by the city water distributor Kiwasco this

21. http://www.mapkibera.org/blog/2010/09/05/kiberas-census-population-politics-precision/ 20120215 09.00

22 - 23 On site observations executed in Nairobi and Kisumu, Kenya during the time period 20120215 - 20120326

has an impact on the water in the town, not to mention the marine life within Lake Victoria. In addition to this there is an existing but not utilized car wash between the Jubilee and Kibuja markets in Kisumu.
The third observation was the water distribution or rather the lack of water distribution at the Chiga market, which is a marketplace a little bit outside of Kisumu. The only source of water at this very dry location was a well with a bucket that was cranked up by children. My personal reflection regarding this is that it must be difficult to have a running market with fresh healthy groceries with only this source of water.[24]

The forth observation was a product developed by Tom Mboya Adera. Tom has developed a system in which he uses the water hyacinth, a plant common in Lake Victoria, to clean water from a variety of toxins. The water that goes through his cleaning process is not clean enough for drinking but it is an interesting experiment and an example of how to make the water somewhat cleaner using a biological cleaning method.[25]
The fifth observation is a group of people called Vendors. To make a living they have large wheel barrels where they load up vessels of water. They fill the water up at public taps or water kiosks, then they distribute it to the people in Kisumu.[26]

Fig.15 Hyacinth used to clean water

24 - 26. On site observations executed in Nairobi and Kisumu, Kenya during the time period 20120215 - 20120326

PERSONAL INVENTORY

I visited the home of Margaret Anyango. The owner of the restaurant where Clinton Oluoch works. She is, besides the restaurant, involved within construction work and the politics of Kisumu. She invited me and my fellow student Shea Hagy for dinner. When we got there she had made way to much food for us. She said to me that she expected us to be more than just two but I had told her that I would just bring one friend with me. Anyway she was cooking some chicken outside on a small barbecue. There where some chickens running around both inside and outside the house. The house is shared between Margaret and her two friends. The yard is big but not maintained at all. She said she had a view of the lake and if I stood on my toes I could see a little bit of water between some trees. She told us to be there at 6PM but we got a little late and arrived around 6.20PM. However when we where there she kept cooking for another hour or so before we could eat. When we where going to eat she had put a lot of different pots on a table and told us that we could take a seat and watch some television. I found this a bit strange. I know that Margaret is a very religious person, especially since the entire interior of her home was covered with icons of Jesus and various saints. I assumed that someone with this mind set would like to sit down and eat a meal in a more proper way than watching television. However she put the television on and we watched some Kenyan movie and Margaret was encouraging us to pay attention to it. However she knows that we do not speak Swahili, which was the language of the movie, so it was impossible for us to follow the plot of the movie. Even though Margaret is 59 years old and seems like a successful citizen in Kisumu her house was a very basic colonial style home that needed maintenance. There where a lot of bugs crawling on the walls and on the floor. However the food was great and we felt a bit bad for not eating more since she had been preparing the meal since 2PM. It was very clear to me that they do not often cook a meal like this in her home. Before coming to her home she said that she would like the Swedish students coming to Kisumu next year to stay at her home instead of at a hostel. She said she had a lot of space, good tables and similar suitable for design and architect related work. However it seemed to me that she wanted that to happen so bad that she was blinded to the fact that she doesn´t have enough space, she doesn´t have any furniture suitable for studies or anything else that would make it suitable for students to come there and work. She sees a business opportunity in everything, which is understandable since these opportunities are very few, but the difference between her image of how this could work and what the real situation is like is huge. On the surface Margaret is very friendly, a bit confused and over all a very charming lady, but there is a purpose of every friendly gesture from her side. Something that comes clear after meeting her a couple of times.[27]

RAPID ETHNOGRAPHY

As a researcher, to really understand the target users it is important to be around them enough for them to act natural around you. The company IDEO calls this method Rapid Ethnography, and this was executed on a daily basis throughout my field-studies in Kenya. When it comes to the people that I got to know on a deeper level during my project there are both similarities but also differences compared with the behaviours of people in Sweden. Both on traditional, economical, cultural and social levels. Besides the people already mentioned I will bring two examples of this up in this text. First of all I got to know a person named William. He lives a bit outside Kisumu and the first time I visited him I stayed the entire day with him and his family. The second time I visited him I stayed an entire weekend and slept in his house. If I would only visit him and conduct an interview he would be very formal and answer my questions in a good way, but since I spent so much time with him I know what he likes to do for fun now. I know how his relation to his brothers differs from

27. Personal Inventory at the residence of Margaret Anyango 20120227

the relation he has to his sisters and so on. Besides creating this image of what kind of person William is, we also spent some time on water related projects around his house. Wiliams family have a couple of sources of water. The water they drink is rainwater collected by the roof of his parents house. The water used for other purposes is collected in a nearby dam or a nearby tap. He told me that they used a well before but the water there looks very dirty now so it´s not used anymore. To make it easier to carry water we made a water carrying stick together. We chopped down one of the thin trees in Wiliams families back yard using a machete, and started working on the new product. Besides this we also created a small rain water collector for Wiliams house, that he built by himself in 2006. We tried both of these products and they actually worked quite well. I used the caring stick to carry the 40 litres of water that is needed for the household and 40 litres of water is much heavier than it might sound. Especially when it is more than 30 degrees warm and the road is covered with huge rocks. It was my idea to develop some kind of water related concepts. I wanted to do this to put me and William in a situation where we had to collaborate, solve problems and at the same time be creative together. This made us get to know each other very well in a short period of time, which was the point of this research method from the beginning. William is a very reserved, religious and hard working medical student. He has high hopes for the future regarding his studies and future career. He is curious about the rest of the world and what it has to offer. He has a very nice sense of humour and can laugh about almost everything. Even if his life is rough sometimes he knows that god has his back, as he describes it.[28]

Something else that I did using this research method was to get to know some people at my case site: Jubilee Market. I started talking with a woman named Mary Wadeya. She is the leader of the Jubilee Dry Fish Women Group at Jubilee Market. She explained to me that I was welcome to join their weekly meetings if I wanted to. The group meets every Thursday at 11AM. The topic of these meetings change a little bit

Fig.16 William with new water carrier

Fig.17 William with new rain harvester

28. Rapid ethnography through household studies and workshop with William 20120310, 20120324 - 20120325

from time to time, but it always has something to do with their private economy. Instead of going to a bank to get a loan when needed it is common that the people in Kisumu solve these kind of problems among themselves. Mary explained to me that at the Jubilee Market there are 29 of these groups at the moment, which in total consists of more than 600 locals. They all know who belongs to which group, since it is related to their profession. When I stated to join these meetings I didn´t know how important it was for the people of Kisumu to form these groups, but it is essential. It is, for some people, the only way to borrow money for school fees, funeral fees and similar. And they are very well structured. If someone wants a loan she/he has to write an application and stipulate the relevant information regarding the request and the group will get together and make a decision. Every week everyone contributes with a small amount of money that will be put into the common money pool. These economical groups turned out to be one of my most important findings.[29]

SURVEY

The survey that was handed and filled out by 20 target users consisted of the following questions:

1. Do you have a water tap in your home?
1a. If yes: are you satisfied with your water?
1b. If no: how far is it to your primary water source?
2. Do you trust that the water you drink daily is clean?
3. How much water does your household use every day?
4. What other sources of water do you know of in Kisumu?

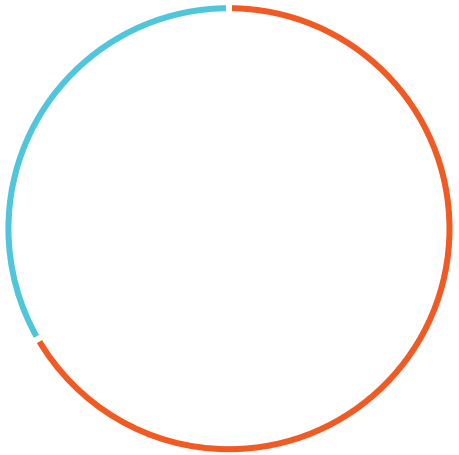


Fig.18 Only 25% had taps at home

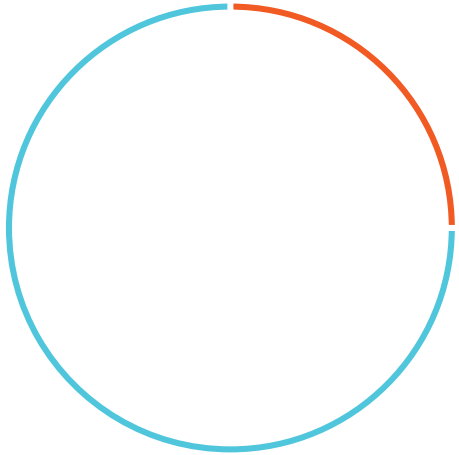


Fig.19 75% where satisfied with the water quality

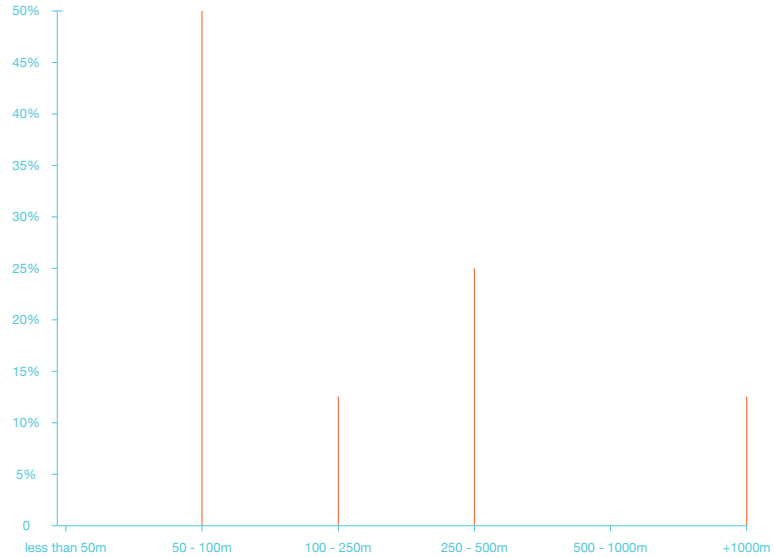


Fig.20 Distance to source of water for people without taps in their homes

29. In context interviews with Mary Wadeya 20120301 - 20120321

The result as a whole indicates that there is a lack of good accessibility to healthy water in Kisumu. Only 25% of the people that participated had a water taps in their homes. Only 25% of the participants trust that the water they consume daily is clean. Out of the 75% of the people who do not have a water tap in their homes 50% has to walk further than 100 meters to collect water. This is time consuming and very hard work since 60% of the participants need more than 100 litres of water in their households every day. Another thing that is clear after conducting this survey is that everyone asked could answer how much water they consume every day, even though there was an option in the survey that said: "I have no idea". This might be a common answer in other countries in the world where water is taken for granted. The last question in this survey was an open question where people where to stipulate what kind of water sources they knew about in Kisumu. The text below is a summary of the different comments on this question.[30]

"Either a private company sold water or super market bought water. Springs, dam, Lake, Spring, bore - holes, lake and tap. Bore holes, lake, dams, swamp. River Wigwa and Auji only. Bore holes, springs, lake and taps. Lake Victoria. Bore holes and rainwater. Bore holes. Borehole. River, lake. The sources that I know are streams. Bore holes, wells and springs"

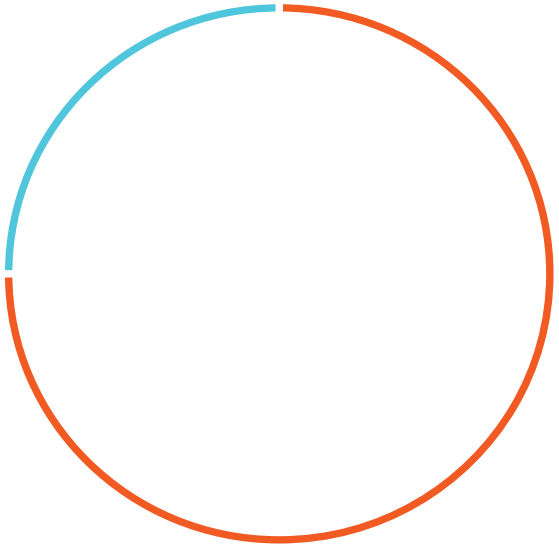


Fig.21 Only 25% trusts that the water they consume daily is clean

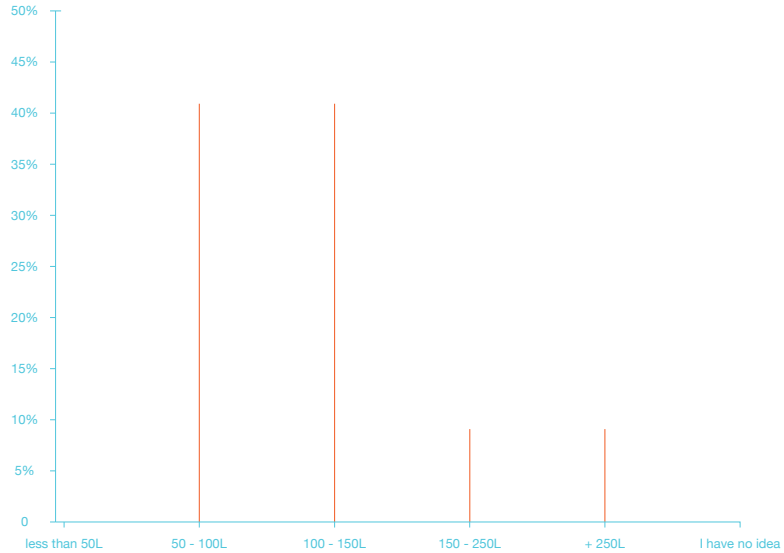


Fig.22 Daily water consumption per household

30. Result of survey executed in Kisumu, Kenya during the period 20120218 - 20120326

ANALYSIS METHODS

Comparing the water distribution system of Kisumu and Gothenburg
Sticky note manifesto
SWOT - Analysis

Fig.23 Kibos River, Kenya

COMPARING THE WATER DISTRIBUTION OF KISUMU AND GOTHENBURG

As shown in appendix 4, the water distribution system in Gothenburg is quite simple and easy to understand. The water that provides the people in Gothenburg is taken from Göta älv. It is then sent to one of the two water treatment plants owned by Göteborgsvatten. From here it goes to public or private taps. When it has been used it is sent to the Gryab sewage plant, where it is cleaned. From here some is used for fertilizer within agriculture and some is sent out to the ocean, in this case Kattegatt. Besides this the waste from the water treatment plants is also piped to the sewage plant to be cleaned. From the other side in this map there is bottled water. It is not necessary to have within this system but it exists in the present situation, which is why it is also a part of the map.[31] If looking at rural areas there might also be wells and bore holes and similar but in this case the map is focused on urban Gothenburg.

When comparing this system with the system of Kisumu (appendix 5) it is easy to see that the system within Kisumu is way more complex. The water provided to the people of Kisumu is harvested by the company Kiwasco from Lake Victoria at one site and from the river Kibos at another site. This water is then cleaned but with an unsatisfactory cleaning process. At the water treatment plants, tank trucks come and buy water which they distribute in the city. Water is pumped out to over head tanks that are attached to buildings. Here the water is stored and used when needed. Farmers also come here and buy material used for fertilizer. Besides this the water is pumped to both public and private taps. During the night it is also pumped to a water reservoir that helps providing the system during the daytime. Some public taps are used as water kiosks where people authorized by Kiwasco sell water to the people. Some public taps are used by the vendor people. These people have wagons loaded with jerrycans of water. They fill the jerrycans up at public taps and sell it to the people. As the map shows, it is also common that people take the water directly from Lake Victoria and various rivers and use it in their daily life. The other side of the map illustrates the groundwater harnessing, the rainwater harnessing and also the bottled water. When all of this water is used some of it is discarded directly into the nearby rivers, or Lake Victoria. Some of it is piped to the biological cleaning area known as the Lagoon. Some people have septic tanks connected to their bathrooms and these are also emptied in the Lagoon. Some of the waste water is piped to the Kiwasco sewage plant, where it undergoes a lacking cleaning process before some of the waste is used for fertilizer and the rest of the water is piped to a nearby river which runs down to Lake Victoria. As shown in appendix 6 and 7, the clean water in the system of Gothenburg is the water sent to both private and public taps. Besides this the bottled water is also clean. In the case of Kisumu the only clean water is the bottled water. Looking at the price of the water in Kisumu in appendix 8 - 11, the water that is provided directly by Kiwasco costs 2KES / 20L. If people buy water from tank trucks, vendors or similar the price can vary from 2 - 20KES / 20L depending on where in the city they live. However the only clean water, the bottled water, costs about 400KES / 20L, which makes it very rare for people to afford. In the long run this makes water into a business in Kisumu and it makes the clean water a luxury that only the people with very good economy can afford. That water is a symbol of economic level at certain places in the world need to change.[32]

STICKY NOTE MANIFESTO

One of the analysis methods used was the sticky note manifesto. This was executed to clarify connections between various stakeholders related to the project and to generate key findings relevant for the suggestion stage of the project.

31. Expert interview with Inger Kjellberg, water treatment expert at Göteborgsvatten 20120125

32. Expert interviews with water chemist: Edwin Watta, during the period 20120220 - 20120325

Strengths

- Knowledge is there
- Openness between locals
- People used to help each other out in various ways
- Committed people wanting to create better solutions
- The informal systems are working but are not enough in numbers and implementation to support the bigger scale
- Strong culture bonding people together
- Many cultures co - exists in harmony
- Innovative solutions when locals do the most of what they have

Weaknesses

- The only clean water is the bottled water
- Water is a status symbol
- Lack of communication and links between stakeholders
- The formal water distribution system is inadequate
- Politicians do not emphasize enough on the informal settlements
- Locals do not have enough economic incitements to invest
- Dependency on aid from the west for new developments
- Lack of maintenance on water related infrastructure
- Water related infrastructure development to slow

Opportunities

- Making the voice of the people heard at the municipality
- Tying various stakeholders together and work towards economical independence
- Decrease bottled water consumption
- Erase the connection between economical situation and water consumption
- Health benefits
- Rainwater and/or groundwater harnessing
- Increase trust regarding water quality and origin
- Implement a second source of clean water
- Make clean water more accessible than before

Threats

- Conflict of interest in regards to aid money
- Locals depending on the present systems will be against change
- Governmental legislations could threat the diversity of water providers today
- Privatization and crating a monopoly of the public service developed
- With time using the resources wastefully with high quality water for everything like in the western world
- Low usage because a neglect of quality in favour for quantity
- No knowledge on what scale a centralized/decentralized system works best/don't work

KEY FINDINGS

KISUMU
- Several cases of water related issues on different sites within Kisumu
- Water accessibility and quality is a question of economical level
- The water provided by the water distributor Kiwasco is not safe to drink
- Locals in general can´t afford to drink bottled water
- Locals don´t trust the water they consume in their daily life
- There is a lack of communication and awareness regarding this topic within the town
- Since Kiwasco has claimed that their water is clean for a long time it would be contradicting for them to act in this matter
- People would be willing to pay for clean water
- The municipality are good at investing but bad at maintaining
- People have difficulties investing but are good at maintaining
- Easy access to groundwater since lake victoria is so close
- People have cell phones

JUBILEE MARKET
- The dry fish market women group
- In total 29 groups with over 600 members
- Water vessel retail
- One single tap for the entire market
- The space of implementation
- Market is sealed of during the night
- Police compounds close
- Hotels close
- Facilities to execute HIV testing close by

THE DESIGN OPPORTUNITY

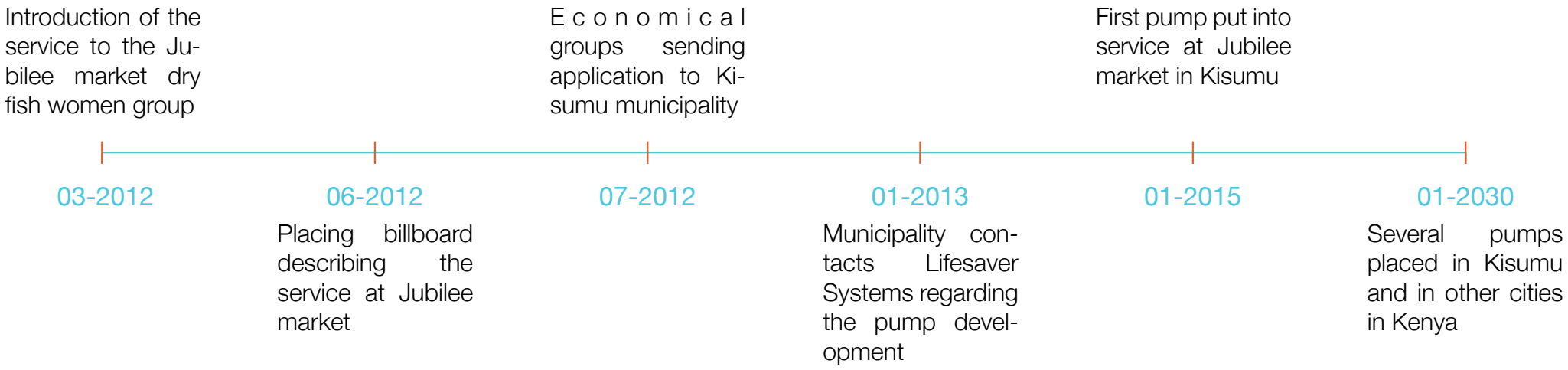
Since Kiwaso has claimed that their water is perfectly clean it is contradicting for them to act within this matter. The design opportunity therefore lies within starting a separate system that supplies the local people in Kisumu with safe and affordable drinking water. A realistic approach from an economical point of view is to start in a small scale and expand the system if it turns out to be successful. Because of this information and the previously mentioned key findings the design opportunity lies within implementing a public water distributor that harnesses and cleans groundwater in a visible, understandable way and distributes it for a price affordable by more people than the bottled water, thus increasing the health among the people of Kisumu, reducing the water as a symbol of economic level, reducing the bottled water consumption and increasing locals confidence and knowledge regarding the water they consume. The new service will, besides the pump, also include information written in an understandable way regarding the cleaning process as well as a website and a phone line where users can discuss, ask questions and similar to increase the confidence and understanding of the system even further. The water will be cleaned using a technology developed by the company Lifesaver Systems, from the U.K. More information about this technology will be given later on in this report.

SUGGESTION METHODS

Macro map
Service implementation strategy
Money and material flow within service
Service map
Stakeholder map
First time user journey
Second time user journey
Emotional journey
Cost of the water provided by the service

Fig.24 Tank Truck, Kisumu, Kenya

SERVICE IMPLEMENTATION STRATEGY



MONEY AND MATERIAL FLOW

As shown in appendix 12, the service starts with a one time investment from the local municipality, which enables Lifesaver Systems to develop the water distributor. The water distributor is then placed at Jubilee Market and the fees that people pay using it is sent to an account owned by the 29 economical groups that exist at this site today. The account will need at least two individuals in order for withdrawals to be made. This to minimize the risk of funds disappearing. Thiese economical means will be used to purchase new filters and parts from Lifesaver Systems and also to hire local water related product distributors to maintain the product. If additional funds can be saved in the account they will be used to implement another product without involving the municipality.

MACRO MAP - THE NEW WATER DISTRIBUTION SYSTEM OF KISUMU

Appendix 13 shows how the new water distributor would fit into the present water distribution system in Kisumu. As shown it will eliminate the vendors business and the bottled water consuming if people trust it and use it. Besides this the system will look the same as it does today. The best way to change the system in Kisumu and in Kenya would probably be to supply every home with a private tap that provides safe and affordable drinking water. However it will take a long time before this will become reality in Kenya, which is why this system could be implemented in order to provide water of this quality faster.

THE SERVICE

Appendix 14 is an illustration of the service itself. There will be three ways for a user to find out about this service. The most common one will probably be word of mouth. There is no plan regarding making advertisement in any newspaper, on TV or similar. However there is a chance that something will be mentioned in a newspaper and on a local radio station. When the user by any of these mediums receive knowledge about the service existence and she/he arrives at the water distributor at the Jubilee Market for the first time the users can be divided into two categories: The first group of users are the people who immediately trusts the service. The second group of users are those who do not. If they do not trust it they might not use it. However if they don´t trust it but are curious about it and are interested in receiving more information they have three options. The most common one will be to ask the nearest person, because it´s free, fast and because the people working at the market will have knowledge about the service. Another option is to make a phone call to the so called hot line. This is not an office with someone working with only this task. Instead this is a phone call that goes to someone from one of the 29 economical groups that will know more than the average Jubilee Market worker about the project, the service and so on. The third option is to log on to the website that will be suggested that the 29 economical groups create, in order for people to discuss this service in an open forum online. The purpose of this, besides providing people with direct information, is to create an opportunity for them to express their own opinion, something that they haven´t been able to do regarding this topic before. Besides these three mediums there will also be written information on the actual water distributor where the user can read about how the project was initiated, where the money goes, how the water cleaning process works and how to pay for the water. After receiving additional information from one or more of these mediums the user will send an SMS that describes how much water they want to purchase.

After a few seconds she/he will receive an answer with a five digit code that she/he enters on the payment terminal on the water distributor. This action activates it. If, however, the user doesn´t receive an answer on her/his SMS it could be because she/he doesn´t have any credit on her/his mobile phone. It could be because there is a bad or no reception at the moment, or because there is something wrong with the service. If something is wrong with the service an SMS will be sent to someone involved within the service in order for her/him to call the local pump retailer for maintenance. However if the user receive the code there might be some problem when using the pump. In this case there will also be an SMS sent to someone involved so she/he can call for maintenance. In most cases the water distributor will work though, and when using it the user first have to place her/his water vessel correctly, which means that it must be very clear how to do this. If the user fails to do so, the water will be wasted. If the user does this correctly she/he can start to pump up the water, which will be cleaned in a visible, understandable way, and distributed into the vessel.

EMOTIONAL JOURNEY

Appendix 15 describes the emotional journey that a first time user might have when using the service for the first time. When the journey starts it is assumed that the person is in a neutral state of mind. The state of mind is assumed natural because of two reasons. First of all it is the most common way to start an emotional journey visualisation. Second of all, even if it´s believable that people arriving at the water distributor might be tired, thirsty, sick or something similar because of their life circumstances in Kisumu, the people in the town grew up here. They live their lives just like anyone else and are used to the routines, culture and lifestyle here, so there is, in my opinion, an equal chance that someone comes there who is very excited, curious or happy. The first thing that happens when the user arrives at the site of the service is, in this journey, that she/he notice the water distributor for the first time. This creates some kind of interest/curiosity within the user and she/he takes a closer look. The user then reads the information provided, which might be a little bit boring but also interesting. The user feels a bit insecure regarding the service, which takes the mood down a bit. The user takes action and receives more information from one of the three ways to do this, which makes the user trust the service and realize that this is a more affordable way to safe drinking water than before. This makes the users mood rise. The user decide to send an SMS to order a specific volume of water. She/he might feel a bit nervous when waiting for the reply. When using the pump the mood might continue down a bit since it is a manual labour to use it. However when the user observe how the water is cleaned the mood rises again and when trying the water for the first time the user will realise that this is sterile, safe drinking water for a lower price than ever before. This will create a satisfactory feeling within the user. After using the water distributor the user will receive another SMS that contains a receipt, which will add on to the feeling of security and confidence regarding the service.

FIRST TIME USER JOURNEY

When a user is using this service for the first time it is a probable scenario that she/he will want some help to understand the service. This user journey illustrate an example of this. See appendix 16

SECOND TIME USER JOURNEY

When a user is familiar with the service since before she/he will know how to use it and won´t need any help doing so. This is why the user journey becomes shorter, faster and less complex. See appendix 17

INDUSTRIAL DESIGN

Product brief
Function analysis
Initial research
Concept development and evaluation
Further research
Form study
Materials and manufacturing
Final result
Scenario

Fig.25 Car washing business, Lake Victoria, Kisumu, Kenya

PRODUCT BRIEF

Introduction
Service Design oriented research executed in the town Kisumu, Kenya, indicates that there is a need of a new source of clean and affordable drinking water. Since Kisumu is located close to lake Victoria and because the water distributor will be used in public environments the water will be extracted from under the ground.

Technologies
The water distributor will be used manually, without any engine or similar, in order to minimize both initial and maintenance costs. The technology that cleans the water within the water distributor comes from the company Lifesaver Systems, from United Kingdom. The user will pay for the water using text messaging and the technology that enables this is the Coin code terminal[33], developed by the Swedish company ASSA Abloy. Both of these technologies will be physically implemented in the water distributor.

Materials and manufacturing
The water distributor itself will be developed and manufactured by Lifesaver Systems, however it is essential that it is maintained locally in Kisumu, which is why the construction needs to be as simple and basic as possible. The materials, however, will be og high quality to maximize the life length of the water distributor.

Target user
The users of this water distributor are the local people in Kisumu that, at present, have a lacking trust regarding the water they consume daily. This is why it is essential that the cleaning process is easy to see, read about and understand on site.

FUNCTION ANALYSIS

The main function of this product the is to offer safe drinking water. Some other important functions are:

Own	Shape
Be	Secure
Maximize	Sustainability
Own	Honesty
Own	Innovation

Since it is a physical object it will own shape. It is essential that it is secure for all involved stakeholders. Both regarding the product itself as well as the water it delivers. When making the statement that it will own honesty I´m talking about showing how the water gets cleaned to increase the awareness within the user. Since the method of cleaning the water is quite new the product will also, from this point of view, own innovation.

33. http://www.assa.se/sv/site/assa/Produkter/?groupId=4096&productId=277461 20120321 08.00

INITIAL RESEARCH

The cleaning process

How will the water distributor clean the groundwater in Kisumu and turn it into safe drinking water? The company Lifesaver Systems is the developer of the technology that will be used in this case. The cleaning process consists of three different steps. The first step is a common sponge that filters away the things large enough to spot with the bare eye. In this case, since the water will come from the underground, there might be some sand and soil particles and similar in the water. The second step in the cleaning process is the Nano Cartridge. This is the step that makes Lifesaver Systems technology superior to it´s competitors at the moment. This step filters the water through holes with a diameter of only 15 nano meters. Before this product the best filters on the market had a pore size of around 200 nano meters. There are bacteria and viruses that are as small as 25 nano meters, which means that the predecessors could not filter these away. However the products from Lifesaver Systems can, since their products has a pore size smaller than this. As a third and final step in the cleaning process there is an active carbon filter that filters away chemicals and bad smell from the water.[34]

The cost of the water

The one time investment made by the Kisumu municipality to buy the water distributor from Lifesaver Systems is exactly that: A one time investment, which doesn´t affect the price of the water in the long run. Neither will the investment of starting the website or opening the bank account or similar. Things that do affect the price of the water, however, is purchasing new filters and other maintenance regarding the water distributor. In order for the water distributor to work it needs both the nano pore filter, the activated carbon filter and the sponge. Since a sponge has an insignificant cost in this context the cost to make this investment

Fig.26 The Lifesaver Bottle

34. http://www.youtube.com/watch?v=pzdBCxZhKpQ 20120320 08.00

is not a part of these estimations. It is also important to notice that the cost estimations made where done to create an image of what the cost could be and should to be taken as reliable, certain information. The prices below are the prices that Lifesaver Systems sell their products for today on their website. It is believable that, if a city such as Kisumu, or a nation such as Kenya would make a larger order of products they might be cheaper than the prices for a private consumer.

The prices for the nano pore cartridges developed by Lifesaver Systems look like this at present:

Cartridge 4000 = 76GBP = 0.019GBP/L[35]
Cartridge 6000 = 110GBP = 0.018GBP/L[36]
Cartridge 10000 = 116GBP = 0.012GBP/L[37]
Cartridge 20000 = 149GBP = 0.00745GBP/L[38]

This pattern indicates that if the filter capacity increase five times the price per cleaned litre decreases with 61%
If this pattern continues if there where even larger filters the prices would continue like this:

Cartridge 100000 = 291GBP = 0.00291GBP/L
Cartridge 500000 = 567GBP = 0.0011349GBP/L

If Lifesaver Systems would manufacture a cartridge for public spaces that can clean 500.000L it would cost 0.0011249GBP/L to run it.
Translated to KES this would be 0.147KES/L

If the price that Lifesaver Systems offer for their largest nano filter today is the best price they can offer per cleaned litre it would cost 0.99KES/L to provide the water distributor in Kisumu with this type of filter, no matter what capacity it has.

Regarding the activated carbon filter Lifesaver Systems only has one size of this product today and the capacity and cost looks like this:

Carbon filter 1000 = 16GBP[39]
16/1000 = 0.016GBP = 2.096KES/L

If the price pattern would be the same as in the case of the Nano Cartridge the pattern would continue like this:

Carbon filter 125000 = 118.75GBP = 0.00095GBP/L
Carbon filter 625000 = 362.18GBP = 0.0005795GBP/L

Translated to KES this would be 0.077KES/L if the filter can clean 625000 litres of water.

Besides these costs the water distributor will need maintenance from time to time. A common daily salary in Kisumu is 300KES. In the best case scenario the estimation is made that the water distributor only needs maintenance one full working day a month. In the worst case scenario it is estimated that it needs maintenance one whole working day every week. Important to notice is that this cost is measured on a time basis, not on a volume of cleaned water basis like the other costs. These two scenarios would on a year basis generate these costs:

Worst case scenario: 14400KES/year + spare parts
Best case scenario: 3600KES/year + spare parts

The price will vary from 4.48 KES / 20L + 3600KES/year + spare part costs - 60KES / 20L + 14400KES/year + spare part costs. This can be compared with the price of 400KES/20L for bottled water. According to interviews most people would be willing to pay around 100KES/20L if the water is safe to drink.

35 - 38. http://www.lifesaversystems.com/buy-water-purification-systems 20120322 08.00

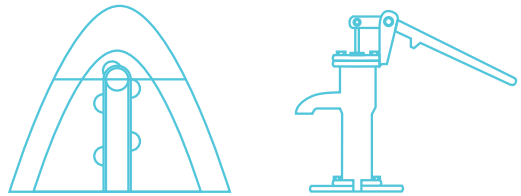
39. http://www.lifesaversystems.com/buy-water-purification-systems 20120322 08.00

The good thing about this is that once the pump is developed by Life-saver Systems it can be purchased and placed where ever there is a need of clean water in the world. The system regarding payment can be different depending on the situation. It is all up to the ones who buy it. Depending on the cost of the actual pump perhaps it can be cheap enough in the future for a small community to buy it together. It doesn´t necessarily have to be a municipality.

CONCEPT DEVELOPMENT AND EVALUATION

Two different concepts where developed. They are based on the two most common methods of harnessing ground water in Kisumu. See sketches of the concepts in appendix 19 and 20. Concept one, inspired by the principle of using a bucket and a rope, has been modified to harness more water than usually. This is the big advantage within this concept. Or is it? To be able to harness a large amount of water in a short time and with just a small effort sounds good but there might be a risk that people don´t experience the water as valuable in this case. This water is only supposed to be used for drinking. Nothing else. This concept also displays the water very well since the outer shape is made of some kind of transparent or semi transparent material. This can make the harnessing and cleaning process very clear and understandable for the user. However the product probably needs a lot of cleaning to look and be fresh in the long run. And if someone cranks up water and leaves it in the product it might get bad after a while, which takes away the entire point of the service since it has already passed the filtering process.

The second concept, however, has a lot of advantages. It works just as any hand pump today which makes it easy for local pump shops to maintain it. It takes up less space, which means that it can be placed at more locations than concept one. It is possible to make it more semantically correct, which will increase the understanding from the user. The only disadvantage this concept has is that it might be difficult to harness enough water fast enough to meet the demand from the users. On the other hand this can create a feeling within the users that this water is valuable. If the demand should be too high there is always a possibility to implement additional pumps to meet the demand, which is the strategy of this service to start with. Based on these thoughts the second concept was taken into the form study stage of the product development.



Amount of water	●	
Innovation	●	
Hygiene		●
Manufacturing		●
Maintenance		●
Maximizing number of users	●	
Minimizing spill		●
Recognition factor		●
Physical size		●
Water visibility	●	

Fig.26 Concept evaluation matrix

FURTHER RESEARCH

Interview at local pump shop

After making the choice of water harnessing method it was vital to talk to someone local that is involved within this, which is why a visit at a local pump shop was executed. The most vital information from this visit was that the most common depth to drill down to in Kisumu is around ten meters, then the water will float up and fill the borehole differently depending on where you drilled. Besides this a conversation took place regarding a pump that this local pump shop sells today. They imported it from India and they maintain it themselves without any external help. The only thing the received when importing the first example of this pump was a manual describing how to use it. No one came to Kisumu to show or tell them how to do it. They learned from the manual and started out from there. It is, according to this interview, crucial that the pump can be maintained locally, since it would take too long time to order spare parts from somewhere else to make the service successful. This opinion the retailer based on an earlier project, similar to this one, which failed because of this very reason. The retailer I spoke with also said that when they make a borehole and place a pump somewhere the water that gets pumped up does not contain any sand, stone or similar, which in the case of the pump developed in this project would be good for the sponge in the cleaning process. When I asked if his organisation would like to be responsible for maintaining and changing cartridge in this service he said yes, that would be very interesting for them to be part of.[40]

How a manual water pump works

A common manual water pump has a force rod. This is moved up and down by the user, which causes one or several pistons within the pump house to move up and down, creating a suction that pushes the water up from under the ground. The number of pistons needed depends on the distance to the water. According to my interview at the pump shop a common relation regarding this is to use one piston every third meter down.[41] However if the depth is less than seven meters there are pumps on the market that can have all the vital parts above ground, which is good when it comes to optimizing maintenance.[42]

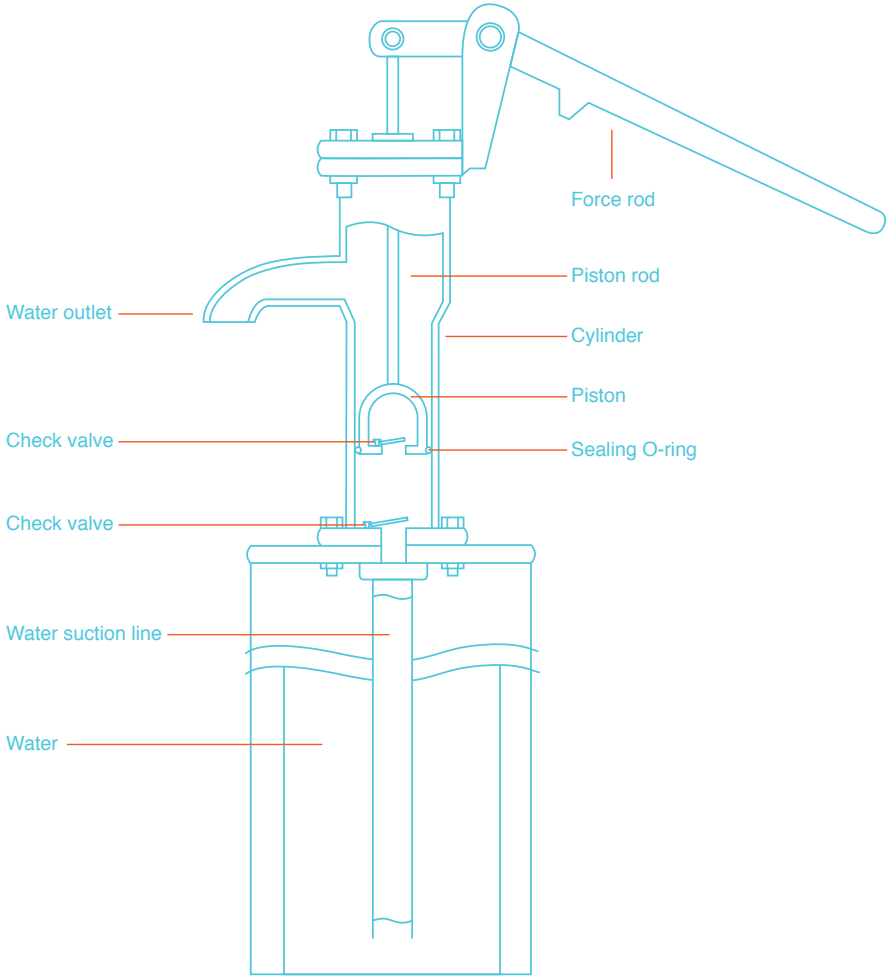


Fig.27 Manual water pump

40. Expert interview with Benson Andayigoo, water pump retailer 20120322 08.00

41. Expert interview with Benson Andayigoo, water pump retailer 20120322 08.00

42.http://www.wateraid.org/uk/what_we_do/sustainable_technologies/technology_notes/244.asp 20120323 08.00

FORM STUDY

Main body
The main body of the pump needs to be and feel stabile and secure. However it can´t feel intimidating by being oversized. It´s also convenient if it has a limited physical size since this maximizes the number of sites it can be placed. The basic shape used as a starting point in this process was a cylinder, since this can be approached with an equal feeling from every direction and since it is easy to manufacture such a basic shape. The matrix in figure 28 was developed to relate the size of the main body of the pump to the size of a human.

Window shape
See appendix 21. The window will be the touch point on the pump, where the user can view the cleaning process. A sketch process took place regarding the shape of this feature on the product. This process generated four concepts. The one taken further in the form study was the one that has one window for each step of the cleaning process in a straight, clear direction. To illustrate that this process starts in the first window, continues through the middle one and ends in the third one, the first and last window has large radius in the corners, but the one in the middle is a plain rectangular shape. To enhance the feeling of the new technology contained within the pump house the lines between the windows are very thin. This, in my opinion, gives a feeling of high quality and precision. One of the steps in this process can be seen in figure 29.

Handle and tap
See appendix 22. After finishing the process regarding the window the form study of the handle and the tap started out. They are in the same form study because I wanted them to be connected on a semantic level. This to enhance the message that if the user does something with the handle something will come out from the tap. A sketch process regard-

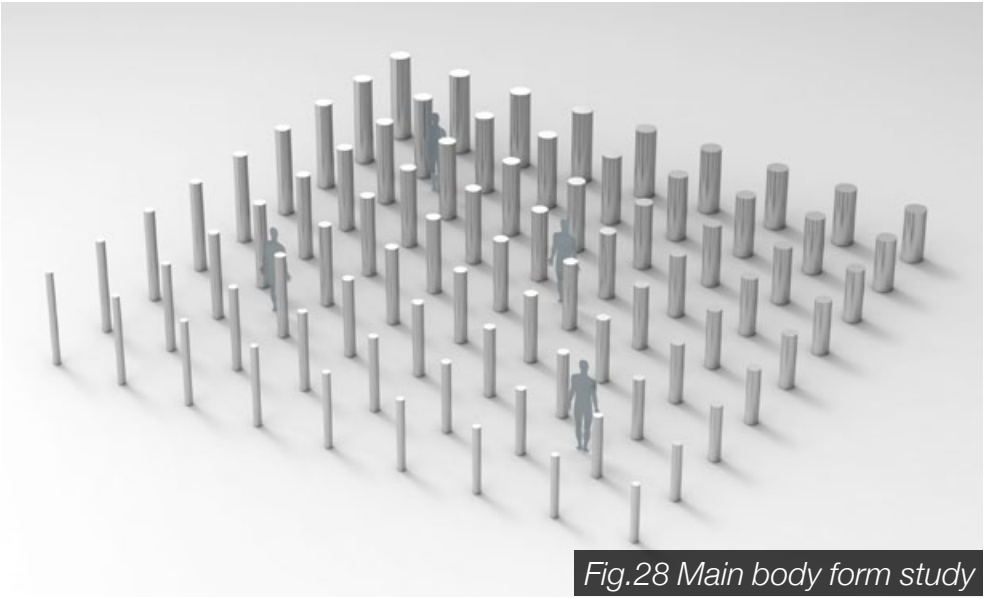


Fig.28 Main body form study

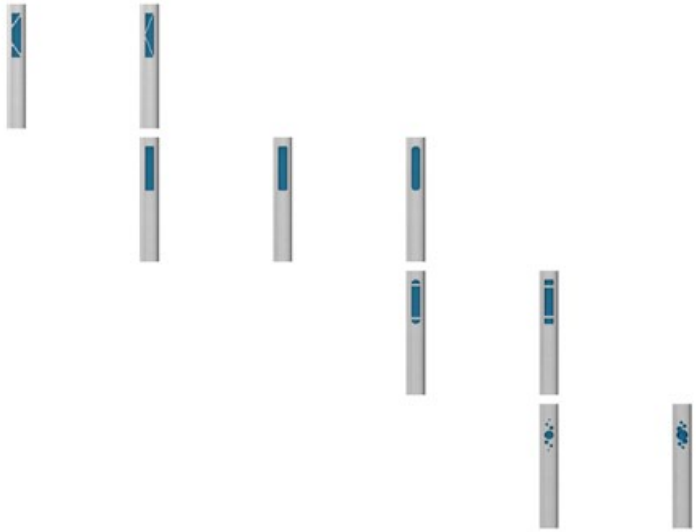


Fig.29 Cleaning process window form study

ing this took place and generated two different concepts. The one that was chosen has the advantage of looking more dynamic than the other one. Since the handle is the only moveable part on the pump it might be easier for the user to realise this if the handle shape exudes this feeling.

The payment terminal

The structure of the buttons in the payment terminal is the same as most mobile phones since this is a structure that people are familiar with in Kisumu. The numbers on the buttons have a separate colour to create a contrast, which makes them more visible from a distance. To make it easier for people with less good eyesight the numbers are emboss. This makes it possible to feel where which number is instead of having to see it. The front of the payment terminal has the same rounded shape as the main body of the pump to follow this shape and not stick out in any way since this would be more vulnerable to vandalism.

Colour

See Appendix 23. To highlight the parts of the pump which will be in direct contact with the user a contrast colour will be used. During the development of the pump it seemed logical to choose a value of blue for this purpose. There was, however, also a certain interest to take a look at some other colours, orange in particular, inspired by the orange sand of Africa and freshness. However the choice still became a blue value since it is a water distributor that has been developed. Figure 30 illustrates some of the blue values that where investigated.

Vessel holder and hose

To make it possible for people to use a variety of vessels when pumping up water there is a vessel holder below the tap on the pump. The holder is designed to give support to vessels of different sizes and shapes. If the vessel is a common PET bottle with a volume of between 0.5L - 2L the bottom surface will be used for placement of the vessel and support will

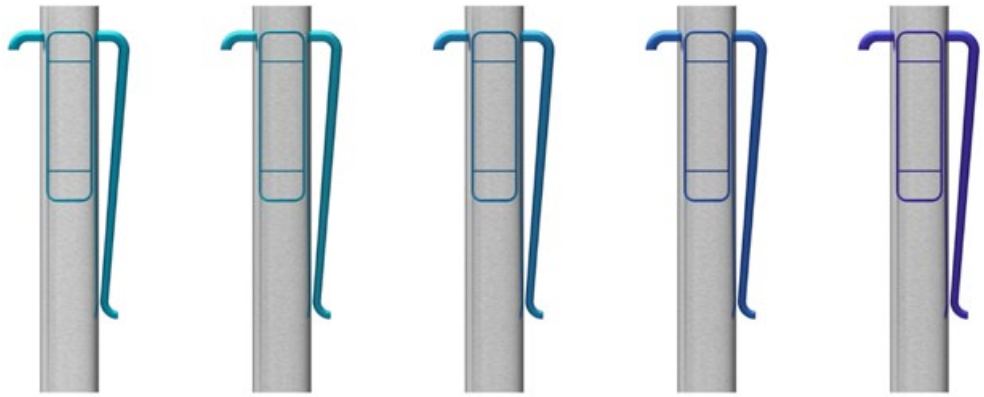


Fig.30 Colour selection

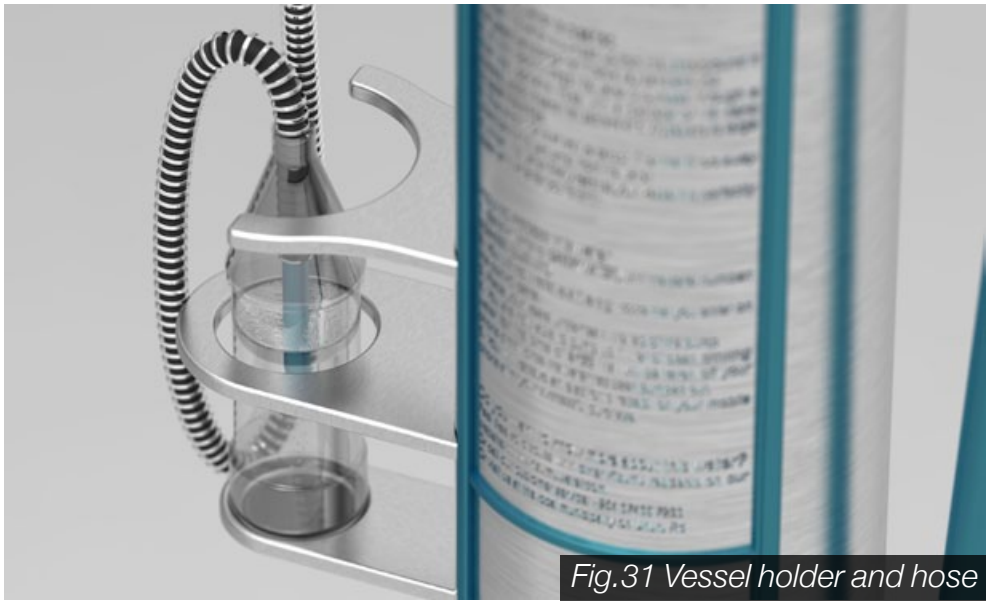


Fig.31 Vessel holder and hose

be given by the second surface of the vessel holder. The second surface, however, is large enough to place cylindrical vessels with a size up to 5L. The cylindrical vessel shape is the most common one but since the third stage of the vessel holder has an open shape it gives support to all kinds of vessel shapes. If, however, a user wants to purchase 10 or 20 litres of water, these vessels can be placed on the ground, since the hose is long enough to reach them there.

MATERIALS AND MANUFACTURING

The pump is constructed as basic as possible from a manufacturing and maintenance point of view. This to minimize the one time investment and the cost of maintenance. The materials, however, are durable to maximize the life length of the pump, before it has to be recycled. The majority of the parts such as the main body, the handle, the tap and the vessel holder are made from stainless steel. This is more expensive than cast iron but, according to the interview at the local pump distributor, will increase the life length of the product about 3-5 times. This is based on the fact that the pump imported from India comes both in cast iron and stainless steel. In some cases the parts are moulded to their shape, in some cases small parts are welded on afterwards. The parts that needs to be transparent in order for the user to take part of the cleaning process are in some cases made of 15mm safety glass and in some cases fibre glass. This will give good security against vandalism. The sponge is made from cellulose wood fibres, the carbon filter is made from carbon and the nano pore filter is made from the same polymer as the existing filters provided by Lifesaver Systems are today. What this polymer is, however, they don´t want to say. The pistons located inside the pump house and in some cases also under the ground, are made from a polymer called POM, since it is common to use instead of metal within construction and since it absorbs a very low amount of water.

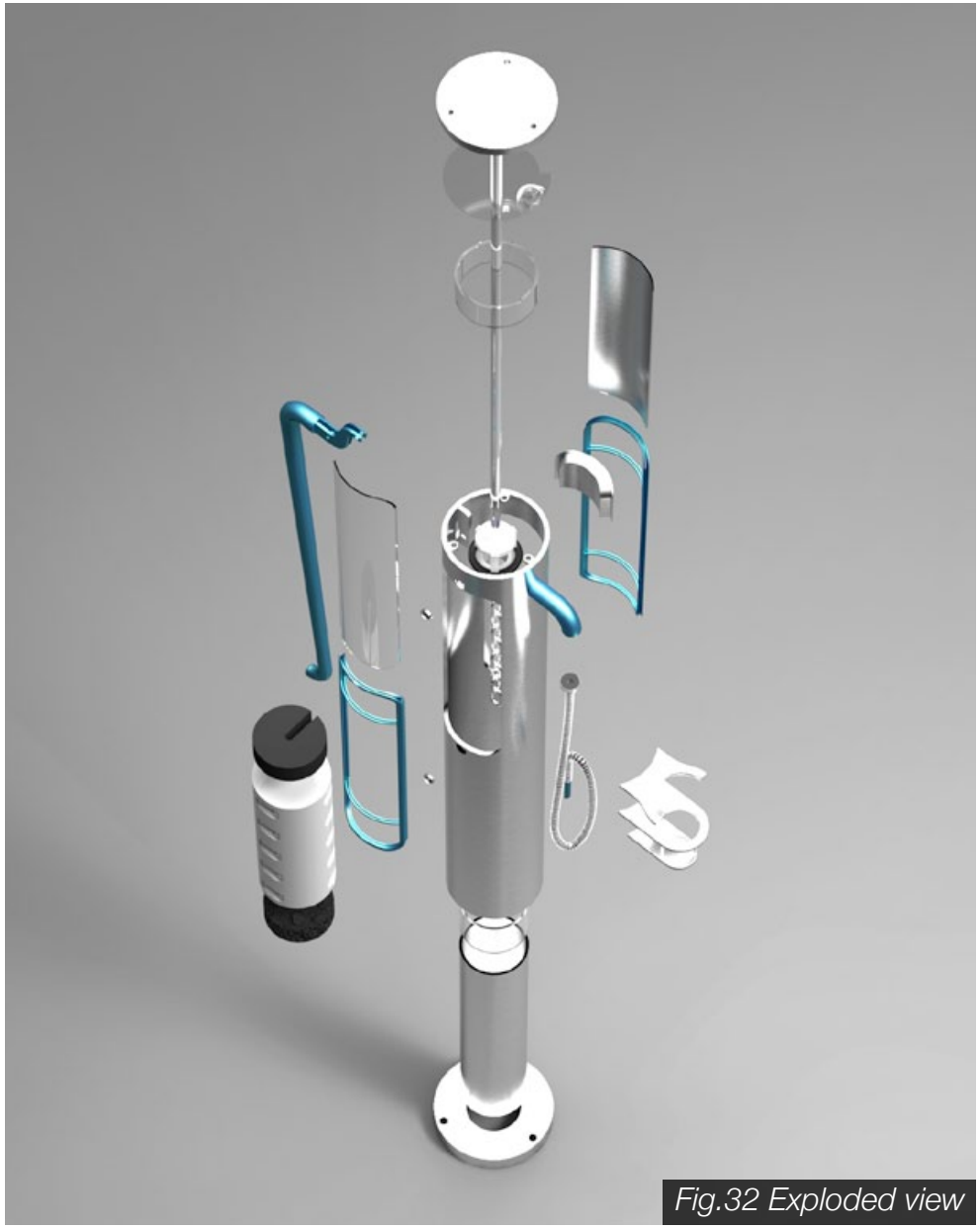


Fig.32 Exploded view

FINAL RESULT

The image on the right and appendixes 24-26 illustrates the final product. The pump has a visible cleaning process to increase the understanding and trust the user feel for the water. The pump can be opened in two ways. The most common one is to open the window on the side of the pump. This is opened when there is a need to exchange any of the filters. The window has two locks, since having only one lock and give one person the responsibility of the filters might cause filters to disappear. The most believable scenario is that one key will be given to someone working at Jubilee Market and that the other key will be given to someone from the maintenance company. The pump has one outer and one inner pump house. The outer one is not pressure safe, but the inner one is. It works and looks like a traditional hand pump since people in Kisumu are used to this type of product and will understand how to use it. However the expression of precision within the shape of the window on the side indicates that this pump contains a new technology and that the water that comes out is different from the water the people usually drink. It is safe, clean and affordable.

SCENARIO

It´s eight in the morning the 2 of April 2016 and the Jubilee Market opens up for the day as usual. The sun just raised and there are long shadows on the ground from the buildings and the trees in the area. The people working at the market are putting up the vegetables, fruits and other items they attempt to sell today. Between the fruit market and the dry fish market there is a water pump. A water pump that provides people with safe drinking water. Something that is new to the people in Kisumu.

This scenario illustrates the situation of William. William lives a bit outside

Fig.33 Final Result

of Kisumu and he is studying medicine at Maseno university in the middle of the town. Yesterday his friend Maurice told him about the pump at the Jubilee Market. Normally Wiliams family harness rainwater which they boil and then drink. However it doesn´t taste very good and they are a bit concerned regarding the quality of the water. This is why today William takes a matatu (mini-van used for public transport) down to the big bus central next to the Jubilee Market to purchase some water.

When William arrives at the pump he feels a bit insecure about how it works so he asks Mary, a lady working as a dry fish retailer, how he should do to use the pump. Mary explains to William that first of all he needs a vessel. A few meters away from the pump a lady named Raman is selling various vessels used for water, diesel, vegetable oil and similar. William buys a 2 litre re-used PET bottle from Raman and goes back to the pump. He places the vessel in the vessel holder and puts the water hose inside it. Mary shows William the number where he needs to send an SMS in order to activate the pump. This number is written on the side of the pump. William sends an sms with the text: 2L, and after a few seconds he receives a reply with a code that he enters on the terminal on the side of the pump. The pump is now active and William can pump up 2 litres of safe drinking water. As he is doing this he takes a look at the cleaning process, which he thinks is quite interesting to take part of and it makes him realize that the water is safe to drink. After pumping up his 2 litres of water the water flow stops and William receives a receipt of his purchase as an SMS on his phone. He tastes the water and it doesn't taste like rainwater at all. When he reads more about the cleaning process on the side of the pump he realize how it works and he feels even more secure regarding the quality of the water. He takes the matatu back home and his family members tries the water.

During the day several people use the pump. Most of them have used it before and knows how to use it, but some, just like William, are using it for the first time and are a bit sceptical regarding the quality of the water, they might need some help regarding how to use it but they feel that they are being well informed and confidence regarding the quality of the water starts to spread. In the case of William and his family the water they use will be discarded in their pit latrine in the form of urine. If any water ended up outside of his vessel when he used the pump it is up to each individual pump installer to decide how/if the pump should be connected to the sewage network or not. Perhaps it is easy because it´close to connect to it, perhaps it´s difficult because it is far away.

REFLECTIONS

Implementing this service in Kisumu is a complex action that affects a lot of stakeholders. A lot of people make a living from water within the town and will be frustrated by this. When starting to work with this project I asked myself if it was the right thing to do on a moral level, since it will have such a negative impact on a number of peoples lives. For me the answer is worth thinking of, yet very clear. Of course it is the right thing to work with the project. The opportunities of work change in a society as it develops. It is a natural thing and unavoidable if there is an ambition of development. When one opportunity is closed because of the development another opportunity is opened. This is my value and this is why I believe that it is a good thing to be working on this project.

As the implementation strategy of this service suggests, the implementation needs to start from an initiative taken by the locals and an investment made by the local municipality. After this action research indicates though that it is valid that the people are responsible of maintaining the service. If the opportunity to implement and maintain the service where given to Kiwasco it is almost certain that nothing would happen since it is a service that competes with their own water that they distribute today. There would also be a risk that corruption within Kiwasco would allow certain individuals to use the service for free and that the price of the water would increase for everyone else if the service turns

out to be a success. When the new mayor of Kisumu: Samuel O. Okello, was announced his position he ended up in a struggle with a lot of peoples in Kisumu since he started to terminate people within the municipality who had been given positions without a relevant academic background. Since they where given their positions without a relevant academic backgrounds it is in this context believable that they where given their positions because of reasons related to corruption. I see the actions of Samuel O. Okello as actions against corruption and therefore the municipality of Kisumu as a more trustworthy organisation behind the investment of this service than Kiwasco. However the people of Kisumu must take the first initiative which is needed to get the attention from the municipality. In a few weeks I will send material to people I know in Kisumu that will make it possible for them to put up a billboard in the town that describes the service, as a starting point for them to talk about wether or not they want to suggest this to the municipality in the town.

The success of the service relies a lot on trust. People have to trust that the water they drink is good for them. They have to trust that the money they spend on the water is used for the right purposes such, as paying the salaries for the people maintaining it and that money is also saved to expand the service in the future. For a short time I was thinking of naming the project simply “Trust” because of these reasons. This was until I discovered that “Trust” is the name of the largest condom brand in Kenya. After I found this out I chose not to name my project at all since this project lies within a different topic. This service is not the optimal long term solution for a high technological society. According to interviews with staff at Kiwasco they have the knowledge within the company to clean, control and provide clean water. The only thing that they are missing to refine their cleaning process and exchange the piping system is time and money.

Another thing that makes the water distribution system hard to develop in Kismumu is that there are a lot of unplanned residential buildings. Another more common word for these are “slum” areas. Even if Kiwasco had the financial means today to expand their system these areas would be very hard to provide since people don´t have addresses, there are no names of the streets, and a lot of people are unemployed and would have difficulties paying for the water, since the first thing they would have to do to get access to it would be to purchase and install a water meter, something that would be very hard on an economical level for most people. Besides this the corruption within Kiwasco would also make this very hard. That´s why this project has focused on implementing a service from the outside that could start providing the people of Kisumu with clean water within only a few years time. However there is a need for the pump to connect to the existing sewage system, to avoid the small amount of water that is wasted during usage to end up somewhere else then at the Kiwaso sewage plant. How to do this will vary from pump to pump depending on the location of implementation related to the piping network in the town.

In general people in Kisumu are seriously religious. There is a risk that this will make it hard for people to realize that something as natural and fundamental as water can be cleaned using something as high technological as a nano sized pore filters. It is therefore important to describe the cleaning process of the water in a simple, clear way to increase understanding and confidence that as many people as possible will accept. I don´t see this as a too large obstacle though, since people here are used to adjusting ti foreign technology. A common example of this is the mobile phone, something that almost everyone in Kisumu use today.

Where I come from, religion is not as apparent as in Kisumu. The general population of Sweden don´t go to church and spend time several times every day praying. However in a place like Kisumu it is essential to do so because the religion is what gives people hope and strength to deal with

the obstacles that they face in their daily lives. This came clear to me during my interviews with the local people in the town. When I asked locals what hobbies or interests they have they had no concept of what this was. Instead they told me what they wanted to do for a living instead of their present occupation. When I asked them to mention something that they stand for or some kind of value they had, every single individual said something related to their religion.

When talking about right or wrong something that I also ask myself is if it is the best solution to implement foreign technology in a place like Kisumu with strong traditional values. Even if people would adjust and use the products or technologies, is it morally sustainable to implement them anyway? This is a complex question and it is hard to have a clear opinion and stand for it. If I would explain what I think of when I hear this question It reminds me of a question that I got from a friend of mine in Kisumu, William. He asked me what I thought would be the largest obstacle for him if he where to study and work abroad in the future. I told him that he needed to think about time in a different way than he does now. In Kenya people are almost expected to be late for meetings and other appointments. It´s just the way people perceive time there. However I told William that it would be fine if Kenya and Africa had the money and where more developed then the rest of the world. Then the rest of the world would have to adjust to their way of perceiving time. This is however not the way the world looks right now, which is why William would have to adjust his behaviour. No one says that it will be easy for him, but that´s the way it is. To get back to the point I think the same principal applies regarding importing foreign technology and adjusting to it. No one will say that it will be easy, it´s just the way the world looks right now. The people I have met and talked to in Kisumu don´t want the lifestyle that applied in Kenya before it started to develop. They want their society to move forward, just like they see that other societies have done already.

Too get back to the implementation of the service another factor that has an impact on it before it even exists is the interest from the company Lifesaver systems to modify their existing technology for public spaces instead of private usage. The products manufactured by lifesaver systems today are far to expensive for a normal family in Kisumu to buy, which is why the only way to make it possible to implement it from an economical point of view is to make it into a public installation.

I had a talk with Lifesaver systems regarding their interest in implementing their technology in a water distributor for public spaces in developing countries, but they said they where afraid of doing so because they can´t control the quality of the water beyond the product they implement. Today Lifesver Systems have three different products. One bottle of 0.75 litre, one backpack and one jerrycan of 20 litres. I asked Lifesaver Systems if they thought that people where drinking directly out of the 20 litres jerrycan as well or if they had any solution of how to control the quality of the water beyond leaving that product. I also asked them about their opinion regarding which is better or worse for peoples health. Having dirty water filled up in dirty vessels, or having clean water filled up in dirty vessels, perhaps clean the vessels with the clean water then fill them up again. Starting to spread clean water in a society will probably result in a more hygienic society. At least that´s what I believe. I did not receive any answers from Lifesaver systems regarding these thoughts which I take as a sign that my arguments made a good point and that they didn´t know how to respond to them. I thought to myself that, if there was any way for Lifesaver Systems to make money from a product such as this one, of course they would be interested. However, I am a subscriber to their newsletter and last month (April 2012) they had an article about a new product from their side. Lifesaver M1. This is a large safe drinking water distributor for public spaces that will be implemented in Malaysia and the production will start in August this year. Just like the concept suggested in this project it will not use any electricity or other fuel.

It will use the same nano pore cleaning technology, it can provide 2 million litres of water before the filters needs to be changed and it will be placed in developing countries where ever it is needed, if the country can pay for it. The only difference between the M1 and the concept suggested in this project is that the M1 will harvest rainwater instead of groundwater. Who will pay for the water, however, the article doesn't say. This agreement between Lifesaver Systems and who ever their investor in Malaysia is, is estimated to be worth 60 million GBP.

A risk regarding the service developed in this project, however is that the so called vendor people that make a living delivering water to people in Kisumu today will take dirty water for free somewhere and claim that it is taken from this pump and sell it to people. If the people then get sick or doesn't like the quality of the water it can create false accusations against this service. It is therefore important that people don´t buy this water in any other way than at the implementation site of the pump. When it comes to the implementation site, the Jubilee Market, it was chosen because of several reasons. First of all the market place is the heart of the town, where a lot of people come every day. Besides this there is a public tap close to the site of implementation, which makes people able to make a choice. If they don´t want to pay for this water they can still get water from this tap, the way they are used to. Besides this the Jubilee Market is closed during the night, with armed guards looking after the area, which will minimise the risk of vandalism on the pump. The specific location between the fruit market and the fish market where it will be implemented is also surrounded by buildings, which makes it impossible for to go there with a car and load up hundreds of litres of water and make a private business out of it. It is important that the water is valued high to exude high quality.

The payment system, using text messaging, is something that I don´t believe will be a problem in Kisumu. Almost everyone has a cellphone and it is a common thing to use text messages to pay for other things. It is also a way of avoiding vandalism on the pump since there won´t be anything of value inside it. Also the costs regarding handling physical money is limited since this method will be used.

To summarise this reflection I want to talk about my project from a personal point of view, since I divided my project description in one personal and one topic related part from the beginning. I have seen the largest part of the time that I spent on this project as something that I executed to deliver a relevant thesis that would be interesting for others to take part of. The other time spent was for my personal winning. I spent a lot of time investigating things in Kenya that didn´t seem related to my project. In some cases they just ended up with me learning something new that was not related to water or to marketplaces, however sometimes they gave vital information to the project. For example when I started to join the weekly meetings with the dry fish women group I had no idea why. I just did so because I was curious about what they where talking about in their meetings and if I could give some kind of input and gain something at the same time. It turned out that they had vital information that had a significant impact on my final result. When asked if all the methods that I used during my project was relevant and if they generated something for the project the only thing I can say is: of course not. However they helped me create an image of the lives and situations of people from another part of the world and that was the point from the beginning if I´m talking about this on a personal level. I have asked locals, staff at Kiwasco, teachers at the universities, people working at market places, people living in both rural and urban areas and they all say the same thing. This would be a great solution for the people of Kisumu, but it would be hard to implement it in the present system because of the effect it would have on the stakeholders in the town. The only thing I can do now is to send this and other material to key people in the town and leave the responsibility to drive this project further to the local residents of Kisumu.

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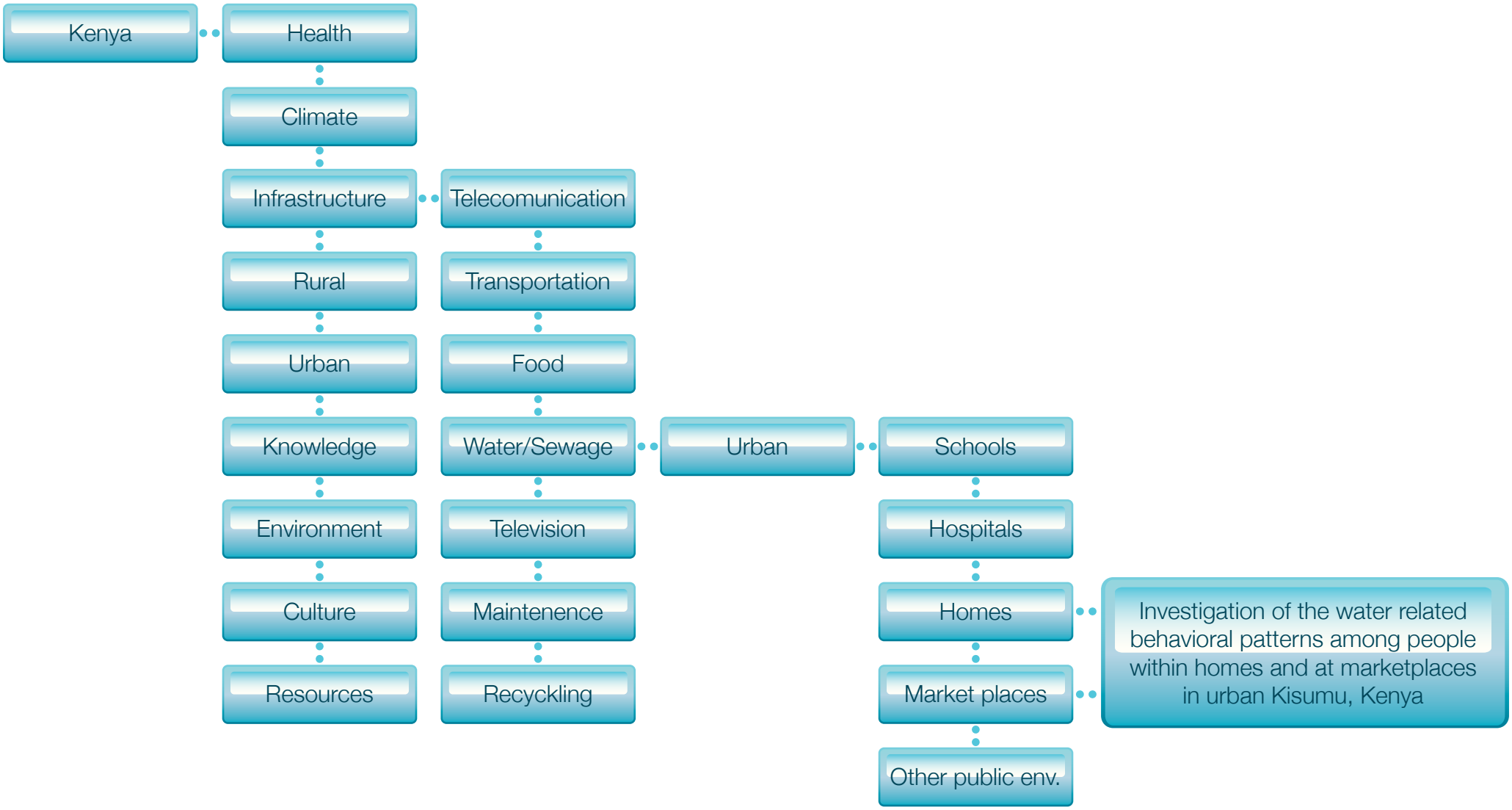
12 http://www.Kisumu.co.uk/History.htm 20111128 11.00
14 http://www.lake-victoria.net/ 20111128 11.30
15.https://student.portal.chalmers.se/sv/studier/kursinformation/kurser/sidor/kursinformation.aspx?hp_id=6833&hp_view=handout&path=Assignments_and_workshops/Reports_Kisumu_2009/Waterwise&parsergrp=1 20120219 08.00
16.http://publications.lib.chalmers.se/cpl/record/index.xsql?pubid=92572 20120220 08.00
21. http://www.mapkibera.org/blog/2010/09/05/kiberas-census-population-politics-precision/ 20120215 09.00
33. http://www.assa.se/sv/site/assa/Produkter/?groupId=4096&productId=277461 20120321 08.00
34.http://www.youtube.com/watch?v=pzdBCxZhKpQ 20120320 08.00
35 - 39. http://www.lifesaversystems.com/buy-water-purification-systems 20120322 08.00
42.http://www.wateraid.org/uk/what_we_do/sustainable_technologies/technology_notes/244.asp 20120323 08.00

Images

All the images in the presentation where taken or visualised by me, with these exeptions:
Fig. 26 http://development.thinkaboutit.eu/think3/post/a_truly_revolution_in_the_access_to_clean_drinking_water
Appendix 2. Kenyan Population Census 1969 - 2009
Appendix 3. _http://opendata.go.ke/Population/Kisumu-Pop-Pyra mid-Age-Groups-2009/xu8d-ezsq

APPENDIXES

Appendix 1. Topic development



Appendix 2. Time scope

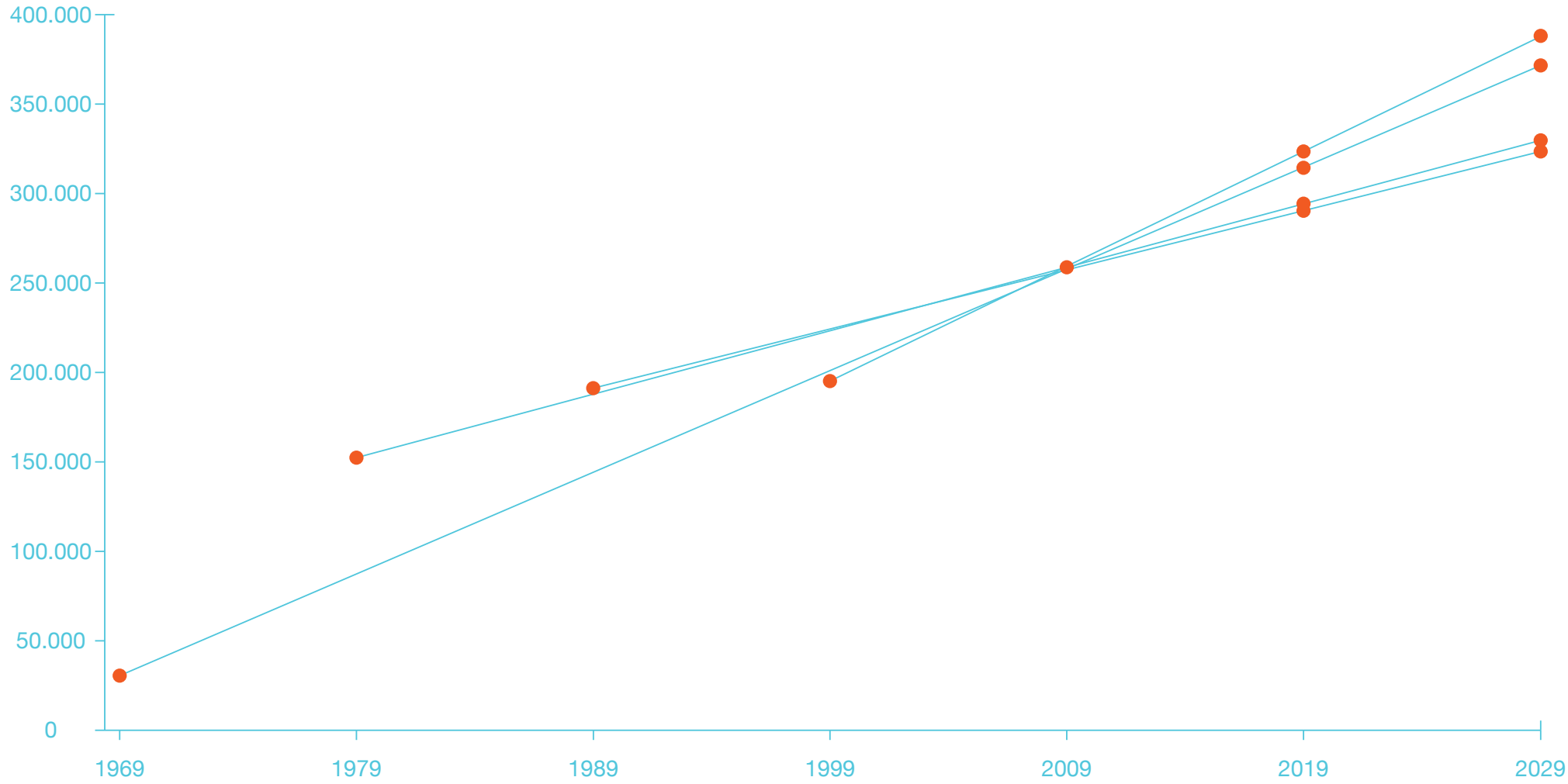


Diagram extracted from Kenyan Population Census 1969 - 2009

Appendix 3. User scope

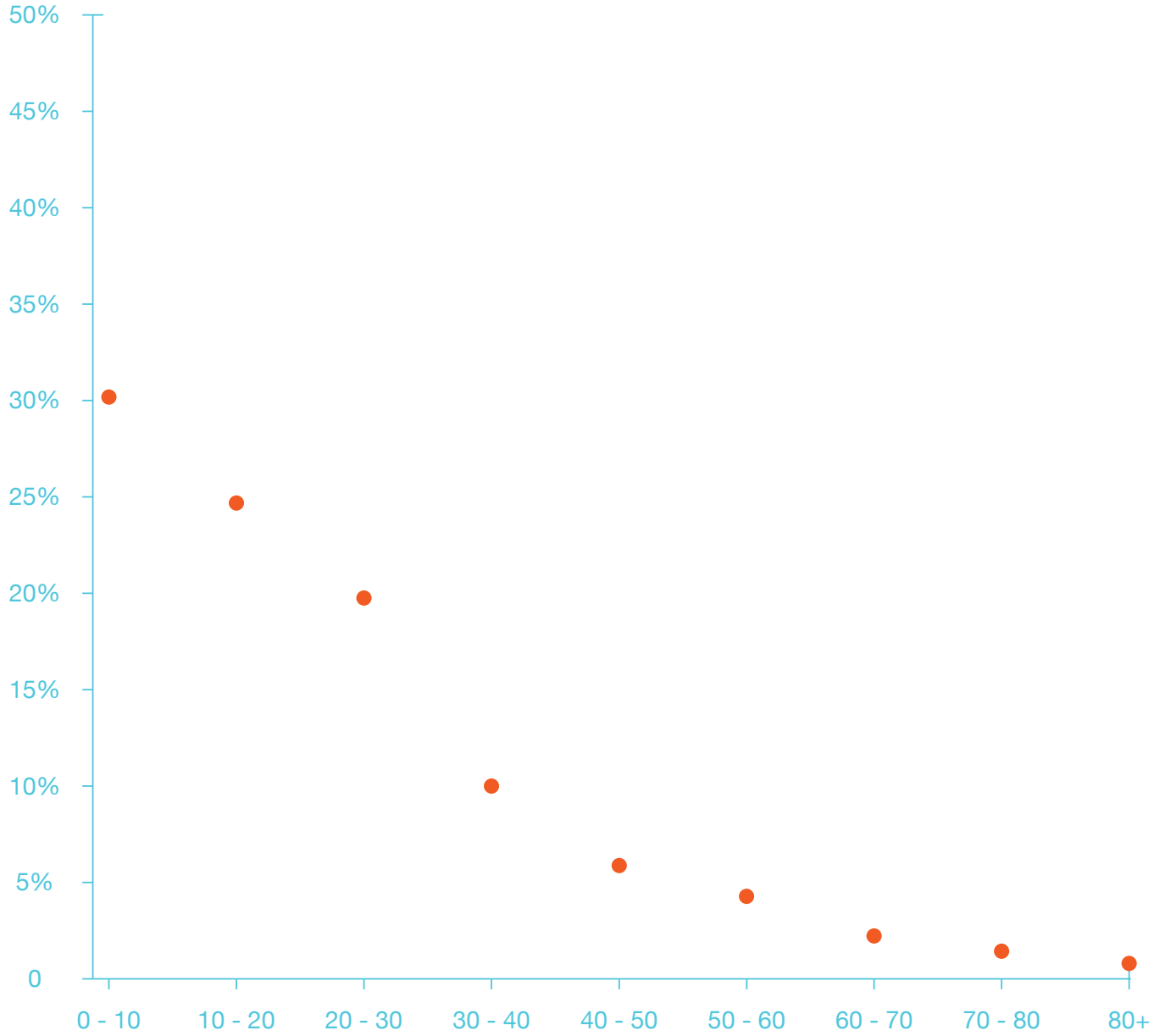
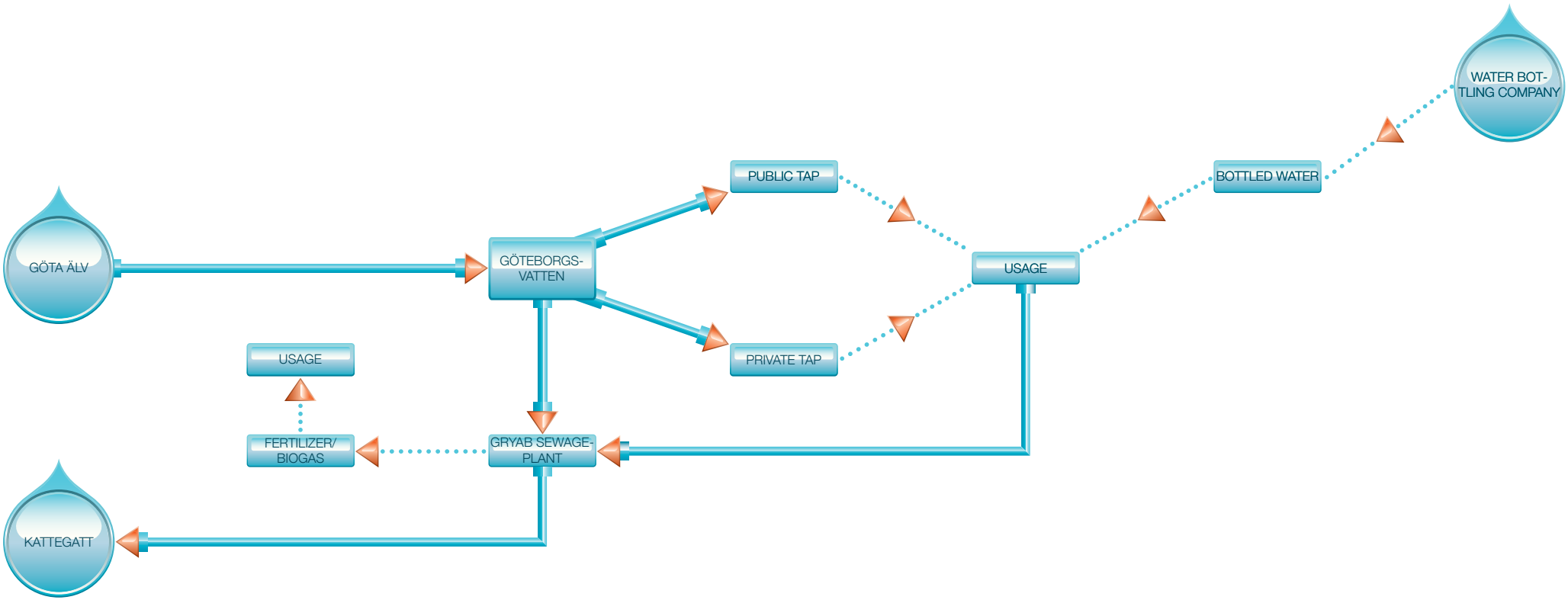
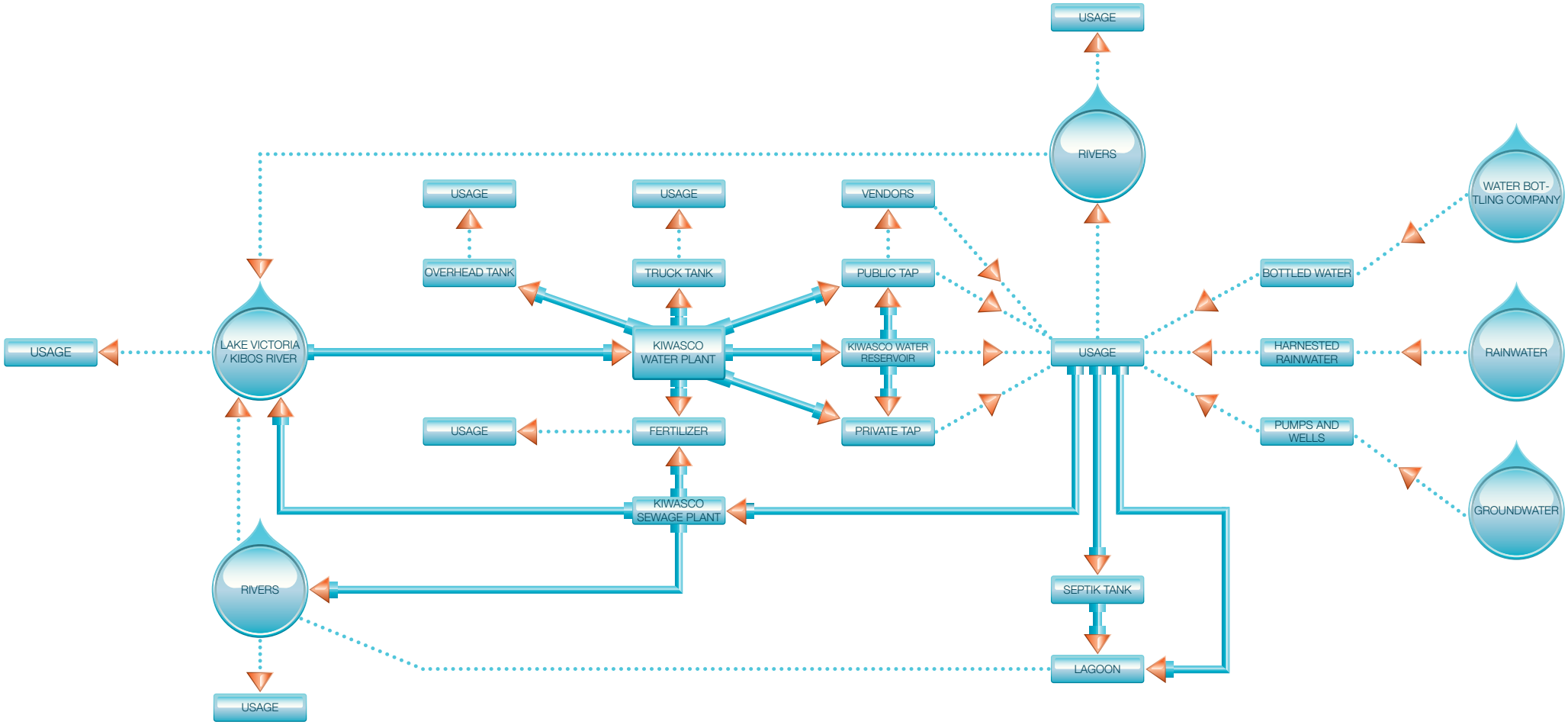


Diagram extracted from _http://opendata.go.ke/Population/Kisumu-Pop-Pyra mid-Age- Groups-2009/xu8d-ezsq

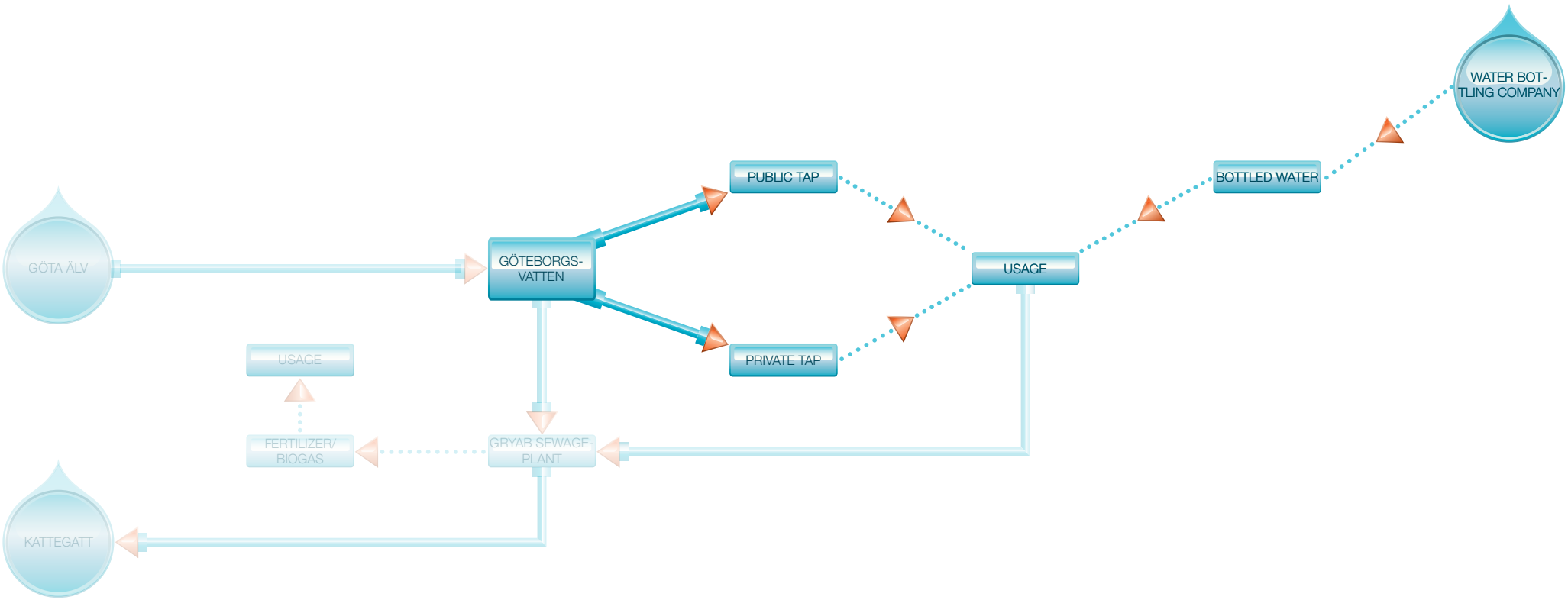
Appendix 4. The water distribution system of Gothenburg



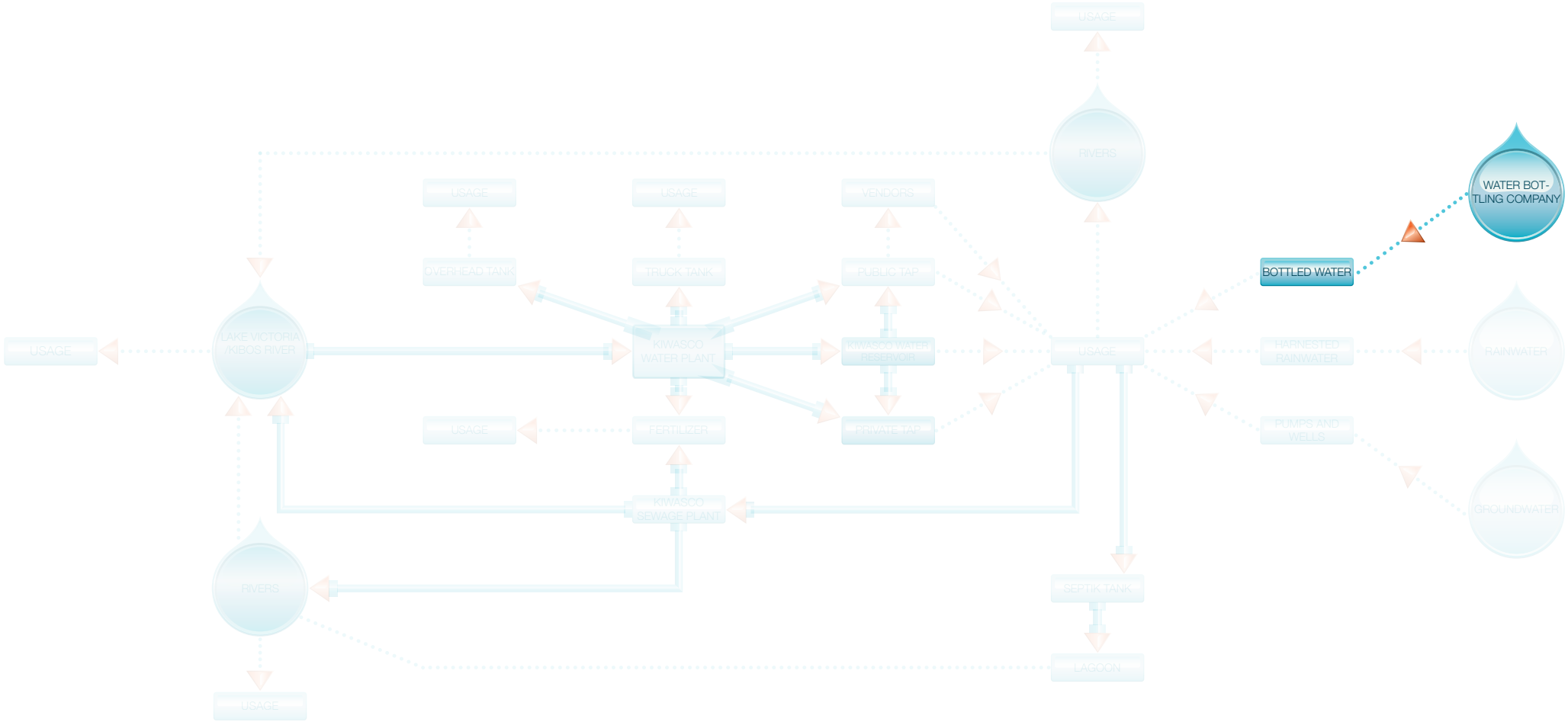
Appendix 5. The water distribution system of Kisumu



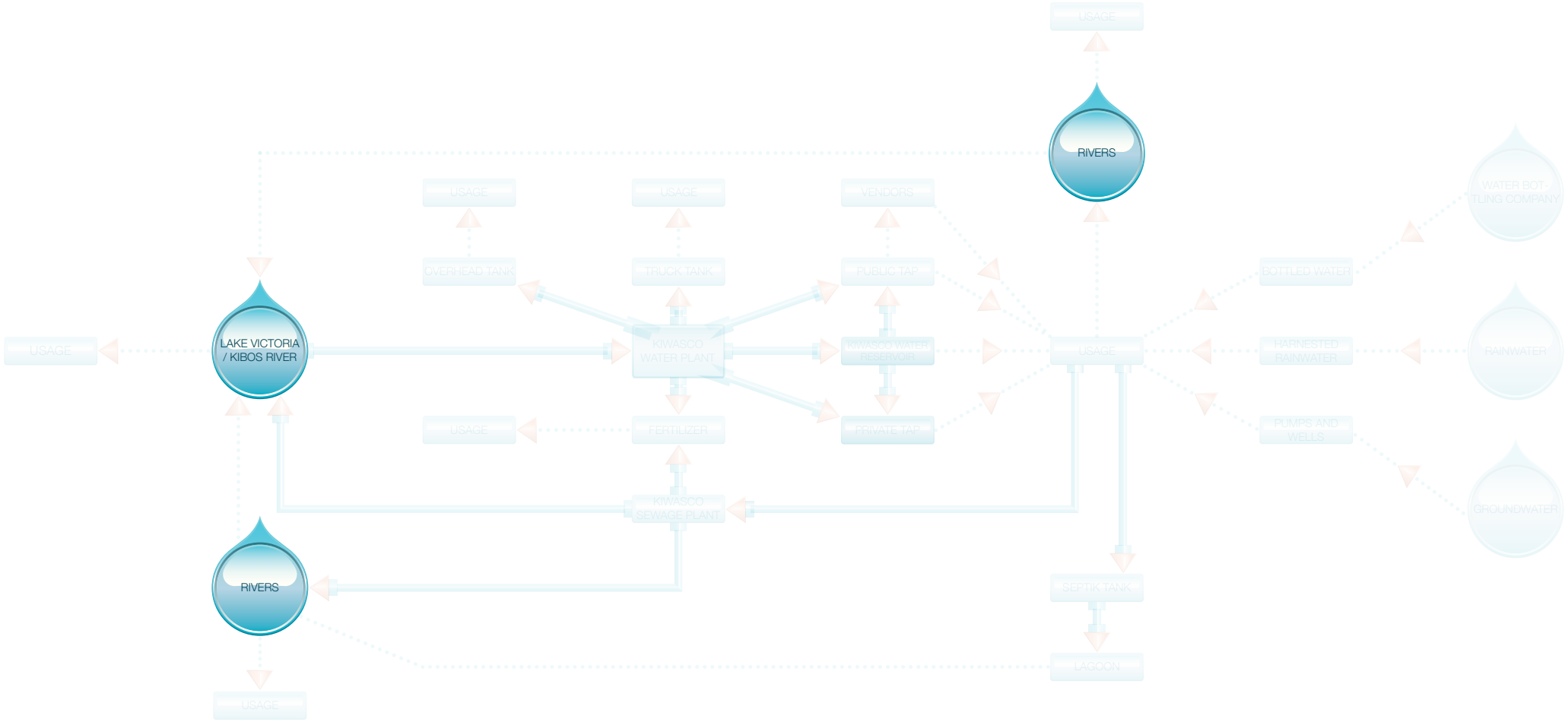
Appendix 6. Clean water in the water distribution system of Gothenburg



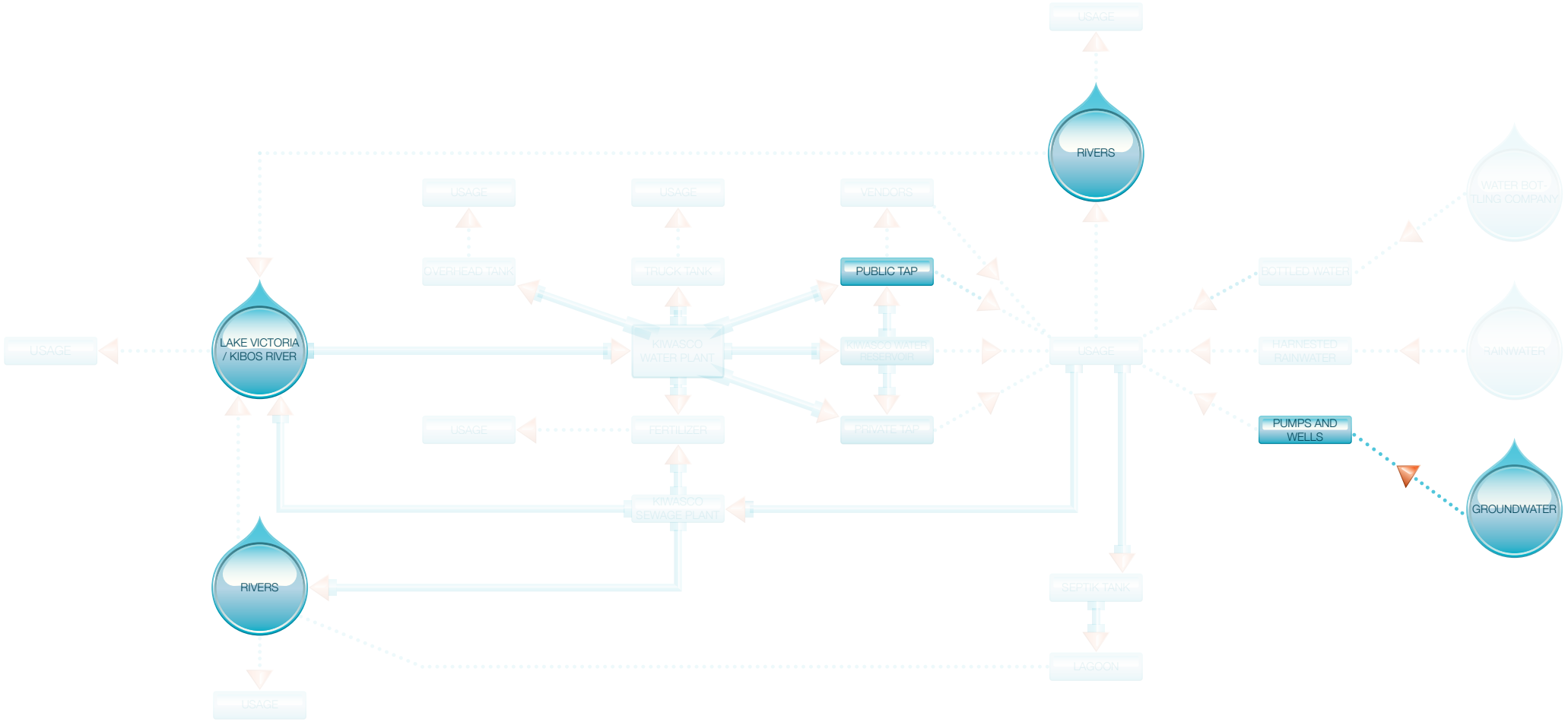
Appendix 7. Clean water in the water distribution system of Kisumu



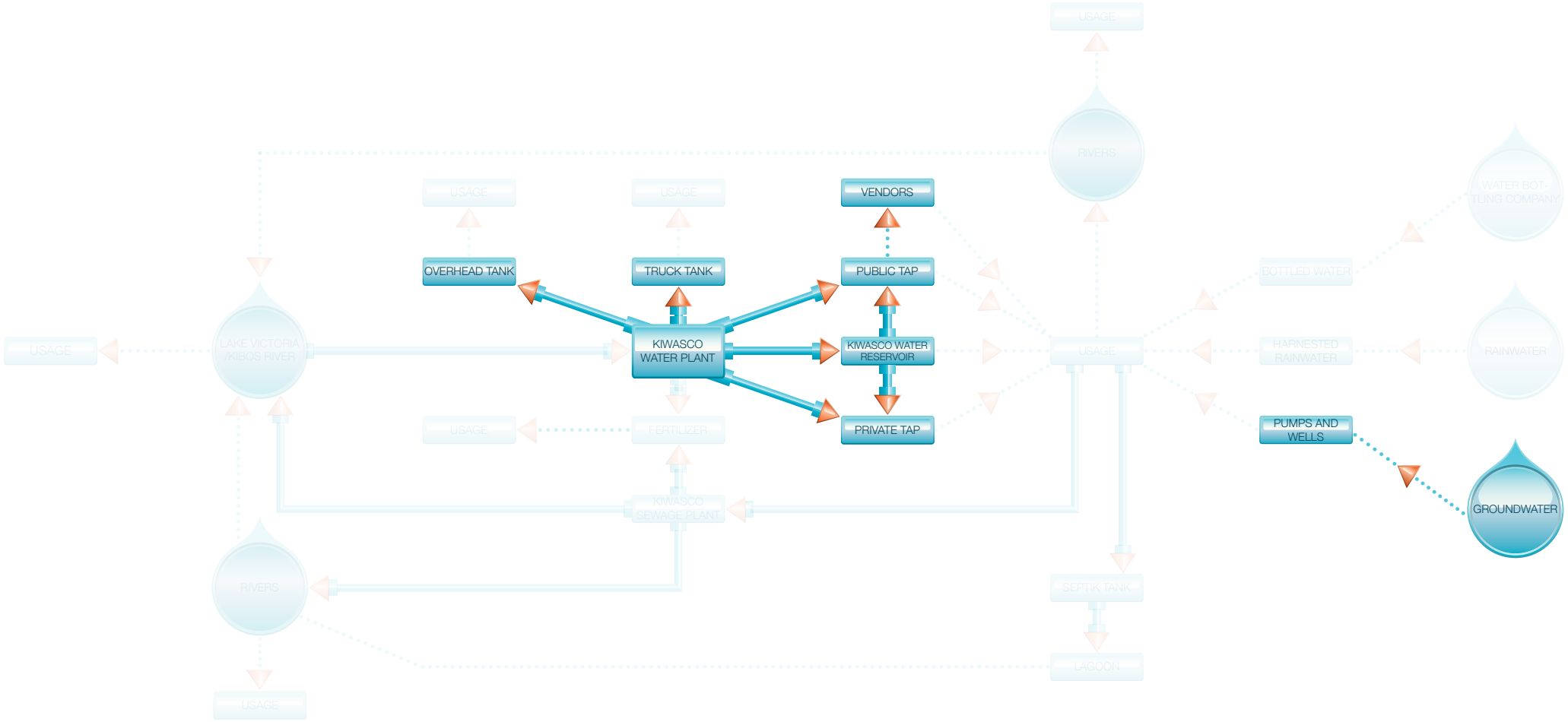
Appendix 8. Water that is always for free in the water distribution system of Kisumu



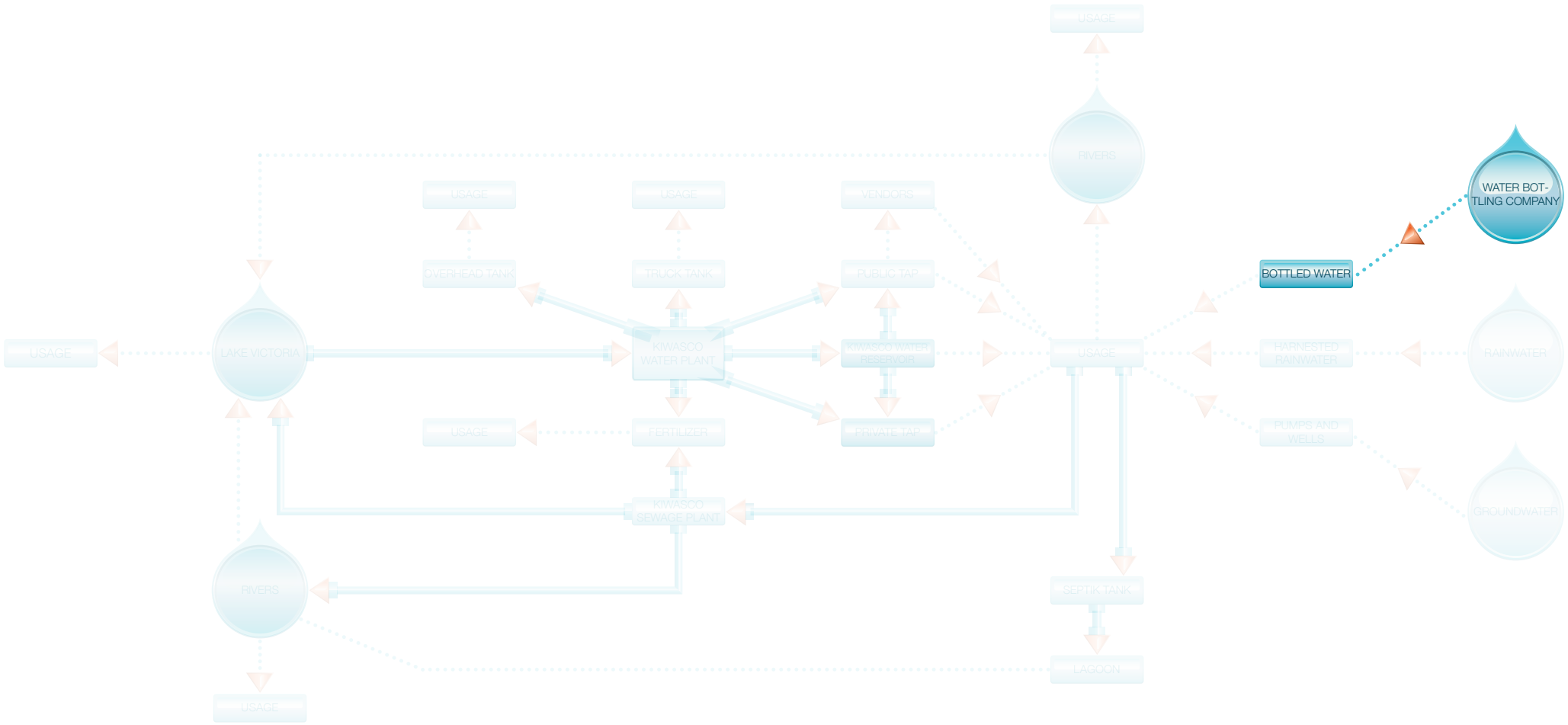
Appendix 9. Water that can be found for free in the water distribution system of Kisumu



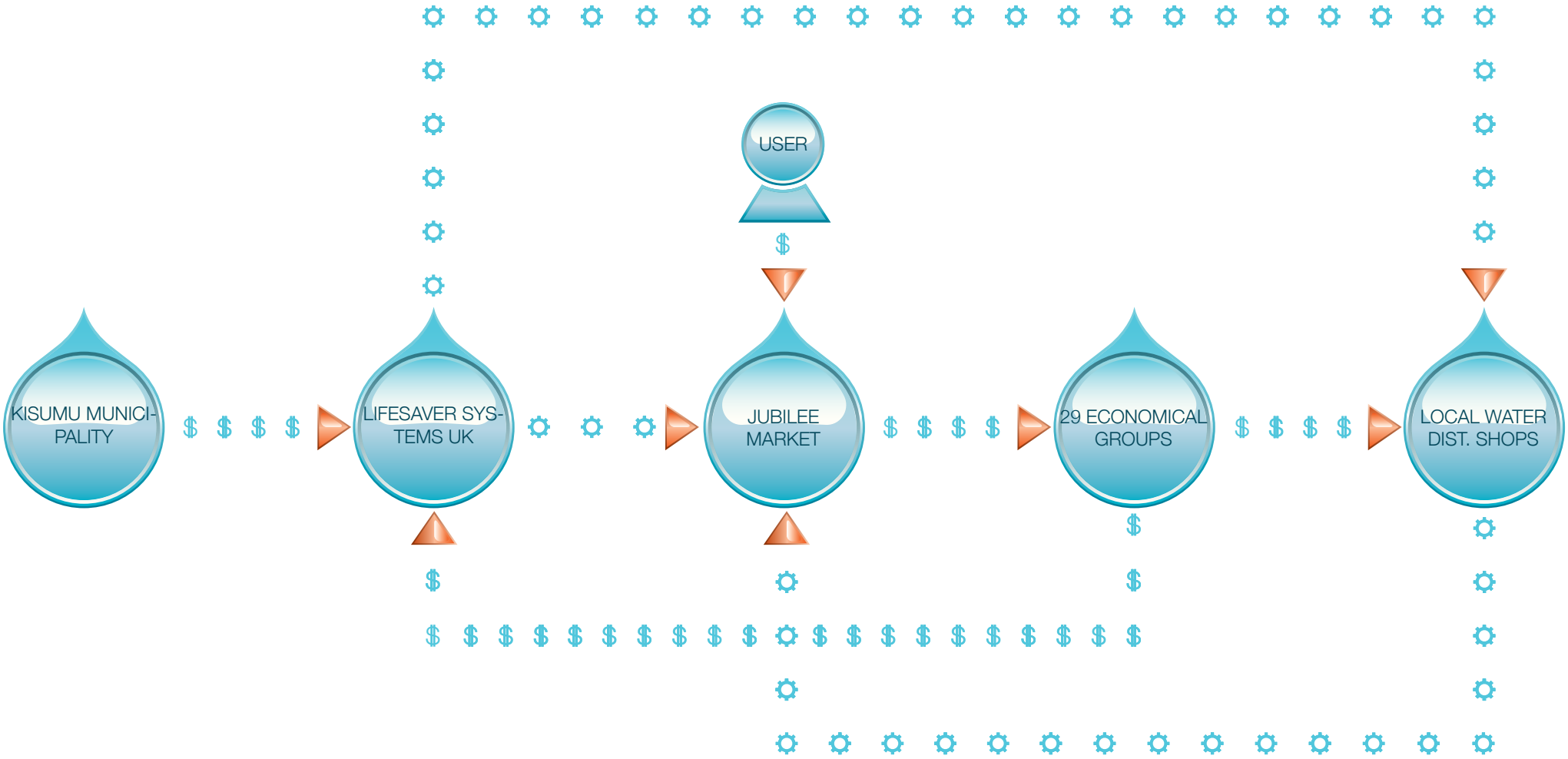
Appendix 10. Water that can be found for a cost of 2 - 20 KES/20L in the water distribution system of Kisumu



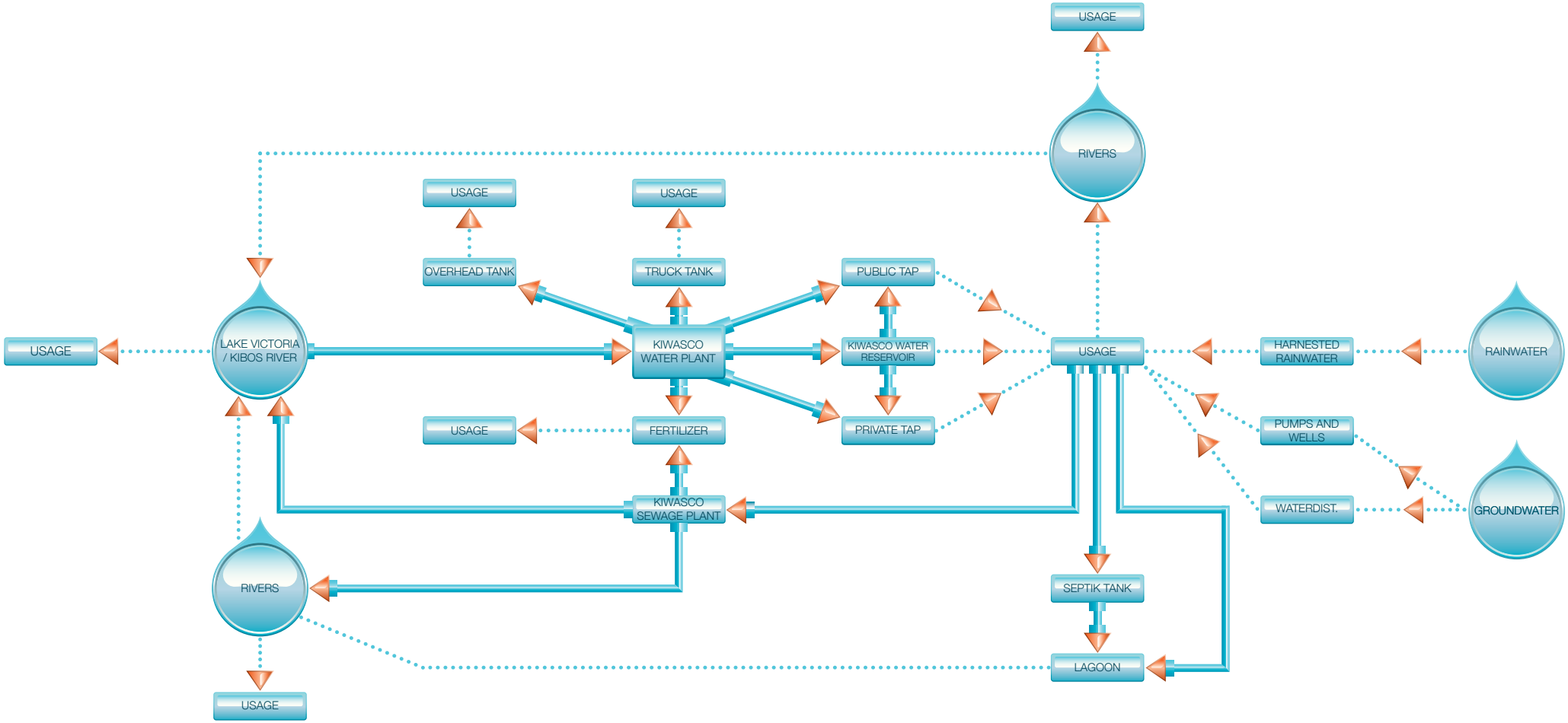
Appendix 11. Water that can be found for a cost of about 400 KES/20L in the water distribution system of Kisumu



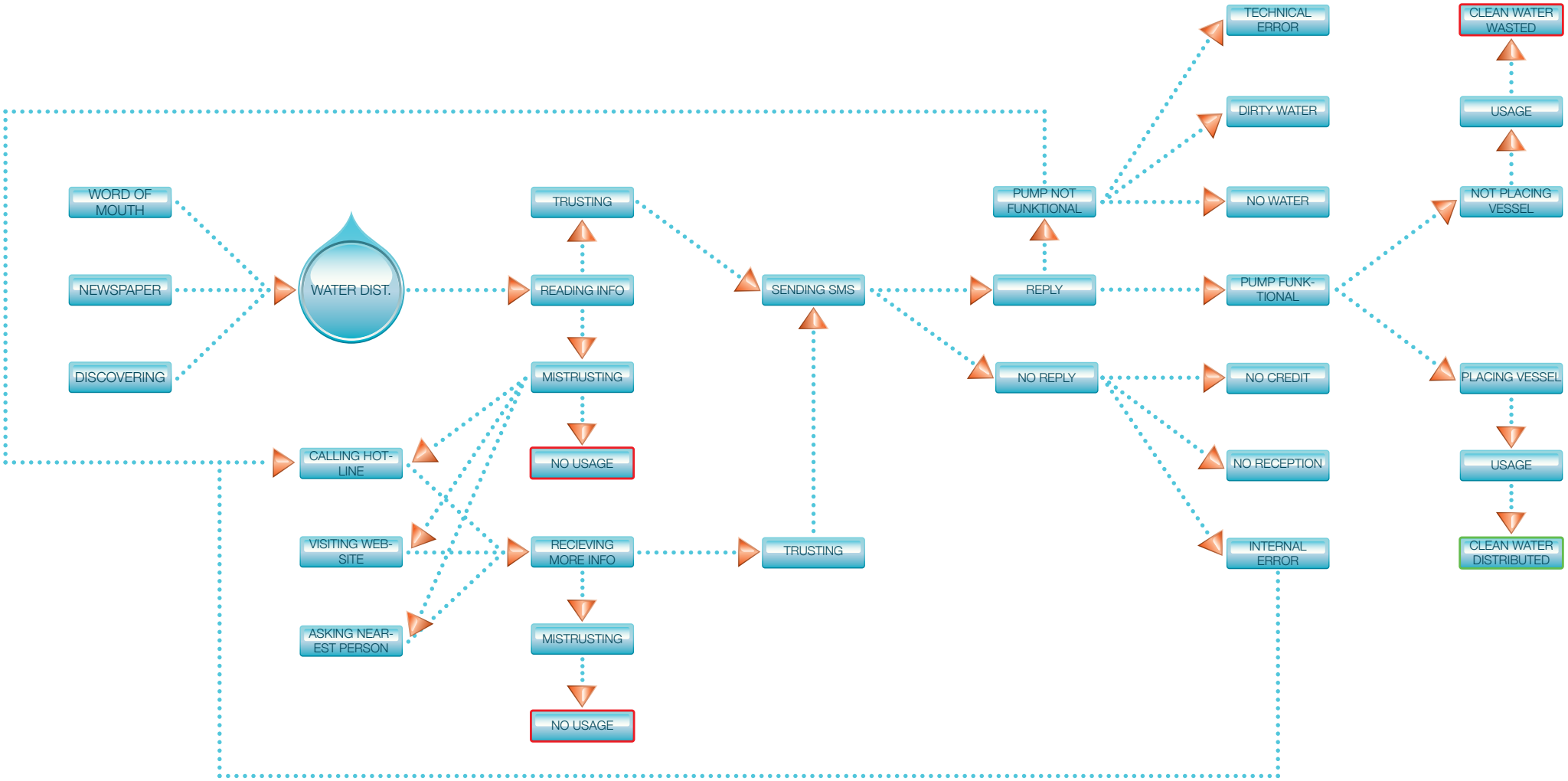
Appendix 12. Money and Material flow



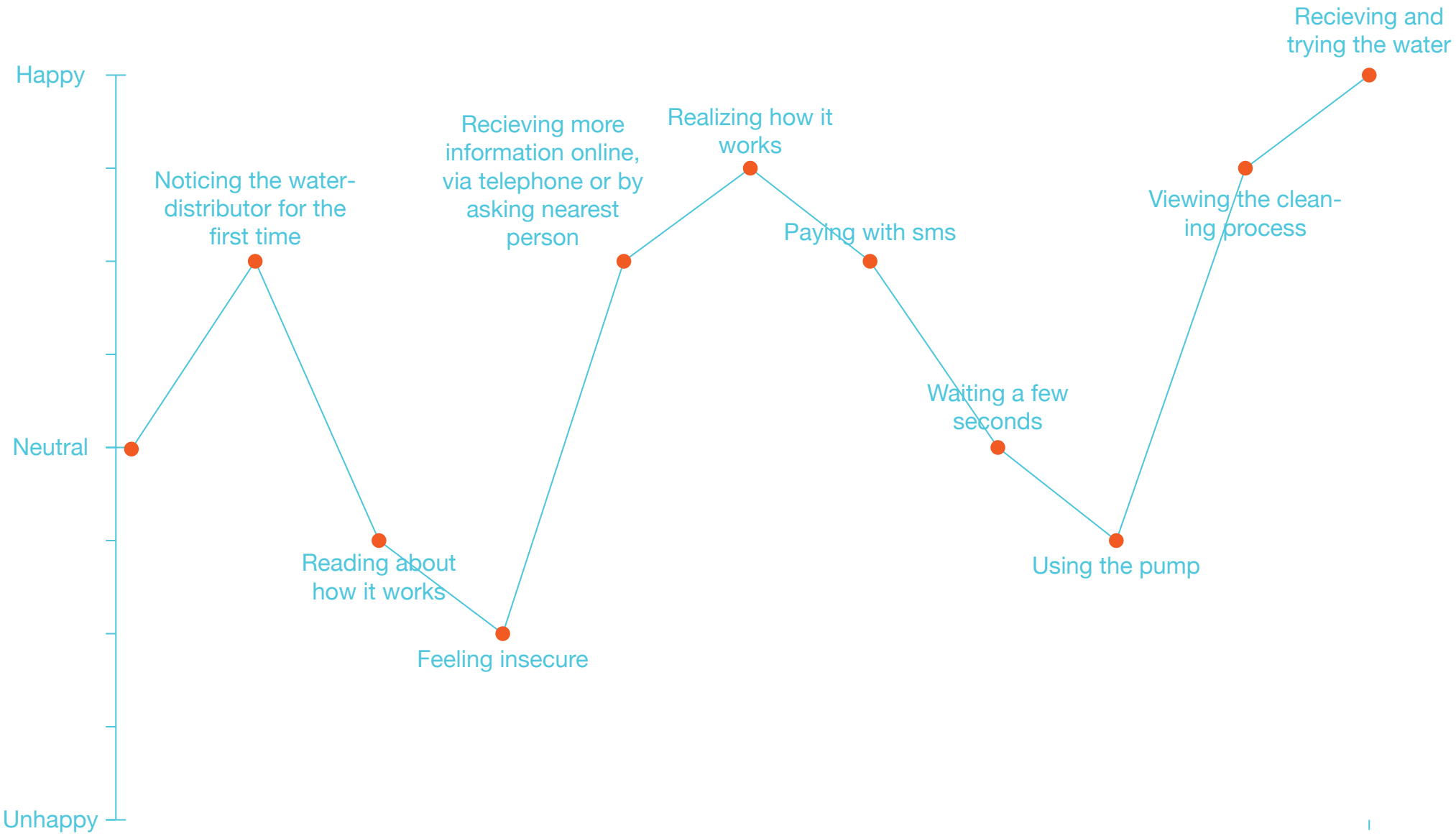
Appendix 13. The new water distribution system of Kisumu



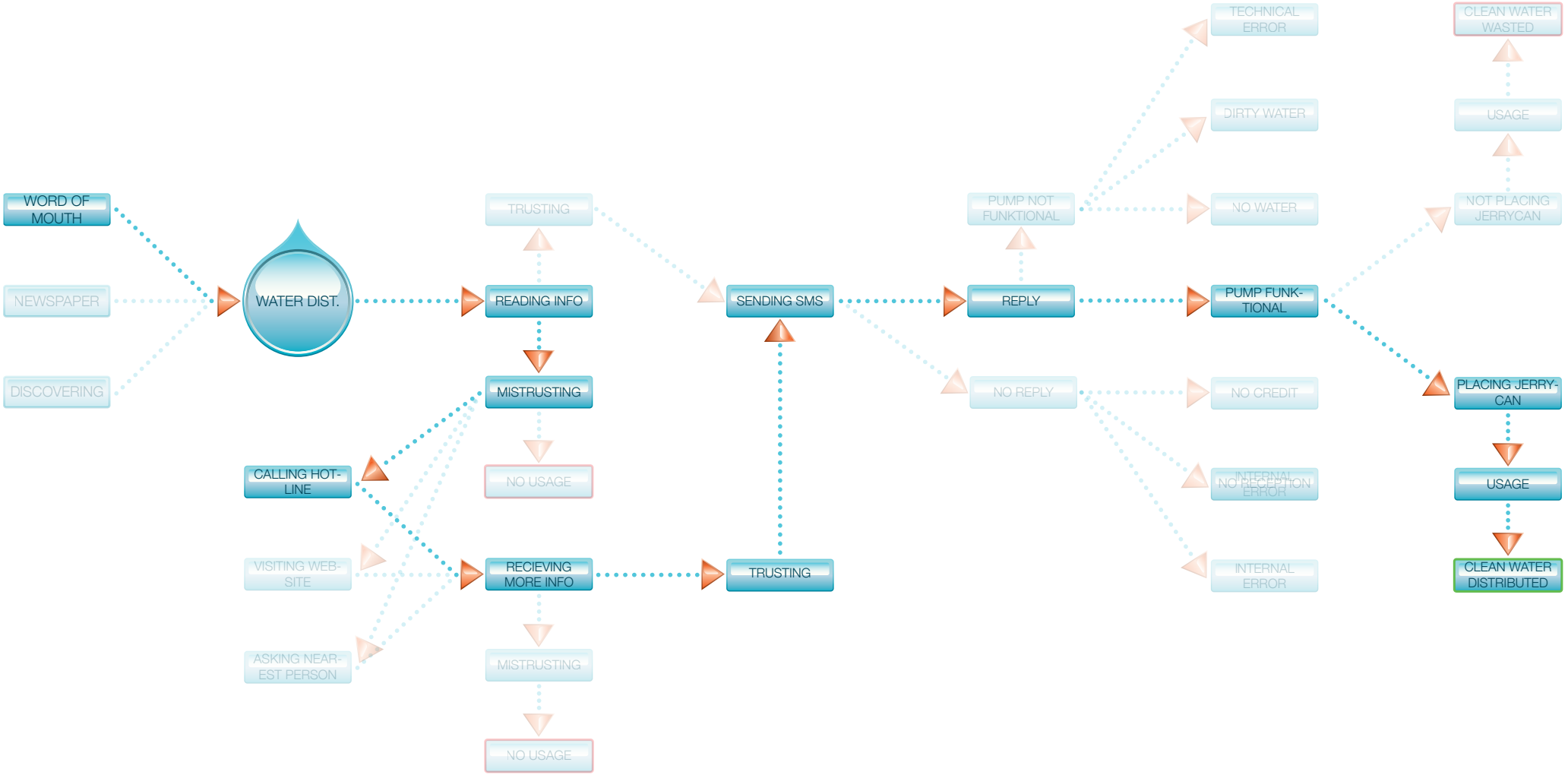
Appendix 14. Service map



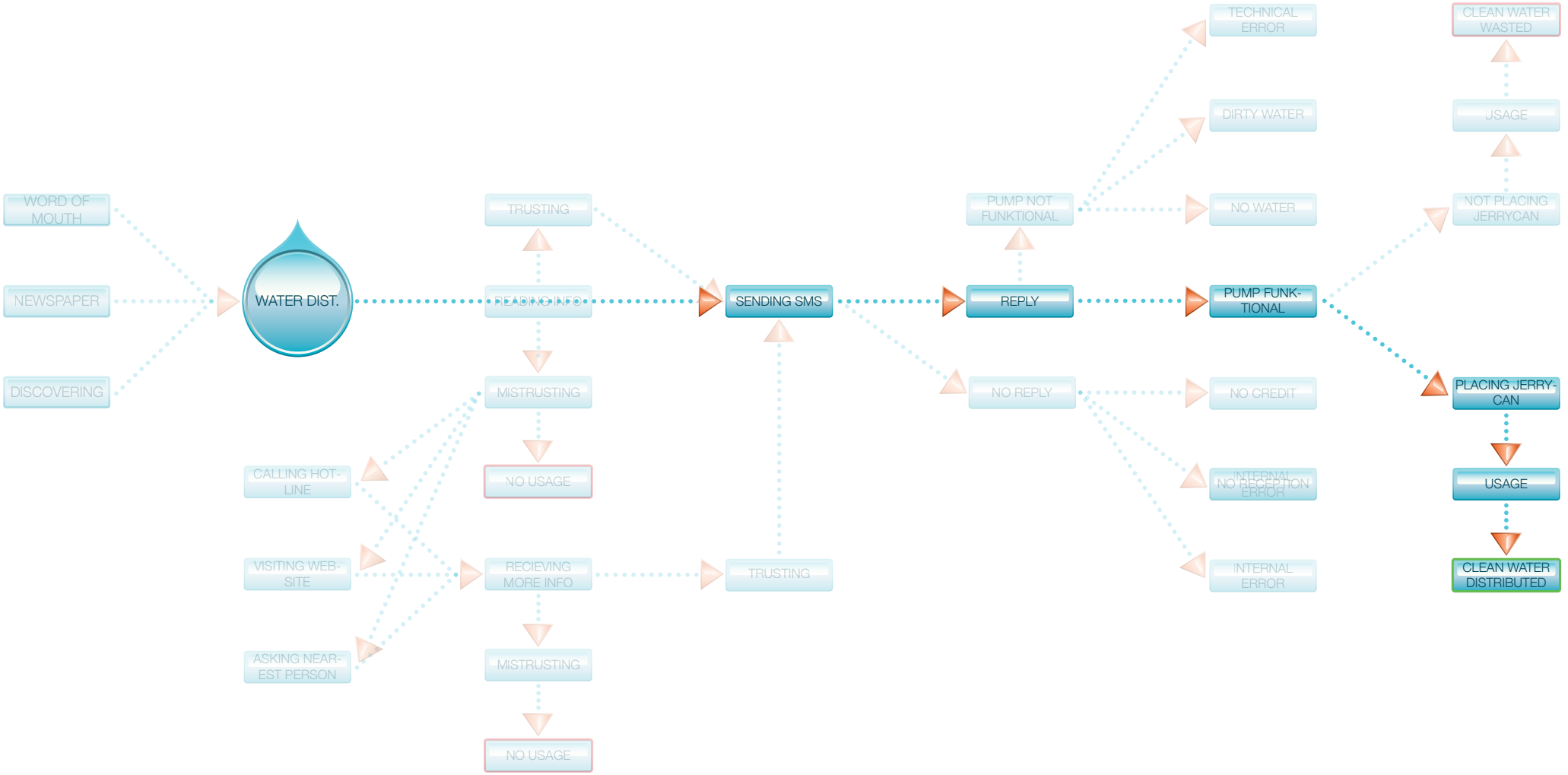
Appendix 15. Emotional journey



Appendix 16. First time user journey



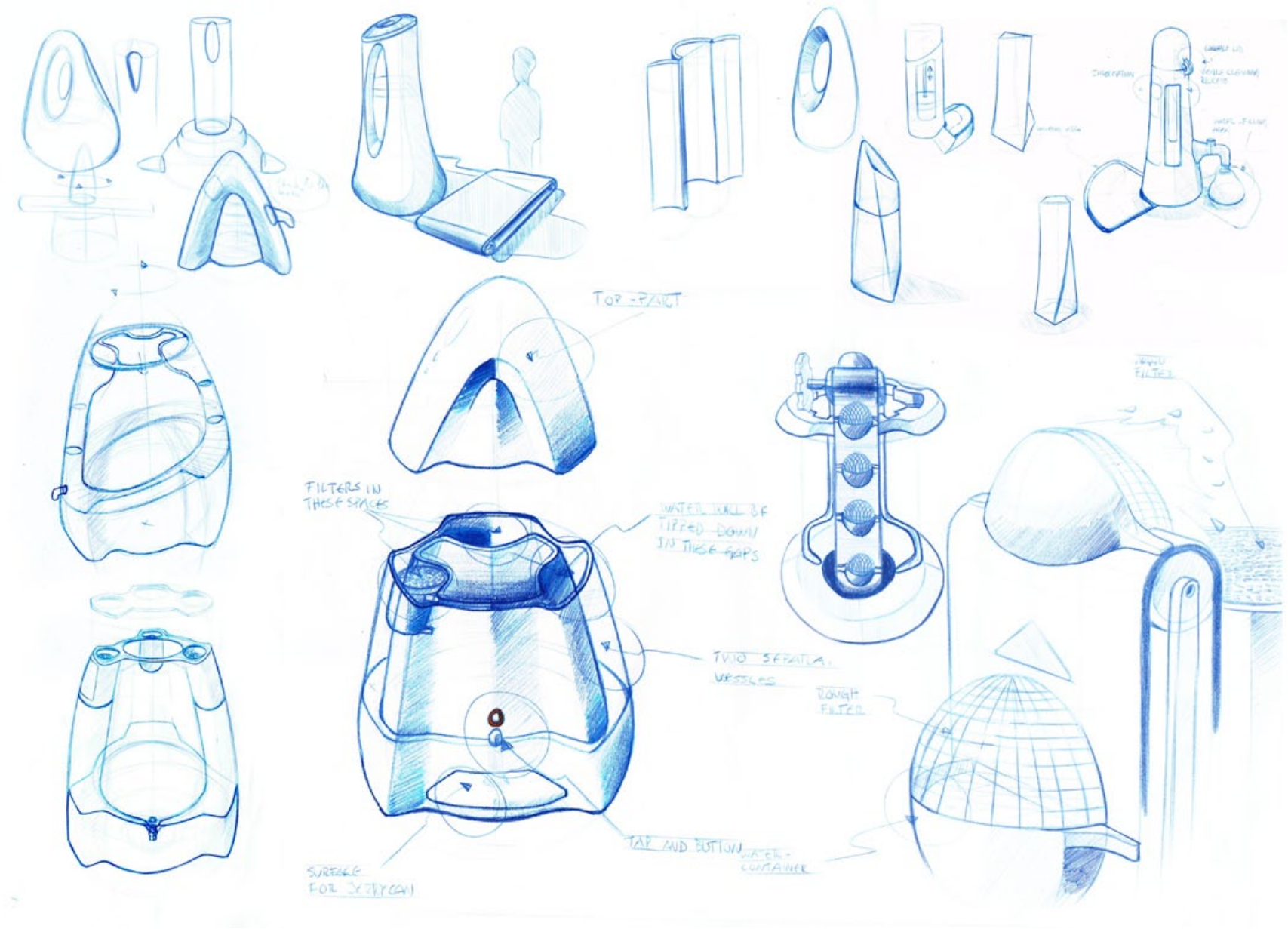
Appendix 17. Second time user journey



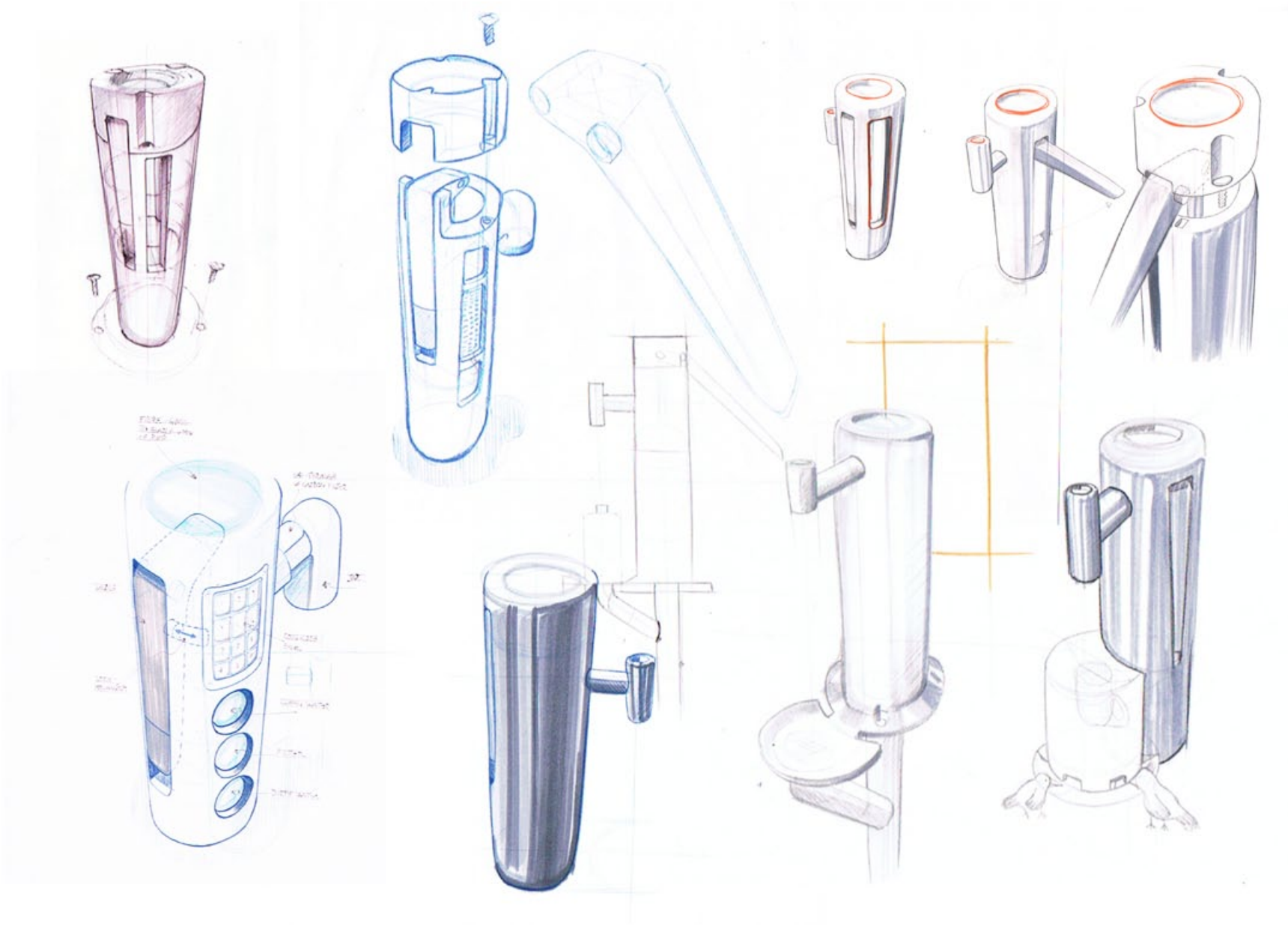
Function analysis - water cleaning pump

Function		Type	Description
Basic functions			
Offer	S.D water	HF	
Own	Shape	N	Physical product
Make easy	Usage	N	
Be	Secure	N	Reliable and safe when used
Maximize	Sustainability	N	Through life length and manufacturing process
Own	Honesty	N	Through visible cleaning process
Allow	Simplicity	D	Easy to understand the product
Offer	Quality	D	High durabilty and water quality
Security			
Be	Lenient	N	To the user during usage
Own	Security	N	Against vandalism
Minimize	Risks	N	For the user
Semiotics			
Make clear	Usage	N	
Exude	Funktion	N	High recognize factor
Increase	Reliability	N	
Own	Obviousness	D	
Market			
Own	Innovation	N	Regarding water cleaning technology and pump method
Be	User oriented	N	The needs of the user in focus
Create	Confidence	N	Through aestetics, security and communication with user
Invite	Usage	N	
Ergonomics			
Maximize	Usage	N	Used by as many users as possible
Minimize	Uncomfort	N	On a long term usage basis
Environment			
Maximize	Sustainability	N	This message should appear through the entire project
Make easy	Recycling	N	
Minimize	Material Usage	D	
Minimize	Wrapping	D	
Production and construction			
Allow	Manufacturing	N	
Allow	Assembling	N	
Allow	Cleaning	N	
Minimize	Material usage	N	
Allow	Maintainence	N	Changing the cleaning filter and other parts with time
Resist	Environment	N	Weather conditions and vandalism
Make easy	Repairs	N	
Minimize	Production lines	D	
Optmize	Logistics	D	
Maximize	Durability	D	Through materials and shape

Appendix 19. Sketches, concept 1 - the bucket and the rope



Appendix 20. Sketches, concept 2 - the hand pump



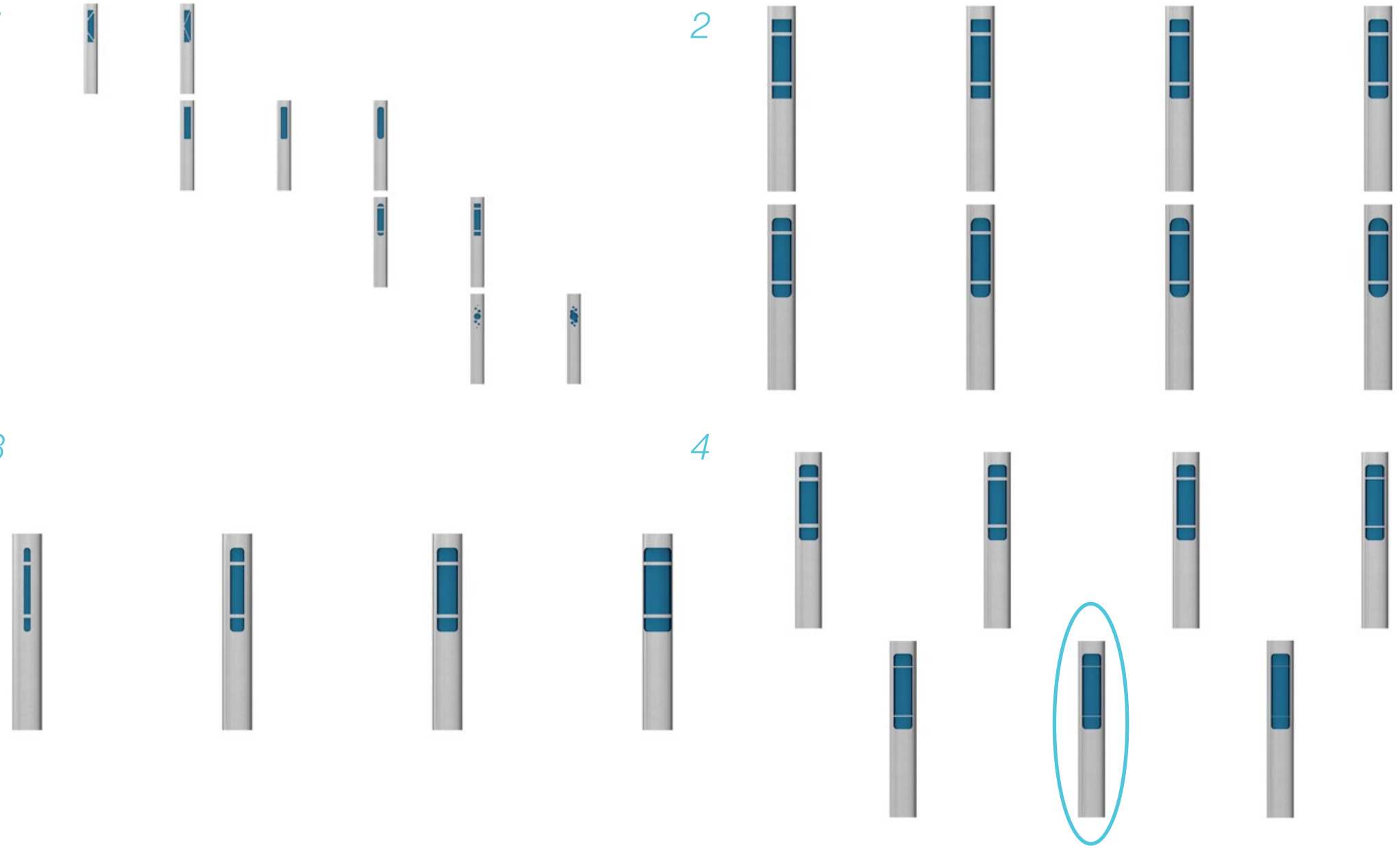
Appendix 21. Window shape process

1

2

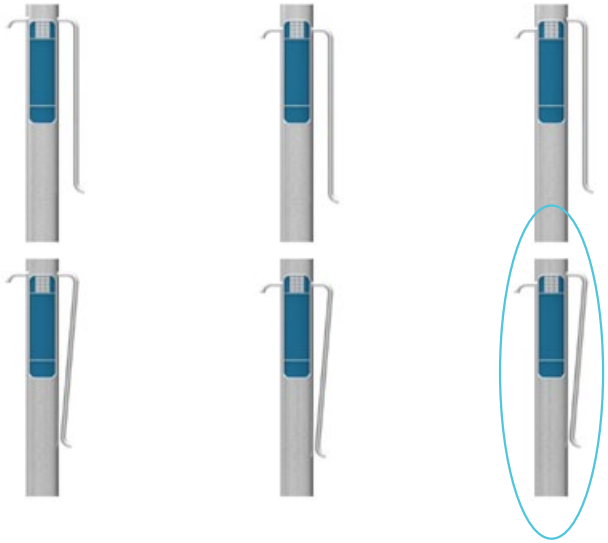
3

4



Appendix 22. Handle and tap process

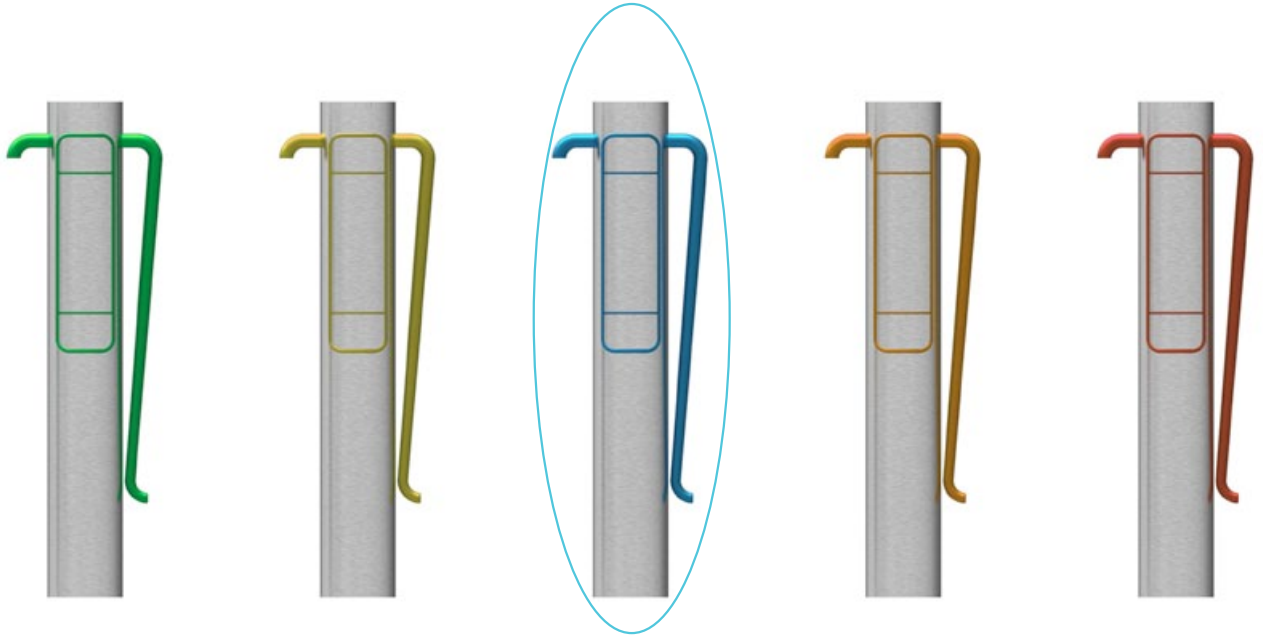
1



2

Appendix 23. Colour

1



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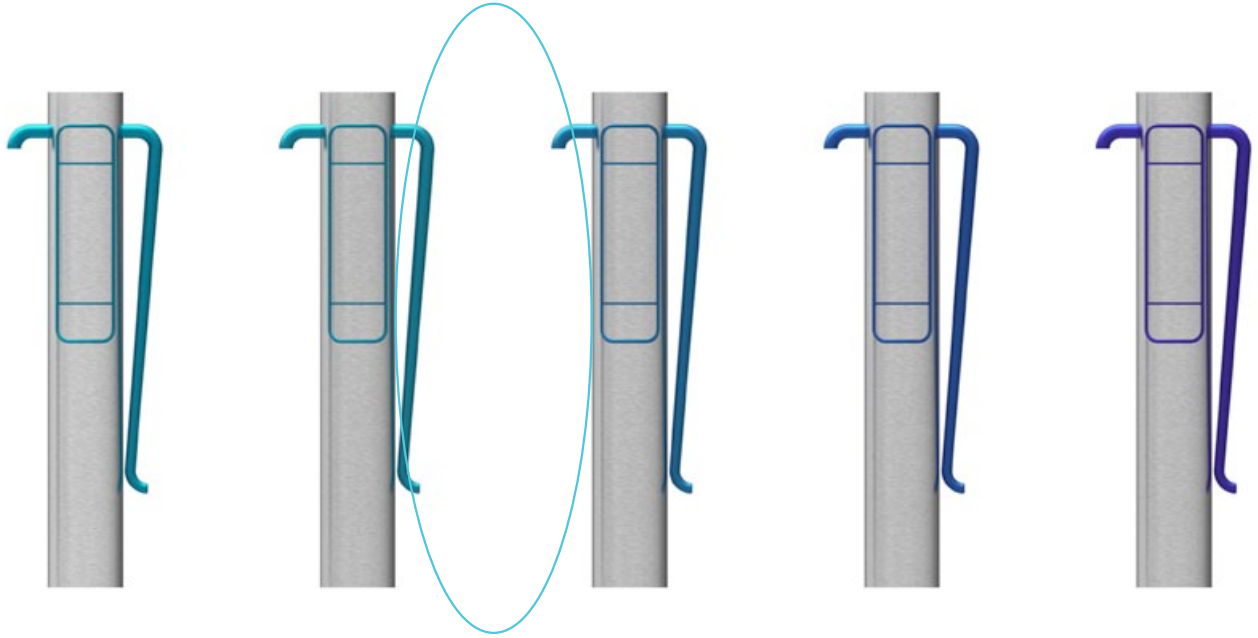
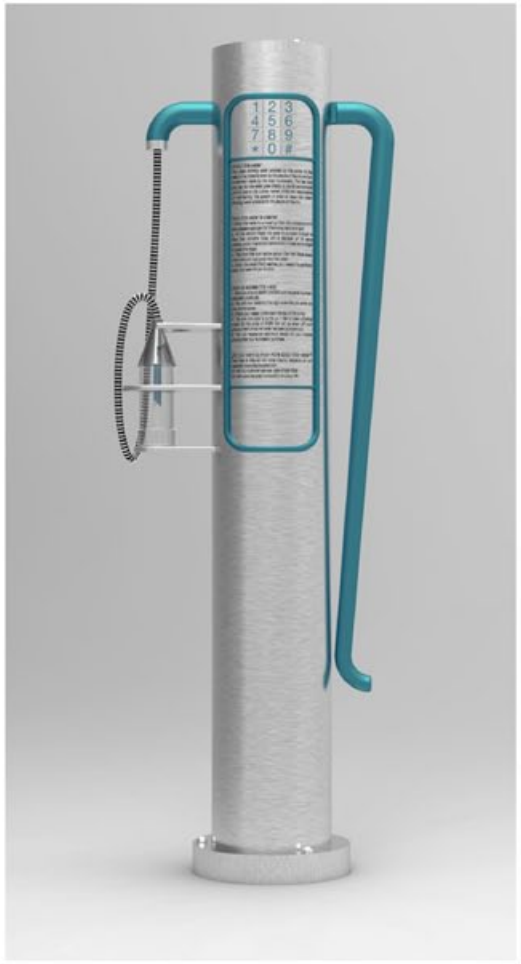
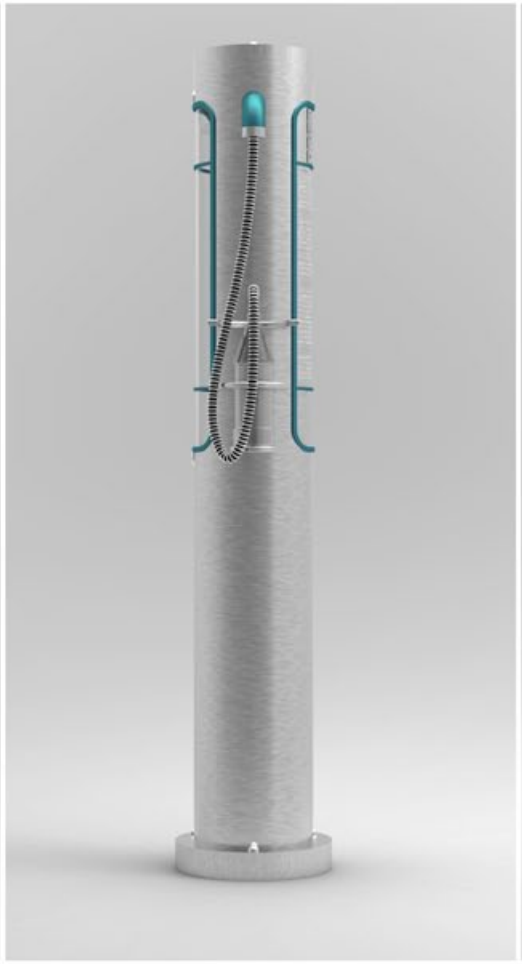
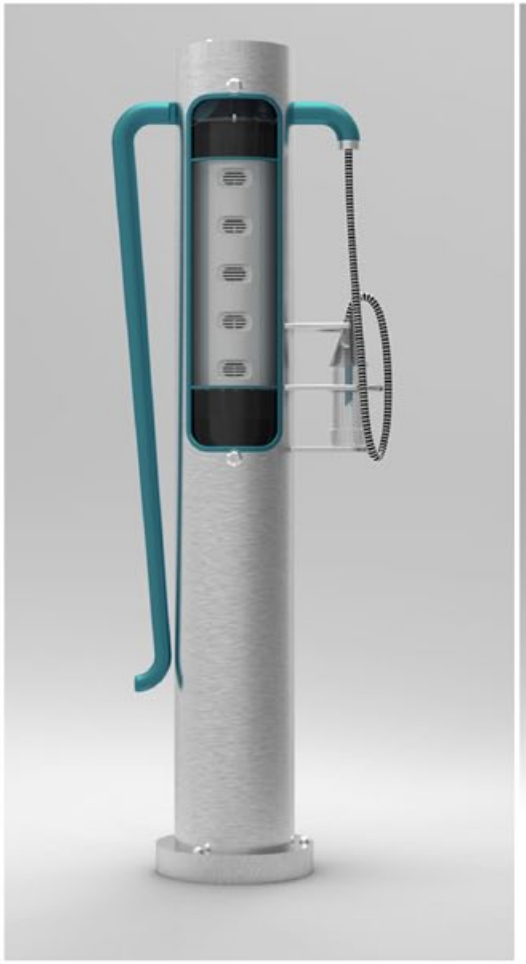
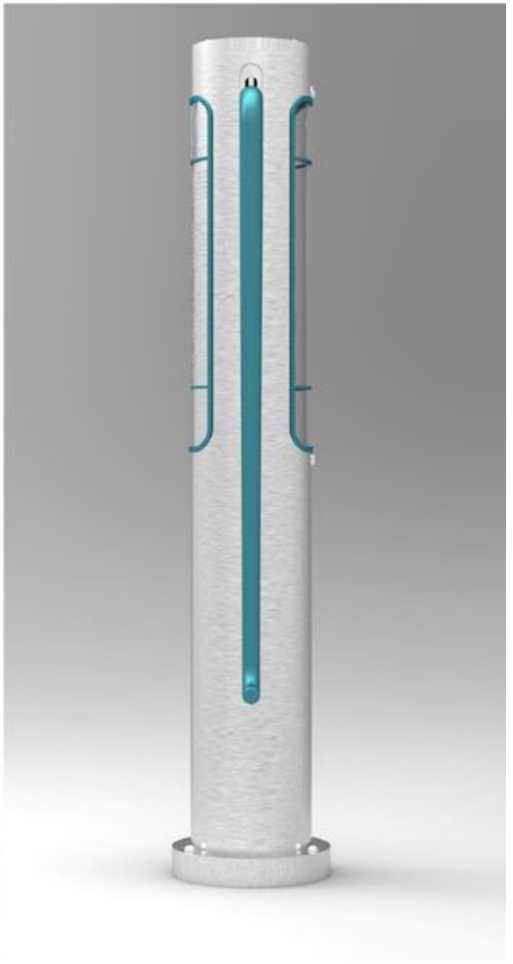


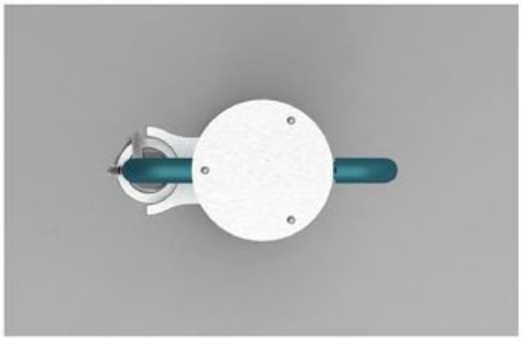
Appendix 24. Final result



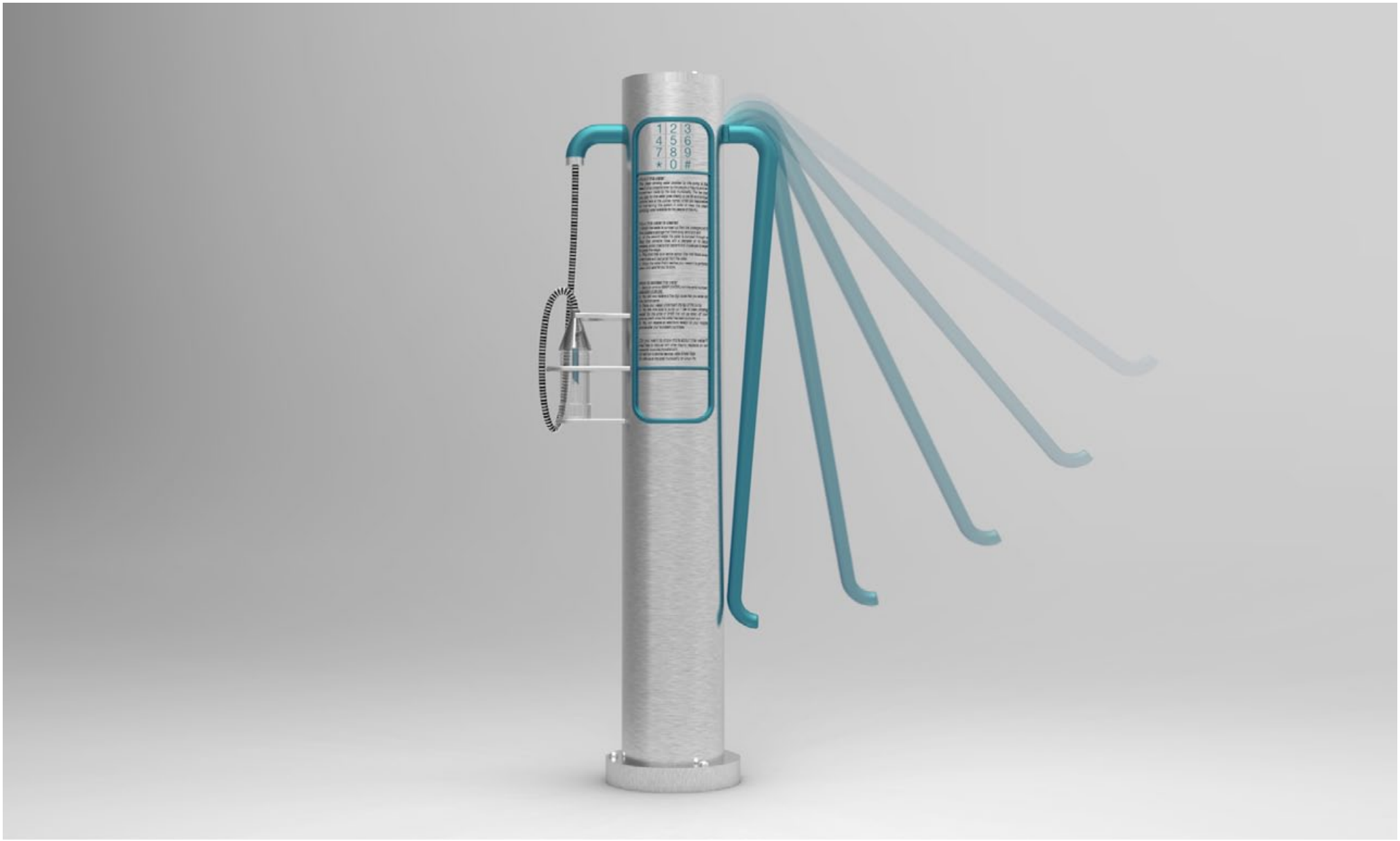








Appendix 25. Final result



Appendix 26. Final result