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Environmental Policy and Technology Project

For the New Independent States
of the former Soviet Union

Prepared for
Bureau for Europe and the New Independent States
U.S. Agency for International Development

By
A USAID Project Consortium Led by CH2M HILL

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UKRAINE

Summary Report on Lviv Vodokanal Workshop 5

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Prepared by
Ukraine, Belarus & Moldova Regional Office
Environmental Policy and Technology Project
A USAID Project Consortium Led by CH2M HILL

PREFACE

Under the 1992 Freedom Support Act the United States Congress initiated a program to provide various forms of assistance to new independent states (NIS) of the former Soviet Union Cooperative Agreements were signed between representatives of the U S government and each country in which assistance was to be undertaken The U S Agency for International Development (USAID) was given the responsibility to coordinate all U S government assistance to the NIS under the Act

Through competitive bidding, USAID awarded a multi year contract to a team managed by CH2M HILL International Services Inc (CH2M HILL) to support implementation of an environmental assistance program to republics of the former Soviet Union Under this contract, termed the Environmental Policy & Technology (EPT) Project, CH2M HILL is to assist USAID's missions in Moscow Kyiv and Almaty undertake a program to promote environmental improvements in the NIS The USAID mission in Kyiv supports environmental, and other assistance programs to Ukraine, Belarus, and Moldova CH2M HILL established an office in Kyiv from which to perform services in these countries under the EPT Project

This report was prepared as a contractually required deliverable under a contract between USAID and CH2M HILL Although work on this report was conducted in cooperation with the assisted governments and USAID, the findings and recommendations are those of the CH2M HILL team They do not necessarily represent official positions of the governments of the assisted countries nor of the United States of America

The CH2M HILL team includes the following organizations

- Center for International Environmental Law
- Clark Atlanta University/HBCUMI Environmental Consortium
- Consortium for International Development
- Ecojuris
- Environmental Compliance Inc
- Harvard Institute for International Development
- Hughes Technical Services Company
- International Programs Consortium
- International Resources Group, Ltd
- Interfax Newsagency
- K&M Engineering
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- Price Waterhouse
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NOTIFICATIONS

NOTE ON TRANSLITERATION

Ukrainian personal, institutional and place names used in EPT documents are transliterated into English from Ukrainian (not Russian), according to the modified U S Library of Congress standard for Ukrainian-to-English transliteration that has been adopted by many Western organizations and publications, including the *Encyclopedia of Ukraine* (University of Toronto Press, 5 vols, 1984-1993) and O Subtelny's authoritative *Ukraine A History* (University of Toronto Press, 1988, 2nd edition 1994), as well as by the Ukrainian Commission on Legal Terminology (Resolution No 9 dated 19 April, 1996)

NOTE ON COST ESTIMATES

The opinions of cost shown, and any resulting conclusions on project financial or economic feasibility or funding requirements, have been prepared for guidance in project evaluation and implementation from the information available at the time the opinion was prepared The final costs of the project and resulting feasibility will depend on actual labor and material costs, competitive market conditions, actual site conditions, final project scope, implementation schedule, continuity of personnel and engineering, and other variable factors As a result the final project costs may vary from the opinions of cost presented herein

TABLE OF CONTENTS

LIST OF TABLES

ABBREVIATIONS, ACRONYMS & GLOSSARY

CH2M HILL	CH2M HILL International Services, Inc A U S -based international environmental engineering consulting firm under contract to USAID to implement a large component of the EPT Project
COWI	COWI Consultants (Denmark)
DHF	District Heating Facility
DMT	District Maintenance Team
DO	Delivery Order
EPT	Environmental Policy & Technology (Project) A USAID-funded program to provide environmental assistance to New Independent States of the former Soviet Union
LVK	Lviv Vodokanal (municipal public water utility)
oblast	A government territorial-administrative unit in the former Soviet Union that is still in use following Ukraine's independence A U S analogue would be something between a state and a county
PADCO	Planning & Development Collaborative, Inc A U S -based consulting firm under contract to USAID to implement part of the U S government's assistance program to Ukraine's housing and communal services sector
PS	Pump Station
USAID	U S Agency for International Development
ZhEK	A municipal entity responsible for operation and maintenance of houses and multi-apartment buildings owned by city administrations, as well as water, sewerage, gas electricity, and heating systems within them

Section 1
INTRODUCTION

As part of a United States government bilateral assistance program, the U S Agency for International Development (USAID) is supporting environmental management in Ukraine Under direction from USAID, a consortium led by CH2M HILL International Services, Inc (CH2M HILL) is implementing part of USAID's Environmental Policy & Technology (EPT) Project by undertaking various tasks that have been agreed to by representatives of the governments of both countries

USAID has authorized CH2M HILL to perform a series of tasks in Ukraine under Delivery Order (DO) 9 Task U2 (Lviv Water Management Demonstration) includes a requirement (Subtask 2 5 - Conduct Workshops for Utilization of Information from the Study of the Lviv Vodokanal) that

> *the Contractor will conduct a series of workshops for the staff of the Lviv Vodokanal, the City of Lviv, and officials from other cities and vodokanals as appropriate Each workshop will be up to one day in length for an average of 15 people and will cover a variety of topics related to the findings and methodology being developed Included in the topics for discussion will be concepts on the value of conducting an economic analysis, and the steps required to complete such an analysis The analysis performed by the contractor for the Lviv Vodokanal should be used as the case study for the workshop Workshop materials shall include appropriate translations into a language specified by USAID/Kiev*

The workshops, held in Lviv, in western Ukraine, dealt with the following topics

(i) Importance of System Measurements
(ii) Meter Installations and Repair
(iii) LVK Billing and Payment Collection
(iv) Inspection and Analysis of LVK Customers with Water Meters Installed
(v) Measurements at Major Water Pump Stations
(vii) Maintenance of the City Distribution System
(viii) Breakages in the Water Distribution System
(ix) Measurement of Flow at the Wastewater Treatment Plant

The first two workshops were held in October 1995, and are reported in the document *Ukraine Summary Report on Lviv Vodokanal Workshops 1 & 2 Lviv 25 & 27 October 1995* Workshops 3 & 4 were held on 27 and 28 March 1996, and are reported in the document *Ukraine Summary Report on Lviv Vodokanal Workshops 3 & 4 Lviv 27 and 28 March 1996* Both documents were submitted to USAID by CH2M HILL

Under the terms of the contract CH2M HILL is required to submit a Summary Report on each workshop This document has been prepared in fulfillment of that obligation, pertaining to Workshops 5

Section 2

RESULTS

Lviv Vodokanal EPT Workshop 5 was organized by and held in the EPT/Lviv office (on LVK premises) on 14 June 1996 Attendees included the Lviv Vodokanal staff the Lviv Water Inspectorate, and PADCO representatives Appendix B lists the workshop attendees, while the presentation topics are listed in Appendix A

Presenters at the workshop were

- Mr Alexander Sipivy, EPT/Lviv task leader
- Dr Kris Buros, a CH2M HILL senior water & wastewater engineer and technical advisor to the EPT Project
- Ms Tamara Gipp, EPT/Lviv senior water and wastewater engineer
- Ms Maria Tryhovska, EPT/Lviv senior water and wastewater engineer
- Mr Michael Sharkov, EPT/Lviv senior water and wastewater engineer
- Mr Oleh Tsarynnyk, EPT/Lviv water and wastewater engineer
- Ms Svitlana Shekhovtsova, EPT/Lviv economist
- Mr Anatoli Kopytin, EPT/Lviv senior water and wastewater engineer

Both Ukrainian and dual English/Ukrainian language versions of all materials were used during the workshop, which was conducted using English-Ukrainian and Ukrainian-English translation

2 1 OVERVIEW OF WORKSHOP 5

Mr Sipivy gave a general overview of the workshop program (see Appendix A)
Dr Buros greeted those present on behalf of USAID

2 2 WORKSHOP 5 TECHNICAL ASPECTS OF SYSTEM MEASUREMENTS AND REVIEW OF POTENTIAL PROJECTS

2 2 1 Importance of System Measurements

On behalf of the EPT Project Mr Sipivy made a presentation of his report *The Importance of System Measurements* (see handout material in Appendix C, pages C-2 to C-6) In his report he emphasized the importance of obtaining accurate data for improving LVK operational and economic performance

Both accurate data on water flow or usage and energy efficiency are extremely important for the operation of the LVK system, and consequently when assessing means of improving these operations Such data on the LVK system is often not available or inaccurate More accurate data and updated measurements could be used to enhance operations and (most important at this time) in devising an investment plan for LVK with the World bank and/or other

international financial institutions

Based on the results of the survey with the portable meter about three large US-made fixed water meters would be furnished to LVK for installation for specific large customers This would then allow LVK to correctly bill for actual water used and may be an incentive for users to conserve water

Special installation tools would be included as part of the procurement, in order to demonstrate how they can save LVK time and effort in the installation of meters, or repair of pipe or meter installations These tools include several cut-off saws that would supplement the one which has already been procured on behalf of USAID and transferred to LVK by the EPI Project

2 2 2 Meter Installation and Repair

Ms Maria Hryhovska described major problems of meter installation and repair (see pages C-7 to C-8)

- Currently LVK has 26 166 primary customers (direct connections to the system) Many of these represent numerous individual users such as separate apartments in a building or group of buildings, that are served by one connection to the system Only a portion of these primary consumers are metered These meters have been installed over the past 50 to 60 years and represent a wide variety of manufacturers The older meters were generally manufactured in Poland, while the newer ones (since 1950) were made in the former USSR A major problem with the newer meters is the frequency of repairs required LVK has reported that the average period that a new meter functions in the system is about 18 months It must then be removed repaired, and then reinstalled

  To make an approximation of the effort that it would take to maintain the meters in the system if all the primary customers were metered, they were divided into three groups based on meter size up to 40 mm, between 40 and 150 mm (100 mm), and 150 mm and above The average repair times (exclusive of removal and replacement) were obtained from LVK and are based on the repair parts being readily available

Table 2-1
Projected Annual Repair Time for Fully-Metered LVK Primary Customers

Meter Size (diam)	Number of Meters	Individual Repair Time (man-hours)	Total Repair Time (man-hours)
40 mm	7,850	3 4	26,690
100 mm	10,466	9 0	94 194
150 200 mm	7,850	7 1	55,735
Total	26 166		176,619

Based on Table 2-1, and assuming one failure per meter per year, if LVK chose to meter all primary customers with the type and quality of meters that are currently purchased, it would require about 90 to 100 people to staff the meter repair group In addition, this would require a large increase in space, tools, and budget allocated to meter repair

- Assuming that the average price of locally manufactured flow meters approximates that shown in the following table, and that the cost for installation (including shut-off valves, bypass piping etc) is about the same as the meter itself for 40-mm meters, twice as much for 100-mm meters and 2 33 times as much for 150 to 200-mm meters, Table 2-2 reflects the estimated cost of installing new meters (and meter facilities) for all primary customers The actual cost could be a bit lower than this, as some of the users already have the facilities to install meters However, the cost is still substantial, and at half the cost it would still be in the range of US$7 million On the other hand, if meters from Western Europe were used, the cost of the meters of 100 mm and larger would be three to ten times as much

Table 2-2
Approximate Cost of Installing Meters for All Primary Customers

Meter Size (diam)	Number of Meters	Individual Meter Cost	Meter Installation Cost	Total Cost (USD)
40 mm	7,850	$100	$100	$1,570,000
100 mm	10,466	$150	$300	$4,710,000
150 - 200 mm	7,850	$300	$700	$7,850,000
Total	26,166			$14,130,000

- Provided that the cost of parts for each repair (in USD) was about $5 to $10, the annual cost of repair parts alone (for half the meters each year) would be in the range of $63,000 to $130,000

- The installation of such a large number of meters would require increasing the maintenance staff, or changing the concept of meter maintenance

The following steps are suggested in order to improve the existing situation

1 It might be necessary to install flow meters first at the biggest water customers (e g , district heating facilities) in order to measure their actual water consumption and compare it with the norm

2 LVK should pay special attention to meter quality Some type of long-term testing program should be initiated to determine the relative quality of meters which can be purchased locally Those meters should then be favored for purchase in the future

3 In order to prevent meter breakages caused by sand and other solid pieces occasionally

3 In order to prevent meter breakages caused by sand and other solid pieces occasionally present in water, it would be advantageous for all meters to be protected by strainers or other devices This would be especially important in the case of the largest users in the system, such as district heating facilities

Overall, the problem of meter installation should be solved by LVK in cooperation with the Lviv city authorities If meters are to be installed at all primary customers the meter installation program must be worked out taking into account all the abovementioned factors

2 2 3 LVK Billing and Payment Collection

Ms Shekhovtsova spoke about difficult problems connected with LVK billing and payments collection (see tables on pages C-9 and C-10)

Analysis of LVK financial performance in 1994, 1995, and the first half of 1996 shows that payments collected have not recovered LVK service production costs In 1994, total payments collected made up 78 percent of the amount billed In 1995 and in the first half of 1996, total payments collected made up 71 percent and 78 percent of the amount billed, respectively The growth in payments collected, up to 78 percent in the first half of 1996, is accounted for by the fact that the industrial enterprises paid their debts In this period the industrial enterprises paid 121 percent of the amount billed

The residential sector is the biggest water consumer In the first half of 1996 the amount billed to the residential sector made up 28 percent of the total amount billed The payment collection rate for the residential sector was 63 percent in 1994, 42 percent in 1995, and 23 percent in the first half of 1996 The total accounts receivable of the residential sector has increased to 1 7 times that in 1995 Currently, the residential debt for LVK services amounts to almost 2 million USD There is a trend to reduce the difference between residential and industrial sector tariffs which means that the income paid by the population is likely to grow

The State municipal public housing administrations (ZhEKs) are, among other things, in charge of water and wastewater services payment collection from the residential sector However, LVK receives no information about when the payments are made and the amount of payments collected It is possible that the ZhEKs do not transfer payments collected to LVK in time and in full In addition, LVK suffers when tariffs change for water supply and wastewater services As a rule, the order to change tariffs is made out a month after the introduction of new tariffs and it takes the ZhEK accounting departments about two months to recalculate LVK services bills for all the residents while, the rate of inflation is 2 to 3 percent every month In order to avoid the possibility of delayed and not-in-full payments by ZhEKs, LVK will have to deal directly with the population and not use the ZhEKs any more as an intermediatory body in charge of collecting payments The problem can be solved by introducing LVK service pay-books as has already been done by Teplokomunenergo (state city communal enterprise in charge of district heating facilities that provide hot water to the central heating system and heat cold water to supply into the water distribution system)

2 2 4 Inspection and Analysis of LVK Customers with Water Meters Installed

Mr Tsarynnyk told those present about metering different groups of LVK customers (see pages C-11 to C-13)

Only about 10 percent of primary customers have functioning meters, so most of the bills are calculated based on current consumption norms These norms, in turn, are based on data gathered in the past covering a wide range of customers throughout the former USSR Since billing of customers using norms represents such a large percentage of billing and, hence, income, it is important that LVK understand if and how actual consumption in Lviv may deviate from these national norms The number of flow meters for the different consumer groups is given in Table 2-3

Table 2-3
Installed and Functioning Meters at Primary Customers, per Group

Group	Installed Meters	Functioning Meters
Residential	13 609	509
Industry	unknown	1,179
Communal	unknown	675
Budget institutions	unknown	260
Total	unknown	2,623

2 2 4 1 Population

To get an understanding of the relationship between national norms and actual usage in Lviv, some primary customers were selected from the residential, communal, and industrial consumer groups for inspection and analysis

About 65 percent of Lviv residents receive water for six hours per day, and only 20 percent of the population has a 24-hour water supply According to LVK official data, there are about 509 calibrated water meters installed in the residential sector Part of these meters are installed in district heating facilities, others are installed in the old part of the city, in 2-3-story houses In fact, there are almost no functioning flow meters at the service connections of 4-9-story residential buildings in the new residential areas

The EPT team inspected 15 residential buildings and selected 10 of them with flow meters installed at the service connections for the survey Total number of consumers was 504 Most of the selected buildings had 3 stories Three quarters of the buildings had six-hour water supply and the rest had a 24-hour supply Ten of the buildings were selected for detailed study Half had a six-hour supply (locations numbers 1 to 5) and the other (6 to 10) had a 24-hour supply Data comparing the actual to the normative consumption are shown in Table C-5

On average, water consumption in the residential buildings with 24-hour water supply was just over twice the norm Water consumption in the residential buildings with a six-hour water supply almost equaled the norm Besides, according to the six-hour supply schedule water is delivered during the peak consumption period It is believed that much of the excess usage in the buildings with 24-hour supply can be explained by leakages in the plumbing

The Russian Academy of Communal Services has defined the expected leakage in buildings based on a number of factors including statistical data on the number of failing water consuming installation and the volume of leakages For each buildings the amount of water losses caused by leakages in sanitary fixtures of the surveyed buildings has defined and compared with the normative and actual consumption The results are given in Table C-6

Based on the data gathered in the EPT survey, it was concluded that

1 The actual amount of water used in a residential building (actual productive usage plus leakage) is affected by the number of hours of service provided to the building

2 On average, it appears that the actual usage in the residential areas in Lviv for buildings receiving 24-hour service is twice what would be expected from national norms

3 On average, it appears that the actual usage in the residential areas in Lviv for building receiving six-hour service is about what would be expected from national norms

4 Leakage from plumbing fittings in a building becomes considerably more significant as a percentage of total consumption as the water services go from six hours to 24 hours per day

2 2 4 2 Industrial Enterprises

The EPT team surveyed 15 enterprises including the largest water consumers in Lviv The expected water consumption was calculated and compared to actual metered consumption, in compliance with current norms The results are shown in Table C-7 The conclusions that can be reached from these data are

1 There is a wide variation between enterprises and the amount of water they consume and the individual norms

2 At this time, on average, the norms and actual usage do not vary that much

3 Although norms could be used to determine the overall demand for all the enterprises in Lviv, this would not be the most equitable way to charge for usage

There are a number of reasons that the actual usage of enterprises could vary from the norms These include water used from sources (like wells or internal reuse) other than the public supply, the capacity that the plant is operating, the level of water conservation (or wastage)

practices in an enterprise, and the way that each enterprise can be defined for purposes of determining the norm

2 2 4 3 Communal and Budget Organizations

The EPT team compared the actual and normative water consumption at 12 communal or budget organizations These data are shown in Tables C-8 and C-9 In both categories there was considerable variation between the actual and calculated norms However, based on the small sample taken the communal service connections tended to average out closer to the norm (a ratio of 1 06 of actual to norm) than the budget organization (1 51)

2 2 5 Universal Metering in Lviv

Mr Burns discussed the reality of achieving universal metering in Lviv

The ability of any water system to accurately measure the amount of water entering and leaving the distribution system is highly desirable Without that, it is not possible to realistically evaluate the amount of losses in the system

However, although this should be a long-term goal of LVK, it is one which must be put in perspective as to the financial ability to accomplish this Currently LVK has about 26,000 primary customers Many of these are residential buildings or complexes which, in turn, may have hundreds of individual apartments (and end-users) linked to one connection

There are two levels to be considered in universal metering The first level would cover just the primary customers (direct connections) to the distribution system

Ms Tryhovska had examined the estimated capital costs and consequences involved in installing meters only for primary customers This was in the range of $7 to $14 million, plus an additional $130,000 per year for repairs and an unknown cost for reading (or verifying) meters and processing bills based on changing consumption rather than a fixed monthly charge Going to this level would be useful in that it would give LVK a better idea of the losses in the system, but due to the general inaccuracies in the meters and the inability to read all the meters at the same time this data would still be subject to error

The second level is to meter each individual end-user This would increase the number of metered connections from about 26,000 (for all direct connections) to something in the order of 200 000 to cover each individual apartment Since many of these individual users are in the large multi-story (6 to 14 floors) apartments built since 1950, it would even require more than one meter (at least two and perhaps three) per apartment This would be needed since the hot and cold water are furnished separately, and it would also require some repiping of the building at each apartment to allow a meter to be installed that would record only an individual apartment's use

Therefore, universal metering on an end-user basis could involve the installation, reading, and billing for an additional 300,000 to 400,000 meters If all of the additional meters (above those needed in the first level) were 25-mm or less in size, and if each one cost $50 with an

additional $50 for installation and repiping, then this would add $30 to $40 million dollars to the overall cost of metering

The money required for the full execution of either level of metering is probably beyond the capital raising ability of LVK at this time There are clearly larger priorities in the system beyond universal metering of the system

The focus of the problem at this time is the growth and development of LVK - not whether a meter exists or not but whether LVK can collect money from customers for services rendered The rate of collections has fallen off even using an easy (relative to universal consumption-based billing) system to administer billings, and there is no reason to believe that a more complex system will in itself increase collections The major debtors (in terms of the percentage of bills unpaid) are domestic and communal customers It appears that there is a legal problem associated with methods (like cutting off service) that could be used to encourage payment of bills

The recommendation for the present is that LVK concentrate on metering large customers and not invest, at this time, in metering small individual users, except where new construction provides a low-cost method to do this Instead, LVK needs to focus its efforts on developing innovative methods to bill and collect the appropriative revenues from customers Some of these methods could include the encouragement of condominium formation so as to transfer responsibility for the water costs to entire apartment complexes rather than individual users This concept should also be explored for use in existing public apartment complexes, so that the cost is assigned to an entity and not to individuals This would reduce the transaction cost for billings and collections for LVK, and offer the opportunity for using different methods to encourage collections, such as reducing the number of hours of service to match payment received, instead of only having the choice of providing or cutting off water supply

2 2.6 Measurements at Major Water Pump Stations

Ms Gipp reported on the problems connected with measuring water delivered to the city (see pages C-14 to C-18)

It is necessary to have reliable information on the amount of water delivered to the city distribution system That will allow LVK to make the right decisions in order to improve the water distribution system

Currently LVK uses ultrasonic water meters made in Samara plant (Russia) for measuring the water delivered to the main pump stations The meters were installed in the period from 1989 to 1993 At all main pump stations, the water is collected in the storage tanks and from there it is pumped into the distribution system At four pump stations, the meters are installed on the pressure pipelines that lead from the pump stations to the city (Karachyniv, Budzen III, Sokilnyky, Vynnyky)

At Zboisk pump station meters are installed on water mains at the tanks inlets There are no meters installed at all two pump stations (Sykhiv III and Malechkovychi) All the tanks have

measurement sticks Every hour, operating staff of the pump stations record the following information

- flow meter readings
- pressure meter readings
- water depth in the tanks
- amperage of each functioning engine
- voltage at the inlets

Based on this information they monitor and calculate the amount of water delivered to the system EPT staff together with the LVK representatives measured the water levels in the tanks during 1/2 hour The results of those measurements differed from LVK reported data by 10-20 percent At the request of the local administration, Information Technology Monitoring, Ltd is in charge of installing experimental clamp-on ultrasonic meters at a number of pump stations (though their work may not be finished)

It was impossible to stop the big pump stations (Sokilnyky, Vynnyky, and Zboisk) Thus the amount of the water that gets to their tanks was not measured These measurements will be done after the clamp-on ultrasonic meters are installed

Further analysis showed that the tanks are not used to their full capacity All the pump stations are equipped with pumps the capacity of which is too large for the current water flow demand So the pumping equipment must be studied in order to find ways to reduce their energy consumption Additional inspection and analysis of the performance of the main pump stations have revealed several problems that need to be investigated in future In order to solve these problems the following steps should be carried out

- continue inflow measurement at the biggest pump stations with the help of clamp-on ultrasonic meters
- study the possibility of more effective usage of the tanks capacity
- continue the survey of pumping equipment performance of the big pump stations in order to improve their energy efficiency

2.2 7 Maintenance of the City Distribution System Breakages

Mr Sharkov described the problems related to maintenance and breakages in the system (see pages C-19 to C-24)

Breakdowns in the city distribution system hinder the regular water supply of the general population and industrial enterprises According to LVK dispatcher data, every year there are about 4,100 breakdowns in the city distribution system Materials provided by the dispatcher department show that there were 6,486 breakdowns last year, 6,268 of which happened on the water mains and 218 at the service connections of residential buildings (see graphs on pages C-21 to C-24)

Analysis of the breakdowns has shown that there are about 540 breakages in the water distribution system every month The biggest number of breakdowns takes place on the water

supply pipelines in the area of Naukova, V Velykoho, Medova Pechera, Pasichna, Zamarstynivska, Zelena, Lychakivska, Varshavska, and other streets (see the map of breakdowns, page C-20) It is noteworthy that the number of breakdowns is not regular throughout a year There are more breakdowns in summer (June) and winter (December) The varying number of breakdowns might be explained by varying water consumption which depends on the season of the year, different temperature of the soil in winter, and it is possible that the time of breakdowns is not accurately registered in the dispatcher registers The dynamics of breakdowns of the water distribution network from 1985 to 1995 is shown in the graph (page C-21)

There are several district maintenance stations that are in charge of elimination and prevention of breakdowns They are equipped with repair equipment and excavators Here is an example of a repair crew working day

Date 4 May, 1996

Address of the water pipeline leakage Kryvchytska road, 75 District maintenance team No 5 (DMT-5) is in charge of this part of the water distribution system

Characteristics of the breakdown place service connections of the private houses, service life is about 25-30 years

Description of the repair work

The chief of DMT-5 received information about a breakdown at 8 50 at a meeting with LVK chief engineer The repair emergency crew (4 people) left for the place of the breakdown After arriving on site they found out that a service connection pipeline was leaking at houses No 73 and 75 It took them 30 minutes to shut off the supply line valves to cut the delivery of water to the place of the breakdown At 11 40 an excavator came on site and dug out the leaking pipe in 15-20 minutes from a depth of 1 2 m It was a non-insulated, steel, 57-mm diameter, 4-mm thick pipe, completely corroded, with 15-20 mm diameter holes in it The repair crew put a metal clamp with a rubber lining over the holes, as they usually do in such cases The breakdown was completely eliminated by 16 00

The average time of breakdown elimination is 3 5 days or 171 5 man-hours, including 96 3 man-hours of working time and 75 2 man-hours of down time (44%)

2 2 8 Measurement of Flow at the Wastewater Treatment Plant

Mr Kopytin described the measurement of wastewater flow at the Lviv Wastewater Treatment Plant, where the following work has been performed

- Parshall flumes location at lines 1 and 2 was identified

- flume dimensions were taken

- the characteristic flow-depth curves for lines 1 and 2 of the Parshall flumes were constructed and an equation of relations between flow and depth was developed

- during two days from 10 June to 12 June 1996, measurements were taken at lines 1 and 2 of the Parshall flumes, with rulers specially made for this task On the basis of these measurements, hourly wastewater flows were determined, daily inflow characteristic curves were constructed, and a 24-hour wastewater flow was determined

It is planned to continue measurements in the future for obtaining more accurate data about the wastewater flow at lines 1 and 2 and to measure the total flow in the tunneled part of the Poltva river collector

2 2 9 Comments and General Discussion

Mr Kmasevych Chief of the Lviv Water Inspectorate, suggested that improvement of the Stryi well field should be included into the list of projects

Mr Kompaniets, Chief of the LVK technical department, expressed a wish to know what projects were planned to be carried out in Lviv and their consecutive order He added that the LVK technical department would be willing to provide the EPT project team with all the necessary data available at LVK He wondered if it was possible to include into the project purchasing an express laboratory for wastewater chemical and biological analysis

Section 3
CONCLUSIONS

Lviv Vodokanal Workshop 5, organized by EPT/Lviv, proved to be very successful New concepts were introduced, and the analysis of discussed problems has represented another important step to continue project development and implementation in Lviv The discussion revealed a strong desire to incorporate many of the ideas and practices presented

Appendix A
TOPICS OF LVIV VODOKANAL WORKSHOP 5

LVIV VODOKANAL WORKSHOP 5 TOPICS

OVERVIEW

- General Greeting and Introduction of Participants - Alex Sipivy
- USAID Welcome - Kris Buros

WORKSHOP 5 TECHNICAL ASPECTS OF SYSTEM MEASUREMENTS AND REVIEW OF POTENTIAL PROJECTS

Current Problems

- Importance of System Measurements - A Sipivy
- Meter Installations and Repair - M Tryhovska
- LVK Billing and Payment Collection - S Shekhovtsova
- Inspection and Analysis of LVK Customers with Water Meters Installed - O Tsarynnyk
- Universal Metering in Lviv - K Buros
- Measurements at Major Water Pump Stations - T Gipp
- Maintenance of the City Distribution System Breakages - M Sharkov

Wastewater System

- Measurement of Flow at Lviv Wastewater Treatment Plant Technological Lines 1 and 2 - A Kopytin

General Discussion

- Water System - CH2M HILL, EPT, COWI and the Lviv Vodokanal

Appendix B
LIST OF WORKSHOP 5 ATTENDEES

LIST OF WORKSHOP 5 ATTENDEES

Attendees 14 June 1996

CH2M HILL

Dr Kris Burns	- senior water & waste water engineer
Mr Alex Sipivy	- the EPT/Lviv task leader
Ms Tamara Gipp	- senior water & waste water engineer
Ms Maria Trelyovska	- senior water & waste water engineer
Mr Michael Shaikov	- senior water & waste water engineer
Ms Svitlana Shekhovtsova	- economist
Mr Sergiy Bautkin	- computer engineer
Ms Marina Gozha	- secretary
Ms Olga Douranova	- office manager
Ms Liudmyla Grigorieva	- translator
Mr Anatoli Kopytin	- senior water & waste water engineer
Mr Oleh Tsarynnyk	- water & wastewater engineer

COWI

Mr Niels Bent Johansen	- project manager for the Lviv Water & Wastewater Project preparation study

PADCO

Mr Kostiantyn Trachenko	- manager of communal services reforms program

Research Triangle Institute (RTI)

Mr David Bauer	- resident technical advisor City of Lviv

Lviv Water Inspectorate

Mr Volodymyr Kinasevych	- Chief of Lviv Water Inspectorate

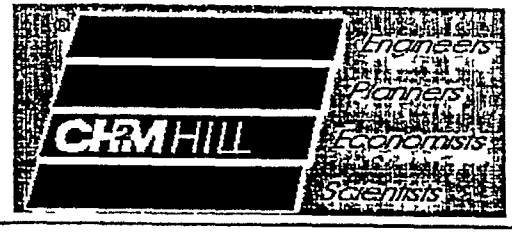
Lviv Vodokanal

Mr Volodymyr Sulypa	- Director
Mr Mykola Odukha	- Deputy Director
Mr Serhiy Kompaniets	- Chief of Production Engineering Department
Ms Oksana Turchyn	- Chief of LVK Department of Well Fields and Pump Stations
Ms Alla Nykytiuk	- Chief of Planning & Economy Department

Appendix C
WORKSHOP 5 HANDOUT MATERIALS

WATER METERING
and
MEASUREMENT

WORKSHOP # 5
June 14, 1996



Lviv Water & Wastewater System

GOAL - Improvement in the

ECONOMIC

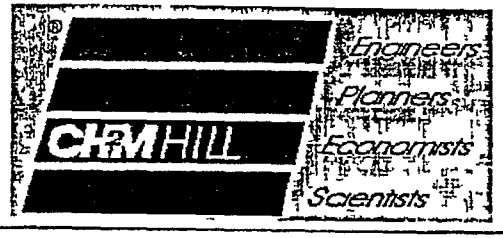
and/or

OPERATION

of the system relative to:

WATER USE

ENERGY



ACCURATE DATA

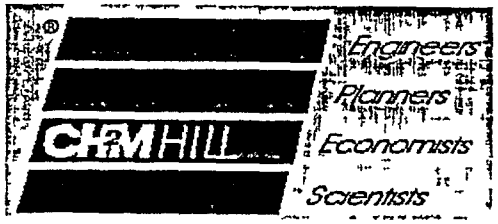
would be used to

enhance OPERATIONS

devise INVESTMENT PLAN

with

USAID
WORLD BANK
INTERNATIONAL



C4

12

EXTREMELY IMPORTANT !!!

In the operation of the Lviv Vodokanal system

ACCURATE DATA

on

- **WATER FLOW**
- **WATER USAGE**
- **ENERGY**

DEMONSTRATION PROJECTS ARE INTERLINKED

They address **MEASUREMENT:**

- **D-1 Large Water Users**
- **D-2 Domestic Water User**
- **D-3 Water Entering System**
- **D-4 Water in the System**
- **D-5 Water related to Energy Usage**
- **D-6 Technology Transfer**

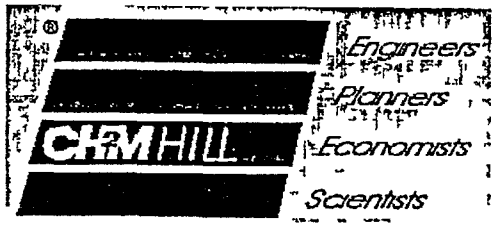


Table C-1 LVK Meters Reported				
Customer Group	**Number of Customers (Kontos)**	**Meters Installed**	**Meters Operating**	**Percent Operating**
Residential	19 632	13 609	509	3
Budget	987	No data	260	26
Communal	2 058	No data	675	33
Industry	3 489	No data	1 179	34
Total	**26,166**	**No data**	**2,619**	**10**

Table C-2
Results of Inspecting Selected Customer Connections

Customer Group	Number of Customers	Meters Installed				Meters Working	
		Yes		No			
		Qty	%	Qty	%	Qty	%
Residential	26	22	85	4	15	5	19
Budget	14	14	100	0	0	6	43
Communal	7	6	86	1	14	2	28
Industry	1	1	100	0	0	1	100
Total	**48**	**43**	**90**	**5**	**10**	**14**	**30**

Table C-3 LVK Financial Performance				
Indicator	**Unit**	**1994**	**1995**	**1st half of 1996**
Total Production Costs	million kbv	318,295	1,942,717	1,423,223
	US$	2,716,000	10,829 000	7,854,000
Amount Billed	million kbv	398 375	2 588,832	2,079,325
	US$	3,399,000	14,431,000	11,475,000
Payments Collected	million kbv	309,774	1,831,845	1,629,318
	US$	2,643 000	10,211,000	8,992,000
Accounts Receivable	million kbv	88,601	756 987	450 007
	US$	756 000	4,220,000	2,483,000
Payment Collection Rate	%	78%	71%	78%
Total Debt	**million kbv**	**122,392**	**924,144**	**1,194,210**
	US$	**1,044,000**	**5,151,000**	**6,591,000**

Note
Ukr Official Exchange Rate (on 25Dec94) was 117,200 kbv for US$1
Ukr Official Exchange Rate (on 25Dec95) was 179,400 kbv for US$1
Ukr Official Exchange Rate (on 25Jun96) was 181,200 kbv for US$1

Table C-4
LVK Financial Perfomance

No	Customers	Measurement Unit	Amount Billed[1]	Payments Collected[1]	Collection Rate	Total Debt
			1994			
1	Residential sector	million kbv	13,847	8,702	63%	10,136
		US$	118,000	74,000		86,000
2	Industry	million kbv	350,279	274,948	78%	98,060
		US$	2,989,000	2,346,000		837,000
3	Others[2]	million kbv	34 250	26 124	76%	14,197
		US$	292,000	223,000		121,000
	Total	**million kbv**	**398,375**	**309,774**	**78%**	**122,392**
		US$	**3,399,000**	**2,643,000**		**1,044,000**
			1995			
1	Residential sector	million kbv	382,417	162,267	42%	232,127
		US$	2,132 000	904 000		1,294,000
2	Industry	million kbv	1,870,180	1,479 417	79%	501,763
		US$	10,425,000	8,246,000		2,797,000
3	Others[2]	million kbv	336 235	190,160	57%	190 254
		US$	1 874,000	1,060,000		1,060,000
	Total	**million kbv**	**2,588,832**	**1,831,845**	**71%**	**924,144**
		US$	**14,431,000**	**10,211,000**		**5,151,000**
			1st half of 1996			
1	Residential sector	million kbv	585,026	137,388	23%	400,447
		US$	3,229,000	758,000		2,210,000
2	Industry	million kbv	1,110,174	1,343,236	121%	502,981
		US$	6,127,000	7,413,000		2,776,000
3	Others[2]	million kbv	384,126	148,694	39%	290,782
		US$	2,120,000	821,000		1,605,000
	Total	**million kbv**	**2,079,325**	**1,629,318**	**78%**	**1,194,210**
		US$	**11,475,000**	**8,992,000**		**6,591,000**

Note

[1] "Amount billed" and "payments collected" include the service cost of LVK structure

[2] The "others" include communal sector, budget organizations and collective farms

[3] Ukr Official Exchange Rate (on 25Dec94) was 117,200 kbv for US$1
Ukr Official Exchange Rate (on 25Dec95) was 179,400 kbv for US$1
Ukr Official Exchange Rate (on 25Jun96) was 181 200 kbv for US$1

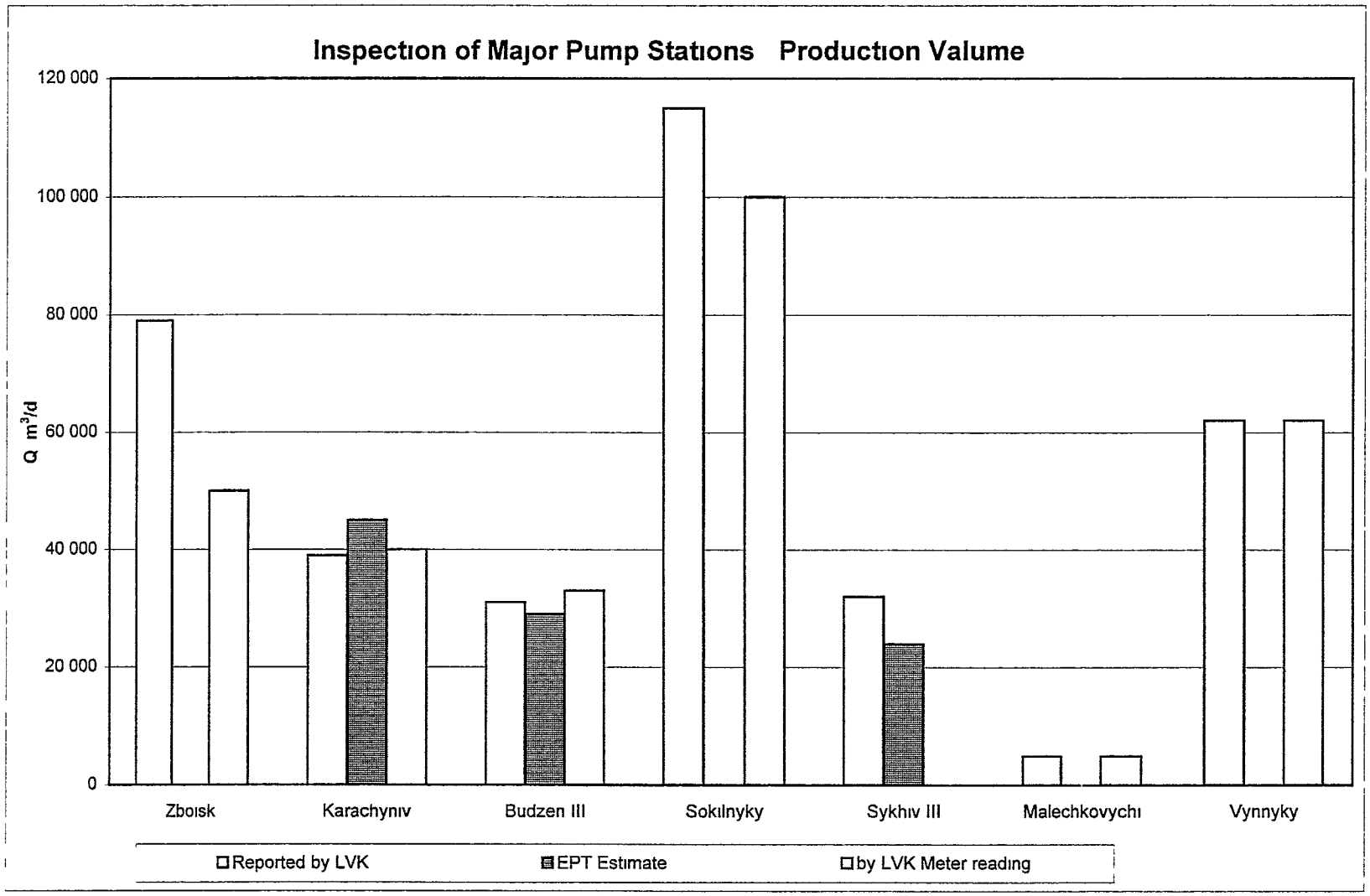
Table C-5 Residential Houses Water Consumption							
No	Address	Number of Residents	Actual Water Consumption		Normative Water Consumption		Ratio Actual/ Norm
			m^3/mo	lcd	m^3/mo	lcd	
1	36 Drahomanova St	14	304	700	91	210	3 33
2	16 N Levytskoho St	36	576	516	234	210	2 46
3	8 Snopkivska St	17	236	448	111	210	2 13
4	3 Hlibova St	31	413	429	202	210	2 04
5	8 Hlibova St	18	107	192	117	210	0 92
	Subtotal	**116**	**1,635**		**755**		**2 17**
6	9 Bohuna St	40	535	431	260	210	2 05
7	10 Donetska St	26	199	247	169	210	1 17
8	63 Vyhovskoho St	264	994	121	1 187	145	0 84
9	25 B Mykhnovskykh	41	198	156	267	210	0 74
10	24 Trusha St	17	54	103	111	210	0 49
	Subtotal	**388**	**1,980**		**1,994**		**0 99**
	Total	**504**	**3,615**		**2,749**		**1 32**

Table C-6 Comparison of Actual and Normative Water Consumption with Leakages						
Water Supply Schedule, hours per day	Number of Residents	Norm Consumption	Total Leakages	Ratio Leakages /Norm	Actual Consumption	Ratio Leakages /Actual
		m^3/d	m^3/d		m^3/d	
24	116	24 4	10 1	0 41	52 8	0 19
6	388	64 3	8 5	0 13	63 9	0 13
Total	**504**	**88 7**	**18 6**	**0 21**	**116 6**	**0 16**

Table C-7 Industrial Enterprises Water Consumption					
No	Enterprise Name	Product Name	Drinking Water Consumption, m^3/d		Ratio Actual / Norm
			Actual	Norm	
1	Mikroprylad Plant	Instruments, measuring devices, consumer goods	1,093	94	11 63
2	Zhyrkombinat Food Plant	Margarine mayonnaise	825	140	5 89
3	Galka Plant	Instant and ground coffee coffee beans	196	52	3 77
4	Dairy Plant No 1	Whole milk and skimmed milk products	848	263	3 22
5	Dairy Plant No 2	Whole milk and skimmed milk products	906	351	2 58
6	Ceramics Plant	Ceramics tiles roof tiles, plumbing equipment	274	107	2 56
7	Lviv Distillery	Alcoholic drinks	326	133	2 45
8	Transport Enterprise 14631	Transportation of passengers	116	64	1 82
9	Lviv Insulator Plant	Insulators, glass blocks	234	186	1 26
10	Iskra Plant	Electric bulbs	1,347	1,194	1 13
11	Promin Knitted Goods Factory	Knitted goods	560	620	0 90
12	Lviv Bakery No 2	Wheat bread	94	136	0 69
13	Halychfarm	Medicines	479	778	0 62
14	Lviv Bakery No 3	Bread	46	80	0 58
15	Coca-Cola Amatil-Kolos	Soft drinks	630	2,225	0 28
	Total		**7,974**	**6,423**	**1 24**

Table C-8 Communal Services Water Consumption				
No	Customer	Water Consumption, m^3/d		Ratio Actual/ Norm
		Actual	Norm	
1	Lviv Hotel	273 4	166 8	1 64
2	Lviv Prylad Plant Club	1 95	2 15	0 91
3	Halychyna Cinema	2 61	3 12	0 84
4	Grand Hotel	36 4	50 4	0 72
5	Circus	100 5	170 7	0 59
	Total	**415**	**393**	**1 06**

Table C-9 Budget Organizations Water Consumption				
No	Customer	Water Consumption, m^3/d		Ratio Actual/ Norm
		Actual	Norm	
1	Lviv Railway polyclinics	410 8	29 5	13 93
2	Secondary School No 88	45 7	14 1	3 24
3	Hospital No 1	58 5	27 6	2 12
4	Lviv Railway Hospital	9 4	5 9	1 6
5	Mental Diseases Hospital	562 1	442 3	1 27
6	Drug-store No 34	10	9 4	1 06
7	Lviv Oblast Blood Transfusion Station	259	366 7	0 71
	Total	**1,355**	**895**	**1 51**



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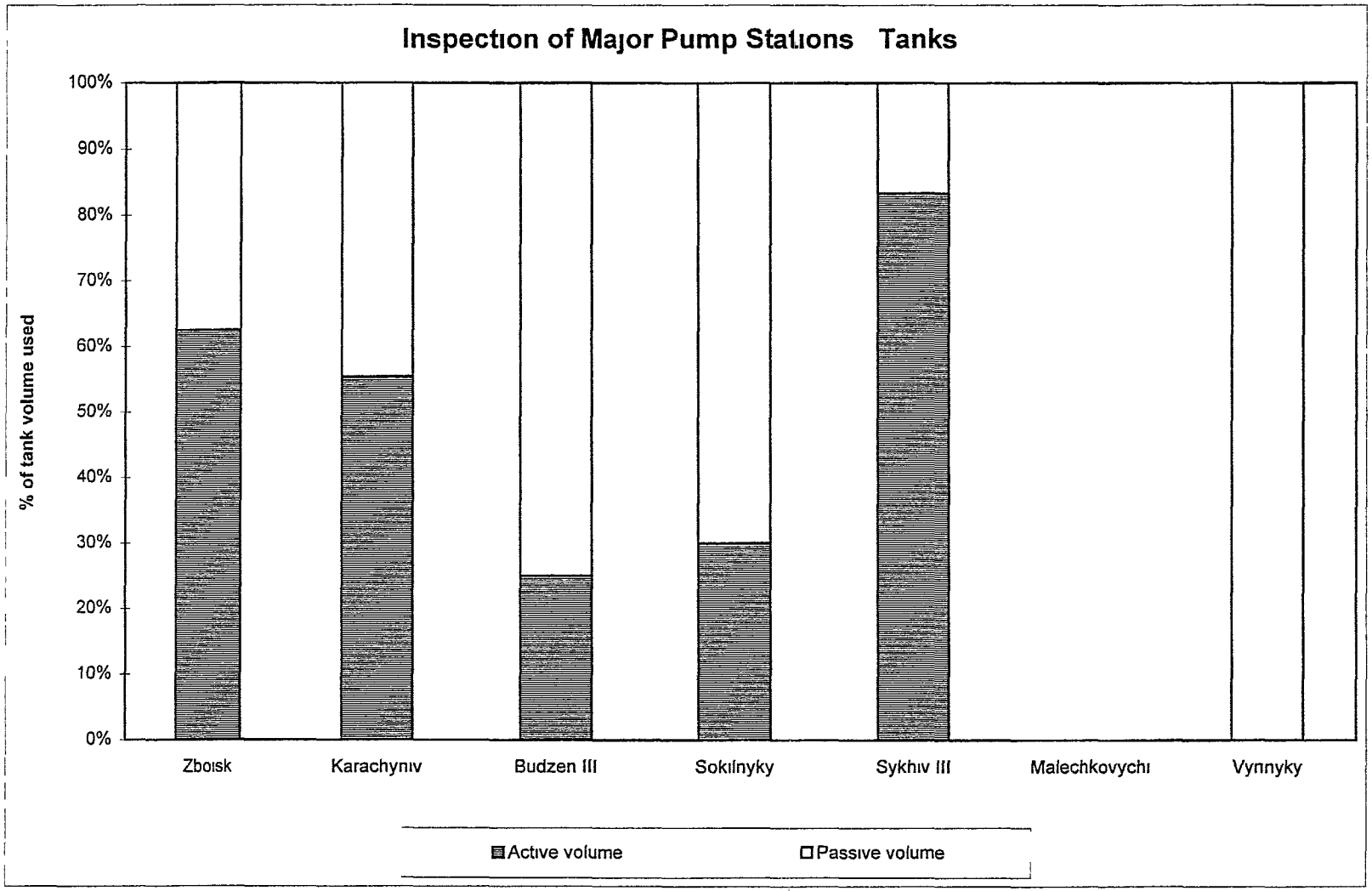

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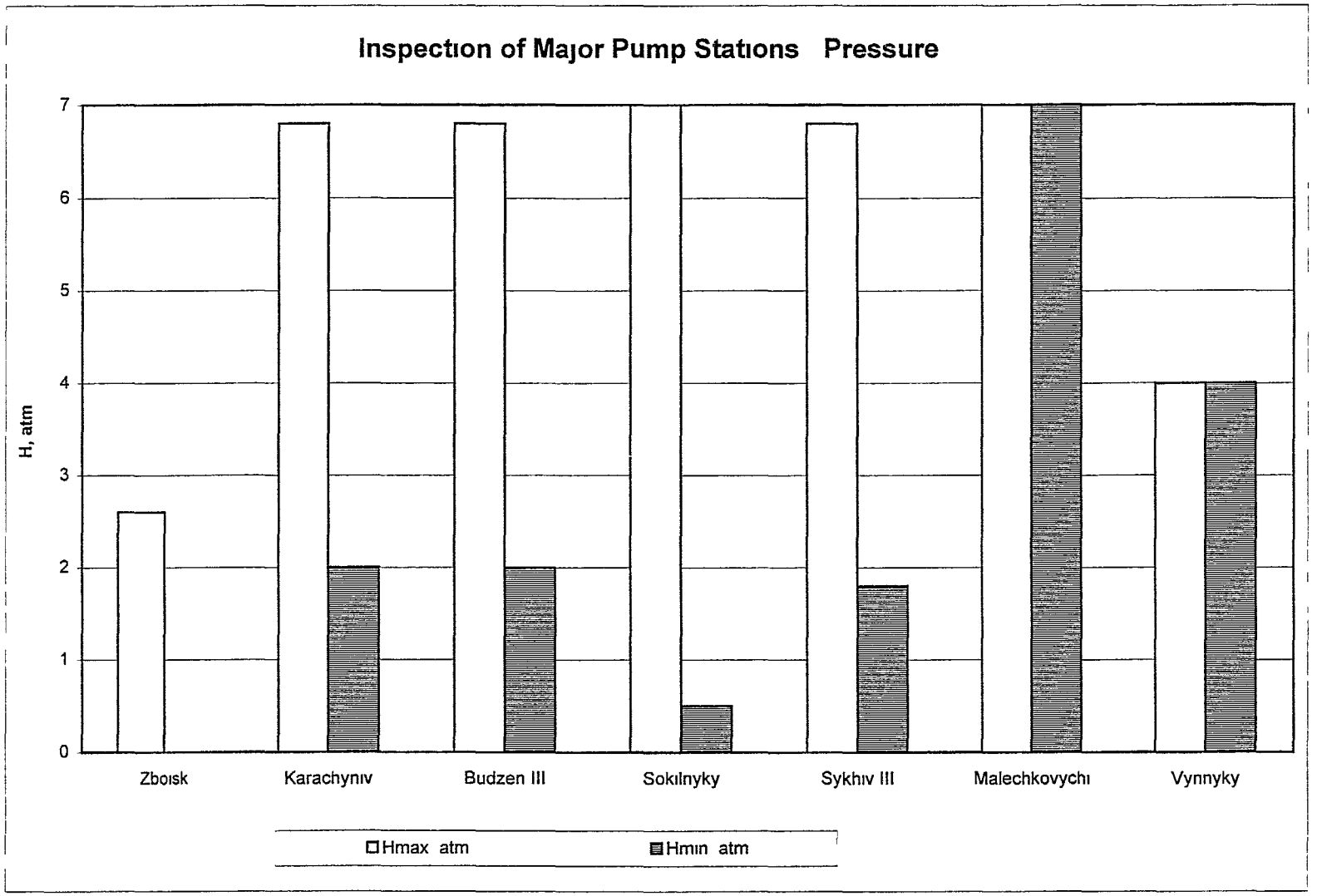

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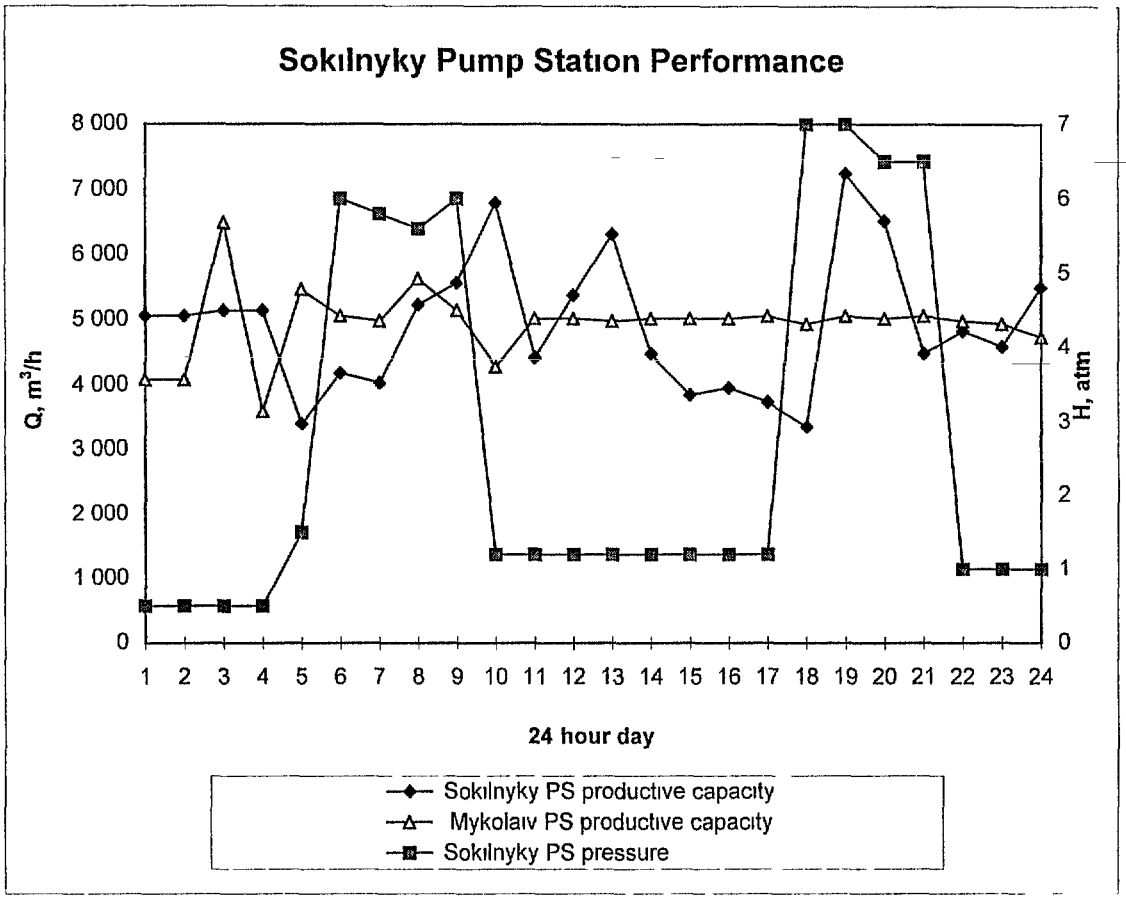

Sokılnyky Pump Station Performance
Q, m3/h
H, atm
24 hour day
Sokılnyky PS productive capacity
Mykolaiv PS productive capacity
Sokılnyky PS pressure

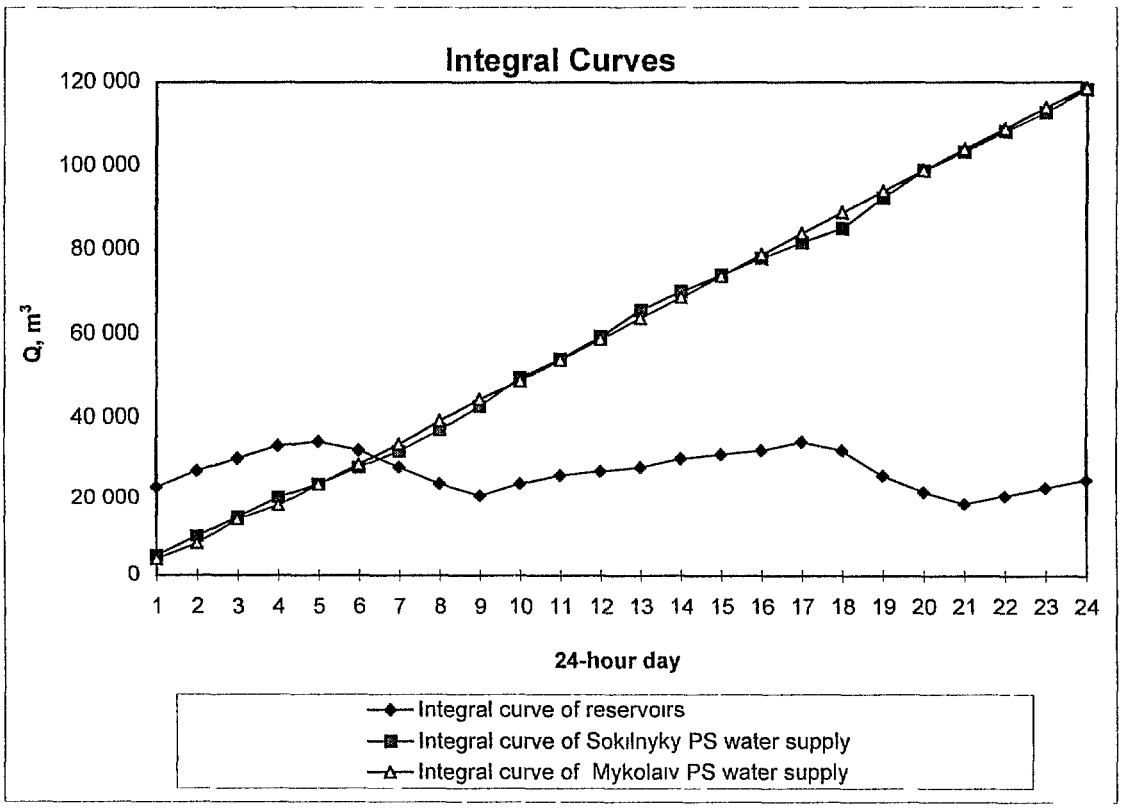
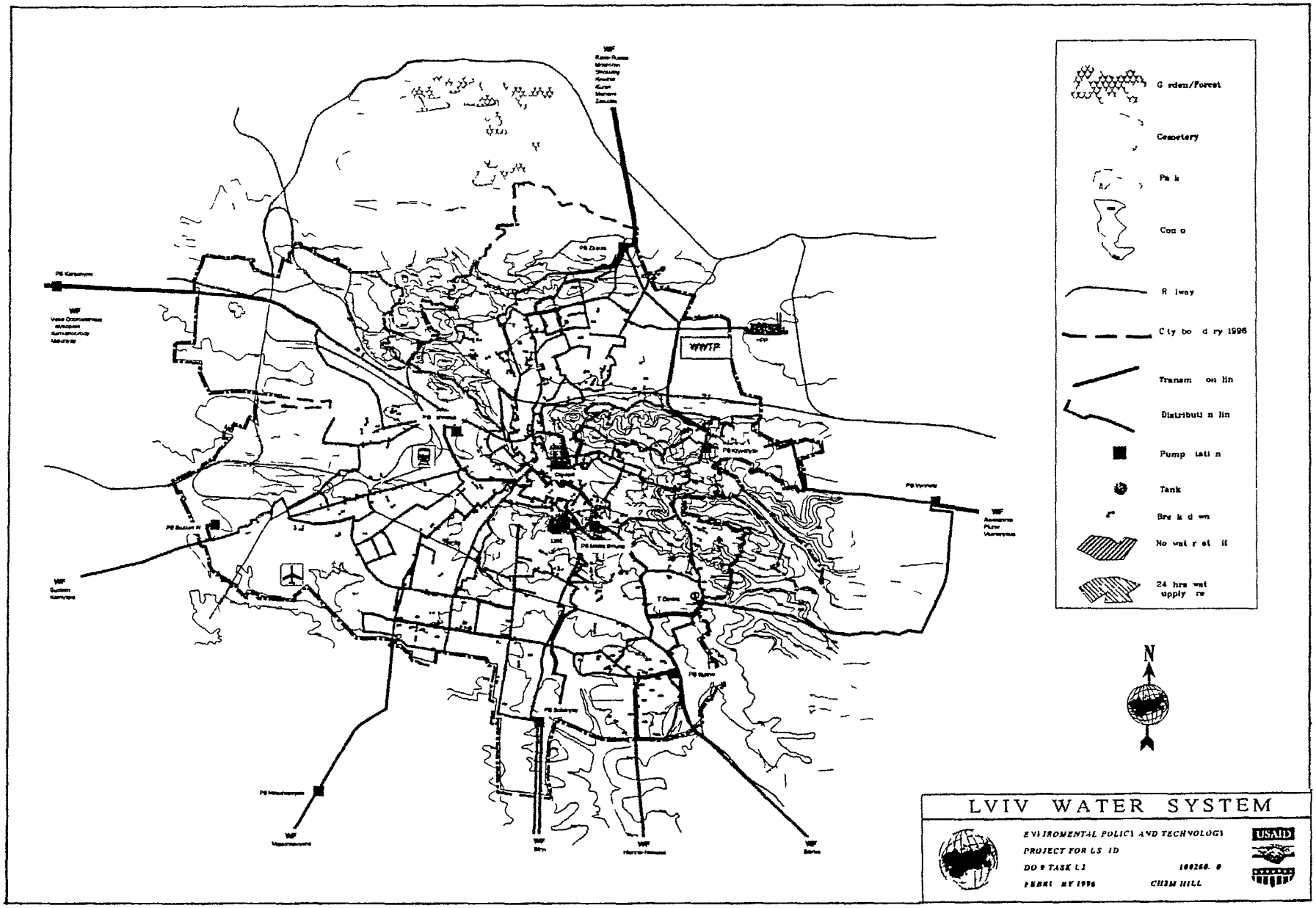
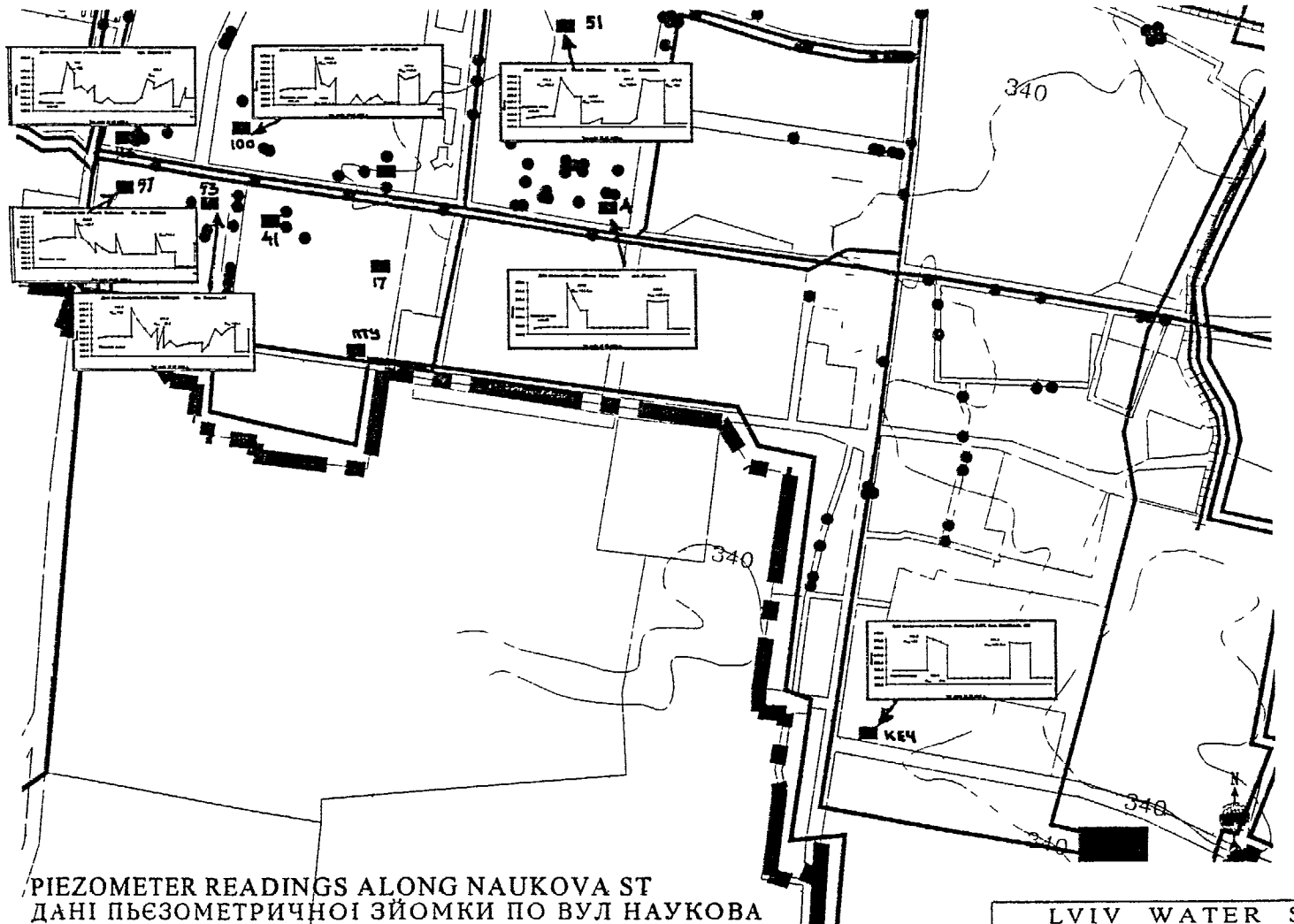

Integral Curves
Q, m3
24-hour day
Integral curve of reservoirs
Integral curve of Sokılnyky PS water supply
Integral curve of Mykolaiv PS water supply

Table C-10
Inspection of Major Pump Stations

Group	Major PS	Other PS/WF	Ground Surface Elev	Static Water Elev	Distance to PS	Average Capacity: Reported by LVK		Actual 11 May 96: Measured	Actual 11 May 96: by Meter m^3/d		Actual 11 May 96: $\triangle$ Q m^3/d		# Well	Tank Volume			Pressure: High		Pressure: Low	
			m	m	km	m^3/d	kw/m^3	m^3/d	min	max	min	max		#	Σm^3	$\triangle$H m	atm	hr	atm	hr
North	Zboisk		322 9			79 000	0 1		50 000	55 000	29 000	24 000		2	20 000	3	2 6	6	0	18
		ps Zarudtsi II recv g	273		13	88 000	0 43							4	4 000	0	7 5	2	7 4	22
		wf Rava Ruska		284 7	48	16 932							8							
		wf Maheriv		284 2	41	8 466							4							
		wf Shostaky		283 2	38	6 350							3							
		wf Krekhiv		242 2	30	13 611							5							
		wf Kunin		242 2	30	5 444							2							
		wf Mokrotyn		231	20	16 222							6							
		wf Zarudtsi		271 2	13	20 927							16							
		Subtotal wf				**88 000**							**44**							
West	Karachyniv		310			39 000	0 46	45 000			6 000			1	6 000	2 9	6 8	7	2	17
		ps/ wf Volia Dobrostansk	283	268	27	7 026	1 47						5							
		ps/wf Velykopole	280	274 4	24	7 015	0 913						5							
		ps/wf Kamianobrody	271 5	268 4	20	15 289	0 581						4							
		ps/wf Malchytsi	280	273	12	15 868							9							
		Subtotal wf				**45 000**							**23**							
	Budzenlll		317			31 000	0 21	29 000			2 000			2	12 000	1 2	6 8	6	2	18
		ps Budzen II recv g	277		18	43 000	1 145							1	500	0 1	7 5	24	0	0
		wf Budzen		308 5	21	31 586							22							
		wf Kernytsia		308 5	24	11 479							8							
		Subtotal wf				**43 000**							**30**							
South	Sokilnyky		344 8			115 000	0 31		80 000	124 000	35 000	10 000		5	50 000	1 7	7	6	1	18
		ps Mykolaiv recv g	264 7		28	118 000	0 561							2	6 000	0 1	15	24	0	0
		wf Stryi		316	75	126 578							34							
		Subtotal wf				**127 000**							**34**							
	Sykhiv III		357 1			32 000	0 3	24 000			8 000			2	12 000	3 8	6 8	8	1 8	16
		ps/wf Hlynna Navaria	330 6	328 8	14 5	14 238	1 04						12	2	1 000	0 1	5 2	24	0	0
		ps/wf Stare Selo	302 1	297 5	16	24 192	0 662						12	2	6 000	0 1	8 4	24	0	0
		Subtotal wf				**38 000**							**24**							
	Malechkovychi		298			4 910	0 68		5 000							0	7	24	0	0
		ps/wf Malechkovychi	298	296 8	7	4 910							1							
		Subtotal wf				**5 000**							**1**							
East	Vynnyky		282			62 000	0 4		62 000	61 000		1000		1	2 000	0 1	4	24	0	0
														2	20 000	0 1	9 5	24	0	0
		ps/wf Pluhiv recv g	285 1	283	74	50 572	0 357						8							
		wf Remezivtsi		280 4	62	7 377							4							
		wf Vilshanytsia		257	46	8 577							4							
		Subtotal wf				**66 000**							**16**							
	Total major PS					**363 000**		**98 000**	**197 000**	**240 000**	**80 000**	**35 000**	**172**							


WWTP
Garden/Forest
Cemetery
Park
Railway
Transmission line
Distribution line
Pump station
Tank
No water outage
24 hrs water supply
N
LVIV WATER SYSTEM
ENVIRONMENTAL POLICY AND TECHNOLOGY
PROJECT FOR LVIV
DO 9 TASK 12
160260.0
FEBRUARY 1996
CHEM HILL
USAID

35



PIEZOMETER READINGS ALONG NAUKOVA ST
ДАНІ ПЬЄЗОМЕТРИЧНОІ ЗЙОМКИ ПО ВУЛ НАУКОВА

LVIV WATER SYSTEM

ENVIROMENTAL POLICY AND TECHNOLOGY
PROJECT FOR USAID
DO 9 TASK 03 160260 20
FEBRUARY 1996 CH2M HILL

USAID

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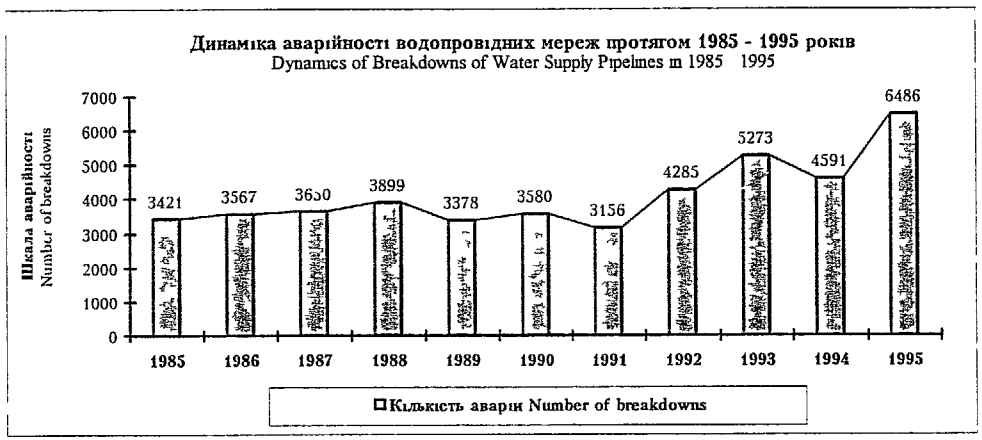
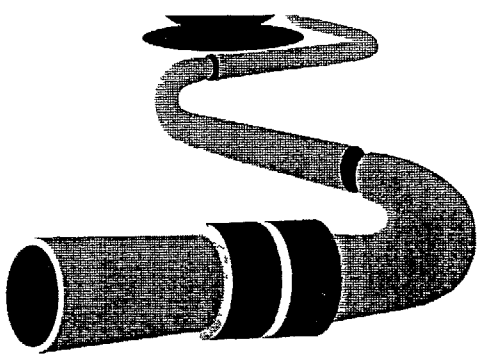
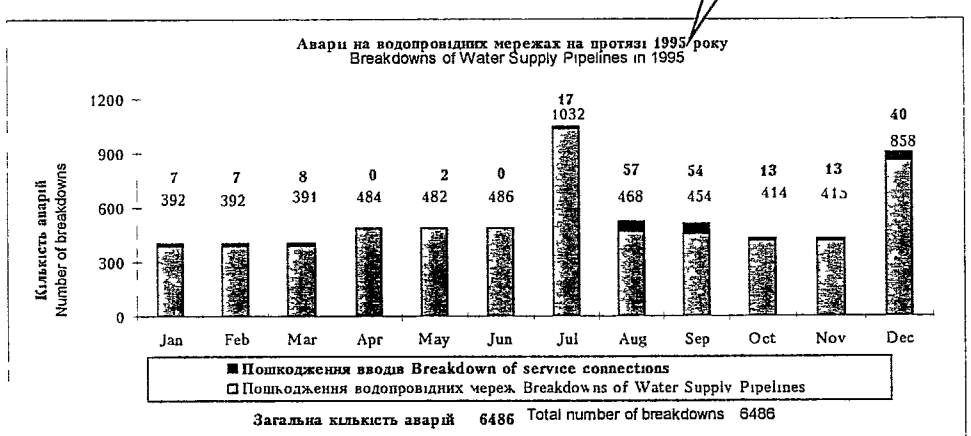
354

Аварійність мереж системи розподілу води

Analysis of Water Distribution System Breakdowns







EPT- CH2M HILL

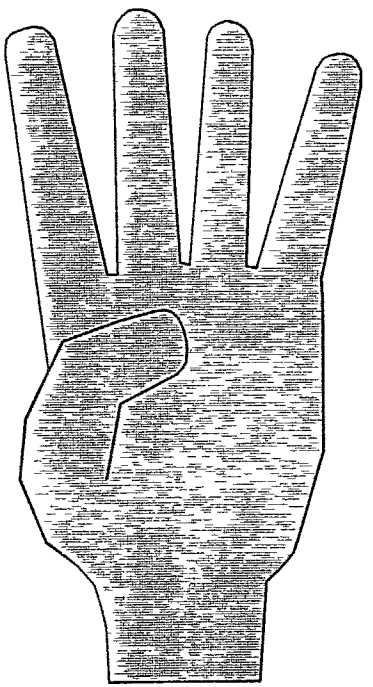
USAID

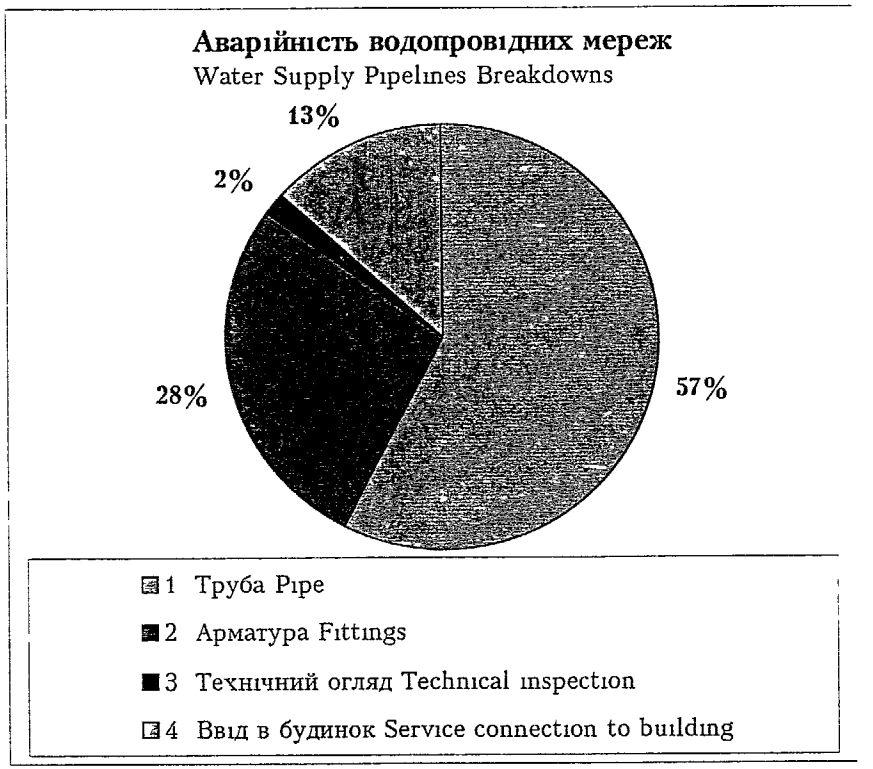
C-21

36

Аналіз аварійності водопровідних мереж

Analysis of Supply Pipelines Breakdowns





EPT- CH2M HILL

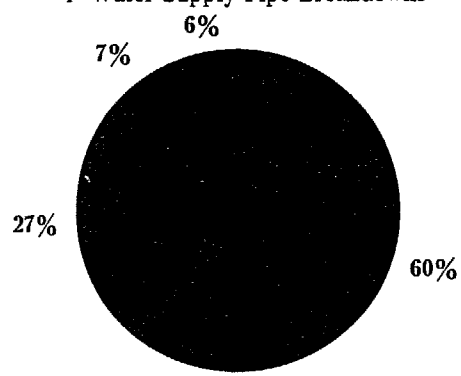
C-22

Аналіз аварійності водопровідних мереж

Analysis of Supply Pipelines Breakdowns

1 Аварійність водопровідних труб

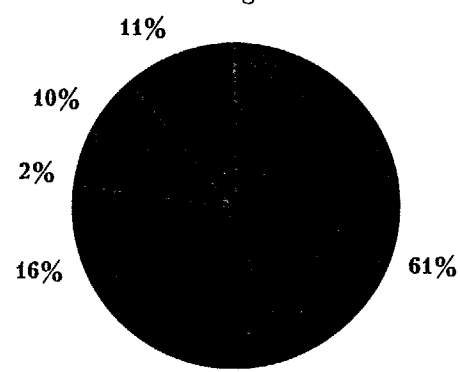
1 Water Supply Pipe Breakdowns



- 1 1 Пошкодження стика Damage between bell and spigot joint
- 1 2 Отвір в сталевій трубі діаметром 10-40 мм Hole in 10-40 mm diameter steel pipe
- 1 3 Отвір в чавунній трубі Hole in cast iron pipe
- 1 4 Отвір в сталевій трубі суцільний Several holes in steel pipe

2 Аварійність арматури

2 Fitting Breakdowns



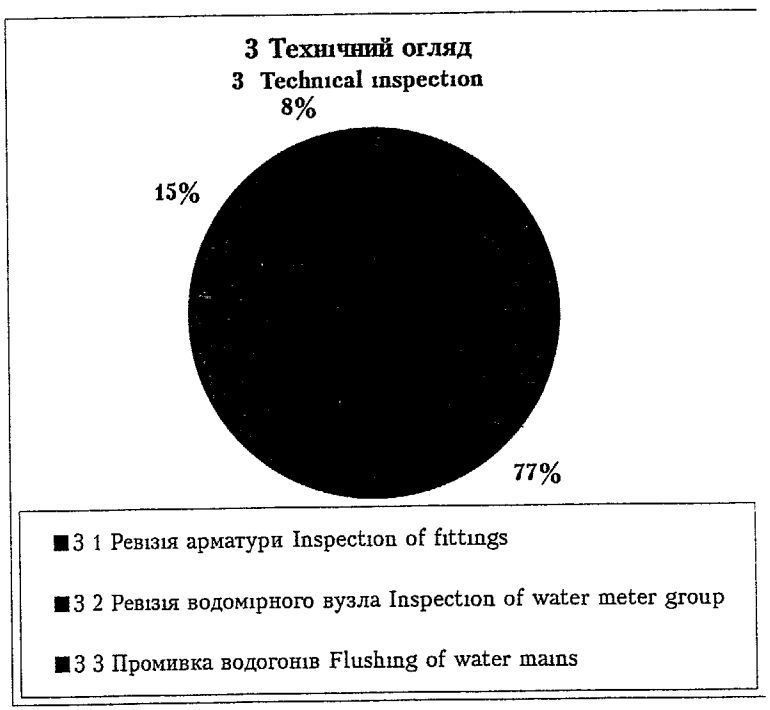
- 2 1 Пошкодження засувки Gate valve damage
- 2 2 Пошкодження гідранта Damaged hydrant
- 2 3 Пошкодження водоміра Damaged water meter
- 2 4 Пошкодження вентилів на вводі Service connection valve damage
- 2 5 Пошкодження водопровідної колонки Public tap damage

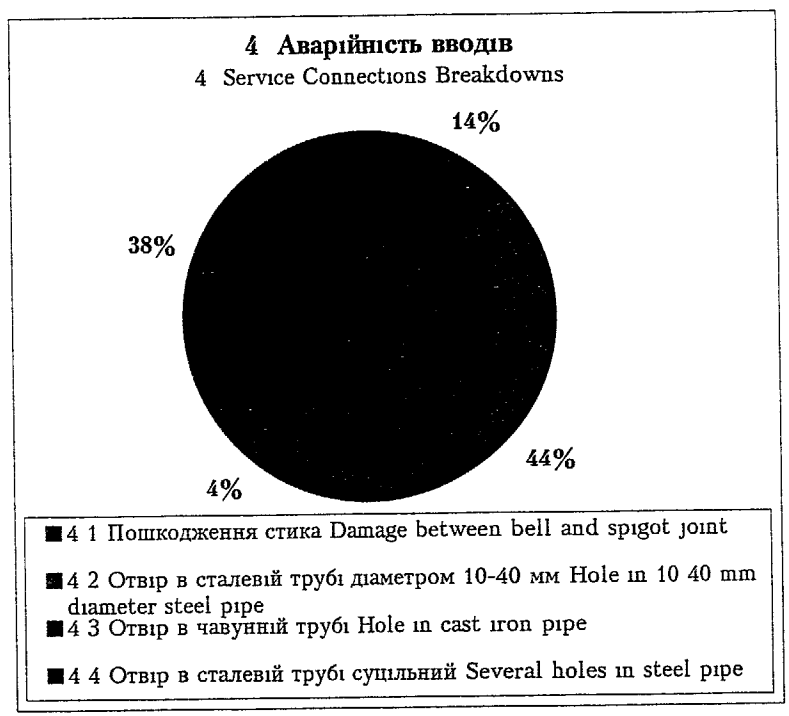
EPT- CH2M HILL

USAID

Аналіз аварійності водопровідних мереж

Analysis of Supply Pipelines Breakdowns





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New Independent States (NIS)

★ **EPT Regional Offices**

The Environmental Policy and Technology (EPT) Project Environmental degradation and natural resource mismanagement threaten public health biodiversity and economic vitality in the New Independent States (NIS) To assist the NIS in alleviating these problems the U S Agency for International Development (USAID) began the EPT Project in 1993 EPT provides technical assistance and policy advice in the environmental sector and promotes environmentally sound economic development through public and private U S and NIS partnerships The EPT Project is managed by USAID with support from the U S Environmental Protection Agency (USEPA) For assistance in project design management and implementation USAID has agreements with CH2M HILL International Harvard Institute for International Development and ISAR As the primary EPT contractor CH2M HILL International has the lead role in delivering technical assistance logistical support and policy support for selected projects EPT Regional Offices are located in Washington D C Moscow Russia Kiev Ukraine and Almaty Kazakhstan

CH2M HILL International Consortium of Subcontractors Center for International Environmental Law Clark Atlanta University/Historically Black Colleges Universities and Minority Institutions Technology Consortium Consortium for International Development Ecojuris Environmental Compliance Inc Harvard Institute for International Development Hughes Technical Services Company International Programs Consortium International Resources Group Interfax K&M Engineering Ogden Environmental and Energy Services Price Waterhouse the World Wildlife Fund and numerous local subcontractors and cooperators throughout the NIS

Environmental Policy and Technology Project
A USAID Project Consortium led by CH2M HILL

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