PN-ACB-143

Environmental Policy and Technology Project

Contract No. CCN-0003-Q-09-3165-00

MOLDOVA

Assessment of Chemical Analytical Capabilities for Environmental Monitoring in Moldova

Delivery Order #09, Task M2
November 1996

Prepared for:
U.S. Agency for International Development
Regional USAID Mission to Ukraine, Belarus & Moldova

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Office of Environment, Energy & Urban Development
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For the New Independent States of the former Soviet Union

A USAID Project Consortium Led by CH2M HILL

A

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:

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- 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
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ABBREVIATIONS, ACRONYMS & GLOSSARY

AAS	Atomic Absorption Spectrophotometer.
BOD	Biological Oxygen Demand.
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).
CHE	(Moldova) Center for Hygiene and Epidemiology.
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.
GC	Gas Chromatograph.
GOST	A soviet-era system of state standards (Gosudarstrennie Standarty)
JSC	Joint Stock Company.
MDEP	Moldova Department of Environmental Protection.
NIS	New Independent States (of the former Soviet Union).
PID	Photo Ionization Detector.
QA/QC	Quality Assurance/Quality Control.
SOP	Standard Operating Procedures.
TLC	Thin Layer Chromatography.
USAID	U.S. Agency for International Development.
USEPA	U.S. Environmental Protection Agency.
USSR	Union of Soviet Socialist Republics.
UV	Ultraviolet.
WHO	World Health Organization.

D

Section 1

INTRODUCTION

1.1 BACKGROUND

As part of a United States government bilateral assistance program, the U.S. Agency for International Development (USAID) is supporting environmental management in Moldova. 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 authorized CH2M HILL to perform a series of tasks in Moldova under Delivery Order (DO) No. 9. Task M2 (Farm Environmental Management Demonstration Project) includes a requirement (Subtask 1: Capabilities Assessment) for CH2M HILL to:

> *... conduct and prepare a report on an assessment of the analytical capabilities and capacity of Moldova to conduct environmental monitoring of the impacts from such [agricultural production] practices and any benefits from improving such practices.*

This report is in response to USAID's requirement to submit an assessment of chemical analytical capabilities. A draft of this report was submitted to USAID in early 1996 for review and comment. Receiving no comments, has CH2M HILL prepared this final report which contains minor modifications to the draft version.

1.2 PURPOSE AND SCOPE

This report on the current status of chemical analytical capabilities with respect to monitoring environmental impact relating to agricultural practices is one component of the overall EPT Project activities in Moldova under DO #9. The analytical capabilities assessment is to evaluate whether additional chemical analytical equipment is needed in Moldova for the country to be able to effectively monitor environmental impacts of agricultural activities. The objective here is to ensure that Moldova can provide the water quality monitoring capabilities to determine the impacts of agricultural production on the environment, and monitor any reduction of impacts through use of improved agricultural methods. This information can then be used by specialists and decision-makers from agricultural, health, and environmental management entities to assess optimal methods to achieve environmental improvements in agriculture.

1.3 REPORT PREPARATION ACTIVITIES

Investigators for this report were **Dr. Lance Stokes** and **Mr. Sven Pavlovics** (see Appendix A). Dr. Stokes, a specialist in water quality and environmental chemistry, spent three weeks

in Moldova (April 22 to May 13, 1995), met with host-country counterparts, and collected information on existing chemical analytical and environmental monitoring capabilities. He collaborated with approximately 20 local specialists from various research institutions and government agencies in compiling information for the report. All the laboratories were notified of the visits prior to the arrival of the evaluator.

Meetings, interviews, assessments, and visits were conducted at several laboratories in Moldova. Meetings typically were one to three hours in length, and site trips were typically two to four hours in duration. A trip to Beltsy was conducted on 2 May, and Orhei was visited on 3 May 1995. Cahul was visited on 4-5 May 1995. The total duration of this study was 21 days (21 April through 13 May 1995), of which approximately 14 days were allowed for investigations and 5 days for review of data and report preparation. The Trip Itinerary for Dr. Stokes is presented in Appendix B.

The data collected during execution of the tasks described above was assembled into a preliminary draft report. Subsequently, the preliminary draft report was reviewed and evaluated in October 1995 by Mr. Sven Pavlovics, an analytical laboratory design and QA/QC specialist, to determine the present capabilities of Moldovan laboratories to analyze soil and water samples for specific agricultural parameters. The Trip Itinerary for Mr. Pavlovics is also presented in Appendix B. The Trip Itinerary includes reference to participation in a symposium that was part of a separate scope of work and is described in a separate report.

Section 2

FINDINGS

Laboratories to be evaluated were selected on the basis of:

- suggestions to Dr. Stokes by Moldovan environmental and chemical lab experts
- proximity of laboratories to the location of potential agricultural demonstration projects to be implemented by the EPT Project in Moldova.

Assessments were made of several chemical analytical laboratories in Moldova responsible for monitoring public health:

- central laboratory of the Center for Hygiene and Epidemiology (CHE), Chisinau
- regional CHE laboratory, Beltsy
- regional CHE laboratory, Orhei
- regional CHE laboratory, Cahul.

In addition, inspections were made of the following:

- laboratory at Department of Ecological Chemistry, Moldova State University
- laboratory at the Chisinau drinking water purification plant
- laboratory at the Cahul drinking water purification plant.

Findings are reported below.

2.1 PUBLIC HEALTH LABORATORIES

2.1.1 Main Laboratory of the Center for Hygiene and Epidemiology, Chisinau

A visit was made to the CHE laboratory in Chisinau, headed Dr. Dumitru Siretseanu, who is director of the CHE. The water analytical laboratory is comprised of a few small rooms, including a sample preparation room, an inorganic laboratory, and an organic laboratory. The laboratory has been in place for some 25 years and was first established under the USSR. There are some 40 CHE locations performing various functions throughout Moldova that were established under the USSR and have existed for approximately the same 25-year period.

There is little variation between the laboratories. The CHE laboratory in Chisinau is the central laboratory of Moldova and thus has a little more equipment, capabilities and staff, while the regional laboratories have substantially less equipment capabilities and personnel.

The estimated area of the central laboratory appeared to be less than 10,000 square feet. The laboratory appeared clean and organized, and work-benches were observed to be unencumbered. There seemed to be four people staffing this laboratory: two holding the

degree of Doctor of Science and two being laboratory assistants. The technicians appeared to be knowledgeable in the work they performed; however, they provided no response to inquiries as to the method of standard additions, or the use of field and trip blanks as a means of internal control. If the laboratory has a formal in-house training program, it was not reflected in the responses given to questions on this matter. Since the laboratory staff could not produce data on quality assurance (QA) blanks or methods of standard addition for sample analyses, it may be concluded that data generated by this laboratory is suspect and at best a qualitative estimate.

It was stated that the laboratory is certified, but information as to when and by what entity could not be established, which implies that laboratory certification is cosmetic and has no scientific basis. No Quality Assurance/Quality Control (QA/QC) manuals, similar to anything found in western laboratories, describing the lab's protocol for handling and analyzing samples and reviewing data, were provided. All inquiries as to QA/QC, as well as to inquiries as to Standard Operating Procedures (SOPs), were responded to with the "GOST Standard". When an inquiry was made as to the documented corrective action that the laboratory takes when analyses are found to be outside of acceptable limits, the response was "The laboratory director takes care of all such matters". These responses appear to indicate the omission or lack of understanding of the procedures to generate analytical data of known quality.

The maximum daily number of samples that the lab can process was first reported to be approximately 10 to 15, but other staff then reported 40 or 50. No sample analysis log books were provided or reviewed to verify this. In addition, the staff reported the normal turn-around time for analytical data as anywhere from one to five days, without defining or referencing sample holding times, or several other procedures that constrain analytical turn-around times. Again, these responses indicate that analytical data generated would not even be considered for use by the international professional lab chemistry community, and that there would be little if any confidence by that community in the representativeness of data generated from this laboratory.

The only instruments observed to be present in the lab were two gas chromatographs (GC) and an atomic absorption spectrophotometer (AAS). One of the GCs was in use by a technician and the AAS was turned on. The carrier gas was nitrogen, but the quality of the carrier gas was not indicated. All of the instruments were of Russian origin and appeared obsolete and/or in questionable condition. Spare parts of fittings, seals, etc. did not seem to be available. No details were given regarding blanks, sample analysis sequences, frequency of calibration, acceptable accuracy, or precision limits of data.

It appeared that no instrument maintenance logs were kept, and corrective action measures were not documented. Samples and standards were stored in refrigerators that also contained food. It was obvious that routine sample analysis procedures did not exist and are not performed. To repeat, therefore, any data generated by this laboratory would be suspect at best, unusable for quantitative purposes, and unacceptable per international standards.

Wet chemistry methods seemed to be the primary methods of analysis used; evidence of gravimetric, volumetric, and calorimetric capabilities were present. Analyses tested on a regular basis were reported to be: chlorides, copper, fluorides, iron, lead, manganese, molybdenum, nitrates, nitrites, pH, phosphates, total dissolved solids, sulfates, strontium, zinc, hardness, turbidity, color, taste, and coliform indices. No analysis sequences were documented, and data was reported as a value had no supporting documentation or QA/QC indicators to define its quality. No blanks, duplicates, or spike samples were analyzed or reported defining the quality of the data. Further, no internal audits, nor any blind performance evaluation standards, appeared to be performed. Also, the laboratory did not appear to be computerized for reporting results.

The lab cleans and recycles all its glassware, and the glassware section was found to be visibly very clean. No plasticware was observed for metals sampling and analysis, thus all metals analyses must be suspect due to the potential for metals leaching from glassware. Distilled water was reported as used for blanks and preparation of standards, but documented data was not available for review.

There was no indication that the laboratory monitors for contamination in sample storage. Samples were observed to be stored separately from standards on counter tops and in a refrigerator. When asked about preservation methods and holding times, it was stated that samples are kept cool and rushed to the laboratory for analysis. Again, no inferences were made as to the types of samples and the appropriate parameter-specific sample preservation techniques and holding times of the samples. Funds were not available to purchase preservation materials. No on-site testing was performed during sample collection, e.g., for pH, residual chlorine, total dissolved solids, conductivity, temperature, etc, because funds are not available to purchase such equipment.

Reagents to conduct chemical analyses were very old, and in some cases their shelf life had expired. No Material Safety Data Sheets were observed, but it was stated that they are available (they were not provided). The response to the question as to how long samples were retained after analysis was "Until they are discarded". Samples were disposed into the sink. The fact that an ecological laboratory does not consider the proper disposal of its potentially hazardous samples again provides an indicator of the lack of understanding of what procedures are required to generate legally defensible analytical data of known quality.

2.1.2 Beltsy Regional CHE Laboratory

The CHE water analysis laboratory in Beltsy is headed by Ms. Raisa Archa. There was an estimated 3,000 square feet of laboratory space for water analysis. It was reported that the laboratory analyzes water for nitrates, nitrites, fluoride, iron, copper, sulfates, chloride, zinc, turbidity, hardness, color, taste, and coliform indices, as well as pesticide content. Analyses were performed via wet bench techniques with determinations made via volumetric, gravimetric, and calorimetric techniques.

GOST manuals were presented in response to all questions regarding SOPs and/or QA/QC procedures (also at all other assessed laboratories). Moreover, there was no evidence to indicate that any independent thought went into defining the accuracy, precision or completeness of the data generated. The estimated number of water samples analyzed was reported as 0 to 12 per day. Distilled water was reportedly used for blanks and the preparation of standards. A standard procedure was described for receiving samples and processing them through the laboratory. Data (results only) are to be recorded into lab notebooks, and final datasheets are to be prepared and shipped to CHE headquarters in Chisinau. QA/QC data is not included with the data sets, and therefore the data would not meet international standards.

The lab had a recent Russian-made gas chromatograph, identified as "Crystal 2000", that was interfaced with a computer. Nitrogen was the carrier gas for the two columns. The purity of the carrier gases was unknown. The GC is used to perform pesticide analysis, which is one of the most complicated environmental analyses to perform. Standards and supporting QA/QC data were not available/performed. Other equipment observed in the lab included pH meters, ion-selective electrodes, and a spectrophotometer. No instrument maintenance logs, sample analysis sequence logs, or documentation of frequency or analysis of blanks, duplicates, spikes, and matrix spikes, or accuracy and precision of data were shown to be maintained.

Three people were employed in the laboratory: one with a medical doctor degree and two with college degrees in medicine (laboratory assistants). It was stated that people who perform sampling receive special training; however, evidence of appropriate sampling equipment, techniques or QA/QC procedures were not apparent.

The prime method of preservation of samples appeared to be keeping them cool and getting them into the laboratory as quickly as possible for analysis, without any indication of parameter specific preservation and/or holding times.

The laboratory benches were clean and free of encumbrances and the lab was well- organized. Most of their reagents were recent and within their shelf life, although the integrity of the dating system on the products themselves could be suspect. No Material Safety Data Sheets appeared to be available to employees. There was no monitoring program for contamination in sample storage, and no temperature monitoring or temperature log books were observed. However, samples were observed to be kept separate from standards.

Samples were discarded into the sink upon completion of analysis unless unusual results were obtained, whereupon the samples were retested. If the unusual results were confirmed, CHE headquarters was requested to give instructions as to what additional steps would be required. Blind performance evaluation, duplicate, matrix spike, or matrix spike duplicate analyses data, were not generated in this laboratory.

The lab cleans and recycles its glassware and sampling containers; however, cleaning procedures, and documentation of and adherence to proper sampling containers for each parameter, were not in evidence.

2.1.3 Orhei Regional CHE Laboratory

The floor space of this water quality laboratory was estimated to be approximately 2,500 square feet. The laboratory appeared clean and organized, and there was adequate work space with unencumbered benches (as evidenced in all other labs).

The chemical analytical lab was staffed by 3 doctors and 5 lab assistants. The bacteriological lab was staffed by 3 doctors and 12 lab assistants. However, not all personnel work at the same time. The head of the laboratory stated that the reason their staff is so large is to accommodate leaves of absence taken by both pregnant mothers and mothers with small children. The amount of compensation paid to staff could not be determined. The lab replicates the one in Beltsy (see Section 2.1.2), with the exception of not having the same number of UV purification rooms.

The laboratory seemed not to have a formal training program for personnel (which was evidenced at all laboratories visited) nor did there appear to be any QA/QC policies or procedures, as practiced in western laboratories. The GOST was referenced as the standard for all aspects of the laboratory, and there seemed to be a lack of knowledge of basic QA/QC principles. This implied that data generated at this laboratory, like other CHE laboratories, was unusable for quantitative purposes.

Analysis of water was performed to determine levels of nitrates, nitrites, fluoride, iron, copper, sulfates, chloride, zinc, turbidity, hardness, color, taste, and coliform indices, as well as pesticides. Wet bench methods were used, and many determinations were made via volumetric, gravimetric, and calorimetric techniques. The lab had a Russian-made GC (Model Crystal 2000) with a photo ionization detector (PID) that seemed to be fairly new. Nitrogen was the carrier gas. (Throughout Moldova, the carrier gas is imported from Kyiv, with no indication of the purity of the gases). The head chemist expressed an interest in learning more about QA and QC methods, which was encouraging that the realization of the importance of QA/QC procedures does exists with some individuals.

At the "Moldova" Agricultural Joint Stock Company in the Orhei Region, Dr. Siretseanu of the laboratory sampled two deep-drilled wells, a water tap in a school, a yard tap, and two shallow-dug wells. The process for taking samples appeared noticeably lax and lacking controls. Samples were placed in random glass containers and left sitting for 5 or 6 hours before they were taken to the lab to be tested. No chain of custody was used; no record was made as to climatic conditions (it was raining) or date or time; and no labels were affixed to sample containers either before or after sampling. The second well was sampled in the same fashion as were the taps. Clear glass containers were randomly selected as well as amber containers. When sampling of the shallow wells took place, samples were obtained by bailing the water with an attached bucket. The bucket was not emptied of its contents nor rinsed several times with well water prior to pouring water into the sample containers. No sampling or QA/QC plans were mentioned or in evidence during these procedures. These sample collection techniques would fail U.S. and international sample collection protocols and would

render the samples non-representative, before they were even delivered to a laboratory for analysis.

2.1.4 Cahul Regional CHE Laboratory

The CHE laboratory in Cahul was certified on 6 April 1995 (no information as to the certifying requirements or entity was provided). Equipment in the laboratory consisted of colorimeters, pH meters, and ion-specific electrodes for fluoride and nitrite analysis. Approximately 30 to 50 samples were analyzed each week. Samples were obtained from points along the Prut River, the Cahul treated water supply, and private hand-dug wells. No QA/QC sample analysis data was in evidence or mentioned (this makes all data generated an estimation only, with no definition of the confidence level associated with the results, thereby making them unusable for quantitative purposes).

Laboratory personnel included two doctors and four college-trained medical technicians. Something similar to a chain of custody was used and accompanied samples to the laboratory (the first evidence of this step in the analytical process). Results of analyses were kept in laboratory notebooks and final reports were prepared by hand and sent to the CHE laboratory in Chisinau, also with no definition or supporting QA/QC data defining the confidence levels.

The laboratory did not appear to have adequate standards and reagents to be able to generate data of known quality. A spectrophotometer was used in the lab; but without any standards, reagents and a QA/QC program, it could not generate useable data. The lab performed analyses using methods similar to those in other CHE labs, namely volumetric, gravimetric, and colorimetric techniques, thereby limiting the capabilities of the laboratory to adequately define levels of public exposure to contaminants of concern.

2.2. LABORATORIES AT DRINKING WATER PURIFICATION PLANTS

2.2.1 Chisinau Drinking Water Purification Plant

The analytical laboratory within the drinking water purification plant for Chisinau was found to be clean and well organized, when the scheduled visit was conducted. The laboratory has been in place for approximately 12 years. Estimated area of the laboratory is approximately 2,000 square feet.

Four or five technical people were observed to be working in the laboratory. The educational levels of the technical personnel were Doctor of Science and medical college- trained lab assistants. The concept of QA/QC as practiced in western laboratories was not familiar to them and any evidence thereof was not observed. This point alone renders all data generated from this laboratory as unusable for quantitative purposes. All procedures used were from the USSR GOST Standard, which is not an internationally acceptable substitute of a QA/QC program.

There did not appear to be any formal training program in the lab, the reason given that the same people have worked there for many years and there is little employee turnover. (It should be noted that employee turnover is not the sole reason for having formal training programs in place. Training programs should address a continual learning curve in the environmental science emphasizing continual improvement which is imperative to generating data of known quality). Lab assistants take samples in the plant and also at tap sites at a hospital and in schools. No sampling plans or QA procedures were evident. Samples within the plant were taken at designated sampling locations where there are taps. A sampling protocol was employed wherein the water is allowed to run from the tap for a specified amount of time prior to taking the samples. Although no preservatives were used, the sample containers -- sterilized recycled amber and clear containers (appearing to resemble wine bottles) -- were kept cool and returned to the laboratory as quickly as possible for analysis. Field blanks, duplicate samples, matrix spikes, etc. were not collected or performed. A color indicator qualitative test was used to detect the presence of chlorine in the field, but without a formal sampling and analysis plan.

Analyses were performed primarily via wet bench methods with volumetric, gravimetric, and calorimetric techniques. Analyses were reported to be for detection of aluminum, beryllium, molybdenum, arsenic, nitrates, nitrites, lead, iron, hardness, etc.

The lab also performed a qualitative analysis for chloraphos and metaphos, using a thin layer chromatographic (TLC) technique with UV detection. If an indication of these analyses was found, the samples were sent to Kyiv for quantitative analysis. Detection limits were not specified and QA/QC protocols were not addressed. Pesticide screening techniques were employed; however, sampling protocols and preservation techniques for pesticide sample shipping were not used, rendering the confirmational analysis as qualitative, at best.

Instruments observed to be in the laboratory were pH meters, calorimeters, spectrophotometers, titration apparatus, and analytical balances, all of which were outdated.

Although deionized water was not available, distilled water was used for blanks and the preparation of standards. Internal audits and the use of blind performance evaluation standards were not concepts familiar to the technicians in this lab.

Samples and standards were observed to be stored separately, and no food materials were observed to be stored in sample and/or standard storage units. Samples were disposed into a sink almost immediately following analysis unless, something unusual was detected. Material Safety Data Sheets were not available to the technicians in the laboratory.

The microbiological lab at the purification plant measured coliform indices. There were a total of 50 sites identified within the plant that were tested to monitor the purification system, and samples were collected on a regular basis. The microbiological lab personnel expressed a concern about the short supply of membrane filters, and stated that a supply of these filters would be greatly appreciated. When asked if they perform analysis for enteric viruses, they stated that they did not, and that they know of no other laboratory in the region that does.

2.2.2 Cahul Drinking Water Purification Plant

The inspection of the laboratory at the Cahul water purification plant was led by Ms. Valentina Timofeeva, head of the laboratory. The area of the analytical water lab was estimated to be approximately 2,500 square feet. The laboratory was clean and well- organized. There was adequate work space and benches were unencumbered. Two people were employed in the chemical analytical lab, Ms. Timofeeva and Ms. Tatiana Bezman, a chemical engineer. Two people were also employed in a bacteriological lab, one of whom was Mr. Michail Volf, technologist and engineer. The lab did not have a formal training program for personnel.

There was no evidence of knowledge of the importance of defining QA/QC policy, or of programs or procedures as exercised in western laboratories. It was indicated that the GOST standard is followed and serves as the SOP for the lab.

The laboratory analyzed water samples from two points within the purification station: one on Prut River water as it enters the plant, and the other on reservoir water after purification. Water samples were tested for levels of nitrates, nitrites, ammonium, pH, chloride, iron, sulfate, aluminum, turbidity, hardness, residuals, taste, odor, color, and fluoride. As with all other CHE laboratories, typical wet chemistry methods were applied using reagents and colorimetric techniques to determine the concentrations. Fluoride testing had not been performed for some time because they did not have a functioning fluoride ion electrode.

Equipment in the lab included a spectrophotometer, calorimeters and pH meters, and ion-specific electrodes. This lab also used a TLC technique followed by UV detection to qualitatively detect pesticides, a method of elevated detection limits and unknown quality that is not used in the U.S.

The laboratory cleaned and recycled its glassware. The technicians took samples using a specific protocol. GOST was the identified source for SOPs, QA/QC, and maximum allowable concentration levels. Samples were disposed into the sink upon completion of analysis. Samples and standards were stored separately. Distilled water was used for blanks and for the preparation of standards when the latter were not available.

No documentation logs of standards preparation, frequency of analysis, blanks, spikes, matrix spikes, or matrix spike duplicate analysis existed, therefore, all data generated should be regarded suspect and of unknown quality.

Laboratory personnel expressed the need for equipment spare parts, particulary ion-specific electrodes as well as standards and reagents.

The bacteriology lab performed coliform indices and was in urgent need of special membrane filters for bacteriological determinations. Staff estimated that, based on their volume of analyses performed, 1,000 membrane filters per year were required. They stated their belief that all purification station laboratories were in need of similar supplies.

2.3 STATE UNIVERSITY DEPARTMENT OF ECOLOGICAL CHEMISTRY LABORATORY

An inspection was made of the laboratory of the Department of Ecological Chemistry at the State University, founded in 1993. It performs research on wastewater, and is involved in the development of water new treatment methods. People working in this lab were relocated from the Department of Physical Chemistry. Professor Giorgio Duca, a member of the Moldovan National Academy of Sciences, is the head of research in this laboratory, which is focused in three directions: 1) reduction-oxidation (redox) process of nitrogen compounds; 2) redox process of natural waters - presently performing field studies on the Byk River, from approximately 10 km outside the city at the beginning of the river down to a point where wastewaters enter the Byk River; and 3) purification of wastewater via electro-deposition of heavy metals. People who work in the laboratory (who are also professors) include:

Dr. Mira Gonta:	Conducts studies on nitrogen content in various compounds. Doctor of Chemical Sciences; also teaches ecology.
Ms. Viorica Iambatteva:	Handles computer applications.
Dr. Elena Goriacheva:	Doctor of Biological Sciences, working on natural/self purification of waters; also deals with problems in, and teaches, hydrochemistry.
Dr. Lidia Romanchiuc:	Doctor of Chemical Sciences.
Mr. Igor Mardari:	Graduate student.
Ms. Olga Kovaliova:	Doctor of Chemical Sciences, teaches environmental engineering. Doing research on electrochemical methods of wastewater purification.

The scientists are conducting research to remove copper from wastewater. They are also studying nitrogen content in surface waters and shallow-well waters. One of their statements was "...in rural areas, nitrogen content is very high, around 200 parts per million". They are studying certain elementary reactions of nitrogen compounds to determine how to inhibit their formation. They also look at the nitrogen concentration in food and body tissue.

A study of the natural/self purification of water is also being pursued, including the interaction between biological, physical, and chemical interactions to purify water. They use chemical modelling. This is an area where a significant contribution could be made if new software and a computer system was provided. Presently they have an IBM-compatible 386 computer with 4 MB of RAM and a 30 MB hard drive.

2.4 REVIEW OF DATA ON POTABLE WATER

Analytical laboratories visited typically focused on various drinking water parameters, and did not perform surface water or soil analyses, which would be required in order to collect data on the environmental impact of the agricultural activities. Analytical data, representing water sampling and analysis results from various locations, water source types, and dates, are presented in Appendix C. This data was transcribed and compiled directly from official records (hard copy sheets) provided by the CHEs. Nitrate levels appeared to occur at elevated levels in water samples taken from shallow hand-dug wells. These wells were in close proximity to solid waste accumulation sources. Sulfate levels were also observed to be high. Coliform levels,when measured, were high.

Overall, the extensive data on file at CHEs, and other data provided, should be regarded as highly suspect. Given that in some instances there were no standards, no current reagents, and poor sampling techniques, the data collected has minimal value, and it is impossible to make any definite statements or base any conclusions on it.

Section 3

CONCLUSIONS AND RECOMMENDATIONS

Based on findings as presented in Section 2, the following conclusions and recommendations are made.

3.1 CONCLUSIONS

Four routine water analysis analytical laboratories, one analytical research laboratory, and two water purification plant laboratories were visited. Personnel appeared to be competent and knowledgeable in the analytical techniques being used. The laboratories were neat, clean, and organized, with ample work space on unencumbered benches. All laboratories were found to have obsolete equipment, and some equipment was highly suspect as to operational capability. Routine calibration and maintenance of equipment was not employed. A prime contributor to this shortcoming was the lack of availability of needed parts, as well as the lack of a repair source and/or funds to procure both. All laboratories were deficient in standards and reagents. Modern QA/QC policies and procedures were not in place and proper sampling techniques were not practiced.

Based on information collected and reviewed for this report, it may be concluded that the typical analytical laboratories and other institutional laboratories do have experienced personnel in order to conduct the analyses required to monitor environmental impact of agricultural activities, but they lack the specific instrumentation, methodologies, and QA/QC procedures to ensure effective monitoring.

3.1.1 General QA/QC

Most analyses performed by the laboratories had little or no calibration data and no documented routine QA/QC procedures. The Russian GOST Standard QA manual was referenced; however, QA/QC documentation to support the analytical data was not generated, and the general lack of knowledge associated with the importance of QA/QC procedures was prevalent. In addition, data management systems generally did not exist, even though they are critical for application and analysis of data generated outside the laboratory.

The overall capabilities of the water quality monitoring and analyses laboratories were inadequate to generate environmental data of known quality or confidence levels, and could not produce the required degree of information needed to determine environmental impacts from agricultural operations, particularly data on pesticides, herbicides, and their degradation products, which require sophisticated analytical capabilities.

Officials were reluctant to point-out deficiencies and make available analytical data, capabilities, and protocols. It was evident that the central CHE laboratory had better-quality equipment; regional laboratories had lesser facilities and could not be expected to have access to equipment, reagents, standards, or information that the central laboratory possessed.

3.1.2 Sampling QA/QC

The lack of QA plans, SOPs, sampling plans, chain-of-custody documentation, sample preservation, use of compatible sampling containers, sampling equipment, and lack of basic sample integrity procedures in all laboratories visited, jeopardized the integrity of quantitative analysis typically performed. Without these practices and procedures, samples become less representative of actual conditions.

3.1.3 Analytical Instrumentation and Methodologies

In general, the laboratories did not have the capability to conduct sophisticated analytical tests need to provide accurate, reliable, and internationally recognized data on pesticides, herbicides, and associated degradation products. Instruments at the laboratories inspected were elementary, probably due to the lack of financial resources at labs to expand and/or upgrade capabilities. Most laboratory analytical equipment was outdated, with limited support and peripheral equipment available. Laboratories inspected did not have acceptable reagents for analytical procedures and standards for calibration procedures, which are critical for producing accurate and precise data.

Internationally recognized standard curves are typically verified at a frequency of 5% of sample through-put. In the laboratories visited, standard curves in some cases were generated several years ago.

3.2 RECOMMENDATIONS

Based on the findings in this report, the following general recommendations are presented:

1) Although existing wet chemistry capabilities are limited, the Moldovan laboratories could generate data of known quality if appropriate standards, reagents, and training were available. The limited instrumentation, reagents, and standards could be utilized to generate relatively low-level, but definable, quality data.

2) A pilot program of environmental monitoring and chemical analyses would offer an excellent opportunity to provide QA/QC training, access and utilization of QA/QC manuals, laboratory management guidelines, QA plan development, sampling plan development, and data quality objectives process implementation. Such a program should include the following component activities:

   - developing QA manuals, procedures, and training workshops for Moldovan chemists

   - conducting sampling and analysis plan preparation workshops, using the USEPA Data Quality Objectives Process

- providing analytical standards and reagents, and training in the maintenance of reagents and standards programs for laboratories
- providing training and equipment for sample collection activities
- providing training for analytical database development and management
- providing workshops and training on environmental laboratory management.

3) Chemical analytical laboratory capability would be improved by the addition of new, up-to-date equipment. A preliminary equipment recommendation is presented in Appendix D.

Appendix A

REPORT INVESTIGATORS

This report was prepared by the following persons under subcontract to CH2M HILL's EPT Project:

- **Mr. Lance Stokes, Ph.D.** Professional experience in environmental economics involving heavy industry. Experienced in environmental assessment of pollution control and waste minimization, and chemical storage. Owns and operates a chemical analytical environmental laboratory in Michigan. Experienced in analyzing air, water, soils, sludge and waste.

- **Mr. Sven Pavlovics, R.E.M.**, has over 12 years of experience in environmental chemistry. He has managed contamination assessment and remediation projects at a multitude of sites with a variety of classes of compounds. Mr. Pavlovics has extensive experience in multifaceted sampling plan design and implementation. He has designed and implemented environmental analytical laboratories and is an expert on chemical analysis quality assurance/quality control procedures.

Appendix B

TRIP ITINERARIES

TRIP ITINERARY
Lance Stokes
22 April - 13 May 1995

April 22, 1995	Arrive in Chisinau, 7 pm
April 23, 1995	Meeting with James Holderbaum and John Jackson.
April 24, 1995	Discussions with staff on history of EPT Project in Moldova, and planning of Itinerary.
April 25, 1995	EPT Offices, Chisinau Meeting with: Dr. Nicolai Opopol, Professor of Hygiene and Epidemiology, State Medical University, Chisinau.
April 26, 1995	EPT Offices, Chisinau Meeting with: Dr. Liubovi Vasilos - Head Laboratory of Scientific Research, Institute of Protection of Maternal Health; Dr. Grigori Friptuliac, Associate Prof, Dept of Hygiene, State Medical University; Dr Serge Ursul, Sr. Research Associate, Institute of Genetics, Moldova Academy of Sciences; Drs. Nicolai Opopol; Zoltan Annau; Hale Vandermer; and Morris Decker. Meeting with: Dr Dumitru Siretseanu, Director, Division of Environmental Hygiene, Center of Hygiene and Epidemiology; Dr. Stoleru, Associate Director, Department of Ecology, Ministry of Health; Dr. Chiriac. Chief of Water Quality Department, Ministry of Health; Dr. Roman Corobov, Senior Research Associate, Institute of Geography, Moldova Academy of Sciences; and Drs Hale Vandermer and Zoltan Annau.
April 27, 1995	EPT Offices, Chisinau Meeting with: Dr. Anna Volnianskaya, Head, Laboratory of Scientific Research Institute of Preventive and Clinical Medicine; Dr. Andrei Vasilos, Head, Laboratory of Scientific Research, Institute of Maternal Health Protection; and Drs. Zoltan Annau and Hale Vandermer.
April 27, 1995	EPT Offices, Chisinau Meeting with: Dr. Dumitru Siretseanu; Mr. Boris Boinchan, Chief, Department of Agricultural Systems, Research Institute of Field Crops "Selectia", Dr. Nicolai Opopol; Dr. Andrei Gavrilitsa, Director, Institute of Water Problems and Amelioration; Dr. Vasilii Voineac, Deputy Director, Institute of Pedology, Agrochemistry and Soil Improvement; Dr. S. Andriesh, Soil Expert; Drs. James Holderbaum, John Jackson, Hale Vandermer, Zoltan Annau, and Morris Decker.
April 28, 1995	EPT Offices, Chisinau Meeting with: Drs. Pavel Gusac, Associate Professor, Department of Histology, State Medical University, Drs. Hale Vandermer and Zoltan Annau. Meeting with Mr. Antrepov, Engineer and Technologist; Mr. Rufnick, Superintendent of the Chisinau Purification Plant. Toured facility and learned the extent of water treatment and of the various water sources that are blended to supply potable water to the area. Visited the Laboratory at the Purification plant in Chisinau. Assessed laboratory. Visited laboratories at Moldova State University. Meeting with Dr. Mira Gonta, Ms Viorica Iambarteva, Dr. Elena Goriacheva, Dr. Lidia Romanche, Mr. Igor Mardari, and Dr. Olga Kovaliova.

May 2, 1995	Trip to "Selectia" Research Institute, Beltsy Meeting with: Dr. Alexander Turcan, Medical Director Visit to the CHE Laboratory in Beltsy Meeting with: Mr. Vasili Turcan, Chief Doctor of regional CHE in Beltsy and Ms Raisa Archa, Head of Lab. Toured and assessed laboratory. Discussed needs. Meeting with Mr. Konstantin Prokopii - Chief of Environmental and Communal Objects.
May 3, 1995	Departed from Beltsy, to travel to Orhei Meeting with Chief Doctor of regional CHE: Mr. Tighineau Constantine. Toured laboratory in Orhei. Discussed lab procedures; assessed lab. Listened to their needs. Visited the Joint Stock Company in the Village of Sirota near Orhei Meeting with: Mr. Teodor Tricolich, Chief Engineer of the JSC. Toured facility to learn water supply system. Took samples of two deep drilled wells, spring taps, street taps and yard taps with Dr. Siretseneau.
May 4, 1995	Departed for Cahul Meeting with Mr. Crihan Hgeorgieviei, Chief Doctor of regional CHE for Cahul. Toured laboratory. Visited "Prietenia" Joint Stock Company, Lebedenco Village. Meeting with: Ms. Tamara Montianu, Director of Farm; Mr. Chitaniue Gavriip Vasile, Head of Dept of Services and Construction.
May 5, 1995	Visit to Cahul water purification plant and laboratory. Meeting with Mr. Crihan Gheorgieviei, Chief Doctor CHE; Ms. Timofeeva Valentina Grigorievna, Head of Purification water analytical lab; Mr. Micheal Nikolai Volf, Technologist and Engineer; and Ms. Tatianna Bezman, Chemical Engineer. Toured and learned about water supply system for Cahul. Toured and assessed laboratory. Identified needs. Visit to the Joint Stock Company Prietenia, Veterinary Station.
May 6, 1995	Return to Chisinau.
May 8, 1995	Chisinau Meeting with: Dr. Ion Ababii, Rector, State University Medical School, Chisinau; Dr. Valeriu Teodor Chico, Dean, School of Preventive Medicine. Meeting with: Dr. Mihai Vasile Magdei, Vice Minister for Health; Dr. Nicolai Ion Bagnarel, Chief Physician, Republican Center of Hygiene and Epidemiology.
May 9-12 1995	Chisinau Develop analytical Report and workshop design report
May 13, 1995	Departed Chisinau

TRIP ITINERARY
Sven R. Pavlovics
2-9 October 1995

October 2, 1995	Arrived in Chisinau, Moldova
October 3, 1995	Discussed project goals and logistics. Attended symposium proceedings and met with Drs. Zolton Annau and Joe Malina. Met all other EPT Project Moldova staff. Attended reception in the evening and met with several symposium attendees.
October 4, 1995	Co-chaired the symposium and presented the ISO 14000 presentation. Meeting with Dr. Giorgio Duca, chairman of the Ecological Chemistry Department at the State University.
October 5, 1995	Meeting with the Director of the Institute of Science. Reviewed all Moldovan analytical capabilities reports and technical reports. Attended meetings with Dr. Vitali Lungo in the evening where the future of Moldovan ecological chemistry and the environment were discussed.
October 6, 1995	Revisions to Moldovan Analytical Capabilities Report and prepared trip report.
October 7, 1995	Assisted in preparations for project evaluations. Reviewed and revised reports, and provided input to project.
October 8, 1995	Assisted in preparations for project evaluations. Reviewed and revised reports, and provided input to project. Conducted lecture to State University students and faculty on environmental laboratory QA\QC.
October 9, 1995	Departed Chisinau.

Appendix C

REPRESENTATIVE CHEMICAL ANALYTICAL DATA

ORHEI

RESULTS IN UNITS OF mg/L or PPM

	PRIVATE WELL		PRIVATE WELL		PRIVATE WELL		STREET WELL		SPRING WATER WELL		DEEP DRILLED WELL		CAPTAGE - ORHEI		CWS ORHEI	
ANALYTE	1994	1995	1994	1995	1994	1995	1994	1995	1994	1995	1994	1995	1994	1995	1994	1995
AMMONIUM	0.043	-	0.043	0.1	0		0	0.08	0	0.6	0	2.9		0.06		0.11
NITRATE	81		81	58	81		69	51.3	0	1.7	1.5	1.6		0.01		0.01
NITRITE	0.14		0.14	0.01	0		0	0.01	0	0.01	0	0.01		44.9		3.9
HARDNESS	17.2		23.6	25.2	24		19.2	27.6	11.6	11.6	9.4	10.1		9.5		9
DRY RESIDUE	1700		3300	2123.8	3200		2750	2535.5	850	946	850	786.8		1122.4		966.2
CHLORINE	120.4		156.1	122.4	169.3		85.7	142.8	31.6	31.6	46.9	26.5		56.6		32.6
SULFATES	370.35		1152.2	916.2	305.3		823	1122.2	205.75	292.4	205.75	293		380.4		308.6
COPPER									0.06	0.06	0	0.206		0.004		0
IRON									8	0.49	0.25	0.77		0.07		0
MOLYBDENEM									0	0	0	0		0		0
ARSENIC									0	0.0003	0	0.0003		0		0
FLUORIDE				0.6				0.4	0.4	0.5	0.49	0.3		0.4		0.4
MANGANESE									0	0	0	0		0		
HCO3																
COLIFORM	<9		<9	N.T.	<9		<9		<3		<3			N.T.		
ZINC										0.02		0.02		0.02		
LEAD										0.01		0.01		0.01		
BERYLIUM										0		0		0		
STRONTIUM										5.95		4.85		0.7		

ORHEI

Results in units of mg/L or ppm

ANALYTE	DEEP DRILLED WELL #1 1994	DEEP DRILLED WELL #2 1991
AMMONIUM	0	0
NITRATE	0	1.55
NITRITE	3	
HARDNESS	150	170
DRY RESIDUE		
CHLORINE	33	42
SULFATES	304	414
COPPER	0.07	
IRON	0	0
MOLYBDENEM		
ARSENIC		
FLUORIDE	0.24	
MANGANESE		
HCO3	368	433
COLIFORM		
ZINC		
LEAD	0.0075	
ALUMINUM		
STRONTIUM	4.24	
PHOSPHATES	0.12	
a-HCCH	0.0048	

CAHUL

ANALYTE	DEEP WELL #493 1995	DEEP WELL #410 1995	LEBENDENCO RESERVOIR 1995	HOSPITAL 1995
AMMONIUM	0.05	0.04	0.05	0.31
NITRATE	15	5.9	15.4	1.3
NITRITE	0.002	0	0.003	0
HARDNESS	6.5	7	10	1
DRY RESIDUE	811	722.4	574.4	623.6
CHLORINE	91.8	63.8	104	15.3
SULFATES	231.9	196.5	211.5	44
COPPER	0.005	0.004	0.006	0.005
IRON	0.02	0.03	0.02	0.03
MOLYBDENEM	0	0	0	0
ARSENIC	0	0.0012	0.0003	0
FLUORIDE	0.4	0.4	0.25	1.3
MANGANESE	0	0	0	0
HCO3				
COLIFORM				
ZINC	0.01	0.02	0.02	0.01
LEAD	0.01	0.004	0.006	0
BERYLIUM	0	0	0	0
STRONTIUM	0.5	0.5	0.5	0.2
PHOSPHATES				
a-HCCH				

CAHUL

ANALYTE	LEBENDENCO CWS	LEBENDENCO CAPTAGE	LEBENDENCO SHALLOW PRVT WELL	URSOAIA CWS	URSOAIA SHALLOW PRVT WELL	URSOAIA DEEP WELL	URSOAIA CAPTAGE
COPPER	0.03	0.01				0.01	0.03
NITRATE	3.9	2.9		57.9	87 - 446	44.5	50
NITRITE	0	0		0	0.03	0	0.002
SULFATE	70.1	126.4			172.7	71.3	104.7
AMMONIUM	0	0		0	0.1	0.03	0.09
CHLORIDE	66.2	19.5			149	88.3	91.5
COLLIFORM	93.00	111	111	93	333		

ORHEI

ANALYTE		SIROTA SHALLOW WELL	SIROTA DEEP WELLS	CUCURUZENI SHALLOW WELL	CUCURUZENI DEEP WELL
COPPER	1994				
	1995		0 - 0.2		0 - 0.1
NITRATE	1994	69 - 180			
	1995	6.3 - 58.5	0 - 10.2	16 - 162	0 - 8.1
NITRITE	1994				
	1995	0 - 0.14		0 - 0.0087	0.004 - 0.087
SULFATE	1994	82.3 - 1152.2	205.75 - 617.4		
	1995	493.8 - 864.2	246.9 - 288.05	452.6 - 1646	288. - 617.2
AMMONIUM	1994				
	1995	0 - 0.043		0 - 0.02	
CHLORIDE	1994	85.7 - 169.3	30.1 - 46.9		
	1995	91.1 - 215.6	28.7 - 34.8	44.5 - 173.4	32.2 - 80.3
COLLIFORM	1994	23			
	1995	23 - 230			

Appendix D

PRELIMINARY RECOMMENDATIONS FOR ANALYTICAL EQUIPMENT AND INSTRUMENTATION FOR MOLDOVA

The following is a preliminary recommendation on the type of instrumentation and equipment that would be appropriate for improving analytical capabilities within Moldovan laboratories:

Field Spectrophotometer

Square Cuvettes

Test Tube Cuvettes

Variable Wavelength Liquid Chromatograph (UV/Visible Range)

HPLC Columns

Portable/Lab Bench Gas Chromatograph (with Electron Capture Detector)

Atomic Absorption Spectrophotometer

Bench Top pH/Ion Meter

Ion Selective Electrodes (low concentration measurements of nitrates, ammonium, fluoride)

Pesticide Standard Solutions

Organophosphate Mixes
Chlorinated Herbicide Acid in Methanol
Organochlorine Pesticide Mixtures
Aldicarb
Aldicarb sulfone
Carbaryl
Carboturan
Methomyl
Oxamyl

Inorganic Potable Water Standards

Metal Potable Water Standards 1

Membrane Filters (for Coliform Analyses)

Sampling Bailers

Chemical Reagents