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July 16, 2010

Aron Yue, Senior Hazardous Substances Engineer
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Subject: Review of "Draft Environmental Impact Report for the Topock Compressor Station Groundwater Remediation Project," by AECOM, Prepared for California Department of Toxic Substances Control, April 14, 2010

The Hualapai Tribe considers the Topock Maze and surrounding landscape to be of great importance to their heritage. The air, the earth's surface, and the subsurface of the landscape are all part of a sacred continuum. Wells, buried pipes, and soil samples are intrusions and desecrations, especially near the Topock Maze. Regardless of the intrusions already carried out and the further intrusions to implement Alternative E, the Hualapai have deep connections with the Colorado River, and recognize that it is important to keep the river clean.

Regarding chromium contamination at the PG&E Topock Compressor Station, the preference of the Tribe would be no more drilling or intrusions into the landscape. However, this may not be possible given the current regulatory setting. Therefore, if the work must be done, the Tribe wants to protect cultural resources as much as possible. During on-the-ground activities, monitoring of cultural sites must be done, and a recognition of the importance of cultural sites must be emphasized. After the work has been completed, the landscape must be returned to its original condition. Following are topics that need to be addressed before remediation begins:

Reduce Impacts to Cultural Resources

Of primary importance to the Hualapai Tribe are the efforts to minimize impacts to cultural resources. More wells will be drilled, pipes will be laid, and monitoring studies will be done. One idea to reduce impacts to ancient cultural artifacts is to conduct alluvial sediment age dating. The ravines and washes may have aggraded since existence of the Topock Compressor Station, where younger sediments overlie older ravine sediments. Artifacts and

remains may be buried in the older ravine sediments. This method could also be helpful in areas already disturbed by man's activities.

Question: Would it be useful to determine the age of soils and sediments using lead-210 methods, then make every attempt to not disturb the older sediments that may contain cultural artifacts?

Chromium in Plants

The Hualapai Tribe believe that the plants are sacred. Willows are still used as materials for basket making by members of the Hualapai Tribe, where willow stems are split with the teeth. Plants and wild flowers are collected for ceremonies. There has been no characterization of chromium concentrations in plants at the Topock site. The risk assessment studies focused on surface water or groundwater as the transport mechanism for contaminant dispersal; however, plants were not considered in the risk assessment.

Question: Do the willows, plants, and wild flowers take up chromium? What are the chromium concentrations in plants at the Topock site?

Colloidal Transport of Chromium

As the chromium-6 is reduced to chromium-3 by the carbon-amended injection water, the chromium-3 will precipitate or adsorb onto aquifer sediments and suspended aquifer colloids. It has been shown that aquifer colloids are responsible for transport of contaminants and bacteria (Hornberger and others, 1992; Kearl and Roemer, 1998). Colloids could transport chromium-3 into oxidizing zones where the chromium-3 could then be oxidized back to chromium-6, and the colloids could be transported to the Colorado River. Borehole scopes are available that record videos of colloid movement in groundwater monitoring wells (http://www.aquavisionenv.com/). From borescope videos, colloid concentrations, groundwater flow direction, and groundwater velocity can be documented. Background colloid chemistry and concentrations need to be described, and the colloidal transport of chromium needs to be monitored during remediation.

Question: Will you monitor aquifer colloid chemistry during remediation?

Groundwater Injections and Mounding

The groundwater modeling reports done by PG&E indicate that the Mohave Valley aquifer discharges about 2,600 acre-feet per year from the basin into the Colorado River, primarily because the alluvial valley pinches out at Topock, forcing groundwater to the surface. As part of remediation, 500 gallons per minute of imported water will be injected into wells. On an annual basis, this is about 807 acre-feet of water. The "fresh water flushing" injection water will be imported from another location, possibly from wells in Arizona. This will increase the Mojave Basin discharge by 30 percent.

Question: Have there been any considerations of the effects of a 30 percent increase in groundwater discharges from the Mohave Basin? In Table 1-2 of the EIR, groundwater mounding is not mentioned as an impact.

Disturbance of Fluvial Organic Layer

To date, the chromium-6 contamination has reportedly not reached the Colorado River because of an organic-rich layer of aquifer sediments adjacent to and beneath the river. This organic layer has been reducing chromium-6 to chromium-3 by natural processes. As part of Alternative E, extraction wells will be drilled into the floodplain near the Colorado River to

reverse the hydraulic gradient away from the river, which might prevent the chromium-6 contamination from reaching the river. This is being done currently as part of Interim Measure 3; however, the current pumping rate is 100 to 135 gpm, and the pumping rate will be increased to 500 gpm for Alternative E. From the schematics of Alternative E, the extraction wells will be right next to the river. In addition, the carbon-amendment injection wells will be installed near the fluvial layer.

Question: Will the fluvial organic layer be disturbed or disrupted by all of the extraction and IRZ wells? If the fluvial organic layer is breached, will the ability of the layer to attenuate chromium-6 be disrupted? In Table 1-2 of the EIR, disturbance of the fluvial organic layer is not mentioned as an impact.

Carbon Amendment Will Mobilize Arsenic, Iron, and Manganese

The in-situ reduction will reduce chromium-6 to chromium-3, but it also will increase the solubilities of arsenic, iron, and manganese. Iron and manganese were not even considered in the Groundwater Risk Assessment.

Question: What if the chromium-6 plume is essentially replaced with a different plume of arsenic, iron, and manganese contamination? Concentrations and speciation of arsenic, iron, and manganese need to be monitored during remediation.

East Ravine and Topock Compressor Station

High concentrations of chromium-6 have been detected in bedrock under the East Ravine, which is located east and southeast of the Topock Compressor Station. Some characterization studies have been done at the East Ravine; however, studies have not been completed. A proposal for remediation of the East Ravine has not been presented.

Question: Will the public be allowed to comment on the proposed remediation method for the East Ravine?

Return the Land to Its Original Condition

The Hualapai were present in the Colorado River area long before Europeans visited, and the Hualapai will likely be present in the area for the rest of eternity. The contamination at the Topock Compressor Station is a desecration to the landscape; however, the time frames represented by the contamination and remediation are small compared to the scope of Hualapai interaction with the land and water.

After the remediation has been done at the Topock Compressor Station, the Hualapai Tribe would like the land to be restored to its original condition. Disfigurements have already been left on the sacred landscape from the railroads, highways, pipelines, and developments. Yet, the Hualapai still recognize the area as a sacred place, regardless of the scars. The most important thing to do is to clean up the aftermath of the injurious activities.

Question: Shouldn't the long-term plans for restoration and renovation be a topic of discussion as part of the remediation plan?

What Is the Reductant?

The remediation goals will be met by injection of a chemical reductant to reduce chromium-6 to chromium-3. However, there has been little mention of the type of reductant that will be used at the Topock site. While these decisions may be presented in the design phase of the remediation plan, the public has the right to know the chemicals that will be

injected into the ground. The type of reductant, and its effects on human health and aquatic life, should be presented in the DTSC EIR.

Question: What is the reductant? Is it poisonous or toxic? Will the same reductant be used for the entire span of the IRZ injections (30 years)? What are the potential organic byproducts and degradation compounds? What are the expected life span of these degradation compounds?

Calcite Supersaturation of Groundwater

The aquifer sediments of the Mohave Valley basin are rich in calcium carbonate (or calcite). This is evident in the calcite-rich coatings on rocks around the Topock Compressor Station and the Maze. When water is injected into the ground as part of Alternative E, the injected water will react with the aquifer sediments, and calcite will be dissolved. As the water flows radially outward from the well where the water is supersaturated with calcite, calcite will precipitate from the water onto the aquifer sediments. If large masses of calcite are deposited in the pores of the aquifer, then the aquifer may become obstructed with calcite, and the ability to inject water will decrease over time. This has already been observed in the injection wells for the Interim Measure 3 at the Topock Compressor Station where acidification of the IM-3 injection wells has been done in order to stimulate injection capacity. With the injection wells proposed as part of Alternative E (as many as 30 wells), wells will become obstructed which will require ongoing maintenance. Replacement wells will be probably drilled, and acid will be injected into the wells to dissolve calcite and provide more injection capacity. These problems will increase the maintenance costs for Alternative E. The well drilling, acid injections, and manipulation of the chemistry of the groundwater are viewed by the Hualapai Tribe as a desecration to the sacred landscape.

Water from wells at the In-Situ Pilot Study shows the effects of supersaturation (Arcadis, 2009). Water-quality data from well PT-6S, PT-6M, and PT-6D were input to the Phreeqc geochemical model. The results indicate that injection of the carbon reductant created geochemical reducing conditions which precipitated chromium-6; however, many other phases also were precipitating. Attachment A, Table 1 shows that 27 different phases, including calcite and dolomite, were precipitating from water in well PT-6S. Iron and manganese species have already gone through a dissolved phase, reaching supersaturation; therefore, iron and manganese solids were precipitating from solution. This was likely creating colloids in groundwater. Notice in Table 1 that arsenic compounds were dissolving.

Question: Have geochemical modeling data been presented to the DTSC? Do you know whether the aquifer can sustain 30 years of injections and geochemical reactions without becoming completely clogged?

In conclusion we would like thank DTSC for allowing us the opportunity to comment on these concerns that we have of the project. If you have any questions or concerns please call me at the above number or contact Ms. Loretta Jackson, Director of the Cultural Resources Department @ (928) 769-2223.

Sincerely,

Wilfred Whatoname, Sr.
Chairman, Hualapai Tribal Council

Enclosed: Attachment A (Table 1 & Table 2)

Attachment A

Table 1. Geochemical state of mineral phases in water from In-Situ Field Experiments [Well PT-6S, June 6, 2006, after IRZ injections began May 3, 2006]

Mineral Phase	Formula	Geochemical State of Phase in the Aquifer after IRZ Injections Began
Aragonite	CaCO3	Precipitating
Birnessite	MnO2	Precipitating
Bixbyite	Mn2O3	Precipitating
Calcite	CaCO3	Precipitating
Cr(OH)3(A)	Cr(OH)3	Precipitating
Cr2O3	Cr2O3	Precipitating
Dolomite	CaMg(CO3)2	Precipitating
Fe(OH)2.7Cl0.3	Fe(OH)2.7Cl0.3	Precipitating
Fe3(OH)8	Fe3(OH)8	Precipitating
FeCr2O4	FeCr2O4	Precipitating
Ferrihydrite	Fe(OH)3	Precipitating
Goethite	FeOOH	Precipitating
Hausmannite	Mn3O4	Precipitating
Hematite	Fe2O3	Precipitating
Huntite	CaMg3(CO3)4	Precipitating
Jarosite-H	(H3O)Fe3(SO4)2(OH)6	Precipitating
Jarosite-K	KFe3(SO4)2(OH)6	Precipitating
Jarosite-Na	NaFe3(SO4)2(OH)6	Precipitating
Lepidocrocite	FeOOH	Precipitating
Maghemite	Fe2O3	Precipitating
Magnesite	MgCO3	Precipitating
Magnetite	Fe3O4	Precipitating
Manganite	MnOOH	Precipitating
Mg-Ferrite	MgFe2O4	Precipitating
Nsutite	MnO2	Precipitating
Pyrolusite	MnO2	Precipitating
Rhodochrosite	MnCO3	Precipitating
Anhydrite	CaSO4	Dissolving
Arsenolite	As4O6	Dissolving
Artinite	MgCO3	Dissolving
As2O5	As2O5	Dissolving
Brucite	Mg(OH)2	Dissolving
Ca3(AsO4)2:6H2O	Ca3(AsO4)2:6H2O	Dissolving
CH4(g)	CH4	Dissolving
Claudetite	As4O6	Dissolving
CO2(g)	CO2	Dissolving
Cr(OH)3(C)	Cr(OH)3	Dissolving
CrCl3	CrCl3	Dissolving
Epsomite	MgSO4:7H2O	Dissolving
Fe2(SO4)3	Fe2(SO4)3	Dissolving
FeAsO4:2H2O	FeAsO4:2H2O	Dissolving
Gypsum	CaSO4:2H2O	Dissolving
Halite	NaCl	Dissolving
Hydromagnesite	Mg5(CO3)4(OH)2:4H2O	Dissolving
Lime	CaO	Dissolving
Melanterite	FeSO4:7H2O	Dissolving
MgCr2O4	MgCr2O4	Dissolving

Mirabilite	Na2SO4:10H2O	Dissolving
Mn2(SO4)3	Mn2(SO4)3	Dissolving
Mn3(AsO4)2:8H2O	Mn3(AsO4)2:8H2O	Dissolving
MnCl2:4H2O	MnCl2:4H2O	Dissolving
MnSO4	MnSO4	Dissolving
Natron	Na2CO3:10H2O	Dissolving
Nesquehonite	MgCO3:3H2O	Dissolving
O2(g)	O2	Dissolving
Periclase	MgO	Dissolving
Portlandite	Ca(OH)2	Dissolving
Pyrocroite	Mn(OH)2	Dissolving
Siderite	FeCO3	Dissolving
Thenardite	Na2SO4	Dissolving
Thermonatrite	Na2CO3:H2O	Dissolving

Table 2. Reference Cited

Arcadis, 2009, First Quarter 2009 Monitoring Report for the Floodplain Reductive Zone In-Situ Pilot Test, PG&E Topock Compressor Station, San Bernardino County, California.

Hornberger, G.M., Mills, A.L., and Herman, J.S., 1992, Bacterial transport in porous media: Evaluation of a model using laboratory observations: Water Resources Research, 28(3), 915-938.

Kearl, P.M., and Roemer, K, 1998, Evaluation of groundwater flow directions in a heterogeneous aquifer using the colloidal borescope: Advances in Environmental Research, 2 (1), 12-23 (http://www.aquavisionenv.com/files/537-97.pdf).

Oze, C., Bird, D.K., and Fendorf, S., 2007, Genesis of hexavalent chromium from natural sources in soil and groundwater: Publications of the National Academy of Sciences of the USA (PNAS) 104(16), 6544-6549.