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In Co-operation with ENTEC AS

REPUBLIC OF ESTONIA

Narva – Jõesuu Water and Wastewater System Improvement Project Feasibility Study

Short Term Investment Programme

FINAL REPORT

Client : AS Narva Vesi **Donor : SOFINEX**

October 2004

Table of Contents

Annexes

Tables

Figures

1 Executive summary

The purpose of the water supply works to be implemented in the Short Term Investment Programme (STIP) is to rationalise the functioning of the system.

The number of boreholes will be reduced from 8 to 1 ; the causes of the massive losses on the pipelines will be identified and solved as 4 720 m of mains will be rehabilitated or replaced.

Moreover, the whole philosophy of water supply in Narva-Jõesuu will be reviewed : the drinking water will be pumped into the existing central storage tank and then provided to the beneficiaries.

Between the storage and the distribution network, a water treatment plant will be installed, in order to balance some chemical components in such a way that the subjective quality of the water is improved and the network is protected.

Measures included in the STIP for waste water include :

- Rehabilitation of 3.3 km of existing pipes and ditches.
- Construction of new sewerage lines (8.6 km).
- Construction of new storm water collection system (5 km).
- Rehabilitation of 320 manholes.
- Construction of 379 new connections.

These works will allow increasing coverage rate, from present 66% to 82% in 2009.

Sewage effluent will be pumped to Narva main wastewater treatment plant, while storm water will be discharged by gravity into Narva River. Since only sewage will be pumped – and despite network and service extension - total operation costs in 2009 will be 4% lower than what they are today.

Project is based on the assumption of a higher participation of household owners, who will be responsible for discharging exclusively non-diluted sewage into sewerage.

The whole STIP expands between 2005 and 2009, considering that the first year will mainly be dedicated to the additional investigations (final studies) and the tendering processes.

The financial analysis of the works and the O&M costs shows that, considering the Narva-Jõesuu systems independently from Narva, the budget is not balanced.

For the recovery of the O&M costs only, the tariffs should be increased by 47%.

A solidarity is required between Narva and its sister city, Narva-Jõesuu ; this solidarity is justified by the socio-economical complementarities between them.

A faster implementation of the investments is possible, if the additional investigations call for emergency or urgent works and/or efforts by the local authorities for the adoption of an appropriate legislative framework in order to allow works on private lots are quickly conducted.

2 Scope of the Programme

2.1 General description

2.1.1 Water supply

Presently, 7 boreholes provide the water supply in Narva-Jõesuu. Taking into account the actual demand (in 2020), as well as the capacity of the underground resource, only 1 borehole is sufficient. The remaining wells will be kept as back-up and/or for spare parts.

Water quality of raw water is in accordance with the norms and regulations presently valid in Estonia and the European Union. But treatment must occur, in order to reduce the level of diluted gases and balance the calco-carbonic levels. This treatment has both a technical and a subjective comfort purpose.

A second booster pumps will be installed, in order to secure the single existing one.

The storage tank will be rehabilitated.

The huge amount of water losses in the network is caused by the poor condition of the pipelines. Some will be replaced and others will be rehabilitated.

Finally, valves and meters have to be installed for an improvement of the network monitoring.

All the described interventions will be preceded by additional investigations.

2.1.2 Waste water system

Existing sewerage provides service to 2/3 of the population, mainly concentrated in the central area. Sewerage collects sewage and storm water altogether, through 4 pumping stations. Wastewater is eventually pumped to Narva, in the recently upgraded main wastewater treatment plant, located some 11 km away.

Because of high infiltration rate - emphasized by drainage facilities - sewage concentration in wastewater is very low (some 14%) and pumping costs are unnecessarily high.

As part of the Long Term Investment Programme, Short Term Investment Programme includes the splitting and extending of the existing sewerage system into two separate networks : one for sewage and one for storm water collection.

Sewage effluent will keep on being pumped to Narva main wastewater treatment plant, while storm water will be discharged, by gravity, into Narva river.

First phase of works includes the construction of most of network lines and rehabilitation of existing manholes.

An important phase of the project is the construction of new household connections, so that sewage and storm water are discharged separately in their respective collection system.

2.2 Objectives and benefits

2.2.1 Water supply

The main objective of the works on the water supply is to optimize the system : at the production, at the distribution, at the operation and management levels.

The technical benefits will be :

- the reduction of the number of wells to maintain and operate,
- to improve the pipelines network and dramatically reduce the losses,

- to increase the quality of the distributed water.

Financially speaking, the simplification of the system will enhance the efficiency during operation. The loss reduction will also have a direct positive impact on the financial balance of the network : less leaking water will be pumped. Cost savings will appear, as the urgent repair actions will be less needed.

Additional costumers are not an issue in present Narva-Jõesuu, as the connection rate is near 100%. But the dimensioning of the mains allows the connection of two large consumers, who presently have their own borehole : the Coast Guards Squad (2 000 m³/year) and Hotel Sanatorium (12 000 m³/year). The quantity of sold water should increase from 125 000 m³/year (2003) to 208 635 m³/year (2020), mainly due to an increase in individual daily consumption (see [15]).

2.2.2 Waste water system

Measures described in the present Short Term Investment Programme (STIP) are only a first step to a global extensive upgrading of the wastewater system in Narva-Jõesuu, to be reached in 2020 according to the Long Term Investment Programme.

As such, STIP will only bring part of total benefits. However, benefits contemplated in STIP include a dramatic increase of coverage rate, from 66% to 82%, on the road to a final coverage of 93% in 2020[1]. In other terms, most of final coverage will be reached during STIP.

Main STIP issues are presented in Table 1 below:

Table 1 : Project and benefits for waste water system (see [14] and [15])

<table>
<tr><th colspan="2">Present situation</th><th>Short Term Investment Programme</th><th>Benefits by 2009</th></tr>
<tr><td rowspan="3">Very diluted effluent (14%)</td><td>Sewage and storm waters are collected altogether through one combined household connection.</td><td>Progressive replacement of existing combined household connections by two separate connections, one for sewage, one for storm and drainage water.</td><td rowspan="3">More concentrated effluent (31%) will be collected and pumped into Narva wastewater treatment plant, implying higher treatment efficiency and lower operation (pumping) costs.
Pumping costs are expected to reach 75% of present expenses despite increasing of coverage rate.</td></tr>
<tr><td rowspan="2">Existing network facilities are deficient, run-off and underground waters enter sewerage.</td><td>Rehabilitation of deficient network sections and manholes.</td></tr>
<tr><td>Separation and extension of storm water collection system</td></tr>
<tr><td colspan="2">Low coverage rate (~66%)</td><td>Extension of sewerage</td><td>Higher connection rate (~82%), thus higher living standards on household lots, higher water table protection and better environmental conditions.</td></tr>
<tr><td colspan="2">Poor condition of ditch system for storm water collection</td><td>Rehabilitation of existing ditch system</td><td>Lesser flooding on streets, higher environmental standards in residential areas</td></tr>
</table>

Measures suggested in STIP will also help to reduce heterogeneity of facilities, implying operation and maintenance will be easier and less expensive.

- Operation and maintenance costs in 2004: 1 733 326 EEK/year
- Operation and maintenance costs in 2009: 1 641 361 EEK/year

[1] Terms of reference require a coverage rate between 90 % and 95 % in 2020.

- Operation and maintenance costs in 2020: 1 012 563 EEK/year

2.2.3 Non-technical benefits

In addition to the above-mentioned technical benefits, the project will also help to change behaviour and responsibility among serviced population.

This is quite a dramatic change compared with the present situation based on a "full public service" approach, where costs are not directly covered by the people using the service, and public service is committed to take care of the whole problem.

By asking households owners to guarantee that only sewage will be discharged into sewerage, they are asked to participate more actively into creating a better environment in their city.

As an example, sewerage will be designed so household facilities located above ground are able to discharge into public sewerage by gravity. Facilities located below ground level (basements) - or located too far away from the supply point - will have to be equipped with pumping devices, at charge of the household owner.

This approach means a new trend in the share of responsibilities between authorities (at municipal, county or national level) and the private sector (Narva Vesi as operator, private companies *and household owners*).

Consequently, it will end up on a lower operation and maintenance costs at operator's and public service level.

3 Additional investigations

3.1 General description

The next step in the course of the investments is to draft detailed measurements of the works and to assess some still pending data.

The needed additional investigations for the improvement of the water supply should include :

- A comprehensive inventory of the existing infrastructures : pipelines, valves, manholes, fire hydrants, sewerage, ditches, manholes, etc…
- A camera inspection is needed, before deciding the needed investments for both boreholes and sewerage rehabilitation.
- A detailed study for the proposed investments (wells, water treatment, storage tank rehabilitation, etc…).
- The identification of the pipelines to be replaced or to be rehabilitated.
- A water network (hydraulic) study with the proposed replacements, according to the field recommendations and assessments.
- A topographic survey for the confirmation of the lengths to be replaced (as a more detailed topographic survey is requested for the wastewater issues, both surveys should be combined).

The following chapters will detail the requested investigations.

3.2 Inventory and diagnosis of existing facilities

LTIP has been designed on the existing information, mainly available in Narva Vesi. Valuable data were found. However, physical works should be based on a much more accurate information regarding existing facilities.

Inventory should then be ran on both quantity and quality:

- Inventory of existing facilities: localisation (GPS), dimensions, material, age (if possible), depth of all networks sections. Inventory will be done accessing the facilities through the manholes, or digging where necessary.
- Conditions of existing waste water facilities should be checked using visual methods (mirrors or CCTV). Length of pipes to be checked is estimated at 4 km.

Inventory should also concentrate on important points of the system, as for instance around main WW pumping station n°4.

The collected data will be included in a database and a unique code will be assigned to these equipments.

The database will be related to the network model to be constructed, as well as to a stock maintenance database. This process will be helpful for detailed design and to the operator (Narva Vesi) for future management of the network.

Inventory of existing facilities could be ran by Narva Vesi or subcontracted. A specialized company should do CCTV inspection.

Needed expertise :

Expertise	Duration
NV Technician	10 days
NV Engineer	5 days
Technician	30 days
Engineer	15 days
CCTV company	15 days

3.3 Camera inspection

A camera inspection will be conducted in the borehole n°1. The inspection will give details on the actual corrosion condition of the borehole, from surface down to the bottom.

This inspection is mandatory in order propose the most appropriate rehabilitation method to apply.

Moreover, possible problems with iron bio-film incrustation will be shown, if any. In this case, a specific treatment will be used to eliminate the bio-film.

The minimum characteristics of the camera should be[2] :

- diameter less than 5",
- high resolution video of side and bottom of the borehole and
- waterproof up-to 100 m pressure.

In order to have a better knowledge of the boreholes condition, the camera inspection will also be conducted on wells n°5, 6 and 7.

The results of the camera inspection will be a comprehensive description of the actual condition of the wells.

Needed expertise :

Expertise	Duration
Technician	4 days
Hydrogeologist	4 days

3.4 Detailed survey

A detailed survey of the proposed works will be conducted. This final study will provide exact measurements for :

- wells : following the camera inspection, the most appropriate method of rehabilitation will be defined.
- water treatment unit : detailed specifications for hydraulic and electric connections, concrete support for CO_2 tanks, building requirements, heating and ventilation system, tarmac for access, etc.,
- storage tank rehabilitation : emptying the tank for inspection, measurement of the surfaces to repair, rehabilitation of hydraulic equipment (if needed), etc.,
- pumps room : detailed study of the equipment or structural elements to repair (electricity, hydraulic, light, windows, doors, security, fire fighting equipments, etc.),
- office : measurement of the repairs (walls, ceilings, doors, windows, toilet and sink, electricity) and equipment (furniture).

[2] See Table 3

Needed expertise :

Expertise	Duration
Technician	15 days
Engineer	5 days

3.5 Pipelines works identification

The exact works on pipelines will be identified and confirmed, following the recommendations of the present study and the field survey (inventory).

The priority for the works (both replacement and rehabilitation) will obey to the following criteria :

- Condition of the pipelines,
- Importance (flow and population) in the network,
- Frequency of repair works,
- Inaccuracy of the diameter, according to the model.

This identification will be conducted in close cooperation with the Narva Vesi local technician, who perfectly knows the situation.

At the end of this process, the pipelines to be replaced or rehabilitated will be known : diameter, street, point-to-point, depth, present material.

The exact length and localisation (side of the roads) will be determined by the topographic survey.

Needed expertise :

Expertise	Duration
Engineer	10 days

3.6 Modelling

The identified works will be included in a model of the network, in order to ensure that transient problems will not occur.

The phasing of the works will be determined at this stage.

Needed expertise :

Expertise	Duration
Engineer	3 days

3.7 Topographic survey

Detailed design will also need additional topographical information. Topographical survey should include:

- XYZ location of both existing water supply and waste water facilities: network, chambers, valves, watermeters, fire hydrants, manholes. Most of this information already exists on Narva Vesi system map, and it might be sufficient to check it on a sample analysis methodology.
- Linear topographical survey of future network lines. Total length to be surveyed is about 7.5 km.
- Field constraints, if any.

Needed expertise :

Expertise	Duration
Topographer	13 days

3.8 Geotechnics

Ground conditions should be checked in some areas of the city, in order to assess the quality of soil, and the presence of water table.

Specialized geotechnical company could do the job.

Needed expertise :

Expertise	Duration
Technician	15 days
Engineer	10 days

3.9 Household census

Main measure to be applied for upgrading Narva-Jõesuu wastewater management includes upgrading facilities at household level.

This upgrading will include separating sewage from storm water collection on private lot. It may also include disconnection of an existing septic tank, or the settling of a private pumping station.

In order to define appropriate schedule of works, priorities should be set according to existing facilities at household level. So it is necessary to run an inventory of all households located within the STIP network, distinguishing between those with or without drainage, septic tank, connections, and so on.

This information will then be crossed with the available data in Narva Vesi (water consumption) in order to list consumers according to priorities, defining schedule of works:

- 1st priority: Big water consumers (apartment buildings, hotels) able to discharge both sewage and drainage water by gravity into respective collection facility (sewerage or storm water collection).
- 2nd priority: Big water consumers (apartment buildings, hotels) able to discharge sewage into sewerage by gravity, but needing a pumping device to discharge drainage water into storm water collection system.
- 3rd priority Households *without* drainage facilities and able to discharge sewage into sewerage by gravity.
- 4th priority Households *with* drainage facilities and able to discharge both sewage and drainage water by gravity into their respective collection facility.
- 5th priority Households *with* drainage facilities, able to discharge sewage into sewerage by gravity, but where a pumping device is needed to discharge drainage water into storm water collection system.

This census could be ran by Narva Vesi (NV), for instance in parallel of water meter reading.

Needed expertise :

Expertise	Duration
NV Technician	30 days
NV Engineer	10 days

3.10 Institutional study

Measures suggested in the present project are of great impact on the existing wastewater management in Narva-Jõesuu. These measures will necessarily need to be backed up by appropriate regulations in order to be implemented.

3.10.1 Non-polluted wastewater management

One of the main issues in Narva-Jõesuu wastewater management is the fate of non-polluted wastewater (storm, drainage, run-off, roof). The Public Water Supply and Sewerage Act defines that "structures and equipment for leading off rain water, drainage water and other soil and surface water are deemed to be part of a public water supply and sewerage system *unless the local government decides otherwise*".

On the other hand, Municipal ("local government") regulation defines that "rain water could be discharged into sewerage *unless the operator decides otherwise*".

These articles are fully compatible with the solutions suggested in the present Feasibility study. However, regulation at operator's level should be completed in an explicit way, fitting the future separate wastewater system, and making clear that non-polluted wastewater should not be discharged into sewerage, but into appropriate storm water collection system: network or ditch, or infiltrating on site.

Regulation will then apply both to existing households (providing deadline of application) and new households.

For this part of the study, expertise on water and wastewater regulations will be needed, completed by national legal expertise.

3.10.2 Works on private settlements

It is expected that in the majority of the cases, splitting sewage from drainage water at household level will be done with relatively low investment. However, investment and operation at owner's costs may be delicate to implement, as it is often the case when applying new regulation.

The institutional study will have to assess the affordability of such burden to the owners. Should private works not be affordable by owners, the study will have to identify alternative financing means, such as incentive measures or subsidies.

Another issue to be treated by the institutional study concerns the existing private sewerage lines, which are planned to be used for public use. If any, transfer conditions should be solved.

For this part of the study, expertise on socio-economics and finance will be needed.

3.10.3 Effluent standards

Existing standards on national level only apply for discharge into *natural environment*, which is after collection and appropriate treatment. According to legislation, quality standards for effluent to be discharged *into sewerage* (before treatment) are to be set on municipal level. This makes sense, since effluent quality standards depend on local collection and treatment conditions.

In the case of Narva-Jõesuu, such standards were not set yet. Quality standards for effluent discharge into sewerage should then be defined and municipal legislation possibly completed.

For this part of the study, expertise on environmental impact will be needed.

3.10.4 Organisation of the operator

New and completed regulations as described above will need a review of the operator's mission and resources. The study will then have to analyze the existing organization of the operator, and if relevant suggest reorganization on legal and institution levels.

Needed expertise :

Expertise	Duration
Specialist institutional studies	30 days
Legal expert	10 days
Socio-economist	10 days
Environmentalist	10 days

3.11 Reporting and drafting of tender documents

In conclusion of all the previous studies, a final technical report (final study) will be produced and the tender documents, according to the financing procedures at the time, will be drafted.

Needed expertise :

Expertise	Duration
Engineer	10 days
Procurement expert	5 days

In total, the additional investigations will require the following expertise (sum of the above detailed investigations) :

Table 2 : Summary of needed expertise

Expertise	Duration
NV Technician	40 days
NV Engineer	15 days
Engineer	53 days
Hydrogeologist	4 days
Technician	64 days
Topographer	13 days
CCTV company	15 days
Specialist institutional studies	30 days
Legal expert	10 days
Socio-economist	10 days
Environmentalist	10 days
Procurement expert	5 days

4 Water supply

4.1 Well rehabilitation

4.1.1 Justification of the works

Presently, 8 boreholes are equipped in Narva-Jõesuu, out of which, 7 actually pump water into the network (non-simultaneously).

Considering the capacity of the Voronka aquifer, it is technically (and hydrogeologically) possible to reduce the number of installations. Thus, the level of fixed assets, the O&M costs and the electricity consumption will decrease.

A single borehole is selected to provide the whole water demand for the network. The most appropriate remaining boreholes will be kept as back-up.

4.1.2 Description of the works

After the camera inspection (see 3.3), a financial and technical comparison between the rehabilitation costs and a new borehole will be made and the most efficient solution will prevail. The two possible solutions are :

- The condition of the borehole is rather good. After rehabilitation, a new pump will be installed.
- If the rehabilitation costs are too expensive, a new borehole will be drilled and equipped in PVC (pipes, screens and pressure pipes). It will be located near the existing n°1.

The characteristics of pipes and screen in borehole n°1 are :

Table 3 : Borehole n°1

Type of pipe	Depth
Steel pipe 10”	0 – 70 m
Steel pipe 8”	64,5 – 75 m
Screen 6”	75 – 108 m
Steel pipe 6”	108 – 119 m

The static water level is around 17 m under surface. The depth of the borehole is 119 m.

A pumping test will be realised in the borehole n° 1 to confirm its production capacity and the best depth for installing the new pump.

The rehabilitation works, in corroded pipe sections, consist in local repairs, using an “air-pump” obturator and a “deformable thin-wall pipe” with vulcanised-rubber on the outside face to ensure good water-tightness will be sufficient. To be economically justified, the number and total length of this type of rehabilitation should not exceed 5-6 zones and a total length of 3 meters.

If the total length exceeds 3 meters, and certainly if the screen itself is corroded, no rehabilitation would guarantee a reliable production for 15 more years. In this case a new borehole will be drilled.

The complete relining of the borehole is not recommended, as this kind of rehabilitation doesn’t completely isolate the existing corroded steel pipes and screen. The relining will only decrease contact and water speed along steel pipes.

So, considering the investment in the network for the next 15 years and the risk of water quality decreasing because of an incomplete rehabilitation, the only solution is to drill a new borehole.

4.1.3 Dimensioning

The new stainless steel immerged pump will have the following characteristics :

Table 4 : New immerged pump specifications

Item	Value
Maximum diameter of the pump	6”
Flow	30 m³/h
Pressure	50 m
Power	5.5 kW

If a new borehole is necessary, a down-hole hammer drilling equipment will be used to drill with a start tool diameter of 14” and a final diameter of 8”. Final depth of the borehole will be between 120 and 130 m.

The equipment will be composed of PVC pipes diameter 12” to 80-90 m and a final diameter of 8”. The screen (diameter of 6” in PVC) will be placed following the information obtained during the drilling process, probably between 80 and 120 m. The filter pack will be chosen in relation with aquifer properties, when the hydrogeologist will analyse the cuttings of the Voronka layers. Development, equipment and pumping test will be realised before starting operation.

4.1.4 Financial influence on O&M

The O&M costs will decrease sensibly :

- Only one pump to operate and maintain permanently.
- The borehole is located in the same premises as the tank, reducing the transportation costs of the technician.
- The remaining boreholes will require less O&M than when they were more actively used.

4.1.5 Costs

The average cost for rehabilitation with an “air-pump” obturator and a “deformable thin-wall pipe” with vulcanised-rubber is 16 000 EEK per 50cm, so the maximum budget is 96 000 EEK.

The cost of a new borehole with 30 m³/h productivity capacity, 120-130 m depth and PVC equipment is estimated at 400 000 EEK.

The cost for a new pump is evaluated as follow :

Item	Cost
Immerged stainless steel pump (30 m³/h at 50 m)	40 000 EEK
Accessories (cables, electric command, …)	16 000 EEK

The protection features already exist and shouldn’t be replaced or renewed.

4.1.6 Time table

The camera inspection should be realised at the very beginning of intervention, during the first month, whenever in the year (the season is not an issue for that).

Immediately after that, at the end of the first month or during the second month, a pumping test will be realised in the borehole n° 1.

During this period, the other boreholes will ensure the water production.

4.2 Water treatment facility

4.2.1 Justification of the works

The project's purpose is to correct the aggressivity of the water and its corrosion propensity in the public water supply network.

The water quality that has been considered representative of the raw water and used to design the treatment process is shown hereafter :

Table 5 : Average raw water quality

Parameter	Units	Values
Temperature	°C	18
Conductivity (calculated)	µS/cm	738.1
Conductivity (measured 25°C)	µS/cm	869
pH		8.2
TH (total hardness)	meq/l	0.68
Alkalinity (CO^{--}_3 + HCO^-_3)	meq/l	3.2
Free CO_2 (calculated)	mg/l	1.997
Calcium Ca^{++}	mg/l	6.8
Magnesium Mg^{++}	mg/l	4.1
Sodium Na^+	mg/l	190
Potassium K^+	mg/l	40.3
Chloride Cl^-	mg/l	201.8
Sulphates SO^{--}_4	mg/l	< 2
Nitrates	mg/l	< 0.4
COD	mgO_2/l	1.5
Manganese Mn	mg/l	<0.02
Iron Fe	mg/l	<0.5

The water is aggressive and corrosive. The aggressivity is due to the unbalanced carbonic acid content of the water. The corrosivity is due to the high NaCl content of the water.

The pumped water is "sparkling" due to depressurization at atmospheric contact.

There is a small organic content in the water (COD), which is less than the requested specification. This organic content is not a concern for the requested process.

4.2.2 Description of the works

A treatment plant is requested after pumping the groundwater from the wells.

The purpose of the treatment plant is :

- to eliminate excessive iron, which may cause a red coloration of the water
- to neutralize the water agressivity and to turn the treated water into a slightly calcifying water, in order to attenuate the chloride corrosivity, thanks to calcium carbonates deposits in the public pipes network.

The proposed treatment process includes 5 steps that are described below.

The plant will consist in two skids ; the building should have the following dimensions : 14.5 m x 10 m x 4.5 m (inside).

4.2.3 Dimensioning

The hydraulic capacity of the plant is 45 m^3/h.

4.2.3.1 STEP 1 : Atmospheric air contact

The purpose of this step is :

1) to depressurize the pumped water from the wells and to bring the water at atmospheric contact to reach atmospheric CO_2 equilibrium.
2) To reach atmospheric O_2 equilibrium for iron oxidation and to attenuate the corrosivity of the water

The pumped water is agitated in a 7.5 m^3 HDPE tank. The contact time at atmospheric pressure is 8 minutes at nominal capacity. During this step, oxygen will reach saturation in the water (9-10 mg O_2/l), carbon dioxide (CO_2) will be relieved during this step. The local building will have to be ventilated to prevent hazardous CO_2 accumulation. The CO_2 relieve is estimated to be 3.32 g CO_2 per treated water m^3.

A dosing pump delivers NaClO (sodium hypochlorite) to oxidize iron (Fe) and/or manganese (Mn) and to flocculate organic matters. The generated particulates will be filtered out on the sand filters of STEP 2.

The plant is divided into two (22.5 m^3/h) parallel lines with a third used as a back-up line during regeneration time of one line.

The tank is equipped with a level controller for pumping control.

STEP 2 is fed through two centrifugal pumps (1 in service + 1 back-up) :

Pump flowrate : 45 m^3/h at 45 m. water column.

The water pH will be 8.64 after this step.

4.2.3.2 STEP 2 : Sand filtering for particulates removal

This step is carried out to remove the suspended solids of the pre-treated water to protect the downstream calcite contactors.

Design :

Three filters are set up (2 in operation and 1 back-up during backwashing). Each filter is designed at a nominal capacity of 22.5 m^3/h.

Technical data per filter :

- Maximal filtration velocity : 15 m/h
- Diameter : 1.6 m
- Filtration surface : 2 m²

- Cylindrical height : 1.5 m
- Sand load : 4 500 kg (diameter 0.5 – 1 mm)
- Filter material : fibreglass reinforced PE (polyester)

The filtration unit is automated. Each filter is equipped with 5 pneumatic actuated valves and pressure control sensors. A filter will be automatically backwashed when the pressure headloss will be higher than a parameterized setpoint in the PLC. The water for backwashing is pumped with a centrifugal pump from the existing storage tank.

Before water backwashing a filter, an air blower will shake up the sand with air to help remove the filtration cake attached on the sand. An air relieve valve is installed on each filter for air venting.

The water pH after this step will be +/-8.64.

4.2.3.3 STEP 3 : CO_2-injection

This step will increase the carbonic acidity of the water to allow a high calcite dissolving capacity for STEP 4 so that the final chemical composition will show enough calcium carbonates content for later $CaCO_3$ deposits in the public pipe network.

Design :

The CO_2 delivering device is designed to dose 44 mg CO_2/l of treated water.

CO_2 dosing capacity : +/- 2 kg CO_2/hour at nominal capacity (45m³/h).

The gas flow is controlled according to the water flow rate and a local pH probe. The dosage is carried out continuously on-line through a spherical nozzle device mounted on the water pipe with the necessary safety devices. The CO_2 is stored on a bottles rack.

The water pH after CO_2 injection will be +/- 6.88.

4.2.3.4 STEP 4 : Calcite ($CaCO_3$) contactor

During this step, the water will dissolve calcite ($CaCO_3$) and increase its calcium content Ca^{++} from 6.8 to 37 mg Ca^{++}/l and reach the calco-carbonic equilibrium.

Design :

Three filters are set up (3 in parallel operation, normally no backwashing). Each filter is designed for a nominal capacity of 15 m³/h.

Technical data per filter :

- Maximal filtration velocity : 7.5 m/h
- Diameter : 1.6 m
- Filtration surface : 2 m²
- Cylindrical height : 1.5 m
- $CaCO_3$ load : 4 300 kg (1.45 t/m³)
- Contactor material : fibreglass reinforced PE (polyester)

$CaCO_3$ uptake rate :

To reach equilibrium, the water will dissolve +/- 76 g $CaCO_3$/m³ treated water.

$CaCO_3$ uptake : 0.076 kg/m³ x 45 m³/h x 20 hours/day = 68.4 kg $CaCO_3$/day or 2.05 t/month. Each filter in service will loose 683 kg calcite per month at nominal capacity and on a 20 h/day working basis (or 0.47 m³ calcite/month per filter).

After calcite contact equilibrium, the pH will be +/- 7.74.

The filtration unit is manual. Each filter is equipped with 4 manual valves and pressure gauges. A filter will be manually backwashed when necessary.

The water for backwashing will be pumped from existing storage tank with a centrifugal pump.

4.2.3.5 STEP 5 : Sodium hydroxide dosing

In this step, a dosing pump will add NaOH to reach a final pH of 7.85.

The NaOH uptake is estimated to be 1.9 g. NaOH(100%)/m³ treated water or 285 g of commercial NaOH solution (50%) per hour at nominal capacity.

With the proposed NaOH storage tank, the autonomy is 4 weeks and a half at nominal capacity on a 20 hour/day working basis.

The dosing pump is controlled according to a water flow rate proportional basis. The flow meter is installed in the feed pipe of the treatment unit.

A pH sensor and transmitter is installed in the existing storage tank to monitor the final pH. This measure can be used to control the NaOH dosing pump (security).

A last hypochlorite dosage is carried out for disinfection purposes.

The final estimated water analysis will be the following :

Table 6 : Average drinking water specifications

Parameter	Units	Values
Temperature	°C	18
Conductivity (calculated)	µS/cm	852
PH		7.85
TH (total hardness)	meq/l	2.21 (or 11.03°F)
Alkalinity ($CO3^{--}$ + HCO_3^-)	meq/l	4.68 (or 23.4°F)
Free CO2 (calculated)	mg/l	6.62
Calcium Ca^{++}	mg/l	37.4
Magnesium Mg^{++}	mg/l	4.1
Sodium Na^+	mg/l	191
Potassium K^+	mg/l	4.3
Chloride Cl^-	mg/l	201.8
Sulphates $SO4^{--}$	mg/l	< 2
Nitrates	mg/l	< 0.4

With this analysis, the water will be slightly ***calcifying*** and subject to $CaCO_3$ deposits in the water supply network. The chloride (Cl^-) related corrosivity still remains but its effect will be attenuated thanks to the carbonates incrustation propensity of the final treated water.

4.2.3.6 Miscellaneous

A compressor is included for valves actuation through pneumatic cabinet with solenoid valves.

Electrical cabinet is included with programmed PLC according to approved functional analysis.

All the equipments are assembled on two skids for direct delivery.

Estimated dimensions : 1 skid : Length = 9 m, Width = 3 m, Height = 3 m.

4.2.4 Financial influence on O&M

The main influence on O&M costs is the purchase of the chemicals. Their influence on the price of the water is explained as follows :

Table 7 : Consumption of the treatment plant (per m³ of drinking water)

Product	Consumption	Unit price	
CO_2	0,0444 kg/m³	10,88 EEK/kg	0,48 EEK/m³
$CaCO_3$	0,0761 kg/m³	0,8 EEK/kg	0,06 EEK/m³
NaOH (50%)	0,0038 kg/m³	4,8 EEK/kg	0,02 EEK/m³
Total			**0,56 EEK/m³**

4.2.5 Costs

The cost estimates is around 7 200 000 EEK, including transportation, installation, civil works, etc., if produced in Western Europe.

An Estonian procurement could decrease this cost, for the same standard of quality, but this could not be precisely determined.

The detailed list of items is presented in Annex III.

4.2.6 Time table

The plant will be installed in 2007, as the study, civil works and tendering process will last for more than one year.

4.3 Booster pump

4.3.1 Justification of the works

Water is provided into the network, out of the storage tank, thanks to a single booster pump. Presently, if the booster pump is, for a few hours, out of service (maintenance, e.g.), the well's pumps can provide the pressure, although this is not a proper system.

In the future management of the network, such a by-pass will not be possible anymore.

The installation of a second booster pump, of the same capacity and power as the existing one, is requested.

Moreover, beside the back-up possibility, this redundancy will allow easier maintenance, alternate functioning of the pumps, the possibility of increasing the pressure, etc.

4.3.2 Description of the works

A second booster pump will be installed next to the existing one.

The type is a GRUNDFOS CR-45. As can be seen on the picture (see : Figure 1), there is plenty of room for this second installation.

Control, electrical connection and hydraulic connections will be provided too.

Although other brands provide similar pumps, with similar characteristics, it would be easier for Narva Vesi to have both pumping systems of the same brand (spare parts, technology, technicity, maintenance, etc…).

Figure 1 : The booster pump

4.3.3 Dimensioning

The curve of the pumps should allow, according to the hydraulic model of the network, a functioning range between 15 and 35 m^3/h, at 36 m.

Diameter of the in and out pipelines is 90 mm.

Flow and pressure meters have to be provided, as well as a separate electrical consumption meter.

4.3.4 Financial influence on O&M

The disconnection of the numerous boreholes in the city will balance the investment in a second pump.

Theoretically, the energy consumption should be the same with only the booster pump to provide the pressure, as with the boreholes' pumps (same power for the same effect). Small differences could occur, as the headlosses in pipelines might not be the same. On one hand, less energy will be lost for the transit of water from the boreholes to the storage tank, when the pipelines work as a primary network (see [15], chapter 3.4.4.5.). On the other hand, some consumers were located near a borehole and had their water directly from these points. So the gain is not easy to measure, as both effects should compensate.

Therefore, electric consumption is not an issue.

But the management of the pumping will be centralised in a single place. The work for the technician will be much easier : one single borehole, two booster pumps, in the same building.

Nowadays, he has to visit the different wells, only to check them, or to start (well n°12), or to adjust the pressure control, etc.

Electrical consumption will be easier assessed, as all the consumption is located in the same room.

4.3.5 Costs

The estimated cost for a second booster pump, including control systems and hydraulic connections, is 200 000 EEK.

No civil works have to be done, as the pump will be installed next to the existing one.

4.3.6 Time table

The second booster pump will be installed right after the water treatment plant, in 2008.

4.4 Storage tank

4.4.1 Justification of the works

The storage tank is a required link between the primary network (the borehole) and the secondary (or distribution) network.

Storage is used as a buffer, in case of maintenance, repair or accident on the primary network.

Moreover, storage is requested in case of water treatment, as explained below.

The structure of the tank (and attached rooms) is still in good condition, but is in desperate need of rehabilitation, in order to secure its future.

Finally, the working environment of the local technician should be improved, as he is indispensable for the every-day functioning of the systems.

4.4.2 Description of the works

The storage tank exists in the centre of the municipality, is ideally located, has enough capacity and will remain.

It represents no threat to the environment and no hazard to human health, but should be rehabilitated.

The total capacity of the tank is 500 m³, in two 250 m³ parts, at ground level. Structure is of reinforced concrete, with flat roof. The pumping station (including boreholes n°1a and 1, as well as booster pump and their automatisms) is attached to the tank. Finally, the office of the local technician (two rooms and a toilet) is also attached to the side of the tank.

In 2002, the flat roof has been rehabilitated, regarding the watertightness.

The needed works are :

- Rehabilitation of the inner watertight cover,
- Rehabilitation and modernisation of the technician's office : paintings, windows and doors, floors cover, water and toilet equipment, furniture, etc…
- Improvement of the environment and the outside : mortar, painting, trees plantation, fence, etc…

4.4.3 Dimensioning

The detailed measurement and cost estimates of the works will be determined by the additional studies (see this chapter).

4.4.4 Financial influence on O&M

This investment will have a positive influence on the maintenance costs, as emergency repairs are more expensive than a one-time rehabilitation of a building.

Lifetime of the storage tank, as well as the office and the pumps room will be increased and their value as well.

4.4.5 Costs

The cost estimates for these works is 800 000 EEK.

4.4.6 Time table

The works execution should take place in 2006, following the additional investigations in 2005.

These works must precede the water treatment plant and the second booster pump.

4.5 Pipelines replacement and rehabilitation

4.5.1 Justification of the works

The existing pipelines in the network need repair or replacement for the following reasons :

- A huge amount of water is lost through leaks, due to the poor condition of the material or the junctions (see [14] and [15]).
- The mains lacked of proper dimensioning at the time of their installation or the dimensions don't fit with the present flow conditions in Narva-Jõesuu (ibid.).
- The diameter of the existing pipelines doesn't comply with the flow requirements of the project's horizon.

Leaks should be reduced in order to improve the network efficiency, reduce the O&M costs and limit the negative environmental impact.

4.5.2 Description of the works

- Replacement of 2 360 m of pipelines
- Rehabilitation of 2 360 m of pipelines

This length amounts to more than 18 % of the total pipelines of the water supply network.

The rehabilitation works will consist in relining (slip-lining) the existing pipes, instead of complete replacement. This is possible as several mains are over-dimensioned. Such a procedure will reduce the costs of the works.

4.5.3 Dimensioning

The material for pipelines is HDPE, as it is the most commonly used material for water supply systems in similar conditions.

The existing pipelines in the network are very different, in terms of material and diameter. Model of the future network (taking into consideration the increase in individual consumption and decrease of losses) shows that pipeline diameters should be at least 100 mm. The main reason is to provide a sufficient flow in case of fire fighting situation. The norms and recommendations to be referred to are : EPN 18.5.3 and SNiP 2.04.02-84.

The 100 mm diameters is recommended for all mains ; of course, final connections may be smaller (between the street and the final consumer).

Replacement will occur on the 100 and 110 mm pipelines. The total length of these pipelines adds-up to 12 166 m, out of which 2 360 m (19.4%) will be replaced in the Short Term Investment Programme.

Rehabilitation (or slip-lining) will occur on the 150 and 200 mm pipelines. The total length of these mains adds-up to 10 705 m (=9 867 + 838), out of which 2 360 m (22.0%) will be rehabilitated in the STIP.

4.5.4 Financial influence on O&M

The most important financial influence of these works is the loss reduction. Considering yearly real losses[3] of 194 811 m³ in 2003 and 54 376 m³ in 2020, the difference is 140 435 m³. The yearly gain is 702 175 EEK, considering an average price of 5 EEK/m³.

The replacement or rehabilitation of pipelines should also reduce dramatically the number of emergency interventions on the network to secure leaks.

By reducing leaks into ground, loss reduction will also have a positive impact on waste water dilution, since much of present infiltration ends up into sewerage lines.

As these interventions are not easy to spot in the company's accounting system, we can't assess this financial impact properly.

Maintenance costs of an efficient network are estimated at 2% of the value of the installed pipelines. Considering the poor present condition of the pipelines, it seems realistic to double this figure for estimates of today. The value is estimated at an average of 1 400 EEK/m of pipeline.

Table 8 : Evolution of the maintenance costs

Year	Length [km]	Value [EEK]	Maintenance [EEK/year]
2005	25.8	36 120 000	1 444 800
2020	31.0	43 400 000	868 00

4.5.5 Costs

The pipeline replacement and rehabilitation costs have been estimated with an average of 1 400 EEK/m for new mains (this includes the digging, the replacement and the restore of the street cover) and 800 EEK/m for rehabilitation.

The length to replace are (see [15], page 49) : 2 360 m of new pipelines and 2 360 m of rehabilitation.

The costs amount to :

1 400 x 2 360 (=3 304 000 EEK) + 800 x 2 360 (=1 888 000 EEK) = 5 192 000 EEK.

These lengths represent 32% of the total in the network.

4.5.6 Time table

The pipeline replacement and rehabilitation will take place during the last 4 years of the STIP, after the completion of the final studies and the procurement and works tendering process.

These works will be coordinated with the sewerage and storm water collection works, in order to reduce as much as possible the disturbance in the city.

[3] See [15], pages 10 and 12.

4.6 Valves and meters

4.6.1 Justification of the works

A water supply network in urban area should be monitored in order to :

- Easily spot leaks and losses,
- Properly manage the supply.

Moreover, the installation of bulk water valves allows the operator to easily isolate branches when repairs, improvements or extension works are required.

The combination of valves and meters allows the operator to have a proper and accurate view or the network's functioning, which can then be improved.

4.6.2 Description of the works

The locations of the valves and meters to be installed are shown on the next figure. They are chosen at key crossings. The proposed locations may be adapted if new valves have been recently installed by Narva Vesi.

NB : in a single chamber, several valves and meters are installed, as there are several branches departing from a single chamber.

The water-meters should be placed according to the installation recommendations, in order to work properly.

The exact location of the equipment will be confirmed after the additional investigations.

4.6.3 Dimensioning

The diameter of the valves and water-meters must be the same as the diameter of the pipelines. The size of the chambers should allow an easy and correct manipulation of the equipment, as well as their replacement.

4.6.4 Financial influence on O&M

This investment should not have any negative impact on the O&M costs. On the contrary, it will improve the knowledge of the system's functioning. Therefore, modelling, extensions and management will be made easier for the company.

In the scope of the SCADA system (see 7.2.3), the information provided by valves and meters are essential to calibrate the network's functioning.

4.6.5 Costs

The installation of 30 valves, at a unit cost of 4 500 EEK, and 10 water-meters, at a cost of 6 000 EEK each, has been recommended.

The total investment amounts to 195 000 EEK, including the procurement and installation.

4.6.6 Time table

Valves and water meters will be installed while the pipeline replacement and rehabilitation work will take place. These investments will last for 4 years (2006-2009).

5 Waste water system

5.1 Sewage network

Short Term Investment Programme should include rehabilitation of existing facilities and extension of sewerage in the following areas (see Annex VI) :

5.1.1 Central and upper households area

This area includes all buildings between Metsa, Linda, J.Poska and Vabaduse streets. It can roughly be divided in two parts:

- Apartment buildings located West of Mäe street
- Households buildings located East of Mäe street

See Figure 6, Annex VI.

Considering:

- it is not feasible to disconnect sewage from storm water in apartment buildings,
- but it is feasible to disconnect drainage from storm and sewage,
- large diameter pipes cover most of the central area,
- the whole system is working fully by gravity,
- upstream roads will eventually be asphalted, increasing run-off,

best alternative for the apartment building area is to use existing primary network (Ø500 and Ø600) for run-off and drainage collection, while smaller existing diameters (Ø150-Ø300 ceramic) will be used for sewage/roof wastewater ("semi-separative").

Primary network, dedicated to storm water, will discharge into the river. Secondary network, fully dedicated to sewage (and some roof storm water), will end up at WWPS4 and be pumped to Narva main wastewater plant for final treatment.

Existing network facilities are concentrated in the apartment building area, with the noteworthy exception of a main Ø150/200 on Linda/Metsa street. According to Narva Vesi plan, some 12 households are already connected to this pipe[4]. This figure is likely to be bigger by now, considering undergoing rehabilitation works on households. Most of them count with basement (relatively high living standards) and discharge sewage *and* drainage into sewerage. Thus disconnecting sewage from storm water will be necessary in these households.

Existing Ø200 ceramic linking Tähe to the WWPS2 should be put out of use and replaced by a connection to the Mesta street line, in order to take advantage of gravity flow.

Existing Ø200/250 on lower Pargi street (between Kudrukula and Koida streets) will be dedicated to sewerage. Any storm or drainage connection will have to be cut off. This criteria is important since this pipe collects exclusively effluents from apartment buildings.

Existing Ø150 on Ed.Vilde street will be turned from private line into public sewerage (see §3.10.2). This line though has to be completed with appropriate manholes.

All of remaining sewerage planned in STIP has to be built. Streets going downhill (Ed.Vilde and Kalevi) will be preferred since distances are shorter and they don't count with asphalt yet. The whole area located between Mäe and Linda streets has to be covered with separate sewerage.

[4] Information collected on graphic support (plan)

Northern sections of Jõe and Sulevi streets will connect to a new sewerage line on J.Poska.

In the central apartment building area, new sewerage has to be built on Karja street from Ed.Vilde crossing to Vadabuse street.

And finally, a new sewerage line has to be laid on Koidu street between A.Hahni street (Kursaal) and Kesk street. This line is also necessary in order to collect pumped effluent from WWSP1.

Table 9 shows the summary of all sewerage works in Central and Apartment area; for estimation sake, 25% of manholes are supposed to be needing rehabilitation.

Diameters are considered to be minimal in this area (PVCØ200). According to Estonian norm EPN 18.6 (see [8]), minimum slope is 0.45%. For such a slope, minimum self-cleaning flow is 2.5 l/s and maximum flow is 12 l/s (see [6]).

Considering peak factor of 3, a PVCØ200 pipe could transport up to (12 l/s / 3 x 86.400 s/d=) 345 m^3/d. If specific consumption is[5] 64.8 l/c.d, theoretically a Ø200 PVC pipe can serve up to (345 000 / 64.8 ≈) 5 000 equivalent-habitants. Thus, this diameter is enough to serve all of Narva-Jõesuu areas.

PVCØ200 will be used as minimum basic diameter, unless a larger section already exists upstream of the planned section.

Table 9 : Sewerage in Central area

Street	Existing section L [m]	Existing section Ø [mm]	Rehabilitated manholes	New PVC sewerage L [m]	New PVC sewerage Ø [mm]	New manholes
Metsa	700	150	4	90	200	3
Kalevi	83	150	2	465	200	10
Ed.Vilde	333	150	2	485	200	10
Kudrukula	121	200	3	132	200	4
	38	300	1			
Lootuse				107	200	4
Sepa	159	250	1			
Rahu	87	200	2			
Koidu	30	250		497	300	12
Vabaduse	166	250	2			
	231	300	3			
Linda	347	150				
Olevi				286	200	18
Sulevi				379	200	12
Jõe				282	200	12
J.Poska	360	300	2			
	112	200	1	525	200	8
Õnne				190	200	5
Mäe				396	250	10
Karja	167	150	1	612	250	15
	95	300	4	50	300	2
Kesk	56	200	1			
	83	200	1			

[5] Specific water consumption is 81 l/c.d, so specific wastewater production is (81 l/c.d x 80%)= 64.8 l/c.d

Street	Existing section		Rehabilitated manholes	New PVC sewerage		New manholes
	L [m]	Ø [mm]		L [m]	Ø [mm]	
Pargi	187	250	2			
	83	200	1	158	200	4
Total	**3 438**		**33**	**4 654**		**129**

5.1.2 Hotels and institutions

The hotel and institutions area is located along the beach, and includes hotels Minister, Sanatorium, Mererana, and the area located North of hotel Minister.

Taking advantage of the proximity of outlets (river and sea), storm water will be diverted by gravity and dumped into the sea (see §5.2.1). Thus existing facilities (pipes and pumping stations) will be used for "semi-separative" sewage collection only: sewage together with roof storm water.

Hotel Mereranna will be discharging into WWSP1 on Aia street. Existing pumping main will discharge effluent into new Ø300 PVC on Koidu street.

Narva-Jõesuu Sanatorium and buildings located nearby across Aia street will keep on discharging into the existing small pumping station near J.Posak street. From this point, effluent will be collected by gravity to main existing Ø300 sewerage line on Vabaduse street. This line also collects effluent from Hotel Minister.

Table 10 : Sewerage in hotels area

Street	Existing section		Rehabilitated manholes	New PVC sewerage		New manholes
	[m]	Ø [mm]		[m]	Ø [mm]	
Total	**3 438**		**33**	**4 654**		**129**
Pargi	133	200	2	158	200	3
Aia	331	200	3			
Sanatorium	127	400	2			
	50	200	1			
Vana	61	150				
Vabriku	61	250	1			
				126	200	4
Total	**763**		**9**	**284**		**7**

5.1.3 Lower household area

Low household area is located between Raja street and the beach, and between Pargi and Auga streets.

See Figure 7, Annex VI.

Most of this area has presently very low sewerage coverage and will be covered with new Ø200 PVC sewerage lines.

Considering topographical conditions, both pumping stations n°1 and n°3 will keep on being necessary.

Catchment’s basin of WWSP1 covers the area between Supeluse, Raja, Kiriku and the beach.

Baseline study (§4.3.1.4) demonstrated that the Ø400 concrete line on Aia street, linking WWPS3 with WWPS1, is suspected to be suffering high infiltration rate (to be confirmed by additional investigations, see Chapter 3.2). Therefore, present project should include replacement of this pipe. It can be replaced by a Ø200 PVC by introducing a new flexible line into the existing gravity sewer, through existing manholes ("slip-lining"). Some of the existing manholes will anyway need rehabilitation.

New sewerage Ø200 PVC will have to be laid on Supeluse, Lennuki, Kiriku, Raja and Nurme streets.

Catchment's basin of WWSP3 covers the area between Kiriku, Raja, Auga and the beach.

New sewerage Ø200 PVC will have to be laid on Aia, Nurme, Kiriku, Raja, Lembitu, Vambola and Auga streets.

Table 11 : Sewerage in Lower household area

Street	Existing section		Rehabilitated manholes	New PVC sewerage		New manholes
	[m]	Ø [mm]		[m]	Ø [mm]	
Aia			5	535	200	
Supeluse				370	200	7
Lennuki				246	200	6
Lembitu				188	200	5
Vambola	83	200	2	123	200	3
Auga				138	200	5
Vabaduse				319	200	8
Nurme	154	200	2	962	200	20
Raja				778	200	17
Total	**237**		**9**	**3 659**		**71**

5.1.4 Summer camp area

The "summer camps" area refers to the large settlement lots located East of Raja street and South of Metsa street. It includes the institutions Hooldekodu, Koshevoi, Tähe, Pääuke, Border Guard Training Centre, Gagarin.

These lots are presently served by the WWPS2, pumping both sewage and storm water. WWPS2 can be turned off and effluent discharged into new sewerage planned for lower household area (see §5.1.3), eventually reaching WWPS1 by gravity through the new Ø200 PVC line on Supeluse street.

Lots located along Metsa street will be served by gravity by the new sewage and storm lines planned in §5.1.1. Only the Tähe camp area will collect wastewater to the lower household area (Raja and Supeluse streets, at WWSP2 location).

Camp Tereshkova will discharge by gravity into new Ø200 PVC line on Lembitu street.

Suggested solution takes advantage of the existing lines, and no extension is needed on public domain. Private connection sections in Hooldekodu, Pääuke and Koshevoi camps will be needed in order to reach the new Ø200 PVC on Metsa street.

Table 12 : Sewerage in Summer camps

Street	Existing section		Rehabilitated manholes	New PVC sewerage		New manholes
	[m]	Ø [mm]		[m]	Ø [mm]	
Tähe	917	200	7			
Border Guards	226	200	3			
Gagarin	252	200	3			
To WWSP2	248	200	2			
To Raja				46	200	2
Total	**1 643**		**15**	**46**		**2**

5.1.5 Financial influence on O&M

Since total length of sewerage will dramatically increase (from 6 km to 14 km), total operation and maintenance costs exclusively dedicated to sewerage will also be higher as they are today.

However, increase of O&M costs of sewerage will be balanced by:

- The reduction of pumping costs (see §5.3.4).
- The reduction of specific maintenance rate of the network (hours/km), since rehabilitated and new sections will allow better collection conditions (better velocities), implying less deposition in pipes.
- The reduction of total septic tanks volume to be emptied and disposed, benefiting household owners.

On the other hand – and as usual in most waste water projects – indirect financial benefits are to be expected on the following items:

- Improvement of environmental conditions, implying better health of the population.
- Improvement of the quality of the water table, since sewage will be collected instead of being infiltrated on site. Indirect financial influence has to be considered on the water supply sources in Narva-Jõesuu.

These improvements do have a positive influence on O&M, but are difficult to assess.

5.2 Storm water facilities

5.2.1 Central and upper households area

See Figure 10, Annex VII.

Due to low densities, most of storm water in upper household area infiltrates on site and main issue in this area (except sewage) is drainage water: some houses have basements, and presently discharge their drainage water in the sewerage line on Metsa street.

So a separate network is needed to collect drainage and run-off water.

Households located along J.Poska street (to Narva) can discharge water directly into Narva river. An outlet is planned at crossing Kudruskula/J.Poska streets down the existing access road to the former fishery industry. Catchment’s basin of this pipe is relatively small, and diameter is estimated at Ø400.

Households located along J.Poska street around Lootuse level can discharge storm water into Narva river using a outlet pipe along the existing road near the Highschool. Catchment's basin of this pipe is relatively small, and diameter is also estimated at Ø400.

Households located between Jõe and Karja streets need to be equipped with new collection facilities. Main collection axis follows downward streets : Kudruküla, Ed.Vilde, Kalevi and Metsa streets.

Main collection pipes on Ed.Vilde and Kudruküla will connect on the existing Ø600 on Karja street.

Main collection pipe on Metsa street will connect on the existing Ø500 after connecting with Hooldekodu connection pipe.

Area located between Vabaduse, Koidu, Pargi and J.Poska streets will be collected through a new storm water network eastbound.

All collection pipes will eventually connect on existing Ø500 on Koidu street. At WWSP4, storm water collection network will be disconnected from the pumping station and connected on the existing outlet to the Narva river.

See Figure 11, Annex VII.

At discharge point, a transition structure should be designed so hydraulic energy is cut before discharging and minimal suspended solids are discharged. Such a structure would then include a screen (to retain solids), a settling tank (for sand), a baffle wall (to block oil) and a shut off gate (in case of upstream pollution accident).

Table 13 : Storm water collection in Central and upper household area

Street	Existing section		Rehabilitated manholes	New PVC sewerage		New manholes
	[m]	Ø [mm]		[m]	Ø [mm]	
Metsa	130	500	1	590	400	13
Kungla	309	500	3			
Kalevi				329	400	6
Ed.Vilde				326	400	7
Kudruküla				359	400	11
Sepa				122	400	2
Koidu	558	500	4			
Vabaduse				215	400	6
J.Poska				474	400	14
Õnne				208	400	5
Mäe				350	400	6
Karja	648	600	5	114	400	2
Kesk				237	400	5
Pargi				272	400	7
Outlet fishery				107	400	3
Outlet school				157	400	3
Outlet WWSP4	305	500	4			
Total	**1 950**		**17**	**3 860**		**90**

5.2.2 Summer camps

Summer camps located along Metsa street should be served by gravity by the new storm lines planned in §5.2.1. These include Hooldekodu, Koshevoi, Tähe, Pääuke.

Lots located East of Raja street should be served by a new storm water collection system in these two lots. Slope would allow to connect a new ditch to the existing ditch system on Nurme street (see §5.2.4).

5.2.3 Hotels and institutions

The hotel and institutions area is located along the beach, and includes hotels Minister, Sanatorium, Mererana, and the area located North of Vana street.

Taking advantage of the proximity of outlets (river and sea) storm water will be collected by gravity and directly discharged into the sea. Considering short distances and low densities, ditches could be used.

Drainage waters should be discharged or pumped to the ditches.

Before discharging on the sea, outlets should be completed by a transition chamber, including a strainer (to retain solids), a settling volume (for sand), a baffle wall or pipe (to block oil) and a safety cap (in case of upstream pollution accident).

5.2.4 Lower household area

Low household area is located between Raja street and the beach, and between Pargi and Auga streets.

See Figure 10, Annex VII.

Storm water collection system is based on the existing open-air ditch network. Considering proximity of outlets (river and sea), ditch system will be upgraded and completed, and water discharged into sea by gravity.

Upgrading of existing ditches will include cleaning and covering with structure material (concrete plates). Accesses to the households will be guaranteed by concrete pipe sections.

Main extension of the ditch network will include:

A new ditch on Raja street between Vambola and Supeluse street. This ditch will discharge into existing ditch sections on Nurme street.

A new ditch on Vabaduse street between Lembitu and Lennuki street. This ditch will discharge into existing ditch sections on Auga, Lennuki and Lembitu streets.

A new ditch on Auga street between Raja and Vabaduse street. This ditch will discharge into existing ditch sections on Auga street.

A new ditch on Vambola street between Raja and Vabaduse street. This ditch will discharge into existing ditch sections on Vambola street.

New ditch sections between Raja and Nurme streets, on Supeluse and Lennnuki streets.

Like in other areas of the city, outlets should be completed by a transition chamber before discharging on the beach.

Table 14 : Storm water collection in Lower household area

Street	Existing ditch [m]	New ditch [m]
A.Hahni	400	
Supeluse		113
Lennuki	455	130
Lembitu	430	
Vambola	302	250
Auga	263	266
Aia	499	
Vabaduse		514
L.Koidula		192
Nurme	864	253
Raja		864
Total	**3 213**	**2 582**

5.2.5 Financial influence on O&M

Like sewerage (see §5.1.5), total length of storm water collection system will increase (from 2 km to 4 km), thus total operation and maintenance costs exclusively dedicated to ditches and transition chambers will also be higher than today.

However, increase of O&M costs of the storm water collection system will be balanced by:

- The dramatic reduction of pumping costs (see §5.3.4), since storm water will be discharged into the sea and the river, instead of being pumped to Narva main waste water treatment plant (present situation).
- the reduction of specific maintenance rate of the network (hours/km), since no sewage will be found in storm water collection network anymore, and thus much lesser deposit.

On the other hand – and as usual in most waste water projects – indirect financial benefits are to be expected on the following items:

- Improvement of environmental conditions, implying better health conditions for the population. Since ditches are going to be covered with concrete plates, there should also be a strong of mosquitoes and rodents.
- Improvement of the superficial environment: roads, streets, park grounds, since flooding occurrence will be reduced.

These improvements do have a positive influence on O&M, but difficult to assess.

5.3 Connections

5.3.1 Location of existing facilities

Before works, the contractor will have to set a plan of the existing facilities. This plan should include the existing in-house facilities.

If necessary, contractor will use marking devices (methylene blue).

5.3.2 Types of connections

Four different types of situation will arise:

a. Where both sewerage and storm collection systems already exist

Only very short sections of streets already count with two separate systems. According to Narva Vesi plan, this situation occurs on Koidu street, near the water tank facility. Some Ø250 ceramic exist next to the Ø500 concrete on some 30 m. Also check on Aia street near Kiriku street, where private Ø150 is located in parallel of the existing ditch.

These cases are exceptional but they can serve as an example for the rest of the works. As such, they could be realized early in time schedule.

b. Where only sewerage exist

This situation is expected to be frequent on Metsa, Pargi, Linda and Vabaduse streets.

Whether households or apartment buildings, it is expected that these existing connections are first collecting sewage and roof water (within building) and then mix with drainage water outside of the building, before discharging into existing sewerage (Ø200 to Ø250).

In these cases, existing drainage facilities should be disconnected from existing connection, and a new "drainage" connection should be made to the new storm water collection system.

If located below level of collection system, this "drainage" connection may include a pumping station.

c. Where only storm water collection system exist

This situation is expected to be frequent on Karja and Koidu streets.

Existing connections discharge sewage and drainage water into storm water collection system. Thus works will include disconnection of sewage discharge (including roof water) and building of a new sewage connection to the new sewerage.

d. Where no collection system exist at all

This is going to be the most frequent situation. Specific applications will concentrate in Upper household area, East of Mäe street.

In these area, two connections should be built: one to the new sewerage, and one to the new storm water collection system.

All connections will be realized according to EPN 18.4 "Design standard of household sewerage" and typical schemes as shown in Annex VIII and Annex IX.

5.3.3 Storm water inlets

New storm water collection system will include storm water inlets, as described in Annex X.

5.3.4 Financial influence on O&M

Disconnecting sewage from storm water on settlements will be the main ground for the dramatic drop in operation costs generated by the pumping stations. See 2.2.2 for figures.

On the long term, quality of connections will be of great influence on operation and maintenance costs. The best the separation between sewage and storm water on private settlements, the cheapest operation and maintenance costs.

Another important issue in assessing the financial influence of O&M of new connections, is to define the share between private and public burden. Addition investigations will have to define who will be in charge of maintaining the household connections (see 3.10.4).

5.4 Pumping stations

5.4.1 Pumping station n°1

Planning has confirmed that WWPS1 will be playing an important role in Narva-Jõesuu wastewater management. It actually collects all waste water from the Lower household area, including:

- WWPS3's basin (South of Kiriku street) and Tereshkova camp
- Summer camp area: Hooldekodu, Koshevoi, Tähe, Pääuke. These institutions are presently connected to WWPS2 but will be connected directly to WWPS3 within the present STIP.

New dry Grundfos pumps were recently installed in WWPS1. However, civil works have not been renewed, and structure has been suffering of corrosion.

Following works are considered for WWPS1:

- Add watertight cover and painting on the tank
- Replace metal works (stairs, accesses to the screens and screens themselves) by stainless steel.
- Add solid waste removal facilities, so to ease screen maintenance. These facilities may include manual removal device, with storage of wastes.
- Install a new water meter on outlet.

Existing pressure main will keep on working, and discharge into the future new sewerage line on Koidu street.

5.4.2 Pumping station n°2

Once new sewerage lines are completed on Raja and Supluse streets, camp effluents (Hooldekodu, Koshevoi, Tähe, Pääuke) will be collected straight to WWPS1. It will then be possible to turn WWPS2 out of function.

5.4.3 Pumping station n°3

Situation in WWPS3 is very similar to WWPS3: new dry Grundfos pumps were recently installed, and civil works have been suffering of corrosion. Same civil works are contemplated in WWPS3 than WWPS1 (see §5.4.1).

Existing pressure main will keep on working, and discharge into the future new sewerage line on Aia street, replacing the present Ø400 (see §5.1.3).

5.4.4 Pumping station n°4

STIP considers layout modification around WWPS4, in order to fulfil with new sewerage requirements. However, no upgrading is considered for the plant itself.

See Figure 8, Annex VI, and Figure 11, Annex VII.

5.4.5 Former pumping tank

Nearby the existing WWPS4 lays the former tank initially foreseen for pumping. The tank is abandoned, open-air. It is not safe, and difficult to maintain (cleaning).

This tank is not needed for either the Short or Long Term Planning. In order to keep the value attributable to real property, it is recommended to fill the tank and strike off the concrete walls located above ground.

5.4.6 Financial influence on O&M

Actions contemplated in the present project on pumping stations will have the following financial influence on O&M:

- Disconnecting WWPS4 means a higher efficiency in both operation and maintenance, since the operator will have fewer facilities to intervene on.
- Rehabilitating and upgrading civil works will also end up on lower operation and maintenance costs, since present facilities are difficult to handle.

6 Costs and timetable

6.1 Investments

Investment calculations are based on the following assumptions:

- All of additional investigations will be executed in 2005 so that works can actually start early 2006.
- 25% of existing networks and manholes need rehabilitation (to be confirmed by additional investigations, see chapter 3.2)
- 80% of pipe laying occur in top soil, 20% in limestone (to be confirmed by additional investigations, see chapter 3.8)
- 25% of new pipes will have to be laid under water table (to be confirmed by additional investigations, see chapter 3.8).
- 90% of total ditches have to be rehabilitated (to be confirmed by chapter 3.2)
- Connection costs are calculated according to type of connection (see chapter 5.3.2)
- Connections are calculated according to network length: one connection every 35 m.
- 25% of connections on networks route will be done during STIP
- 50% of all storm water inlets need rehabilitation.

6.2 Phasing

6.2.1 Works

Once confirmed by the additional investigations described in chapter 3, phasing of the works depend on the following criteria:

- Build water supply, sewage and storm water collection system in parallel in order to minimize excavation works, whenever it is technically possible.
- Possibility of the rehabilitation instead of replacement, whenever it is technically possible.
- Start from downstream and continue building the sewerage networks upstream.
- By-pass WWPS4 only when sewerage is completed, in order to avoid temporary sewage discharge into the river.
- Serve households and apartment buildings according to priorities set in §3.8.
- Minimize operation costs.
- No delay in the administrative processes : tendering, analysis, awarding of contracts, procurement delays, installation delays, invoice approval, availability of the funds, customs regulations for imported goods, etc.
- The atmospheric conditions at the moment of the works.

6.2.2 Financing

See table next page

Table 15 : Currency repartition and phasing of the investments 2005-2009

num	Description	Total Cost		Part in		Part in		2005	2006	2007	2008	2009
		[EEK]	=[EUR]	[EEK]	[%]	[EUR]	[%]					
1.	**Additional Investigations**											
1.1.	Full diagnosis of existing facilities	560.000	35.791	392.000	70%	10.737	30%	560.000				
1.2.	Camera inspection	496.000	31.700	446.400	90%	3.170	10%	496.000				
1.3.	Engineering and supervision	4.468.720	285.605	1.340.616	30%	199.924	70%	1.000.000	867.180	867.180	867.180	867.180
1.4.	Institutionnal study	800.000	51.130	80.000	10%	46.017	90%	800.000				
	Total Investigations	**6.324.720**	**404.226**	**2.259.016**	**36%**	**259.847**	**64%**	**2.856.000**	**867.180**	**867.180**	**867.180**	**867.180**
2.	**Well rehabilitation**	**400.000**	**25.565**	**320.000**	**80%**	**5.113**	**20%**	**0**	**160.000**	**240.000**	**0**	**0**
3.	**WS Networks**											
3.1.	Pipelines replacement	3.304.000	211.165	2.973.600	90%	21.117	10%		330.400	660.800	1.321.600	991.200
3.2.	Pipelines rehabilitation	1.888.000	120.666	1.699.200	90%	12.067	10%		188.800	377.600	755.200	566.400
3.3.	Valves	135.000	8.628	27.000	20%	6.903	80%		13.500	27.000	54.000	40.500
3.4.	Meters	60.000	3.835	12.000	20%	3.068	80%		6.000	12.000	24.000	18.000
	Total WS Networks	**5.387.000**	**344.294**	**4.711.800**	**87%**	**43.153**	**13%**	**0**	**538.700**	**1.077.400**	**2.154.800**	**1.616.100**
4.	**WS Infrastructures**											
4.1.	Water treatment facility	7.200.000	460.167	5.760.000	80%	92.033	20%			7.200.000		
4.2.	Second booster pump	200.000	12.782	40.000	20%	10.226	80%				200.000	
4.3.	Storage tank rehabilitation	800.000	51.130	800.000	100%	0	0%		800.000			
	Total WS Infrastructures	**8.200.000**	**524.079**	**6.600.000**	**80%**	**102.259**	**20%**	**0**	**800.000**	**7.200.000**	**200.000**	**0**
	Total WS (2+3+4)	**13.987.000**	**893.938**	**11.631.800**	**83%**	**150.526**	**17%**	**0**	**1.498.700**	**8.517.400**	**2.354.800**	**1.616.100**
5.	**WW Networks**											
5.1.	Sewerage	12.568.343	803.269	12.316.976	98%	16.065	2%		3.142.086	3.142.086	3.142.086	3.142.086
5.2.	Storm water collection system	10.603.150	677.669	10.391.087	98%	13.553	2%		2.650.788	2.650.788	2.650.788	2.650.788
5.3.	Manholes	1.557.250	99.527	1.479.388	95%	4.976	5%		389.313	389.313	389.313	389.313
5.4.	Connections	1.819.054	116.259	1.728.101	95%	5.813	5%		454.764	454.764	454.764	454.764
5.5.	Equipment	630.000	40.265	94.500	15%	34.225	85%	630.000				
	Total WW Networks	**27.177.797**	**1.736.989**	**26.010.052**	**96%**	**74.633**	**4%**	**630.000**	**6.636.949**	**6.636.949**	**6.636.949**	**6.636.949**
6.	**WW Infrastructures**											
6.1.	Civil works rehabilitation	500.000	31.956	475.000	95%	1.563	5%		500.000			
6.2.	Automation	500.000	31.956	150.000	30%	21.875	70%		500.000			
	Total WW Infrastructures	**1.000.000**	**63.912**	**625.000**	**63%**	**23.438**	**37%**	**0**	**1.000.000**	**0**	**0**	**0**
	Total WW (5+6)	**28.177.797**	**1.800.901**	**26.635.052**	**95%**	**98.070**	**5%**	**630.000**	**7.636.949**	**6.636.949**	**6.636.949**	**6.636.949**
	TOTAL GENERAL (1+2+3+4+5+6)	**48.489.517**	**3.099.065**	**40.525.868**	**84%**	**508.444**	**16%**	**3.486.000**	**10.002.829**	**16.021.529**	**9.858.929**	**9.120.229**
	Unforeseen (10%)	**4.848.952**	**309.906**	**4.052.587**	**84%**	**50.844**	**16%**	**348.600**	**1.000.283**	**1.602.153**	**985.893**	**912.023**
	TOTAL GENERAL	**53.338.468**	**3.408.971**	**44.578.455**	**84%**	**559.288**	**16%**	**3.834.600**	**11.003.112**	**17.623.682**	**10.844.822**	**10.032.252**

6.3 Compliance with EU Directives

Water supply regulations in Estonia are in line with the EU directives (e.g. 98/83/EC). The recommended works will enable an easier compliance with the valid directives as well as the Estonian norms and regulation for water supply.

But generally speaking, water supply in Narva-Jõesuu complies with all valid norms in Estonia and EU.

The European council directive 91/271/EEC concerns the collection, treatment and discharge of urban waste water.

The objective of the directive is to protect the environment from the adverse effects of the abovementioned waste water discharges.

Compliance with EU directive can then be considered on two levels:

6.3.1 Budget directly linked to compliance

Annex I of the EU directive defines that:

"*The design, construction and maintenance of collecting systems shall be undertaken in accordance with the best technical knowledge not entailing excessive costs, notably regarding:*

- *volume and characteristics of urban waste water,*
- *prevention of leaks,*
- *limitation of pollution of receiving waters due to storm water overflows*."

The point of the present project is to increase collection and treatment efficiency by reducing dilution rate of pumped and treated effluent. This objective is reached by increasing coverage rate and disconnecting sewage from storm water.

In that sense, 100% of networks works should be regarded as directly and fully linked to compliance with EU directives.

Physical works for network completion, including manholes and connections, sum 85% of total project costs.

6.3.2 Budget indirectly linked to compliance

Additional measures will help reach full compliance with EU directive:

- Laboratory analyses procedures, fulfilling annex 1.D of directive 91/271/EEC
- Equipment and automation (SCADA), indirectly participating to environmental impact reduction and pollution limitation.
- Additional studies – in particular regarding institutional and regulation frame – will help fulfilling phased compliance with EU directive, especially article 14.2

These measures sum 4% of total budget.

7 Implementation and functioning

7.1 Implementation

7.1.1 Construction supervision

Supervision of works will be divided in different parts:

- Networks
- Connections
- Civil works

All of these works will need the intervention of a supervision-engineering firm. Works on private settlements (connections) will also need a back up activity from the Municipality.

The costs for works supervision have been included in the financial tables of the STIP, as the item "Additional Investigations" also includes an "Engineering and supervision" budget line. The budget of external expertise represents 13.04% of the overall budget of the STIP (excl. the 10% of "Unforeseen" expenses).

7.1.2 Start-up

The start-up procedure is only relevant for the new water treatment plant, as no other new of specific installation will be implemented in Narva-Jõesuu in the course of the present STIP.

The company who will provide the plant, will give an on-site training to the Narva Vesi technicians and engineers, in order to let them being able to operate properly the new facilities.

Nevertheless, once disconnected from the main WWPS4, storm water (drainage) will start discharging into Narva River. At this point, special follow up will be needed in order to ensure minimal impact. Such follow up would include at least :

- Previous public information
- A quality survey (analysis) of the water to be discharged.

7.2 Management and O&M

In the Short Term Investment Programme, no specific investment is foreseen for the management and O&M related issues.

These investments should take place after a serious improvement of the facilities and network.

The suggested improvements mainly concern the control of the network and the optimization of its functioning.

After the installation of valves and water meters, a remote control system should be installed. In a first stage, it will allow the remote reading of the values ; in a second stage, some valves could be automated.

Electronic reading of the water-meters at the costumer is also going to be promoted in the coming years, reducing the readings related costs, but also in a scope of network management performance.

Finally, all the improvements, automatisations and optimisations should be combined with the comprehensive and adequate development of a numeric model of the networks (both water supply and sewerage). Many software's are available on the market and should be used for the system's management.

A link between the technical inputs and the commercial department data, via a centralised digital system, will be a common situation in the following years.

7.2.1 Activities

7.2.1.1 Routine on-site activities

Since they are going to be part of Narva Vesi, operation and maintenance activities in Narva-Jõesuu should be considered as an extension of activities that are to be run in Narva main city.

The Narva Vesi operator already runs many of routine activities :

- The checking of hydraulic equipment at pumping stations, including civil works, painting, and condition of the storage volume.
- The disposal of solid waste out of the screens.
- Declogging of accessible sections.

In the future, the differences will be mainly :

- Operation and maintenance of only one borehole (instead of 8),
- Operation and maintenance of the water treatment plant,
- Operation of a second booster pump instead of a single one.
- Operation and maintenance of 3 waste water pumping stations, instead of 4.
- Operation and maintenance of two waste water networks instead of one hybrid system (partially network, and septic tanks).

In order to conduct properly these activities, the on-site staff should be provided with appropriate equipment, including :

- A light duty van with body floor,
- Tools (shovels, wheelbarrow, etc.),
- Cellular phone,
- Office equipment: computer, printer, modem, etc.
- Security, safety and first aid kit.

7.2.1.2 Inspection

Several inspection procedures are considered for Narva-Jõesuu :

- Inspection of valves,
- Check of the automatisms,
- Visiting the waste water systems using mirrors in manholes: this procedure is suitable for fast results.
- Inspection by CCTV: allows pinpointing the exact point in which the problem is, minimizing works.

7.2.1.3 Maintenance

Regular maintenance will be done with equipment and staff from Narva.

The valves and water meters will be controlled and operated on a regular basis, as well as automatisms.

The proper and regular maintenance of the water treatment plant will be done according to the manual to be provided.

As an estimate, 20 % of the waste water network will be cleaned annually (some 3.4 km).

This operation could be ran by Narva Vesi or subcontracted to private company.

As far as ditches are concerned, operator will be the Municipality.

7.2.2 Staffing

7.2.2.1 Profiles

Table 16 shows the staff profiles needed for operating and maintaining the existing, rehabilitated and new wastewater facilities in Narva-Jõesuu. These resources are identified as "manpower", regardless of present staff availabilities in Narva Vesi or in the Municipality.

These occupation rates involve the facilities considered in the present STIP (existing and projected). They do not include O&M needs of – for instance – septic tanks maintenance. This service is presently running independently of the networks.

Staffing is for the whole network as planned for 2009 (17 km of sewerage and storm water collection system).

Table 16 : Staffing

Job	Profile	Occupation for Narva-Jõesuu facilities	Sharing
On-site supervision and operation	Experimented technician located in Narva-Jõesuu	100%	None
Supervision of the electromechanical equipment (pumps)	Technician	10%	With Narva Vesi on Narva pumping stations or wastewater treatment plant
Maintenance of the networks	2 unskilled workmen	2 x 100%	With Narva Vesi staff dedicated to Narva networks
Maintenance of the ditches	2 unskilled workmen	2 x 100%	With the Municipality

7.2.2.2 Training

Training of human resources should not be limited to Narva-Jõesuu, but done in accordance with Narva Vesi training criteria.

However, below are presented some hints about training needs as would a city like Narva-Jõesuu need:

- Direct training of technical staff, for instance by participating to a dedicated training course (including SCADA, see §7.2.3).
- Technical upgrading by participating to national, regional and international forums and conferences.

As far as Narva-Jõesuu is concerned, it would be suitable to complement the basic technical training by additional specific training courses on environmental criteria, especially regarding water treatment, sea outfalls and river estuaries.

7.2.3 Telecontrol

Because of its size and the fact that most of the facilities will be new, Narva-Jõesuu wastewater system is relatively simple. Pumping equipments are the only mechanized devices.

SCADA (Supervisory Control And Data Acquisition) project in Narva-Jõesuu wastewater system would aim at two goals:

a. Transmit information from pumping stations to the Narva Vesi central unit about flows, pressure, water level in pumping tanks.
b. Remote control to operate pumps from the central unit. Data is then transmitted two ways (information in, orders out).

At the central unit, information will be processed and security limits (alarms) will be defined.

Presently, all pumping stations have Grundfos automatic control system PM 2000. Distance control is achieved by GSM modem link (modem - Siemens M20 Terminal). Data collection centre is located in Narva wastewater treatment plant. However, remote control is disturbed by communication facilities located in Russia. One solution would be to replace existing GSM by radio transmitters.

Decentralized unit of Narva Vesi in Narva-Jõesuu should get a copy of the SCADA information.

7.2.4 Services

7.2.4.1 Laboratory analyses

The EU Directive 98/83/EC (3 November 1998) specifies the frequency of sampling and analysis procedure for drinking water. Quantities produced in Narva-Jõesuu require a check monitoring of 4 samples per year and 1 audit monitoring sample per year. The existing laboratory of Narva Vesi presently conducts these analyses, in full compliance with the technical requirements of the directive.

No particular change in the procedures is expected after the implementation of the STIP.

The European council directive of 21 May 1991 concerning urban waste water treatment (91/271/EEC) defines in Annex I.D Reference the methods for monitoring and evaluation of results the procedure for analyses.

Setting is at 12 samples during the first year, four samples in subsequent years.

Parameters to be analyzed are:

- Those relevant to storm water discharge into the river Narva: samples will be taken at storm water collection system outfall.
- Those relevant to sewerage discharge into Narva main wastewater treatment plant: samples will be taken
  - In WWPS4 (before pumping main). Results of analysis will have to comply with Municipal regulation on sewage quality effluent (standards to be set, according to §3.10.3 above).
  - At entrance of the Narva main wastewater treatment plant (after pumping main).

7.2.4.2 Vacuum truck

Short Term Investment Programme will take care of most of the waste water in the urban area. However, parts of the city will remain out of this first phase of works and will have to keep on using septic tanks. Consequently, collection and water removal by vacuum tanker services offered by Narva Vesi will keep necessary.

7.3 Human resources

The existing human resources presently active in Narva-Jõesuu are well trained and sufficient to provide the required services, for a normal functioning of the systems.

As automation and electronic data treatment increase, additional training will be required.

In the course of the investments implementation, additional human resources will be needed.

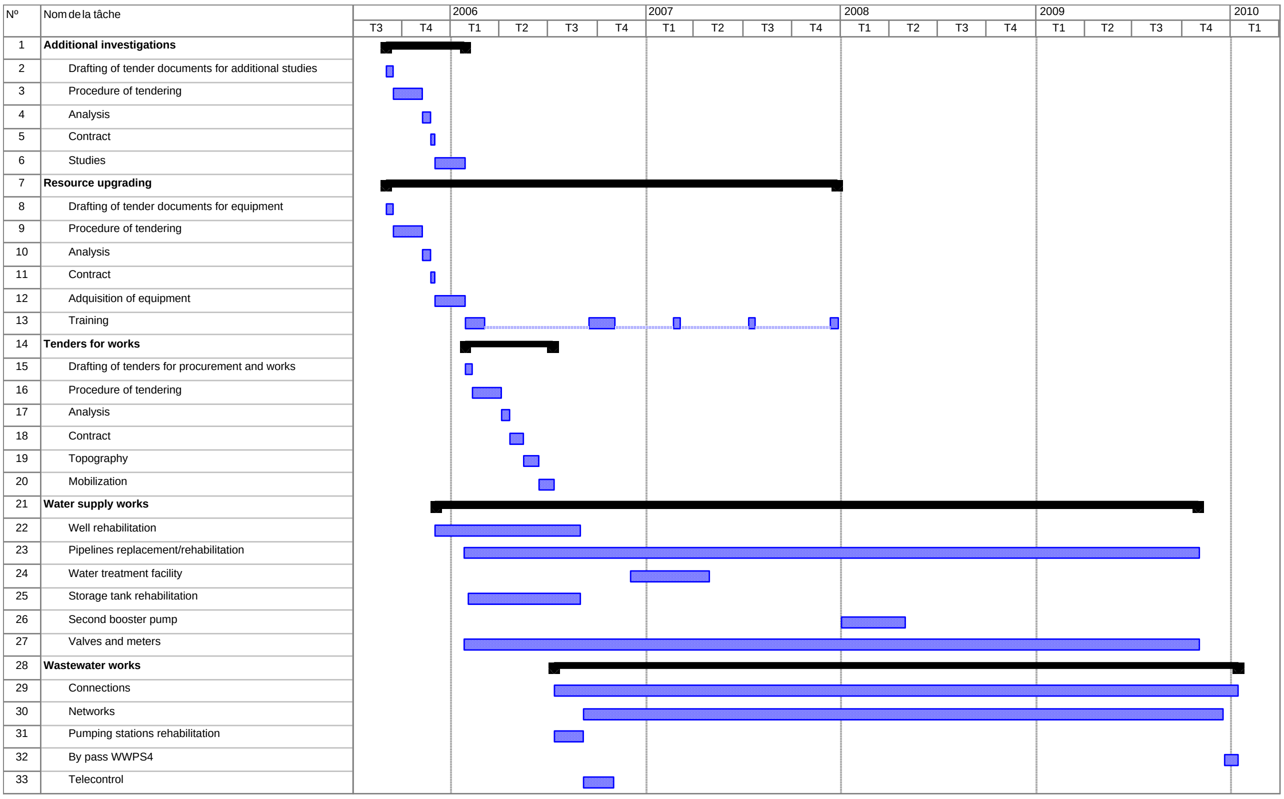
The additional investigations should be sub-contracted to a consulting agency, with sufficient knowledge, skills and human resources for the completion of the requirements. It is not suggested that the own Narva Vesi engineers conduct these additional investigations, as they are needed for their everyday job at the company. Nevertheless, they should be associated to the study process, in order to bring their knowledge of the actual situation.

The works supervision should be conducted by the same consulting agency. This will ensure that this company will support the full responsibility of their propositions.

In order to provide the easiest administrative structure for this contract, we would suggest combining these interventions into Technical Assistance to Narva Vesi. This TA should be included, for financial reasons, in the TA of other investment projects to Narva Vesi.

7.4 Operation and maintenance

The timetable for the investments implementation should be as follows :



8 Recommendations

8.1 Summary of suggested investments

The following table (Table 17) shows the suggested investments that are needed on a long period of time, made after the whole process of investigations of this assignment.

The substance of the investments, as well as their time schedule, is based on :

- Our field visits,
- Our documents analyses,
- Our understanding of the actual condition of the system and pipe networks,
- The present administrative and institutional situation of the water and wastewater management in Narva-Jõesuu,
- Urban development projections, as presented by local authorities.

In the present Short Term Investment Programme, we suggest that, before end 2009, the following investments are made in priority : see Table 18.

The reasons of separating these two sets of investments are mainly technical, economical and institutional.

8.2 Option A

If the additional investigations confirm the situation as described in the present documents, the timetable for investments, divided between a Short Term Investment Programme (2005-2009) followed by a Long Term Investment Programme (2009-2020), should remain as such.

This includes the fact that the institutional study shows that the improvements of local legislation and the pace for adapting the connections at household level and separating wastewater network systems will take some time.

As far as wastewater is concerned, main future investments include the replacement of pumping main to Narva WWTP. When all the wastewater collection systems will be split into two separate networks, only sewage will be pumped to Narva WWTP. Flows will be reduced by one half, compared to the existing situation, and replacement of the pumping main will then be necessary in order to (i) reduce retention times in pipe and avoid anaerobic digestion, and (ii) optimize pumping costs.

Replacement of the pumping main would then only make sense when most of separative connections and networks will be achieved, estimated in 2015.

This option has been described as “conservative” and suggests a slow pace on investments. Total actualized costs would be lower. And investments made on a safer basis since done in parallel of actual development.

8.3 Option B

On the opposite, investment for replacing the existing pumping main would be contemplated on the Short Term in two cases:

- Diagnosis of existing facilities (part of the additional investigations) show that pumping main does not fulfil its duty because of worse condition than expected. Similarly, if the additional investigations find a worse-than-expected condition of the water pipelines, some investments that have been foreseen later could be implemented before 2009.

- All of the suggested measures are to be applied at a much higher pace (including separate household connections and networks). Apart from much faster works execution, this achievement would need an appropriate legislative framework in order to allow works on private lots. This framework will be identified during the institutional study as described in the additional investigations.

This option is considered as "emergency", and should be considered if the actual situation is worse than expected, but also if the efforts by the local authorities can go fast.

8.4 Conclusive recommendation

Taking into consideration that :

- the results of the additional investigations are of the utmost importance for the coming project,
- that the local authority will act quickly to improve the wastewater system, as it is its own (financial and environmental) interest,

we recommend that the financing request should include the investments identified until 2015.

The requested amount is 85 671 925 EEK, representing 86% of the overall figure (99 403 137 EEK). The remainder, 13 731 212 EEK will be provided by Narva Vesi and/or Narva-Jõesuu municipality, when needed.

Table 17 : Summary of Long Term Investment Programme

num	Description	Total Cost	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1.	**Additionnal Investigations**																	
1.1.	Full diagnosis of existing facilities	560 000	560 000															
1.2.	Camera inspection	496 000	496 000															
1.3.	Engineering and supervision	7 988 548	1 000 000	867 180	867 180	867 180	867 180						2 776 044	743 784				
1.4.	Institutionnal study	800 000	800 000															
	Total Investigations	**9 844 548**	**2 856 000**	**867 180**	**867 180**	**867 180**	**867 180**	**0**	**0**	**0**	**0**	**0**	**2 776 044**	**743 784**	**0**	**0**	**0**	**0**
2.	**Well rehabilitation**	**400 000**		**160 000**	**240 000**													
3.	**WS Networks**																	
3.1.	Pipelines replacement	10 319 055		330 400	660 800	1 321 600	991 200	701 505	631 355	631 355	631 355	631 355	631 355	631 355	631 355	631 355	631 355	631 355
3.2.	Pipelines rehabilitation	5 896 600		188 800	377 600	755 200	566 400	400 860	360 774	360 774	360 774	360 774	360 774	360 774	360 774	360 774	360 774	360 774
3.3.	Valves	135 000		13 500	27 000	54 000	40 500											
3.4.	Meters	380 000		6 000	12 000	24 000	18 000	320 000										
	Total WS Networks	**16 730 655**	**0**	**538 700**	**1 077 400**	**2 154 800**	**1 616 100**	**1 422 365**	**992 129**	**992 129**	**992 129**	**992 129**	**992 129**	**992 129**	**992 129**	**992 129**	**992 129**	**992 129**
4.	**WS Infrastructures**																	
4.1.	Water treatment facility	7 200 000			7 200 000													
4.2.	Second booster pump	200 000				200 000												
4.3.	Storage tank rehabilitation	800 000		800 000														
	Total WS Infrastructures	**8 200 000**	**0**	**800 000**	**7 200 000**	**200 000**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	Total WS (2+3+4)	**25 330 655**	**0**	**1 498 700**	**8 517 400**	**2 354 800**	**1 616 100**	**1 422 365**	**992 129**	**992 129**	**992 129**	**992 129**	**992 129**	**992 129**	**992 129**	**992 129**	**992 129**	**992 129**
5.	**WW Networks**																	
5.1.	Sewerage	29 880 051		3 142 086	3 142 086	3 142 086	3 142 086						15 455 054	1 856 654				
5.2.	Storm water collection system	13 655 127		2 650 788	2 650 788	2 650 788	2 650 788						1 525 989	1 525 989				
5.3.	Manholes	1 917 876		389 313	389 313	389 313	389 313						180 313	180 313				
5.4.	Connections	5 620 731		454 764	454 764	454 764	454 764	345 607	345 607	345 607	345 607	345 607	345 607	345 607	345 607	345 607	345 607	345 607
5.5.	Equipment	2 680 000	630 000										1 000 000	1 050 000				
	Total WW Networks	**53 753 785**	**630 000**	**6 636 949**	**6 636 949**	**6 636 949**	**6 636 949**	**345 607**	**345 607**	**345 607**	**345 607**	**345 607**	**18 506 963**	**4 958 563**	**345 607**	**345 607**	**345 607**	**345 607**
6.	**WW Infrastructures**																	
6.1.	Civil works rehabilitation	750 000		500 000										250 000				
6.2.	Automation	687 500		500 000										187 500				
	Total WW Infrastructures	**1 437 500**	**0**	**1 000 000**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**437 500**	**0**	**0**	**0**	**0**
	Total WW (5+6)	**55 191 285**	**630 000**	**7 636 949**	**6 636 949**	**6 636 949**	**6 636 949**	**345 607**	**345 607**	**345 607**	**345 607**	**345 607**	**18 506 963**	**5 396 063**	**345 607**	**345 607**	**345 607**	**345 607**
	TOTAL GENERAL (1+2+3+4+5+6)	**90 366 488**	**3 486 000**	**10 002 829**	**16 021 529**	**9 858 929**	**9 120 229**	**1 767 972**	**1 337 736**	**1 337 736**	**1 337 736**	**1 337 736**	**22 275 136**	**7 131 976**	**1 337 736**	**1 337 736**	**1 337 736**	**1 337 736**
	Unforeseen (10%)	**9 036 649**	**348 600**	**1 000 283**	**1 602 153**	**985 893**	**912 023**	**176 797**	**133 774**	**133 774**	**133 774**	**133 774**	**2 227 514**	**713 198**	**133 774**	**133 774**	**133 774**	**133 774**
	TOTAL GENERAL	**99 403 137**	**3 834 600**	**11 003 112**	**17 623 682**	**10 844 822**	**10 032 252**	**1 944 769**	**1 471 510**	**1 471 510**	**1 471 510**	**1 471 510**	**24 502 649**	**7 845 173**	**1 471 510**	**1 471 510**	**1 471 510**	**1 471 510**
	Cumulative Sum		**3 834 600**	**14 837 712**	**32 461 394**	**43 306 216**	**53 338 468**	**55 283 237**	**56 754 747**	**58 226 257**	**59 697 766**	**61 169 276**	**85 671 925**	**93 517 098**	**94 988 608**	**96 460 118**	**97 931 627**	**99 403 137**
			4%	**15%**	**33%**	**44%**	**54%**	**56%**	**57%**	**59%**	**60%**	**62%**	**86%**	**94%**	**96%**	**97%**	**99%**	**100%**

Table 18 : Summary of Short Term Investment Programme

num	Description	Total Cost		Part in		Part in		2005	2006	2007	2008	2009
		[EEK]	=[EUR]	[EEK]	[%]	[EUR]	[%]					
1.	**Additional Investigations**											
1.1.	Full diagnosis of existing facilities	560 000	35 791	392 000	70%	10 737	30%	560 000				
1.2.	Camera inspection	496 000	31 700	446 400	90%	3 170	10%	496 000				
1.3.	Engineering and supervision	4 468 720	285 605	1 340 616	30%	199 924	70%	1 000 000	867 180	867 180	867 180	867 180
1.4.	Institutionnal study	800 000	51 130	80 000	10%	46 017	90%	800 000				
	Total Investigations	**6 324 720**	**404 226**	**2 259 016**	**36%**	**259 847**	**64%**	**2 856 000**	**867 180**	**867 180**	**867 180**	**867 180**
2.	**Well rehabilitation**	**400 000**	**25 565**	**320 000**	**80%**	**5 113**	**20%**	**0**	**160 000**	**240 000**	**0**	**0**
3.	**WS Networks**											
3.1.	Pipelines replacement	3 304 000	211 165	2 973 600	90%	21 117	10%		330 400	660 800	1 321 600	991 200
3.2.	Pipelines rehabilitation	1 888 000	120 666	1 699 200	90%	12 067	10%		188 800	377 600	755 200	566 400
3.3.	Valves	135 000	8 628	27 000	20%	6 903	80%		13 500	27 000	54 000	40 500
3.4.	Meters	60 000	3 835	12 000	20%	3 068	80%		6 000	12 000	24 000	18 000
	Total WS Networks	**5 387 000**	**344 294**	**4 711 800**	**87%**	**43 153**	**13%**	**0**	**538 700**	**1 077 400**	**2 154 800**	**1 616 100**
4.	**WS Infrastructures**											
4.1.	Water treatment facility	7 200 000	460 167	5 760 000	80%	92 033	20%			7 200 000		
4.2.	Second booster pump	200 000	12 782	40 000	20%	10 226	80%				200 000	
4.3.	Storage tank rehabilitation	800 000	51 130	800 000	100%	0	0%		800 000			
	Total WS Infrastructures	**8 200 000**	**524 079**	**6 600 000**	**80%**	**102 259**	**20%**	**0**	**800 000**	**7 200 000**	**200 000**	**0**
	Total WS (2+3+4)	**13 987 000**	**893 938**	**11 631 800**	**83%**	**150 526**	**17%**	**0**	**1 498 700**	**8 517 400**	**2 354 800**	**1 616 100**
5.	**WW Networks**											
5.1.	Sewerage	12 568 343	803 269	12 316 976	98%	16 065	2%		3 142 086	3 142 086	3 142 086	3 142 086
5.2.	Storm water collection system	10 603 150	677 669	10 391 087	98%	13 553	2%		2 650 788	2 650 788	2 650 788	2 650 788
5.3.	Manholes	1 557 250	99 527	1 479 388	95%	4 976	5%		389 313	389 313	389 313	389 313
5.4.	Connections	1 819 054	116 259	1 728 101	95%	5 813	5%		454 764	454 764	454 764	454 764
5.5.	Equipment	630 000	40 265	94 500	15%	34 225	85%	630 000				
	Total WW Networks	**27 177 797**	**1 736 989**	**26 010 052**	**96%**	**74 633**	**4%**	**630 000**	**6 636 949**	**6 636 949**	**6 636 949**	**6 636 949**
6.	**WW Infrastructures**											
6.1.	Civil works rehabilitation	500 000	31 956	475 000	95%	1 563	5%		500 000			
6.2.	Automation	500 000	31 956	150 000	30%	21 875	70%		500 000			
	Total WW Infrastructures	**1 000 000**	**63 912**	**625 000**	**63%**	**23 438**	**37%**	**0**	**1 000 000**	**0**	**0**	**0**
	Total WW (5+6)	**28 177 797**	**1 800 901**	**26 635 052**	**95%**	**98 070**	**5%**	**630 000**	**7 636 949**	**6 636 949**	**6 636 949**	**6 636 949**
	TOTAL GENERAL (1+2+3+4+5+6)	**48 489 517**	**3 099 065**	**40 525 868**	**84%**	**508 444**	**16%**	**3 486 000**	**10 002 829**	**16 021 529**	**9 858 929**	**9 120 229**
	Unforeseen (10%)	**4 848 952**	**309 906**	**4 052 587**	**84%**	**50 844**	**16%**	**348 600**	**1 000 283**	**1 602 153**	**985 893**	**912 023**
	TOTAL GENERAL	**53 338 468**	**3 408 971**	**44 578 455**	**84%**	**559 288**	**16%**	**3 834 600**	**11 003 112**	**17 623 682**	**10 844 822**	**10 032 252**

9 Economical and financial evaluation

The financial and economical impact of the investments on the functioning of Narva Vesi is rather difficult to identify for reasons that have been detailed in the Baseline study. Mainly :

- Impossibility to isolate expenses for Narva-Jõesuu networks in the accountancy system,
- Huge difference in the turnover of the activities in Narva compared to Narva-Jõesuu.
- No data available to the mission about Narva Vesi global investment plan. For that reason, it was not possible to include this study in a full financial forecast model of the Narva Water Company.

The financial and economic evaluation is based on technical choices presented in previous reports and is limited to investments justified in those reports. As there were no technical alternatives to study (see [15]), no financial alternative could be studied too.

9.1 Description of methodology

The purpose of this chapter is to give some financial data to be integrated in the overall (Narva + Narva-Jõesuu) application.

The first step is cash-flow forecasts drafting. The cash flow is calculated from figures justified in the Long Term Investment Program (see [15]).

- On the basis of the Long Term Investment Programme (Annex VII), a summary investment and O&M costs are calculated.
- To estimate the revenues, we use the volume of water that should be invoiced in 2020 calculated in the Long Term Investment Programme, based on invoiced quantities known today and considering population forecast up to 2020.

  Starting with the current tariffication scale, one can have an estimation of total revenues expected taking into account the repartition between inhabitants and companies.

Then the value of the IRR (Internal Rentability Rate) over a period of 30 years is calculated. To have an idea of how much of the new costs can be supported by the consumer, IRR is simulated in 6 scenarios, taking into account different tariffication scales and different costs covered (total costs or O&M only).

Finally a sensitivity and risk analysis is presented considering a variation, + and – 10% on expenses and on revenues.

For these calculations, we use constant prices for expenses and revenues estimation.

9.2 Investment and O&M costs

The following table gives a summary of Investments and O&M costs for both Water Waste and Water supply. These figures come directly from the Long term Investment Programme.

Table 19 : Financial summary

Description	Total [EEK]
Total Investigations	9 844 548
Total Investments WS	25 330 655
Total Operation & maintenance WS	23 282 528
Total Investment WW	55 191 285
Total Operation & maintenance WW	23 124 812
Unforeseen	9 036 649
Total General	145 810 477

For the purpose of IRR calculation, we have estimated the residual value for investment, to be added as revenue at the end of the period (30 years). For the WS investments, this value represents 12 972 524 EEK (or 67% of the investments) and 40 072 126 EEK (or 85% of the investments) for WW investment. Detailed calculation is shown in Annex XI.

9.3 Revenues estimation

To estimate the quantity of water that will be invoiced during the 2005 - 2020 period, a linear growth in consumption has been used, between the present consumption (125 000 m³ invoiced in 2003) and 208 635 m³ (supposedly invoiced in 2020, taking into consideration the population growth and unit consumption increase). After 2020, population and consumption are assumed to remain stable, due to the geographical limits of the site.

From these quantities, one can evaluate the revenue depending on tariffication scale and consumer type. We assumed that, like in the present days, two-third of the water is sold to inhabitants and the last third to companies. This repartition should remain unchanged in the coming years considering the socio economic situation in Narva-Jõesuu.

The estimated revenue for 2005 is calculated in Annex XII, based on the 2004 Narva-Jõesuu tariffs. One can see that revenue, with unchanged tariff scale in 2005, is 1 477 900 EEK up to 2 466 734 EEK in 2020.

9.4 Cash flow calculation

In Annex XV, the table shows the different cash flows for each of the six scenarios. One can see that cash flows stay negative during the whole period for scenario 1, and becomes positive in year 13 for scenario 2 and 3, in year 15 for scenario 4, in year 12 for scenario 5 and in year 9 for scenario 6. The cumulated cash flows stay negative for scenarios 1, 2 and 4 while they become positive for the other three scenarios. Only scenarios 4, 5 and 6 could be supported within day-to-day treasury, but this is with the assumption that the financing of all investments is done by external source.

9.5 IRR calculation and scenarios

The IRR can be calculated in different situations. The main influent factor (and easiest to handle and control by the company) is the tariffs. The objective of this chapter is to show the influence of tariffs modifications on the value of the IRR.

There are two different cases:

- The first case is IRR calculation, taking into account all expenses : Investments and Operation and Maintenance (O&M). This is shown in Annex XII, scenarios 1 to 3.

- The second case is IRR calculation taking into account Operation and Maintenance only. This is shown in Annex XIII, scenarios 4 to 6. In this case, the total investment is supposed to be financed and supported by an external source.

Scenario 1 : all expenses with present tariffication. The IRR is not calculable. Figures are too extreme to calculate an IRR. This scenario is excluded.

Scenario 2 : all expenses with a low IRR at 2.5%. The increase of tariffs should be 281%. This means that, in order to balance expenses with revenues (including a small surplus) during a 30 years whole period, including residual value of the investments, present tariffs should be multiplied more than two and a half times. This is not realistic and this scenario must be excluded too.

Scenario 3 : all expenses with an IRR at 10%. The increase of tariff should be in this case 453 %. This means that, in order to get an excess of 10% on revenues over the expenses during a 30 years period, including residual value of the investments, present tariffs should be multiplied more than four times. This is not realistic at all and this scenario is excluded.

Scenario 4 : with present tariffication and only O&M costs. Figures are too extreme to calculate an IRR. This scenario is excluded.

Scenario 5 : Operation and maintenance expenses only and a 2.5% IRR. The increase of tariff should be 124 %. This means that, in order to balance O&M expenses with revenues during a 30 years period, the tariff increase should be 24 %. This is more realistic but, in this case, expenses and revenues are only balanced with a small financial reserve only.

Scenario 6 : Operation and maintenance expenses only and a 10% IRR The increase of tariffs should be 149 %. This means that, in order to balance O&M expenses with revenues during a 30 years period, tariffs should be increased by 49 %. This is more realistic, as the tariff increase covers the O&M costs and generates a 10% revenue on operations.

Table 20 : Tariffication study

Description	IRR	Tariff variation needed
Scenario 1 : Invest. + O&M	Not calculable	-
Scenario 2 : Invest. + O&M	2.5 %	281 %
Scenario 3 : Invest. + O&M	10 %	453 %
Scenario 4 : O&M only	Not calculable	-
Scenario 5 : O&M only	2.5 %	124 %
Scenario 6 : O&M only	10 %	149 %

9.6 Sensitivity analysis

With the sensitivity, one measures the importance of IRR variation when incomes or expenses increase or decrease.

The sensitivity analysis is made for scenarios 5 and 6. A detail of calculations is given in Annex XIV.

The table below shows the sensitivity calculated for scenario 5.

The original IRR of scenario 5 is 2.5 %, when expenses and incomes have 0% variation. If incomes are 10% higher and expenses 10% lower, then the IRR will be 8 %. But, if expenses increase by 5 or 10%, the rentability is bellow 0. This shows that scenario 5 is not good enough.

Table 21 : Sensitivity of Scenario 5

	Expenses				
Incomes	**-10%**	**-5%**	**0%**	**5%**	**10%**
-10%	3%	2%	--	--	--
-5%	4%	3%	--	--	--
0%	6%	4%	2,5%	--	--
5%	8%	6%	4%	3%	--
10%	11%	8%	6%	4%	3%

The table below shows the IRR elasticity for the scenario recommended (scenario 6) in the case of variation (decrease or increase) of expenses and/or incomes. The original IRR of scenario 6 is 10% when expenses and incomes have 0% variation. If incomes are 10% higher and expenses 10% lower, then the IRR will be 23%. In the other side, if incomes are 10% lower and expenses are 10% higher the IRR will be 2% only. This shows a rather high elasticity, meaning that one must be careful in the management to respect the forecast expenses and incomes.

Table 22 : Sensitivity of Scenario 6

	Expenses				
Incomes	**-10%**	**-5%**	**0%**	**5%**	**10%**
-10%	10%	8%	6%	4%	2%
-5%	12%	10%	8%	6%	4%
0%	15%	12%	10%	8%	6%
5%	18%	15%	12%	10%	8%
10%	23%	19%	16%	13%	10%

9.7 Conclusions

The foreseen investments will not bring any significant decrease in the operational expenses (some decrease in electricity and repair labour cost). In these conditions, the justification for the investment must be found in :

- environmental improvement : the need to reach the EU standards, mainly with waste water criteria, and
- on socio-economic field : the importance for Narva-Jõesuu, as a tourist resort, to provide a high standard of quality for water supply and waste water management.

The profitability of a water and sewerage system, like the one in Narva-Jõesuu, is not easy to ensure for several reasons: the housing is dispersed, with many individual houses, few industries (that could have been big consumers) and some non-permanent inhabitants (summer houses, tourists, etc.). Most of the tourists are only one-day tourists.

Taking these issues into consideration implies that solidarity should prevail between the city of Narva and Narva-Jõesuu, unless it would be virtually impossible to invest in the proposed works considering the small size and turnover of Narva-Jõesuu.

This solidarity is justified as Narva-Jõesuu and Narva have mutual interests.

As far as O&M costs are concerned, it is possible for Narva-Jõesuu to balance its accounts if the present tariffs are multiplied by 1.5. At that level, there is a possible rentability with an acceptable sensivity to variation of expenses and incomes foreseen.

There should be room for this significant increase, as tariffs in Narva-Jõesuu are rather low and much lower if compared with cities where new investments have been realized.

As shown earlier (see [13]) the average tariff[6] in 28 Estonian water companies is 19.98 EEK/m³, which is much more expensive than in Narva-Jõesuu (average of 13.81 EEK/m³). Taking into consideration an increase of 67%, the average price in Narva-Jõesuu would reach 23.06 EEK/m³.

In comparison, one cubic-meter of water and sewerage service in the Walloon Region is 37.92 EEK/m³.

Narva-Jõesuu will be capable to pay for operation and maintenance costs but not for the investments. These investments must be financed by external source.

[6] data from Association of Water and Waste Water Services of Estonia

Annex I. Glossary and definitions

Appropriate pretreatment	Treatment of wastewater by any process and/or disposal system, which allows to meet the relevant quality objectives for discharge into sewerage. Appropriate pretreatment implies further treatment has to be provided.
Appropriate treatment	Treatment of wastewater by any process and/or disposal system which after discharge allows the receiving final environment to meet the relevant quality objectives.
Centralized treatment	Treatment of wastewater associated with sewerage.
Combined sewerage:	System of pipes that collects and conducts a mixture of sewage with any of the above mentioned effluents.
Decentralized treatment	Treatment of wastewater without collection through sewerage. This definition includes septic tanks and watertight tanks.
Drainage water	Water flow collected by drains located under ground. The aim of drainage is to protect basements of households and to ensure dry conditions of upper ground level.
Roof water	Water flow originated by rainwater on roofs.
Run-off water	Water flow originated by rain water run-off on watertight surfaces located on the ground: streets, parking lots, …
Semi-separate sewerage:	System of pipes that collects and conducts sewage together with roof storm water, while run-off on streets water and drainage are diverted to another evacuation system.
Separate sewerage:	System of pipes that collects and conducts sewage exclusively, while rainwater and drainage are diverted to another evacuation system.
Septic tank	Facility for pretreatment of wastewater.
Sewage	Effluent from residential settlements and services, which originates predominately from the human metabolism and from household activities (also called "domestic wastewater").
Supply point	Connection point between a public sewerage system and the sewerage facilities of a registered immovable
Sewerage	System of pipes that collects and conducts wastewater. Definition includes pipes and manholes, but not necessary pumping, since sewerage can be by gravity or pressurized.
Wastewater	Sewage alone or mixture of sewage with any of the above mentioned effluents.
Watertight tank	Storage facility of wastewater. Treatment is operated by removal (vacuum tanker or other) and transportation to treatment facility.

Annex II. Bibliography

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[3] Narva-Jõesuu strategic plan for 2004-2014 - Land Use Plan (Hendrikson 1999).

[4] Narva Vesi

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[6] Real estate household sewerage (Kinnistu Kanalisatsioon) ET-1 1003-0559 (Eesti Ehitusteave, 2004)

[7] L'assainissement en milieu urbain ou rural (Le Moniteur Technique, 1988)

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[12] Groundwater management in the Northern Peipsi-Narva River basin. R. Perens, E Andresmaa, et alii. 2001.

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[14] Narva - Jõesuu Water and Wastewater System Improvement Project Feasibility Study. Baseline Study. S.H.E.R. Ingénieurs-Conseils s.a. & ENTEC AS. July 2004.

[15] Narva - Jõesuu Water and Wastewater System Improvement Project Feasibility Study. Long Term Investment Programme. S.H.E.R. Ingénieurs-Conseils s.a. & ENTEC AS. July 2004.

Annex III. Water treatment plant

1	**Air relieve and filters feed pumps + attached equipments**
1.1	Atmospheric contact tank (7.5 m³ PEHD)
1.2	Atmospheric equilibrium distribution nozzle
1.3	Agitator
1.4	Hydrostatic level sensor
1.5	Suction pipe and pre-filter
1.6	Feed pumps
1.7	Hand valves and by-pass
1.8	Piping from feed pumps
2	**Sand filter unit (3 roundabout filter)**
2.1	Pneumatic actuated valves
2.2	Pressure gauge 0-4 bars
2.3	Electromagnetic flow meter DN 80
2.4	3 glass fibre reinforced polyester tanks - dia 1.5 m - H = 2 meters
2.5	Filtering mass
2.6	Junction piping
3	**CO2 dosing unit with storage racks**
3.1	CO_2 dosing panel + injection nozzle
3.2	ECOGAZ central unit, 2 x 1 rack (for 12 bottles per rack) polyester roof included for outdoor storage
4	**Calcite CaCO3 contactors (3 roundabout filters)**
4.1	Hand valves for filters operation
4.2	3 glass reinforced polyester tanks - dia 1.5 m - H = 2 metres
4.3	Calcite mass (initial load)
4.4	Filter junction piping
5	**Chemicals dosing unit**
5.1	Sodium hypochlorite dosing pumps (oxidant + disinfection)
5.2	NaOH dosing pump (polishing) storage tank dosing pump (5 m³) double encasement
5.3	Final pH control
5.4	Vented cabinet for dosing pumps + retention tanks
6	**Shaking up unit for sand filters and for backwashing calcite contactors and sand filters backwashing**
6.1	Air blower (150 Nm³/h - 800 mbars) with phonic insulation – stainless steel piping included
6.2	Backwashing pump
6.3	Electromagnetic flow meter DN80
6.4	Pressure gauge
7	**Electrical cabinet + PLC**
7.1	Electro valves cabinet for pneumatic actuation + compressor
7.2	Electrical panel + PLC (programming all included)
8	**Skid – for supporting equipments pre-assembled**
8.1	2 skids : 3 x 3 x 9 metres

Annex IV. Second booster pump

See next page

Company name:
Created by:
Phone:
Fax:
Date: 9/09/2004

Position	Qty.	Description	Single Price
	1	CR 45-2-2	Price on request

Note! Product picture may differ from actual product

Product No.: 96122798
Vertical, non-self-priming, multistage, in-line,
centrifugal pump for installation in pipe systems
and mounting on a foundation.

The pump has the following characteristics:
- Impellers and intermediate chambers are made of Stainless steel DIN W.-Nr. 1.4301 DIN W.-Nr..
- Pump head and base are made of Cast iron .
- The shaft seal has assembly length according to DIN 24960.
- Power transmission is via cast iron split coupling.
- Pipework connection is via DIN flanges.

The motor is a 3 -phase AC motor.

Liquid:
Liquid temperature range:-30 ..120 °C

Technical:
Speed for pump data:2900 rpm
Rated flow:45 m³/h
Rated head:30 m
Type of shaft seal:HQQE

Materials:
Material, pump housing:Cast iron
EN-JS1050 DIN W.-Nr.
80-55-06 ASTM
Material, impeller:Stainless steel
1.4301 DIN W.-Nr.
304 AISI

Installation:
Maximum ambient temperature:40 °C
Max pressure at stated temp:16 / 120 bar / °C
Standard, pipe connection:DIN
Size, pipe connection:DN 80
Pressure stage, pipe connec.:PN 16 / PN 25 / PN 40
Flange size for motor:FF265

Electrical data:
Motor type:132SB
Efficiency class:2
Number of poles:2
P2:5.5 kW

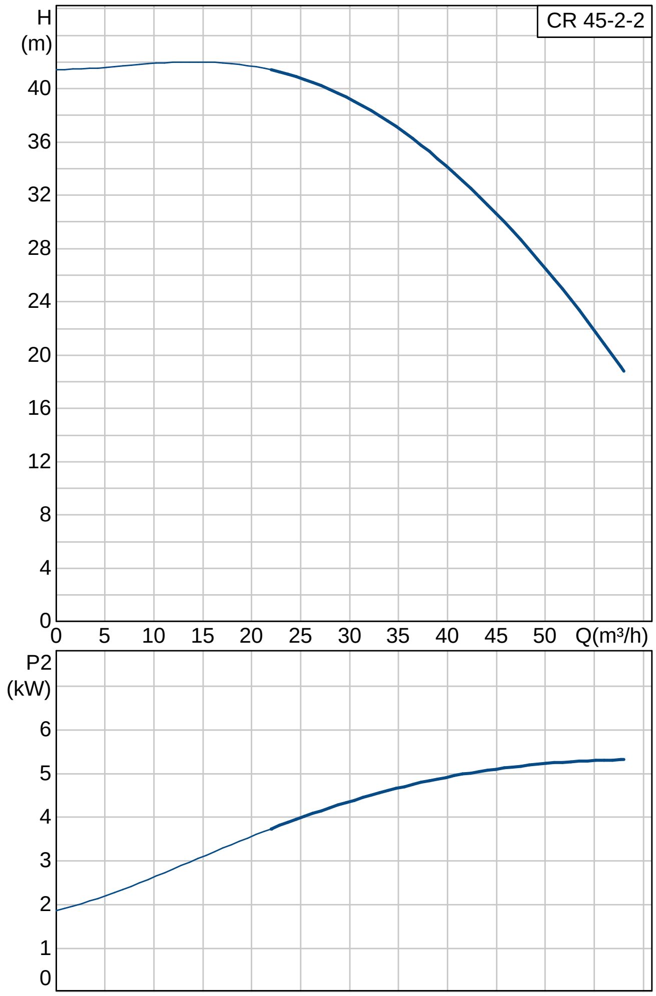
Company name:	
Created by:	
Phone:	
Fax:	
Date:	9/09/2004

Position	Qty.	Description	Single Price
		Mains frequency:50 Hz Rated voltage:3 x380-415 D V Rated current:11 A Starting current:890-970 % Cos phi - power factor:0,89-0,86 Rated speed:2890-2910 rpm Enclosure class (IEC 34-5):IP55 Insulation class (IEC 85):F Others: Net weight:113 kg Gross weight:173 kg Shipping volume:0.301 m³	

GRUNDFOS

Company name:
Created by:
Phone:
Fax:
Date: 9/09/2004

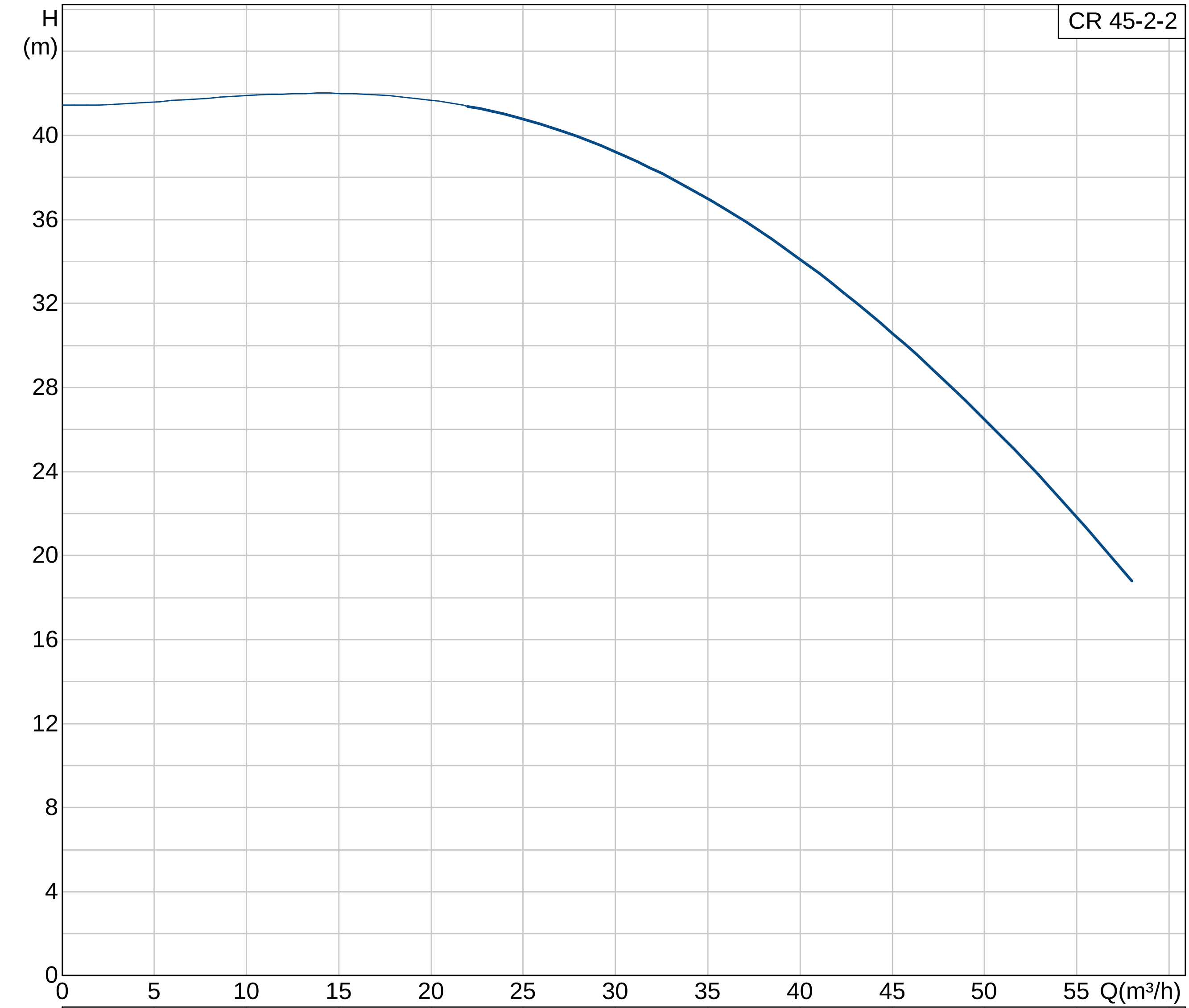
Description	Value
Product name:	CR 45-2-2
Product No:	96122798
EAN number:	5700396688428
Speed for pump data:	2900 rpm
Rated flow:	45 m³/h
Rated head:	30 m
Impellers:	2
Impeller reduc.:	2
Type of shaft seal:	HQQE
Stages:	2
Pump version:	A
Model:	A
Material, pump housing:	Cast iron
	EN-JS1050 DIN W.-Nr.
	80-55-06 ASTM
Material, impeller:	Stainless steel
	1.4301 DIN W.-Nr.
	304 AISI
Material code:	A
Code for rubber:	E
Maximum ambient temperature:	40 °C
Max pressure at stated temp:	16 / 120 bar / °C
Standard, pipe connection:	DIN
Connect code:	F
Size, pipe connection:	DN 80
Pressure stage, pipe connec.:	PN 16 / PN 25 / PN 40
Flange size for motor:	FF265
Liquid temperature range:	-30 .. 120 °C
Motor type:	132SB
Efficiency class:	2
Number of poles:	2
P2:	5.5 kW
Mains frequency:	50 Hz
Rated voltage:	3 x 380-415 D V
Rated current:	11 A
Starting current:	890-970 %
Cos phi - power factor:	0,89-0,86
Rated speed:	2890-2910 rpm
Enclosure class (IEC 34-5):	IP55
Insulation class (IEC 85):	F
Motor protec:	PTC
Motor No:	85817417
Net weight:	113 kg
Gross weight:	173 kg
Shipping volume:	0.301 m³

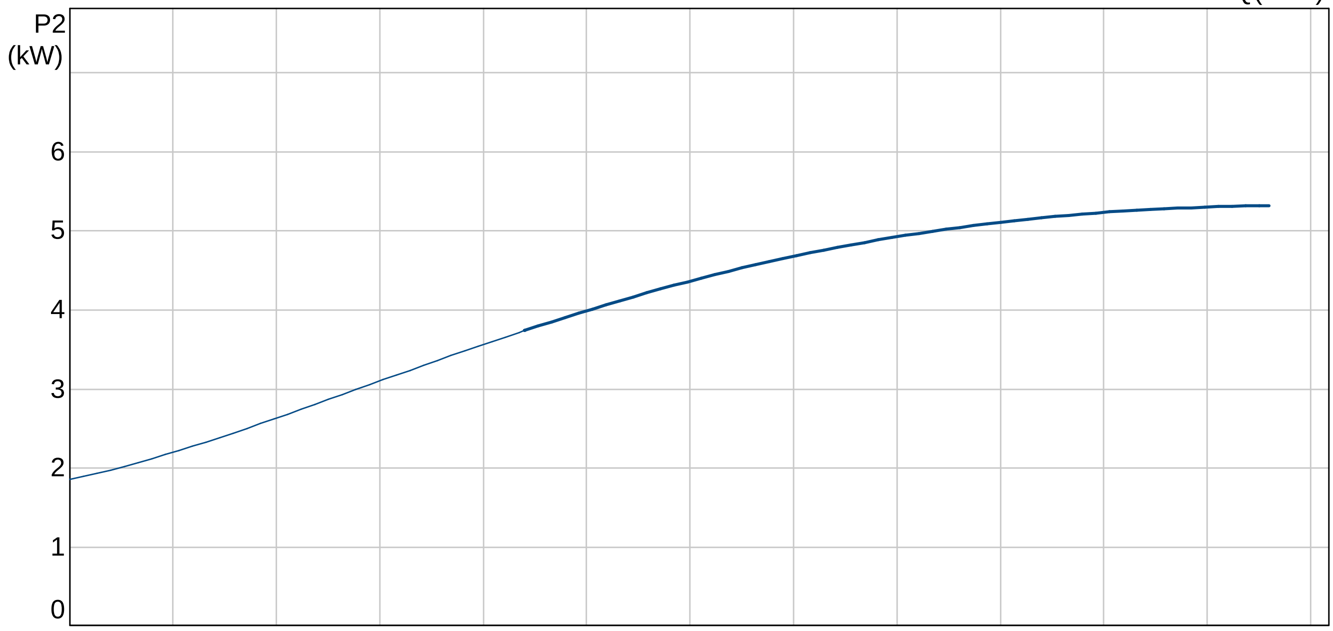


GRUNDFOS

Company name:
Created by:
Phone:
Fax:
Date: 9/09/2004

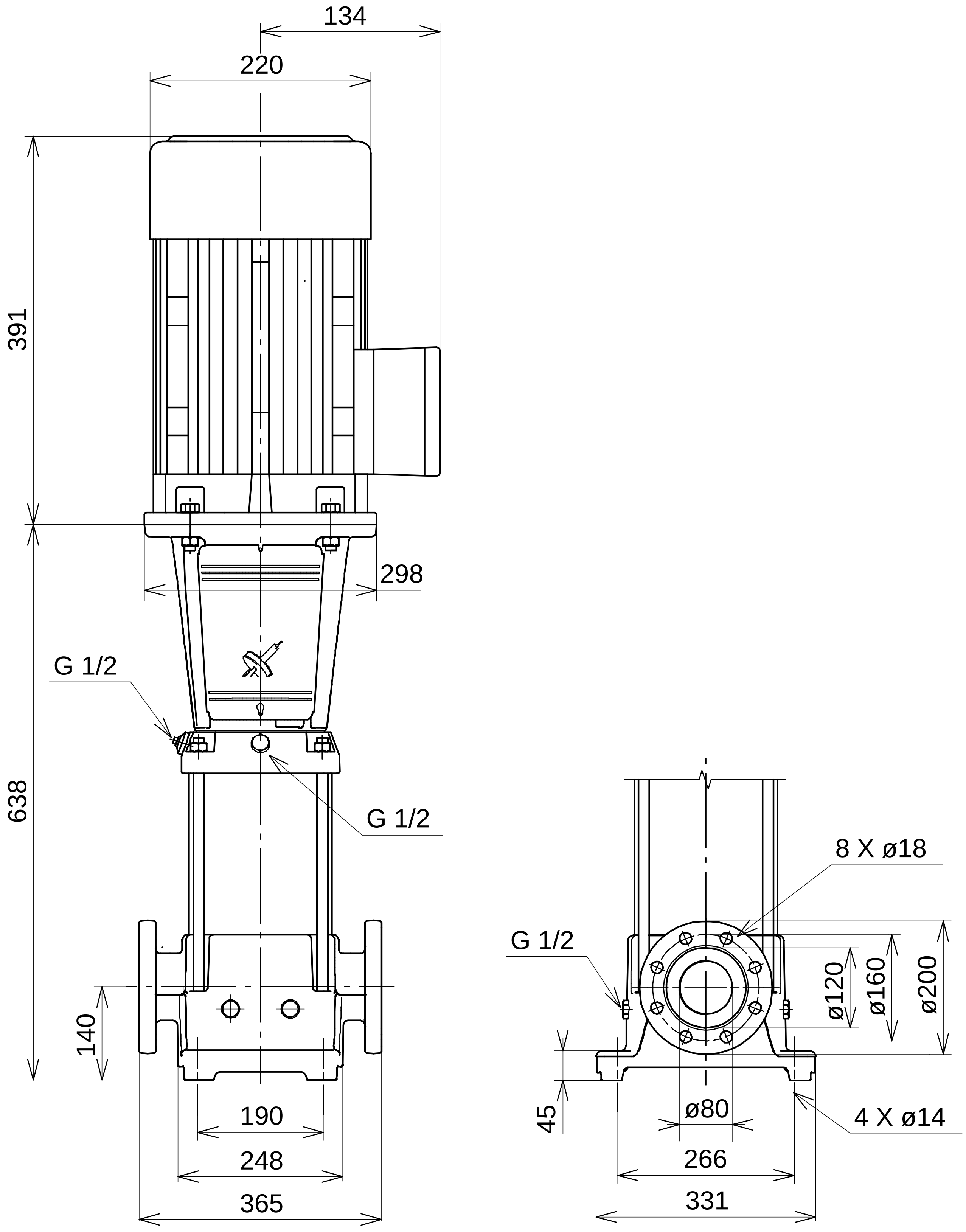
96122798 CR 45-2-2





Company name:
Created by:
Phone:
Fax:
Date: 9/09/2004

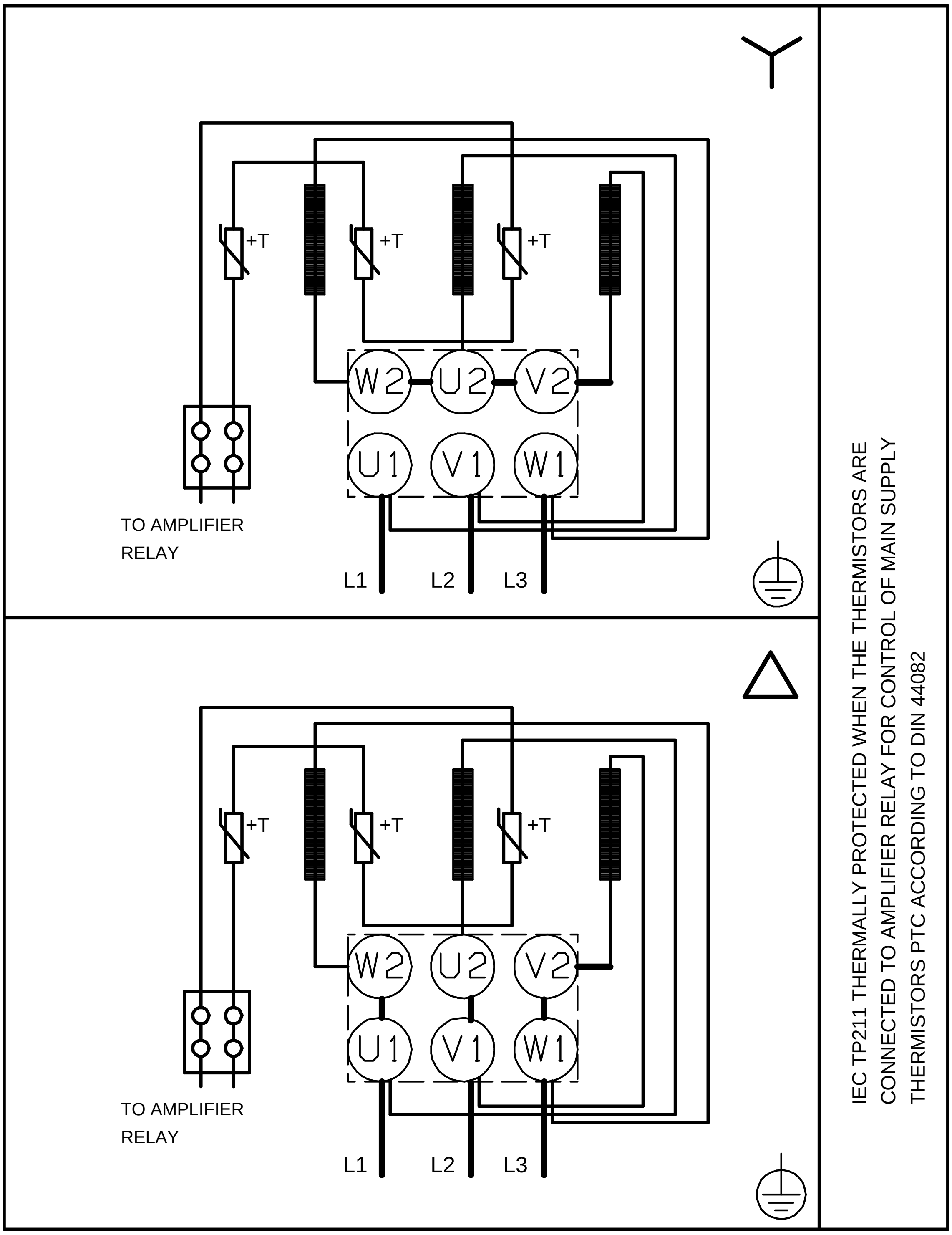
96122798 CR 45-2-2



Note! All units are in [mm] unless others are stated.

Company name:
Created by:
Phone:
Fax:
Date: 9/09/2004

96122798 CR 45-2-2



Annex V. Future Water Supply Network

Table 23 : Junctions

Label	Base Flow [m³/h]	Calculated Age [hours]	Calculated Hydraulic Grade [m]	Pressure [m]
J-1	0.9	1.28	45.41	37.2
J-2	0.4	1.60	45.41	37.0
J-3	0.9	2.24	45.41	36.8
J-4	0.3	0.60	45.43	36.9
J-5	0.1	0.40	45.47	38.2
J-6	0.6	1.71	45.41	36.3
J-7	0.2	2.76	45.41	35.6
J-8	0.0	14.92	45.41	40.3
J-10	0.0	0.30	45.67	41.1
J-11	0.0	0.20	45.68	41.1
J-12	0.0	15.43	45.40	41.8
J-13	0.0	19.00	45.40	41.8
J-14	0.0	1.94	45.41	35.6
J-15	0.0	0.20	45.68	40.3
J-17	0.0	0.30	45.67	41.0
J-18	0.0	45.63	45.37	41.7
J-21	0.2	4.61	45.42	39.3
J-23	0.0	18.20	45.40	41.3
J-24	0.1	0.42	45.58	40.5
J-25	1.1	0.52	45.56	40.5
J-26	0.0	3.12	45.42	39.2
J-27	0.2	2.95	45.43	39.6
J-28	0.0	13.94	45.52	39.7
J-29	0.2	15.95	45.52	41.7
J-30	0.0	17.08	45.40	32.9
J-32	0.0	20.85	45.41	39.8
J-33	0.0	1.08	45.45	39.9
J-34	0.0	0.79	45.46	38.9
J-35	0.2	26.05	45.40	33.3
J-36	0.0	13.20	45.41	39.0
J-37	0.1	13.88	45.41	39.2
J-38	0.1	11.67	45.40	41.1
J-39	0.0	12.52	45.41	39.0
J-40	0.4	12.37	45.40	32.6
J-41	0.4	28.23	45.37	41.6
J-42	0.3	0.98	45.55	41.6
J-43	0.0	1.46	45.55	40.7
J-45	0.0	0.40	45.62	40.8
J-46	0.0	33.65	45.37	41.3
J-47	0.0	2.36	45.40	34.8
J-48	0.1	16.89	45.40	41.2
J-49	0.0	1.76	45.43	36.9
J-50	1.0	1.88	45.41	36.2
J-51	0.0	2.94	45.41	35.3
J-52	0.1	0.72	45.54	40.5
J-53	0.1	1.03	45.52	40.2
J-54	0.8	13.53	45.41	40.0
J-55	0.0	6.59	45.40	33.3
J-56	0.0	5.10	45.40	32.8
J-57	0.0	3.27	45.50	41.1
J-58	0.1	1.22	45.50	40.9
J-59	0.1	1.59	45.45	39.7
J-60	0.0	10.29	45.41	41.1
J-61	0.0	9.39	45.41	41.1
J-62	0.0	9.31	45.52	40.1

Short Term Investment Programme

Label	Base Flow [m³/h]	Calculated Age [hours]	Calculated Hydraulic Grade [m]	Pressure [m]
J-63	0.1	12.54	45.52	39.4
J-64	0.4	1.27	45.43	37.4
J-65	0.0	24.70	45.37	41.3
J-66	1.9	2.86	45.39	37.0
J-67	0.0	72.00	45.40	39.1
J-68	0.0	4.42	45.40	36.9
J-69	0.1	1.25	45.44	37.1
J-70	0.1	6.45	45.45	41.9
J-71	0.1	3.44	45.41	35.0
J-72	0.0	11.92	45.40	33.0
J-73	0.1	5.57	45.47	41.8
J-74	0.0	9.90	45.42	39.1
J-75	0.0	11.03	45.42	38.8
J-76	0.2	5.08	45.41	34.8
J-77	0.1	4.23	45.41	34.0
J-78	0.0	3.91	45.50	42.1
J-79	0.3	20.49	45.38	41.3
J-80	0.5	19.42	45.38	41.1
J-81	0.2	8.75	45.42	39.3
J-82	0.0	5.27	45.39	37.0
J-83	0.0	2.46	45.44	39.6
J-84	0.3	38.33	45.37	41.3
J-85	0.0	5.59	45.52	41.9
J-86	0.1	4.70	45.48	42.2
J-87	0.0	8.59	45.52	40.2
J-88	0.0	11.50	45.40	33.0
J-90	0.1	17.89	45.40	33.5
J-91	0.0	8.43	45.41	41.1
J-93	0.7	1.80	45.42	37.8
J-94	0.7	1.28	45.42	36.8
J-95	0.2	4.23	45.43	40.8
J-96	0.1	1.74	45.57	40.0
J-97	0.5	2.61	45.57	40.0
J-98	1.4	1.37	45.44	37.6
J-99	0.7	1.22	45.46	38.9
J-100	0.0	17.25	45.40	33.4
J-101	0.3	24.32	45.40	33.7
J-102	0.2	3.84	45.52	40.7
J-103	0.2	5.44	45.52	41.1
J-105	0.0	0.64	45.45	37.7
J-106	0.0	6.07	45.40	33.9
J-107	0.1	6.74	45.40	33.5
J-108	0.0	2.37	45.56	42.1
J-109	0.0	2.10	45.57	42.1
J-110	0.3	2.35	45.42	36.9
J-111	0.2	2.68	45.41	36.3
J-112	0.0	9.56	45.40	32.8
J-113	0.0	16.89	45.59	42.2
J-114	0.0	1.73	45.59	42.2
J-115	0.0	3.18	45.52	41.9
J-116	0.4	6.99	45.40	32.9
J-117	0.4	0.30	45.52	38.7
J-118	0.0	3.98	45.52	40.4
J-119	0.1	14.23	45.52	40.9
J-120	0.7	1.74	45.44	38.1
J-121	0.0	0.91	45.44	37.7
J-122	0.1	20.81	45.41	42.1
J-123	0.7	3.76	45.41	36.8
J-124	0.0	2.80	45.54	42.1
J-125	0.0	6.78	45.43	41.1

Short Term Investment Programme

Label	Base Flow [m³/h]	Calculated Age [hours]	Calculated Hydraulic Grade [m]	Pressure [m]
J-126	0.2	2.01	45.44	40.8
J-127	0.0	14.55	45.40	33.5
J-128	0.2	12.05	45.52	40.5
J-129	0.0	34.51	45.55	41.9
J-130	0.0	0.59	45.54	39.9
J-131	0.2	7.41	45.42	40.6
J-132	0.0	1.35	45.61	41.9
J-133	0.1	12.17	45.52	37.7
J-134	0.2	9.37	45.41	40.3
J-135	0.1	8.45	45.41	40.5
J-136	0.0	0.74	45.64	41.6
J-137	0.5	2.83	45.55	41.8
J-138	0.0	0.72	45.57	40.8
J-139	0.0	41.05	45.61	41.5
J-140	0.1	29.02	45.40	34.3
J-141	0.1	3.90	45.41	38.3
J-142	0.0	3.36	45.52	40.6
J-143	0.0	72.00	45.40	33.3
J-144	2.3	5.90	45.34	37.8
J-145	0.2	8.84	45.40	33.3
J-146	0.3	10.26	45.40	35.1
J-147	0.1	56.87	45.37	41.7

Table 24 : Pipes

Label	Calculated age [hours]	Pressure Pipe Headloss [m]	Diameter [mm]	Discharge [m³/h]	Length [m]	Material	Velocity [m/s]
P-1	0.68	0.02	100.0	2.8	124.00	PE (new)	0.10
P-2	1.39	0.00	100.0	1.1	58.50	PE (new)	0.04
P-3	1.88	0.00	100.0	0.8	83.50	PE (new)	0.03
P-4	0.45	0.04	100.0	3.9	128.50	PE (new)	0.14
P-5	2.87	0.00	100.0	0.4	171.50	PE (new)	0.01
P-6	2.62	0.00	100.0	0.5	166.00	PE (new)	0.02
P-7	39.38	0.00	100.0	0.1	91.00	PE (new)	0.00
P-8	35.84	0.00	100.0	0.3	199.50	PE (new)	0.01
P-9	30.83	0.00	100.0	0.3	282.50	PE (new)	0.01
P-10	26.57	0.00	100.0	0.6	321.50	PE (new)	0.02
P-11	22.39	0.00	100.0	0.6	333.00	PE (new)	0.02
P-12	19.91	0.00	100.0	0.9	147.50	PE (new)	0.03
P-13	17.45	0.02	100.0	1.3	668.50	PE (new)	0.05
P-14	11.99	0.00	100.0	0.7	83.00	PE (new)	0.03
P-15	10.92	0.00	100.0	0.8	169.00	PE (new)	0.03
P-16	9.78	0.00	100.0	0.8	119.00	PE (new)	0.03
P-17	199.93	0.00	150.0	0.0	29.50	Cast iron	0.00
P-18	19.09	0.00	100.0	0.6	18.50	PE (new)	0.02
P-19	18.50	0.00	100.0	0.6	43.50	PE (new)	0.02
P-20	17.43	0.00	100.0	0.6	92.50	PE (new)	0.02
P-21	5.96	0.02	100.0	1.8	264.00	PE (new)	0.07
P-22	9.26	0.00	100.0	0.8	158.50	PE (new)	0.03
P-23	10.41	0.00	100.0	0.8	135.00	PE (new)	0.03
P-24	11.73	0.00	100.0	0.8	171.50	PE (new)	0.03
P-25	12.82	0.00	100.0	0.8	81.50	PE (new)	0.03
P-26	13.49	0.00	100.0	0.8	84.50	PE (new)	0.03
P-27	17.39	0.00	100.0	0.1	74.50	PE (new)	0.00
P-28	25.01	0.00	100.0	0.1	108.50	PE (new)	0.00
P-29	2.79	0.01	100.0	1.4	179.50	PE (new)	0.05
P-30	1.97	0.01	100.0	1.4	221.50	PE (new)	0.05
P-31	1.29	0.01	100.0	1.5	129.00	PE (new)	0.05
P-32	0.89	0.00	100.0	1.5	72.00	PE (new)	0.05
P-33	0.95	0.01	100.0	2.0	139.00	PE (new)	0.07
P-34	7.43	0.00	100.0	0.3	204.00	PE (new)	0.01

Short Term Investment Programme

Label	Calculated age [hours]	Pressure Pipe Headloss [m]	Diameter [mm]	Discharge [m³/h]	Length [m]	Material	Velocity [m/s]
P-35	10.85	0.00	100.0	0.3	146.00	PE (new)	0.01
P-36	14.92	0.00	100.0	0.2	64.50	PE (new)	0.01
P-37	1.18	0.00	100.0	1.0	84.50	PE (new)	0.04
P-38	6.75	0.00	100.0	0.5	343.00	PE (new)	0.02
P-39	199.91	0.00	150.0	0.0	42.50	Cast iron	0.00
P-40	3.81	0.00	100.0	0.6	154.00	PE (new)	0.02
P-41	3.00	0.01	100.0	2.3	65.50	PE (new)	0.08
P-42	4.22	0.00	100.0	0.3	160.50	PE (new)	0.01
P-43	2.56	0.01	100.0	2.0	173.50	PE (new)	0.07
P-44	2.16	0.01	100.0	2.0	113.50	PE (new)	0.07
P-45	1.95	0.00	100.0	2.0	36.50	PE (new)	0.07
P-46	1.80	0.02	100.0	2.9	97.00	PE (new)	0.10
P-47	2.05	0.00	100.0	0.4	123.50	PE (new)	0.02
P-48	1.01	0.00	100.0	0.8	123.50	PE (new)	0.03
P-49	1.53	0.01	100.0	1.4	142.50	PE (new)	0.05
P-50	2.36	0.00	100.0	0.5	98.00	PE (new)	0.02
P-51	5.80	0.00	100.0	0.4	111.00	PE (new)	0.02
P-52	4.62	0.00	100.0	1.0	143.50	PE (new)	0.03
P-53	3.79	0.00	100.0	1.1	138.50	PE (new)	0.04
P-54	3.05	0.00	100.0	1.1	131.50	PE (new)	0.04
P-55	1.98	0.00	100.0	0.9	25.00	PE (new)	0.03
P-56	5.09	0.02	100.0	1.9	263.50	PE (new)	0.07
P-57	4.26	0.02	100.0	1.9	263.50	PE (new)	0.07
P-58	4.61	0.00	100.0	0.3	146.50	PE (new)	0.01
P-59	2.19	0.00	100.0	0.3	112.00	PE (new)	0.01
P-60	0.30	0.05	100.0	5.9	87.00	PE (new)	0.21
P-61	0.20	0.01	100.0	5.9	15.00	PE (new)	0.21
P-62	0.20	0.01	100.0	4.4	27.00	PE (new)	0.16
P-63	199.87	0.00	150.0	0.0	35.50	Cast iron	0.00
P-64	0.10	0.01	140.0	12.7	28.00	PE (new)	0.23
P-65	0.32	0.09	100.0	6.6	129.00	PE (new)	0.23
P-66	0.42	0.02	100.0	4.3	62.50	PE (new)	0.15
P-67	0.57	0.02	100.0	3.3	108.00	PE (new)	0.12
P-68	0.77	0.02	100.0	3.1	102.00	PE (new)	0.11
P-69	14.63	0.00	100.0	0.1	84.00	PE (new)	0.00
P-70	199.95	0.00	150.0	0.0	65.00	Cast iron	0.00
P-71	19.90	0.00	100.0	0.1	75.50	PE (new)	0.00
P-72	24.01	0.00	100.0	0.0	132.00	PE (new)	0.00
P-73	4.75	0.01	100.0	1.7	198.50	PE (new)	0.06
P-74	45.01	0.00	100.0	0.0	132.00	PE (new)	0.00
P-75	199.92	0.00	100.0	0.0	123.50	Cast iron	0.00
P-76	1.35	0.02	100.0	2.5	130.00	PE (new)	0.09
P-77	8.86	0.01	100.0	0.8	138.50	Cast iron	0.03
P-80	6.58	0.02	100.0	1.7	103.50	Cast iron	0.06
P-81	7.14	0.01	100.0	0.9	131.00	Cast iron	0.03
P-82	7.99	0.00	100.0	0.5	110.00	Cast iron	0.02
P-83	14.35	0.00	100.0	0.7	120.00	Cast iron	0.03
P-84	10.06	0.00	100.0	0.6	139.00	Cast iron	0.02
P-85	8.87	0.00	100.0	0.7	123.50	Cast iron	0.03
P-86	7.89	0.01	100.0	0.8	153.00	Cast iron	0.03
P-87	5.70	0.01	100.0	0.6	278.00	Cast iron	0.02
P-88	3.07	0.01	100.0	0.7	273.50	Cast iron	0.03
P-89	2.26	0.01	100.0	1.1	112.50	Cast iron	0.04
P-90	0.97	0.00	100.0	0.6	73.00	Cast iron	0.02
P-91	0.47	0.02	100.0	2.0	80.50	Cast iron	0.07
P-92	0.30	0.05	100.0	6.1	88.00	PE (new)	0.22
P-93	0.56	0.08	100.0	2.3	237.00	Cast iron	0.08
P-94	1.05	0.02	100.0	1.7	105.50	Cast iron	0.06
P-95	1.96	0.00	100.0	0.4	109.50	Cast iron	0.02
P-96	2.47	0.01	100.0	1.3	76.50	Cast iron	0.05

Short Term Investment Programme

Label	Calculated age [hours]	Pressure Pipe Headloss [m]	Diameter [mm]	Discharge [m³/h]	Length [m]	Material	Velocity [m/s]
P-97	4.10	0.01	100.0	0.6	275.50	Cast iron	0.02
P-98	1.75	0.02	100.0	1.2	177.00	Cast iron	0.04
P-99	1.26	0.02	100.0	2.5	64.00	Cast iron	0.09
P-100	1.07	0.06	100.0	3.1	99.00	Cast iron	0.11
P-101	9.60	0.00	100.0	0.0	13.00	Cast iron	0.00
P-102	10.19	0.00	100.0	0.2	106.00	Cast iron	0.01
P-103	7.08	0.00	100.0	0.2	126.50	Cast iron	0.01
P-104	4.72	0.00	100.0	0.5	134.00	Cast iron	0.02
P-105	8.93	0.00	100.0	0.1	88.50	Cast iron	0.00
P-106	4.58	0.00	100.0	0.3	67.00	Cast iron	0.01
P-107	8.62	0.00	100.0	0.1	119.00	PVC	0.00
P-108	13.19	0.00	80.0	0.2	66.00	PVC	0.01
P-109	17.78	0.00	100.0	0.0	106.00	Cast iron	0.00
P-110	0.65	0.03	100.0	1.7	158.00	Cast iron	0.06
P-111	1.04	0.00	100.0	0.5	123.00	Cast iron	0.02
P-112	2.12	0.00	100.0	0.4	63.00	Cast iron	0.01
P-113	1.57	0.07	100.0	2.0	270.50	Cast iron	0.07
P-114	0.92	0.07	100.0	2.4	199.50	Cast iron	0.08
P-115	0.51	0.04	100.0	2.4	127.50	Cast iron	0.08
P-116	0.45	0.08	100.0	3.5	109.00	Cast iron	0.12
P-117	0.64	0.08	100.0	3.5	118.50	Cast iron	0.12
P-118	5.53	0.00	100.0	0.6	103.00	Cast iron	0.02
P-119	6.36	0.00	100.0	0.6	73.50	Cast iron	0.02
P-120	8.09	0.00	100.0	0.3	133.50	Cast iron	0.01
P-121	10.46	0.00	100.0	0.3	81.00	Cast iron	0.01
P-122	11.66	0.00	100.0	0.2	13.00	Cast iron	0.01
P-123	14.51	0.00	100.0	0.2	136.00	Cast iron	0.01
P-124	19.01	0.00	100.0	0.2	65.00	Cast iron	0.01
P-125	24.49	0.00	100.0	0.1	152.50	Cast iron	0.00
P-126	16.07	0.00	100.0	0.2	105.00	Cast iron	0.01
P-127	60.33	0.00	100.0	0.0	211.00	Cast iron	0.00
P-128	11.61	0.00	100.0	0.2	211.00	Cast iron	0.01
P-129	7.67	0.00	100.0	0.4	179.50	Cast iron	0.02
P-130	199.67	0.00	100.0	0.0	28.50	Cast iron	0.00
P-131	13.98	0.00	100.0	0.1	92.00	Cast iron	0.00
P-132	3.29	0.01	100.0	1.6	86.00	Cast iron	0.06
P-133	2.19	0.01	100.0	1.7	75.50	Cast iron	0.06
P-134	1.86	0.02	100.0	1.7	109.00	Cast iron	0.06
P-135	1.49	0.02	100.0	1.7	112.00	Cast iron	0.06
P-136	21.11	0.00	100.0	0.0	128.00	Cast iron	0.00
P-137	1.00	0.03	100.0	1.7	180.00	Cast iron	0.06
P-138	0.47	0.02	100.0	1.7	126.00	Cast iron	0.06
P-139	0.20	0.01	100.0	3.9	55.50	PE (new)	0.14
P-140	0.20	0.16	100.0	8.8	132.50	PE (new)	0.31
P-141	1.85	0.00	100.0	0.4	134.00	Cast iron	0.01
P-142	6.00	0.00	100.0	0.5	172.00	Cast iron	0.02
P-143	9.99	0.00	100.0	0.2	182.50	Cast iron	0.01
P-144	9.08	0.00	100.0	0.3	219.00	Cast iron	0.01
P-145	20.28	0.00	100.0	0.1	142.00	Cast iron	0.00
P-146	5.54	0.05	100.0	2.0	200.50	Cast iron	0.07
P-147	3.46	0.02	100.0	1.7	227.00	PVC	0.06
P-148	4.11	0.01	100.0	1.7	142.50	PVC	0.06
P-149	2.35	0.02	100.0	1.0	329.50	Cast iron	0.04
P-150	3.17	0.00	100.0	0.6	113.50	Cast iron	0.02
P-151	1.50	0.00	100.0	0.6	56.50	Cast iron	0.02
P-152	1.28	0.00	100.0	0.6	89.00	Cast iron	0.02
P-153	2.94	0.02	100.0	1.6	101.50	Cast iron	0.06
P-154	2.54	0.02	100.0	1.7	120.00	Cast iron	0.06
P-155	9.17	0.00	100.0	0.0	82.50	Cast iron	0.00
P-157	0.84	0.02	100.0	1.5	120.00	Cast iron	0.05

Short Term Investment Programme

Label	Calculated age [hours]	Pressure Pipe Headloss [m]	Diameter [mm]	Discharge [m³/h]	Length [m]	Material	Velocity [m/s]
P-158	1.45	0.02	100.0	1.5	112.00	Cast iron	0.05
P-159	3.62	0.00	100.0	0.6	61.50	Cast iron	0.02
P-160	3.55	0.00	100.0	0.4	36.50	Cast iron	0.02
P-161	51.62	0.00	50.0	0.1	343.00	Cast iron	0.01
P-162	0.00	0.00	150.0	0.0	34.00	Cast iron	0.00
P-163	0.00	0.00	150.0	0.0	46.50	Cast iron	0.00
P-164	15.85	0.00	100.0	0.6	198.50	PE (new)	0.02
P-165	0.00	0.00	150.0	0.0	48.00	Cast iron	0.00
P-166	0.00	0.00	150.0	0.0	34.00	Cast iron	0.00
P-167	0.00	0.00	150.0	0.0	43.00	Cast iron	0.00
P-168	0.00	0.00	150.0	0.0	56.50	Cast iron	0.00
P-169	0.00	0.00	150.0	0.0	1.00	Cast iron	0.00
P-170	0.00	0.00	150.0	0.0	65.00	Cast iron	0.00
P-171	0.10	0.02	140.0	10.4	57.50	PE (new)	0.19
P-174	0.00	0.00	150.0	0.0	1.00	Cast iron	0.00
P-175	0.00	0.00	150.0	0.0	65.00	Cast iron	0.00
P-176	0.00	0.00	150.0	0.0	37.00	Cast iron	0.00
P-177	0.00	0.00	150.0	0.0	43.00	Cast iron	0.00
P-178	0.00	0.00	150.0	0.0	44.00	Cast iron	0.00
P-179	0.00	0.00	150.0	0.0	43.50	Cast iron	0.00
P-180	3.67	0.00	100.0	0.5	138.00	PE (new)	0.02
P-181	7.63	0.00	100.0	0.3	236.50	Cast iron	0.01
P-278	7.55	0.01	100.0	0.9	260.50	Cast iron	0.03
P-279	0.00	0.00	140.0	23.1	2.00	PE (new)	0.42
P-280	0.00	0.00	100.0	0.0	47.00	PE (new)	0.00

Figure 2 : Watermeters and Valves

Figure 3 : Water distribution model (1)

Figure 4 : Water distribution model (2)

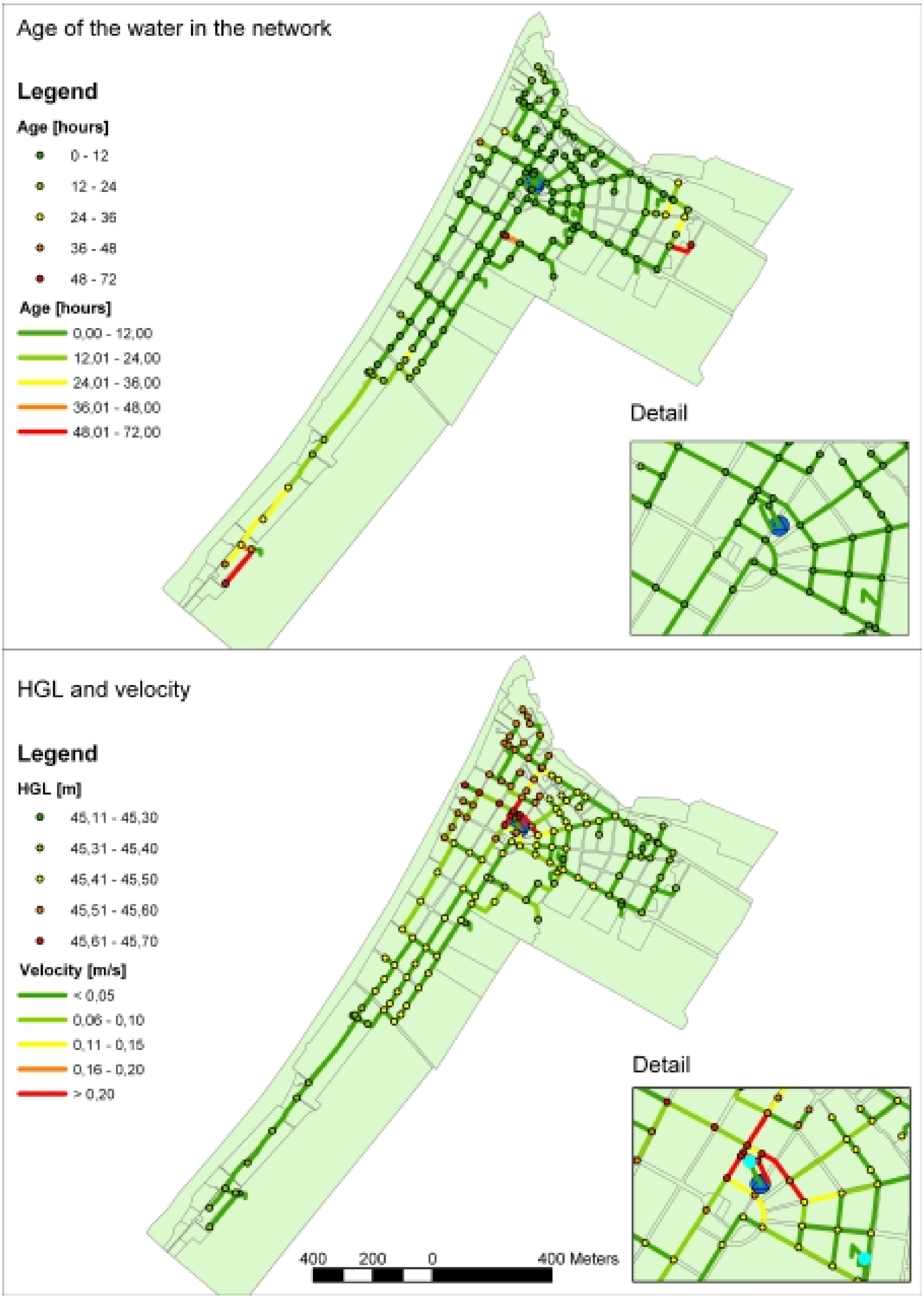
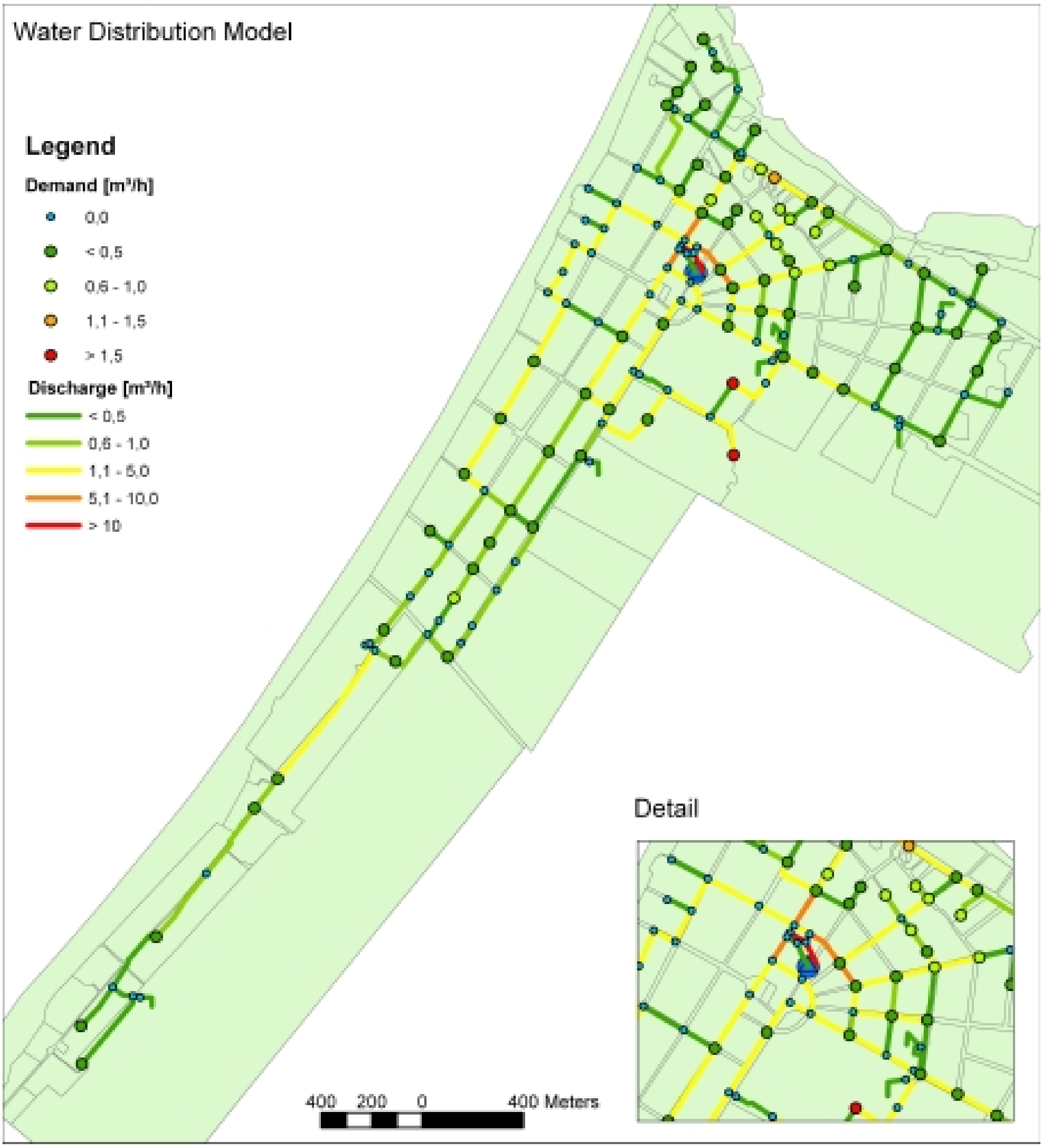


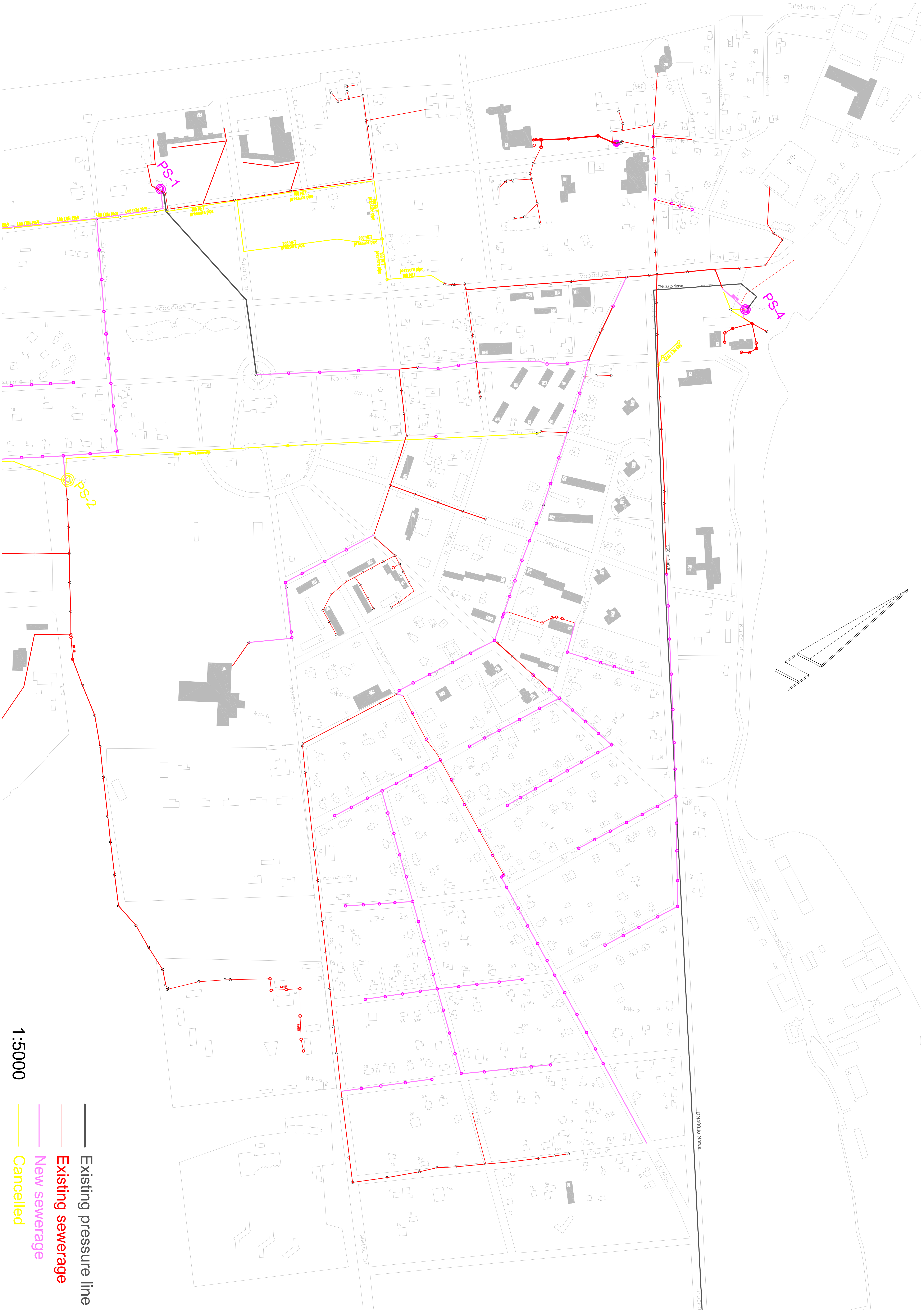
Figure 5 : Water distribution model (3)



Annex VI. Summary of sewerage works

Figure 6 : Central and Upper Household area

See next page



PS-1
PS-2
PS-4
Vabaduse tn
Koidu tn
Rahu tn
Sepa tn
Kalda tn
Linda tn
Tuletorni tn
DN400 to Narva
1:5000
Existing pressure line
Existing sewerage
New sewerage
Cancelled

Figure 7 : Lower Household area

See next page

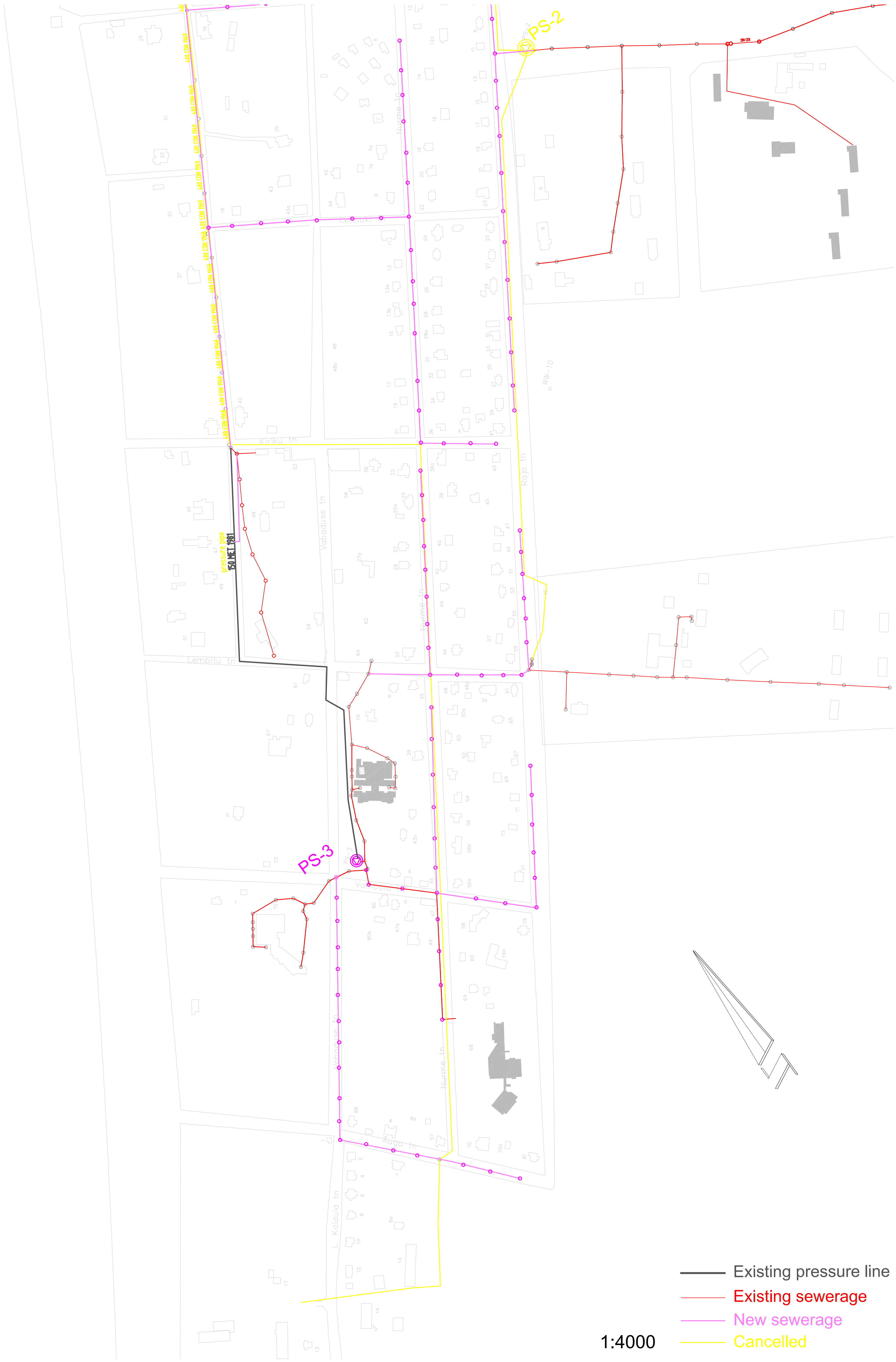
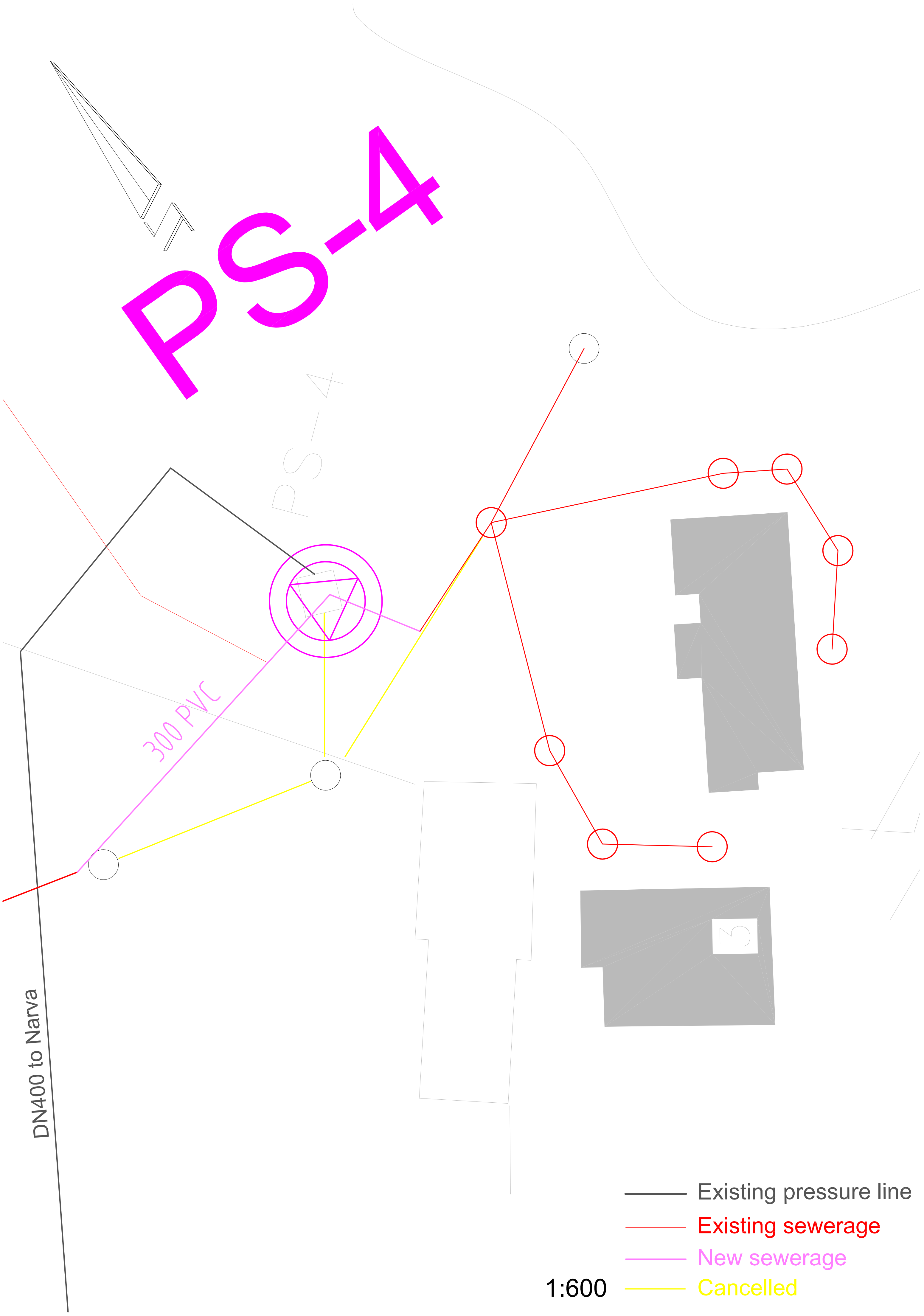

PS-2
PS-3
pressure pipe
150 MET 1981
Existing pressure line
Existing sewerage
New sewerage
Cancelled
1:4000

Figure 8 : Pumping station n°4

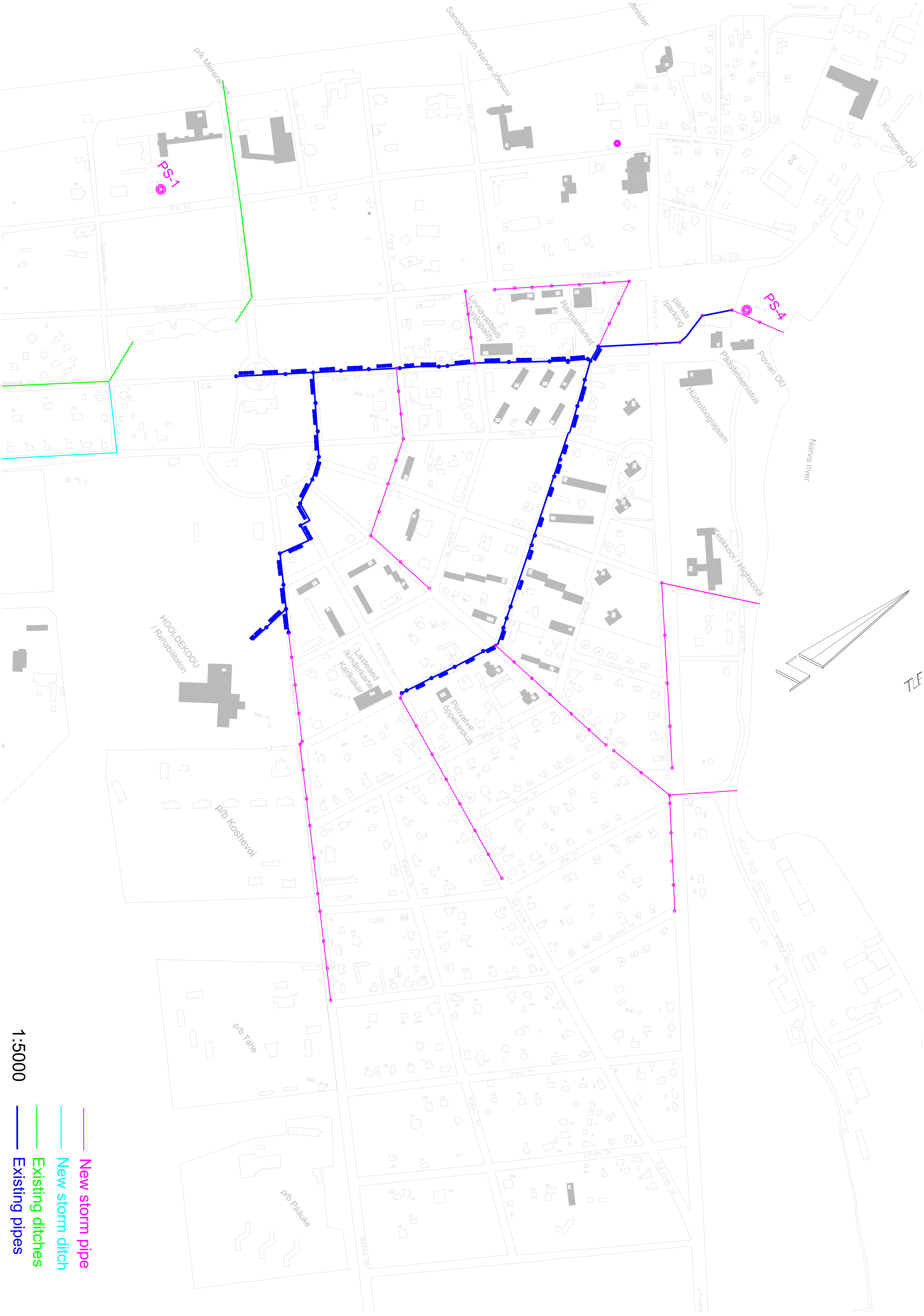
See next page


PS-4
PS-4
300 PVC
3
DN400 to Narva
1:600
Existing pressure line
Existing sewerage
New sewerage
Cancelled

Annex VII. Summary of storm water collection system works

Figure 9 : Central and Upper Household area

See next page



Sanatoorium Narva-Jõesuu
p/k Mereranna
Minister
Tuletorni tn
Kirderand OÜ
PS-1
Aia tn
Vabaduse tn
Linnavalitsus / Municipality
Rannamarket
parkla / parking
PS-4
Povian OÜ
Päästeteenistus
Hüdroloogiajaam
Narva river
Koidu tn
Rahu tn
Sepa tn
Keskkool / Highscool
Lootuse tn
Lasteaed /kinderkarten Karikakar
Piirivalve õppekeskus
HOOLDEKODU / Rehabilitaton
p/b Koshevoi
Õnne tn
Jõe tn
Sulevi tn
Ed.Vilde tn
Olevi tn
Kalevi tn
Linda tn
p/b Tähe
p/b Pääuke
Metsa tn
J.Poska
1:5000
New storm pipe
New storm ditch
Existing ditches
Existing pipes

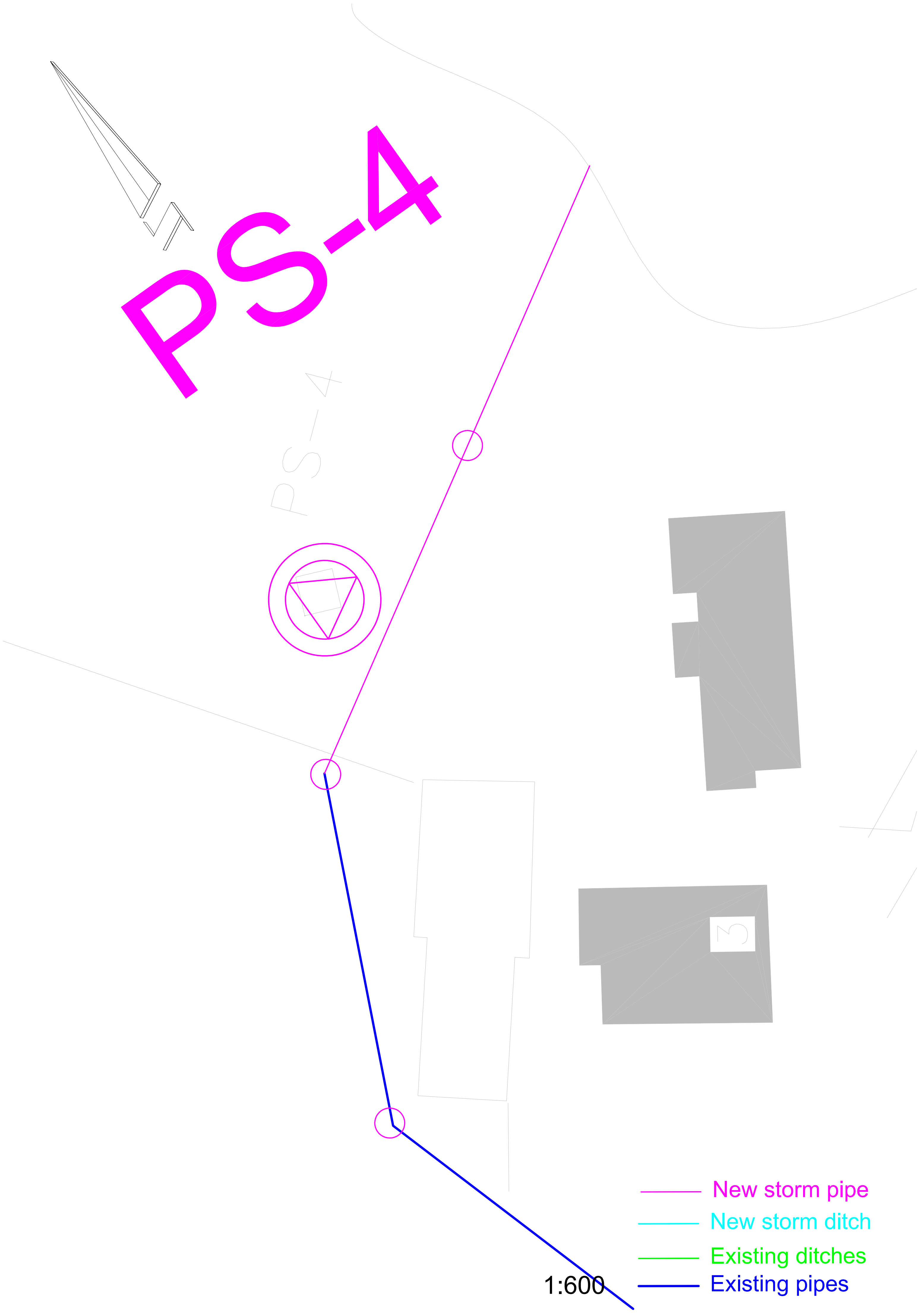
Figure 10 : Lower Household area

See next page

p/b Gagarin
Piirivalve õppekeskus
/ Border Guard Training Centre
p/b Tereshkova
p/k Kajakas
PS-3
p/k Põhjarannik
LASTEKODU
Narva gulf
New storm pipe
New storm ditch
Existing ditches
Existing pipes
1:4000

Figure 11 : Pumping station n°4

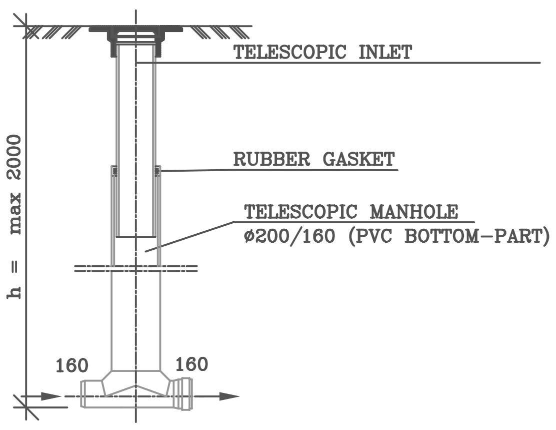
See next page


PS-4
New storm pipe
New storm ditch
Existing ditches
Existing pipes
1:600

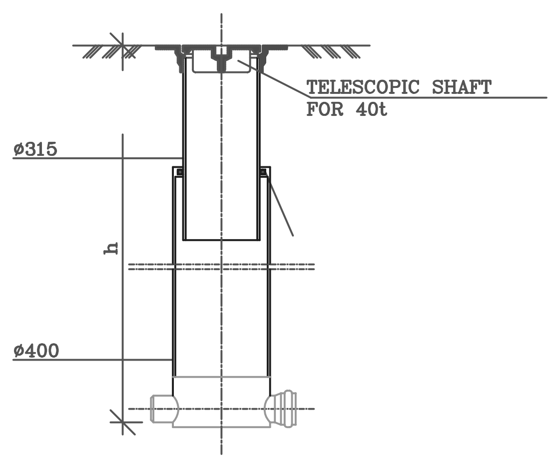
Annex VIII. Typical connections

See next page

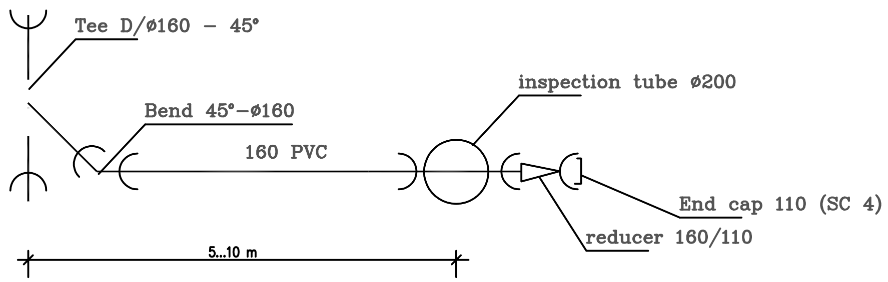
TYPICAL INSPECTION TUBE FOR HOUSE CONNECTION



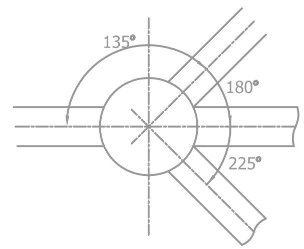
TYPICAL MANHOLE FOR STORM- AND WASTEWATER



TYPICAL SERVICE CONNECTION (WASTEWATER)



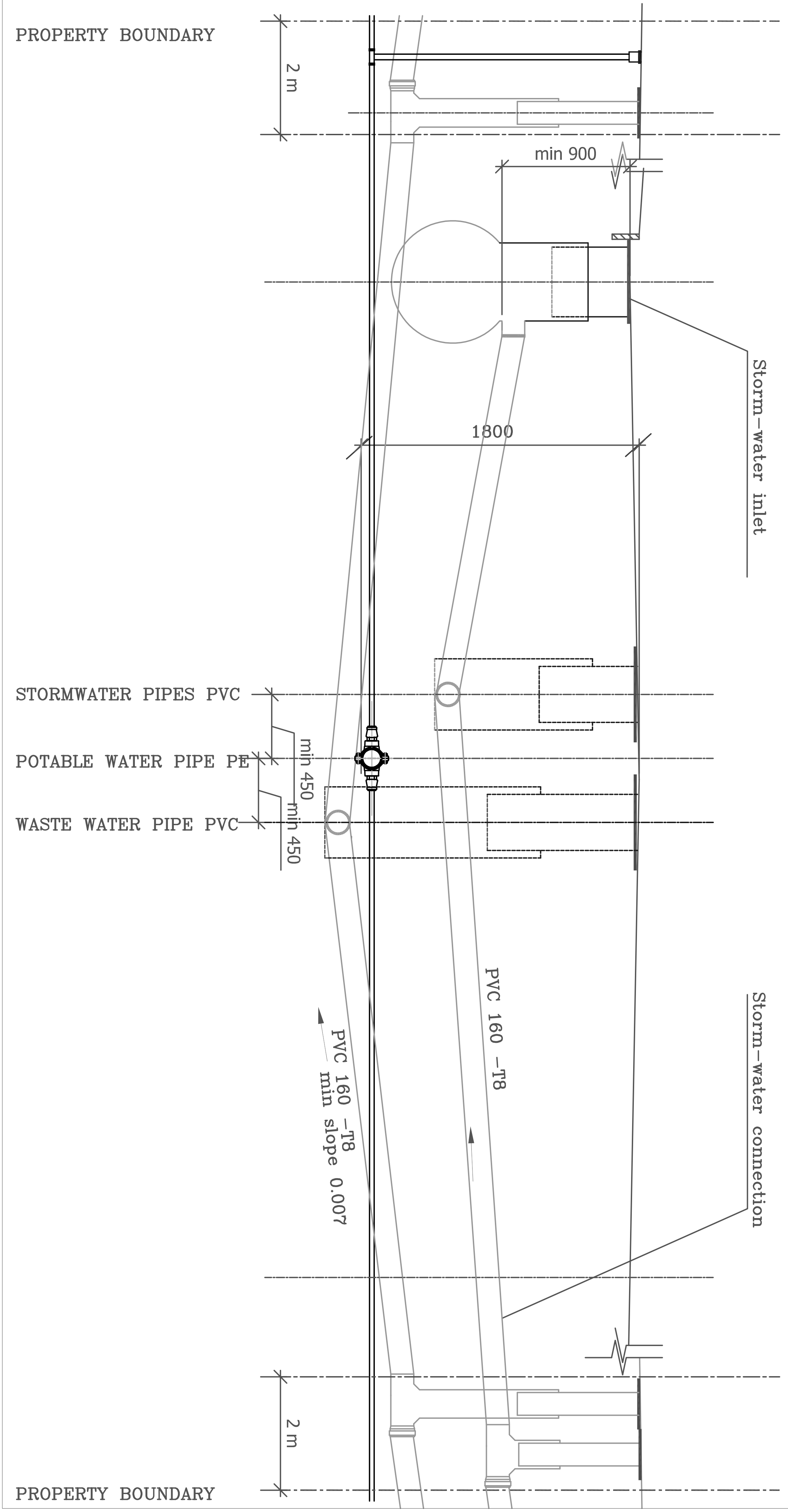
JOINING SCHEME
MANHOLES



Annex IX. Typical cross section

See next page

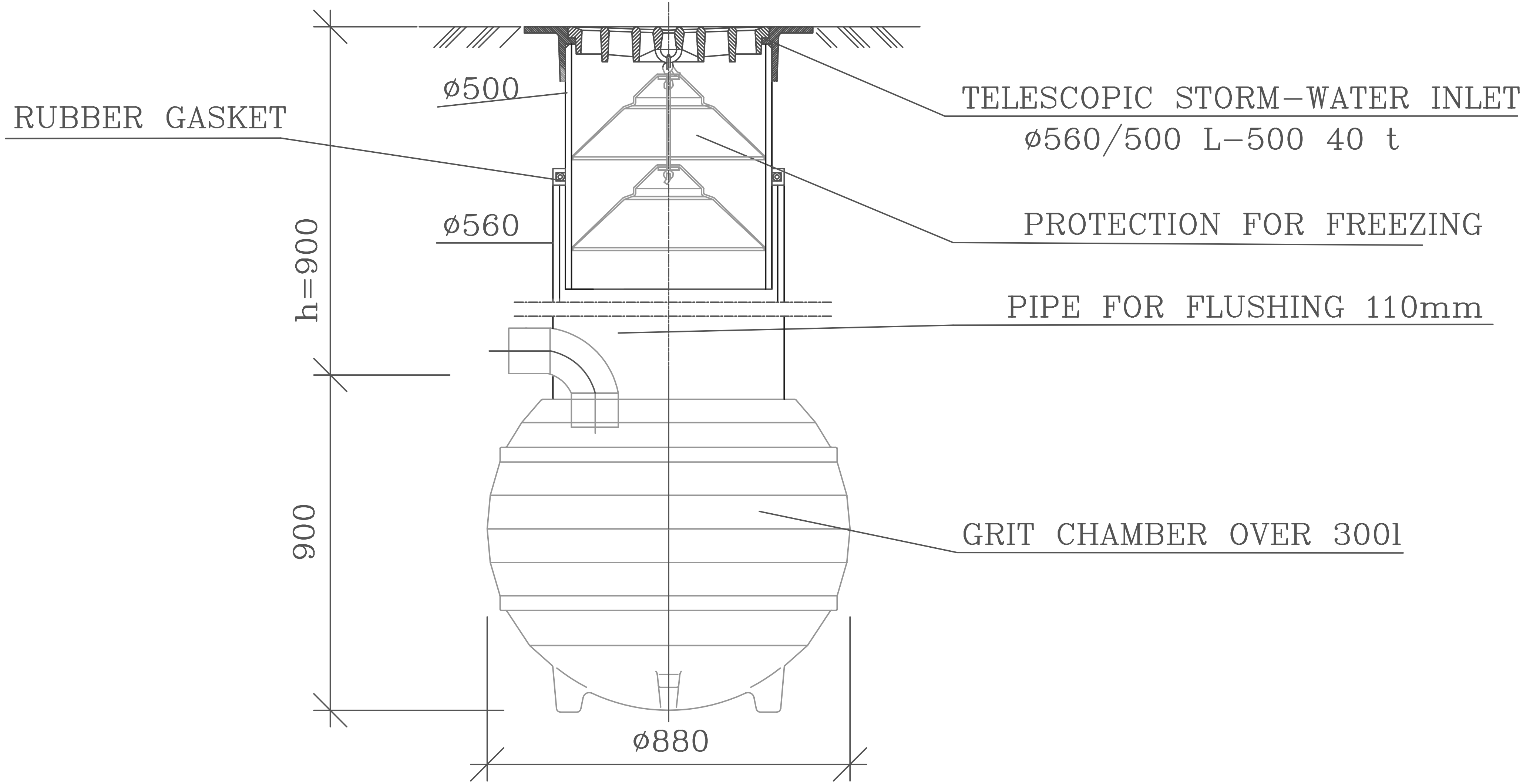
TYPICAL CROSS-SECTION OF STREET WITH PIPES, MANHOLES, STREET INLETS



Annex X. Typical storm inlet

See next page

TYPICAL STORM-WATER INLET



Annex XI. Calculation of residual value in 2030

Description	Total in EEK	Residual %	Residual Value
Well rehabilitation	**400 000**	**0%**	**0**
WS Networks			
Pipelines replacement	10 319 055	80%	8 255 244
Pipelines rehabilitation	5 896 600	80%	4 717 280
Valves	135 000	0%	0
Meters	380 000	0%	0
Total WS Networks	**16 730 655**		**12 972 524**
WS Infrastructures			
Water treatment facility	7 200 000	0%	0
Second booster pump	200 000	0%	0
Storage tank rehabilitation	800 000	0%	0
Total WS Infrastructures	**8 200 000**		**0**
Total WS	**25 330 655**		**12 972 524**
WW Networks			
Sewerage	29 880 051	80%	23 904 041
Storm water collection system	13 655 127	80%	10 924 102
Manholes	1 917 876	80%	1 534 301
Connections	5 620 731	66%	3 709 682
Equipment	2 680 000	0%	0
Total WW Networks	**53 753 785**		**40 072 126**
WW Infrastructures			
Civil works rehabilitation	750 000	0%	0
Automation	687 500	0%	0
Total WW Infrastructures	**1 437 500**		**0**
Total WW	**55 191 285**		**40 072 126**
TOTAL GENERAL	**80 521 940**		**53 044 650**

Annex XII. IRR Calculation, including investment and O&M costs [EEK]

Scenario 1	[EEK/m³]	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020–2030
Water sold [m³]		125 000	130 576	136 151	141 727	147 303	152 878	158 454	164 030	169 605	175 181	180 757	186 332	191 908	197 484	203 059	208 635
Present prices																	
WS Inhabitants (66.67%)	4.36	363 352	379 559	395 766	411 974	428 181	444 389	460 596	476 803	493 011	509 218	525 426	541 633	557 840	574 048	590 255	606 463
WS Companies (33.33%)	6.53	272 056	284 191	296 326	308 462	320 597	332 732	344 867	357 002	369 137	381 273	393 408	405 543	417 678	429 813	441 948	454 083
WW Inhabitants (66.67%)	6.15	512 526	535 387	558 248	581 110	603 971	626 833	649 694	672 555	695 417	718 278	741 139	764 001	786 862	809 724	832 585	855 446
WW Companies (33.33%)	7.92	329 967	344 685	359 404	374 122	388 840	403 558	418 277	432 995	447 713	462 432	477 150	491 868	506 586	521 305	536 023	550 741
Total		1 477 900	1 543 822	1 609 745	1 675 667	1 741 589	1 807 511	1 873 434	1 939 356	2 005 278	2 071 200	2 137 123	2 203 045	2 268 967	2 334 889	2 400 812	2 466 734

Scenario 2	[EEK/m³]	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020–2030
Water sold [m³]		125 000	130 576	136 151	141 727	147 303	152 878	158 454	164 030	169 605	175 181	180 757	186 332	191 908	197 484	203 059	208 635
Present prices x 2.81																	
WS Inhabitants (66.67%)	12.25	1 021 018	1 066 561	1 112 103	1 157 646	1 203 189	1 248 732	1 294 275	1 339 818	1 385 360	1 430 903	1 476 446	1 521 989	1 567 532	1 613 075	1 658 617	1 704 160
WS Companies (33.33%)	18.35	764 478	798 577	832 677	866 777	900 877	934 977	969 076	1 003 176	1 037 276	1 071 376	1 105 476	1 139 575	1 173 675	1 207 775	1 241 875	1 275 974
WW Inhabitants (66.67%)	17.28	1 440 197	1 504 437	1 568 678	1 632 918	1 697 159	1 761 399	1 825 640	1 889 880	1 954 121	2 018 361	2 082 602	2 146 842	2 211 083	2 275 323	2 339 564	2 403 804
WW Companies (33.33%)	22.26	927 207	968 566	1 009 924	1 051 282	1 092 641	1 133 999	1 175 358	1 216 716	1 258 074	1 299 433	1 340 791	1 382 150	1 423 508	1 464 866	1 506 225	1 547 583
Total		4 152 900	4 338 141	4 523 383	4 708 624	4 893 866	5 079 107	5 264 349	5 449 590	5 634 832	5 820 073	6 005 314	6 190 556	6 375 797	6 561 039	6 746 280	6 931 522

Scenario 3	[EEK/m³]	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020–2030
Water sold [m³]		125 000	130 576	136 151	141 727	147 303	152 878	158 454	164 030	169 605	175 181	180 757	186 332	191 908	197 484	203 059	208 635
Present prices x 4.53																	
WS Inhabitants (66.67%)	19.75	1 645 982	1 719 402	1 792 821	1 866 241	1 939 661	2 013 080	2 086 500	2 159 919	2 233 339	2 306 759	2 380 178	2 453 598	2 527 017	2 600 437	2 673 857	2 747 276
WS Companies (33.33%)	29.58	1 232 414	1 287 386	1 342 359	1 397 331	1 452 303	1 507 275	1 562 248	1 617 220	1 672 192	1 727 164	1 782 137	1 837 109	1 892 081	1 947 053	2 002 026	2 056 998
WW Inhabitants (66.67%)	27.86	2 321 741	2 425 303	2 528 865	2 632 427	2 735 989	2 839 551	2 943 113	3 046 675	3 150 237	3 253 799	3 357 361	3 460 923	3 564 485	3 668 048	3 771 610	3 875 172
WW Companies (33.33%)	35.88	1 494 751	1 561 424	1 628 098	1 694 772	1 761 446	1 828 120	1 894 794	1 961 467	2 028 141	2 094 815	2 161 489	2 228 163	2 294 837	2 361 510	2 428 184	2 494 858
Total		6 694 888	6 993 516	7 292 144	7 590 771	7 889 399	8 188 027	8 486 654	8 785 282	9 083 910	9 382 538	9 681 165	9 979 793	10 278 421	10 577 048	10 875 676	11 174 304

IRR Scenario 1	#DIV/0!																
	Total costs	7 338 361	14 433 101	20 979 899	14 149 504	13 327 895	5 146 381	4 579 090	4 490 059	4 398 529	4 306 998	27 251 918	10 363 741	3 898 546	3 807 016	3 715 485	3 623 954
	Total revenues	1 477 900	1 543 822	1 609 745	1 675 667	1 741 589	1 807 511	1 873 434	1 939 356	2 005 278	2 071 200	2 137 123	2 203 045	2 268 967	2 334 889	2 400 812	2 466 734
	Net cash flow	-5 860 461	-12 889 279	-19 370 155	-12 473 837	-11 586 305	-3 338 869	-2 705 657	-2 550 704	-2 393 250	-2 235 797	-25 114 796	-8 160 696	-1 629 579	-1 472 126	-1 314 673	-1 157 220

IRR Scenario 2	2.5%																
	Total costs	7 338 361	14 433 101	20 979 899	14 149 504	13 327 895	5 146 381	4 579 090	4 490 059	4 398 529	4 306 998	27 251 918	10 363 741	3 898 546	3 807 016	3 715 485	3 623 954
	Total revenues	4 152 900	4 338 141	4 523 383	4 708 624	4 893 866	5 079 107	5 264 349	5 449 590	5 634 832	5 820 073	6 005 314	6 190 556	6 375 797	6 561 039	6 746 280	6 931 522
	Net cash flow	-3 185 461	-10 094 960	-16 456 517	-9 440 880	-8 434 029	-67 274	685 258	959 531	1 236 303	1 513 075	-21 246 604	-4 173 185	2 477 251	2 754 023	3 030 796	3 307 568

IRR Scenario 3	10.0%																
	Total costs	7 338 361	14 433 101	20 979 899	14 149 504	13 327 895	5 146 381	4 579 090	4 490 059	4 398 529	4 306 998	27 251 918	10 363 741	3 898 546	3 807 016	3 715 485	3 623 954
	Total revenues	6 694 888	6 993 516	7 292 144	7 590 771	7 889 399	8 188 027	8 486 654	8 785 282	9 083 910	9 382 538	9 681 165	9 979 793	10 278 421	10 577 048	10 875 676	11 174 304
	Net cash flow	-643 473	-7 439 585	-13 687 756	-6 558 733	-5 438 496	3 041 646	3 907 564	4 295 223	4 685 381	5 075 540	-17 570 753	-383 948	6 379 874	6 770 033	7 160 192	7 550 350

Annex XIII. IRR Calculation, including O&M costs only [EEK]

Scenario 4	[EEK/m³]	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020–2030
Water sold [m³]		125 000	130 576	136 151	141 727	147 303	152 878	158 454	164 030	169 605	175 181	180 757	186 332	191 908	197 484	203 059	208 635
Present prices																	
WS Inhabitants (66.67%)	4.36	363 352	379 559	395 766	411 974	428 181	444 389	460 596	476 803	493 011	509 218	525 426	541 633	557 840	574 048	590 255	606 463
WS Companies (33.33%)	6.53	272 056	284 191	296 326	308 462	320 597	332 732	344 867	357 002	369 137	381 273	393 408	405 543	417 678	429 813	441 948	454 083
WW Inhabitants (66.67%)	6.15	512 526	535 387	558 248	581 110	603 971	626 833	649 694	672 555	695 417	718 278	741 139	764 001	786 862	809 724	832 585	855 446
WW Companies (33.33%)	7.92	329 967	344 685	359 404	374 122	388 840	403 558	418 277	432 995	447 713	462 432	477 150	491 868	506 586	521 305	536 023	550 741
Total		1 477 900	1 543 822	1 609 745	1 675 667	1 741 589	1 807 511	1 873 434	1 939 356	2 005 278	2 071 200	2 137 123	2 203 045	2 268 967	2 334 889	2 400 812	2 466 734

Scenario 5	[EEK/m³]	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020–2030
Water sold [m³]		125 000	130 576	136 151	141 727	147 303	152 878	158 454	164 030	169 605	175 181	180 757	186 332	191 908	197 484	203 059	208 635
Present prices x 1.24																	
WS Inhabitants (66.67%)	5.41	450 556	470 653	490 750	510 847	530 945	551 042	571 139	591 236	611 333	631 431	651 528	671 625	691 722	711 819	731 917	752 014
WS Companies (33.33%)	8.10	337 350	352 397	367 445	382 492	397 540	412 588	427 635	442 683	457 730	472 778	487 826	502 873	517 921	532 968	548 016	563 063
WW Inhabitants (66.67%)	7.63	635 532	663 880	692 228	720 576	748 924	777 272	805 620	833 969	862 317	890 665	919 013	947 361	975 709	1 004 057	1 032 405	1 060 753
WW Companies (33.33%)	9.82	409 159	427 410	445 660	463 911	482 162	500 412	518 663	536 914	555 164	573 415	591 666	609 917	628 167	646 418	664 669	682 919
Total		1 832 596	1 914 340	1 996 083	2 077 827	2 159 571	2 241 314	2 323 058	2 404 801	2 486 545	2 568 288	2 650 032	2 731 776	2 813 519	2 895 263	2 977 006	3 058 750

Scenario 6	[EEK/m³]	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020–2030
Water sold [m³]		125 000	130 576	136 151	141 727	147 303	152 878	158 454	164 030	169 605	175 181	180 757	186 332	191 908	197 484	203 059	208 635
Present prices x 1.495																	
WS Inhabitants (66.67%)	6.52	543 210	567 441	591 671	615 901	640 131	664 361	688 591	712 821	737 051	761 281	785 511	809 741	833 972	858 202	882 432	906 662
WS Companies (33.33%)	9.76	406 724	424 866	443 008	461 150	479 292	497 434	515 576	533 718	551 860	570 002	588 144	606 287	624 429	642 571	660 713	678 855
WW Inhabitants (66.67%)	9.19	766 226	800 404	834 581	868 759	902 937	937 115	971 292	1 005 470	1 039 648	1 073 826	1 108 003	1 142 181	1 176 359	1 210 537	1 244 714	1 278 892
WW Companies (33.33%)	11.84	493 301	515 305	537 308	559 312	581 316	603 320	625 324	647 328	669 331	691 335	713 339	735 343	757 347	779 351	801 354	823 358
Total		2 209 461	2 308 015	2 406 568	2 505 122	2 603 676	2 702 230	2 800 783	2 899 337	2 997 891	3 096 445	3 194 998	3 293 552	3 392 106	3 490 659	3 589 213	3 687 767

RRI Scenario 4	#DIV/0!																
	O&M cost only	3 503 761	3 429 989	3 356 217	3 304 682	3 295 643	3 201 612	3 107 581	3 018 550	2 927 019	2 835 488	2 749 269	2 518 568	2 427 037	2 335 506	2 243 975	2 152 444
	Total revenues	1 477 900	1 543 822	1 609 745	1 675 667	1 741 589	1 807 511	1 873 434	1 939 356	2 005 278	2 071 200	2 137 123	2 203 045	2 268 967	2 334 889	2 400 812	2 466 734
	Net cash flow	-2 025 861	-1 886 167	-1 746 473	-1 629 015	-1 554 053	-1 394 100	-1 234 147	-1 079 194	-921 741	-764 288	-612 146	-315 523	-158 070	-617	156 837	314 290
RRI Scenario 5	**2.5%**																
	O&M cost only	3 503 761	3 429 989	3 356 217	3 304 682	3 295 643	3 201 612	3 107 581	3 018 550	2 927 019	2 835 488	2 749 269	2 518 568	2 427 037	2 335 506	2 243 975	2 152 444
	Total revenues	1 832 596	1 914 340	1 996 083	2 077 827	2 159 571	2 241 314	2 323 058	2 404 801	2 486 545	2 568 288	2 650 032	2 731 776	2 813 519	2 895 263	2 977 006	3 058 750
	Net cash flow	-1 671 165	-1 515 649	-1 360 134	-1 226 855	-1 136 072	-960 298	-784 523	-613 749	-440 474	-267 200	-99 237	213 208	386 482	559 757	733 031	906 306
RRI Scenario 6	**10.0%**																
	O&M cost only	3 503 761	3 429 989	3 356 217	3 304 682	3 295 643	3 201 612	3 107 581	3 018 550	2 927 019	2 835 488	2 749 269	2 518 568	2 427 037	2 335 506	2 243 975	2 152 444
	Total revenues	2 209 461	2 308 015	2 406 568	2 505 122	2 603 676	2 702 230	2 800 783	2 899 337	2 997 891	3 096 445	3 194 998	3 293 552	3 392 106	3 490 659	3 589 213	3 687 767
	Net cash flow	-1 294 300	-1 121 975	-949 649	-799 560	-691 967	-499 382	-306 797	-119 213	70 872	260 957	445 729	774 984	965 069	1 155 154	1 345 238	1 535 323

Annex XIV. Sensibility Analyses

SCENARIO n° 5	Year n°1	Year n°2	Year n°3	Year n°4	Year n°5	Year n°6	Year n°7	Year n°8	Year n°9	Year n°10	Year n°11	Year n°12	Year n°13	Year n°14	Year n°15	After
Additional Revenues	2 209 461	2 308 015	2 406 568	2 505 122	2 603 676	2 702 230	2 800 783	2 899 337	2 997 891	3 096 445	3 194 998	3 293 552	3 392 106	3 490 659	3 589 213	3 687 767
Additional Expenses	3 503 761	3 429 989	3 356 217	3 304 682	3 295 643	3 201 612	3 107 581	3 018 550	2 927 019	2 835 488	2 749 269	2 518 568	2 427 037	2 335 506	2 243 975	2 152 444
Total Investments																
Total Add. Expenses	3 503 761	3 429 989	3 356 217	3 304 682	3 295 643	3 201 612	3 107 581	3 018 550	2 927 019	2 835 488	2 749 269	2 518 568	2 427 037	2 335 506	2 243 975	2 152 444

	Year n°1	Year n°2	Year n°3	Year n°4	Year n°5	Year n°6	Year n°7	Year n°8	Year n°9	Year n°10	Year n°11	Year n°12	Year n°13	Year n°14	Year n°15	After
Flux1	-1 423 730	-1 234 172	-1 044 614	-879 516	-761 163	-549 320	-337 477	-131 134	77 959	287 052	490 302	852 483	1 061 576	1 270 669	1 479 762	1 688 855
Flux2	-1 534 203	-1 349 573	-1 164 942	-1 004 772	-891 347	-684 432	-477 516	-276 101	-71 935	132 230	330 552	687 805	891 971	1 096 136	1 300 301	1 688 855
Flux3	-1 644 676	-1 464 974	-1 285 271	-1 130 028	-1 021 531	-819 543	-617 556	-421 068	-221 830	-22 592	170 802	523 127	722 365	921 603	1 120 841	1 320 078
Flux4	-1 755 149	-1 580 374	-1 405 599	-1 255 284	-1 151 715	-954 655	-757 595	-566 035	-371 725	-177 415	11 052	358 450	552 760	747 070	941 380	1 135 690
Flux5	-1 865 622	-1 695 775	-1 525 928	-1 380 541	-1 281 899	-1 089 766	-897 634	-711 001	-521 619	-332 237	-148 698	193 772	383 155	572 537	761 919	951 302
Flux6	-1 248 542	-1 062 673	-876 803	-714 282	-596 381	-389 240	-182 098	19 793	224 310	428 827	627 766	978 411	1 182 928	1 387 444	1 591 961	1 796 477
Flux7	-1 359 015	-1 178 073	-997 132	-839 538	-726 565	-524 351	-322 137	-125 173	74 415	274 004	468 016	813 733	1 013 322	1 212 911	1 412 500	1 612 089
Flux8	-1 469 488	-1 293 474	-1 117 460	-964 794	-856 749	-659 463	-462 176	-270 140	-75 479	119 182	308 266	649 056	843 717	1 038 378	1 233 039	1 427 701
Flux9	-1 579 961	-1 408 875	-1 237 788	-1 090 050	-986 933	-794 574	-602 216	-415 107	-225 374	-35 640	148 516	484 378	674 112	863 845	1 053 579	1 243 312
Flux10	-1 690 434	-1 524 276	-1 358 117	-1 215 306	-1 117 116	-929 686	-742 255	-560 074	-375 268	-190 462	-11 234	319 701	504 506	689 312	874 118	1 058 924
Flux11	-1 073 354	-891 173	-708 992	-549 048	-431 599	-229 159	-26 719	170 721	370 661	570 601	765 229	1 104 339	1 304 279	1 504 219	1 704 160	1 904 100
Flux12	-1 183 827	-1 006 574	-829 321	-674 304	-561 783	-364 271	-166 758	25 754	220 766	415 779	605 479	939 662	1 134 674	1 329 687	1 524 699	1 719 711
Flux13	-1 294 300	-1 121 975	-949 649	-799 560	-691 967	-499 382	-306 797	-119 213	70 872	260 957	445 729	774 984	965 069	1 155 154	1 345 238	1 535 323
Flux14	-1 404 773	-1 237 375	-1 069 978	-924 816	-822 151	-634 494	-446 837	-264 180	-79 023	106 134	285 979	610 307	795 464	980 621	1 165 778	1 350 935
Flux15	-1 515 246	-1 352 776	-1 190 306	-1 050 072	-952 334	-769 605	-586 876	-409 146	-228 917	-48 688	126 229	445 629	625 858	806 088	986 317	1 166 546
Flux16	-898 166	-719 674	-541 181	-383 814	-266 817	-69 079	128 660	321 648	517 012	712 375	902 692	1 230 268	1 425 631	1 620 995	1 816 358	2 011 722
Flux17	-1 008 639	-835 074	-661 510	-509 070	-397 001	-204 190	-11 379	176 682	367 117	557 553	742 943	1 065 590	1 256 026	1 446 462	1 636 898	1 827 333
Flux18	-1 119 112	-950 475	-781 838	-634 326	-527 185	-339 302	-151 418	31 715	217 223	402 731	583 193	900 913	1 086 421	1 271 929	1 457 437	1 642 945
Flux19	-1 229 585	-1 065 876	-902 167	-759 582	-657 368	-474 413	-291 458	-113 252	67 328	247 909	423 443	736 235	916 815	1 097 396	1 277 976	1 458 557
Flux20	-1 340 058	-1 181 277	-1 022 495	-884 838	-787 552	-609 524	-431 497	-258 219	-82 566	93 086	263 693	571 557	747 210	922 863	1 098 516	1 274 168
Flux21	-722 978	-548 174	-373 371	-218 580	-102 035	91 002	284 039	472 576	663 363	854 150	1 040 156	1 356 196	1 546 983	1 737 770	1 928 557	2 119 344
Flux22	-833 451	-663 575	-493 699	-343 836	-232 219	-44 109	144 000	327 609	513 468	699 328	880 406	1 191 519	1 377 378	1 563 237	1 749 096	1 934 956
Flux23	-943 924	-778 976	-614 027	-469 092	-362 402	-179 221	3 961	182 642	363 574	544 505	720 656	1 026 841	1 207 773	1 388 704	1 569 636	1 750 567
Flux24	-1 054 397	-894 376	-734 356	-594 348	-492 586	-314 332	-136 079	37 675	213 679	389 683	560 906	862 163	1 038 167	1 214 171	1 390 175	1 566 179
Flux25	-1 164 870	-1 009 777	-854 684	-719 604	-622 770	-449 444	-276 118	-107 292	63 785	234 861	401 156	697 486	868 562	1 039 638	1 210 714	1 381 791

Short Term Investment Programme

SCENARIO n° 6	Year n°1	Year n°2	Year n°3	Year n°4	Year n°5	Year n°6	Year n°7	Year n°8	Year n°9	Year n°10	Year n°11	Year n°12	Year n°13	Year n°14	Year n°15	After
Additional Revenues	2 209 461	2 308 015	2 406 568	2 505 122	2 603 676	2 702 230	2 800 783	2 899 337	2 997 891	3 096 445	3 194 998	3 293 552	3 392 106	3 490 659	3 589 213	3 687 767
Additional Expenses	3 503 761	3 429 989	3 356 217	3 304 682	3 295 643	3 201 612	3 107 581	3 018 550	2 927 019	2 835 488	2 749 269	2 518 568	2 427 037	2 335 506	2 243 975	2 152 444
Total Investments																
Total Add. Expenses	3 503 761	3 429 989	3 356 217	3 304 682	3 295 643	3 201 612	3 107 581	3 018 550	2 927 019	2 835 488	2 749 269	2 518 568	2 427 037	2 335 506	2 243 975	2 152 444

	Year n°1	Year n°2	Year n°3	Year n°4	Year n°5	Year n°6	Year n°7	Year n°8	Year n°9	Year n°10	Year n°11	Year n°12	Year n°13	Year n°14	Year n°15	After
Flux1	-1 423 730	-1 234 172	-1 044 614	-879 516	-761 163	-549 320	-337 477	-131 134	77 959	287 052	490 302	852 483	1 061 576	1 270 669	1 479 762	1 688 855
Flux2	-1 534 203	-1 349 573	-1 164 942	-1 004 772	-891 347	-684 432	-477 516	-276 101	-71 935	132 230	330 552	687 805	891 971	1 096 136	1 300 301	1 688 855
Flux3	-1 644 676	-1 464 974	-1 285 271	-1 130 028	-1 021 531	-819 543	-617 556	-421 068	-221 830	-22 592	170 802	523 127	722 365	921 603	1 120 841	1 320 078
Flux4	-1 755 149	-1 580 374	-1 405 599	-1 255 284	-1 151 715	-954 655	-757 595	-566 035	-371 725	-177 415	11 052	358 450	552 760	747 070	941 380	1 135 690
Flux5	-1 865 622	-1 695 775	-1 525 928	-1 380 541	-1 281 899	-1 089 766	-897 634	-711 001	-521 619	-332 237	-148 698	193 772	383 155	572 537	761 919	951 302
Flux6	-1 248 542	-1 062 673	-876 803	-714 282	-596 381	-389 240	-182 098	19 793	224 310	428 827	627 766	978 411	1 182 928	1 387 444	1 591 961	1 796 477
Flux7	-1 359 015	-1 178 073	-997 132	-839 538	-726 565	-524 351	-322 137	-125 173	74 415	274 004	468 016	813 733	1 013 322	1 212 911	1 412 500	1 612 089
Flux8	-1 469 488	-1 293 474	-1 117 460	-964 794	-856 749	-659 463	-462 176	-270 140	-75 479	119 182	308 266	649 056	843 717	1 038 378	1 233 039	1 427 701
Flux9	-1 579 961	-1 408 875	-1 237 788	-1 090 050	-986 933	-794 574	-602 216	-415 107	-225 374	-35 640	148 516	484 378	674 112	863 845	1 053 579	1 243 312
Flux10	-1 690 434	-1 524 276	-1 358 117	-1 215 306	-1 117 116	-929 686	-742 255	-560 074	-375 268	-190 462	-11 234	319 701	504 506	689 312	874 118	1 058 924
Flux11	-1 073 354	-891 173	-708 992	-549 048	-431 599	-229 159	-26 719	170 721	370 661	570 601	765 229	1 104 339	1 304 279	1 504 219	1 704 160	1 904 100
Flux12	-1 183 827	-1 006 574	-829 321	-674 304	-561 783	-364 271	-166 758	25 754	220 766	415 779	605 479	939 662	1 134 674	1 329 687	1 524 699	1 719 711
Flux13	-1 294 300	-1 121 975	-949 649	-799 560	-691 967	-499 382	-306 797	-119 213	70 872	260 957	445 729	774 984	965 069	1 155 154	1 345 238	1 535 323
Flux14	-1 404 773	-1 237 375	-1 069 978	-924 816	-822 151	-634 494	-446 837	-264 180	-79 023	106 134	285 979	610 307	795 464	980 621	1 165 778	1 350 935
Flux15	-1 515 246	-1 352 776	-1 190 306	-1 050 072	-952 334	-769 605	-586 876	-409 146	-228 917	-48 688	126 229	445 629	625 858	806 088	986 317	1 166 546
Flux16	-898 166	-719 674	-541 181	-383 814	-266 817	-69 079	128 660	321 648	517 012	712 375	902 692	1 230 268	1 425 631	1 620 995	1 816 358	2 011 722
Flux17	-1 008 639	-835 074	-661 510	-509 070	-397 001	-204 190	-11 379	176 682	367 117	557 553	742 943	1 065 590	1 256 026	1 446 462	1 636 898	1 827 333
Flux18	-1 119 112	-950 475	-781 838	-634 326	-527 185	-339 302	-151 418	31 715	217 223	402 731	583 193	900 913	1 086 421	1 271 929	1 457 437	1 642 945
Flux19	-1 229 585	-1 065 876	-902 167	-759 582	-657 368	-474 413	-291 458	-113 252	67 328	247 909	423 443	736 235	916 815	1 097 396	1 277 976	1 458 557
Flux20	-1 340 058	-1 181 277	-1 022 495	-884 838	-787 552	-609 524	-431 497	-258 219	-82 566	93 086	263 693	571 557	747 210	922 863	1 098 516	1 274 168
Flux21	-722 978	-548 174	-373 371	-218 580	-102 035	91 002	284 039	472 576	663 363	854 150	1 040 156	1 356 196	1 546 983	1 737 770	1 928 557	2 119 344
Flux22	-833 451	-663 575	-493 699	-343 836	-232 219	-44 109	144 000	327 609	513 468	699 328	880 406	1 191 519	1 377 378	1 563 237	1 749 096	1 934 956
Flux23	-943 924	-778 976	-614 027	-469 092	-362 402	-179 221	3 961	182 642	363 574	544 505	720 656	1 026 841	1 207 773	1 388 704	1 569 636	1 750 567
Flux24	-1 054 397	-894 376	-734 356	-594 348	-492 586	-314 332	-136 079	37 675	213 679	389 683	560 906	862 163	1 038 167	1 214 171	1 390 175	1 566 179
Flux25	-1 164 870	-1 009 777	-854 684	-719 604	-622 770	-449 444	-276 118	-107 292	63 785	234 861	401 156	697 486	868 562	1 039 638	1 210 714	1 381 791

Annex XV. Cash flows scenarios

in EEK	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
Year n°1	-5 860 461	-3 185 461	-643 473	-2 025 861	-1 671 165	-1 294 300
Year n°2	-12 889 279	-10 094 960	-7 439 585	-1 886 167	-1 515 649	-1 121 975
Year n°3	-19 370 155	-16 456 517	-13 687 756	-1 746 473	-1 360 134	-949 649
Year n°4	-12 473 837	-9 440 880	-6 558 733	-1 629 015	-1 226 855	-799 560
Year n°5	-11 586 305	-8 434 029	-5 438 496	-1 554 053	-1 136 072	-691 967
Year n°6	-3 338 869	-67 274	3 041 646	-1 394 100	-960 298	-499 382
Year n°7	-2 705 657	685 258	3 907 564	-1 234 147	-784 523	-306 797
Year n°8	-2 550 704	959 531	4 295 223	-1 079 194	-613 749	-119 213
Year n°9	-2 393 250	1 236 303	4 685 381	-921 741	-440 474	**70 872**
Year n°10	-2 235 797	1 513 075	5 075 540	-764 288	-267 200	260 957
Year n°11	-25 114 796	-21 246 604	-17 570 753	-612 146	-99 237	445 729
Year n°12	-8 160 696	-4 173 185	-383 948	-315 523	**213 208**	774 984
Year n°13	-1 629 579	**2 477 251**	**6 379 874**	-158 070	386 482	965 069
Year n°14	-1 472 126	2 754 023	6 770 033	-617	559 757	1 155 154
Year n°15	-1 314 673	3 030 796	7 160 192	**156 837**	733 031	1 345 238
Year n°16	-1 157 220	3 307 568	7 550 350	314 290	906 306	1 535 323
Year n°17	-1 157 220	3 307 568	7 550 350	314 290	906 306	1 535 323
Year n°18	-1 157 220	3 307 568	7 550 350	314 290	906 306	1 535 323
Year n°19	-1 157 220	3 307 568	7 550 350	314 290	906 306	1 535 323
Year n°20	-1 157 220	3 307 568	7 550 350	314 290	906 306	1 535 323
Year n°21	-1 157 220	3 307 568	7 550 350	314 290	906 306	1 535 323
Year n°22	-1 157 220	3 307 568	7 550 350	314 290	906 306	1 535 323
Year n°23	-1 157 220	3 307 568	7 550 350	314 290	906 306	1 535 323
Year n°24	-1 157 220	3 307 568	7 550 350	314 290	906 306	1 535 323
Year n°25	-1 157 220	3 307 568	7 550 350	314 290	906 306	1 535 323
Year n°26	-1 157 220	3 307 568	7 550 350	314 290	906 306	1 535 323
Year n°27	-1 157 220	3 307 568	7 550 350	314 290	906 306	1 535 323
Year n°28	-1 157 220	3 307 568	7 550 350	314 290	906 306	1 535 323
Year n°29	-1 157 220	3 307 568	7 550 350	314 290	906 306	1 535 323
Year n°30	-1 157 220	3 307 568	-3 623 954	314 290	906 306	1 535 323
Cumulated cash flows	-130 454 484	-10 829 151	91 673 658	-10 450 213	5 411 710	22 265 002