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SAND2002-0484
Unlimited Release
Printed April 2002

The Navruz Project: Transboundary Monitoring for Radionuclides and Metals in Central Asian Rivers

Sampling and Analysis Plan and Operational Manual

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Prepared by
Sandia National Laboratories
Albuquerque, New Mexico 87185 and Livermore, California 94550

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Sampling and Analysis Plan and Operational Manual

Howard Passell, David Barber, David Betsill, and Adriane Littlefield,
International Security Initiatives;
Amir Mohagheghi and Sonoya Shanks, Radiation Protection and Laboratory Services;
Carole Lojek, Lab Planning and Evaluation;
Sandia National Laboratories, P.O. Box 5800, Albuquerque, NM 87185-1371 U.S.A.

Bekhzad Yuldashev, Umar Salikhbaev, and Raisa Radyuk, Institute of Nuclear Physics,
Tashkent, Uzbekistan
Akram Djuraev and Anwar Djuraev, Atomic Energy Agency, Tajik Academy of Sciences,
Dushanbe, Tajikistan;
Ivan Vasiliev, Bajgabyl Tolongutov and Alekhina Valentina, Institute of Physics,
Bishkek, Kyrgystan;
Vladimir Solodukhin and Victor Pozniak, Institute of Nuclear Physics,
Almaty, Kazakhstan

Abstract

The transboundary nature of water resources demands a transboundary approach to their monitoring and management. However, transboundary water projects raise a challenging set of problems related to communication issues, and standardization of sampling, analysis and data management methods. This manual addresses those challenges and provides the information and guidance needed to perform the Navruz Project, a cooperative, transboundary, river monitoring project involving rivers and institutions in Kazakhstan, Kyrgyzstan, Tajikistan, and Uzbekistan facilitated by Sandia National Laboratories in the U.S. The Navruz Project focuses on waterborne radionuclides and metals because of their importance to public health and nuclear materials proliferation concerns in the region. This manual provides guidelines for participants on sample and data collection, field equipment operations and procedures, sample handling, laboratory analysis, and data management. Also included are descriptions of rivers, sampling sites and parameters on which data are collected. Data obtained in this project are shared among all participating countries and the public through an internet web site and are available for use in further studies and in regional transboundary water resource management efforts. Overall, the project addresses three main goals: to help increase capabilities in Central Asian nations for sustainable water resources management; to provide a scientific basis for supporting nuclear transparency and non-proliferation in the region; and to help reduce the threat of conflict in Central Asia over water resources, proliferation concerns, or other factors.

Acknowledgments

The authors offer great thanks to the long list of scientists and technicians in Central Asia and the United States who have contributed to the Navruz Project; to Scott Anderholm of the U.S. Geological Survey for his early consultation; and to Diane Ross and Robert Matthews at SNL for help with editing the document.

Contents

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Nomenclature

AA	activation analysis
ADC	analog to digital converter
AES-ICP	atom emission spectrometry with inductively coupled plasma
Am	americium
As	arsenic
Be	beryllium
Ca	calcium
CMC	Cooperative Monitoring Center
CME	Cooperative Monitoring Experiment
Co	cobalt
COC	chain of custody
Cs	cesium
DO	dissolved oxygen
FDA	U.S. Food and Drug Administration
FWHM	full width at half maximum
g/L	grams per liter
GPS	global positioning system
H	hydrogen
Hg	mercury
HPGe	high purity germanium
IAEA	International Atomic Energy Agency
ICP-MS	inductively coupled plasma mass spectrometry
INP	Institute of Nuclear Physics
K	potassium
LCS	laboratory control sample
LSC	liquid scintillation counter
m^3/s	cubic meters per second
MCA	multi-channel analyzer
Navruz	project name meaning “new beginning” or “new day”
NIST	National Institute of Science and Technology
PI	principal investigator
ppb	parts per billion
ppm	parts per million
Pu	plutonium
QC	quality control
Ra	radium
redox	oxidation-reduction potential
RK	Republic of Kazakhstan
RNA	radionuclide analysis
SAP	Sampling and Analysis Plan
Sb	antimony
SNL	Sandia National Laboratories
SNL/CMC	Sandia National Laboratories/Cooperative Monitoring Center
SOP	standard operating procedure
Sr	strontium
TDS	total dissolved solids
Th	thorium
U	uranium
UPS	United Parcel Service
XRF	x-ray fluorescent
Y	yttrium

1. Introduction

Effective and sustainable management of rivers and watersheds transcending international boundaries must meet the difficult challenge of transcending those international boundaries as well (UN/ECE 1992, Salman and de Chazournes 1998, Correia and da Silva 1999, Elhance 1999, Lueck 1999, Wolf 1999). The next generation of effective transboundary river and watershed monitoring and management projects must aim to overcome transboundary cultural and communication barriers, transboundary variation in objectives and methods, and they must build the trust and confidence essential for transboundary resource management. These projects must contain: a.) a social framework for cooperation, transparency and data sharing; b.) standardized objectives, sampling, analysis, and data management methods, and; c.) communications technology that allows free and easy information and data exchange (Tidwell et al. 2000). Various transboundary projects exist in which some combinations of these components are included (Chenoweth 1999, Lueck 1999, Dieperink 2000).

The study of waterborne radionuclide and metals concentrations in Central Asia is of particular interest in the region because of the history of nuclear materials mining, fabrication, transport and storage, and nuclear weapons testing during the regime of the Soviet Union. This development left a legacy of radionuclide and metals contamination in some Central Asian regions which poses a clear health hazard to populations who rely heavily upon surface water for cropland irrigation and direct domestic consumption. Further, changes in riverborne radionuclide concentrations over time can provide a signal revealing the status of proliferation activities within the watershed. Therefore, monitoring for radionuclides and metals in rivers can be an effective tool both for helping safeguard public health, and for creating transparency, building confidence, and supporting non-proliferation treaties (OTA 1995, Wogman, et al. 2001).

This manual describes the standardized technical approaches implemented by the Navruz partners in a cooperative, transboundary river monitoring project in Central Asia, including the republics of Kyrgyzstan, Kazakhstan, Uzbekistan and Tajikistan. The technical objectives of the project are to use standard methods across all four countries for sample collection, analysis, and data management, so that data are easily comparable across national boundaries, and so they can be easily applied to transboundary resource management and planning. Basic water quality parameters are measured in this project in addition to metals and radionuclide concentrations. Rivers and sampling locations are also described.

Ultimately, the purpose of this project is to help develop cooperation and collaboration, both on transboundary water resources management and on nonproliferation, thereby reducing the threat of future conflict in the region over those issues. The data are intended for current and future studies, and to contribute to water resource management efforts both within and between countries. The project aims to help develop confidence and trust among Central Asian nations on both transboundary water resource management and nuclear materials transparency, and to help create an infrastructure for future cooperation. Finally, the project will demonstrate a science-based approach for establishing nuclear transparency in Central Asia and other regions in compliance with the Non-Proliferation Treaty. More on this project, including data, reports and photos, can be found at http://www.cmc.sandia.gov/Central/centralasia.html.

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2. Description of Watersheds and Rivers

> *"Mowarannakhr is the richest country in Muslim world… Sogd is the most fecund from all countries. It has the best fruits, all houses have gardens, water reservoirs and flowing waters; it is quite rare when street or house has no canal with flowing water. And peoples here are the most kind, generous, educated, peaceful, and hospitable."*
>
> Description of Central Asia by Arab traveler, Al-Istarkhi

2.1 Tajikistan

[1]One of the largest water-supplying territories of Central Asia region is Tajikistan, which contains the main part of the watershed of the Amudarya (199,350 km^2), the largest Central Asia River. The Amudarya watershed comprises more than one thousand glaciers and many glacial snowfields. The annual flux of the Amudarya is about 79 km^3 (three times more than that of Syrdarya). The majority of rivers of the Amudarya watershed are fed from glaciers and snowfields. The main tributaries are the Puandzh, the Vakkhsh, the Kafirnigan, the Kyzylsu, the Yakhsu, and others. The most industrialized region is the Vakkhsh River watershed. The biggest South-Tajik industrial-territorial complex, comprised by such enterprises as the Yavan electro-chemical plant and the Vakkhsh nitrogen fertilizer plants, are located on the Vakkhsh. Hydropower plants on the Vakkhsh (the biggest is the Nurek power plant) are the main suppliers of electricity in Tajikistan. The main cities in this watershed are Nurek, Kurgantyube, and Sarband. Another tributary of the Amudarya, the Kafirnigan River, is also of great industrial interest due to a large amount of mining industry activities and the nearby cities of Dushanbe, Kafirnigan, and Gissar.

In the northern part of Tajikisan is the second largest Central Asia river, the Syrdarya. This river also is fed from glaciers and snowfields. In Tajikistan, the main tributaries of the Syrdarya River are the Isfara, the Isfana, the Aksu, and the Khodzhabakirgan rivers. Of these tributaries, the largest is the Isfara, with a summer runoff high water flux up to 42 cubic meters per second (m^3/s) and an autumn base-flow low water of 3-5 m^3/s. The smallest tributary is the Isfana River with a summer runoff high water flux up to 1.4-1.6 m^3/s and autumn base-flow low water of 0.5 m^3/s. The intermediate tributaries are the Khodzhabakirgansaj and Aksu Rivers, with high and low waters measuring 23 m^3/s and 14 m^3/s, and 5.2 m^3/s and 4.0 m^3/s respectively. The waters from these rivers are used for irrigation and only a small portion reaches the Syrdarya. The Syrdarya watershed , containing such industrial cities as Khudzhant, Chkalovsk, Isfara, Kannibadam, and Kajrakkum, is the main industrial and mining region in the northern part of Tajikistan. Two artificial lakes (the Kajrakkum, created in 1956, and the Farkhad, created in 1947) are used for water storage in the Syrdarya watershed and regulate its water flow.

[1] Regional descriptions and some other sections in this document are composed by Central Asian Navruz project partners.

2.2 Uzbekistan

The main rivers in Uzbekistan are the Amudarya, with a length of 1,440 km and an average water flux of 2500 m^3/s; the Syrdarya, with a length of 2,140 km and a flux of 1200 m^3/s; the Zarafshan, with an average flux of 164 m^3/s; the Kashkadarya (50 m^3/s); the Surkhandarya (52 m^3/s); the Chirchik (22 m^3/s), and the Akhangaran (23 m^3/s). The Syrdarya is the largest river of the Central Asia Region. It crosses all of the Central Asian countries and is impacted by manmade influences. The watershed has more than 5,000 industrial sites.

According to data from the Uzbekistan Nature Protection Committee, the Amudarya River is polluted in the regions of the Aral Sea and the Bukhara oasis, and is moderately polluted in the Termez-Nukus region. The Syrdarya River is moderately polluted, characterized by a 2- to 3-fold increase of biogenic mineral and organic components of common mineralization contents. The concentration of heavy metals ions, petroleum products, and pesticides has also increased (2 to 3 times permissible concentration levels). A water system is deemed polluted when measurements are 3 to 5 times higher than background levels. The main danger of contamination in the Syrdarya River is the Majlisu River, which flows in the Kyrgyz Republic and in Uzbekistan (Andizhan vilayat). Because of uranium mining in the area, 23 tailings and 13 dumps with high uranium concentration are located on the banks of the Majlisu.

2.3 Kyrgyzstan

Kyrgyzstan rivers are present in 76.5% of its territory and are related to the Aral Sea basin. The mean annual discharge of all of the rivers is about 52 km^3. The largest river is the Naryn, which originates from the Petrov Glacier and merges with the Karadarya River to form the Syrdarya River. The main tributaries of the Naryn River are the Chong-Naryn, the Kichi-Naryn, the At-Bashi, the Alaburga, the Kek-Irim, the Kekemeren, the Suusamyr, the Chychkan, and the Kara-Suu. The Karadarya has the following tributaries: the Karakuldzha, the Yassy, the Kegart (flows from the Fergana montain ridge), the Tar, and the Kurshab (flows from the Alaj mounatain ridge). The length of the Naryn River on Kyrgyzstan territory is more than 500 km and the watershed territory in the Alexeevka region is about 52,000 km^2. There are approximately 2,075 glaciers in the Naryn watershed and approximately 1,414 glaciers in the mountain circle of Fregana valley.

The industrial cities of Karakul, Tash-Kumyr, Majli-Suu and others are located in the watershed of the Naryn River. The numerous tributaries of Karadarya River are polluted by industrial waste from the cities of Kok-Yangak, Uzgen, Kara-Suu, and others.

2.4 Kazakhstan

The main tributaries of the Syrdarya in Kazakhstan are the Arys River (length: 378 km and watershed: 14,900 km^2) and the Keles River (length: 241 km and watershed: 3,310 km^2). The tributaries of the Arys River are the Badam, the Aksu, the Boraldaj, the Kabulsaj, and the Zhabaglysu rivers. The Arys River is fed from snow thawing and precipitation; its average flux is 40.2 m^3/s. There are 11 water reservoirs and 3 hydropower plants in the Arys watershed. The Keles River originates from springs in the Karzhantau and Kazygurt mountains whose slopes flow into the Chardarya artificial lake. The Keles River is fed from snow, underground water, and precipitation; its average flux is 6 m^3/s.

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3. Sampling Locations and Frequencies

3.1 Sampling Locations Listed by Republic

Fifteen sampling locations have been identified in each of the four republics for a total of 60 sampling locations in the Navruz project. Sampling will occur in the fall and the spring of each sampling year. A unique sampling code is provided for each sampling location in Appendix B. The sampling locations are shown in the map below.

Figure 1. Map of Central Asia Countries and Sampling Locations in the Navruz Study

3.2 Kazakhstan Sites

The INP of NNC of Kazakhstan uses the following 15 sites in the Syrdarya watershed in Kazakhstan for radiation monitoring:

Table 1. Kazakhstan Sampling Sites

Site	**Location**
1	Chardara Reservoir: Southeastern part of the coast between the Keles and Kurukkeles Rivers.
2	Chardara Reservoir: Northeastern part of the coast near Chardara town. Sites 1 and 2 measure the impact of economic and technogenic human activity on the environment (Site 2) and provide a comparison with the impact of natural factors (Site 1). Site 2 will also provide initial information for comparison with all other sites.
3	Keles tributary, Saryagash town (upstream).
4	Keles tributary, Saryagash town (downstream), Abaj village. Sites 3 and 4 will measure the environmental conditions in this resort zone (mineral water springs).
5	Badam tributary, Chymkent town (upstream), Sajram village.
6	Arys tributary, Chymkent town (downstream), near Obruchevka. Sites 5 and 6 measure the influence of the industrial center at Chymkent.
7	Chernak village, below Turkestan town. Site 7 measures the influence of agriculture activity and the status of the Turkestan canal.
8	Chyily (upstream), Tomlnaryk village.
9	Chyily.
10	Chyily (downstream), Zhulek village. Sites 8, 9, and 10 will cover several uranium deposits.
11	Kyzyl-Orda, upstream, Belkul' village.
12	Kyzyl-Orda, downstream, Abaj village. Sites 11 and 12 will measure the impact of industrial activities in Kyzyl-Orda town.
13	Korkyt village, below Zhusa town. Site 13 will measure the joint influence of the towns Terenozek, Dzhalagat, and Dzhusaly on the Karaozek tributary.
14	Bajkonur town below Toretam village, near Bay-Kozha. Site 14 will measure the influence of activities at the Bajkonur space center.
15	Kazalinsk town. Site 15 will provide a control on the total influence of all areas/sites and all activities related to Syrdarya River (in comparison with Site 2).

3.3 Kyrgyzstan Sites

The Institute of Physics of the National Academy of Sciences uses the following 15 sites in the watershed of Syrdarya River:

Table 2. Kyrgyzstan Sampling Sites

Site	Location
1	The tributary Kichi-Naryn before the confluence with the Chong-Naryn River.
2	The tributary Chong-Naryn before the confluence with the Kichi-Naryn River.
3	Naryn River after the confluence of the Chong-Naryn and Kichi-Naryn tributaries.
4	Tributary At-Bashy before its confluence into the Naryn River.
5	Naryn River after the confluence of the At-Bashy tributary. The investigation in the area of Toktogul reservoir is related to the study of agricultural and technogenic affects in the area.
6	Chychkan River before the confluence into the Toktogul reservoir.
7	Naryn River before its confluence in the Toktogul reservoir (hydrological post Uch-Terek).
8	Toktogul Reservoir.
9	Naryn River after the Toktogul Reservoir (region of Kara-Kul town).
10	Naryn River, southeast part of the town of Tashkumyr.
11	Mailuu-Su River, on the bridge (boundary with Uzbekistan).
12	Mailuu-Su River at the departure from Mailuu-Su town.
13	Mailuu-Su River near the Transformer factory.
14	Right tributary of the Mailuu-Su River.
15	Mailuu-Su River 200 meters from the tributary.

3.4 Tajikistan Sites

The following sites have been identified for sample collection in Tajikistan, as shown below:

Table 3. Tajikistan Sampling Sites

Site	Location
1	The Varzob River, 18 kilometers above Dushanbe city.
2	The Varzob River, 9 kilometers below Dushanbe city.

Site	Location
3	The Kafirnigan River, 1 kilometer above the confluence with the Varzob River.
4	The Kafirnigan River, 3 kilometers below its confluence with the Elok River.
5	The Kafirnigan River at the Shaartuz railway bridge.
6	The Elok River, 1 kilometer above its flow into the Kafirnigan River.
7	The Vakkhsh River at the Dzhilikul bridge.
8	"Chiluchor chashma," the spring.
9	The Vakhsh River, 1 kilometer below Norak City.
10	The Yekhsu River at hydrological post "Vose", the settlement Vose.
11	The Kyzylsu River, 5 kilometers from the settlement Vose, before its confluence with the Yekhsu River.
12	The Kyzylsu River, Gulistan Village.
13	The Syrdarya River, 60 kilometers above the Kayrakkum reservoir, (unfinished frontier bridge), settlement Bulok.
14	The Syrdarya River, the bridge on the entrance of Khudzhand city.
15	The Isfara River, the settlement Yangiobod between Rabot city and Nefteobod city.

3.5 Uzbekistan Sites

Five major watersheds are used for sample collection sites in Uzbekistan. Each watershed is presented below with their corresponding sites for a total of 15 sites.

Table 4. Uzbekistan Sampling Sites

Amudarya River (Tuyamuyun, Kyzyldzhar and Kipchak – in Lower Amudarya)	
Site	**Location**
Intro	Site selection was affected by the proximity of various industrial activities, including uranium mining. This river resource provides water for irrigation, hydropower plants, industrial purposes, and drinking water. The water system is polluted from the dumping of agriculture wastewater (mainly from Turkmenistan), and drainage waters from the cities of Termez and Nukus. Sampling sites at the Amudarya River are located at existing meteorological stations.
1	Kyzyldzhar village, Karakalpakstan, 1 km above the terminating range of the Amudarya River (the nearest town is Kungrad).
2	Kipchak town, Karakalpakstan, 0.5 km above the town.
3	Tuyamuyun site, 8 km below the dam (Khorezm region).

<table>
<tr><th colspan="2">Syrdarya River (Chinaz, Bekabad and Karadarya)</th></tr>
<tr><th>Site</th><th>Location</th></tr>
<tr><td>Intro</td><td>This river resource provides water for irrigation, industrial purposes, and drinking water. The sewage effluent from the many industrial activities in this watershed has an impact on water resources. Among these enterprises are Chirchik-”Elektrokhimprom,” the Altyaryk oil processing factory, fiber crops plants, sewage disposal, and the factories of Angren, Almalyk, Gazalkent, Chirchik, Tashkent, and Chinaz. Sampling sites at Syrdarya River are located at existing meteorological stations.</td></tr>
<tr><td>4</td><td>Karadarya River, Namangan region, 20 km southwest from Namangan, at Kol’ village. The meteorological post is below the merging point of the Karadarya and Naryn Rivers with the Syrdarya River.</td></tr>
<tr><td>5</td><td>Bekabad, Tashkent region, 0.9 km below the dump of drainage waters of “Vodokanal” enterprise.</td></tr>
<tr><td>6</td><td>Chinaz town, Tashkent region, 3.5 km SSW from Chinaz.</td></tr>
<tr><th colspan="2">Akhangaran River (Tuyabuguz, Angren, Yangiabad)</th></tr>
<tr><th>Site</th><th>Location</th></tr>
<tr><td>Intro</td><td>The basin of the Akhangaran River is a tributary of the Syrdarya River. Sampling sites at the Akhangaran River are located at existing meteorological stations.</td></tr>
<tr><td>7</td><td>Yangiabad town, Tashkent region, 5.5 km below Dukant village.</td></tr>
<tr><td>8</td><td>Angren town, Tashkent region, 5.5 km below the Angren dam.</td></tr>
<tr><td>9</td><td>Tuyabuguz, Tashkent region, Soldatskoe village, 0.5 km above the outfall of the Akhangaran River.</td></tr>
<tr><th colspan="2">Chirchik River (Gazalkent, Kibraj, Zangiota)</th></tr>
<tr><th>Site</th><th>Location</th></tr>
<tr><td>Intro</td><td>The Chirchik River basin, one of Syrdarya River’s tributaries, receives effluent from industrial and private sewage and drainage waters. Sampling sites at the Chirchik River are located at existing meteorological stations.</td></tr>
<tr><td>10</td><td>Gazalkent town, Tashkent region, 3.5 km below the town.</td></tr>
<tr><td>11</td><td>Kibraj village, Tashkent region, 3 km below the UZKTZhM enterprise sewage effluent.</td></tr>
<tr><td>12</td><td>Tashkent City, Tashkent region, 3 km below the sewage effluent from the Segeli KSM plant.</td></tr>
</table>

Zaravshan River (Ravatkhodzha, Kattakurgan, Navoi)	
Site	**Location**
Intro	The Zarafshan River is related to the Amudarya River basin. Sampling sites at the Zarafshan River will be located at existing meteorological stations. (Note: Sampling from Zarafshan River sites will not be done in the present stage of the Navruz experiment. In the future, if the monitoring experiment is extended, these sites will be included in the sampling.)
13	Ravatkhodzha, Samarkand region, 3.7 km below the outfall of the Taligulyan dump.
14	Kattakurgan, Samarkand region, 0.8 km below the outfall of the Chegonak collector.
15	Navoi City, Navoi region, 0.8 km below the sewage effluent from “NavoiAzot” enterprise.

3.6 U.S. Sites

Sampling by SNL will occur at two sites along the Rio Grande near Albuquerque in Central New Mexico.

Table 5. U.S. Sites

Rio Grande near Albuquerque	
Site	**Location**
1	Bernalillo, approx. 25 km upstream of Albuquerque
2	Los Lunas, approx. 40 km downstream of Albuquerque

4. Sampling Media and Parameters Measured

4.1 Parameters Measured

Sampling will occur in five different media, using methods described in Section 6. The five different media are: water (dissolved); water (suspended); bottom sediments; aquatic vegetation; soils.

Tables 6-8 below show all the parameters measured in the Navruz project, and their units.

Table 6. Basic Water Quality Parameters

Time	Discharge (m^3/s)	Water Temp. (deg C)	Dissolved Oxygen (% saturation)	Dissolved Oxygen (mg/L)	Specific Conductivity (uS/cm)	Salinity (g/L)	TDS (g/L)	Depth (m)	pH	Redox Potential (mV)

Table 7. Radionuclide Parameters

Alpha activity Beta activity

Be-7 Na-22 Na-24 K-40 Cr-51 Mn-52 Mn-54 Co-56 Co-57 Ni-57
Co-58 Fe-59 Co-60 Zn-65 Sr-85 Y-88 Zr-95 Mo-99 Ru-103 Ru-106
Ag-108m Ag-110m Sn-113 Cd-115 Sb-122 Sb-124 Sb-125 I-131 Ba-133 Cs-134
Cs-137 Ce-139 Ce-141 Ce-144 Nd-147 Eu-152 Gd-153 Eu-154 Eu-155 Ta-182
Ta-183 Ir-192 Tl-201 Hg-203 Tl-207 Tl-208 Pb-210 Pb-211 Bi-212 Pb-212
Bi-214 Pb-214 Rn-219 Ra-223 Ra-224 Ra-226 Th-227 Ac-228 Ra-228 Th-228
Th-229 Pa-231 Th-231 Th-232 Pa-233 U-235 Np-237 U-238 Pu-239 Am-241
Cm-243

Alpha and beta activity reported in Becquerel/kilogram (Bq/kg)
Water (dissolved) and water (suspended) reported in Becquerel/liter (Bq/L).
Sediments, vegetation, and soils reported in Bq/kg.

Table 8. Metals Parameters

Al Ag As B Ba Be Ca Cd Co Cr Cu Fe Hg
K Mg Mn Mo Na Ni Pb Se Si Tl V Zn

Water (dissolved) and water (suspended) reported in micrograms/liter (µg/L).
Sediments, vegetation, and soils reported in µg/g.

4.2 Characteristics of Selected Parameters

Table 9. Characteristics of Basic Water Quality Parameters

Discharge	Discharge, or stream flow, is the volume of water that moves past a designated point during a fixed period. Discharge data are critical for understanding the general hydrology in the system, for understanding changes in concentrations of chemical constituents over time, and for calculating total loads of constituents in a volume of water. Discharge is recorded in cubic meters per second.
Dissolved Oxygen (DO)	DO is a measure of the amount of oxygen present in water and is reported in both mg/L and as a percent of the total oxygen saturation value. DO is an important factor for many biological and chemical reactions in surface water.
Oxidation-Reduction Potential (Redox)	The oxidation-reduction potential (redox) is an indication of how oxidizing or reducing a solution is and measures the tendency of electrons to “flow” either toward or away from a noble metal electrode. Redox is an important factor in chemical reactions involving metals in water. Redox potential is an especially important measurement in poorly oxygenated ground water or surface water, but is less important in well-oxygenated surface waters.
pH	The pH parameter describes the balance between H^+ and OH^- ions in water. It is calculated as: $pH = -\log [H^+]$, where $[H^+]$ represents the molar concentration of hydrogen ions. Values for pH are reported on a scale that ranges from 0 to 14. A pH measurement of < 7 is acidic; a pH measurement of 7 is defined as a neutral solution; a pH measurement > 7 is an alkaline (or basic) solution. The pH of water directly affects solubilities of metals and the physiological functions of plants and animals.
Salinity	Salinity is a measure of salts in water, and is commonly calculated directly from specific conductivity. Salinity is reported in g/L. Irrigation water with high values for salinity is known to salinate croplands and reduce crop productivity.
Specific Conductivity	Specific conductivity is a measure of the capacity of water to conduct an electrical current through the water’s dissolved ionic content. Conductivity is reported in microSiemens (1×10^{-6} Siemens) or milliSeimens (1×10^{-3} Siemens) per centimeter at 25 degrees Celsius (uS/cm at 25°C).
Temperature	Temperature is an important factor in chemical and biological reactions in water. Accurate data values for DO, conductivity, and pH all rely on accurate temperature measurements.
Total Dissolved Solids (TDS)	TDS refers to the amount of solid materials, including ions, colloids, and organic material dissolved in water. TDS can be calculated directly from specific conductivity and is reported in mg/L.

Table 10. Characteristics of Selected Radionuclides

^{238}U	Uranium is a very heavy metal that can be used as a source of energy. It is the heaviest of all the naturally occurring elements with a density of 18.7 g/cm^{3}. Human intake of uranium is due primarily to food ingestion. Two naturally occurring uranium isotopes are found in the earth's crust: ^{238}U and ^{235}U. More than 99% of the uranium that occurs in nature is the ^{238}U. The ^{238}U decay chain consists of 19 isotopes. The half-life of ^{238}U is 4.51×10^{9} years.
^{232}Th	Thorium-232 occurs naturally. It has a half-life of 141 billion years and decays by alpha and gamma emission. Thorium-232 is at the top of the thorium series, which includes 12 isotopes and ends with the stable isotope ^{208}Pb. Thorium-232 concentration levels in soil are typically around 1 pCi/g, however the levels may range anywhere from 0.10 to 3.4 pCi/g.
^{226}Ra	^{226}Ra, a member of ^{238}U decay chain, is an alkali-earth element, and its salts dissolve easily in water. Radium migrates from uranium ores and may form such minerals as radio-calcite, radio-borate, and radio-fluorite. Its half-life is 1,602 years.
^{40}K	Potassium is the seventh most abundant metal and makes up about 2.4% of the Earth's crust. It is found in most soils and is essential for plant growth, which is why it is a key ingredient in fertilizers.^{40}K, a radioactive isotope, occurs naturally but presents no appreciable hazard. The average human contains approximately 120,000 pCi of ^{40}K. The half-life of ^{40}K is 1.27 billion years. ^{40}K decays by beta and gamma emission, which accounts for the positive correlation between high ^{40}K activity levels and high beta activity levels in most every soil sample.
^{90}Sr	^{90}Sr has a half-life of 28.1 years. It is produced during the fission process in reactors and nuclear weapons tests. It is a pure beta-emitter with an average radiation energy of 195.8 keV. This radionuclide accumulates in human bones and historically is the most popular object of studies relating to nuclear weapons tests.
^{228}Th	^{228}Th is a member of the ^{232}Th series and is usually found in the soil in radioactive equilibrium with ^{232}Th. ^{228}Th has a half-life of 1.9 years, and decays with emission of alpha and gamma radiation.
^{210}Pb	^{210}Pb is a member of the ^{238}U series, has a half-life of 22.3 years, and decays with emission of beta and gamma radiation. In the soil, ^{210}Pb may not be in radioactive equilibrium with long-lived precursors: isotopes of uranium (238, 234) and ^{226}Ra. It may accumulate in vegetation and animals.
^{137}Cs	^{137}Cs is an artificial radionuclide and has a half-life of 30 years. It is formed as a result of fission in nuclear explosions and nuclear power plants).
^{239}Pu	^{239}Pu, a nuclear fuel, has a half-life of 24,000 years and decays with emission of alpha radiation. The source of plutonium in the environment is nuclear tests and accidents, such as Chernobyl. It is a well-known toxin.
^{241}Am	^{241}Am is a radioactive isotope that decays by emitting alpha particles to ^{237}Np. It also emits an easily detected gamma ray with energy of 60 keV. It has a half-life of 432 years and is a daughter of Pu-241, which is produced in reactors and during nuclear explosions. Am-241 is therefore a good indicator for the presence of Pu. In the environment, it tends to exist as an oxide that is relatively insoluble, and generally tightly bound to soil particles. If absorbed in the body, like most transuranic elements, it is a bone-seeker and accumulates on bone surfaces.

Table 11. Characteristics of Selected Metals

Antimony	While antimony is, in elemental form, a brittle, crystalline substance, its primary industrial use is as a hardener of lead plates in storage batteries. Exposure to high levels of antimony has been linked to various health problems, and animal studies have shown such acute effects as eye irritation, hair loss, lung damage, heart problems, and fertility problems. In low doses, antimony is used as a medication for parasite infections.
Barium	Barium is a silvery white metal. Its compounds have numerous industrial uses, and barium sulfate is used in medical diagnostics. Water-soluble barium compounds in high doses cause breathing difficulties, increased blood pressure, heart rhythm changes, stomach irritation, brain swelling, muscle weakness, and damage to the liver and other internal organs.
Cadmium	Cadmium metal does not corrode easily and has industrial applications in pigments, plating, metal coatings, and plastics. It is also used extensively in batteries. Ingesting high levels of cadmium is associated with severe toxic effects including lung damage, vomiting, and diarrhea, and can cause death. Long-term exposure to low levels can lead to build-up in the tissues and can cause kidney damage. The U.S. Department and Health and Human Services has determined that cadmium and cadmium compounds are probable carcinogens.
Copper	A common and economically important metal, copper is also an essential element for all plants and animals. High levels can be toxic, however, and long-term exposure to airborne copper can cause irritation, dizziness, headaches, and diarrhea. Drinking water with high levels of copper can cause digestive system distress, and contact with the skin causes allergic reactions in some people.
Lead	Lead and lead compounds are found throughout the environment, due to burning fossil fuels as well as mining and manufacturing activities. Lead toxicity has been a subject of concern for many years, leading to its removal from motor fuels, paints, etc. Lead ingestion is particularly damaging to children because of its severe and permanent effects on the central nervous system. Lead acetate and lead phosphate have been identified as possible carcinogens through animal studies.
Manganese	Manganese does not occur naturally in elemental form, but its compounds are commonly used in steel making, pesticides, and as a gasoline additive. It is an essential trace element for good health, but exposure to high levels can cause nervous system damage. It may also cause respiratory problems and sexual dysfunction.
Mercury	Mercury is a liquid metal that, when heated, forms a colorless, odorless gas. Inorganic salts of mercury and, along with elemental mercury, have many industrial uses. Organic compounds are also common; methyl mercury is produced by microorganisms in water and soil. Exposure to high levels of metallic, inorganic, or organic mercury can permanently damage the brain, kidneys, and developing fetus. The U.S. EPA has determined that methyl mercury and mercuric chloride are possible human carcinogens.

Nickel	Nickel is abundant in the Earth's crust and is economically important. It has uses in metal alloys and catalysts. Nickel is an essential trace element for animals, and probably for humans as well. The most common health effect of nickel exposure in humans is allergic reaction. Breathing dust of nickel and nickel compounds has been linked with cancers of the respiratory tract.
Selenium	Selenium is found most often as a sulfide ore in conjunction with silver, copper, lead, or zinc. It is an essential trace element for humans. It is sufficiently common in the United States food supply such that most diets contain enough selenium to meet the daily requirement. In China and other places where selenium is lacking in the soil, the deficiency is associated with heart problems and muscle pain. Selenium poisoning has caused reproductive failure and death in aquatic organisms and waterfowl. High-level exposure in humans to selenium has toxic effects including loss of feeling and muscle control in the arms and legs. Animal studies indicate that selenium is a probable carcinogen in large, prolonged doses.
Silver	Silver is economically important for electronics and photography as well as jewelry and silverware. It is also used as a disinfectant and antibacterial agent. Exposure to large amounts of silver can cause discoloration of the skin, but the effect appears to be mainly cosmetic. Allergic reactions are also possible.
Zinc	Zinc is one of the most common elements in the Earth's crust and has uses in corrosion-resistant coatings, batteries, and alloys (brass and bronze). Its compounds are widely used in industry. Zinc is an essential dietary element, but like other trace elements, too much can be harmful. Effects of overdose include acute digestive problems, and, after long exposure, anemia, pancreas damage, and lowered levels of high-density lipoprotein.

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5. Field Instrument/Equipment Operation, Maintenance, and Training

Two pieces of equipment, a Hydrolab instrument and an AA flow meter, will be provided to each Navruz partner for surface water quality and flow measurements.

5.1 Hydrolab Instrument

The Hydrolab instrument is a multi-probe surface water quality monitoring system configured in the Navruz Project to measure the following parameters: water temperature, specific conductivity, oxidation-reduction potential, pH, DO, salinity, and TDS. For forms related to Hydrolab maintenance, see Appendix A. This manual supplements the Hydrolab manual provided with each instrument, and the training session that occurred during the Tashkent meeting in fall 2000. A Hydrolab videotape for training or review of Hydrolab operation and maintenance was delivered to each partner.

Information on the two-year warranty for these instruments is located in the back of the operation manual. Participants must purchase Hydrolab supplies, such as pH solutions, directly from Hydrolab.

5.2 Hydrolab Maintenance

Dissolved Oxygen (DO) Sensor: Maintain if calibration becomes impossible, or if the DO membrane is damaged. Replace the membrane for each new sampling season.

Replacing the Membrane	
Step	**Action**
1	Remove the O-ring and old membrane.
2	Rinse the sensors twice with distilled water.
3	Fill the sensor with DO electrolyte so that the meniscus forms.
4	Cut the membrane in half, bend the membrane into a “U” shape between your thumb and finger and place onto the meniscus.
5	Drop the O-ring onto the membrane.
6	Holding sensors with fingers, roll the O-ring down onto the DO sensor with your thumbs, securing the membrane.
7	Make sure the membrane has no bubbles.
8	Trim excess membrane from around the edges.
9	Allow the membrane to soak overnight in tap water before calibration.

Maintaining the Circulator	
Step	**Action**
1	Dirt can prevent circulator from spinning freely. If needed, clean the circulator with a toothbrush and water.
2	Use a small screwdriver to remove the circulator blade from the sensor.
3	Pull the screw completely free of the circulator blade.
4	Rinse the screw and screw hole in the blade and reassemble.

Maintaining the Conductivity Sensor	
Step	**Action**
1	Visually check the window for dirt.
2	Clean by rinsing or with a toothbrush. Erratic readings from the sensor can be caused by an air bubble trapped in the conductivity sensor window.

Maintaining the pH Electrode (glass bulb)	
Step	**Action**
1	Maintain if dirty, or if calibration becomes impossible.
2	When cleaning the pH bulb, use cotton swabs or a very soft cloth. Use methanol. DO NOT scratch the bulb, or the metallic ring on the ORP sensor.

pH Reference Electrode

Change the electrolyte before every sampling season. Change the Teflon junction if it becomes clogged so as to impede the flow of water or air through it. Discoloration of the Teflon junction is acceptable.

pH Reference Electrode	
Step	**Action**
1	Hold the sonde so that the sensors point down.
2	Remove the electrode from the platform by pulling and wiggling it gently.
3	Pour out the electrolyte.
4	Rinse the electrolyte twice with the DW.
5	Refill the electrode with electrolyte; tap the electrode with something hard to dislodge the air bubbles.

pH Reference Electrode	
Step	**Action**
6	Holding the sonde so that the sensors are pointed down, push the electrode onto the post just far enough that the electrolyte will not leak out, but do not push it all the way on.
7	Turn the sonde so that the sensors point up. Push the electrode firmly onto the post. With the sensors pointing up, any air in the electrode will move to the top, and will escape through the Teflon junction when the electrode is pushed firmly onto the post.
8	You should see the electrolyte bubbling up out of the Teflon junction when you press the electrode firmly onto the post. If the electrolyte does not bubble out, it could mean that the Teflon junction is clogged, and should be replaced. It is okay if the Teflon junction becomes discolored, but if it does not allow the electrolyte to escape. To remove the Teflon junction, simply pull it out of the reference electrode.

5.3 Surveyor Power Supply and Battery Replacement

The Surveyor data logger and sonde operate with power from a Duracell DR30 7.2 nickel-metal-hydride battery. The battery in the Surveyor is expected to work for 2 to 3 years, and so no provisions have been made at the beginning of the project for replacement of the battery. If battery replacement is necessary, please follow the instructions in Chapter 3 of the *Surveyor User's Manual*.

The battery is normally charged from a 110-V or 220-V power source using the battery charger. Since the chargers were designed for use in 110-V outlets, Navruz researchers must use a voltage converter to use them in 220-V outlets, and the converter has been provided. The Surveyor display shows the amount of charge in the battery with the heading "IBV", which stands for internal battery voltage. The battery should be charged when the IBV reaches 6.5 volts.

Battery recharging takes approximately 3.5 hours. Various data appear on your Surveyor screen describing the rate at which charging is occurring. See Chapter 3 of the *Surveyor User's Manual* for a complete description of these data. Most importantly, the Surveyor will tell you when charging is complete by displaying the message "Charging is complete! Disconnect charger cable for normal operation."

Cables can be purchased from Hydrolab Corporation for charging your Surveyor either from the cigarette lighter in an automobile, or directly from the engine battery in an automobile. These recharging methods may be convenient for prolonged field sampling excursions when 220 V power sources are unavailable. The contact information for the Hydrolab Corporation is listed at the end of the SOPs.

The Surveyor also has a small lithium battery for powering the internal clock. No damage occurs and no data is lost if the battery runs out, although remote monitoring with timed readings will be impossible. Since the battery is expected to last for 2 years, no provision is being made at the early stage of Navruz for replacement of the battery. If you need to replace the battery, follow the instructions in Chapter 3 of the *Surveyor User's Manual*.

5.4 Hydrolab Calibration

Dissolved Oxygen Sensor	
Step	**Action**
1	Note the barometric pressure reading displayed on the Surveyor.
2	Hold the sonde with sensors pointed up.
3	Remove the cap from the calibration cup.
4	Pour tap water into the calibration cup until the water is just below the O-ring on the DO sensor.
5	Place the calibration cap upside down on the calibration cup; do not screw it into the calibration cup. (By placing it upside down on the calibration cup, you seal water vapor in the calibration cup, which allows the relative humidity inside the cup to rise to 100%. If you screw the cap into the cup, you will raise the air pressure inside the cup enough to distort the reading.)
6	Press "setup/calibrate", "calibrate", "sonde"; select "DO % saturation"; press "select"; enter new barometric pressure; press "done". The Surveyor should read "calibration successful".
7	DO mg/L is calibrated automatically with calibration of DO % saturation.

Conductivity Sensor	
Step	**Action**
1	Rinse the sensors twice with distilled water.
2	Remove the calibration cup and dry the conductivity sensor window with a soft cloth.
3	Press "setup/calibrate", "calibrate", "sonde"; select "conductivity uS/cm" (if you are sampling water with very high conductivity, then you might want to calibrate the sonde in mS/cm); press "select". When the conductivity sensor window is completely dry, conductivity should be zero. Enter zero for the new number. The Surveyor should read "calibration successful".
4	Although the sonde does not prompt you to calibrate at a second value, it expects you to do so. Choose the second calibration standard close to the values you expect to see in your region. Rinse the calibration cup once with a small amount of that standard, and then discard the standard. Fill the calibration cup with the second standard. Calibrate a second time for the value of the second standard using step 3 above. The Surveyor should read "calibration successful".

pH Sensors	
Step	**Action**
1	Rinse the sensors twice with distilled water.
2	Rinse the sensors once with a small amount of pH 7 buffer, then discard that buffer.
3	Fill the calibration cup with pH 7 buffer so that all the sensors are covered. Allow 1 to 3 minutes for the reading to stabilize.
4	Press “setup/calibrate”, “calibrate”, “sonde”; select “pH”, press “select”, enter “7” for the new number, press done. The Surveyor should read “calibration successful.”
5	Although the sonde does not prompt you to calibrate at a second value, it expects you to do so. Rinse the sensors twice with distilled water. If you will be sampling in basic water, choose the pH 10 buffer solution for your second calibration. If you will be sampling in acidic water, choose the pH 4 buffer solution for your second calibration.
6	With the buffer of your choice, use a small amount to rinse the sensors, then discard. Follow steps 3 and 4 above to calibrate for the second value.
7	It should be noted pH is temperature dependent. Table 12 indicates pH values accurate to ±0.01 for buffer solutions at various temperatures.

Table 12. pH Values Accurate to –0.01 for Buffer Solutions at Various Temperatures

pH 4 Buffer		**pH 7 Buffer**		**pH 10 Buffer**	
°C	**pH**	**°C**	**pH**	**°C**	**pH**
0	4.01	0	7.13	0	10.34
5	4.01	5	7.10	5	10.26
10	4.00	10	7.07	10	10.19
15	4.00	15	7.05	15	10.12
20	4.00	20	7.02	20	10.06
25	4.00	25	7.00	25	10.00
30	4.01	30	6.99	30	9.94
35	4.02	35	6.98	35	9.90
40	4.03	40	6.97	40	9.85
50	4.06	50	6.97	50	9.78
60	4.09	60	6.98	60	9.70

ORP Sensor	
Step	**Action**
1	Rinse the sensors twice with distilled water.

ORP Sensor	
Step	**Action**
2	Rinse the sensors once with a small amount of redox standard, then discard the standard.
3	Fill the calibration cup with ORP standard.
4	The temperature of the standard can affect the value in mV for the standard. For Zobell's standard the formula for calculating the exact value in mV at different temperatures is: mV = 428 – [2.2(T-25)], where T is temperature of the standard in degrees centigrade. Perform this calculation and use the resulting value for mV in the following step.
5	Press "setup/calibrate", "calibrate", "sonde", select "ORP", press "select", enter the value of the standard as calculated in step 4; press "done". The Surveyor should read "calibration is successful".

Barometer (inside Surveyor)	
Step	**Action**
1	Press "setup/calibrate," "calibrate," "Surveyor4;" select "Sur4a: User Cal." Enter the new barometric pressure in mmHg from a current, reliable source and press "done".

5.5 Solving Problems with Hydrolab Instruments

To solve problems with the Hydrolab instrument, use the following procedure:

Solving Problems with Hydrolab Instruments	
Step	**Action**
1	Refer to the instrument manual provided by the manufacturer for guidance.
2	Email Howard Passell (hdpasse@sandia.gov) to describe the problem. We may have encountered a similar problem with our Hydrolab and could help you solve your problem.
3	If the problem persists after failed attempts in Steps 1 or 2, contact the Hydrolab representative to correct the problem through email, fax, and/or phone correspondence. Contact the Hydrolab representative, Mr. Cooper Petterson, for technical support at techsupport@hydrolab.com or phone 800-949-3766.

4	If the problem persists, and at Hydrolab's recommendation, send the instrument to Austin, Texas, United States. The complete address is: Hydrolab Corporation, Attention: Cooper Petterson, 8700 Cameron Road, Suite 100, Austin, Texas USA 78754. IMPORTANT: You must contact Hydrolab through email at techsupport@hydrolab.com or phone 800-949-3766 to obtain a RETURN NUMBER BEFORE sending the equipment to the USA. Fill out the appropriate form located in Appendix A. This form must accompany the shipment.

5.6 Surveyor Operation

Recommendations for Navruz: The Surveyor stores 350,000 data entries. In Navruz, researchers should begin by creating a different file for every sampling location. Then, whenever that sampling location is visited from season to season, the data can be entered into the file for that location and stored there, where they can serve as back-up files.

To Create a File	
Step	**Action**
1	Press "files" and then "Sur4a".
2	Highlight "create", and press "select". "manual" is highlighted by default. "Time-trig" stands for time-triggered, and allows the user to set up the Surveyor so that it records data automatically at preset time intervals. This is useful if the sonde will be submerged on a bridge piling or in a well for a long time.
3	Press "select".
4	Use the keyboard to enter the name for the new file, and press "done". A new file has been created.

To Store Data to a File You Have Created	
Step	**Action**
1	Wait until the data stabilizes and then press "store". The names of all the files you have created will appear on the screen, and the first one will be highlighted.
2	Scroll down to see and/or highlight other files.
3	Highlight the file to which you want the current data stored, and press "select". Data are stored to the highlighted file. Data stored into files automatically contain time and date of data storage.

To Add Notes to (Annotate) a Data File	
Step	**Action**
Intro	Notes can be added to individual data entries, either before or after the entry itself.

To Add Notes to (Annotate) a Data File	
Step	**Action**
1	**To annotate a file**, press “files”, “Sur4a” and then select “annotate”.
2	Scroll down and highlight the file that you want to annotate, and press “select”.
3	Use the keyboard to enter the annotation, and press “done”. The annotation will appear before the next data entry.

To View All Data Stored in Your Surveyor	
Step	**Action**
1	Press “files”, press “Sur4a”, highlight “review” and press “select”.
2	Highlight the file from which you wish to see data, and press “select”.
3	Scroll down to see the annotations and data entered in that file.

To Erase Data From the Files	
Step	**Action**
Intro.	This action preserves the file structure and keeps the file names on the Surveyor but removes the data.
1	Press “files”, press “Sur4a”, highlight “wipe”, and press “select”.
2	Highlight the file from which you wish to erase the data, and press “select”.
3	The Surveyor will ask if you are sure you want to “wipe” the data. Enter “1” for yes, and press “done”. The file will remain in the Surveyor for future use, but data in that file will be erased.

To Delete Files	
Step	**Action**
Intro.	This action deletes files and all data contained in those files.
1	Press “files”, press “Sur4a”, highlight “delete” and press “select”.
2	Highlight the file you want to delete, and press “select”.
3	Surveyor will ask if you are sure you want to delete the data. Enter “1” for yes, and press “done.” The file and all data will be deleted.

Downloading Files from the Surveyor to a Computer	
Step	**Action**
1	Connect the Surveyor to the computer communications port.
2	On the Surveyor, press “files”, select “transmit”, select the file to be transmitted, select “SS-importable” (this stands for “spreadsheet-importable”. The Surveyor prompts you with “to start Xmodem transfer, press any key”.
3	On the computer (in Windows 98), click on the following: “Start”, “Programs”, “Accessories”, “Communications”, and “Hyperterminal”. Double-click on the Hyperterminal icon, or on the hyperterm.exe application.
4	In the dialogue box labeled “Connection description” type the word “Hydrolab” and choose any icon to be associated with the Hydrolab connection. Click “okay”.
5	In the dialogue box labeled “Connect to”, go to the “Connect using” line and scroll down to see options. Click on “direct to COM1,” or to whatever communications port you are using. Click “okay”.
6	In the dialogue box labeled “COM1 properties”, make the following settings: • Bits per second 19,200 • Data bits: 8 • Parity: none • Stop bits: 1 • Flow control: Xon/Xoff Click “okay”.
7	In the box labeled Hydrolab – Hyperterminal, click on “Transfer,” and then on “Receive file.”
8	In the box labeled “Receive file”, in the first field (labeled “place received file in the following folder”) choose the location for storing your transferred data; at the second field (labeled “Use receiving protocol”) scroll down and select “Xmodem”. Click “receive”.
9	In the box labeled “Receive filename”, type a name for the file you are about to transfer with .xls as a prefix (this makes it a Microsoft Excel file; if .xls doesn’t work, try .csv). Click “okay”.
10	On the Surveyor, press any key. Files should transfer, and the Surveyor display should read “Transfer is complete.” The computer screen returns to a box labeled “Hydrolab – Hyperterminal. Click on “File,” then “save as”, then “save”.
11	Close the “Hydrolab – Hyperterminal” window. The Hyperterminal application should still be open, and you should be able to see the Hydrolab icon. Drag the icon out of the Hyperterminal application and onto your “desktop” for easier use later.

Downloading Files from the Surveyor to a Computer	
Step	**Action**
12	Open Microsoft Excel. Click “file”, “open” and go to the location of the file you just transferred. Double click on it.
13	A box labeled “Text import wizard, step 1 of 3” should appear. Click “delimited”, start import at Row 1, and the file origin should be “Windows (ANSI)”. Click “next”.
14	A box labeled “Text import wizard, step 2 of 3” should appear. Click “tab” and “comma” as delimiters. Choose the sign “ as the “text qualifier”. Click “next”.
15	A box labeled “Text import wizard, step 3 of 3” should appear. Click “general”. Click “next.” Data should appear neatly placed in rows and columns.
16	Click “file”, then “save as”. The box labeled “save as” should appear. At the bottom of that box in a field labeled “save as type” scroll down and select “Microsoft Excel Workbook”. Click “okay”. The file is saved as a Microsoft Excel file and is ready for use.

5.7 Hydrolab Operation

Preparation for Sampling with the Hydrolab	
Step	**Action**
1	The instrument should be well-maintained and calibrated in the lab immediately before a sampling event.
2	Perform field checks on the sensors twice a day: once before sampling begins in the morning, and once before sampling begins in the afternoon. A field check means checking the calibration of the sensor by taking a reading from a known standard. Follow the instructions for calibration. However, actual calibration may not be necessary. Tolerances for the different sensors are listed below. If the reading on the standard is not within the tolerance, then that sensor must be recalibrated. If it is impossible to calibrate the instrument to a value within the tolerance, then the sensor must be maintained. **Frequent field checks and re-calibration of the instrument are essential for the collection of meaningful and accurate data.**

Tolerances	
Barometer	± 5 mmHg (at 25°C, for 6 months)
DO% saturation	± 1%
DO mg/L	± .2 mg/L
Specific Conductivity	± 1% of standard value ± 1 uS/cm (.001 mS/cm)
Salinity	± .2 g (this is calibrated automatically with Spec. Cond.)
TDS	± .005 mg/L (calibrated automatically with Spec. Cond.)
pH	± .2
ORP	± 20 mV

Perform Sampling with the Hydrolab

Step	**Action**
1	Turn the Surveyor on. Make sure DO circulator is operating. If it is not, press "“setup/calibrate”, “setup”, “sonde”; highlight “circulator”, press “select”, enter a new setting, and press “select”.
2	Visually check the sensors and circulator before every sample to be sure nothing is clogged or broken.
3	Replace the calibration cup with the weighted sensor case.
4	Wade out into the river to a place where the current is moving swiftly downstream. Face upstream and hold the sonde in the water in front of you (to the upstream side) so that the sensors are at a depth of approximately 30 cm. Be careful not to disturb the bottom of the river with the sensor. Hold the sonde so that it is vertical in the water. Do not hold the sonde by the cable so that it trails behind you, since this affects the DO reading (depending on the strength of the current).
5	If you are disturbing sediment as you walk into the river, and if the river is moving so slowly that the water around you is filled with that sediment, wait until the water clears before you take a reading.
6	If readings are to be taken from a bridge, lower the sonde from the bridge to the water surface, being careful not to damage the cable on the edge of the bridge or the bridge railing. While lowering the sonde, be careful not to allow it to swing against the bridge, or against bridge pilings.
7	Allow the sonde to rest in the water with the sensors approximately 30 cm below the surface; be careful not to place the sonde into a sandbar, very shallow water, or into brush or other debris snagged on bridge pilings or stuck in the river.

Perform Sampling with the Hydrolab	
Step	**Action**
8	Allow the sonde to remain in the water for at least 30 seconds while the sensors adjust to the water. Watch the sensors during this time, and when readings have stabilized completely, store the data.
9	Carefully observe the data readings before recording or storing data into the Surveyor. Anomalous (very unusual) readings are a sign that something is wrong with the sensors, or with the sensor placement. Commonly, a bubble trapped in the window of the specific conductivity sensor can produce conductivity readings that are extremely low (<1 uS). Errors of this type must be caught before the data are logged.

5.8 For Additional Information about Hydrolab Instruments

If you have questions about the Hydrolab Instrument, if the instrument needs repair, or if you need spare parts, please contact the Hydrolab Corporation directly at:

Hydrolab Corporation
12921 Burnet Road
Austin, Texas 78727
USA
Phone: 1-800-949-3766 (toll free from inside the U.S.)
Phone: 512-255-8841
Fax: 512-255-3106
Email: sales@hydrolab.com
URL: www.hydrolab.com

5.9 Using the AA Current Meter and Wading Rod

Purpose:
To provide project guidance and instrument instruction for the collection of surface water flow measurements

Procedures:

Maintaining the Flow Meter	
Step	**Action**
1	After every use, disassemble and clean the flow meter so that the moving parts are free of dirt. Add a drop of oil to the spindle assembly.
2	The spindle has a point on it that can wear down over time, causing the meter to become less accurate. If the spindle wears down, it must be replaced.
3	Adjust the spindle assembly so that there is some “play” in the cups, but movement should be no more than approximately 0.5 mm.

Maintaining the Flow Meter	
Step	**Action**
4	When spun forcefully by hand and held horizontally, the cups should spin for 1 to 2 minutes or more. If they do not, then the unit must be maintained, or the spindle must be replaced.
5	Adjustment of spindle assembly takes a little practice, and is done with the two screws below the cups.
6	During storage, tighten down the barrel adjuster at the spindle assembly against the cups to prevent the cups from spinning.
7	Maintain the pygmy meter in the same way as the AA meter. However, for storage, remove the spindle, and insert a dummy spindle in the meter instead.
8	Never remove the tiny spindle adjusting screw on the bottom of the spindle assembly, unless necessary for cleaning. The screw is difficult to put back in, and easy to lose.

Flow Metering by Wading	
Step	**Action**
1	Attach the tag line reel on the near side of the river.
2	Using the wading rod without the meter attached for balance, walk across the river with the free end of the tag line. Upon reaching the far side of the river, use a stick to fix the free end of the tag line into the sand or mud so that "zero" on the line is at the edge of the water. Zero on the line is found at the center of a series of marks on the line (see the line for a clear understanding of this).
3	Walk back to the other side of the river counting the marks on the line as you go. Marks on the line are at two-foot intervals.
4	On the first line of the data sheet, write the width of the river. Take 25 to 30 measurements on any river. (If any metering section contains more than 5 percent of the river discharge, final calculations will be incorrect.) So, if the river is 128 feet wide, measurements should be taken at 4-foot intervals, yielding 32 measurements. (Measurements at 6-foot intervals would yield approximately 21 measurements, which would be too few.) On the data sheet, write the "distance from initial point" at which metering should take place for the entire width of the river. For a river 128 feet wide with measurements every four feet, the list would read 128, 124, 120, 116 … On the row marked "128", enter zeroes all across the row; no measurements will be taken at the 128-foot mark because that is the edge of the river. In very narrow rivers, the AA meter can be used as close as every 0.5 feet; the pygmy meter can be used as close as every 0.3 feet.

River Depth	Meter	Depth of Meter
<0.3 feet (0.09 - 0.46 m)	None used	No accurate metering can be done
0.3 - 1.5 feet (0.09 - 0.46 m)	pygmy	0.6 of the total depth, measured from the surface.
1.5 – 2.5 feet (0.46 – 0.76 m)	AA	0.6 of the total depth, measured from the surface.
> 2.5 feet (0.76 m)	AA	0.2 and 0.8 of the total depth (see step 13 below)

5	Attach the flow meter to the wading rod. Insert the headphone cord into the plug at the top of the wading rod, and attach the wire from the headphone to one of the two junctions on the flow meter. The junction marked “1” will transmit 1 click/revolution of the cups. The junction marked “5” will transmit 1 click for every 5 revolutions of the cups. In very fast water, it is easier to count 1 click for every 5 revolutions.
6	Follow the tag line to the second “distance from initial point.” Using numbers from the example above, the second “distance from initial point” would be 124. Stand downstream of the meter and wading rod. Place the base of the wading rod on the bottom of the river. Flow of the river will push the fins of the meter in such a way as to align the flow meter so that it faces directly into the current.
7	Note the depth of the river by looking at the marks on the base of the wading rod. Each mark (-) represents 0.1 foot; a double mark (=) represents .5 foot; a triple mark (Ξ) represents 1 foot.
8	The meter and wading rod must be calibrated to the depth of the river. A calibrating lever is located at the top of wading rod. That lever controls the movement of the two different rods, a thicker one and a thinner one. There is a short section at the top of the thicker rod that is marked off in 0.1-foot increments, and is shown as 0,2,4,6,8,10. The thinner rod is marked off in 1-foot increments. If the depth of the river at the second “distance from initial point” is 1.8 feet, then the two rods must be aligned so that the mark on the thin rod indicating 1 foot is aligned with the mark on the thicker rod indicating 0.8 feet. When these marks are aligned, the flow meter will be approximately 1.1 feet below the surface of the river ($1.8 \times 0.6 = 1.08$).
9	Use headphones to listen for the first click, indicating that the cups on the meter have made one revolution. Start the stopwatch and start counting with that first click.

10	Count revolutions for at least 40 seconds. The total number of revolutions at every metering point must correspond to the numbers across the top of the standard rating table. There is a rating table for the pygmy meter and a rating table for the AA meter, but the total numbers of revolutions are similar. They are 3, 5, 7, 10, 15, 20, 25, 30, 40, 50, 60, 80, 100, etc. If after 40 seconds you have counted a number of revolutions that correspond to one of those numbers, then you stop counting. If after 40 seconds you have not counted up to one of those numbers exactly, then you keep counting until you reach one of those numbers. Then you write on your data sheet the number of seconds and the number of revolutions. For example, if after 40 seconds you had counted 22 revolutions, you would keep counting another 5 or 6 seconds until you reached 25 revolutions.
11	Move to the next "distance from initial point." Note the depth of the river on the wading rod. If the depth at the second metering point is different from the depth at the first, adjust the two rods at the top to reflect the new depth, as in step 12 above. Then continue with steps 13 and 14.
12	Use the pygmy meter to measure the current in places where the river is shallower than 1.5 feet.
13	In places where the river is deeper than 2.5 feet, count the revolutions at 0.2 and 0.8 of the total depth, and then average the results for entry into the data form. The wading rod can be adjusted to measure at 0.2 and 0.8 in the following way. Divide the depth by .5, and use this value to adjust rods; meter will measure flow at 0.2 of the total. Then double the depth, and use this value to adjust the rods; meter will measure the flow at 0.8 of the total. For example, if the depth was 4.4, you would set the rods at 2.2 for your 0.2 reading, and you would set the rods at 8.8 for your 0.8 reading.
14	When you have crossed the entire river and measured the flow at each "distance from initial point", you should have filled on your data form the columns with these headings: Distance from initial point, depth, observation depth, revolutions, and time in seconds. After returning to dry land, go back and fill in the column marked "width", which should be the distance between each metering point.
15	Use the standard rating table to find the velocity (in feet per second) for each metering point in the river. Write the velocity in the column marked "velocity." If you metered the flow at only 0.6 of the total, enter that value into the column marked "at point." If you metered the flow at 0.2 and 0.8 of the total depth and averaged the results, then enter that value into the column marked "mean in vertical."
16	After "width" is recorded, multiply "width" times "depth" and write the answer into the column marked "area".
17	Multiply the area times the discharge, and write that value down under the column marked "discharge".
18	Add together all the values in the "discharge" column. The result is the discharge for the entire river in cubic feet per second.

5.10 Solving Problems with Flow Meters

If you have problems with the flow meter instrument, follow these steps:

Solving Problems with Flow Meters	
Step	**Action**
1	Refer to the instrument manual provided by the manufacturer for guidance.
2	Email Howard Passell (hdpasse@sandia.gov) to describe the problem. We may have encountered a similar problem with our flow meter and could help you resolve your problem.
3	If the problem persists after failed attempts in Steps 1 or 2, contact the Kazecology representative to correct the problem through email, fax, and/or phone correspondence. Contact Kazecology by: telephone at (3272) 631201, (3272) 631512 or (3272) 639875, or fax at (3272) 631210, or email at kazecology@kaznet.kz for technical support and assistance. If a problem occurs with the flow meter within one year from the date of shipment, American Sigma should fix it in accordance with their warranty.

Optimal use of the AA Current Meter in some large rivers will require the use of bridge boards and cranes. This equipment has not been provided.

6. Field Sampling Procedures

These procedures were compiled collaboratively by Navruz Central Asian partners, and translated here from Russian into English.

6.1 Collection of Water Samples

Preparing for Sample Collection	
Step	**Action**
1	Prepare polyethylene containers for the samples: • Containers: Clean, 5L in volume • Labels • Field log book • Field forms • Nitric acid • Clean rubber or latex gloves • Sampling and Analysis Plan

Water Sample Collection	
Step	**Action**
1	Choose a sample collection place that provides sufficient water flow. Avoid areas where the water is stagnant, areas with floating debris, or areas with an overabundance of aquatic plants.
2	Enter the following into the field log book: • any unusual conditions, such as excessive amounts of water plants, debris, etc. • weather conditions • names of the members of the sample collection group • any applicable information regarding the location of the sample collection place • important terrain features
3	Before collecting a water sample, wash the containers with river water. Wear gloves during sample collection.
4	Split the width of the river into five sections.
5	At each of the five locations collect one liter of water from a depth of 0.3 to 0.5 meters below the surface, and combine those samples into one large container.
6	While sampling, avoid stirring the water or making contact with the river bottom because it may cause sediment to be collected in the sample.

Water Sample Collection	
Step	**Action**
7	If you are at a site selected for duplicate sampling take a second one-liter sample (see Section 7, Field Sampling Quality Control). The duplicate samples are sent to SNL, and samples from all locations are sent to the labs in Uzbekistan and Kazakhstan (See Section 8, Laboratory Preparation of Water, Vegetation, Sediment, and Soil Samples). To ensure the sample identification number is identified correctly for duplicate samples, a "D" is added after the number (See Appendix B).
8	Filter water through 50-micron filter(s); different countries will use different techniques for filtering. Save the filtered water. If the conditions do not allow for filtering of the water sample within 24 hours, then record the period of time from the moment of sample collection to the moment of filtering.
9	Using plastic scissors to avoid metal contamination of the sample, cut the filter(s) in half, pack each half separately into a polyethylene bag and label them with the following information: • place and time of sampling, • name of the sampler, • volume of filtered water, • weight of the filter and • project name («Navruz»). One bag will be sent to the Kazakh lab, one will be sent to the Uzbek lab. Use separate filter for duplicate sample, and package that filter separately for delivery to SNL.
10	Preserve each sample of filtered water by adding 3 to 5 ml of concentrated nitric acid per each liter of water sample.
11	Dry the outer surface of each water sample container and attach label with the following information: place of sampling, date and time, name of the sampler, and project name (Navruz).
12	Use GPS locator to obtain the coordinates of the location where the sample was collected and enter that data into the field log book and into the Hydrolab Field Data Collection Form (See Appendix A).
13	Fill in the information required in the Chain of Custody (COC) form (see Appendix A).
14	Use a separate COC form for each analytical laboratory.
15	Complete the information on the COC form immediately after the collection of the sample. This assures the completeness of documentation for each sample.

6.2 Collection of Aquatic Vegetation Samples

Guidelines:

- Collect vegetation samples at the same location where the samples of water and bottom sediments were collected.
- Keep everything clean. While collecting and packing the samples, wear clean rubber gloves.

Collection of the Samples of Aquatic Vegetation	
Step	**Action**
1	Prepare polyethylene containers, filter paper, craft paper, labels, field log book, field forms, SAP, and clean rubber or latex gloves.
3	At the sample collection point, record the field environment in the field log book.
4	Wearing gloves, collect 2 kg of plants at all locations. Carefully rinse the collected sample in river water to remove the sediment, wipe with filter paper on a plastic tray, let air dry and than pack in craft paper. The label should be enclosed in a polyethylene envelope and attached to the prepared sample.
5	If you are at one of the two sites per country selected for duplicate sampling, take a second 1 kg sample, and package separately.
6	Write down the names of the collected water plants in the field log book.
7	Put all the samples in the appropriate transport containers, and label appropriately.
8	Write the information on the COC form immediately after the collection of the sample.

6.3 Collection of Bottom Sediment Samples

Guidelines:

- Collect samples at the same location where the samples of water and plants were collected.
- Keep everything clean. While collecting and packing the samples, wear clean rubber or latex gloves.

Collection of the Samples of Bottom Sediment	
Step	**Action**
1	Prepare polyethylene containers, labels, field log book, field forms, SAP, clean rubber gloves, digging tool, and distilled water.
2	At the sample collection point, record the field environment in the field log book.
3	Wearing gloves, collect bottom sediment samples by hand or with a small shovel. The mass of the collected sample should be no less than 2 kg dry weight.
4	If you are at one of the two sites per country selected for duplicate sampling, take a second 1 kg sample, and package separately.

Collection of the Samples of Bottom Sediment	
Step	**Action**
5	Prepare and label containers for the samples, and label appropriately.
6	Fill in the information required in the COC form.

6.4 Standard Operating Procedures for Collection of Soil Samples

Collection of Soil Samples	
Step	**Action**
1	Prepare polyethylene containers, labels, field log book, field forms, SAP, clean rubber or latex gloves, digging tool.
2	Wearing gloves, collect the soil sample at dry locations along the river banks, near the points of collection of water samples.
3	The collection of the soil sample is conducted on a principle of an envelope with 10 cm sides. Collect soil within the square 10 × 10 cm, 5 cm deep. As much as possible, remove stones and plants from the sample. The mass of the collected sample should be no less than two kg by dry weight.
4	If you are at one of the two sites per country selected for duplicate sampling, take a second 1 kg sample.
5	Prepare and label containers for the samples.
6	Record the field environment in the field log book.
7	Fill out separate COC form for each analytical laboratory.
8	Fill in the information to the COC form immediately after collecting the sample

6.5 Sample Location Photography

At the same time as the sampling is done, a series of four photographs will be taken at each sampling location looking upstream, downstream, to the left, and to the right. Photography locations should be noted and documented in the field logbook. SNL/CMC provides digital cameras. The images are sent via internet to the project database.

6.6 Sample Location GPS Coordinates

GPS will be used to determine the latitude and longitude of each sampling location, and to confirm the correct sample collection location during subsequent sampling events. GPS measurements will be recorded on the Hydrolab Field Data Collection Log (Appendix A) and in the field logbook. Hand-held GPS units provided by SNL/CMC will be used and the coordinates sent via internet to the project database.

7. Field Sampling Quality Control

7.1 Field Instrument Calibration

The Hydrolab instrument calibration should be performed at the start of a sampling season and thereafter as needed based on the daily "Field Checks." Calibration will be documented on the e Hydrolab Calibration Form (Appendix A). Instrument Field Checks will be performed twice daily (before sampling begins in the morning and once before sampling begins in the afternoon) and recorded on the Hydrolab Field Check Form (Appendix A). These field checks are essential for the collection of meaningful and accurate data. If the field check values are not within the tolerance range, re-calibration of the Hydrolab instrument will be necessary. The tolerances are provided in the SOP for Hydrolab Operation located in Section 5.

7.2 Field Logbooks

Each institution will receive a bound field logbook to document and record sample collection events. Field logbook documentation should include the following:

- Dates and time of entry
- Names of field team members collecting measurements and samples
- General field observations at each location (weather condition, temperature, etc.)
- General description of each sample location (landmarks, directions to sample location, features associated within the sample location such as mine tailings, industrial plants, etc.)
- Comments on the sample collection processes
- Comments and description on water, flora, soil, and sediment samples collected at each location
- GPS information (latitude and longitude at each sample location).

7.3 Field Forms

Field measurements and sample collection at each location will be documented on the appropriate field forms.

- Hydrolab Calibration Form (see Appendix A)
- Hydrolab Field Data Collection Log (see Appendix A)
- Hydrolab Field Check Form (see Appendix A)
- Flow Measurement Form (see Appendix A)

The Laboratory Request/Chain-of-Custody Form will be completed for laboratory analysis and will accompany the samples during transportation to the laboratory. This form is located in Appendix A.

7.4 Field Duplicates

Duplicate samples are collected to evaluate analytical and sampling technique reproducibility. True duplicate samples are not entirely possible for water, soil, sediments, and vegetation because these media are not homogeneous. For each sampling season, a duplicate sample will be collected at a frequency of two sites per country. A duplicate sample is collected immediately following the collection of the sample it is intended to represent for water, soil, sediment, and vegetation samples. As the name implies, this is a duplication of the "routine" or original sample. To ensure the sample identification number is identified correctly for duplicate samples, a "D" is added after the number. For example, if a duplicate sample was collected at Location 14 in Bajkonur town, Kazakhstan, the sample identification number would be KZ-14-Date-WD-D (for water dissolved, duplicate sample), KZ-14-Date-WS-D (for water suspended, duplicate sample), KZ-14-Date-S-D (for soil, duplicate sample), KZ-14-Date-B-D (for bottom sediment, duplicate sample), and KZ-15-Date-V-D (for vegetation, duplicate sample). See Appendix B.

7.5 Trip Blanks

The purpose of a trip blank is to determine whether factors present during the transport of samples to the laboratory may have affected sample quality. Trip blanks can be prepared and kept at the institution before sample collection (within 1 to 2 days). The trip blank will accompany and be handled during the entire sample collection event in the same manner as the "real" samples. Refer to the procedure in Section 7.

8. Laboratory Preparation of Water, Vegetation, Sediment, and Soil Samples

These procedures were prepared collaboratively by all Navruz partners.

8.1 Procedures for Preparing Samples

Preparation of Water Samples for Shipment to Analytical Laboratories	
Step	**Action**
1	Partially evaporate each water (dissolved) sample at a temperature of 80°C from 5.0 liters to 50 mL.
2	Split the concentrated water sample into two halves and transfer into two polyethylene bottles that are labeled with the water sample ID. Write the initial and final volumes on the COC.
3	Ship the concentrated water samples, plus the filters from the field (suspended portion), to the analytical laboratories of Kazakhstan and Uzbekistan.

Preparing Trip Blanks	
Step	**Action**
Intro	Trip blanks can be prepared and kept at the institution before sample collection (within 1 to 2 days). The trip blank will accompany and be handled during the entire sample collection event in the same manner as the "real" samples.
1	Fill a plastic container approximately 500 mL in volume with de-ionized water or a reagent-grade water that is prepared in the laboratory.
2	Secure the container lid.
3	Prepare a sample label and attach it to the container.
4	Place the plastic container in a sturdy shipping container on the morning of the sample collection event. **Do NOT open the trip blank** until it is ready to be analyzed at the laboratory at the end of the sample collection event.

Laboratory Preparation and Shipment of Aquatic Vegetation Samples	
Step	**Action**
1	In the laboratory, weigh the samples. Dry the samples, measure the dry weight and record the weight. Burn the sample to ash, and weigh the ash. Record the initial, dry, and ash weights for each sample on the COC.
2	Pack the ash in polyethylene bags and label them with sample ID.
3	Fill in the information required in the COC form (see Appendix A).

Laboratory Preparation and Shipment of Aquatic Vegetation Samples	
Step	**Action**
4	Fill out a separate COC form for each analytical laboratory. At the end of the season, this form will be used to account for all collected samples.
5	Ship the labeled samples to the analytical laboratories.

Laboratory Preparation of the Samples of Bottom Sediment	
Step	**Action**
1	Weigh the sample. Dry the samples of the bottom sediment in the laboratory and sieve them through 1 mm mesh. Weigh the dried sample. Record the wet and dry weights in the COC.
2	For all analytical laboratories the mass of the prepared samples should be 300 g.

Preparation of Soil Samples for Shipment to Analytical Laboratories	
Step	**Action**
1	Weigh the sample. Dry the samples of the bottom sediment in the laboratory and sieve them through 1 mm mesh. Weigh the dried sample. Record the wet and dry weights in the COC.
2	Sieve them through 1 mm mesh.
3	For all analytical laboratories, the mass of the prepared samples should be 300 g.
4	Pack the sample and send it to a laboratory for analysis (refer to following procedures).

8.2 Procedures for Packaging, Labeling, and Transporting Samples

Preparation of the Samples	
Step	**Action**
1	Label each sample container with the following information: • Unique sample identification number (see Appendix B) • Date and time of selection • Project name ("NAVRUZ") • The river name • Site of selection (range number, distance to the bank, depth) • Sample volume • Requested laboratory analysis • Name of person who collected samples.

Preparation of the Samples	
Step	**Action**
2	Label vegetation and sediment samples in the same manner with an indication of vegetation or sediment type.
3	Package and label dried samples. Indicate the mass of the sample after drying.
4	At the end of the sample season, each institution will have a maximum of three sturdy shipping containers for shipment to (1) Institute of Nuclear Physics in Kazakhstan, (2) Institute of Nuclear Physics in Uzbekistan, and (3) Sandia National Laboratories. The principal investigator will prepare the shipping containers for transport.

Shipping Samples to Sandia National Laboratories	
Step	**Action**
1	Place samples in sturdy shipping containers and at the same time verify that the label information on each sample container matches the information on the Chain-of-Custody (COC) form.
2	Place sufficient amount of packing material around samples to prevent any damage or shifting of the samples during transport.
3	Complete the DHL Worldwide Express shipping form (SNL/CMC will provide pre-printed forms for each institution). **IMPORTANT:** The samples for SNL can be cleared by U.S. Customs under General Article 651, which is “no duties and taxes” because there is no commercial value.
4	Declare <u>“no commercial value”</u> for the samples on the shipment form.
5	To ensure compliance with the U.S. Food and Drug Administration (FDA) the description of the items must be shown as <u>“Environmental Testing Samples”</u> on the agent’s air waybill and the shipping container.
6	The principal investigator should then contact the agent to arrange for a pick-up at the institution. See carrier information below.

Table 13. Carrier Location and Cost Information

Carrier	Telephone	Hours of Operation	Service	Transit Time (business days)	Transportation Cost* (US Dollars)
DHL Worldwide Express 157a Abaya Ave. Almaty, Kazakhstan 480009	3272-509416	Mon-Fri: 0900-1800 Sat-Sun: Closed Holidays: Closed	Air Express	5-7	$97.42
DHL Worldwide Express 107, Kievskaya Bishkek, Kyrgyzstan 720001	312-611111	Mon-Fri: 0800-1800 Sat: 0900-1600 Sun: Closed Holidays: Closed	Air Express	5-7	$97.42
DHL Worldwide Express 18 Rudaki Ave Dushanbe, Tajikistan 734025	3772-210280	Mon-Fri: 0900-1800 Sat-Sun: Closed Holidays: Closed	Air Express	5-7	$97.42
DHL Worldwide Express 42 Prospect Druzhby Narodov Tashkent, Uzbekistan 700097	8712-781436	Mon-Fri: 0900-1800 Sat-Sun: Closed Holidays: Closed	Air Express	5-7	$97.42

* In most cases, a $15.00 handling charge and a $25.00 processing fee will be charged in addition to the transportation cost.

Step	Action
7	The institution (principal investigator) signs the COC form in the "relinquished" box and the DHL Worldwide Express agent signs the COC form in the "received" box.
8	Make two copies of the COC form for the project files.
9	Place the original laboratory request/COC form in a plastic bag and tape it to the inside of the shipping container.
10	Secure the shipping container with strong adhesive shipping tape and/or a metal-type strapping tape around both ends of the container.
11	Write in large letters on the outside of the shipping container "ENVIRONMENTAL TESTING SAMPLES". The package is now ready for transport.
12	**IMPORTANT:** For purposes of tracking the items to the United States, and preparation for Customs entry and clearance, a copy of the air waybill should be faxed to Howard Passell at SNL/CMC after the cargo agent has recovered the item for transportation. The fax number for Howard Passell is 505-284-5055.

NOTE: United Parcel Service (UPS) is **not** recommended as a carrier because they do not recognize Albuquerque, New Mexico, USA as a port of entry. They will attempt to clear Customs in Louisville, Kentucky and will refuse to transfer cargo in-bound to Albuquerque, thereby resulting adding further costs. Suggested alternate carriers are listed below.

Table 14. Suggested Alternate Carriers

Alternate Carrier	Telephone	Hours	Service	Transit Time (business days)	Transportation Cost (US Dollars)
Airborne Express: Agent Consulate Cargo International 1st Yamskovo Pola 17 Str 1 Moscow, Russia 125124 *Service from all areas	7095-937-7277	Not provided	Express	7	Not published
FedEx: Agent AO M&M Militzer & Munch Germany Service from Kazakhstan	7-3272-503-566	Not provided	Int'l Express	5-7	$210.75
RBS Inc. Service from Kyrgyzstan	996 (3312) 650128	Not provided	Int'l Express	5-7	$210.75
Elf 91/FedEx Service from Uzbekistan	7-3712-501-871	Not provided	Int'l Express	5-7	$210.75

*FedEx does not provide service from Tajikistan
*FedEx costs do not include agent service fees or accessorial charges.

8.3 Procedures and Requirements for Transferring Custody of Samples from Sample Collection in the Field to Arrival at Analytical Laboratories

Each principal investigator will select a field team member to take custody of the samples at the end of the sampling season and to complete the Laboratory Request/COC Form (located in Appendix A) as described below:

Completing the Laboratory Request/COC Form	
Step	**Action**
1	Complete the COC form.
2	The appointed team member (transferee) will sign and record the date and time in the “relinquished by” column at the bottom of COC form.

Completing the Laboratory Request/COC Form	
Step	**Action**
3	The next person to receive the samples from the sample member becomes the new custodian or “caretaker” and will sign and record the date and time in the “received by” column at the bottom of the COC form.
4	This process of “relinquished by” and “received by” repeats until the samples arrive at the laboratory. This provides an accurate written record of the transportation process to the laboratory to ensure the samples remain intact.

8.4 Sample Management and Chain of Custody (COC)

Use consistent nomenclature for identifying sample locations for every part of the project. A Laboratory Analysis/COC form will be completed and signed by the sample team members to ensure sample integrity during transport to laboratories. This form also provides the necessary information for the laboratories. The COC form is located in Appendix A.

Section 9.1 and 9.2 were composed by Navruz Central Asian partners and translated here from Russian to English.

8.5 Uzbekistan Laboratory

8.5.1 Facilities Available at Uzbekistan Laboratory

The laboratory at the Institute of Nuclear Physics (INP) in Uzbekistan has the capability to measure total β- and α- activity, and to carry out γ-spectrometry to determine the content of naturally occurring and man-made radionuclides. This laboratory also performs analysis of many chemical elements by neutron activation. Instruments Available at Uzbekistan Laboratory

Table 15. Instruments Available at Uzbekistan Laboratory

Multi-channel gamma-spectrometer with germanium detector	Type GGPC 25-185-R, #52599 with the following characteristics: external diameter – 57.7 mm; length – 45 mm; sensitive volume V – 113 cm^3; efficiency – 26.6%; and measured resolution for 122keV – 0.66keV, 1332keV – 1.75keV. This device is designed for environmental sample monitoring in laboratories. It accomplishes fast and effective collection of spectrometric data, including analysis, identification of gamma spectra, determination of activity, quantitative and qualitative analysis, and determination of nuclide composition and their activities. The gamma-spectrometric system provides a practical method of determining radionuclide composition in soil for providing nuclear safety on rehabilitation sites or nuclear facilities sites.
Multi-channel gamma-spectrometer with Ge-Li detector	DGDK – 63, V – 63 cm^3, measured resolution for 1332keV – 2.5keV and Multi-Channel Analyzer (MCA) AMA-02-F1, USSR, MCA PC/Card, Mod.9408.
Scintillation spectrometer of gamma-radiation “Gamma-01C”	Dubna, Russia. This spectrometer was designed for measuring and processing gamma radiation spectra from scintillation detectors; the energy resolution for 661keV is < 7.6%.
Scintillation spectrometer of beta-radiation “Beta-01C”	Dubna, Russia. This spectrometer provides quantitative and qualitative analysis of various samples on the presence of beta-emitting radionuclides. The energy resolution at conversion electron peak of Cs-137 (624keV) is < 14.2%.
Alpha-beta-automate NNR-610	Designated for the automatic change and measuring of samples with low activity. Detector type – POB 302, flowing proportional counting device with window. Low background level provides radioactivity measurements of 10^{-2} Bq and higher.

8.5.2 Calibrations Made at Uzbekistan Laboratory

All instruments are calibrated using standard sources (point and volume) before each use.

8.5.3 Equipment Checks Made at Uzbekistan Laboratory

All instruments receive equipment checks as listed in Table 4.

Table 16. Equipment Checks Made at Uzbekistan Laboratory

Gamma spectrometry	Laboratory gamma sources are measured, and the position of photopeaks, their half-width (FWH) and count rates are determined. ^{241}Am, ^{137}Cs, and ^{60}Co sources are usually measured. Standard International Atomic Energy Agency (IAEA) specimens and background are periodically measured. Results of measurements of standard specimens are compared with passport data.
Beta spectrometry	A standard ^{90}Sr + ^{90}Y specimen and background are measured.
Alpha spectrometry	A standard ^{241}Am specimen is measured, the position of the alpha peak, its area and the half-width of the alpha line are determined, and the results are compared with passport data. The background is measured.

8.5.4 Training Available at Uzbekistan Laboratory

All laboratory employees work in the field of radioecology. Skill advancement seminars are ongoing.

8.6 Kazakhstan Laboratory

8.6.1 Facilities Available at Kazakhstan Laboratory

The Institute of Nuclear Physics (INP) of NNC of Kazakhstan has the following facilities: one room for measuring specimens, one room for packaging specimens, two rooms for drying and ashing specimens, two rooms for pulverizing samples, one room for evaporating water specimens, and two rooms for measuring specimens.

8.6.2 Instruments Available at Kazakhstan Laboratory

Radionuclide analysis (RNA) is based on α–, β–, γ–spectrometry of natural or artificial objects. There are three basic types of RNA, categorized by the determined radionuclides: the instrumental (γ–spectrometric) RNA for determination of artificial (Am-241, Eu-154, Eu-152, Cs-137, Co-60) and natural (U-238, Th-232, K-40) radionuclides; the radiochemical RNA for determina tion of Pu-239, Am-241, and Sr-90; and the γ–spectrometric RNA (requires preliminary concentrating) for radon determination.

Table 17. Analysis Methods Used at Kazakhstan Laboratory

Purpose	Technique
Activation analysis (AA)	AA is based on irradiation of an analyzed object by nuclear particles or quanta followed by investigation of the radiation spectrum of the produced radioactive nuclei. Two main types are used: (1) the instrumental AA and (2) the radiochemical AA (with radiochemical separation). The instrumental version is faster and less labor-intensive, whereas the radiochemical one provides a better detection limit, but is rather labor-intensive. The **advantages** of AA are: low detection level; opportunity for determination of a whole group of elements within one series of analysis; opportunity for proximity assay of some elements, provided automation is used; and an opportunity for nondestructive analysis. The **disadvantages** of AA are: relatively high cost of analysis, large stationary equipment, and a need for highly qualified personnel.
X-ray fluorescent (XRF) analysis, or X-ray radiometric analysis	XRF analysis, or X-ray radiometric analysis, is based on the irradiation of an analyzed object by X-ray radiation or low-energy gamma-quanta followed by investigation of the secondary X-ray radiation spectrum. **Advantages**: the opportunity for relatively rapid (3 to 30 minutes) and comparatively simple element determination; low cost; and applicability to working in field conditions. **Disadvantages:** the technique is less accurate (compared to AA) in terms of detection limits (10^{-4} to 10^{-5} %).
Atom emission spectrometry with inductive coupled plasma (AES-ICP)	AES-ICP is based on the excitation of atoms in an analyzed sample with high-frequency plasma and investigation of its emission optical spectrum. At the INP, this technique is implemented by means of the spectrum analyzer «JY-70P» (France) that operates in polychromator and monochromator modes. AES-ICP **advantages:** low detection limit (to 10^{-11} %) (which is similar to AA); in the monochromator mode, the technique allows the determination, in succession, of a large number of elements (more than 70), including those inaccessible for AA; in the polychromator regime, it provides determination of up to 23 elements; the technique is very rapid, provided a process of sample preparation is automated; and the technique is less labor intensive than other methods of analysis. **Disadvantages** of AES-ICP are: the analysis, as a rule, requires preliminary sample preparation (water is the only exception), which makes the technique more complicated and which affects resultant accuracy; relatively high cost of analysis; and the need for highly qualified personnel to operate it.

Technique Application

The comparison of the characteristics between the element analysis techniques results in the following conclusions:

Purpose	Preferred Technique
For studying macro-composition of an analyzed object…	XRF is the most convenient.
For determination of rare and trace elements in geological samples, toxic elements in environmental objects and micro-admixtures in super-pure materials…	AA and AES-ICP are the most suitable.
For analysis of water as well as the plant or biological materials…	AES-ICP is the most suitable.

8.6.3 Calibrations Made at Kazakhstan Laboratory

All measuring instruments are calibrated with respect to IAEA specimens and specimens of Gosstandart RK (Office of State Standards, Republic of Kazakhstan).

- Gamma spectrometers are verified daily by the laboratory of Gosstandart RK. Specimens for verification contain radionuclides with emission energy from 59 keV to 2614 KeV.
- The alpha spectrometer is calibrated and verified by the laboratory of Gosstandart RK in the range from 4 MeV (^{232}Th) to 5.75 MeV (^{236}Pu).
- The beta spectrometer is verified daily by the laboratory of Gosstandart RK with respect to specimens of ^{90}Sr + ^{90}Y.

8.6.4 Equipment Checks Made at Kazakhstan Laboratory

Table 18. Equipment Checks Made at Kazakhstan Laboratory

Gamma spectrometry	Laboratory gamma sources are measured, and the position of photopeaks, their half-width and count rate are determined. ^{241}Am, ^{137}Cs and ^{60}Co sources are usually measured. Standard IAEA specimens and background are periodically measured. Results of measurements of standard specimens are compared with passport data.
Beta spectrometry	A standard ^{90}Sr + ^{90}Y specimen and background are measured.
Alpha spectrometry	A standard ^{241}Am specimen is measured, the position of the alpha peak, its area and the half-width of the alpha line are determined, and the results are compared with passport data. The background is measured.

8.6.5 Training Available at Kazakhstan Laboratory

All laboratory employees work in the field of radioecology. Skill advancement seminars are ongoing. In addition, laboratory employees undergo internship at the analytical laboratory of the IAEA in Seiberdorf (Austria).

8.7 Sandia National Laboratories

8.7.1 Facilities Available at SNL

Sandia National Laboratories has the following facilities:

- One sample-receiving area with a fume hood.
- Three fully equipped sample preparation laboratories with fume hoods, microwave digestion ovens, hot plates, muffle ovens, and other customary laboratory items.
- Four sample analysis laboratories.

8.7.2 Instruments Available at SNL

Table 19. Instruments Available at SNL

8 laboratory gamma spectrometers	Each spectrometer consists of a graded lead shield, a liquid nitrogen-cooled High Purity Germanium (HPGe) detector, pulse-shaping electronics, an Analog to Digital Converter (ADC), an 8,192-channel MCA, analysis computer, hardware control software, and analysis software for spectrum analysis and reporting. Three systems are equipped with sample changers for up to twelve samples each.
6 portable gamma spectrometers	Each portable system consists of an HPGe detector , an integrated electronics/MCA system, a laptop, and analysis software for spectrum analysis and reporting.
5 Tennelec gas proportional detectors	Five Tennelec gas proportional detectors (2 inches in diameter) equipped with sample changers. The system is a computer-controlled gas flow proportional counter using P-10 gas (90% argon/10% methane). The control panel allows for either automatic or manual operation of the sample changer. Low background capability is maintained by lead shielding around the detector, and a guard detector that effectively blocks events caused by cosmic radiation. It is used mostly for analyzing swipes and air filters.
8 Packard Liquid Scintillation Counters (LSC)	Eight Packard LSC with automatic sample changers. All systems are equipped with circuitry to separate alpha and beta pulses, which are stored in separate MCAs.

Table 7. Instruments Available at SNL, continued

20 alpha spectrometers	Each spectrometer consists of a 450-mm^2 surface barrier detector, a vacuum chamber, pulse-shaping electronics, MCA, analysis computer, hardware control software, and analysis software for spectrum analysis and reporting.
1 ICP-MS system and 1 ICP-AES system	One ICP-MS system and one ICP-AES system with auto samplers.

8.7.3 Calibrations Made at SNL

All instruments are calibrated using standards that are traceable to the National Institute of Science and Technology (NIST).

Table 20. Calibration Information for Instruments at SNL

Instrument	Calibration Cycle
Gamma spectrometers	Gamma spectrometers are calibrated once every two years for energy, shape, and efficiency for various geometries. Each standard contains a mix of radioisotopes ranging in energy from 46 keV to 1836 keV. Routine geometries include: liquid 500 mL Marinelli beaker; solid 500 mL Marinelli beaker; solid 200 mL jar; point source; one-inch and two-inch air filters; a 4-inch by 5-inch air filter; and an assortment of other specialized shapes.
Portable gamma spectrometers	Portable gamma spectrometers are calibrated once every two years for energy, shape, and efficiency for a point source and in-situ measurements.
Gas proportional detectors	Gas proportional detectors are calibrated once every three years for various beta energies (Ni-63, C-14, Tc-99, Cl-36, and Sr-90) and one alpha energy (Pu-238). Two-inch standards with the isotope of interest are prepared on two-inch planchets, similar to actual samples.
LSC systems	LSC systems are calibrated once every three years for H-3, Ni-63, Cl-36 (gross beta), and Cm-244 (gross alpha). The pulse-shape discrimination setting is optimized for the alpha/beta separation function. For each isotope, a quench set consisting of 10 vials is prepared and used to determine the quench curves.
Alpha spectrometers	Alpha spectrometers are calibrated every three years for energy, shape, and efficiency for various distances from the detector. Each source is prepared by electroplating U-233 (4.8 MeV), Pu-239 (5.2 MeV), Am-241 (5.5 MeV), and Cm-244 (5.8 MeV) isotopes on a stainless steel disk with a diameter of 7/8”.
ICP-AES and ICP-MS systems	ICP-AES and ICP-MS systems are calibrated before each use with NIST traceable standards containing the metal of interest. At least three different concentrations are used to establish the instrument response before each use. The instrument calibration is re-checked after each batch of samples has been analyzed.

8.7.4 Equipment Checks Made at SNL

Table 21. Equipment Checks Made at SNL

Gamma Spectrometry	A mixed gamma source is counted on a detector and an analysis is performed to determine the location, full-width at half-max (FWHM), and count rate for a set of photopeaks covering a range of interest. For most HPGe detectors, these are the 60 keV, 662 keV, and 1332 keV peaks. The background of the system is characterized by taking an empty shield spectrum for typically 1000 minutes, or as long as the longest sample count time. A peak search is performed on the spectrum and peak areas are calculated. The routine QC check tracks the total count rate for all of the channels. In addition, the count rates for photopeaks associated with gamma ray emissions from natural sources and common contaminants are evaluated. Typically, these are the 93 keV, 511 keV, 609 keV, 662 keV, and 1,61 keV peaks. The QC results are available as control charts to give operators a visual indication of system operation and calibration parameters over time. Control charts are helpful in evaluating when re-calibration may be required or when the system may be operating improperly.
Gas Proportional Detectors	Routine QC tests are run to ensure that the instrument is maintaining the calibrated performance. A mixed check source with alpha- and beta-emitting isotopes is counted for five minutes or a count time that yields at least 10,000 counts in each channel. The counts are compared to the limits established during the calibration process to ensure that the detector response has not changed. The intrinsic background of the system is characterized for both background subtraction from a sample count and system QC checks. The system background is determined by performing a 240-minute count without a source present. QC charts are used to track calibration values over long periods. Calibration checks are performed daily or before system use to ensure that the system is still within operating limits. These daily results are logged onto control charts. The control charts can give operators a visual indication of system calibration trends over time. The charts are very helpful in indicating when a re-calibration might become necessary or in spotting a system problem that may arise over time.
LSC Systems	Routine QC samples are used to provide continuous testing of the status of the instrument. A blank sample, an H-3 standard, and a C-14 standard are counted and analyzed every time the system is used. These samples help the operator to determine if the instrument is maintaining the calibrated performance. Variations in the results for the QC samples may indicate a problem with the instrument and the variations should be investigated before the instrument is used again. A statistically significant shift in the QC sample results, such as two successive points outside the two sigma error limits of the sample mean or unusual statistical data trends, generally indicate a problem, such as the need for re-calibration.
Alpha Spectrometry	A mixed alpha source is counted at least once a week to check the system's energy calibration, shape calibration, and efficiency. Results are stored in control charts.

8.7.5 Training Available at SNL

All laboratory staff members are radiological workers. In addition, all staff members are trained in the proper use of the specific instruments and methods in use. All training is documented and maintained in employee's files.

9. Laboratory/Analytical Procedures

9.1 Uzbekistan Laboratory Analytical Procedures

Analysis on the following media will include:

- the filter paper with the suspended solids left behind on it from the filtering process;
- Concentrated water sample (dissolved solids) from evaporation process, measured by gross alpha and beta analysis in the LSC;
- a minimum of 0.3 to 0.5 kg of dried vegetation;
- 1 kg of dried bottom sediment measured by gamma spectrometry and gross alpha and gross beta analysis;
- 1 kg of dried soil measured by gamma spectrometry and gross alpha and gross beta analysis;

9.2 Kazakhstan Laboratory Analytical Procedures and Detection Limits

Instrumentation available at the INP includes an atomic reactor WWR-K and an isochronous cyclotron U-150.

γ-, α-, β-spectrometry is provided with the following instruments:

- Ge-detector "Ortec" GEM-20180 (20%-efficiency; 1.7 keV - resolution)
- Ge-detector "Ortec" GLP-25325, planar (resolution – 319 eV)
- Ge-detector "Canberra" GX-1520 (15%-efficiency; 1.7 keV - resolution)
- Ge-detector "Canberra" GLP-1010R (resolution – 230 eV)
- Ge-detector "Canberra" GCW-4023
- Si- detector "Ortec" CLP-10180, for XRF (resolution – 180 eV)
- α-spectrometer "Canberra" 2-cameras, model 7401
- α-spectrometer "Canberra" 8-cameras, model Alpha Analyst
- β-spectrometer "Packard" TRI-CARB 3100TR

The software "Canberra," "GENIE-2000," "Alpha Analyst," "Packard," and "Quanta Smart" are used in addition to software designed by employees of the lab.

Type	Purpose of Analysis	Detection Limits
AA	Provides determination of many metals with high sensitivity	For sediments and biota sampling analysis, in ppm : Cr - 0.08; As - 0.04; Hg - 0.02; Sb - 0.001; Cu - 0.2; Zn - 1.5; Ag - 0.2; Au - 0.01; Se - 0.1; and U - 0.1.
AES-ICP	Used for analysis of water, as preliminary sample preparation is not required	In ppb: Cr - 1.0; As - 15; Hg - 10; Sb - 20; Cu - 1.0; Zn - 0.5; Ag - 2.0; Au - 7; Se - 30; U - 30; Cd - 2; P - 20; Pb - 8; Bi - 10; and Th - 3
XRF	Used for the determination of macrocontent, (i.e., As, Br, Ca, Co, Cr, Cu, Fe, K, Mn, Ni, Rb, Sr, Ti, V, and Zn).	Made in an interval of 5÷-1000 ppm
RNA	Used both in instrumental and in radiochemical variant	In Bq/kg: ^{228}Th - 2; ^{226}Ra - 2; ^{210}Pb - 10; ^{214}Pb - 2; ^{214}Bi - 2; ^{40}K - 100; ^{241}Am - 3; ^{137}Cs - 1; ^{90}Sr - 10; $^{239+240}$Pu - 0.05; ^{3}H – 5.

9.3 Sandia National Laboratories Analytical Procedures and Detection Limits

Sandia National Laboratories (SNL) will perform independent verification on duplicate samples from two locations per country per sampling event. Each country will choose the locations for those duplicate samples and SNL with the following:

- the filter paper with the suspended solids left on it from the filtering process,
- 50 ml concentrated water sample (dissolved solids) from evaporation process,
- a minimum of 0.3 to 0.5 kg of dried vegetation,
- 1 kg of dried bottom sediment, and
- 1 kg of dried soil.

9.3.1 Gross Alpha Beta Analysis by Liquid Scintillation Counting

Samples that require gross alpha, gross beta, and/or tritium (or other low-energy beta) analysis may be analyzed using an LSC. The sample is added directly to the counting cocktail, counted, and analyzed. This process allows a method for screening the amount of radioactive material contained in a sample. While this method is only a screening technique, the benefit is that it requires essentially no radiochemistry be performed on the sample.

LSC Analysis

The Packard Tri-Carb Liquid Scintillation Counter is designed to perform gross alpha, gross beta, and tritium analysis on a liquid scintillation sample. The system provides several protocols that can be set up with the specific requirements for each type of analysis. The group of samples counted under any one protocol at any one time will have a blank counted as the first sample, and that blank will be subtracted from the final counting results. The counting results are saved in a computer file named by the protocol number that was used. This name is used every time that the protocol is used; therefore, it is necessary to move the computer file that contains the data to another file before a protocol can be reused. This is accomplished by analyzing the data for a protocol off-line. During analysis, the sample quench number (tSIE) is used to determine the counting efficiency for a sample. The efficiency is applied to the count results, and the activity is calculated. This information is then printed to obtain the final report.

LSC Detection Limits

Nuclide	pCi/g	pCi/L
Gross Alpha	1.0	4.0
Gross Beta	2.0	8.0

Laboratory Procedures

Liquid Sample Preparation	
Step	**Action**
1	Don protective clothing. The protective clothing requirements are a lab coat, disposable gloves, and some type of eye protection (prescription glasses or safety glasses).
2	Place a large area wipe in an appropriate-sized secondary spill container.
3	Install a new pipette tip on a calibrated 5 mL pipette, and transfer 5 mL of sample into the LSC vial.
4	Remove the disposable pipette tip and place it on a large area wipe.
5	Using the repipetter, dispense 15 mL of Ultima Gold XR scintillation cocktail into the LSC vial containing the sample, and then place the cap on the vial.
6	Write the laboratory batch number on the cap of the vial.
7	Shake the loaded LSC vial for approximately 10 seconds (using the electric shaker or by hand) to thoroughly mix the sample and the cocktail.
8	Inspect the samples for phase separation or excessive clouding. If a sample phase separates or if excessive clouding occurs, prepare another sample using a smaller sample aliquot. Consult the Project Leader, if necessary, to determine the size of the smaller aliquot.
9	Clean the outside of the vials using an area wipe. Using clean wipes, hold the vial and wipe the outside of the vial including the cap. This should remove any radioactive material that may have been transferred inadvertently to the outside of the vials by contaminated gloves. Removing any external contamination is important, since the vials will later be handled without gloves.

Solid Sample Preparation	
Step	**Action**
1	Don protective clothing. The protective clothing requirements are a lab coat, disposable gloves, and some type of eye protection (prescription glasses or safety glasses).
2	Place a large area wipe inside an appropriate-sized secondary container in the sample preparation area.
3	Stretch out a cotton ball into a flat smooth rectangle and place the formed cotton ball into a labeled LSC vial. The cotton ball should fit throughout the vial. The cotton is used to suspend the solid sample.
4	Place a fresh weighing paper on the analytical balance, then place the labeled LSC vial on the weighing paper and tare the balance.
5	Using a clean disposable scoop, dispense 0.5 grams of sample into the LSC vial that is on the balance. Carefully transfer the sample so none is spilled outside the vial.
6	Cap the vial and gently shake the vial to deposit the sample uniformly onto the flattened cotton ball. Uncap the vial.
7	Use the re-pipetter to aliquot 18 mL of Ultima Gold XR Scintillation Cocktail and gently dispense into the LSC Vial.
8	Screw the cap on the vial and write the laboratory batch number on the cap of the vial.
9	If the sample has started to settle, re-shake the LSC vial gently for approximately 10 seconds by hand to thoroughly mix the sample and the cocktail.
10	Inspect the samples for phase separation or excessive clouding. If a sample phase separates or if excessive clouding occurs, another sample should be prepared using a smaller sample aliquot. Consult the Project Leader, if required, to determine the size of the smaller aliquot.
11	Clean the outside of the vials using an area wipe. Using clean wipes, hold the vial and wipe the outside of the vial including the cap. This should remove any radioactive material that may have been transferred inadvertently to the outside of the vials by contaminated gloves. Removing any external contamination is important, since the vials will later be handled without gloves.

9.3.2 Gamma Spectrometry Analysis

Samples that require gamma spectroscopy analysis will be analyzed using a High Purity Germanium detector (or equivalent) and gamma spectroscopy software. This method is effective for screening a sample's concentration of various gamma-emitting radionuclides. These methods have been chosen to minimize the potential for contamination to personnel, the laboratory, or its equipment.

Batch procedures are developed to automate sample analysis for the gamma spectroscopy systems using the Canberra Genie-2K software. The batch procedure used for routine sample analysis:

- prompts the user for sample information,
- automatically clears the MCA,
- acquires a spectrum for the entered live time,
- saves the spectrum,
- analyzes the saved file, and
- prints a detailed and summary report.

A similar batch procedure is written to reanalyze a saved spectrum. This procedure prompts the user for sample information, analyzes the saved file, and prints a detailed and a summary report.

In addition, a batch procedure is written to perform a laboratory control sample (LCS) analysis. An LCS is a sample of known composition and activity. For aqueous and solid LCSs, analysis is performed using the same analytical methods employed for routine sample analysis. By utilizing the LCS analysis, the usability of routine sample analysis data is monitored by plotting the measured LCS activity for Am-241, Cs-137, and Co-60 and comparing these values to control limits of ±25% from the known activity for each isotope.

Table 22. Gamma Spectroscopy Detection Limits

Nuclide	pCi/g	pCi/L	Nuclide	pCi/g	pCi/L
BE-7	9.43E–02	7.12E+01	CE-141	1.89E–02	1.35E+01
NA-22	1.25E–02	8.92E+00	CE-144	8.23E–02	5.65E+01
NA-24	4.65E–02	3.39E+01	ND-147	7.96E–02	5.87E+01
K-40	1.39E–01	1.03E+02	EU-152	1.21E–01	8.34E+01
AR-41	4.73E+02	3.38E+05	GD-153	3.38E–02	2.13E+01
SC-46	1.41E–02	9.86E+00	EU-154	6.17E–02	4.32E+01
CR-51	8.45E–02	6.91E+01	EU-155	4.68E–02	2.96E+01
MN-54	1.40E–02	9.68E+00	TA-182	4.14E–02	2.89E+01
CO-56	1.79E–02	1.24E+01	TA-183	8.38E–02	4.68E+01
MN-56	3.28E+01	2.25E+04	IR-192	1.01E–02	8.28E+00
CO-57	1.11E–02	7.34E+00	TL-201	4.92E–02	3.43E+01
NI-57	2.72E–02	1.97E+01	HG-203	9.50E–03	7.88E+00
CO-58	1.24E–02	8.55E+00	TL-207	5.14E+00	3.54E+03
FE-59	2.27E–02	1.58E+01	TL-208	2.91E-02	2.11E+01
CO-60	1.33E–02	9.58E+00	PB-210	1.59E+02	3.47E+03
CU-64	1.28E+01	9.27E+03	PB-211	2.31E–01	1.81E+02
ZN-65	2.79E–02	1.95E+01	BI-212	1.82E–01	1.27E+02
SR-85	1.68E–02	1.25E+01	PB-212	1.46E–02	1.52E+01
Y-88	1.23E–02	1.01E+01	BI-214	2.50E–02	1.80E+01
NB-95	4.16E–02	3.44E+01	PB-214	2.08E–02	1.68E+01
ZR-95	2.23E–02	1.56E+01	RN-219	8.38E–02	6.96E+01
MO-99	1.27E–01	8.88E+01	RA-223	7.45E–02	4.85E+01
TC-99m	2.18E–01	1.52E+02	RA-224	2.02E–01	1.68E+02

Nuclide	pCi/g	pCi/L	Nuclide	pCi/g	pCi/L
RU-103	1.06E–02	7.95E+00	RA-226	1.86E–01	1.47E+02
RU-106	1.19E–01	8.46E+01	AC-227	5.88E–01	4.37E+02
CD-109	1.00E+00	6.41E+02	TH-227	7.15E–02	5.92E+01
AG-110m	1.22E–02	8.66E+00	AC-228	4.90E–02	3.37E+01
CD-115	2.65E–02	2.16E+01	RA-228	5.63E–02	3.89E+01
IN-115m	1.46E+00	1.19E+03	TH-228	2.44E–01	2.01E+02
SB-122	2.10E–02	1.53E+01	TH-229	9.33E–02	5.88E+01
SB-124	1.41E–02	1.02E+01	PA-231	3.38E–01	2.79E+02
SB-125	3.18E–02	2.46E+01	TH-231	2.22E–01	1.45E+02
I-131	1.15E–02	9.19E+00	TH-232	7.54E–02	6.12E+01
TE-132	1.15E–02	9.43E+00	PA-233	2.12E–02	1.74E+01
BA-133	1.46E–02	1.17E+01	TH-234	2.21E-01	1.40E+02
XE-133	6.34E–02	4.20E+01	U-234	1.62E+01	4.52E+03
CS-134	1.44E–02	1.03E+01	U-235	8.18E-02	5.81E+01
CS-137	1.39E–02	9.82E+00	NP-237	1.63E-01	1.05E+02
CE-139	1.02E–02	7.74E+00	U-238	5.73E-01	3.76E+02
BA-140	4.38E–02	3.22E+01	PU-239	9.31E+01	6.30E+04
LA-140	2.27E–02	1.74E+01	AM-241	8.25E-02	4.67E+01

Laboratory Procedures

Liquid Sample Preparation	
Step	**Action**
1	Don protective clothing. The minimum protective clothing requirements are a lab coat, disposable gloves, and some type of eye protection (prescription glasses or safety glasses).
2	Place a large area wipe in an appropriate secondary spill container (in a fume hood, if required).
3	Insert a ruler into an empty Marinelli beaker, measure 8.5 cm (3¼") from the bottom of the beaker, and mark this point on the beaker with a permanent ink marker. Perform this for all of the Marinelli beakers that will be required.
4	Place one beaker on the balance (include the cover and tape), and tare the balance. Do not tare this balance again until the sample is weighed again after loading (see below).
5	Remove the beaker from the balance, and place it in the work area which was prepared for filling.
6	Fill the beaker to the mark made in the above step with liquid from the sample container. This will yield approximately 450 mL of sample in the beaker.
7	Snap the lid on the beaker, and tape the lid onto the beaker using an elastic tape. This will seal the lid on the container and prevent leakage.
8	If any sample spilled on the outside of the container, use a large area wipe to clean the outside of the beaker.

Liquid Sample Preparation	
Step	**Action**
9	Place the sealed beaker back on the balance where the tare of the empty beaker was performed above. NOTE: It is important that another tare has not been performed on the balance before this measurement is made.
10	Write the net weight (reading displayed on the balance) in the appropriate column of the Sample Analysis Request Form.
11	Write the laboratory batch number on the top of the beaker using a permanent ink marker.

Solid Sample Preparation	
Step	**Action**
1	Don protective clothing. The minimum protective clothing requirements are a lab coat, disposable gloves, and some type of eye protection (prescription glasses or safety glasses).
2	Place a large area wipe in an appropriate secondary spill container (in a fume hood, if required).
3	Insert a ruler into an empty Marinelli beaker, measure 8.5 cm (3¼") from the bottom of the beaker, and mark this point on the beaker with a permanent ink marker. Perform this for all of the Marinelli beakers that will be required.
4	Place one beaker on the balance (include the cover and tape), and tare the balance. Do not tare this balance again until the sample is weighed again after loading (see below).
5	Remove the beaker from the balance, and place it in the work area which was prepared for filling.
6	Fill the beaker to the mark made in the above step with solid from the sample container.
7	Snap the lid on the beaker, and tape the lid onto the beaker using an elastic tape. This will seal the lid on the container and prevent spillage.
8	If any sample spilled on the outside of the container, use a large area wipe to clean the outside of the beaker.
9	Place the sealed beaker back on the balance where the tare of the empty beaker was performed above. It is important that another tare has not been performed on the balance before this measurement is made.
10	Write the net weight (reading displayed on the balance) in the appropriate column of the Sample Analysis Request Form.
11	Write the laboratory batch number on the top of the beaker using a permanent ink marker.

Analysis of a Saved File	
Step	**Action**
1	Perform a peak search to locate all the peaks in the spectrum.
2	Determine the net areas for each peak.
3	Subtract the net area of the background (empty shield) peaks from the sample peaks.
4	Compute the counting efficiency for each peak.
5	The corrected peaks are matched against a user-defined library to identify candidate isotopes. Candidate isotopes are corrected for nuclides with interfering lines. The calculated activities are then decay-corrected to the time of sample collection. A detailed report is generated. Lastly, a sorting program is executed that generates a summary report that includes sample information, activity, and the 2-sigma error associated with the isotopes found, and an MDA value for all nuclides in the library.

9.3.3 Metals Analysis

The samples are digested or leached using a microwave oven and are analyzed using an Inductively Coupled Plasma Atomic Emission Spectrometer (ICP-AES).

ICP-AES Sample Analysis

Samples are analyzed using a Leeman spectrometer for the metals of interest and a report is generated.

Table 23. ICP-AES Detection Limits

Analyte	mg/kg	mg/L	Analyte	mg/kg	mg/L
Aluminum	0.2	10	Lead	0.3	0.15
Antimony	0.06	3	Magnesium	5	250
Arsenic	0.01	0.5	Manganese	0.5	0.75
Barium	0.2	10	Nickel	0.4	0.2
Beryllium	0.5	0.25	Potassium	5	250
Cadmium	0.5	0.25	Selenium	0.5	0.25
Chromium	0.5	0.5	Silver	0.1	0.5
Cobalt	0.5	2.5	Thallium	0.1	0.5
Copper	0.2	1.3	Vanadium	0.5	2.5
Iron	0.1	5	Zinc	0.02	2.0

Laboratory Procedures

Liquid Sample Preparation	
Step	**Action**
1	Carefully acid wash and rinse all digestion vessels and volumetric ware with reagent water.
2	Measure a 15 mL aliquot of a well-shaken sample in a graduated cylinder.
3	Pour this aliquot into the digestion vessel and record the number of the vessel on the preparation sheet.
4	Add 5 mL of concentrated nitric acid to each vessel that will be used.
5	Tighten the caps to a uniform torque pressure to the manufacturer's recommended specifications.
6	Weigh each capped vessel to the nearest 0.01 g.
7	Program the microwave unit according to the manufacturer's recommended specifications. Choose a sequence that will bring the samples to 160ºC ±4ºC in 10 minutes and will permit a slow rise to 165 to 170 ºC during the second 10 minutes.
8	Start the turntable motor Ensure the vent fan is running on high and the turntable is turning.
9	Start the microwave generator.
10	At the end of the microwave program, allow the vessels to cool for at least 5 minutes in the unit before removal to avoid possible injury if a vessel vents immediately after heating.
11	When the vessels have cooled to room temperature, weigh and record the weight of each vessel assembly. If the weight of the sample plus acid has decreased by more than 10%, discard the sample.
12	If the digested sample contains particulates that may clog nebulizers or interfere with injection of the sample into the instrument, the sample may be centrifuged, allowed to settle, or filtered.
13	The concentration values obtained from analysis must be corrected for the dilution factor from the acid addition.

Solid Sample Preparation	
Step	**Action**
1	Carefully acid wash and rinse all digestion vessels and volumetric ware with reagent water.
2	Aliquot 0.500 g of a well-mixed sample into the sample vessel.
3	Add 10 mL of concentrated nitric acid in a fume hood.

Solid Sample Preparation	
Step	**Action**
4	If a vigorous reaction occurs, allow the reaction to stop before capping the vessel.
5	Cap the vessel and weigh the vessels to the nearest 0.001 g.
6	Place the vessels in the microwave carousel.
7	Irradiate each group of sample vessels for 10 minutes. The temperature of each sample should rise to 175ºC in less than 6 minutes and remain between 170 to 180ºC for the balance of the 10-minute irradiation period. The pressure should peak at less than 6 atm for most samples. The pressure will exceed these limits in the case of high concentrations of carbonate or organic compounds. In these cases, the pressure will be limited by the relief pressure of the vessel to 7.5 ± 0.7 atm. All vessels should be sealed according to the manufacturer's recommended specifications.
8	At the end of the microwave program, allow the vessels to cool for a minimum of 5 minutes before removing them from the microwave unit.
9	When the vessels have cooled to room temperature, weigh and record the weight of each vessel assembly. If the weight of acid plus sample has decreased by more than 10 percent from the original weight, discard the sample.
11	If the digested sample contains particulates that may clog nebulizers or interfere with injection into the instrument, it may be centrifuged, allowed to settle, or filtered.
12	Calculations: The concentrations determined are to be reported on the basis of the actual weight of the original sample.

10. Laboratory Quality Control

10.1 Uzbekistan Laboratory Control

In analytical laboratories, the quality control (QC) information obtained during the determination of chemical characteristics, measuring of gross alpha, beta-activity, and determination of isotope composition of samples analyzed should be provided.

The laboratory utilizes IAEA standard samples for calibration and QC to determine the effectiveness of obtained measurements of radionuclide content in environmental samples. The laboratory is prepared to participate in national inter-comparison programs for independent demonstration of technical proficiency.

10.2 Kazakhstan Laboratory Control

QC is done as analyses are being conducted in analytical laboratories. For each batch of 10 to 15 specimens, measurements are done on background specimens that do not contain certain radionuclides or elements. In addition, measurements are done periodically both on standard IAEA specimens and on laboratory standards in which the content of elements to be analyzed is known.

Once a year, representatives of Gosstandart RK verify procedures and measurements.

10.3 SNL/CMC Laboratory Control

In analytical laboratories, the QC information obtained during the determination of chemical characteristics, measuring of gross alpha, beta-activity, and determination of isotope composition of samples analyzed should be provided.

The QC samples for each batch of samples (maximum of 15 samples per batch) shall consist of a laboratory blank, a matrix blank, and a lab control sample. The results of the QC samples will be reported with the sample results.

Blank Sample – A sample that is the same matrix as the actual samples and is known **not** to contain the isotope or element of interest. Blank analysis results are assessed to determine the existence and magnitude of sample contamination problems. The criteria for evaluation of blanks apply to any blank associated with the samples. If problems with any blank exist, all data associated with the blank shall be carefully evaluated to determine whether or not there is an inherent variability in the data, or if the problem is an isolated occurrence not affecting other data.

Laboratory Control Sample (LCS) – A sample matrix similar to the actual samples with a known amount of the isotope or element under investigation, the LCS serves as a monitor of the overall accuracy and performance of all steps in the analysis, including the sample preparation. The LCS should contain greater than 10 times the radionuclide’s detection limit activity.

The laboratory participates in national inter-comparison programs such as the DOE-EML program, the NIST Radiochemistry Inter-Comparison Program, and the AIHA PAT and ELPAT programs for independent demonstration of technical proficiency.

The laboratory performs an internal systems audit at least once a year.

11. Data Management

11.1 Software and Formatting

SNL/CMC will provide, through the Navruz website (http://www.cmc.sandia.gov/Central/centralasia.html), a set of Excel spreadsheets formatted for the transmittal of the laboratory and field data to SNL. Partners should download the required spreadsheet, enter data into it, and then send the spreadsheet by email to project staff at the CMC at SNL in Albuquerque, New Mexico, USA.

After review by SNL staff, these data are loaded into the Navruz website for data sharing among partners and the public. Having undergone no peer review, these data are labeled "provisional" and the public is advised to contact project principal investigators (PIs) before using the data in any way.

Subsequent public reports and data analysis will appear on the website as well.

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12. Data Analysis

12.1 Objectives for Data Analysis

The objectives for data analysis are to provide a framework to ensure that data is confirmed and verified accordingly. It is our objective to obtain information that provides a qualitative and quantitative measure of site conditions, so that appropriate recommendations can be taken relative to the overall long-term project goals.

12.2 Analysis of Quality Control Data, and Its Use in Other Analysis

Each PI and laboratory should incorporate QC measures to ensure accuracy and precision in the analysis of the data. For example, each PI should incorporate a peer review and/or discussion on the data analysis and interpretation.

12.3 Software and Techniques to be Used

Software and techniques to perform data analysis and validation is at the discretion of each PI and laboratory. However, Microsoft Office Version 6 is the project's choice for receiving/sending files among the project colleagues.

12.4 Products to be Generated

Annual reports on the results of data analysis will be prepared by each partner and distributed via the Central Asia Project World Wide Web Site
http://www.cmc.sandia.gov/Central/centralasia.html

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References

Agency for Toxic Substances and Disease Registry, 2001. ToxFAQs: Frequently Asked Questions About Contaminants Found at Hazardous Waste Sites. http://www.atsdr.cdc.gov/toxfaq.html

Chenoweth, J. 1999. Effective multi-jurisdictional river basin management: data collection and exchange in the Murray-Darling and Mekong River basins. *Water International* 24(4):368-376.

Correia, F.N., and J.E. Da Silva. 1999. International framework for the management of transboundary water resources. *Water International* 24(2):86-94.

Dieperink, C. 2000. Successful international cooperation in the Rhine catchment area. *Water International* 25(3)347-355.

Eaton, A.D., L.S. Clesceri and A.E. Greenberg, editors, *Standard Methods for the Examination of Water and Wastewater*, American Public Health Association, American Water Works Association and Water Environment Federation, Washington, D.C., 1995.

Eisenbud, M. and T. Gessell, *Environmental Radioactivity from Natural, Industrial and Military Sources*, Fourth Edition, Academic Press, San Diego, 1997.

Elhance, A. 1999. *Hydropolitics in the third world; conflict and cooperation in international river basins*. U.S. Institute of Peace Press, Washington, D.C.

Lueck, A.H. 1999. Transboundary water resources management and the European Union's (EU) water policy. *Water International* 24(1):70-72.

Naiman, R.J. and R.E. Bilby, *River Ecology and Management*, Springer-Verlag, New York, 1998.

Office of Technology Assessment (OTA), U.S. Congress, 1995. Environmental Monitoring for Nuclear Safeguards*,* OTA-BP-ISS-168, U.S. Government Printing Office, Washington, DC:, September 1995.

Salman, M.A. and L. B. de Chazournes, editors. *International watercourses: enhancing cooperation and managing conflict: proceedings of a World Bank seminar*. World Bank Technical Paper No. 414. World Bank, Washington, D.C.

Tidwell, V.C., R.M. Salerno, H.D. Passell, K.L. Larson, E. Kalinina, A.T. Wolf, J. A. Cooper, J. Curtis, S.H. Conrad, D.P. Thomas and O.H. Paananen. 2001. *Integrating monitoring and decision modeling within a cooperative framework: Promoting transboundary water management and avoiding regional conflict.* SAND2001-0756. Sandia National Laboratories, Albuquerque, N.M.

United Nations/Economic Commission for Europe (UN/ECE). 1992. Convention on the protection of transboundary watercourses and international lakes. http://www.unece.org/env/water/.

United States Geological Survey, *National Field Manual for the Collection of Water Quality Data*, Handbooks for Water Resources Investigations, United States Geological Survey, Washington, D.C., 1999.

Wogman, N. A.; M. S. Wigmosta, D. W. Swindle, and P. W. Krey, 2001. Wide-area aquatic sampling and analysis for the detection of nuclear proliferation, *Journal of Radioanalytical and Nuclear Chemistry* 248 (3): 611-615.

Wolf, A.T. 1999. The transboundary freshwater dispute database project. *Water International* 24(2):160-163.

Appendix A. Forms

A.1 Hydrolab Calibration Form

HYDROLAB Calibration Form

NOTE: Calibration should be performed at the start of each sampling season and thereafter as needed based on the hydrolab field checks to be performed daily.

Calibrations Performed By/
Operator Name: **Signature:**

Date: **Institution:**

Meter Make and Model: Hydrolab/MiniSonde	**Serial #:**
Last Calibration Date:	**Project: Navruz**

pH

pH Calibrated To (standard):				pH sloped To (standard):		
	4.00		7.00		10.00	
	Instrument Value	Temp. °C	Instrument Value	Temp. °C	Instrument Value	Temp. °C
Time:						
Standards Expiration Date:						

ORP (mV = millivolt)

Reference value:				
	Instrument Value	Temp. °C		
Time:				
Standards Expiration Date:				

Conductivity (mSc = microsiemens/centimeter)

Reference value: (circle one: 1.413 or 12.85 mSc)			
	Instrument Value	Temp. °C	
Time:			Calibrate at zero first
Time:			Then calibrate to reference value: 1.413 or 12.85 mSc
Standards Expiration Date:			

DO %

Calibration Value	% Saturation	
	Value (%)	Atmospheric Pressure(mm Hg)
Time:		

A.2 Hydrolab Field Data Collection Log

Hydrolab Field Data Collection Log

Operator Name:	Project Name: Navruz
Hydrolab Serial number:	Institution:

Ec = Electrical Conductivity measured in micoSiemens per cm

ORP = Oxidation Reduction Potential measured in millivolts

DO% = Dissolved Oxygen, % of total saturation

Hydrolab Measurements

Sample Location	GPS Measurements Latitude/Longitude	Date/Time	Temp.(C)	DO %	DO (mg/L)	Ec (Conductivity)	Salinity (g/L)	TDS (g/L)	Depth	pH	ORP (mV)	Color

A.3 Hydrolab Field Check Form

Hydrolab Field Check Form

Note: Field Checks should be performed 3 times per day on the hydrolab instrument to ensure accurate field instrument meaurements

Operator Name: ________________ **Signature:** ________________

Date: ________________ **Institution:** ________________

Project: Navruz

pH		4.00		7.00		10.00	
	Sample Location	Value	Temp. °C	Value	Temp. °C	Value	Temp. °C
Time:							
Time:							
Time:							

Reference value: 250mV

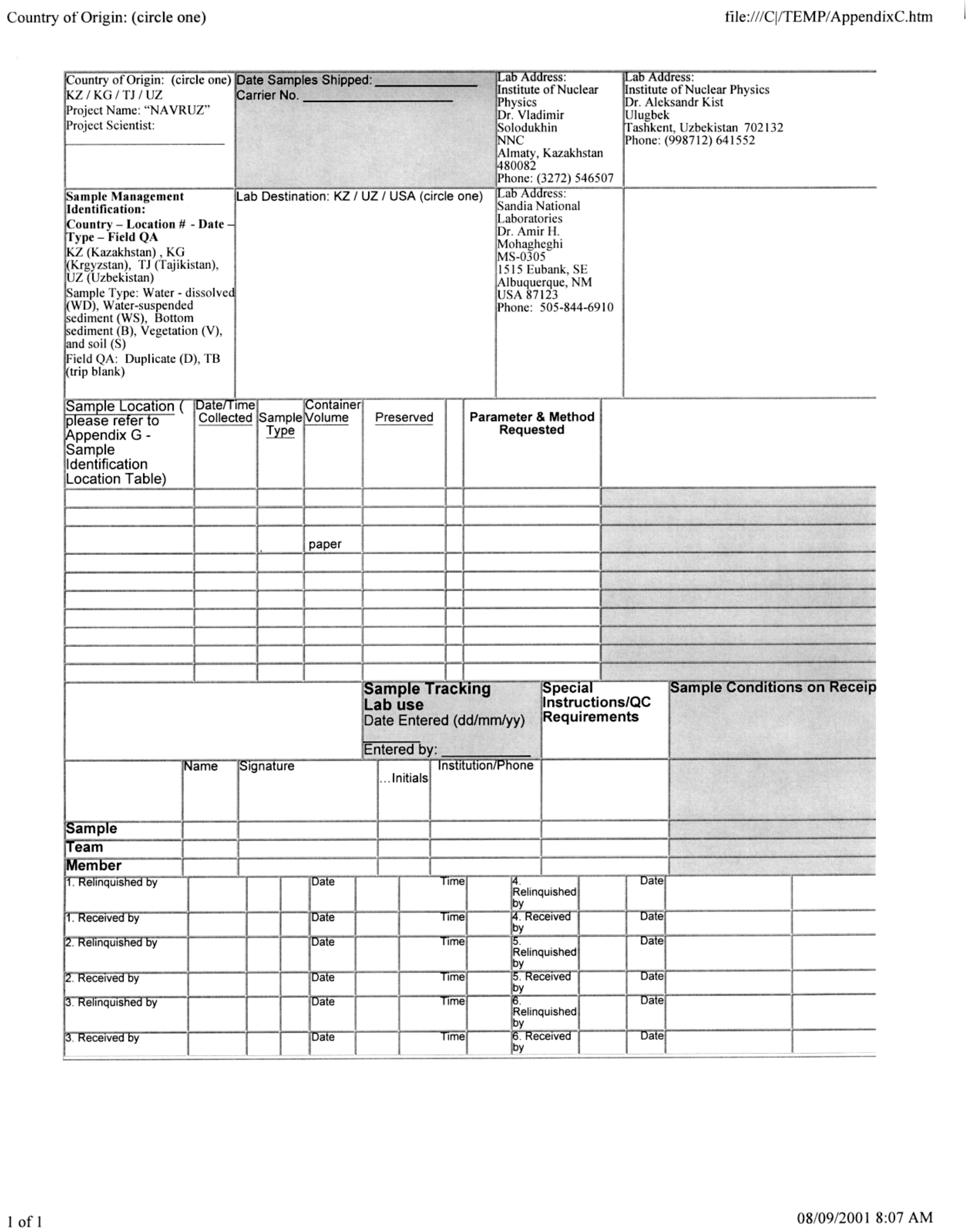
ORP (mV)	Sample Location	Value (mV)	Temp. °C
Time:			
Time:			
Time:			

Reference Value: 12.85 or 1.413 (circle)

Conductivity	Sample Location	Value(mSc/cm)	Temp. °C
Time:			
Time:			
Time:			

DO %	Sample Location	Value (%)	Temp. °C	Atmospheric Pressure (mm Hg)
Time:				
Time:				
Time:				

A.4 Laboratory Request/Chain of Custody Form



Country of Origin: (circle one) file:///C|/TEMP/AppendixC.htm

Country of Origin: (circle one) KZ / KG / TJ / UZ Project Name: "NAVRUZ" Project Scientist: ____________________	Date Samples Shipped: ____________ Carrier No. __________________	Lab Address: Institute of Nuclear Physics Dr. Vladimir Solodukhin NNC Almaty, Kazakhstan 480082 Phone: (3272) 546507	Lab Address: Institute of Nuclear Physics Dr. Aleksandr Kist Ulugbek Tashkent, Uzbekistan 702132 Phone: (998712) 641552
Sample Management Identification: **Country – Location # - Date – Type – Field QA** KZ (Kazakhstan) , KG (Krgyzstan), TJ (Tajikistan), UZ (Uzbekistan) Sample Type: Water - dissolved (WD), Water-suspended sediment (WS), Bottom sediment (B), Vegetation (V), and soil (S) Field QA: Duplicate (D), TB (trip blank)	Lab Destination: KZ / UZ / USA (circle one)	Lab Address: Sandia National Laboratories Dr. Amir H. Mohagheghi MS-0305 1515 Eubank, SE Albuquerque, NM USA 87123 Phone: 505-844-6910	

Sample Location (please refer to Appendix G - Sample Identification Location Table)	Date/Time Collected	Sample Type	Container Volume	Preserved		Parameter & Method Requested	
			paper				

			Sample Tracking Lab use Date Entered (dd/mm/yy) ________ Entered by: __________	**Special Instructions/QC Requirements**	**Sample Conditions on Receip**
	Name	Signature	…Initials	Institution/Phone	
Sample					
Team					
Member					

1. Relinquished by				Date			Time		4. Relinquished by		Date		
1. Received by				Date			Time		4. Received by		Date		
2. Relinquished by				Date			Time		5. Relinquished by		Date		
2. Received by				Date			Time		5. Received by		Date		
3. Relinquished by				Date			Time		6. Relinquished by		Date		
3. Received by				Date			Time		6. Received by		Date		

1 of 1 08/09/2001 8:07 AM

A.5 Hydrolab Service Form

R.G.A. No.: **1-TJ**

Date Shipped to Hydrolab ____________________

HYDROLAB

SERVICE MEMORANDUM

The following information is requested in order to process your order for warranty or non-warranty service. Please include this form, fully completed, with your return shipment .

Customer Contact Name: ***Akram Djuraev, scientific secretary of Agency on an atomic energy of an Academy of sciences of Republic of Tajikistan***

Customer Phone Number: **(992 372) 21 50 83; 21 50 84**

Customer FAX Number : **(992 372) 21 23 32; 25 29 69**

Customer e-mail Number anwar@ac.tajik.net or akram_dj@mail.ru

I prefer communication by E-mail

Address for return shipment of repaired equipment,

City: **Dushanbe**
State: **Tajikistan**
Zip: **299/1, Ayni St., 734063**

Address for billing (or purchase authority) for repair charges not covered by warranty.

____
____
City ____________________
State ____________________
Zip ____________________

In the event that your equipment is NOT under a Hydrolab warranty , please fill in this information:

Method of payment: ☐ VISA/MC ☐ P.O. No. ____________________
☐ Other ____________________
☐ If charges are less than $_______ , proceed with work; otherwise please call me first.

SHIPPING INSTRUCTIONS- Please refer to the instructions given under the SERVICE and LIMITED 2-YEAR WARRANTY form (found after this SERVICE MEMORANDUM) before packaging your instrument for shipment to Hydrolab.

Address each carton to:

HYDROLAB CORPORATION
SERVICE DEPARTMENT
12921 BURNET ROAD
AUSTIN. TX 78727 U.S.A.

Note:
Please install protective plugs and fill storage cups with 1 inch of water *maximum*.

Clearly mark each box with: **R.G.A. No.** ________________
Carton # _______ **of** ________

IMPORTANT: Please include RGA# on your purchase order.
Describe equipment symptoms on the reverse side of this memorandum.

HYDROLAB CORPORATION
12921 Burnet Rd. Austin, TX 78727 U.S.A.
Phone (512) 255-8841 or 800-949-3766 .FAX (512) 255-3106

INVENTORY OF EQUIPMENT BEING RETURNED

Instrument Type and Description	Serial No.
Surveyor 4a	S1993
MiniSonde 4a	37919

Description of Symptom(s) or Explanation

(Thorough descriptions can increase the speed of the repair .)

Please include how the instrument was being used (application) when symptom occurred.

Having kept within 24 hours the Surveyor 4a in normal temperature we had failure with its starting (shimmering or jumping of the screen and absence of picture).

The problem with the equipment is that when you turn it on you do not get a screen, but just a set of jumping lines like the horizontal hold does not work on a TV set.

We hooked the instrument to the probe but no change.

We opened the instrument in order to check the Internal Battery. Internal Battery's contacts were damp. It's voltage was 7.8 V. We made dry all contacts.

We tried several times to start the Surveyor 4a by pressing of “hidden” and "ON" keys at the same time (according to Surveyor 4a User's Manual ADDENDUM, April 1999 (Upgrades manual to revision D,1. Front Panel)). There was a failure.

A.6 Sample Minisonde Service Form

SERVICE, REPAIR, AND RETURN FORM

RGA-number: 1-TJ

1. **Instrument type: MiniSonde 4a**

2. **Model and serial number: 37919**

3. **Parameters' settings (in the Main Menu, under *Setup* and *Display* for the multiprobes, and under *Tabular:Display* for the surveyor 4):**

   The parameters were not established

4. **Deployment and site information:**

Having kept within 24 hours the Surveyor 4a in normal temperature we had failure with its starting (shimmering of the screen and absence of picture). We opened the instrument in order to check the Internal Battery. Internal Battery's contacts were damp. Its voltage was 7.8 V. We made dry all contacts. We tried several times to start the Surveyor 4a by pressing of hidden and "ON" keys at the same time (according to Surveyor 4a User's Manual ADDENDUM, April 1999 (Upgrades manual to revision D,1. Front Panel)). There was a failure.

A.7 Sample Surveyor Service Form

SERVICE, REPAIR, AND RETURN FORM

RGA-number: 1-TJ

1. **Instrument type: Surveyor 4a**
2. **Model and serial number: S1993**
3. **Parameters' settings (in the Main Menu, under *Setup* and *Display* for the multiprobes, and under *Tabular:Display* for the surveyor 4):**
4. **The parameters were not established**
5. **Deployment and site information:**

Having kept within 24 hours the Surveyor 4a in normal temperature we had failure with its starting (shimmering of the screen and absence of picture). We opened the instrument in order to check the Internal Battery. Internal Battery's contacts were damp. Its voltage was 7.8 V. We made dry all contacts. We tried several times to start the Surveyor 4a by pressing of hidden and "ON" keys at the same time (according to Surveyor 4a User's Manual ADDENDUM, April 1999 (Upgrades manual to revision D,1. Front Panel)). There was a failure.

A.8 Free Entry to U.S. Form

DEPARTMENT OF THE TREASURY
UNITED STATES CUSTOMS SERVICE

Form Approved
OMB No. 1515-0043

DECLARATION FOR FREE ENTRY OF RETURNED AMERICAN PRODUCTS

19 CFR 7.8, 10.1, 10.5, 10.6, 10.66, 10.67, 12.41, 123.4, 143.23, 145.35

1. PORT

2. DATE

3. ENTRY NO. & DATE

4. NAME OF MANUFACTURER

5, CITY AND STATE OF MANUFACTURE

6. REASON FOR RETURN

7. U.S. DRAWBACK PREVIOUSLY ☐ CLAIMED ☐ UNCLAIMED

8. PREVIOUSLY IMPORTED UNDER TSUSA 864.O5? ☐ YES ☐ NO

9. MARKS, NUMBERS, AND DESCRIPTION OF ARTICLES RETURNED

10. VALUE*

* If the value of the article is $10,000 or more and the articles are not clearly marked with the name and address of U.S. manufacturer, please attach copies of any documentation or o evidence that you have that will support or substantiate your claim for duty free status as American Goods Returned.

11. I declare that the information given above is true and correct to the best of my knowledge and belief; that the articles described above are the growth, production, and manufacture o United States and are returned without having been advanced in value or improved in condition by any process of manufacture or other means; that no drawback bounty, or allowanc been paid or admitted thereon, or on any part thereof; and that if any notice(s) of exportation of articles with benefit of drawback ☐ was ☐ were filed upon exportation of the merchandise from the United States, such notice(s) ☐ has ☐ have been abandoned.

12. NAME OF DECLARANT

13. TITLE OF DECLARANT

14. NAME OF CORPORATION OR PARTNERSHIP (If any)

15. SIGNATURE (See note)

16. SIGNATURE OF AUTHORIZING CUSTOMS OFFICER

NOTE: If the owner or ultimate consignee is a corporation, this form must be signed by the president, vice president, secretary, or treasurer of the corporation, or by any employee or a of the corporation who holds a power of attorney and a certificate by the corporation that such employee or agent has or will have knowledge of the pertinent facts.

Notice required by Paperwork Reduction Act of 1980: This information is needed to ensure that importers/exporters are complying with U.S. customs laws, to allow us to compute and co the right amount of money, to enforce other agency requirements, and to collect accurate statistical information on imports. Your response is mandatory.

Statement Required by 5 CFR 1320.21: The estimated average burden associated with this collection of information is 6 minutes per respondent or recordkeeper depending on individua cumstances. Comments concerning the accuracy of this burden estimate and suggestions for reducing this burden should be directed to U.S. Customs Service, Paperwork Managem Branch, Washington DC 20229, and to the Office of Management and Budget, Paperwork Reduction Project (1515-0043), Washington DC 20503.

Customs Form 3311 (062496)

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Appendix B. Sample Location Identification

The sample identification code used in this database: **KG-01-081201-WD**. A description follows of the various components of the code.

In each sample identification code, the five participating nations are abbreviated as follows: Kyrgyzstan = KG; Kazakhstan = KZ; Tajikistan = TJ; Uzbekistan = UZ; United States, US. So, in the example above, "KG-01" identifies sampling location 1 in Kyrgyzstan. The term "081201" indicates the sample was collected on 8 December 2001.

Five kinds of samples were collected at each site, and they are abbreviated as follows:

Water, dissolved fraction = WD; water, suspended fraction = WS; Bottom sediment = B; Vegetation = V; Soil = S. So, the sample in the example above is for water, dissolved fraction. If the above sample was a duplicate sample, the last terms of the code would be WD-D.
(For further reference click on "Map of Sampling Locations" at
http://www.cmc.sandia.gov/Central/centralasia.html.)

Kyrgyzstan

KG-01, Kichi-Naryn River before the confluence with the Chong-Naryn River, Kyrgyzstan
KG-02, Chong-Naryn River before the confluence with the Kichi-Naryn River, Kyrgyzstan
KG-03, Naryn River before the confluence of the Kichi-Naryn, Kyrgyzstan
KG-04, At-Bashy River before its confluence into the Naryn River, Kyrgyzstan
KG-05, Naryn River after the confluence of the At-Bashy tributary, Kyrgyzstan
KG-06, Chychkan River before the confluence into the Toktogul water pool, Kyrgyzstan
KG-07, Naryn River before its confluence in the Toktogul reservoir (hydrological post Uch-Terek), Kyrgyzstan
KG-08, Toktogul reservoir, Kyrgyzstan
KG-09, Naryn River after the Toktogul reservoir (region of Kara-Kul town), Kyrgyzstan
KG-10, Naryn River, southeast part of the town of Tashkumyr, Kyrgyzstan
KG-11, Mailuu-Su River, on the bridge (boundary with Uzbekistan), Kyrgyzstan
KG-12, Mailuu-Su River at the departure from Mailuu-Su town, Kyrgyzstan
KG-13, Mailuu-Su River near the transformer factory, Kyrgyzstan
KG-14, Mailuu-Su River, right tributary, Kyrgyzstan
KG-15, Mailuu-Su River 200 meters from the tributary, Kyrgyzstan

Kazakhstan

KZ-01, Chardarya reservoir, southeastern coast between the Keles and Kurukkeles Rivers, Kazakhstan
KZ-02, Chardarya reservoir, northeastern coast near Chardarya, Kazakhstan
KZ-03, Keles River, Saryagash town (upstream), Kazakhstan
KZ-04, Keles River, Saryagash town, (downstream), Kazakhstan
KZ-05, Badam River, Chymkent (upstream), Kazakhstan
KZ-06, Arys River before the confluence with the Badam River, Chymkent (downstream), near Obruchevka, Kazakhstan
KZ-07, Syrdarya, Chernak village (below Turkestan town), Kazakhstan
KZ-08, Syrdarya, Chyily (upstream), Tomlnaryk village, Kazakhstan
KZ-09, Syrdarya, Chyily, Kazakhstan
KZ-10, Syrdarya, Chyily (downstream), Zhulek village, Kazakhstan
KZ-11, Syrdarya, Kyzyl-Orda (upstream), Belkul village, Kazakhstan
KZ-12, Syrdarya, Kyzyl-Orda (downstream), Abaj village, Kazakhstan

KZ-13, Syrdarya, Korkyt village, below Zhusa town, Kazakhstan
KZ-14, Syrdarya, Bajkonur town, below Torwtam village, near Bay-Kozha, Kazakhstan
KZ-15, Syrdarya, Kazalinsk, Kazakhstan

Tajikistan

TJ-01, Varzob River, 18 kilometers above Dushanbe city, Tajikistan
TJ-02, Varzob River, 9 kilometers below Dushanbe city, Tajikistan
TJ-03, Kafirinigan River, 1 kilometer above the confluence with the Varzob River, Tajikistan
TJ-04, Kafirnigan River, 3 kilometers below its confluence with the Elok River, Tajikistan
TJ-05, Kafirnigan River, at the Shaartuz railway bridge, Tajikistan
TJ-06, Elok River, 1 kilometer above its flow into the Kafirnigan River, Tajikistan
TJ-07, Vakhsh River, at the Dzhilikul bridge.
TJ-08, Vakhsh River, "Chiluchor chashma," the spring, Tajikistan
TJ-09, Vakhsh River, 1 kilometer below Norak City, Tajikistan
TJ-10, Yekhsu River, at hydrological post "Vose", the settlement Vose, Tajikistan
TJ-11, Kyzylsu River, 5 kilometers from the settlement Vose, before its confluence with the Yekhsu River, Tajikistan
TJ-12, Kyzylsu River, Gulistan Village, Tajikistan
TJ-13, Syrdarya, 60 kilometers above the Kayrakkum reservoir, (unfinished frontier bridge), settlement Bulok, Tajikistan
TJ-14, Syrdarya, the bridge on the entrance of Khudzhand city, Tajikistan
TJ-15, Isfara River, the settlement Yangiobod between Rabot city and Nefteobod city, Tajikistan

Uzbekistan

UZ-01, Amudarya, Kyzyldzhar village, Karakalpakstan, 1 km above the terminating range of the Amudarya River (the nearest town is Kungrad), Uzbekistan
UZ-02, Amudarya, Kipchak town, Karakalpakstan, 0.5 km above the town, Uzbekistan
UZ-03, Amudarya, Tuyamuyun site, 8 km below the dam (Khorezm region), Uzbekistan
UZ-04, Karadarya, Namangan region, 20 km southwest from Namangan, at Kol' village, Uzbekistan
UZ-05, Syrdarya, Bekabad, Tashkent region, 0.9 km below the dump of drainage waters of "Vodokanal" enterprise, Uzbekistan
UZ-06, Syrdarya, Chinaz town, Tashkent region, 3.5 km SSW from Chinaz, Uzbekistan
UZ-07, Ankangaran River, Yangiabad town, Tashkent region, 5.5 km below Dukant village, Uzbekistan
UZ-08, Akhangaran River, Angren town, Tashkent region, 5.5 km below the Angren dam, Uzbekistan
UZ-09, Akhangaran River, Tuyabuguz, Tashkent region, Soldatskoe village, 0.5 km above the outfall of the Akhangaran River, Uzbekistan
UZ-10, Chirchik River, Gazalkent town, Tashkent region, 3.5 km below the town, Uzbekistan
UZ-11, Chirchik River, Kibraj village, Tashkent region, 3 km below the UZKTZhM enterprise sewage effluent, Uzbekistan
UZ-12, Chirchik River, Tashkent City, Tashkent region, 3 km below the sewage effluent from the Segeli KSM plant,
UZ-13, Zaravshan River, Ravatkhodzha, Samarkand region, 3.7 km below the outfall of the Taligulyan dump, Uzbekistan
UZ-14, Zaravshan River, Kattakurgan, Samarkand region, 0.8 km below the outfall of the Chegonak collector, Uzbekistan
UZ-15, Zaravshan River, Navoi City, Navoi region, 0.8 km below the sewage effluent from "NavoiAzot" enterprise, Uzbekistan

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Kazakhstan Principal Investigator
Vladimir Solodukhin, INP NNC,
480082, Almaty
Telephone No: (3272) 546507
E-mail: Solodukhin@npi.sci.kz
Fax No: (3272) 546467

Kyrgyzstan Principal Investigator
Vasil'ev Ivan,
Manager, Institute of Physics,
720071, Kyrgyz Republic, Bishkek, Chuj av. 265à Telephone No: (996-312) 253907
E-mail: Vacuum@freenet.kg
Fax No (996-312) 243693

Tajikistan Principal Investigator
Djuraev Akram, Atomic Energy Agency at the
Tajik Academy of Sciences;
33 Rudaki Ave., 734025,
Dushanbe, Tajikistan
Telephone No: (992-372) 252969
E-mail: Anwar@ac.tajik.net
Fax No. (992-372) 214911

Uzbekistan Principal Investigator
Bekhzad Yuldashev, Institute of Nuclear Physics, AS RU, Ulugbek, Tashkent –702132, Uzbekistan
Telephone No: (998712) 641552
E-mail: yuldashev@iae.tashkent.su
Fax No: (998712) 642590

Sandia National Laboratories/Cooperative Monitoring Center Project Manager
Dave Barber, PO Box 5800, Albuquerque, NM 87185, USA
Phone No: (1-505) 845-3487
E-mail: Dsbarbe@sandia.gov
Fax No: (1-505) 284-5055