# REMEDIAL ACTION CONTRACTOR RESPONSIVENESS: DEWATERING AND THE IPS DURING CONSTRUCTION AT THE DURANGO DISPOSAL CELL

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## ABSTRACT

In the fall of 1988, alert field personnel identified a line of contaminated seepage emerging along the eastern slope of the uranium mill tailings disposal embankment being constructed at a site near Durango, Colorado. This paper describes the investigations and solutions implemented by the Remedial Action Contractor (RAC) in response to the changed conditions during construction at the site. This site is one of 24 being remediated under the U.S. Department of Energy's Uranium Mill Tailings Remedial Action (UMTRA) Project. Although the eastern slope of the embankment was nearly complete, a large portion of the contaminated material had not yet been relocated to the disposal cell when the seep appeared. In addition to the potential of the failure at the base of the slope, no cover material could be placed on the soft saturated surface and thus closure of the contaminated facility could not be accomplished. In response, investigations conducted by the RAC indicated that the seep originated from precipitation and dust control water, applied in accordance with emission control standards, which were percolating through the tailings and ponding in the disposal cell. Initial water levels, referred to as the IPS (indicated phreatic surface) led to estimates of 15 million gallons of drainable water. A pilot dewatering system of 17 pumping wells and 10 observation wells was designed and constructed in the summer of 1989, Field observations during drilling and sampling of the pumping and observation wells led to questions as to whether the lower regions of the cell were actually saturated. When the pumping wells came into operation, the southern wells produced much less water than the northern wells, although the soils sampled and the construction of the wells appeared to be the same in all areas. A decision was made in the fall of 1989 to install a toe trench to gravity drain the contaminated water and to abandon the wells due to low flow yields. During construction activities for the toe trench installation, three test pits were dug at the base of the eastern slope. While excavating the first test pit, an intermediate layer of six inches of low permeable soil was encountered on top of which water had perched. The "indicated" phreatic surface in the form of a perched water condition within the constructed fill was confirmed. Estimates of drainable water were lowered to 2-3 million gallons. Because of the success of the toe drain in keeping the seepage from resurfacing, closure of the disposal embankment was possible.

## CHALLENGE

The Durango disposal site is one of 24 inactive uranium mill tailings piles being remediated by the U.S. Department of Energy as part of the Uranium Mill Tailings Remedial Action (UMTRA) Project. The Durango site is located in the southwest corner of Colorado, near the city of Durango. The remedial action entails the relocation of roughly 2.3 million cubic yards of contaminated material from the processing site on Smelter Mountain to the Bodo Canyon disposal site approximately 3.5 road miles away.

Starting in August, 1987, contaminated materials were consolidated into an embankment constructed largely above grade and covered with various protective layers to reduce radon emanation into the atmosphere and to limit water infiltration into as well as prevent erosion of the disposal cell. The base of the cell had been excavated into the natural topography so that it slopes to the east terminating in a sump region at an elevation of 7040 feet MSL. A low permeability clayey soil layer lines the base to reduce contaminant transport. Maximum thickness of contaminated material within the disposal cell is ninety feet.

The relocated material includes fine grained sand from the milling process, contaminated wind blown material, building foundations from the mill, and contaminated subpile rock and soil along with "vicinity property" materials contaminated by the use of tailings as fill beneath buildings, play yards, roads, race tracks, etc.

In the fall of 1988, alert field personnel identified a line of seepage emerging along the eastern side of the disposal cell. This sideslope was nearly complete except for the protective cover layers. Two feet of clayey material had been placed over the purplish sand tailings for temporary erosion protection until the subsequent layers were placed. The seepage raised several concerns: 1) slope stability at the toe of the pile; 2) difficulty in placing cover materials; and 3) contaminant release to the environment both from the seepage on the side slope and from water exiting the bottom of the disposal cell. The seepage initially appeared in several locations along an elevation of 7055 feet MSL and quickly enlarged over a 200 foot length of the slope. A grab sample of seepage water was analyzed and found to contain several constituents above background levels. Subsequent well samples exceeded Federal standards for arsenic, chromium, molybdenum, selenium, and uranium.

## PRELIMINARY INVESTIGATIONS

Several preliminary investigations were undertaken to better identify the water conditions within the cell and to gather data for response actions to be planned for the next construction season. The investigations aided in predicting the source of the seep and the volume of water within the cell.

A review of historical maximum groundwater elevations in the vicinity of the Bodo Canyon showed levels 15 feet below the bottom of the disposal cell. Therefore, groundwater was ruled out as a source of the seepage.

Five shallow holes were hand-augered upgradient of the seepage to establish the water level within the embankment. The piezometric surface in this region of the embankment was at elevation 7057 feet indicating a saturated thickness of 17 feet above the cell bottom.

These initial investigations led to the hypothesis that the seep originated from precipitation, snowmelt, and dust control water (to comply with emission control standards), percolating through the tailings and ponding in the disposal embankment.

In November, 1988, six monitor wells (MW 1-5, MW 7) were installed to observe the water elevation fluctuations within the embankment through the winter shutdown.

The volume of drainable water in the cell had to be estimated despite the paucity of available data. Isopachs of saturated thickness were drawn based on water level data from the monitor wells and assuming complete saturation to the bottom of the cell. The volume of water drainable by gravity was estimated to be about 15,000,000 gallons.

It was determined that the potential environmental threat and the surface instability of the slope were sufficient to mandate remedial action. Several plans for removing and treating as much of the trapped water as possible were developed. The remedial action was to be accomplished as far as possible without disrupting the schedule: delaying the project would have a major cost impact and would itself pose an environmental risk by slowing the relocation of the contaminated materials and capping of the disposal cell.

## SEVENTEEN-WELL DEWATERING SYSTEM

There was a growing conviction that conditions were significantly different from those first assumed. More information was needed; however, it was imperative that placement of the tailings should proceed.

A pilot dewatering system was installed consisting of a grid of 17 pumping wells on the completed east slope, west of the seep (Fig. 1). This pumping operation would have limited impact on the construction schedule, would begin the process of removing and treating the water, and with careful instrumentation, would provide data for reliable determination of the final fix. These 17 wells were supplemented by 6 piezometers (P2-P7) located within and adjacent to the well array to provide drawdown data at key points.

During drilling of the pumping wells and piezometers, geologists recorded data and inspected the samples. The field geologists observed that a number of samples recovered from below the indicated phreatic surface (IPS) did not appear saturated. This was an early indication that the zone of saturation did not extend all the way from the IPS to the low permeability liner.

Although the constructed fill was heterogeneous by nature (brick, wood fibers, black soil, variety of colored tailings from the contaminated processing site and vicinity properties cleanup activities), the bulk of the eastern slope contained fine grained sand from uranium ore mill processing. The samples of the tailings material were generally similar in appearance, but laboratory tests indicated that the fines fraction, water content and density varied widely at comparative depths and locations.

## RESULTS OF 17-WELL PUMPING TEST

Daily measurements of flow rates and drawdowns were recorded throughout the summer of 1989 to determine trends and effectiveness of the dewatering system.

Figure 2 is a summary of the flow rate (gpm) for the seventeen pumping wells through November of 1989. When all wells (except D2) were initially pumping on July 20, total combined flow was approximately 8 gpm (11,500 gallons per day [gpd]). The pumping rate declined to 6 gpm (8600 gpd) by July 25, to 4 gpm (5760 gpd) by September 8 and prior to shutdown had dropped to less than 3.5 gpm ( < 5000 gpd). The pumping rates for the well field showed decreased flows in wells trending from the north to the south. As an example, on August 25, 1989 the A-line of wells showed flows for the northern A-1 well reading 0.57, the middle well A-2 reading 0.23 and the southern A-3 well reading 0.18. This trend held quite consistently for the other well lines. Plotting individual maximum flow rates for each well, Fig. 3 illustrates the trend of higher flow from wells in the north to lower flow in the southern wells.

As drawdown and flow rate data became available, analysis by various methods attempted to quantify aquifer parameters that would conform with observations. Results were inconsistent, as long as full saturation below the IPS was still assumed. For example, the consistent pattern of decreasing well yeild from north to south presented an

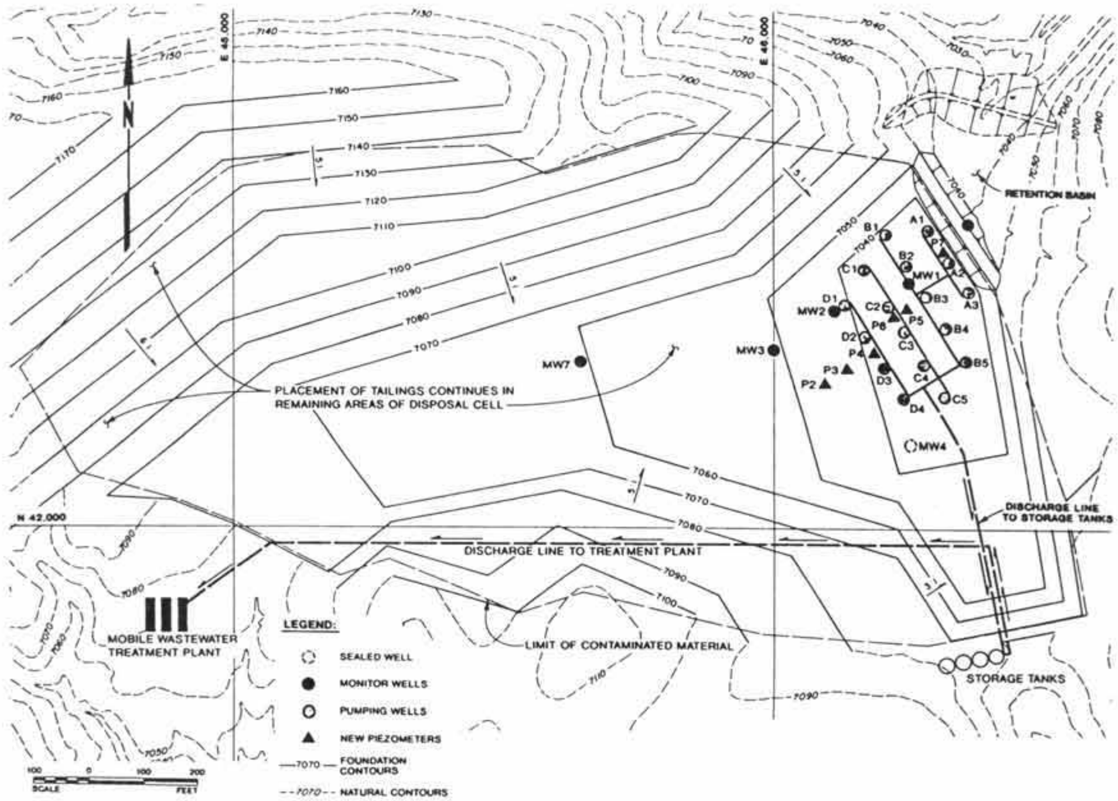


Fig. 1. Plan view of the 17 wells dewatering system.

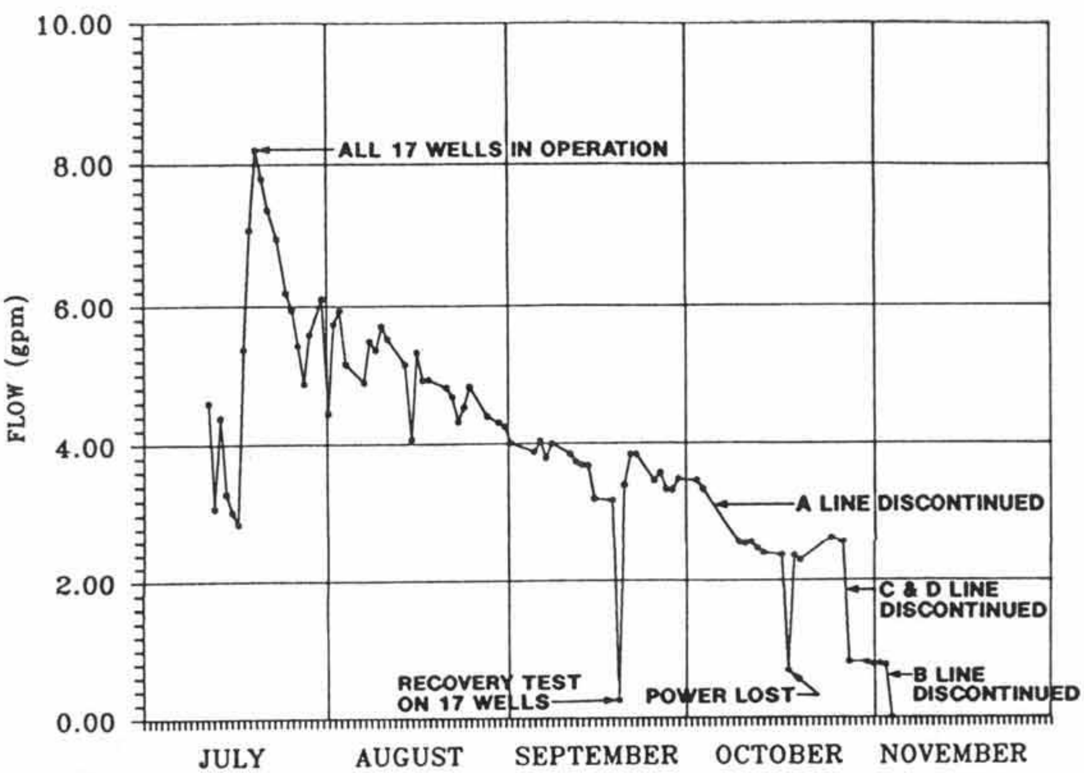


Fig. 2. Summary of the flow rate for the seventeen well pumping system.

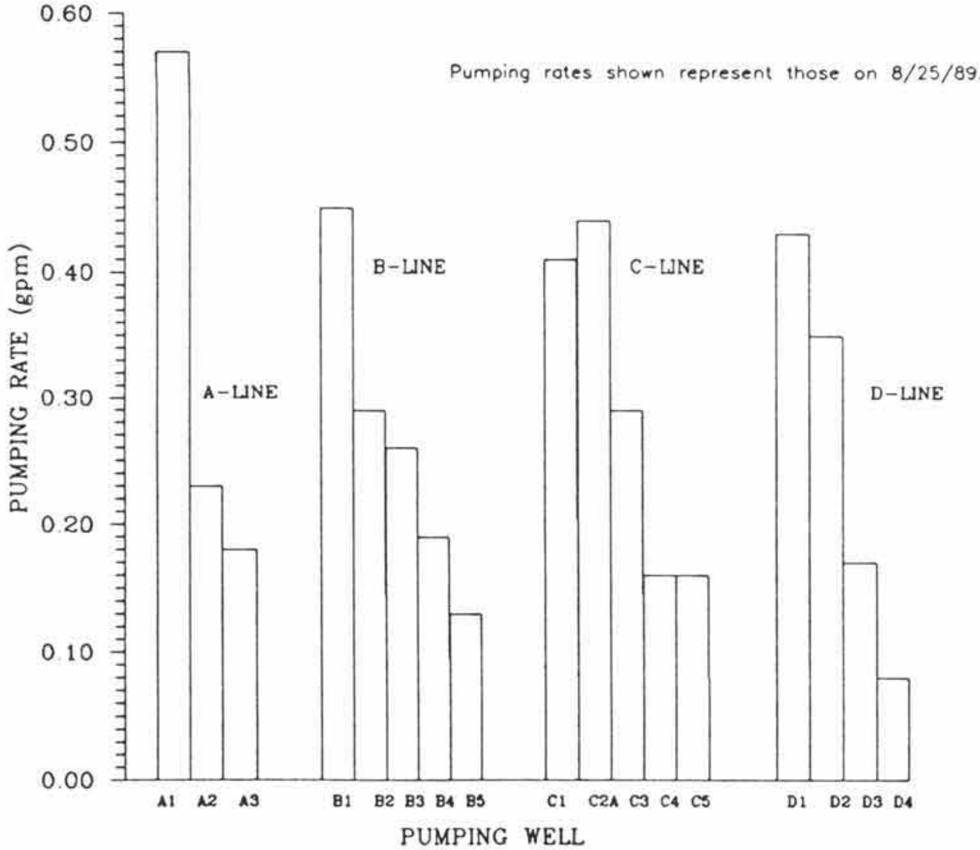


Fig. 3. Pumping rates for seventeen well pumping system.

anomaly that could not be explained by any observed differences in grain size, tailings density, or by any change in saturated thickness.

By September total flow from the wells had declined to 4 gpm. A decision needed to be made regarding continued operation of the 17-well dewatering system through the winter. The system could be operated through the winter, and remove an estimated additional one million gallons. At considerable cost, however, a major winterization effort would be required for operation after November 1.

On the other hand, complete shutdown of the system presented other problems. During the well system operation, the seep at the toe of the slope had dried up, and the softened clay cover had stabilized sufficiently for construction equipment to operate on it. The previous spring conditions might redevelop over the winter if drainage ceased and could badly delay placement of the radon barrier.

## TOE DRAIN INSTALLATION

The accumulating data very strongly indicated that some form of drainage must continue for a period of time after the contaminated material had been placed and the cell closed. A toe drain along the eastern slope became an attractive alternative. Draining by gravity to a lined holding pond, it could operate through the winter with minimum maintenance and prevent the seep from being reestablished. Water collected in the holding pond would be treated and eventually released. For this problem the toe drain was an optimum solution.

In September, a decision was made to proceed with the toe drain and to abandon the pumping wells. In order to lower the water elevations of the saturated zone, a wellpoint system was employed to assure safety and efficiency in constructing the toe drain. The wellpoint system went into operation October 19,1989, pumping an average of 2 gpm for all wellpoints combined. It was also decided to excavate test pits to determine the actual conditions within the embankment prior to toe drain installation.

## PERCHED WATER

On October 25-26, 1989, three pits were dug on the eastern slope downgradient of the well points in the area into which the toe drain was later installed. The well point system had been in operation approximately one week when a backhoe excavated Test Pit 1 through the tailings to the low permeability liner. Between elevations 7048' and 7049' a six inch layer of dark soil was encountered and was identified as low level contaminated vicinity property (vp) material placed as winter cover in 1987. The sandy tailings above the layer began to slough and seep water while the tailings material beneath the layer remained dry (without seeping water). The well point system just west of the test pit indicated an IPS at elevation 7051' although the soil in the test pit below elevation 7048' was apparently not saturated. For months, the data and analyses indicated that the tailings were not fully saturated below the IPS. But the indications had been inconclusive. The test pits finally confirmed that the true condition was a perched water body above the 1987 winter cover. Beneath the layer, the tailings were unsaturated. Figure 4 depicts the perched water in an east/west cross section through the eastern slope of the disposal embankment.

From aerial photographs taken in the winter of 1987 and quality assurance (QA) data collected during contaminated material placement in October and November of 1987, the vp winter cover surface elevation contours were estimated. The embankment surface dipped to the northeastern corner not covered with the vp material. This corner acted as a sump where water accumulated from snowmelt and rainfall. During the following construction season, the ponded water was removed and the saturated contaminated material excavated, spread in a thin lift on top of the dry material adjacent to the sump region, and allowed to dry prior to compaction. Construction continued with placement of tailings and other contaminated material.

The anomalies perceived in the data were at last explained. The southern wells pumped less than the northern ones because the 1987 winter cover rose to the south, and the saturated thickness intercepted by the southern wells was less.

## SUMMARY AND CURRENT STATUS

Various observations and analyses during the investigation that began in October 1988 indicated that the tailings might not be fully saturated from the IPS to the low permeability liner. When the perched condition was finally confirmed by the test pits in October 1989, a reevaluation of the situation could be made with confidence.

The amount of drainable water accumulated in the cell was much less than originally estimated. Because of the perched condition, and a revised estimate of specific yield Sy, the original estimate of 12 to 15 million gallons was reduced to 2 to 3 million gallons.

Because the toe drain kept the side slope dry, construction of the disposal embankment could continue. Official closing ceremonies for the Durango disposal embankment were held November 1, 1990.

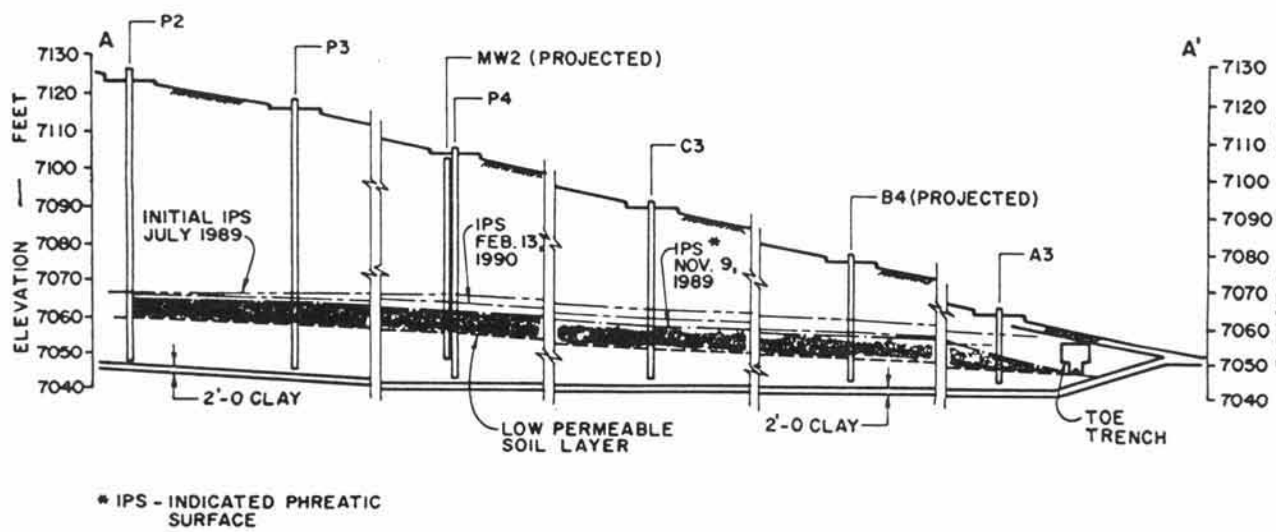


Fig. 4. Cross section through observation and pumping wells showing the perched water on top of the low permeable soil layer.

The current plan is to continue the toe drain operation until sufficient water has been removed to assure radon barrier stability at the toe of the slope, and to reduce the risk of escaping contaminated water to acceptable levels. Toe drain discharge and water levels within the cell continue to be monitored.

The investigation and analyses of the seepage problem at Durango presented a series of anamolies. As the study proceeded during the construction season the principal challenge was to avoid interfering with the construction work; delay presented an environmental risk, and would escalate costs. The analysis that eventually achieved adequate understanding of the problem and workable dewatering solutions involved nearly all recognized hydrogeological and analytical methods, and several innovations, all tempered with experiential judgement.

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