

Work Plan

I. Summary Project Information

1. Project Title

Post-containment Management and Monitoring of Mercury Pollution in Site of Former PO “Khimprom” and Assessment of Environmental Risk Posed by Contamination of Groundwater and Adjacent Water Bodies of the Northern Industrial Area of Pavlodar

2. Project Manager

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3. Participating Institutions

3.1. Leading Institution

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3.2. Other Participating Institutions

Participant Institution 1

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Participant Institution 2

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Participant Institution 3

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Participant Institution 4

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4. Foreign Collaborators/Partners

4.1. Collaborators

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4.2. Partners

Institution: US Environmental Protection Agency	
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5. Project Duration

36 months

6. Project Location and Equipment

Institution	Location, Facilities and Equipment
Leading Institution AIPET	Baytursynov Str. 126, Almaty, the Republic of Kazakhstan. The analytical laboratory (rooms ## 528 and 530) has all necessary analytical equipment and volumetric glassware, including AFS analyzer PS Analytical Millennium-Merlin, AAS analyzer Perkin-Elmer AAnalyst 100 and GC Varian Star 3400CX. It also has a necessary infrastructure including central heating, water, the drains and exhaust ventilation. Office of BG Chair of Environmental Technology (rooms # 410 and 411) has the computer equipment connected to a network of Institute and Internet, e-mail, fax and telephones. The Chair also has the equipment necessary for the fieldwork including 3 portable GPS instruments, 2 cars with trailers (UAZ and Niva), rubber boat with motor, portable power-station, equipment for boreholes' pumping, various samplers & augers (for soils, sediments and water samples) etc.
Participant Institution 1 PCP	Northern Industrial Area 1, Pavlodar, the Republic of Kazakhstan. The Laboratory of Environmental Protection (located in 6 rooms in the special laboratory premises) has necessary common analytical equipment and volumetric glassware, as well as AAS mercury analyzer RA915+ (Lumex) and portable AAS mercury analyzer AGP-01. It has a necessary

	infrastructure including central heating, water, the drains and exhaust ventilation. The office of the Plant has the computer equipment connected to Internet, e-mail, fax and telephones.
Participant Institution 2 BMP	9 th Mikroraion, Stepnogorsk, Kazakhstan. Laboratory of monitoring has all necessary equipment and labware for conduction of chemical and microbiological analyses including GLC HP6890 Hewlett Packard, LC Perkin Elmer Series 200, AAS analyzer Perkin Elmer AAnalyst 300, SPH Hewlett Packard 8453, microbiological microscopes Zeiss Standard 25. The Laboratory has computers, faxes, telephones and is connected to Internet and e-mail. It has a necessary infrastructure including central heating, water, the drains and exhaust ventilation. The work will be carried out in rooms ## 213, 211a, 207a and 207b.
Participant Institution 3 PSU	Lomov Str. 64, Pavlodar, the Republic of Kazakhstan. Biology and Chemistry Institute has offices with computer equipment connected to a network of Institute and Internet, e-mail, fax and telephones (Building A – offices 8/1, 224,325, 127,515). It has a necessary infrastructure including central heating, water, the drains and exhaust ventilation. It also has the equipment necessary for the fieldworks including 2 cars.
Participant Institution 4 IHH	Valikhanova Str. 34, Almaty, the Republic of Kazakhstan. The Laboratory of Informatics and Hydrogeological Processes' Modelling has an office (room 181) and 4 ancillary rooms with necessary infrastructure. It has 6 computers and 2 servers connected to a local network and Internet as well as e-mail, fax and telephones. It also has a reel-feeding plotter HP DesignJet-500. The software possessed by the Laboratory includes the special hydrological-modelling tool ModFlow GMS 3.1.

II. Specific information

1. Introduction and Overview

The Northern outskirts of Pavlodar are contaminated with mercury as a result of activity of chlor-alkali production of former PO “Kimprom” that was finally closed in 1993. The total losses of mercury during the whole period of operation of chlor-alkali production can be estimated as 720 tons, 80% of which (i.e. approximately 580 tons) were unaccounted mechanical losses deposited in the concrete floor and underneath of factory building # 31.

In 1995 JV “Evrohim” proposed a design of demercurizaion of the closed chlor-alkali production which assumed to recover most of mercury loss. The design was accepted for implementation in 1998.

In 2001-2002 the area of mercury contamination was studied by the consortium of research institutions (including AIPET and JV “Evrohim”) in the framework of EU-funded project ICA2-CT2000-10029 “Toxicmanagement”.

Using the existing network of observation boreholes as well as the newly constructed ones the groundwater conditions in the Northern outskirts of Pavlodar were studied. The plume of mercury contaminated groundwater was found, which spreads on the depth of 6-14 m in parallel to the river Irtysh to the distance of 2.5 km from the building # 31. Field studies and computer modeling with ModFlow GMS 3.1 software was used to forecast the spread of mercury-contaminated groundwater in the Northern industrial area of Pavlodar. The software package “ArcGIS – Spatial analysis” was used to create and analyze the maps of distribution of Hg in soils located on industrial site of PCP and surrounding territory (in the layers 0-0.1; 0.1-0.2 and 0.2-0.5 m). The monitoring of the mercury contamination of surface water, fish and grazing grass was also conducted, as well as the risk assessment for the population living in the neighborhood. Basing on these studies a strategy for limiting the risks of mercury proposed by JV “Evrohim” was revised.

The revision of Evrohim design was carried out in 2003 and had the principal idea to cancel any attempts to extract mercury by any means from the concrete floor of building # 31, and highly contaminated grounds and construction materials. Instead of that it was decided to construct the isolating cut-off wall to the depth of underlying bed not only around the building # 31 but also around the other principal sources of mercury pollution (four sources in total). It also was decided to make special engineered capping above the areas isolated by cut-off walls in order to avoid the mercury transport to atmosphere. Therefore, the revised Evrohim design lies in the isolation and containment strategy instead of the strategy of excavation and recovery of Hg. The newly formulated design was funded from the budget of the Republic of Kazakhstan and must be completed at the end of 2004.

In 2003-2004 the Program of Post-containment Mercury Monitoring for the period of 2005-2020 was developed in AIPET by request of PCP. This Program is stipulated for a small amount of funding from the budget of the Pavlodar oblast. In August 2004 AIPET and PCP will for the first time carry out together trial fieldworks in accordance with this Program.

In 2003 the Pavlodar Hydrogeological Expedition has found a plume of groundwater contaminated with petroleum and oil derivates in the Northern industrial area of Pavlodar. The source of this contamination is Pavlodar Oil Refinery located nearby the former PO “Khimprom”. Due to the limited funding only a small number of observation boreholes was constructed which did not allow gathering any kind of complete database about this plume. It was presumed that the oil plume spreads in the same direction as the plume of mercury polluted groundwater. However, during the field research on the project ICA2-CT2000-10029 “Toxicmanagement” the research team of AIPET has found low quality of water in a number of operating boreholes in the northern outskirts of Pavlodar that makes this water unacceptable for drinking purposes, though mercury was not detected there.

Although the main risk posed by mercury contamination on site of former PO “Khimprom” is currently contained by cut-off walls and capping of the most contaminated sites significant risks in the Northern outskirts of Pavlodar still remain due to:

1. possible change of plume direction and/or upward movement of mercury-polluted groundwater to the surface in the pastures of the depression next to lake Balkyldak;
2. high level of contamination of wastewater storage pond – lake Balkyldak as well as the fish within it;
3. possible spread of plume of groundwater contaminated with oil and petroleum derivates towards village Pavlodarskoye (which has a groundwater off take) and further to river Irtysh.

The monitoring studies in the Northern outskirts of Pavlodar will allow the assessment of those residual risks and thus will make them manageable.

The objectives of this research are:

- a). to identify the risk associated with the spread of groundwater plumes contaminated with mercury and oil derivatives, including their movement through the network of water intake boreholes in village Pavlodarskoye, and further towards river Irtysh and/or their rise onto the pastures and, if significant, identify a management strategy to contain risk;
- b). to identify a management strategy for containing the environmental risk, caused by the mercury pollution of lake Balkyldak, including the pathway of pollutants bioaccumulation via food chains;

The project will specifically aim at the following:

1. Study of the movement of mercury in the groundwater rise in depressed area in saturated and unsaturated zones and its accumulation in the shallow ponds and vegetation. Development of management strategy to contain the risk to population in the vicinity and livestock:
 - To facilitate the Laboratory of environmental protection of PCP with the equipment for conduction of mercury monitoring, and to train the local staff;
 - To carry out 3-year post-containment monitoring program in the Northern industrial area of Pavlodar, including the monitoring of soils and vegetation of pastures in the close vicinity of contamination, and to develop recommendations for the further implementation of monitoring program;
2. Assessment of possibility for mercury-polluted groundwater flow to change its direction; study of interaction of contaminated groundwater with bearing strata and underlying aquifers:
 - To upgrade and detail the models of groundwater in the Northern industrial area of Pavlodar and contamination of groundwater with mercury;
 - To investigate the possible connection in the aureole of mercury pollution between the groundwater of Low-Medium Pliocene deposits of Pavlodar assise and groundwater of Oligocene deposits of Nekrassovskaya suite;
 - To define more accurately forecast for spread of mercury-containing groundwater in Northern industrial area of Pavlodar taking into account adsorption/desorption of mercury on bearing strata of aquifers and on surface of basalt clay;
3. Study of the spread of groundwater plume contaminated with oil products from the territory of Pavlodar Oil Refinery; development of model and assessment of environmental risk posed by oil-products contamination of groundwater in the Northern industrial area of Pavlodar:
 - To facilitate the Laboratory of environmental protection of PCP with the equipment to monitor contamination of groundwater with oil products, and to train the local staff;
 - To drill and equip new observation boreholes for groundwater sampling and to do chemical analyses in order to define the direction of spreading the plume of groundwater contaminated with oil and petroleum derivatives;
 - To develop the model of spreading the oil products with groundwater in Northern industrial area of Pavlodar.
4. Assessment of possibility to contain the risk posed by mercury pollution of lake Balkyldak including the fish within it:
 - To study the mercury contamination of bottom sediments in lake Balkyldak, and to estimate the amount of deposited mercury;
 - To study the food chains of lake Balkyldak and to assess the bioaccumulation of mercury in aqueous organisms.
5. To draw up and discuss with local stakeholders the recommendations for the 2nd stage of demercurization and other remediation activities in the area of the former PO “Khimprom” (Northern industrial area of Pavlodar), including the recommendation for abolishment or further safe use of the wastewater storage pond – lake Balkyldak.

2. Expected Results and Their Application

The proposed study is an applied research in the field of environmental protection. It is assumed that in the course of this works new facts might be revealed that would require the deepening and the extension of the research. The results of the research and its stages will be presented as interim and final reports.

- One of the most important results of proposed study will be the foundation of monitoring laboratory of PCP that will be capable to implement Post-containment monitoring Program in Northern industrial area of Pavlodar during 2005-2020 after completion of proposed ISTC study. This laboratory will be also capable to conduct other investigations in the field of environmental protection. The completion of Phase I of Demercurization Project does not assume termination of the investigation of mercury pollution in Pavlodar. The Phases II & III are starting that will require more detailed and more extensive studies of the residual mercury pollution and associated risk. These reasons will allow the laboratory of PCP to become self-supporting;
- PCP together with AIPET will carry out the monitoring study of the mercury contamination of groundwater in the Northern industrial area of Pavlodar;
- AIPET together with PCP will study the extent mercury contamination of pastures in the areas where the upward movement of polluted groundwater is possible;
- BMP together with PCP will conduct the monitoring study regarding to the groundwater contamination with petroleum and oil derivatives in Northern industrial area of Pavlodar;

- AIPET together with PSU will determine the levels of total mercury content in bottom sediments and biota from wastewater storage pond – lake Balkyldak;
- AIPET together with IHH will assess the risks associated with the residual mercury contamination of groundwater and wastewater storage pond – lake Balkyldak;
- IHH together with AIPET will assess the risks posed by contamination of groundwater with oil and petroleum derivatives;
- IHH will upgrade the groundwater model for the Northern industrial area of Pavlodar and make it more accurate. IHH will make forecasts for the future spread of groundwater contaminated with Hg and oil products;
- AIPET together with IHH will draw up and discuss with local stakeholders and state authorities the proposal for risk management in Northern outskirts of Pavlodar including possible implementation of 2nd stage of PO “Khimprom” demercurizing and/or brining wastewater storage pond – lake Balkyldak to safe conditions.

3. Meeting ISTC Goals and Objectives

The proposed project:

- provides weapon scientists and engineers in Kazakhstan, particularly those who possess knowledge and skills related to weapons of mass destruction, opportunities to redirect their talents to peaceful activities;
- encourages integration of scientists of Kazakhstan into the international scientific community;
- supports applied research for peaceful purposes, notably in fields of environmental protection and remediation.

4. Scope of Activities

AIPET will coordinate fieldworks and chemical-analytical activities. AIPET will also render a support to the local staff of PCP monitoring laboratory in training related to the determination of total mercury in environmental samples. AIPET together with PCP laboratory will carry out fieldworks and chemical analyses associated with the study of mercury contamination of groundwater. The pathways of mercury accumulation via food chains in wastewater storage pond – lake Balkyldak will be studied by AIPET in cooperation with PSU. AIPET will estimate the amount of mercury deposited in bottom sediments of lake Balkyldak and gather the data in order to justify the proposals for its safe use. The recommendations for the 2nd stage of demercurizing and remediation activities will be drawn up by AIPET together with IHH.

IHH will conduct all activities related to the computer modeling including upgrading and detailed elaboration of models of groundwater contamination in Northern industrial are of Pavlodar. IHH will coordinate and manage monitoring and fieldworks in cooperation with AIPET. The results of this work will be incorporated into upgraded model that will allow assessing and managing the risk posed by mercury and oil-derivates contamination of groundwater.

PCP will establish monitoring laboratory and train its staff in the methods of determination of total mercury in environmental compartments and oil products in natural water samples. PCP will conduct the analyses of bottom sediments samples for the content of total mercury. PCP will create the network of observation boreholes in order to track groundwater contaminated with oil products. PCP will carry out post-containment monitoring in the Northern industrial area of Pavlodar together with AIPET and the study of groundwater contamination with petroleum and oil derivatives together with BMP.

PSU will carry out the sampling of bottom sediments of wastewater storage pond – lake Balkyldak and together will study food chains in this water body.

BMP will render a support to the local staff of PCP monitoring laboratory in training related to the determination of oil products in natural water samples. BNL together with PCP will carry out fieldworks and chemical analyses associated with the study of oil-products contamination of groundwater.

The project includes the following tasks:

1. Study of the movement of mercury in the groundwater rise in depressed area in saturated and unsaturated zones and its accumulation in the shallow ponds and vegetation. Development of management strategy to contain the risk to population in the vicinity and livestock:

- *To facilitate the Laboratory of environmental protection of PCP with the equipment for conduction of mercury monitoring, and to train the local staff;*

The laboratory of PCP already possesses the chemical and analytical equipment (made in Soviet Union and Russia) for the determination of total Hg in air and solid samples. The personnel experienced in using of this equipment is also available. The purchase of highly sensitive AFS-analyzer will be required for the determination of total mercury in water and biological tissues. The personnel will be trained for the using methods which allow detection of mercury at ppt level (i.e.

using the specially cleaned glassware, clean room practice, quality control/quality assurance procedures including application of special methods and standard reference materials etc.). The purchase of additional equipment for the sampling of surface and ground water is required (water level measuring devices, portable power generator, immersible pumps with hoses, filtration units etc.), and the subsequent training of PCP staff for application of special sampling method will be necessary.

- *To carry out 3-year post-containment monitoring program in the Northern industrial area of Pavlodar, including the monitoring of soils and vegetation of pastures in the close vicinity of contamination, and to develop recommendations for the further implementation of monitoring program;*

The Program of post-containment monitoring for 2005-2020 will be revised and extended in compliance with the more comprehensive capabilities of PCP regarding to the trace level analysis of mercury (e.g. to enlarge the Program with Hg determination in the samples of grazing grass, milk and other biological samples). The hydrogeological parameters (water levels in boreholes, pH, temperature, redox potential) will be measured and samples of surface and ground water as well as biological samples will be taken during 3-year period according to the Monitoring Program. Chemical analyses of samples will be done in the laboratory of PCP, and the inter-laboratory control will be conducted by the laboratory of AIPET. The results of analyses will be analyzed by statistical mean, entered to the database and transferred to AIPET. In the course of these activities the new proposals for the further revision of Monitoring Program might be drawn up.

2. Assessment of possibility for mercury-polluted groundwater flow to change its direction; study of interaction of contaminated groundwater with bearing strata and underlying aquifers:

- *To upgrade and detail the models of groundwater in the Northern industrial area of Pavlodar and contamination of groundwater with mercury;*

The model of groundwater of Northern industrial area of Pavlodar will be converted into updated version of ModFlow GMS 5.0 software. The additional data characterizing the hydrogeological structure of eastern border of river Irtysh valley will be entered to the model. The detailed “incut” model will be created for the area of Hg contaminated groundwater. More accurate forecasts will be worked out for the spread of mercury pollution and the risk will be assessed regarding to Hg polluting of the network of operating boreholes in Pavlodarskoye village and river Irtysh floodplain.

- *To investigate the possible connection in the aureole of mercury pollution between the groundwater of Low-Medium Pliocene deposits of Pavlodar assise and groundwater of Oligocene deposits of Nekrassovskaya suite;*

Additional observation boreholes reaching the second aquifer will be constructed in the area of mercury pollution (special precautions will be taken to avoid polluting of underlying aquifer with Hg). The samples of bearing strata will be taken during boreholes’ drilling for further laboratory studies. Water samples will be taken for the determination of concentrations of Hg and major anions. The threat of spreading mercury via underlying aquifers will be assessed.

- *To define more accurately forecast for spread of mercury-containing groundwater in Northern industrial area of Pavlodar taking into account adsorption/desorption of mercury on bearing strata of aquifers and on surface of basalt clay;*

The laboratory experiments will be conducted in order to study the capability of the samples of bearing strata to adsorb/desorb the cationic mercury and chloride complexes of Hg. The modeling of mercury spread with groundwater will be done taking in account the parameters of adsorption/desorption both in the bulk of bearing strata and on the surface of basalt clay. The forecasts for mercury pollution spread will be detailed for the different scenarios of technogenic changes of hydrogeological conditions in the area of interest.

3. Study of the spread of groundwater plume contaminated with oil products from the territory of Pavlodar Oil Refinery; development of model and assessment of environmental risk posed by oil-products contamination of groundwater in the Northern industrial area of Pavlodar:

- *To facilitate the Laboratory of environmental protection of PCP with the equipment to monitor contamination of groundwater with oil products, and to train the local staff;*

The purchase sensitive GC is required as well as necessary accessories and consumables for it in order to determine the oil hydrocarbons in the extracts from groundwater samples. The personnel of PCP will be trained to apply methods allowing determination of oil hydrocarbons at ppb level (i.e. using specially cleaned glassware, clean room practice, quality control/quality assurance procedures including application of special methods etc.). The purchase of sampling equipment and training of PCP staff to apply relevant sampling methods are also required.

- *To drill and equip new observation boreholes for groundwater sampling and to do chemical analyses in order to define the direction of spreading the plume of groundwater contaminated with oil and petroleum derivatives;*

The most likely direction of the spread of oil products with groundwater will be determined and the cross-section of boreholes will be constructed at right angle to this direction in order to detect the plume of contamination. Using the concurrent drilling and chemical analysis the plume of oil contamination will be contoured and its extent will be estimated.

- *To develop the model of spreading the oil products with groundwater in Northern industrial area of Pavlodar.*

Using the updated version of groundwater model in the Northern industrial area of Pavlodar and the results of field research the forecasts for the spread of oil products will be drawn up at various hydrogeological conditions. The risks for the population of Northern outskirts of Pavlodar and for river Irtysh floodplain will be assessed.

4. Assessment of possibility to contain the risk posed by mercury pollution of lake Balkyldak including the fish within it:

- *To study the mercury contamination of bottom sediments in lake Balkyldak, and to estimate the amount of deposited mercury;*

The vector map of lake Balkyldak will be created and the sampling plan for bottom sediments will be designed. Bottom sediments from lake Balkyldak will be sampled (on regular grid during the winter) using the different types of samplers and augers (the samples of silts will be taken from the whole depth, and clay ill be sampled from the surface only). The map of contamination of bottom sediments will be created and analyzed using the software package “ArcGIS – Spatial Analysis”.

- *To study the food chains of lake Balkyldak and to assess the bioaccumulation of mercury in aqueous organisms.*

The samples of biota will be taken from lake Balkyldak and the existing food chains will be described. Total mercury content will be determined in biota samples. The pathways of Hg bioaccumulation will be identified and the possible solutions to break these pathways will be developed.

5. To draw up and discuss with local stakeholders the recommendations for the 2nd stage of demercurization and other remediation activities in the area of the former PO “Khimprom” (Northern industrial area of Pavlodar), including the recommendation for abolishment or further safe use of the wastewater storage pond – lake Balkyldak:

The work program and obtained results will be discussed with Pavlodar regional department of environmental protection and with the managers of Pavlodar Chemical Plant. The workshops, press-conferences and presentation will be help to discuss the interim results. The final results and conclusions will be published in scientific journals (both regional and Western ones) and in mass media.

Task 1: Task 1

Task description and main milestones		Participating Institutions
Study of the movement of mercury in the groundwater rise in depressed area in saturated and unsaturated zones and its accumulation in the shallow ponds and vegetation. Development of management strategy to contain the risk to population in the vicinity and livestock: <ul style="list-style-type: none"> • To facilitate the Laboratory of environmental protection of PCP with the equipment for conduction of mercury monitoring, and to train the local staff. • To revise the Program of Post-containment Monitoring by expanding the study of pollution of groundwater and biota, and by adding the tests of grazing grass and milk. To carry out 3-year monitoring program (sampling and analysis), including the monitoring of soils, surface and ground water, aquatic biota, milk, and grazing grass in the close vicinity of groundwater contamination. To measure the hydrogeological parameters (water levels in boreholes, pH, temperature, redox potential) simultaneously with groundwater sampling.		AIPET (Leading) PCP (Subinstitution)
Description of deliverables		
1	Database on sampling and results of chemical analyses	
2	Publications in mass media/ and scientific journal	
3	Proposals for the revision of Monitoring Program for 2008-2020	
4	Quarter reports	

5	Final reports
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Task 2

Task description and main milestones		Participating Institutions
<p>2. Assessment of possibility for mercury-polluted groundwater flow to change its direction; study of interaction of contaminated groundwater with bearing strata and underlying aquifers:</p> <ul style="list-style-type: none"> To convert the model of groundwater of Northern industrial area of Pavlodar into updated version of ModFlow GMS 5.0 software. To enter into the model the additional data characterizing the hydrogeological structure of eastern border of river Irtysh valley will be entered to the model. To create the detailed “incut” model for the area of Hg contaminated groundwater. To make detailed forecasts for mercury pollution spread taking into account the parameters of adsorption/desorption equilibrium. To assess the risk posed by mercury pollution for the network of operating boreholes in Pavlodarskoye village and river Irtysh floodplain. To construct additional observation boreholes reaching the second aquifer in the area of mercury pollution. To take samples of bearing strata during drilling of additional boreholes and samples of groundwater after drilling for subsequent laboratory experiments. To analyze the samples of groundwater for the concentration of total Hg and major anions. <p>To conduct laboratory study of adsorption equilibrium in the system bearing strata – solution of Hg (II) nitrate and HG (II) chloride; to perform the leaching tests for adsorbed mercury.</p>		<p>AIPET (Leading) IHH (Substitution) PCP (Substitution)</p>
Description of deliverables		
1	Forecasts of mercury pollution spread for different scenarios of technogenic changes of hydrogeological conditions in the area of contamination	
2	The results of risk assessment and, if necessary, the proposal for managing the mercury pollution risk for the network of operating boreholes in Pavlodarskoye village and river Irtysh floodplain.	
3	Publications in mass media and scientific journal	
4	Quarter reports	
5	Final reports	

Task 3

Task description and main milestones		Participating Institutions
<p>3. Study of the spread of groundwater plume contaminated with oil products from the territory of Pavlodar Oil Refinery; development of model and assessment of environmental risk posed by oil-products contamination of groundwater in the Northern industrial area of Pavlodar:</p> <ul style="list-style-type: none"> To facilitate the Laboratory of environmental protection of PCP with the equipment to monitor contamination of groundwater with oil products, and to train the local staff. Basing on the hydrogeological model of Northern industrial area of Pavlodar to estimate the most likely direction of the plume of oil products with groundwater. To construct the cross-section of boreholes at right angle to 		<p>AIPET (Leading) BMP (Substitution) IHH (Substitution) PCP (Substitution)</p>

<p>plume direction at the distance of 1-1.5 km from pollution source in order to detect the plume of contamination. To use concurrent drilling of new boreholes and sampling & chemical analysis of groundwater.</p> <ul style="list-style-type: none"> To contour the plume by creation of the network of observation boreholes in the plume direction. To use concurrent drilling of new boreholes and sampling & chemical analysis of groundwater. To draw up the forecasts for the spread of oil products with groundwater using the hydrogeological model in the Northern industrial area of Pavlodar. <p>To assess the risks posed by groundwater contamination with oil products for the population of Northern outskirts of Pavlodar and for river Irtysh floodplain.</p>	
Description of deliverables	
1	Database on sampling and results of chemical analyses
2	Forecasts of oil pollution spread including the scenario of technogenic changes of hydrogeological conditions in the area of contamination.
3	The results of risk assessment and, if necessary, the proposal for managing the oil products pollution risk for the network of operating boreholes in Pavlodarskoye village and river Irtysh floodplain.
4	Publications in mass media and scientific journal
5	Monitoring Program for groundwater pollution with oil products in the Northern industrial area of Pavlodar.
4	Quarter reports
5	Final reports

Task 4

Task description and main milestones	Participating Institutions
<p>4. Assessment of possibility to contain the risk posed by mercury pollution of lake Balkyldak including the fish within it:</p> <ul style="list-style-type: none"> To create the vector map of lake Balkyldak and to design two versions of sampling plan (for summer and winter sampling). To assess the performance of each sampling option and to select the optimal solution. To sample the bottom sediments from lake Balkyldak by regular grid using the different types of samplers and augers. To create and analyze the map of Hg contamination of bottom sediments using the software package “ArcGIS – Spatial Analysis”. To take the samples of biota from the lake Balkyldak and to describe the existing food chains. To conduct chemical analysis (including the determination of total mercury content) and morphological studies of the taken samples of biota. <p>To identify the pathways of Hg bioaccumulation and to develop the possible solutions to break these pathways.</p>	<p>AIPET(Leading) IHH (Subinstitution) PCP(Subinstitution) PSU(Subinstitution)</p>
Description of deliverables	
1	Database on sampling and results of chemical analyses
2	Map of Hg contamination of bottom sediments in lake Balkyldak. Calculation of the volume of contaminated silts and amount of deposited mercury basing on the analysis by software package “ArcGIS – Spatial Analysis”.
3	The results of risk assessment and the proposal for managing the risk posed by the mercury contamination of lake Balkyldak.
4	Publications in mass media and scientific journal

4	Quarter reports
5	Final reports

Task 5

Task description and main milestones		Participating Institutions
<p>To draw up and discuss with local stakeholders the recommendations for the 2nd stage of demercurization and other remediation activities in the area of the former PO “Khimprom” (Northern industrial area of Pavlodar), including the recommendation for abolishment or further safe use of the wastewater storage pond – lake Balkyldak:</p> <ul style="list-style-type: none"> To discuss the work program and obtained results with Pavlodar regional department of environmental protection and with the managers of Pavlodar Chemical Plant. <p>To hold the workshops, press-conferences and presentation in order to discuss the interim results.</p>		<p>AIPET(Leading) BMP (Substitution) IHH(Substitution) PCP(Substitution) PSU(Substitution)</p>
Description of deliverables		
1	The recommendations for the 2 nd stage of demercurization and other remediation activities in the Northern industrial area of Pavlodar.	
2	Publications in mass-media	
3	Quarter reports	
4	Final reports	

5. Role of Foreign Collaborators/Partners

Collaborator Trevor W. Tanton will be a consultant during coordination and conduction of fieldworks as well as during the stage of risk assessment from contamination by mercury and oil derivatives. He will also participate in drawing up the recommendation on management of such risk.

The Partner will carry out activities, monitoring and audit in the whole duration of the project. The Partner will evaluate the possibility of further cooperation after the project finish date.

Foreign Partner Paul Randall is a key person in achieving the goals and objectives of the project. Close interrelation is anticipated between the scientists of research laboratories of Kazakhstan and USA. The exchange of materials, scientific data is foreseen, and joint preparation of scientific publications will be carried out. The communications will be done by means of e-mail, telephone, fax and express mail.

6. Technical Approach and Methodology

During sampling and chemical analyses the methods recommended by US EPA will be used as well as standard procedures on Quality Control/Quality Assurance accepted in the West. Determination of mercury in solid samples will be carried out using AAS analyzer (Lumex RA 915+); AFS analyzer (PS Analytical Millennium Merlin System) will be used for Hg determination in water samples and biological tissues. Chemical analysis of oil products' concentration in water will be conducted using CG Perkin Elmer Clarus 500.

The following methods will be used for the chemical analyses and quality control:

- US EPA method # 1631 Revision E – for the determination of total Hg in water;
- US EPA method # 7474 – for the determination of total Hg in biological tissues;
- US EPA method # 7471 Revision B – for the determination of total Hg in soils, sediments and bottom deposits;
- US EPA method # 9071 Revision A – for the extraction of oil and petroleum derivatives;
- US EPA method # 1664 – for the determination of N-Hexane extractable oil products by extraction and gravimetry;
- Method of the Massachusetts Department of Environmental Protection (MADEP) – for determination of extractable petroleum hydrocarbons (EPH) by Gas Chromatography. Assessment and management of risk associated with groundwater contamination will be carried out using hydrogeological models received by means of the ModFlow GMS 5.0 software. The preliminary assessment of risk (Tier 1 of risk assessment) posed by mercury contamination of pastures and fish will be conducted using the monitoring of the level of mercury pollution and subsequent comparison of pollution indices with existing state standards and guidelines values.

8.2. Managerial responsibilities

