Chapter 3
Background Information

3.1. Geography and Socio-Economy of the Study Area

The study has been done in Amphoe Sattahip, one of the districts of Chonburi Province.

3.1.1 Chonburi Province

Chonburi Province is one of the 76 provinces of Thailand. It is located on the eastern coast of the Gulf of Thailand, 81 km from Bangkok. Chonburi Province border with Chachoengsao Province in the North, with Rayong Province in the South, with Chanthaburi Province in the East, and with the Gulf of Thailand in the West.

Chonburi Province is administratively divided into 9 Amphoes (or Districts) and 1 King Amphoe:

1. Amphoe Muang Chonburi
2. Amphoe Ban Bung
3. Amphoe Nong Yai
4. Amphoe Bang Lamung
5. Amphoe Phan Thong
6. Amphoe Phanat Nikhom
7. Amphoe Si Racha
8. Amphoe Sattahip
9. Amphoe Bo Thong
10. King Amphoe Ko Sichang

Chonburi Province is a major agricultural and industrial producer, with extensive sugar cane, tapioca and coconut plantations, shallow and deep water fishery, manufacturing plants, and also a very tourist seaside destination.

3.1.2 Amphoe Sattahip

Amphoe Sattahip is located on Dongtan Bay. It has a total area of 348.12 km² and border with Amphoe Bang Lamung in the North, with the Gulf of Thailand in the South, with Amphoe Bang Lamung and Rayong Province in the East and with the Gulf of Thailand in the West.

Amphoe Sattahip is constituted by 5 subdistricts or communities: Sattahip, Chom Thian, Bang Sare, Phlu Ta Luang, and Samaesarn.

It has a total population of 100943 inhabitants. Most of the population are Buddhist and earn their living by fishing. There is also a Navy base and because of that some territories and services are belonging to the military.
3.3 Water Supply in Amphoe Sattahip

3.3.1 Water Resources

There are 3 basins under the administration of East Water:

- The Eastern Seaboard basin
- The Bang Prakong basin
- The Prachin Buri basin

These three basins have a total combined area of 32300 square kilometres with the potential for water run-off of 20000 million cubic meters per year. According to the 1994 study for the development of the basins, the water storage capacity of all reservoirs in the area totalled 640 million cubic meters or 3.2% of the total run-off. However, government agencies, such as the Royal Irrigation Department, have drawn up plans for eastern seaboard water resources development. This will consist of approximately 14 projects, which will result in an increase in water storage capacity to 3200 million cubic meters per year, or 16% of the total run-off of the area. With the implementation of these plans, it is expected that there will be sufficient water to meet growing industrial, agricultural and household demand in the region.

East Water produces raw water to serve Sattahip from Dokkai and Nong Pla Lai reservoirs at Rayong Province. These reservoirs are property of the Royal Irrigation Department. East Water has a concession to manage these reservoirs, as well as Nongkhor reservoir. In table 3.3 the characteristics of the reservoirs managed by East Water are reported [5].

<table>
<thead>
<tr>
<th>Reservoirs Managed by East Water</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dokkrai Reservoir</strong></td>
</tr>
<tr>
<td>Reservoir Capacity</td>
</tr>
<tr>
<td>Catchment Area</td>
</tr>
<tr>
<td>Yearly water run-off</td>
</tr>
<tr>
<td><strong>Nongkhor Reservoir</strong></td>
</tr>
<tr>
<td>Reservoir Capacity</td>
</tr>
<tr>
<td>Catchment Area</td>
</tr>
<tr>
<td>Yearly water run-off</td>
</tr>
<tr>
<td><strong>Nong Pla Lai Reservoir</strong></td>
</tr>
<tr>
<td>Reservoir Capacity</td>
</tr>
<tr>
<td>Catchment Area</td>
</tr>
<tr>
<td>Yearly water run-off</td>
</tr>
</tbody>
</table>

Table 3.3: Reservoirs managed by East Water.
3.3.2 Raw Water Transmission Systems

Dokkrai – Map Ta Phut – Sattahip Network.

This system consists of a steel pipeline approximately 26.5 kilometres in length and with a diameter of 1350 millimetres, which runs from the Dokkrai reservoir to the receiving facilities in the Map Ta Phut area. Water is conveyed to the receiving facilities in the Map Ta Phut area by being pumped from the Dokkrai reservoir and stored at the head tank before being transmitted by gravity flows to the receiving well at Map Ta Phut area. The system used to transmit water from Map Ta Phut pumping station to the facilities in Sattahip consist of 2 steel pipelines 900 and 700 millimetres in diameter stretching for 8.3 and 14.3 kilometres respectively. Water is pumped from the Map Ta Phut receiving well to the head tank and then released with gravity flows through the pipelines to the receiving wells at Sattahip [5].

Nong Pla Lai – Map Ta Phut Network

This network consists of steel pipelines 1500 and 1350 millimetres in diameter and approximately 13 and 18 kilometres long which runs from the Nong Pla Lai reservoir to the receiving facilities at the Map Ta Phut area. Water is conveyed to the receiving facilities at Map Ta Phut area by being pumped from the Nong Pla Lai reservoir and stored at the head tank before being transmitted by gravity flows to the receiving well at Map Ta Phut area. The characteristics of the water distribution network that serves raw water to Sattahip treatment plant are reported in table 3.4 [5].

<table>
<thead>
<tr>
<th>Water Distribution Network</th>
<th>Pipeline Length (Km)</th>
<th>Distribution Capacity (Million m³ / year)</th>
<th>Distribution Volume of 2001 (Million m³ / year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dokkrai – Map Ta Phut – Sattahip</td>
<td></td>
<td>150.00</td>
<td>79.55</td>
</tr>
<tr>
<td>Dokkrai – Map Ta Phut</td>
<td>26.50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Map Ta Phut – Sattahip</td>
<td>22.50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nong Pla Lai – Map Ta Phut</td>
<td>32.00</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3.4: Raw Water Distribution Network to Sattahip treatment plant.
Figure 3.8: Raw Water Distribution System.
3.3.3 Water Treatment at Sattahip Treatment Plant

The production of drinking water at Sattahip Treatment Plant is done as follows:

1. The raw water from the reservoirs is transmitted to the Treatment Plant.

2. Before flowing into the Mixing Tank Alum and Lime are added to raw water for coagulation. As the quality of water in a lake or a reservoir is subject to seasonal changes (eutrophication), these chemical products should be added in an optimum ratio depending on raw water quality in each season. In the reservoirs that supply Sattahip treatment plant with raw water these seasonal changes are not very important.

3. Once Alum and lime are Added to the raw water and mixed in the Mixing Tank the water is conveyed to the Flocculation Tank where the agitation of the chemically treated water induces the coagulation. In this manner, very small suspended particles collide and agglomerate into larger heavier floc that settles out by gravity.

4. After flocculation takes places, the water is conveyed to the Sedimentation Tank, where the solid particles are removed from suspension by gravidity and deposited in the bottom of the tank.

5. After sedimentation takes place, supernatant is filtered in a Rapid Gravity Sand Filter, to remove the non-settled floc.

6. After filtration, Chlorine gas is added to the water to remove pathogen bacteria and control taste and odour.

7. After chlorinating takes place, the water is stored in the Clear Well where stays a maximum of 6 hours. This water is already drinking water.

8. The drinking water is pumped to the Elevated Tank to be provided from there to the consumers with the adequate pressure.
Figure 3.9: Scheme of Sattahip Treatment Plant.
3.3.4 Water Quality

The water quality standards for raw water and drinking water in Thailand follow the US and the WHO standards. The WHO standards are related to water of lower quality that which would be demanded by rich and sophisticated communities, but they are realistic in developing countries as they have been intended for those areas. Comparing US and WHO water quality standards reported in Annex I it can be observed that US standards are more restrictive than WHO standards. The quality standards for drinking water from the Council Directive 98/83/EC in force in the European Union are also reported in Annex I for comparison.

In Table 3.5 water quality of raw water from the reservoirs managed by East Water that provide raw water to Sattahip treatment plant is reported [5].

<table>
<thead>
<tr>
<th>Testing Detail</th>
<th>Testing Result</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dokkrai Res.</td>
</tr>
<tr>
<td>pH</td>
<td>7.90</td>
</tr>
<tr>
<td>Total Suspended Solids (mg/l)</td>
<td>2.00</td>
</tr>
<tr>
<td>Total Hardness (mg/l as CaCO₃)</td>
<td>32.00</td>
</tr>
<tr>
<td>Turbidity (NTU)</td>
<td>3.40</td>
</tr>
<tr>
<td>Conductivity (µS/cm)</td>
<td>145.00</td>
</tr>
<tr>
<td>BOD (mg/l)</td>
<td>1.40</td>
</tr>
</tbody>
</table>

Table 3.5: Raw Water Testing Report (Month: April 2002).

The US EPA (Environmental Protection Agency) standards for pH values of surface waters used for domestic water supplies are between 5 and 9 [6].

It can be observed from Table 3.5 that the Total Suspended Solids parameter is very low. For a treatment plant to be fully effective the suspended solids concentration in raw water in river should preferably be less than 1000 mg/l [7]. As it can be observed from Table 3.5 the TSS value in the reservoirs is considerably lower as a result of the storage of the water in the reservoirs that cause the natural settling of the suspended solids.

The WHO standard hardness parameter for potable piped water supplies is 200 mg/l as CaCO₃ (Highest Desirable Concentration) and the upper limit for this parameter in a considered “high class water” is 80 mg/l as CaCO₃ [7], quite higher than hardness value obtained from reservoirs’ water.

The turbidity level is also very low as rapid gravity sand filters used in Sattahip treatment plant are able to produce good quality drinking water with incoming water of 10 NTU [7]. The EPA regulations establishes that to avoid filtration turbidity level cannot exceed 5 NTU in representative samples of the source water immediately prior to the first or only point of disinfectant application [8]. Water from Dokkrai and Nong Pla Lai reservoirs comply with
this regulation before filtration so water will arrive to the point of disinfectant application with quite lower turbidity than 5 NTU.

The conductivity indicator parameter established in the Council Directive 98/83/EC is 2500 \( \mu \text{S/cm} \) at 20\(^\circ\) C [9], quite higher than the conductivity value reported in Table 3.5.

Regarding the BOD parameter raw water with average BOD (5 days) between 0.75 mg/l and 1.5 mg/l is qualified as excellent source of water according to the American Society of Civil Engineers [7].

From Table 3.5 and references quoted above it can be conclude that water from Dokkrai and Nong Pla Lai reservoirs conveyed to Sattahip treatment plant is good quality raw water to produce drinking water.

The water treated at the treatment plant is analysed every day. Every week samples of water from the consumers’ tap are also analysed. Some results of these analyses are reported in Tables 3.6 and 3.7.

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Turbidity (NTU)</th>
<th>pH</th>
<th>Chlorine (PPM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 April 2002</td>
<td>08:00 h</td>
<td>0.85</td>
<td>7.2</td>
<td>0.7</td>
</tr>
<tr>
<td>2 April 2002</td>
<td>08:00 h</td>
<td>0.71</td>
<td>7.3</td>
<td>0.8</td>
</tr>
<tr>
<td>3 April 2002</td>
<td>08:00 h</td>
<td>1.72</td>
<td>7.1</td>
<td>0.7</td>
</tr>
<tr>
<td>4 April 2002</td>
<td>08:00 h</td>
<td>1.34</td>
<td>7.2</td>
<td>0.6</td>
</tr>
<tr>
<td>5 April 2002</td>
<td>08:00 h</td>
<td>1.15</td>
<td>7.1</td>
<td>0.7</td>
</tr>
<tr>
<td>6 April 2002</td>
<td>08:00 h</td>
<td>0.71</td>
<td>7.3</td>
<td>0.9</td>
</tr>
<tr>
<td>7 April 2002</td>
<td>08:00 h</td>
<td>1.25</td>
<td>7.2</td>
<td>0.9</td>
</tr>
<tr>
<td>8 April 2002</td>
<td>08:00 h</td>
<td>1.41</td>
<td>7.3</td>
<td>0.7</td>
</tr>
<tr>
<td>9 April 2002</td>
<td>08:00 h</td>
<td>1.43</td>
<td>7.2</td>
<td>0.7</td>
</tr>
<tr>
<td>10 April 2002</td>
<td>08:00 h</td>
<td>1.05</td>
<td>7.4</td>
<td>0.6</td>
</tr>
<tr>
<td>11 April 2002</td>
<td>08:00 h</td>
<td>0.95</td>
<td>7.3</td>
<td>0.5</td>
</tr>
<tr>
<td>12 April 2002</td>
<td>08:00 h</td>
<td>0.87</td>
<td>7.3</td>
<td>0.7</td>
</tr>
<tr>
<td>13 April 2002</td>
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<td>0.71</td>
<td>7.3</td>
<td>0.8</td>
</tr>
<tr>
<td>14 April 2002</td>
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<td>0.93</td>
<td>7.3</td>
<td>0.8</td>
</tr>
<tr>
<td>15 April 2002</td>
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<td>1.21</td>
<td>7.1</td>
<td>1.1</td>
</tr>
<tr>
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<td>1.07</td>
<td>7.2</td>
<td>1.1</td>
</tr>
<tr>
<td>17 April 2002</td>
<td>08:00 h</td>
<td>0.74</td>
<td>7.1</td>
<td>1.3</td>
</tr>
<tr>
<td>18 April 2002</td>
<td>08:00 h</td>
<td>0.66</td>
<td>7.1</td>
<td>1.3</td>
</tr>
<tr>
<td>19 April 2002</td>
<td>08:00 h</td>
<td>1.74</td>
<td>7.1</td>
<td>0.8</td>
</tr>
<tr>
<td>20 April 2002</td>
<td>08:00 h</td>
<td>0.76</td>
<td>7.2</td>
<td>0.7</td>
</tr>
<tr>
<td>21 April 2002</td>
<td>08:00 h</td>
<td>0.94</td>
<td>7.2</td>
<td>0.6</td>
</tr>
<tr>
<td>22 April 2002</td>
<td>08:00 h</td>
<td>0.76</td>
<td>7.1</td>
<td>0.5</td>
</tr>
<tr>
<td>23 April 2002</td>
<td>08:00 h</td>
<td>0.6</td>
<td>6.9</td>
<td>1.4</td>
</tr>
<tr>
<td>24 April 2002</td>
<td>08:00 h</td>
<td>0.5</td>
<td>6.9</td>
<td>0.7</td>
</tr>
<tr>
<td>25 April 2002</td>
<td>08:00 h</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>26 April 2002</td>
<td>08:00 h</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>27 April 2002</td>
<td>08:00 h</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>28 April 2002</td>
<td>08:00 h</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>29 April 2002</td>
<td>08:00 h</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>30 April 2002</td>
<td>08:00 h</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Max: 1.74, 7.4, 1.4
Min: 0.5, 6.9, 0.5
Average: 1.02, 7.16, 0.81

Table 3.6: Analysis of drinking water from Sattahip treatment plant (April 2002).
Table 3.7: Analysis of tap water from Samaesarn Community (December 2001).

Regarding turbidity the WHO standard establishes that for effective terminal disinfection average turbidity should be at most 1 NTU and a single sample should not exceed 5 NTU [10].

The EPA standard establishes different parametric values for turbidity depending on the kind of filtration used. In the case of Sattahip treatment plant the filter used is a rapid gravity sand filter and according to this the EPA standards for turbidity establish that turbidity level for a system’s filtered water must be less than or equal to 0.5 NTU in at least 95% of the measurements taken each month. If it could be assured that higher level of turbidity do not interfere with disinfection a higher turbidity limit could be accepted for that system. However, in no case a turbidity limit that allows more than 1 NTU in more than 5% of the samples taken each month could be accepted [8]. The Council Directive 98/83/EC establishes that in the case of surface water treatment turbidity parametric value should not exceed 1NTU in the water ex treatment works [9].

In Figure 3.10 the turbidity values from Table 3.6 are represented and it can be clearly observed that in around 42% of the measurements taken in April 2002, turbidity level is higher than 1 NTU instead of the at least 5% specified in EPA standards. The average turbidity parameter from April, reported in Table 3.6, is also a little bit higher than 1 NTU, but no measurement presents a turbidity level higher than 5 NTU.
From both Table 3.6 and Figure 3.10 it follows that water from Sattahip treatment plant does not meet the EPA or the Council Directive 98/83/EC standards regarding turbidity. It meets WHO standards for turbidity but it is in the limits.

From Table 3.7 it can be observed that the turbidity parameter in measurements taken from the user’s tap is much higher than at outlet from the treatment plant although does not exceed 5 NTU. This must be due to a lack of watertightness in the distribution system.

These turbidity values (higher than 1 NTU but not exceeding 5 NTU) could be considered acceptable if it could be assured that there is no significant interference with disinfection at this higher turbidity levels. High turbidity levels in addition to interfere with disinfection may give raise to complaints from consumers because of water appearance.

Regarding pH value the standards from different authorities are quite similar. EPA standard establishes a parametric value between 6.5 and 8.5 [6]. The Council Directive 98/83/EC establishes a parametric value between 6.5 and 9.5 [9].

The WHO standard recommend a pH lower than 8.0 for an affective disinfection with chlorine [10].

It can be observed from Tables 3.6 and 3.7 that in all the cases water supplied in Samaesarn subdistrict meets these standards.

For effective disinfection there should be a residual concentration of free chlorine of 0.5 mg/l after at least 30 minutes contact time at pH < 8.0 according to WHO standards [10].

The EPA standards establish that the residual disinfectant concentration in the water entering the distribution system cannot be less than 0.2 mg/l for more than 4 hours and [8].

From the values of chlorine concentration at outlet from the treatment plant reported in Table 3.6 disinfection could be assured.

In the WHO standards is observed that concentrations of residual chlorine in drinking water between 0.6 and 1 mg/l while safe to consume, may give raise to complaints from consumers because of taste and odour [10]. The concentration of residual chlorine obtained from the consumers’ tap samples is much lower than these values.
3.3.5 Water Distribution System

The water distribution system in Amphoe Sattahip covers the subdistricts of Sattahip, Bang Sare, Phlu Ta Luang, and Samaesarn.

Sattahip waterworks (the treatment plant and the existing distribution system) have been implemented by PWA almost 4 years ago. In the case of Sattahip, Bang Sare and Phlu Ta Luang subdistricts PWA managed the system for a year before Universal Utilities Co. Ltd. took on the management of the waterworks by means of a leasing contract. In the case of Samaesarn subdistrict the system have been implemented only for 2 and a half years and has been managed only by Universal Utilities.

Characteristics of the System

The drinking water produced at Sattahip treatment plant is stored in 2 tanks of 3000 and 500 m³, before being supplied to the consumers.

The waterworks system production capacity is 12000 m³/day, the water production is about 4000 m³/day, and the water sales in Sattahip are around 3100 m³/day. The difference between production and sales are losses in the system. The losses in the production of water are around 5%, and in the distribution system around 23% [12]. The target of Universal Utilities is to reduce losses to less than 20%. With a level of water losses between 20% and 25% a distribution system can be qualified as a good system according to Table 3.8 [13]. Standards in Table 3.8 are used to qualify spanish waterworks. In any case it has to be taken into account that spanish waterworks use to be much older than Sattahip waterworks and the level of water losses should be higher than the one expected in a system 4 years old. The percentage of losses in PWA waterworks system is around 30% [14] and in MWA waterworks system around 40% [15].

<table>
<thead>
<tr>
<th>Non Revenue Water (N.R.W)</th>
<th>Qualification</th>
</tr>
</thead>
<tbody>
<tr>
<td>N.R.W ≤ 20%</td>
<td>Excellent</td>
</tr>
<tr>
<td>20% &lt; N.R.W ≤ 25%</td>
<td>Good</td>
</tr>
<tr>
<td>25% &lt; N.R.W ≤ 30%</td>
<td>Acceptable without objections</td>
</tr>
<tr>
<td>30% &lt; N.R.W ≤ 35%</td>
<td>Acceptable with objections</td>
</tr>
<tr>
<td>35% &lt; N.R.W</td>
<td>Rejected</td>
</tr>
</tbody>
</table>

Table 3.8: Distribution Systems Qualification according to water losses.

Around 70% of the pipelines in the distribution system are made from PVC and the 30% remaining made from PE. Most of the PE pipelines are located in the areas close to the coast.
Recommendations for Water Supply Projects in Developing Countries: A Case Study in Amphoe Sattahip (Thailand)

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Figure 3.11: Sattahip Piped Water Distribution System.
Samaesarn Water Supply System

The distribution system in Samaesarn subdistrict is not yet finished. Part of the service pipelines that reach the households have to be built so that many households still have not connection to piped water. Regarding the registered connections data from Universal Utilities office at Sattahip, only 585 households from the total 1493 registered households in Samaesarn subdistrict had connection to piped water at the end of May 2002. It means that around the 60% of the total registered households still not having connection to piped water.

Universal Utilities is not investing in the expansion of the pipeline system in Samaesarn Subdistrict as it is mentioned in point 3.2.3 because there is not benefit in the investment and because of the overlapped responsibilities that obstruct the decision of investment [16]. Therefore the expansion of the service pipeline to supply all the households in Samaesarn subdistrict depends on the government budget. PWA is the responsible to deal with the government budget for water supply in this area, deciding where and how much to invest. Because of government budget is not enough to cover all the necessities of PWA responsible area, it is uncertain when will be finish the service pipeline system at Samaesarn subdistrict. Samaesarn Municipality has also invested part of its budget in the construction of some service pipelines.

In Figure 3.12 some of the pipelines are shown. Is not a very detailed map, and also some of the pipelines are missing. The situation of the drawn pipelines have been reported by the staff at Samaesarn Municipality and also observed in the fieldwork. Although Universal Utilities have a GIS system with maps of the pipeline system in Samaesarn subdistrict, it was not possible to get a copy due to technical problems.
Main Pipeline (reported by Universal Utilities staff in Sattahip)
Secondary Pipeline constructed with Municipality's budget (reported by Samaesarn Municipality head office, Khun Sakorn)
Secondary Pipeline (observed during the fieldwork in Samaesarn subdistrict)

Figure 3.12: Samaesarn Pipeline Scheme.
3.3.6 Price of Piped Water Connection

For those people that do not have connection to piped water because there is not service pipeline that reach their households but would like to connect to the piped water supply system, the solution is either to wait until the system will be finished or pay for the service pipeline construction.

All the households that would like to get a connection to the piped water supply system have to pay for the necessary equipment (meter, pipes, ...) and also for the installation of this equipment. This payment is called Connection Fee. Those households that are not situated next to the existing pipelines have to add to the Connection Fee the price of construction of the secondary pipeline that reach the household. The total cost of construction (connection fee and service pipeline construction) differs from one case to another since it depends on different factors. It depends, mainly, on the distance from the household to the main pipeline, but also on the typology of the construction. For a distance between the main pipeline and the household less than 10 meters the price of the connection fee does not depend on the distance and it remains constant; for a distance higher than 10 meters the price of the connection fee increases as the distance from the main pipeline to the household also increases. In Annex II two different examples of connection are commented to see how the typology of the construction can affect the price of the connection fee.

As the price of construction of the service pipeline could be too high to be paid only for one household, when a new service pipeline has to be built the households along its course use to agree in sharing the construction costs. In any case connection fee has to be paid for each individual household.

Many people still have not connection to piped water because cannot afford to pay the connection fee or the construction costs.
3.3.7 Process to get a Piped Water Connection

For those people that are willing to pay for the connection fee or the construction costs, the process to get a piped water connection is as follows:

1. The request has to be received in Universal Utilities office at Sattahip (immediately).
2. Survey and study of the area (1-2 days).
3. Estimation of the cost (2-5 days).
4. The cost is communicated to the consumer (immediately).
5. The consumer has to pay for the construction (immediately).
6. Universal Utilities has to found a company to build the new pipeline (1 day).
7. Universal Utilities monitors the installation of the new pipeline (1 day).
8. The new user has to be registered (1 day).

According to the Universal Utilities schedule, the new user gets the piped water connection between 9 and 13 days after the request have been made. From the fieldwork it follows that to get a connection to piped water is not always fast and easy. Complaints about delays in the process to get a connection to piped water have been collected in the questionnaires and interviews done in Samaesarn area. People that are willing to pay the construction costs and that have already request the connection to the company several times, still wait for it.
3.3.8 Price of Water

East Water buys raw water from the Dokkrai and Nong Pla Lai reservoirs, property of the Royal Irrigation Department, and sells it to Universal Utilities at 6 – 7 baht/m³. The price that East Water pays to the Royal Irrigation Department is considered confidential.

The Government fixes the price of water for the consumers in the PWA service area. PWA or Universal Utilities, in the case of Sattahip, cannot raise the price fixed by Government. This fact sometimes represents a problem for the private investment in PWA responsible area, because private companies want to fix the price of water according to the amount of money that they invest.

The price of water per cubic meter depends on the category of the water user and also on the amount of water consumed as it is shown in Figure 3.13.

Three different categories of users are considered:

1. Domestic users
2. State Enterprise, Government and Small Business
3. Big Industries and Business.

According to the amount of water consumed the price per cubic meter will change. If the consumption increases, the price per cubic meter also increases. This billing method is called “Step by Step” and is part of a campaign from the government to promote the saving of water.

![Figure 3.13: Water Price per Unit according to User Category and Consumption.](image-url)
Explanatory tables on how to do the billing following the Step by Step method are included in Annex III.

From Figure 3.13 it can be observed that for consumptions up to 30 m$^3$ the price per cubic meter for Domestic Users is lower than the price per cubic meter for Government, Small and Big Business. For water consumptions higher than 30 m$^3$ the price per unit for Domestic Users, Government and Small Business is the same, and for Big Business is higher. It can be observed too, that for Big Business the price per cubic meter when the consumption is higher than 3000 m$^3$ decreases a little bit.

From that it can be inferred that the profit margin in domestic sales should not be very high for the company and that should be a better business to supply big industries, as the charge per unit is higher.

This pricing policy rewards the low consumptions and punishes the high consumptions promoting the saving of water. It is also a very fair policy since the major consumers like industries or businesses pay a higher price per cubic meter than the small consumers like domestic users.

In addition to the amount of water consumed, other different concepts are included in the water bill:

1. Service fee: Its price depends on the size of the meter. For a standard meter for domestic use (1/2") the price of the Service fee is 30 baht/month.

2. Minimum Consumption fee: The households that spend 0, 1, 2, or 3 m$^3$ per month have to pay a minimum consumption fee of 64 baht/month. This corresponds to:
   
   | Service Fee: | 30 baht |
   | Minimum consumption: | 30 baht |
   | VAT: | 4 baht |
   | Total: | 64 baht |
3.2. Water Supply Company Background

The piped water supply in Sattahip is provided by Universal Utilities Company Limited. Universal Utilities Co. Ltd. is a subsidiary of East Water Resources Development and Management Public Company Limited (East Water). East Water is a Public Company set up by the Provincial Waterworks Authority (PWA). Its share holding structure is as follows:

<table>
<thead>
<tr>
<th>Shareholding</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provincial Waterworks Authority</td>
<td>44%</td>
</tr>
<tr>
<td>Industrial Estate Authority of Thailand</td>
<td>5%</td>
</tr>
<tr>
<td>General Public</td>
<td>51%</td>
</tr>
</tbody>
</table>

3.2.1 Provincial Waterworks Authority (PWA)

The Provincial Waterworks Authority was established as a State Enterprise by the Government of Thailand in 1979 in an effort to better co-ordinate the installation and maintenance of urban and rural piped water systems. The overall institutional objective of PWA was to develop the capacity to serve a rapidly expanding consumer population with an adequate quantity of hygienically reliable drinking water at a reasonable cost.

The duties of PWA established in the act of 1979 are:

- Conducting survey, providing sources of water and procuring raw water for production
- Producing, delivering and distributing water supply across the country except Bangkok Metropolitan Area, Nonthaburi and Samut Prakan Province which are responsibility of Metropolitan Waterworks Authority (MWA).
- Undertaking other businesses related to or in continuation with the water supply business.

At present, the growth of population in PWA service area causes the rising demand of water every year. PWA therefore has to improve and expand its production and distribution facilities to fulfil consumers’ needs, to develop water resources, to improve the water supply systems transferred from local authorities, and to expedite any necessary improvements of these waterworks. The PWA’s budget is not enough to deal with all these responsibilities. Due to this, nowadays PWA allows private sector participation in its water business, in accordance with the Government Policy, in order to overcome budgetary constraint and to increase efficiency in the improvement and expansion of water supply systems.

These are some of the statements of the Government Policy:

1. To permit the private investors to participate and invest in the activities which are responsibility of PWA, to reduce PWA investment. It is believed that private investment provides more effective and faster results.
2. Public Company (East Water) it's more reliable for water users because of higher efficiency and quality service.

3. Public Company can expand the business, like drinking water production and raw water transmission for industrial use. This expansion will benefit all the users.

4. Government promotes the industrial expansion in different areas of the country. This industrialisation results in an increase of water demand.

5. The Government Policy increases the budget to provide clean water to rural areas.

6. The economic development of the country result in an expansion of the urban regions and in the increase of water consumption.

The objective of the Government Policy is to privatise completely the water sector in the future. Nowadays there are different types of public-private participation in the water sector like East Water, a Public Company that stands at the stock market, Build-Own-Operate (BOO) and Build-Own-Operate-Transfer (BOOT) contracts, leasing contracts, management contracts. An impediment for the development of the private participation in the water business is the fact that in PWA's responsible area the price of water is fixed by the Government and cannot be raised either by PWA or private companies. This fact sometimes restrains the private investment since private companies use to fix the water prices according to the amount of money invested in the management and improvement of the waterworks.

One of the main aims of the privatisation policy is also to clearly separate the policy, regulatory and operating functions that nowadays are overlapped between the relevant ministries and water operators.

Studies on how to carry out the privatisation of the water sector are being done, but the Government has not approved them yet [2].
Regional Offices:
1. Chonburi (17 Waterworks)
2. Saraburi (26 Waterworks)
3. Ratchburi (23 Waterworks)
4. Suratthani (20 Waterworks)
5. Songkhla (19 Waterworks)
6. Khon Kaen (27 Waterworks)
7. Udonthani (21 Waterworks)
8. Ubonratchathani (20 Waterworks)
9. Chiangmai (26 Waterworks)
10. Nakornsawan (25 Waterworks)

Figure 3.4: PWA Responsible Area.
3.2.2 Eastern Water Resources Management and Development Company Limited (East Water)

PWA established Eastern Water Resources Management and Development Company Limited (East Water) by the Cabinet’s resolution on 12 of September 1992. The company initially takes responsibility in the development and management of the main raw water pipelines in the Eastern Seaboard of Thailand. The provinces under responsibility of the company are 7: Chonburi, Rayong, Chachoengsao, Prachin Buri, Sa Kaeo, Chanthaburi and Trat.

![East Water Responsible Area Map](image)

**Figure 3.5:** East Water Responsible Area.
The Eastern Seaboard of Thailand is one of the most important industrial zones in the country. It is home to numerous industrial states, steel works, automobile plants and oil refineries. East Water was set up to manage the raw water transmission in that area since raw water transmission is not responsibility of PWA, and PWA cannot take charge of it.

In the Figure 3.6 it can be seen that 80% of East Water water users are industries.

![Figure 3.6: Proportion of Water User Categories.](image)

The company presently has responsibility in the management of four routes of raw water pipelines in Chonburi and Rayong provinces. Some pipelines are connected as a network with the total length of 143 kilometres having the capacity of supplying 188 million cubic meters of water per year. The connection of pipelines in the two provinces enables the company to manage all the pipelines and water resources more efficiently. Water from Rayong province can be deployed to support areas in Chonburi province, where water is not sufficient. This is to ensure consumers there will be no shortages in water supply under the management of the company.

In addition to its main responsibility, East Water also provides consulting services to customers regarding the raw and clean water production systems, pipelining and water distribution pipelines and equipment maintenance, including the sale of all equipment and accessories for pipelining. The company also involves in the co-investment in other related business such as water supply treatment systems, and manufacturing and sale of relevant equipment [3].

### 3.2.3 Universal Utilities Company Limited

Universal Utilities Co. Ltd. was established by East Water on 15 December 1998, and it is wholly owned by East Water.

The company business area are production and distribution of clean water; wastewater management and treatment; production and distribution of chemical agents and equipment; survey, design, construction and
construction control or consultation as well as maintenance of any systems related to clean water production and wastewater treatment.

**UNIVERSAL UTILITIES CO. LTD.**

- **Waterworks Management**
- **Engineering Services**
- **Wastewater Treatment**

**Figure 3.7:** *Universal Utilities Co. Ltd. Operational Direction.*

These are some of the statement of the company policy:

1. To participate in waterworks business belonging to government, state enterprises (as PWA) and local administration offices and any others through a joint investment, a concession, management contract, etc…
2. To participate in the operation and management of wastewater treatment systems belonging to government, state enterprises (as PWA) and local administration offices by coordinating with wastewater management organizations and/or local and foreign private companies having experience in wastewater treatment.
3. To co-invest or participate in the operation of water supply production and distribution systems, automatic meter reading (AMR) manufacturing to support the expansion of waterworks countryside.
4. To provide maintenance service on water pipelines and accessory equipment including the installation of SCADA control system for waterworks and for other pipelines.
5. To provide consulting services on water production systems, water pipeline systems, SCADA control systems. To provide maintenance services on equipment used in clean water production systems, wastewater treatment systems, water pipelines and SCADA control systems.
6. To introduce and apply advanced technologies in clean water production systems, water production from seawater, and communication and remote controls, for the efficiency of waterworks operation and wastewater treatment systems.
7. To introduce ISO 9002 to the clean water production systems and wastewater treatment systems.
8. To introduce capital through the Stock Exchange or to co-invest with strategic partners in order to support business expansion in the future.
Universal Utilities Co. Ltd. is not yet involved in all the activities and businesses described in the company’s policy. Its current performance covers the waterworks management of Sattahip and Si Chang Island; the production of tap water for Chachoengsao Waterworks Office, Bangpakong Waterworks Office and Nakornsawan Waterworks Office; the pipeline maintenance and SCADA services for East Water; the design, control of construction and waterworks system installation as well as non-revenue water technology.

Since January 2000, Universal Utilities Co. Ltd. in collaboration with East Water has taken on the management of Sattahip waterworks system from PWA. The leasing contract lasts for a period of 10 years. After this period of ten years the concession will be put out to a tender and Universal Utilities has the option to renew it for 10 more years. Other private companies can apply for the concession as well.

In the leasing contract is stipulated the minimum amount of money that Universal Utilities Co. Ltd. has to invest in the improvement of the waterworks system. Universal Utilities Co. Ltd. is not obtaining benefit from Sattahip waterworks management since the initial investment to set up SCADA and GIS systems has been very high. Since it is a 10-years investment plan, the company plan to get benefits not during the first years of management, but before the concession will be finished. Regarding the distribution system expansion in Samaesarn subdistrict Universal Utilities is not investing at all, because there is not benefit in the investment. Before investing, a study cost-benefit has to be carried out. There is also an overlapping of responsibilities between different authorities involved in the water supply field in Samaesarn Subdistrict (PWA, Universal Utilities Co. Ltd. and Samaesarn Municipality) that makes difficult the investment, since before investing Universal Utilities Co. Ltd. has to find out if there is any plan from PWA or from Samaesarn Municipality to invest in the same place [4].
Figure 3.1: Map of Thailand Provinces.
Figure 3.2: Map of Chonburi Province.

Figure 3.3: Map of Amphoe Sattahip.

A more detailed map of Amphoe Sattahip can be found at the end of the report.
3.1.3 Samaesarn Subdistrict

The chosen study area is the Samaesarn Community, a subdistrict located in the southeastern part of Amphoe Sattahip. Samaesarn border with Sattahip subdistrict, in the north, with Phlu Ta Luang subdistrict in the east, and with the Gulf of Thailand in the south and in the west. It has a total area of 45.92 km².

The Samaesarn Community is divided into 4 different areas: Chong Samaesarn area, Nong Ngram Khem area, Hua Haem area, and Nong Krajong area.

The number of registered households in each area is represented in table 3.1.

<table>
<thead>
<tr>
<th>COMMUNITY</th>
<th>NUMBER OF HOUSEHOLDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Chong Samaesarn</td>
<td>416 households</td>
</tr>
<tr>
<td>2. Nong Ngram Khem</td>
<td>513 households</td>
</tr>
<tr>
<td>3. Hua Haem</td>
<td>276 households</td>
</tr>
<tr>
<td>4. Nong Krajong</td>
<td>288 households</td>
</tr>
<tr>
<td>TOTAL</td>
<td>1493 households</td>
</tr>
</tbody>
</table>

Table 3.1: Registered households in Samaesarn subdistrict.

All the households have connection to electricity.

The registered population in each area is reported in table 3.2.

<table>
<thead>
<tr>
<th>COMMUNITY</th>
<th>POPULATION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
</tr>
<tr>
<td>1. Chong Samaesarn</td>
<td>683</td>
</tr>
<tr>
<td>2. Nong Ngram Khem</td>
<td>1086</td>
</tr>
<tr>
<td>3. Hua Haem</td>
<td>465</td>
</tr>
<tr>
<td>4. Nong Krajong</td>
<td>510</td>
</tr>
<tr>
<td>TOTAL</td>
<td>2744</td>
</tr>
</tbody>
</table>

Table 3.2: Registered population in Samaesarn subdistrict.

The economic activities in this area are fishing and little business like shops, little restaurants, and small factories, located in the ground floor of the houses. There are also illegal immigrants from Burma and Laos working in the sailing and fishing sector.

The social services in Samaesarn subdistrict are:

1. Primary school
2. Temples
3. Small Hospital
The water sources belonging by the Samaesarn municipality are:

- 3 groundwater wells in the temple
- 7 shallow wells
- 1 reservoir

These data are from year 2001 [1].
Figure 3.3: Map of Samaesam Subdistrict.