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EUWI+ EU WATER INITIATIVE FOR EASTERN PARTNERSHIP

European Union Water Initiative Plus for
Eastern Partnership Countries (EUWI+): Results 2 and 3

ENI/2016/372-403

# LABORATORY ASSESSMENT REPORT ARMENIA

May 2019, Final Version
(based on Version 2.0 – Final Draft; December 2017)

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## Abbreviations

AFS ..... Atomic fluorescence spectroscopy
BC ..... Beneficiary country
BQE ..... Biological quality element
CW ..... Coastal waters
DOA ..... Description of action
DOC ..... Dissolved organic carbon
EaP ..... Eastern Partnership
EC ..... European Commission
EECCA ..... Eastern Europe, Caucasus and Central Asia
EMIC ..... Environmental Monitoring and Information Centre of the Ministry of Nature Protection of the Republic of Armenia
ENP ..... European Neighbourhood Policy
EPIRB ..... Environmental Protection of International River Basins
EQS ..... Environmental Quality Standards
EU ..... European Union
EUWI+ ..... European Union Water Initiative
GC ..... Gas chromatography
HPLC ..... High-performance liquid chromatography
IEC ..... International Electrotechnical Commission (International Standards and Conformity Assessment for all electrical, electronic and related technologies)
ISO ..... International Standards Organisation
LLE ..... Liquid-liquid extraction
LOD ..... Limit of detection
LOQ ..... Limit of quantification
MNP ..... Ministry of Nature Protection of the Republic of Armenia
MS ..... Mass spectrometry
NFP ..... National focal point
NPD ..... National policy dialogue
PTS ..... Proficiency testing scheme
QA ..... Quality assurance
QC ..... Quality control
QM ..... Quality management
RBMP ..... River Basin Management Plan
TOC ..... Total organic carbon
TW ..... Transitional waters
USAID ..... United States Agency for International Development
WB ..... World Bank
WFD ..... Water Framework Directive
WSS ..... Water supply and sanitation
WTP ..... Water treatment plant
WUA ..... Water Users Association

**Country Specific Abbreviations – Armenia**

EIMC ..... The Environmental Impact Monitoring Centre
HMC ..... Hydrogeological Monitoring Centre
MNP ..... Ministry of Nature Protection
SCWS ..... State Committee on Water Systems
SWCIS ..... State Water Cadastre Information System of Armenia
WRMA ..... Water Resources Management Agency

# 1 PROJECT SUMMARY

The Eastern Partnership (EaP) is a policy initiative launched at the Prague Summit in May 2009. It aims to deepen and strengthen relations between the European Union and its six eastern neighbours: Armenia, Azerbaijan, Belarus, Georgia, Moldova and Ukraine.

In recent years, the countries of the Eastern Partnership have demonstrated a willingness to align their water policies and practices with the general principles and specific requirements of the EU Water Framework Directive (WFD), as well as other thematic and sectoral water directives and UN Multilateral Environmental Agreements (MEAs). Moreover, Georgia, Moldova, and Ukraine have assumed commitments to reform water policies and implement the EU water *acquis* as part of the Association Agreements signed with the EU in 2014.

It is within this context that the *European Union Water Initiative Plus for the Eastern Partnership* (EUWI+) for Eastern Partnership Countries was initiated by the Directorate-General for Neighbourhood and Enlargement Negotiations (DG NEAR) of the European Commission.

The *European Union Water Initiative Plus for the Eastern Partnership* (EUWI+) was launched in September 2016 to assist the six Eastern Partnership countries to approximate to the EU Water Framework Directive and its associated directives. Its objective is to improve the sustainable management of water resources with a focus on trans-boundary river basin management.

EUWI+ focuses on five thematic areas:

- Legislation, policy development and institutional consolidation
- Laboratory and monitoring system enhancement
- River Basin Management Plan development
- River Basin Management Plan implementation
- Public awareness, communications, and data/information management

The OECD and UNECE are implementing activities under thematic area 1. Thematic areas 2–5 are being undertaken by a consortium of EU member states comprised of the Environment Agency Austria (UBA) and the International Office for Water (OIEau/IOWater) of France. Experts from other EU member states will also be involved in project activities.

The budget for these thematic areas for all six countries amounts to a total of EUR 24.6 million and is financed by the European Union with contributions from the governments of Austria and France. Its planned period of operation is from September 2016 until August 2020 (48 months).

A website has been created (http://euwipluseast.eu/en/) for the publication and dissemination all the data, information and services developed and used within the framework of this project.

# 2 EXECUTIVE SUMMARY

The *European Union Water Initiative Plus for the Eastern Partnership* (EUWI+) was launched in September 2016 to assist the six Eastern Partnership countries in approaching the EU Water Framework Directive (WFD) and its associated directives. The project objective is to improve the sustainable management of water resources with a focus on trans-boundary river basin management.

In order to establish project priorities and targets, an assessment of the current laboratory situation for the hydro-chemical testing of water was carried out during the second and third quarters of 2017 with the aim of identifying gaps and fields of improvement in the following areas, as defined in the description of the action (DOA) to the Grant Contract: the assessment of laboratory infrastructure, personnel capacities, analytical quality assurance, accreditation status, WFD-relevant sampling and testing methods, and documentation.

**Laboratory infrastructure:** The Environmental Monitoring and Information Centre of the Ministry of Nature Protection of the Republic of Armenia (EMIC) acts as the main partner and maintains a laboratory, which is responsible for water analysis. All types of water analyses (surface and ground water, waste water, sediment, soil) are carried out in this laboratory. The assessment of the laboratory's general infrastructure revealed that the building and premises of the laboratory selected did not meet ISO/IEC 17025:2005 requirements. The decision was made to improve the EMIC's water laboratory by relocating it to the building of the Institute of Chemical Physics Academy of Sciences of the Republic of Armenia with the support of the EUWI+ project.

**General staff capacities:** The EMIC water laboratory personnel consist of twenty staff members, with advanced academic (chemistry) and university degrees. The personnel are well trained, committed, motivated to perform their assignments and meet the personnel capacity needs.

**WFD-relevant testing and sampling methods:** Several WFD-relevant testing methods for water are already established and are performed.

**Accreditation status:** The laboratory is not yet accredited according to ISO/IEC 17025 standards. A draft quality manual is partly written and already in use. This could be complemented gradually and would represent an enormous step towards preparatory work accreditation.

**New equipment:** The additional equipment needed for the analysis of new parameters and approaching the WFD has been prepared and harmonised with EMIC.

**Training:** Three different training courses should be provided for all three laboratories: (i) General laboratory training that can be conducted independently on equipment, (ii) Hands-on training with existing equipment and (iii) Training on new equipment. The general training curriculum for the laboratory has been prepared and harmonised with the EMIC laboratory. In addition, the supply of the relevant ISO- and chemical reference standard for existing equipment is foreseen, as well as method validation and the training of laboratory personnel. A list of parameters and methods has been prepared for the new equipment and as soon as the equipment is successfully installed, training can begin.

**Recommendation:** Most of the laboratory equipment involves expensive investments and requires consumables (gases, chemicals, solvents etc.), maintenance, servicing, spare parts and budget for the establishment of new methods and a number of cost-intensive, supplementary procedures, which are needed to achieve valid results. For this reason, the drafting of a laboratory strategy would help identify critical items and establish actions to overcome bottlenecks. The authors of this report recommend developing a laboratory strategy for the EMIC water laboratory for a period of 10 years.

# 3 INTRODUCTION

The European Neighbourhood Policy (ENP) provides a framework for closer relations between the EU and its neighbouring countries. The European Union Water Initiative Plus for Eastern Partnership Countries project (EUWI+) aims to furnish the neighbouring countries with further support in improving their water quality and has a special focus on trans-boundary river basin management in the light of the WFD principles.

The EUWI+ action is built on the lessons learned from several development initiatives of the European Union in the water sector in Armenia, consisting primarily of the EUWI EECCA and EPIRB projects.

This overall project objective addresses existing challenges in both the development and implementation of efficient water resource management.

One key, outstanding challenge is the further enhancement of water monitoring capacity through the geographical coverage of monitoring networks, laboratory infrastructure and the methodological basis for sampling, (physical-)chemical analyses, ecological and hydro-morphological status determination.

Capacity building and increased regular national budgets for monitoring activities are often more urgently needed than sampling or laboratory equipment and this is especially true of Armenia.

Monitoring and appropriate laboratory capacities play a central role in the implementation of the WFD. Therefore, the WFD's daughter directive on technical specifications for chemical analyses and the monitoring of water status (Commission Directive 2009/90/EC[1] – QA/QC Directive) duly addresses quality assurance and the comparability and reliability of analytical results. Accreditation provides government bodies and regulators with confidence in the technical competence and quality of the data generated by the laboratories carrying out testing.

Consequently, the main objective of the EUWI+ project is to consolidate the monitoring infrastructure (monitoring network and laboratory infrastructure, sampling, measurement and laboratory equipment incl. maintenance thereof), which is closely related to and goes hand-in-hand with activity 2.2.1 on capacity building through staff training (sampling, analytics, QA/QC, accreditation and ecological status or potential determination), which also contributes to output from activity 2.3, the implementation of RBMPs.

The assessment was carried out by visiting the laboratories involved in person, in order to examine existing equipment, personnel, infrastructure and the laboratory premises, and by studying the list of required parameters in the WFD and checking their degree of implementation.

The main focus of this assessment report is on chemical analyses, including the physical-chemical parameters and priority substances according to the Commission Directive 2013/39/EC[2] and corresponding QA/QC topics. During the assessment phase, it became apparent that according to ISO/IEC 17025:2005[3] requirements, in general the laboratories' infrastructure (buildings, premises) is inadequate.

In the course of the assessment it was soon evident that the physical conditions at the Environmental Monitoring and Information Centre's (EMIC) water laboratory did not match the criteria for buildings and accommodation as laid down by ISO 17025. The project team informed the management of EMIC and was asked to draft a document describing the deficits and suggesting amendments. Building on

[1] COMMISSION DIRECTIVE 2009/90/EC of 31 July 2009, which, pursuant to Directive 2000/60/EC of the European Parliament and of the Council, lays down technical specifications for chemical analysis and monitoring of water status.
[2] Directive 2013/39/EU of the European Parliament and of the council amending Directives 2000/60/EC and 2008/105/EC as regards priority substances in the field of water policy.
[3] ISO/IEC 17025:2005, General requirements for the competence of testing and calibration laboratories, International Standard Organisation, Switzerland.

these suggestions, a government of Armenia resolution has been attained for the relocation of the EMIC's water laboratory to the building of the Institute of Chemical Physics Academy of Sciences of the Republic of Armenia. EUWI+ will support this procedure by co-financing the relocation. The process is currently in progress and the steps necessary for the quick relocation of the laboratory are being taken. At the same time, contractual issues are being solved, in order to soon come to a collaboration agreement.

This assessment report has also been drawn up and refers to the technical equipment of the laboratory and training needs.

# 4 ASSESSMENT METHODOLOGY

During the inception phase there was already an opportunity for short visits to selected laboratories involved in regulatory water monitoring. In addition, laboratory questionnaires were distributed in order to gather relevant information in a systematic manner, i.e. a brief description of the laboratory, general personnel capacities, laboratory facilities, equipment, test methods, analytical quality assurance, documentation, reporting and support needed for the EUWI+ project. Together with the country priorities and results from the previous EPIRB project, this information provided an initial indication of the current status and the basis for the in-depth, on-site assessment of selected candidate laboratories under project activity 2.1.1.

Beginning in July 2017 two assessment missions took place. During these different missions the following aspects were covered via direct interviews with the responsible personnel:

- General staff capacities
- Laboratory facilities and infrastructure
- Analytical equipment, spare parts and consumables
- WFD relevant testing and sampling methods (detailed methodology see Figure 1)
- Status of accreditation (based on the ISO/IEC 17025 requirements)
- Training needs

## 4.1 Parameter assessment approach

Figure 1 illustrates the general procedure for the in-depth assessment of the current laboratory scope of analysis for WFD parameters. The Commission Directive 2013/39/EC[4], "As regards priority substances in the field of water policy" not only defines the 45 priority substances, but also indicates the EQS values of the corresponding parameters in the relevant matrix (inland and other surface water and biota). Current analytical methods were compared with state of the art analytical methods for the determination of priority substances in surface water[5]. Analytical methods for the determination of priority substances in biota were compared with the methods indicated in the guidance document 33[6]. Apart from the assessment of priority substances in surface water, the WFD defines six physico-chemical quality elements (thermal conditions, oxygenation, salinity, nutrient status, acidification status, other pollutants). However, the EU member states are responsible for the selection of the relevant parameters for physico-chemical monitoring. Therefore, the guidance document published by the Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management was used for the current physico-chemical parameter assessment[7].

[4] DIRECTIVES DIRECTIVE 2013/39/EU OF THE EUROPEAN PARLIAMENT AND OF THE OUNCIL of 12 August 2013 amending Directives 2000/60/EC and 2008/105/EC as regards priority substances in the field of water policy.

[5] R. Loos, 2012, Analytical methods relevant to the European Commission's 2012 proposal on Priority Substances under the Water Framework Directive, European Commission – Joint Research Centre (JRC), Institute for Environment and Sustainability (IES), Italy.

[6] European Union, Common implementation strategy of the water framework directive (2000/60/EC), 2014, Guidance document No. 33 on analytical methods for biota monitoring under the water framework directive, technical report 2014-084, Luxembourg.

[7] K. Deutsch et al., 2010, Leitfaden zur typspezifischen Bewertung gemäß WRRL, allgemein physikalisch-chemische Parameter in Fließgewässern, Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft, Sektion VII, Wien.

The core parameters (oxygen content, pH value, conductivity, nitrate, and ammonium) to be analysed for the groundwater parameter assessment are listed in Annex V of the WFD. Additional groundwater parameters (e.g. heavy metals and pesticides), which are mandatory for compliant WFD groundwater monitoring, are laid down in the groundwater directive 2006/118/EC[8]. In addition, EU member states are responsible for defining the limit values of the corresponding groundwater parameters. In this case, the Austrian Quality Target Ordinance for Groundwater was used as a basis for limit values for the current groundwater parameter assessment[9].

The assessment determines if the (WFD) parameter is within the scope of the analysis, is accredited according to ISO 17025, the LOD and LOQ of the corresponding parameter. Moreover, it evaluates if the LOQs are compliant with WFD EQS values, current instruments and the methods used for analysis.

The assessed data will lead to an identification of actions such as method adaptation (e.g. when LOQs need to be reduced in order to comply with WFD-EQS values, ISO technical standards require implementation instead of national standards), method expansion (e.g. when the parameter is not yet in scope of analysis), the procurement of equipment and consumables and personnel training.

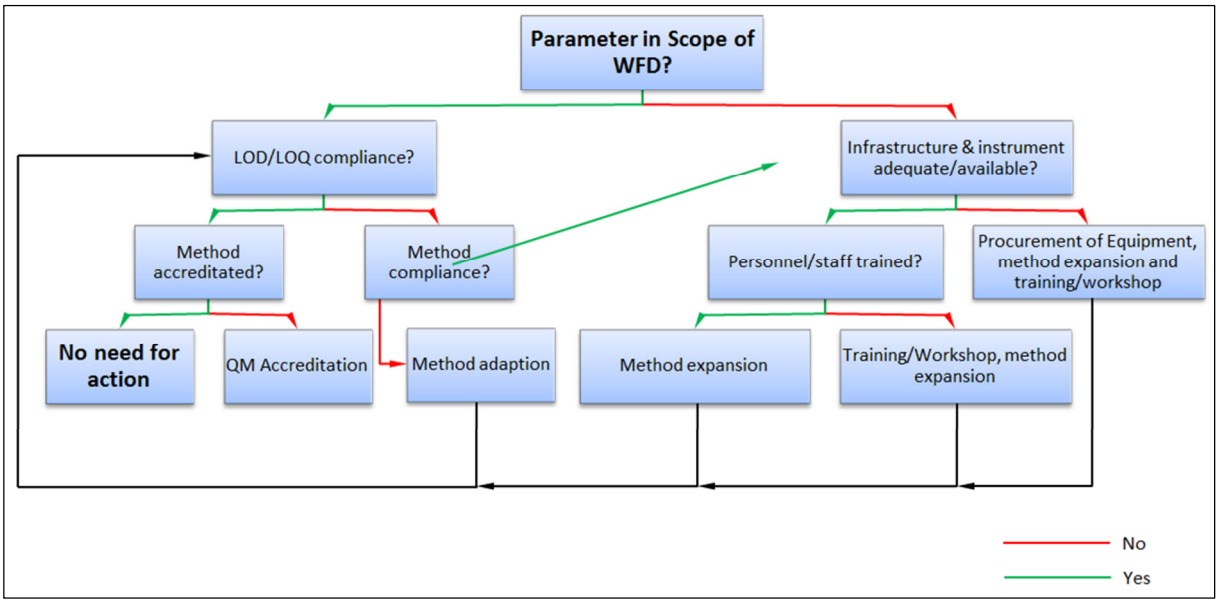


**Figure 1: Flowchart illustrating the detailed hydro-chemical parameter assessment according to WFD requirements**

[8] Directive 2006/118/EC of the European Parliament and the Council on the protection of groundwater against pollution and deterioration.

[9] BGB II Nr. 89/2010: Bundesgesetzblatt für die Republik Österreich, 2010, Qualitätszielverordnung Chemie Grundwasser, Verordnung des Bundesministers für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft über den guten chemischen Zustand des Grundwassers.

## 4.2 Chronology

Three assessment missions took place and are summarised in the following chronology with main assessment milestones.

Questionnaire during the inception phase:

- 1st laboratory assessment mission 2. – 6.7.2017
- 2nd laboratory assessment mission 28.8. – 2.9.2017
- 3rd laboratory assessment mission 3. – 6.10.20176

# 5 LABORATORY SELECTION

The EMIC acts as the main partner and maintains a laboratory, which is responsible for water analysis. The EMIC is a state-owned, non-commercial organisation and is part of the Ministry of Nature Protection of the Republic of Armenia.

All types of water analyses (surface and ground water, waste water, sediment, soil) are carried out in this laboratory. The main analyses are chemical, physical-chemical and biological.

## 5.1 Laboratory facilities and Infrastructure

The current building and the rooms at the water laboratory are in a poor condition. In a preliminary assessment of the laboratory situation, the EUWI+ experts recommended the relocation of the laboratory, as under the current conditions no compliance with the criteria regarding laboratory rooms of ISO/IEC 17025 was given. Furthermore, under such circumstances the installation of new equipment to be procured in the course of the project could not be justified. It was suggested to relocate the laboratory in the building of the Institute for Chemical Physics of the Academy of Sciences of the Republic of Armenia.

The Armenian Minister of Nature Protection, Mr. Artsvik Minasyan, confirmed on 4 October that a governmental resolution regarding the basis for the relocation was in preparation, on the basis of the proposal contained in the document drawn up during the assessment. The Government of Armenia Resolution No 1584-A was adopted on 7 December 2017 thereby allocating a 539.1 $m^2$ space on the first floor of the premises of the Institute of Chemical Physics to the EMIC laboratory.

However, this assessment report does not refer to the premises of the laboratory before its relocation. The main focus is on a staff training and equipment assessment.

## 5.2 General staff capacities

The EMIC water laboratory personnel consist of twenty staff members, with advanced academic (chemistry) and university degrees. The head of laboratory performs managerial tasks. The personnel are well trained and motivated and there would seem to be sufficient manpower.

## 5.3 Analytical equipment, spare parts and consumables

Organic and inorganic measurements are performed in the laboratory. An equipment list was already provided during the inception phase (Table 1). The main instrumentation is for ICP-MS, GC-MS/FID/ ECD, ion chromatography, titrimetric and photometric measurements.

**Table 1: equipment list of EMIC water laboratory**

| Type | Brand | Date of 1st operation | Status Operational (in use)/ Out of order/Ordered/etc. |
|---|---|---|---|
| ICP-MS, ELAN 9000 | PerkinElmer | 2003 | *Operational* |
| Ion chromatograph (liquid) | DIONEX 1000 | 2007 | *Operational* |
| GC-MS 7890A/5975C | Agilent | 2010 | *Operational* |
| GC-FID, Clarus 400 | PerkinElmer | 2008 | *Operational* |
| GC-ECD | Varian CP-3800 | 2004 | Non-operational |
| Handheld multiparameter instrument | YSI 556 | 2016 | *Operational* |
| UV spectro photometer | UV 1650 PC SHIMADZU | 2008 | *Operational* |
| UV spectro photometer | Lambda 35 | 2008 | *Operational* |
| UV spectro photometer | Analitik Jena Specord 205 BU | 2010 | *Operational* |
| Multiparameter meter | WTW 340i | 2004 | *Operational* |
| Handheld meter | OXi/SET 340 i – WTW | 2010 | *Operational* |
| Handheld meter | WTW pH 340i | 2010 | *Operational* |
| Multiparameter meter (in situ) | YSI water quality multiparameter meter 6600 (in situ) | 2008 | *Operational* |
| Analytical balance | Ohaus Vojager 200V | 2005 | *Operational* |
| TOC analyser | Elementary 1000 vario TOC/$TN_b$ cube | 2011 | *Operational* |
| Digital microscopy | XDS3+Optikam Pro 3 | 2010 | *Operational* |
| Digital microscopy | B600T+Optikam Pro 3 | 2010 | *Operational* |
| Digital microscopy | SZM-2 | 2010 | *Operational* |
| Microwave pressure digestion system | Berghoff MWS-3+DAK-100 | 2010 | *Operational* |

## 5.4 WFD relevant testing and sampling methods
(for detailed methodology see Table 1)

Several WFD-relevant testing methods for water are already established and are being performed. Organochlorine pesticides, PCBs and chlorobenzenes are partly established, but their scope could be extended. Between 300 and 1,700 samples are analysed annually.

## 5.5 Status of accreditation (based on the ISO/IEC 17025 requirements)[10]

The laboratory is not yet accredited according to ISO/IEC 17025 standards. A draft quality manual is partly written and already in use. This could be complemented gradually and would represent an enormous step towards preparatory work accreditation.

[10] ISO/IEC 17025:2005, General requirements for the competence of testing and calibration laboratories, International Standard Organisation, Switzerland

# 6 ACTIVITIES

## 6.1 Activity 2.1.2 – Equipment procurement

The main focus in the assessment phase was on the relocation of the laboratory as a basis for future monitoring activities. Several meetings and reports were necessary in order to come to a final decision. Therefore, the project team assumes that the new laboratory will meets all relevant criteria to properly accommodate existing and new equipment.

Several needs have been discussed during the assessment phase, but the following list of needs will have to be reviewed and elaborated in the agreement phase of this report. First priority has ion chromatography.

**Table 2: Suggested list for procurement of equipment and consumables for EMIC**

| WFD relevance | Substance name/parameter | Equipment & consumables | Estimated costs, EUR |
|---|---|---|---|
| **Equipment list** | | | |
| Yes | Ions | Ion chromatography | 70.000 |
| Yes | Volatiles | GC Headspace sampler | 30.000 |
| Yes | UV/VIS parameters | Spectro photometer | 10.000 |
| Yes | Metals | ICP-MS consumables (pumps etc) | 34.000 |
| Yes | General | Water purification system | 5.000 |
| Yes | General | Field multimeter | 5.000 |
| Yes | General | Automated pipette dispensers | 5.000 |
| Yes | general | Laboratory dish washer | 10.000 |
| Yes | general | Lab oven | 15.000 |
| Yes | General | Glass ware | 10.000 |
| Yes | general | Contribution to laboratory relocation | 40.000 |
| | | Total | 236.000 |
| **List of consumables** | | | |
| Yes | Organochlorine pesticides | Pesticide grade solvents | 1.000 |
| Yes | Alachlor, isodrin, hexachlorbutadiene, delta-hexachlorocyclohexane, pentachlorobenzene, trichlorobenzene, dicofol, bifenox, heptachlor, aclonifen | Purchase of chemical reference materials for expanding the current analytical methods | 500 |
| Yes | Atrazine, chlorfenvinphos, chlorpyrifos (chlorpyrifos-ethyl), simazine, trifluralin, cybutryn, cypermethrin, dichlorvos, terbutryn, benzene, carbon tetrachloride, trichloroethylene, tetrachloro-ethylene, 1,2-dichloroethane, dichloromethane, trichlormethane, bis(2-ethyl-hexyl)phthalat (DEHP), 4-tert-octylphenol, nonylphenol (4-nonylphenol, hexabromocyclododecane (HBCDD) | Purchase of chemical reference materials for method adaption | 2,500 |
| Yes | Organochlorine pesticides | GC capillary column | 700 |

| WFD relevance | Substance name/parameter | Equipment & consumables | Estimated costs, EUR |
|---|---|---|---|
| Yes | EN ISO 10695, EN ISO 15680, EN ISO 22032, EN ISO 10301, ISO 12010, ISO EN 18856, EN ISO 11369, EN ISO 18857-1, EN ISO 12673, EN ISO 17353, EN ISO 25101, EN ISO 11369, ISO/NP 21677, ISO 5667-12 | Technical standard methods (ISO, EN) for the determination of priority substances | 200 |
| Yes | Sampling of water for organic priority substances | 50 amber glass bottles with conical shoulders (1L)<br>25 amber glass bottles with conical shoulders (2L)<br>Cooling/transport boxes | 1,500 |
| **Total (consumables)** | | | **€ 6,400** |
| **Placeholder** | | | **€ 13,600** |
| **Total (equipment and consumables)** | | | **€ 250,000** |

## 6.2 Technical support of laboratories for accreditation (Activity 2.1.3)

This activity deals with the preparation of training plans and the organisation of hands-on training and trainer training with regard to monitoring and laboratory analyses, and the support of laboratories for accreditation, as indicated in the DOA.

The following training needs were identified as a result of visits during the inception phase and the in-depth analysis of the current status of the technical capacity of the laboratories. Efforts were made to differentiate between hands-on training directly in the laboratory premises using both existing equipment and the equipment to be purchased in the course of the project, and more general training, which can be held independently.

The dates indicated are preliminary and subject to the availability of MS experts, BC experts and coordination with other project activities.

**Table 3: Planned activities for EMIC**

| Topic | Timeline | Costs |
|---|---|---|
| Participation in proficiency testing schemes (PTS) for the water analysis of selected groups of parameters<br>Programme: http://www.umweltbundesamt.at/en/services/laboratory_services/interlaboratory_comparison/ic_wateranalysis/ | Two different rounds of PTS: one participation in 2018, the second in 2020 | € 2,500 |
| Study tour of selected laboratories and administrative bodies of the consortium partners by one laboratory staff member | 2019 | -- |

In addition, the following technical support to laboratories for accreditation under Activity 2.1.3 is planned:

**Table 4: Suggested technical support to EMIC**

| Substance name/parameter | Equipment, consumables & services | Estimated costs |
|---|---|---|
| PCB (7unit) (28, 52,101,118, 138, 153,180), conc.100 ug/ml, min. volume 5 ml in isooctane, organochlorine pesticides, arochlor 1260, 1242 and 1254, perfluorotributylamine (PFTBA), Cu+Cr+Pb+Cd+Mn+Ni p/u AAS, 1g/l, 100 ml, reference material for heavy metals (Cu, Zn, Ni, Pb, Cd, Mn) | Purchase of chemical reference materials for existing accredited test methods | € 3,000 |

All training is summarised under Activity 2.2.1. (Chapter 6.3)

## 6.3 Preparation of training plans and organisation of hands-on training and trainer training with regard to monitoring and laboratory analyses and the support of laboratories for accreditation (Activity 2.2.1)

The following training needs were identified as a result of visits during the inception phase and the in-depth analysis of the current status of the technical capacity of the laboratories. We differentiated between hands-on training on existing equipment and the equipment to be purchased in the course of the project, and more general training, which can be held independently.

### 6.3.1 Equipment-dependent training for the EMIC

Training is required for QA/QC activities, as is specific practical training on analytical methods using the instruments to be procured in the project's next phase. In particular, method development and training on the use of GC is foreseen. Sampling training is also planned.

### 6.3.2 Existing equipment – method extension, adaption and validation

For the following parameters, method adaption, the purchase of the relevant ISO- and chemical reference standard equipment, method validation and the training of laboratory staff members will be provided directly in the laboratory premises.

**Table 5: Suggested implementation of parameters with existing equipment**

| Priority | Substance name/ parameters | Comment (suggested techn. ISO standard) | Method description | Dates |
|---|---|---|---|---|
| 1 | PAH | DIN 38407-39 | GC-MS | Q2/2018 |
| 1 | Ion chromatography | EN ISO 10304 | Ion chromatography | Q2/2018 |

### 6.3.3 New equipment – method expansion, adaption and validation

For the equipment procured under activity 2.1.2 method validation is planned after successful installation and test runs for the following groups of compounds and related ISO standard methods indicated in Table 6.

**Table 6: Suggested implementation of parameters with new equipment**

| Priority | Substance name/ parameters | Comment (suggested techn. ISO standard) | Method description | Dates |
|---|---|---|---|---|
| 1 | Atrazine, chlorfenvinphos, chlorpyrifos (chlorpyrifos-ethyl), simazine, trifluralin, cybutryn, cypermethrin, dichlorvos, terbutryn | EN ISO 10695 | LLE with dichloromethane and detection by GC-NPD or GC-MS | Q1/2019 |
| 1 | Bis(2-ethylhexyl)phthalate (DEHP) | ISO EN 18856 | C18-SPE and detection by GC-MS | Q1/2019 |
| 1 | 4-tert-octylphenol, nonylphenol (4-nonylphenol | EN ISO 18857-1 | LLE with toluene and detection by GC-MS | Q1/2019 |
| 2 | Pentachlorophenol | EN ISO 12673 | Derivatisation with acetic anhydride, extraction with n-hexane and detection by GC-MS | Q3/2019 |

## General training for laboratory personnel

- **Training for QA/QC and method validation (Q4/2017)**
  - Method validation (LOD, LOQ, measurement uncertainty)
  - QA/QC measurements (e.g., blank values, control samples, recoveries)
  - Use of control charts
  - Improvement of LOQ
  - Measurement traceability
- **ISO 17025: 2017 new edition** – training on new, changed requirements and the exchange of experience for implementation (Q4/2018 as earliest, or Q1/2019)
- **Training of internal auditors** based on the ISO 19011 guideline for auditing management systems and the specific requirements of the ISO 17025 (Q3-4/2018)

# 7 RELATED ISSUES

## 7.1 Laboratory waste management

At present, used chemicals, organic solvents and other hazardous laboratory waste are collected and stored in the laboratories. Sooner or later, the maximum storage capacities will be reached. In particular, an increase in technical capacity will also lead to a rise in the production of hazardous waste. An alternative solution for the handling of hazardous chemical waste needs to be found.

## 7.2 Import regulations

Restrictions on the import of goods, consumables, services and spare parts to Armenia were not discussed during the assessment phase. However, several issues relating to the ordering of spare parts and consumables were mentioned during the discussion. These matters have to be clarified in advance of the procurement phase.

## 7.3 Data security

A thorough check of the data infrastructure has yet to be carried out.

For this reason, we recommend the establishment of network or server-based data handling applications in the laboratory. We trust in the awareness of the laboratory management to deal with this issue, as there is a high degree of consciousness with respect to the critical items and prerequisites laid down in ISO 17025.

# 8 INSTITUTIONAL SUSTAINABILITY OF SELECTED LABORATORIES

In order to run a laboratory properly, a basic budget for infrastructure maintenance and the purchase of essentials is needed. Essentials are seen as including standards (norms), reference materials, consumables, equipment and a budget for servicing of instruments and equipment, etc. Sustainable laboratory work needs a sustainable budget, which according to the information provided basically exists.

Nevertheless, we must mention that modern analytical work demands high-end instrumentation and the appropriate quality management procedures. However, high-end instruments, are costly investments and require subsidies for use (energy), consumables (gases, chemicals, solvents etc.), maintenance, servicing, spare parts, the expense for the establishment of new methods and the various cost-intensive support procedures needed to achieve valid results. These aspects have also to be taken into account in the conceptualisation phase. It is imperative that this aspect is also mentioned and appropriate budgeting be considered in order to guarantee sustainable performance beyond the timeframes of funded projects. For this reason, the drafting of a laboratory strategy would help identify critical items and determine actions to overcome bottlenecks.

In a major step, the Ministry of Nature Protection decided to relocate the laboratory and to equip it with modern and adequate fittings on the basis of a collaboration agreement with EUWI+. Moreover, at least for 2018, shortages in the budgets of all governmental institutions in Armenia will not apply. This is a big step forward and important signal from the Ministry with regard to effective monitoring in Armenia.

# 9 RECOMMENDATIONS AND STRATEGIC OUTLOOK

During this assessment only the EMIC laboratory has been assessed. This assessment can therefore not be seen as representative for the situation of all the laboratories throughout the country. However, as examples, the laboratory of the Institute of Chemical Physics of the Academy of Sciences of the Republic of Armenia and the Standard Dialog LLC laboratory in Yerevan were visited. They show that there is a market for high-level analytical services. Naturally, there is the option of collaboration on a franchise basis, as laid down in the ISO/IEC 17025, should commercial constraints not allow the provision of services for non-routine parameters.

As stated in the previous chapter, the authors recommend the preparation of a laboratory strategy for the EMIC water laboratory for a period of 10 years.

# 10 NEXT STEPS

With respect to this report the following steps need to be implemented as soon as possible:

- A review of the final draft assessment report by the beneficiaries
- The start of the procurement procedure (see section 6.1)
  - The purchase of consumables
  - Drafting of technical specifications for the new equipment by the beneficiaries in-line with WFD requirements in the English language
  - A review of the technical specifications by Environment Agency Austria experts
- Planning of technical support to the laboratories (see section 6.2)
- Planning of training activities (see section 6.3)
- A visit to the EMIC laboratory by an IOW expert to assess the data security status

EUROPEAN UNION WATER INITIATIVE PLUS FOR THE EASTERN PARTNERSHIP (EUWI+ 4 EaP)

# PRELIMINARY CONCLUSIONS AND RECOMMENDATIONS

## Assessment Mission AM

## 1 MISSION OBJECT

The aim of the mission (2/7 – 6/7/2017, 28/8 – 2/9/2017) was to assess the laboratory of EMIC in terms of the current status of its analytical work relating to the WFD and the existing quality standards according ISO/IEC 17025:2005.

The focus lay on the priority substances of the WFD in respect of methods, LOQ and quality procedures according to the WFD. In addition, existing quality standards according to ISO/IEC 17025:2005 were evaluated.

The outcome of the assessment shows the capacities and capabilities of the EMIC laboratory and the identification of the need for equipment and training to fulfil at least part of the WFD.

### Technical aspects

Liaison with representatives of the ministry and local officials

Interviews with the responsible laboratory contact persons – technicians, QA manager

Evaluation of the interview results in accordance to the WFD and ISO/IEC 17025:2005

### Persons to be met/institution to be visited

EMIC Director, Mr. Simon PAPAYAN

EMIC technical representatives

Head of the EMIC Environmental Monitoring Service, Mr Sasun Sahakyan

Head of the EMIC International Cooperation Department, Ms Ani Margaryan

EMIC Deputy Director, Ms Gayane Shahnazaryan

Head of the Water Laboratory, Ms Alina Zurnachyan

National Academy of Sciences of the Republic of Armenia, Institute of Chemical Physics, Mr. Seyran Minasyan

# 2 OUTCOME

As laid down in the mission report and according to the original planning, a second mission to AM will take place from 28 August 2017 onwards, to finalise the assessment. However, as there is an ongoing, internal process regarding improved conditions for the laboratory, several preliminary observations and recommendations can already be provided.

This paper refers exclusively to the conditions of the laboratory building and the individual laboratory rooms. In particular, we would like to highlight the fact that even under the existing conditions the performance of the laboratory is very high, as has been proven by many high-grade results from independent laboratory comparisons.

## 2.1 Current laboratory facilities

- The building and rooms of the laboratory are in a very poor condition
- The premises are rented and the EMIC is subject to the danger that if it refurbishes the rooms, the owner might decide to increase the rent, or make use of the rooms for its own/other purposes. Moreover, according to recent information, given the geographical location of the building and depreciation, the building was submitted for 100% privatisation in the near future ((code 90034, (6)) under the law governing the programme FOR THE PRIVATIZATION OF RA STATE PROPERTY 2006-2007
- Partly damaged and crumbling walls, dust and water damage
    - Humidity, dust, noise, vibrations and, electromagnetic fields influence occupational safety and work performance (interference and cross-contamination of samples and analytical processes)
- No separation of the laboratory and offices
    - Due to the absence of a designated room and appropriate conditions, laboratory employees eat and drink in the laboratory (safety issue!), and store food in refrigerators intended for standards or samples (!)
    - Unnecessary exposure of personnel to chemicals, noise and other stress factors in the laboratory during office and administrative work

## 2.2 Current technical infrastructure

- The water supply appears to work properly and in sufficient quantity; however, water damage (probably due to broken pipes) was observed on the walls/ceilings
- Electrical supply problem (network black-outs, unstable voltage) and insufficient network; short black-outs were experienced repeatedly during the assessment
    - Threat to high-end instruments, which can be ***severely*** damaged by these fluctuations
    - To overcome the instable power supply, sufficient UPS (uninterruptible power supply) devices are needed
    - We recommend the installation of an isolated electrical network with UPS for instruments and their control computers

- Insufficient fume extraction
  - The existing fume hoods appear to be insufficient in terms of their capacity to extract toxic and corrosive gases
  - The number of fume extractors is insufficient
- Air-conditioning
  - Although air-conditioning is in place in one room (ICP-MS), its capacity is insufficient to keep the rooms at a constant temperature (e.g. open windows, fluctuating temperature). The same applies to the room heating in winter.
  - High-end instruments (like ICP-MS) require very stable ambient conditions in order to perform accurately.

## 2.3 Existing equipment

| Type | Brand | Date of 1st operation | Status Operational (in use)/ Out of order/Ordered/etc. |
|---|---|---|---|
| ICP-MS, ELAN 9000 | PerkinElmer | 2003 | Operational |
| Ion chromatograph (liquid) | DIONEX 1000 | 2007 | Operational |
| GC-MS 7890A/5975C | Agilent | 2010 | Operational |
| GC-FID, Clarus 400 | PerkinElmer | 2008 | Operational |
| GC-ECD | Varian CP-3800 | 2004 | Non-operational |
| Handheld multiparameter instrument | YSI 556 | 2016 | Operational |
| UV spectro photometer | UV 1650 PC SHIMADZU | 2008 | Operational |
| UV spectro photometer | Lambda 35 | 2008 | Operational |
| UV spectro photometer | Analytik Jena Specord 205 BU | 2010 | Operational |
| Total organic carbon/nitrogen analyser | Elementar vario TOC cube | 2012 | Operational |

Without commenting on the request list in detail, which the EMIC provided earlier, several high-end, analytical instruments exist, or will be procured for the measurement of priority substances in water according to the WFD. These instruments and analytical procedures require a minimum room standard, which is also laid down in the EN ISO 17025:2005. **Under the current conditions, the purchase and installation of new equipment cannot be justified.**

Therefore, the member states consortium EUWI+ experts recommend the following ideal configuration and design of the future laboratory:

# 3 GENERAL RECOMMENDATIONS FOR A FULLY COMPLIANT LABORATORY

## 3.1 Location of the laboratory

- Traffic-calmed area to avoid exposure to contaminated air, especially with regard to the long-term vision of increasing the scope of the laboratory in the direction of air analyses, etc.
- Easy access for logistics (sample pick-up and delivery)
- Easy access via public transport

## 3.2 Configuration of rooms

- As laid down in chapter 6.2 (“Accommodation and environmental conditions”) of ISO/IEC 17025:2005, laboratory facilities must not invalidate results, or adversely affect the required quality of any measurement.
- Appropriate design of individual laboratory rooms, adapted to the instruments used
  - ICP-MS measurement room
  - GC-MSD, GC-FID, GC-ECD measurement room
  - Measurement room consisting of instruments, essential infrastructure (pumps, gas supply) and small desk for simple vial treatment (but not chemical work!)
  - IC measurement room, together with photometers and multi-parameter
  - Sample preparation rooms for organic and inorganic sample preparation; an additional room should be available to avoid cross-contamination (solvents, etc.)
  - Sample reception and distribution, bottle/equipment cleaning
  - Weighing room
  - Sample extraction
  - Milling, grinding, sieving, storage, possibly also a refrigerated room for sample storage
  - If possible, facilities for hazardous waste collection, storage and/or treatment
- Ideally, the rooms should not be higher than 2.5-2.8 meters in order to avoid a high volume for air conditioning
- External sun protection (blinds); temperature and radiation
- Fume extractor hoods installed in sample preparation rooms
- Extractors for rooms with high-temperature instruments (GC, ICP etc.)
- The rooms should be fitted with the appropriate materials (ceramic floor, ceramic table surfaces, dust-repellent wall painting, air-tight windows etc.) to facilitate regular cleaning

## 3.3 Minimum technical infrastructure

- Stable electrical power supply, in the case of using UPS-equipment for sensitive analytical equipment
- Appropriate heating and cooling (A/C) systems to guarantee stable indoor working conditions and the achievement of correct results by the equipment
- Stable water supply, sufficient in quantity
- Fume extractor hoods for sample preparation, extraction/evaporation, digestion and other processes involving exposure to gaseous or particulate chemicals

## 3.4 Recommendations regarding technical training

- Training on definitions according to ISO/IEC 17025:2005 to clarify the unambiguous use of terms during the project (end of 2017)
- Training on method validation - accuracy (veracity and precision) of measurement methods and results
- Specific training on methods and equipment will be agreed at a later date

## 3.5 Recommendations regarding quality standards

Current quality standards according to ISO/IEC 17025:2005

- As long as the aforementioned questions (3.1 to 3.3) concerning alternative premises are not clarified, the EMIC should focus primarily on SOPs for the different existing methods in use, including procedures for the calibration and validation of these methods, as these are essential and major parts of ISO/IEC 17025:2005.
- As there is currently no expert in charge as an overall quality manager (pursuant to ISO/IEC 17025:2005) who would take care of all activities related to quality management, we recommend that a member of staff, or a newly recruited employee be appointed as the quality manager
- This position shall have defined responsibilities and the authority needed to ensure that the quality system is implemented and followed at all times. As such, the position needs to be allocated the funds necessary for maintaining quality assurance in daily practice (ISO/IEC 17025:2005, chapter 5).

# 4 SPECIFIC RECOMMENDATIONS

## 4.1 Recommendation to relocate to the premises at the Academy of Sciences

Potential laboratory premises were visited during the second assessment. Amongst them, the building of the Institute of Chemical Physics of the National Academy of Sciences of the Republic of Armenia appeared to fulfil many of the criteria mentioned in the above sections. In particular, the building has been designed as a laboratory centre and thus provides basic laboratory infrastructure. The building is located in a traffic-relaxed area and is not influenced by major contamination sources. Piping for fume extraction is available, the foreseen third floor provides enough space to shelter sensitive instruments and sufficient rooms are available for the splitting of preparatory, analytical and administrative/office operations.

However, refurbishment is needed in order to adapt the rooms adequately. As one example of good practice we would refer to the GC/MS laboratory on the second floor[11]. At this point, we would like to encourage our Armenian colleagues to consider the combination of equipment from the other EMIC laboratories, where this is deemed feasible and logical.

## 4.2 Specific recommendation of an amalgamation

During our second assessment mission in August 2017, we learned about other recent activities related to laboratories in Armenia. In particular, we were informed about a UNDP-GEF project “Elimination of Obsolete Pesticide Stockpiles and Addressing POPs Contaminated Sites within a Sound Chemicals Management Framework”, (UNDP-GEF joint project in Armenia, Project ID 91031). A draft report had been written by Mr. Seyran Minasyan (Armenian Academy of Science), which roughly concludes that an improvement in the EMIC’s laboratory facilities is also necessary.

It is anticipated that from 2018 onwards, a more cost efficient implementation of WFD-compliant monitoring will have to be carried out in Armenia. Among other facts, financial shortages have to be accounted for and we learned that several priority parameters are already being analysed in the laboratory of the Institute of Chemical Physics (National Academy of Sciences of the Republic of Armenia). The method is validated and covers approximately 30 substances, including priority substances (pesticides) according to the WFD. Joining forces and seeking collaboration among public institutes and the use of this capacity would also seem to be reasonable. This approach would enable EUWI+ to provide more specific support for the improvement of EMIC’s lab facilities and other priorities.

It should be considered that the new equipment required to establish new methods in the laboratory will demand additional budget for maintenance, servicing, spare parts, consumables (gases, chemicals, solvents, etc.) and effort (costs). This expenditure could be made available for the other needs of the laboratory.

Therefore, we recommend that a franchising agreement with the Academy of Sciences for the performance of the established analyses be prepared. A collaborative approach is covered by the ISO/IEC 17025:2005 and would bring advantages for both sides.

[11] The laboratory for gas chromatography has been refurbished and represents a demonstration laboratory for this purpose

## 4.3 Draft outline of the next steps

- Receipt of a written decision of the Government of the Republic of Armenia to relocate the EMIC water laboratory and the request for co-financing by EUWI+
- Negotiation of a co-financing agreement within the project's budgetary limits
  - Detailed calculation of costs for
    - The removal of disused equipment/furniture from the new laboratory rooms on the third floor of the Academy of Sciences for disposal/storage
    - Architectural planning of the laboratory
    - Costs for the necessary replacement or refurbishment of room infrastructure (windows, doors, floor, heating, power supply, air conditioning, water, etc.)
    - Refurbishing of walls, etc.
    - Costs for new laboratory furniture
    - Relocation of existing instruments and reinstallation
- Presentation of a detailed schedule for the activities foreseen
- Kick-off and implementation of the plan





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