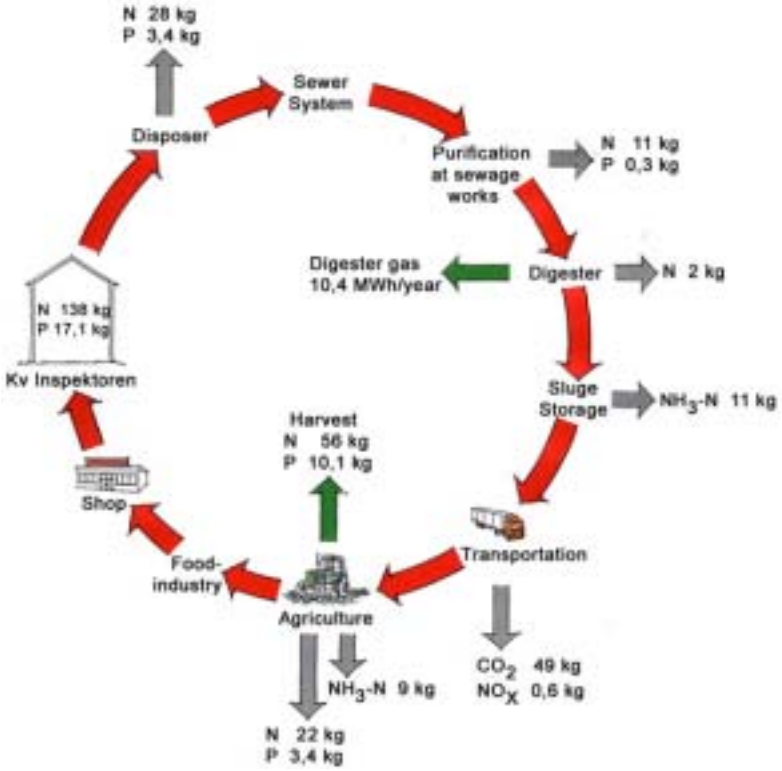
The Inspektoren Residential Area

Work Package 4.1

Kalmarhem AB

Water and Drainage

– Report –



Kalmar, Sweden 2002

Vatten och Samhällsteknik AB – Kalmar Vatten och Renhållning AB

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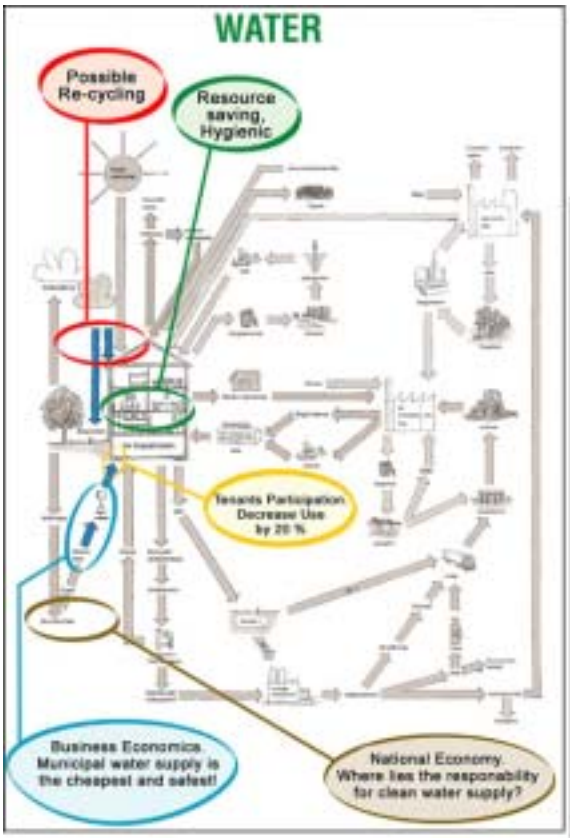
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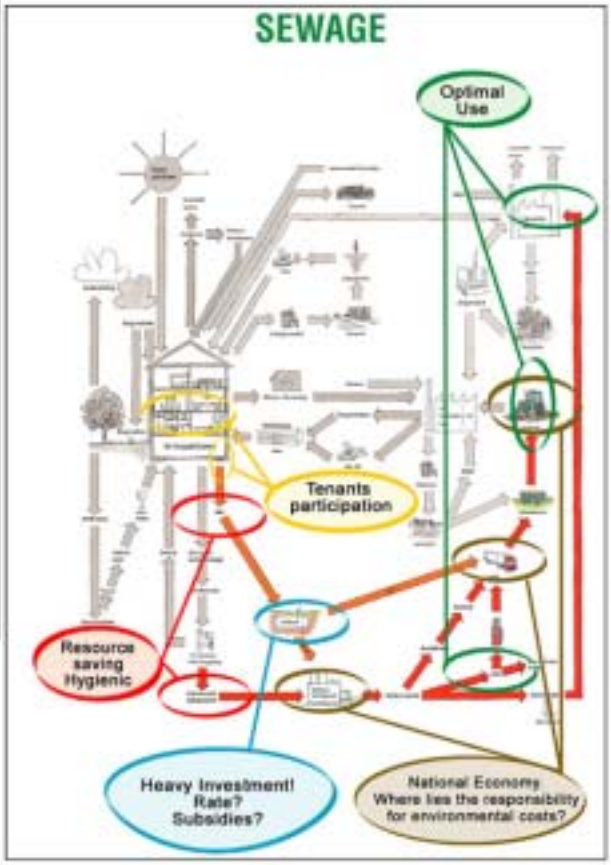
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1. GENERAL

The Inspektoren area constitutes a rather typical residential area from the post-war era. The area, now under the administration of Kalmarhem AB, was completed in 1956 and consists of five three-storey buildings containing in total 159 flats with a living area of approximately 7000 m^2. The total land area amounts to some 15 700 m^2. Kalmarhem AB has carried out a total renovation of the residential area.

A comprehensive investigation and plan was completed prior to the renovation/ refurbishment. One basic objective was that the refurbishment would be maximally adapted to closed-loop recycling principles (e.g. decreased water consumption and utilization of waste water) but at the same time it would be performed at a "normal" cost so that the tenants would not be subjected to extra rent increases. The goals are shown in the illustrations regarding the recycling loop for the Inspektoren area with "information" about those parts affecting water and waste water.

All the basic consumption parameters and their respective environmental factors were measured within the framework of a particular measurement group with the aim of evaluating conditions in the area. Flow measurements in the water and drainage system have been made under the management of Kalmar Vatten och Renhållning AB. The purpose was partly to create a basis for further calculations and partly to enable a later evaluation of the refurbishment.

This report has been compiled in collaboration with Vatten och Samhällsteknik AB, Kalmar Vatten och Renhållning AB, BRa VVS and Kalmarhem.

2. CONDITIONS

The following material has been used in the preparation of this investigation:
- Working plans for the refurbishment of the Inspektoren area, land and pipe work, plans M1 – M11 and M21 – M24, Vatten och Samhällsteknik AB, dated 15-10-98.
- Flow data from the metering well for waste water.
- Precipitation data from measurement stations in Funkabo, Skälby, Bottorp, Påryd, Trekanten, Lindsdal and Läckeby.

3. INFRASTRUCTURE FOR WATER AND DRAINS

Water supply in Kalmar is based on ground water from the Nybroåsen area approximately 20 km south of the city. The raw water is alkalised at the waterworks in Skälby but does not undergo any further treatment before it is distributed to the mains water network. When required the water can be chlorinated.

Waste water from Kalmar is piped to a modern sewage works at Tegelviken in the southern part of the city. There is a biogas plant at the works consisting of two sections: the first is made up of the sewage works' usual sludge treatment where the sludge is treated in a sedimentation tank (digester). The second section, which was originally a second digester but is now redundant, is now purely a biogas plant in which manure and abattoir waste decays for biogas production. The biogas produced here is used for powering vehicles.

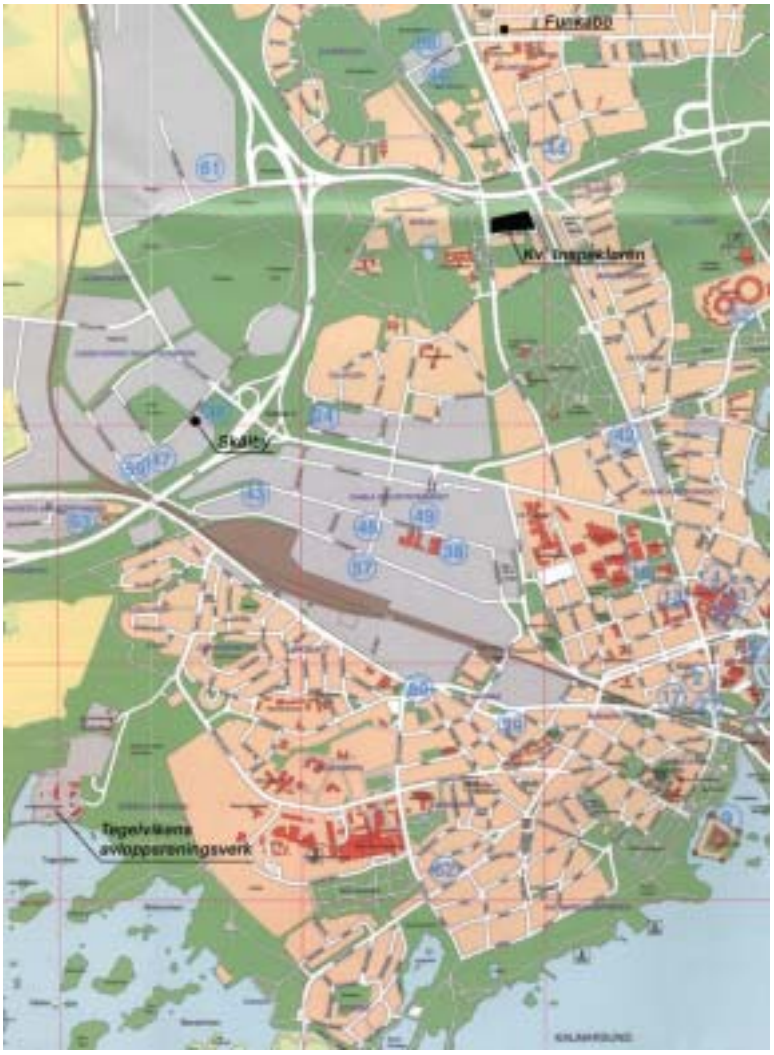

Figure 1. Map showing position of the various plants and the Inspektoren area

4. WATER AND DRAINS IN THE INSPEKTOREN AREA

4.1 Water

The drinking water to the buildings has undergone comprehensive modernisation, which has meant replacement of materials as described below:

- All copper pipes have been replaced with plastic PEX pipes and for visible sections stainless steel pipes, Mapress, have been used. According to the manufacturer of the PEX pipes (REHAU), they have very good hygienic properties. The joints are brass.
- Most of the taps have been replaced with mixer taps, “MORATEMP ESS”. The use of these can decrease water consumption, especially of hot water, by up to 20%. Powder coating has been shown to have an environmental profile.
- All toilets have been replaced with wall-mounted “Victor” models connected to a special pipe cassette. The flush volume is normally 4 litres.
- Most of the washing machines have been replaced by newer models with low water consumption. Some heavy duty washing machines have been retained.

4.11 Goals regarding water consumption

The following goals were set up for water consumption when the refurbishment was discussed:

- Water supply shall be provided in a hygienically acceptable fashion and the consumption shall be as low as possible.
- Consumption must be reduced by at least 20% from the earlier figure of around 240 l/flat, day to 190 l/flat, day.
- The possibilities of recycling waste water or surface water should be given close attention.

4.2 Surface water

The surface water systems of the buildings has undergone a complete modernisation including inspection and replacement of materials as follows:

- All vertical drain pipes have been replaced and are now located in a cassette in the vertical shaft. The material is cast iron, type MA.
- All toilets have been replaced with wall-mounted Gustavsberg “Victor” models with 4 l flush volume. A special environmental declaration exists for these.
- A separate vertical drainpipe for urine has been installed to cover the possibility of future urine separation.
- Drain pipes in basement floors have been cleaned, flushed using a high pressure jet, and filmed. Existing cast iron drainpipes have generally been retained, but partly replaced by plastic pipes, type PP.
- Floor drains have been replaced with stainless drains, model “Eurodrain”.
- Most of the washing machines have been replaced with models that use less water and less washing powder. Some larger, heavy duty machines have been kept.

In addition to the above, a new collecting drainpipe for surface water from the whole area has been constructed along Klockhusgatan. One single connection point to the municipal (mains) network has been retained. At this point a metering well has been built to enable flow measurement as well as integrated sample removal, see **Figure 2**. The pipe from the mains network at the point of connection is a 225 mm diameter concrete pipe.

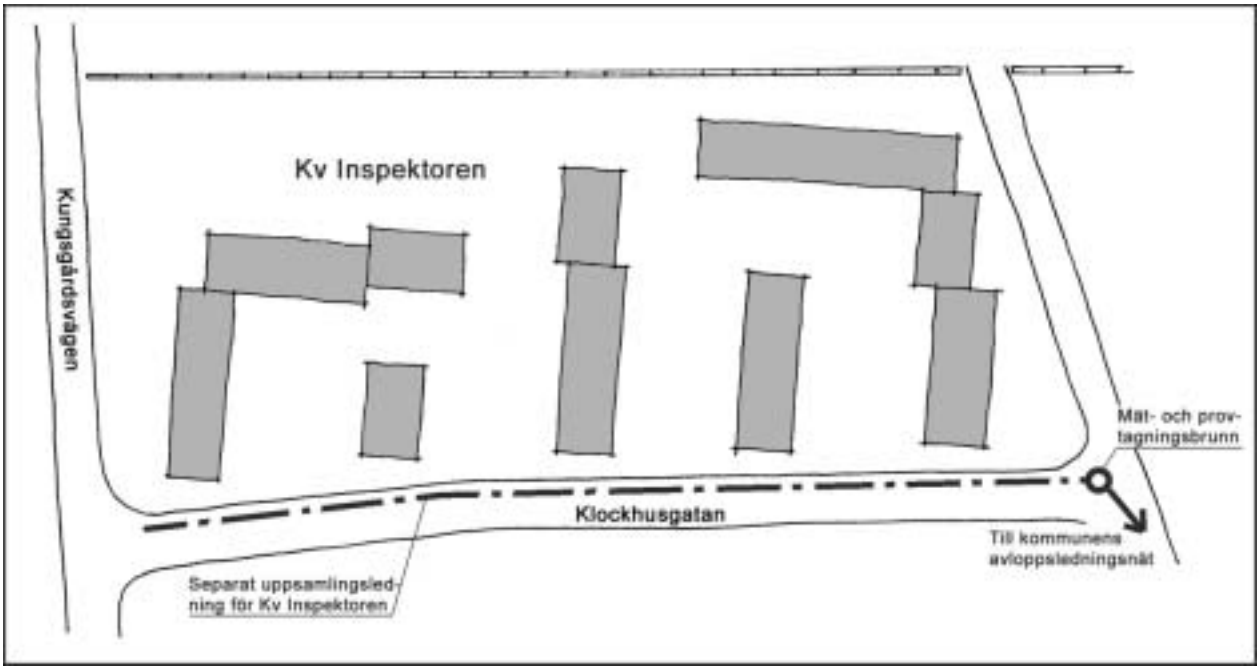

Figure 2. Map showing surface water drainage system

4.21 Urine separation

Before the refurbishment extensive investigations were carried out as well as studies of other buildings and study visits together with the tenants since there had been a great deal of interest in the idea of urine separation. In-depth evaluations were made by a researcher at Högskolan in Kalmar. The question was also discussed at a seminar with participants from research projects, organisations and authorities. The result of the discussions was considered and summarised in the form of a basis for decision:

- System analysis in the form of a lifecycle analysis, **Figure 3**

Based on the above it was unanimously decided not to introduce urine separation but instead to make necessary preparations for future eventualities by installing a separate drainpipe for urine.

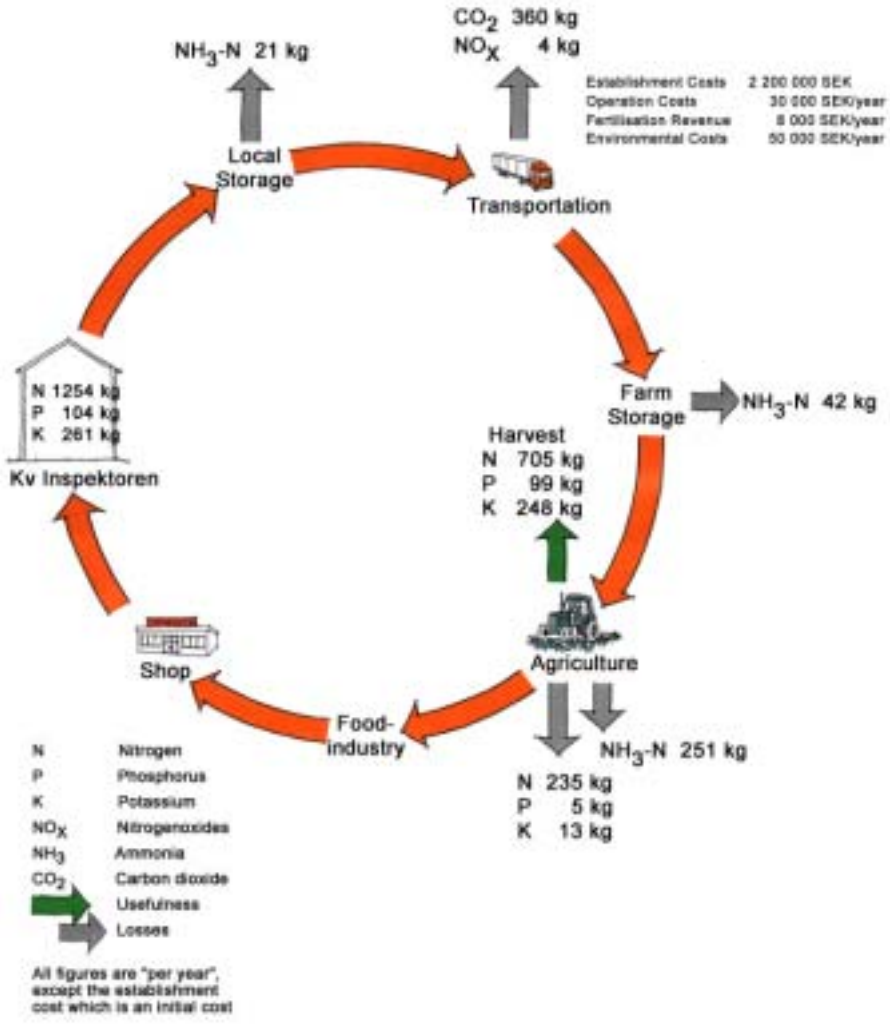

Figure 3. Lifecycle analysis regarding system solution with urine separation.

4.22 Waste disposal units

In the same fashion as for the question of urine separation, extensive investigations were carried out as well as studies of other buildings and study visits together with the tenants before coming to any decisions regarding the installation of waste disposal units. In-depth evaluations were made partly by Kalmar Vatten and partly by a researcher at Högskolan in Kalmar. The question was also discussed at a seminar with participants from research projects, organisations and authorities. The result of the discussions was considered and summarised in the form of a basis for decision:

- System analysis in the form of a lifecycle analysis, **Figure 4**
- Evaluation in accordance with a prototype for sustainable evaluation, **Figure 5**

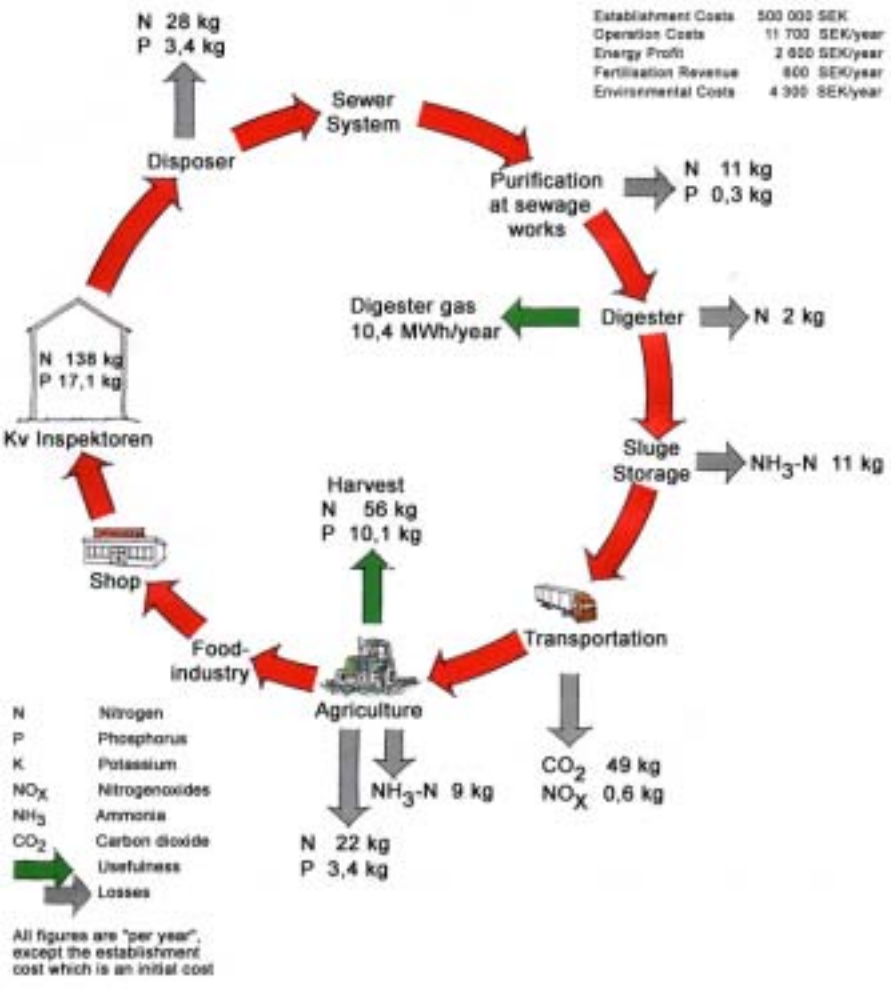

Figure 4. Lifecycle analysis of system solution with waste disposal units

	Disp-oser	Trans-porta-tion	Com-post	Local biogas	Envir. station	●	●
Natural Resources							
Natural Resources, Construction							
Eco Cycling							
Indoor Environment							
Flexibility							
Quality of Living							
Operation Economy							
Hygiene/Health							
Laws and Regulations							
National/Global Economy							
●							
●							
Possibility of Participation in Policy Issues for Tenants	LARGE	LARGE	MEDIUM	EXTRA LARGE	SMALL		

1. Recommended
2. 2:nd best Recommendation
3. Accepted
4. Avoided
5. Unacceptable

Figure 5. Evaluation of alternative system solutions for organic waste

Based on the above it was decided unanimously to **install waste disposal units in all flats**. The final selection was**:**

Disperator Model 77, Figure 6

Figure 6. Kitchen waste disposal unit mounted under a sink

4.23 Goals for waste water and kitchen waste

The following goals were set up before the refurbishment of the area regarding waste water and kitchen waste:

- The overall goal is to optimally utilize plant nutrition resources (phosphorus and nitrogen)
- Minimise risks of technical and hygienic problems
- Optimally utilize the plant nutrition substances and energy
- Consider the significance of tenants' involvement in organising possible events for the result of such solutions

4. Operational data

4.3.1 Operational data for water

There are sufficient data covering total water consumption in the area both before and after the refurbishment:

- **Before:** **185 l/person, day**
- **After:** **157 l/person, day**
  (divided into 100 l/person, day cold water and 57 lperson, /day hot water)

As a factor for various calculations, it has been assumed that the average number of tenants living in any one flat is **1.3 persons.**

The total water consumption has thus decreased by about **15%.** In order to achieve the goal for the project, 20%, more work is necessary in cooperation with the tenants. To reach the general savings goal of 40% set in the EU, there must be careful consideration given to the factors of technology, health and hygiene. These considerations should be the object of detailed studies in a long-term perspective.

Regarding the water consumption after refurbishment, it should be noted that this figure should remain constant in the near future, especially considering that continued close contact with the tenants may lead to a further decrease in water consumption.

Furthermore, with the newly installed individual metering, the possibility now exists to study in more detail water consumption figures and their distribution on different days and at different points during the same day.

There are signs that indicate that the quantity of water consumed when the waste disposal units are used is higher than the theoretical figures given. This affects hot water consumption in particular. The reason seems to be tenants' desire for good hygiene in the kitchen.

4.32 Water quality

Through samples of waste water analysed, there are indications that the copper content of the drinking water could be unexpectedly high. For this reason water tests have been made at three points in the system for copper analysis, giving the following results:

Testing point	**Copper content**
Incoming water at sub-station	< 0,02
After hot water (accumulator) tank	0,11
Tap water in a flat	0,18

It may be noted that these values are under the 0.2 mg/l limit stipulated by the National Food Administration, but are nevertheless unexpectedly high in comparison with the levels in Kalmar as a whole. Continued checks in cooperation with Kalmar Vatten och Renhållning have been started.

4.33 Operational data for waste water

Kalmar Vatten och Renhållning have been responsible for measurements of the waste water flow at the collection well just before the mains drainage network. A series of graphs have been put together in **Appendix 1** *(only in some copies of the report).* One example of the measurements results is illustrated in **Figure 7**.

Measurements have been taken over seven months. Some data were considered less than accurate and have therefore been omitted from the report.

Comparative studies of precipitation in Skälby just under two kilometres west of Kalmar show clear effects of rainfall on the flow of surface water in the drains. There is a relatively rapid change in the flow during intensive rain periods. This is partly due to the base flow that increases (minimum flow during the night) after a continuous rain period. A similarly noticeable increase in volume in connection with precipitation was noted when summarising the total waste water flow over 24 hours. A follow up of the reasons for the effects of the rainfall should take place and has indeed been initiated.

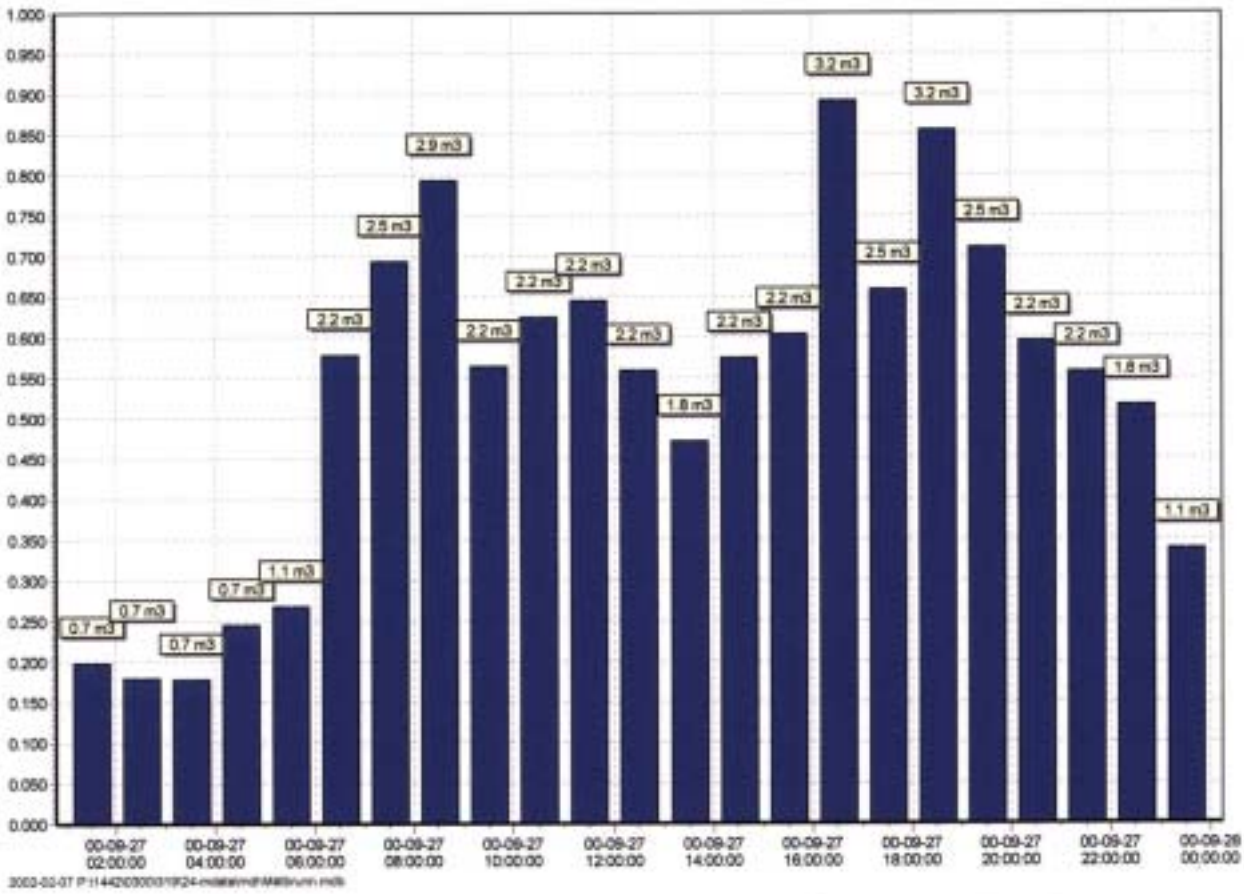

Figure 7. Measured waste water flow during a normal 24-hour period

4.34 Sampling waste water

Measurements and sampling of waste water and surface water have taken place to follow up the situation in the Inspektoren area. The following samples and analyses have been carried out on waste water:

Random tests have been made 5 times over one year. The aim was to take at least four samples during wet periods with higher rainfall. The weather conditions were duly noted.

The samples have been analysed with respect to:
- COD_{Mn}
- BOD
- Substances in suspension
- Total nitrogen content
- Total phosphorus content
- Metals through ICP with high accuracy

The majority of the analysed values have been summarised in the table below:

Table 1. Waste water

Parameter	Date 000918	Date 001116	Date 010122	Date 010409	Date 010517	Comparison Value	Addition For WDU	Remarks
Sub. in susp. mg/l	260	470	230	280	188	875	30	
COD, mg/l	690	190	690	820	757			
BOD, mg/l	170	640	320	330	420	240	52	001116 – confused with COD?
Total N, mg/l	60	36	55	56	49	67	7	
Total P, mg/l	15	0,26	6,5	13	13	10-15	10	001116 – to low?
Pb, mg/l	0,003	0,026	0,011	0,006	0,007	0,015	160	
Cd, mg/l	<0,0001	<0,0001	0,0003	0,0002	0,0003	0,003	3	
Cu, mg/l	0,09	0,10	0,12	0,091	0,073	0,036	65	Copper should be followed up
Cr, mg/l	0,001	0,005	0,006	0,010	0,003	0,025	110	
Ni, mg/l	0,06	0,008	0,009	0,008	0,004	0,0155	55	
Zn, mg/l	0,16	0,19	0,16	0,15	0,11	0,305	39	
Hg, mg/l	<0,0002	<0,0002	<0,0002	<0,0002	<0,0002			

From the summary it can be seen:

COD: the COD and BOD values were probably reversed in the second sample.

BOD: gradually increasing values. Should be followed up in future and related to usage rates of WDU's.

Copper: The consistently high copper values are surprising since all the copper pipes in the buildings have been replaced with PEX pipes. A continued follow up of supply water has been initiated *cf* item 4.32 Water quality.

Nickel: The high value from the first sample seems to have been a chance occurrence.

4.35 TV inspection of drainpipes

Kalmar Vatten and Renhållning AB carried out TV inspections of the mains surface water drainpipes leading away from the area. Observations made show the following:

- The pipes' interior **surface condition** was judged to be Grade 1 – 2
- **Coating** of pipe wall (at waterline) from fat in the waste water was judged as Grade 1 (<5%)
- **Sediment** material in the form of sludge was also judged to be Grade 1 (<5%)
- **Accumulation** of liquid contamination was Grade 1 in connection with moderate hollows.

The mains waste water drainage system in the area consists of pipes of the same age as the buildings constructed in the area, i.e. from the 1950's. The pipes are concrete and the system has functioned without operational disturbances so far.

One example of the pipes' internal condition is shown in **Figure 8**. The intention is to repeat the inspections on suitable occasions after the waste disposal units have been in operation for some time.

Figure 8. Photograph of interior of drainpipe, 225 mm diameter.

As mentioned earlier, the tenants seem to use more water for flushing in connection with the use of waste disposal units than the theoretical figures would indicate. The motive would seem to be hygienic considerations. The amount of flushing water could be of fundamental significance for the mains drainage system. If the flushing water volume decreases, the risk of sedimentation in the drainage system will of course increase. Such effects may need to be monitored in detail in the future when filming of the drains and further studies of water usage are carried out.

5. DISCUSSION

Based on the measurements made and samples taken to date, it will be especially interesting to perform follow ups in future. The copper content of the drinking water and waste water in particular needs following closely since only a marginal increase will lead to the copper content exceeding the norms stipulated by the National Food Administration.

Water saving must not take place to the detriment of health and hygiene. The municipal infrastructure is judged to be of such a standard and level of water resources so good that exaggerated economising would be erroneous and unnecessary seen from an overall environmental perspective.

The effects of waste disposal units on flow and composition of waste water have probably not yet reached their maximum levels since the tenants, according to random checks, have so far been rather passive in their use of the units. It seems too that tenants for hygienic reasons use more (hot) water than theoretically necessary in conjunction with the waste disposal units. Continued co-operation with the tenants regarding how and how much the waste disposal units are used has been initiated and should be continued.

Since flow measurements in the drainpipes indicated a certain amount of leakage of surface water or waste water into the system, continued investigation of possible faulty connections should be made. This had already been started.

In the four specially constructed flats, the so-called “state-of-the-art” flats, there is some specific equipment that has significance for the water and drainage system. Evaluation of these flats could be a basis for modifications made to the other flats in the buildings. These special systems are important for completion of the recycling process regarding the utilization of nutrients and energy.

The municipal water and drainage rates include a special charge for flats with a waste disposal unit installed. It is appropriate to continue discussions about effects and pricing with the water and drainage company while continued technical monitoring takes place.

6. SUMMARY

The ultimate solutions regarding choice of water and drainage systems and equipment have been guided by the fundamental aims of the sustainable society. Basic ecological concepts were the starting point. Overlaying these are social aspects and economic realities. Great importance has been attached to hygiene and comfort. The tenants have been involved in judgements made and selection of systems used. Financial considerations have been weighed in to avoid any abnormal rent increases.

The goal to utilize nutrients and energy in the waste water as a resource has been partly achieved by installing waste disposal units. The goal can only be fully realised by linking up with the municipal infrastructure's modern sewage treatment plant and digester/biogas generator, as well as developed cooperation with the tenants. It was primarily hygienic aspects and environmental efficiency that lead to urine separation not being introduced although it has been prepared for. All the solutions require tangible participation from the tenants.

A decrease in water consumption has been achieved through relatively conventional methods of economic installations and machines. The primary goal to decrease consumption by 20% has not entirely been achieved yet. Further savings require co-operation on the part of the tenants, in which hygiene and health must be given high priority.

Continued quality control of waste water indicates that further monitoring of certain parameters should take place and be coordinated with monitoring of surface water quality.

Function, economy and results of the waste disposal units must be followed up in cooperation with researchers (technicians and behavioural scientists) and not least with the tenants and the municipal water and drainage company. In this connection special weight should be given to the question of flush water volume used with the waste disposal units, linked with the tenants' requirements for good hygiene.

Kalmar, Sweden 2002

Vatten och Samhälls teknik AB
Lars Kylefors

Kalmar Vatten och Renhållning AB
Kenneth Svensson