99e Activities for Prevention the Threat of River Irtysh Mercury Pollution in Pavlodar, Kazakhstan

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The threat of polluting the river Irtysh by mercury was caused by high losses of Hg during 1975-1993 during chlor-alkali production at the former PO "Khimprom", Pavlodar, North-East Kazakhstan (at present JSC "Pavlodar Chemical Plant"). These losses were the highest among similar factories in the former USSR /1/. On average, they could be estimated as 1.6 kg Hg per ton of produced caustic soda (total losses could be estimated as 1310 tons of those 1100 tons were non-counted mechanical losses of metal mercury). The majority of this mercury was concentrated beneath the electrolysis factory (building #31) and formed the hotspot of groundwater contaminated by soluble mercuric chloride. The other adverse effects that took place include: losses of Hg-contaminated wastewater from plant drain; contamination of topsoil within industrial site #1 and around lagoons for mercury waste; and contamination of surface water in wastewater storage – lake Balkyldak (having capacity more than 80 million m3). The closest sites subject to risk of mercury pollution are the village Pavlodarskoye (having 200 ha of groundwater fields) and the river Irtysh, located in 3-5 km to the west from chlor-alkali production. The original design of the clean-up was developed in 1995, based on small-scale investigations conducted during the Soviet period. The scope of designed works included the following activities: (i) demolishing of building #31; (ii) excavation and thermal treatment of concrete floors, (iii) selected excavation of contaminated soil from beneath of building 31 and its treatment by soil washing technique; (iv) construction of impermeable screen (so called "cut-off wall") around building 31 which is the main source of mercury contamination spread; and (v) construction of underground landfill for IV hazardous class waste in 50 m to the south from building 31 for further disposal of materials with low Hg content. BG Chair of Environmental Technology of AIPET conducted a series of investigations during 2001-2005 in cooperation with 10 partners from 6 countries (Projects ISTC K-756-p, ICA2-CT-2000-10029 "Toxicmanagement" and contract with JSC "Pavlodar Chemical Plant). The results have shown that the extent of Hg contamination posing a risk for the environment and to the public is much higher than was previously thought. Several large hotspots were revealed where the threshold value for Hg in soil (2.1 mg/kg) was exceeded by 500 times and more. Four hotspots were located within the industrial site #1 and were related to the building #31 and facilities for regeneration of solutions, wastewater storage and treatment facilities. One hotspot was located on the bank of lake Balkyldak and was related to the lagoons used for storage of mercury waste. The volume of soil contaminated above 10 mg/kg in top 0-0.5 m layer was estimated as well as amount of mercury deposited in this soil (excluding Hg deposited underneath building 31 and within the lagoons for Hg waste). These estimates give 19263 m3 of contaminated soil and 2931 kg of Hg for the industrial site # 1, and 79542 m3 of contaminated soil and 16022 kg of Hg for the area between industrial site of former PO "Khimprom" and lake Balkyldak. Sampling and analysis of groundwater from the existing network of boreholes and newly established ones (in total more than 200 boreholes) revealed the plume of Hg-contaminated groundwater spreading from the main source (building 31) and secondary source of pollution (pumping station for wastewater) in north-north-west direction almost in parallel to river Irtysh. The maximum width of the plume is 350 m and its length – more than 2 km. The contaminated groundwater is spreading above basalt clays of Pavlodar assise at the depth 6-14 m depending on landscape. Within the major Hg concentration in the groundwater reached 150 ug/L (near the building 31) and 120 ug/L (near the wastewater pumping station). Concentration decreased with the distance from hotpots reaching after every 300 m 45 ug/L, 0.8 ug/L, 1.1 ug/L, 0.9 ug/L and 0.4 ug/L correspondently. The surface water contamination was characterized with the following values: (i) atmospheric precipitations accumulated in lagoons for Hg waste contained up to 50 mg/L; (ii) surface water in pits to the south from lagoons contained 3-30 ug/L; (iii) surface water in the ditch along lake Balkyldak shore contained 2-18 ug/L; and (iv) Hg concentration in surface water of lake Balkyldak varied from 3.4 ug/L near the lagoons to 0.1-

0.3 ug/L along the rest of the shore. Hg concentration in water of unfinished emergency canal going from lake Balkyldak to the west did not exceed 0.01 ug/L. Hg concentration in oxbow lakes near Pavlodarskoye village was less than 0.009 ug/L. Finally, the water of river Irtysh contains less Hg than detection limit of AFS analyzer (i.e. <0.002 ug/L). Concentration of Hg in tissue of fish from lake Balkyldak varied from 0.18 to 2.2 mg/kg and generally exceeded approved sanitary standards. Hg concentration in the tissue of predatory fish species (mainly pike) caught in river Irtysh and oxbow lakes near Pavlodarskoye village was 0.075-0.16 mg/kg which is below acceptable threshold value. Using groundwater modeling software GMS 3.1 it was determined that existing direction of groundwater plume is caused by a combination of natural and man-made factors. Four scenarios were addressed to produce a forecast of Hg transport with groundwater until 2030. In the case of a zero-change scenario, the contaminated plume will continue to spread in a north-north-west direction above basalt clays at the depth 5-15 m. Thus, if the direction of plume does not change mercury will not pose a serious threat for Pavlodarskoye village and river Irtysh. At the same time limited amount of Hg might enter the emergency canal going from lake Balkyldak to the west. The second scenario assumes the construction of cut-off wall around building 31. It will not solve the problem of water quality due to the presence of other sources of pollution near the wastewater pumping station, though the latter sources are less intensive. The third scenario assumes containment of both sources of pollution, which ultimately will eliminate the groundwater contamination. The fourth scenario assumes changes of hydrogeological conditions in the northern industrial area of Pavlodar depending on industrial development or degradation. At certain conditions the direction of plume could turn towards the west, which will cause the threat for the Pavlodarskoye village and the river Irtysh. The conducted research allowed for revision of the strategy for the management of mercury contamination in Pavlodar. Instead of expensive and non-effective recovery of Hg from wastes with high levels of concentration, the containment strategy was proposed assuming isolation of major hotspots from the atmosphere, surface run-off and groundwater. From 2003 to 2005 the hydraulic barrier (cut-off wall) was constructed around four major hotspots. The depth of cut-off wall reached basalt clay at 15-20 m and its width was 0.6 m. The total length of the barrier is 3588 m, including 699 m around building 31, 185 m around buildings #40, 240 m around wastewater pumping station and 2464 m around lagoons for Hg-containing waste. Contaminated topsoil was excavated to the depth of 0.5 m and removed to the sites isolated by cut-off walls. The hotspots were covered by clay over a total area of 180,000 m2. All of the facilities of building 31 were demolished and the debris were placed into the cell (3 m deep trench) lined with 0.5-m clay layer. These materials were further stabilized with cement and covered with an asphalt layer. Therefore, the monolith storage facility with total area 15671 m2 was constructed, which is stable against the impact of groundwater and surface run-off. Starting from 2005, local authorities initiated a 15-year Program of mercury contamination monitoring in northern industrial area of Pavlodar. This Program is expected to answer the question as to whether the clean-up activities implemented to date are sufficient. US EPA gives support to this program via the ISTC. The three-year project K-1240 is expected to start from mid 2005. Reference 1. M.A.Ilyushchenko, L.V.Kuzmenko, E.V.Lapshin, R.I.Kamberov. Management of mercury pollution and its monitoring in Pavlodar, Kazakhstan. 2005, 62 p. http://Hg-Pavlodar.narod.ru