DESIGN DESCRIPTION

Mine Pool Discharge Rate

The estimate of the initial "blowout" discharge rate was reported to be about 10,000 gpm. Within 24 hours through an OSM Emergency Contract with SPSI, two diesel pumps (8" and 12") were deployed with a combined estimated discharge rate of about 8,000 gpm. Continuous pumping was needed by both pumps for about one full day to eliminate the surface discharge at the "blowout". Upon lowering the mine pool elevation below the ground surface, both pumps were reported to have been "throttled back" to a combined estimated flow rate of about 4,000 gpm. The mine pool elevation continued to decrease and pumping was periodically ceased to observe mine pool response. Within two weeks, the 12" pump was removed leaving the 8" pump, with an estimated maximum discharge rate of about 2,500 gpm, on-site. This pump was operated on a periodic basis to maintain the mine pool at about 3 - 5 feet below the surface of the ground. (Reported by Mark Slack, SPSI.)

The 8" pump was eventually replaced with a Gorman-Rupp model 16C2-4045D diesel pump (6" pump) on 03/04/05. Approximate installation parameters for the 6" pump: 25' suction hose; 8' suction head; 1,000' discharge hose; and about 70' elevation difference from the pump (at ~1055 feet) near the "blowout" to Robb Run (at ~985 feet) along the southern boundary of the McDonald Borough Building parking lot. Information provided by the manufacturer on 3/16/05 (personal communication) indicated that the estimated flow rate for the given parameters would be about 1,200 gpm.

Continuous pumping (24 hrs/day, 7 days/wk) with only short periodic interruptions for minor maintenance and refueling, was conducted from 03/04/05 to 03/16/05. During this period the mine pool was observed to be lowering about 0.1' per day. Based on this information, the target design flow rate for the permanent solution was estimated to be about 1,000 gpm.

Site Considerations

In order to achieve the ultimate project goal of providing a permanent, low-maintenance, non-pumping conveyance for the drainage to a receiving stream, numerous options were developed and evaluated. Paramount to the site design considerations was public health and safety followed by effectiveness, community impact, long-term maintenance requirements, installation cost, and finally, aiding future work including grouting to address mine subsidence issues and treatment of the discharge. (See Appendix C - Conceptual Design Options.)

"Miller Run" (Option #2, 3, 8): The options reviewed included draining the mine pool to the watercourse; however, existing permanent facilities that convey "Miller Run" along the foundation of a private dwelling include a 24" vitreous clay pipe that was observed to be in poor condition. Downgradient of this residential property, this culvert pipe enters stormwater facilities that convey this flow and other drainage under East Lincoln Avenue (Noblestown Road) to discharge via a 36" concrete culvert to a channel which confluences with Robinson Run. In order to avoid potential public road flooding issues and impact to private property, these options were given a low priority. The option to horizontally bore to an area that appeared very responsive to pumping operations at the "blowout", was also given a low priority based on the above noted site conditions and cost considerations.

"Home Run" (Option #4): Mine pool response tests and monitoring indicated a strong hydrologic connection between the "blowout" and monitoring well 24B located near the headwaters of "Home Run". This option was all but abandoned due to the potential impact to numerous private properties and dwellings, a recently installed sanitary sewer (circa 2004), as well as the absence of a continuous, open-channel, receiving stream, and adequate storm drainage facilities.

Robb Run (Option #5, 9): Abandoned Mine Drainage (AMD) sewer options were evaluated to drain the mine directly from the location of the "blowout". One option was to install an AMD sewer along Liberty Street and either cross North McDonald Street, traverse private property, and empty into Robb Run, or turn along North McDonald Street, cross Valley Street and empty into Robb Run. Another option was to install an AMD sewer easterly along Liberty Street and tie into an existing 12" storm sewer along Fannie Street. These options seemed viable but were ranked low due to community impact and capacity of the existing stormwater facility, respectively. In addition, the drainage would need to remain anoxic to minimize maintenance issues caused by metal precipitate accumulation. Maintaining anoxic conditions in an open channel flow-type sewer system would be problematic. Other AMD sewer options not shown on the attached plan (See Appendix C - Conceptual Options.) included a more direct route to Robb Run via School Street; however, this option was essentially eliminated at the request of the McDonald Borough Council in order to preserve the historic, brick-surfaced, roads (Coal and School Streets).

"Alexander Run" (Option #1, 6, 7): Based on field investigations, the closest and most robust existing storm drainage facility, was located ~1/3 mile east of McDonald Borough under Noblestown Road near the intersection with Alexander Drive. A relatively new arch-type culvert (approximately 4' H X 9' W) conveys the drainage of "Alexander Run" toward Robinson Run. This was the receiving watercourse chosen for the permanent solution due to the existing hydraulic capacity of the receiving watercourse and related drainage facilities, as well as for essentially eliminating impact to the densely populated residential area. In addition, cost of installation would be substantially less by implementation in this undeveloped area, as there are no impacts to utilities, private buildings, roadways, or other infrastructure. Furthermore, the proposed facilities would be located on property owned by a cooperative and helpful landowner who provided written permission to conduct drilling, excavate test pits, and install permanent facilities to control the mine pool.

Mine Pool Elevation

Ideally, the water level in the Nickle Plate mine pool would be controlled at an elevation that allowed the Pittsburgh No. 8 coalbed to be perpetually inundated while concurrently providing an adequate amount of "freeboard" between the mine pool elevation and unplanned or unwanted discharges (i.e., at the Liberty Street "blowout" location). Drilling data indicate that the coalbed has small local "rolls" within the project area. A difference in elevation of up to nine feet on the base of the Pittsburgh No. 8 coal has been noted within a few hundred feet horizontally. The controlling factor, therefore, is the mine pool elevation at the Liberty Street "blowout". The marker at the "blowout" during the investigation was the "top-of-brick" with an elevation of 1051.2 feet above mean sea level. A consensus was reached between BAMR and EIS that the mine pool should be maintained about sixty inches (60" or 5') below the "top-of-brick". The calculated design elevation for the mine pool at the "blowout" is 1046.2 feet.

Preliminary indicators observed during the investigation period in April 2005, a time without significant precipitation, showed a mine pool elevation delta of about 1.3 feet between the "blowout" and the proposed permanent gravity drain located on "Alexander Run". (Water elevations based on measurements taken by EIS personnel on 4/13/05 at about 1900 EDST: "Blowout" = 1047.0'; Temporary Primary Drain = 1045.7') A measurable hydraulic gradient was not unexpected given the likely partially collapsed nature of the Nickle Plate Mine. The mine pool elevation at the permanent gravity drain, therefore, would need to be about 1044.9 feet. Additional elevation information pertaining to the temporary and permanent gravity drain is presented on the attached graph "Mine Pool Response by Discharging at Primary Drain". These data indicate that the delta between the Early Warning System (EWS), located at the "blowout", and the Primary Drain has ranged from 1.2' to 1.7'.

Permanent Solution Description ***(See attached "As-Builts" with plan views and sections.)***
Primary Drain Design: The outlet of the permanent Primary Drain is a rectangular concrete structure. The structure, approximately four feet wide, five feet high, and thirteen feet long (4'W x 5'H x 13'L), includes a "weir-like" water level control feature that facilitates limited mine pool elevation manipulation (maximum ~5') as well as relatively accurate flow rate estimations. The structure has been set on two concrete footers with wing walls extending to the top outside of the structure to provide a solid foundation in addition to functioning as "anti-seep" devices to prevent unwanted discharge of the mine pool around the facility.

At the inlet end of the structure, flow is intercepted and conveyed by the following three components: three, 8" perforated pipes extended into the mine void, an 18" perforated vertical riser with 18" perforated barrel, and a non-calcareous, R-4, (6" average diameter) rock drain. The vertical riser was installed in the temporary "mine sump" area, excavated as Test Pit 1 (TP1). This riser allows monitoring and access for pumping if needed in the future. The top of the riser is protected by a concrete manhole with the access cover secured by bolts. The cover has a single 1" perforation at the center to allow for manual water level measurements and venting of gases, if present. The TP1 sump area was backfilled with R-4 rock then geotextile fabric was used for layer separation of select on-site fill. Where appropriate, the area was graded and revegetated.

The channel is covered with a concrete lid approximately six feet wide and nine feet long (6'W x 9'L). The lid deters unauthorized entry and provides a secure outlet. Locking and hinged grating has been placed immediately above the weir portion of the channel for access if needed for mine pool manipulation as well has continued monitoring. A stilling well has also been installed to facilitate water level measurements. A riprap-lined (R-4) channel conveys the discharge to "Alexander Run".

Primary Drain Hydraulic Capacity: Each of the three 8" pipes has two perforated sections (~13' in length) placed into the mine void. These pipes were perforated with a row (along pipe circumference) of five holes (1" in diameter) every 6½". This results in about 240 perforations per run and a total of 720 perforations for all three runs. Each of the runs extends about 60' from the mine void to the concrete outlet structure. For the design flow of 1,000 gpm, the approximate head loss for the 8" piping, without taking into consideration the R-4 stone or perforated 18" riser and barrel, is as follows: Flow into perforations 0.0'; Perforated pipes into mine 0.2'; Solid pipe runs from mine void to outlet structure 0.3'; Total Head Loss 0.5'.

The 18" vertical riser is perforated from the bottom elevation at ~1034' to about the elevation of the top of the concrete outlet structure at about ~1048'. There are rows of about seven, 1" perforations every 3½", totaling 48 rows and subsequently a total of about 336 perforations in the riser. Assuming a design mine pool elevation of 1044.9', approximately 260 perforations in the vertical riser are within the saturated zone. Using an assumed head of 0.1', the capacity of the perforations is about 970 gpm. For the barrel extending from the riser to the outlet structure, using an assumed head based on a full 18" pipe, the barrel has a capacity of about 3,500 gpm. The perforations at the given elevation are the flow-limiting factor; however, the first section of pipe extending from the 45° elbow towards the outlet structure is also perforated in a similar manner as the riser to allow additional water to enter the pipe. To supplement the 3 runs of 8" pipe and the 18" riser and pipe, water can also be conveyed from the mine void through the R-4, non-calcareous, riprap to the in-by side of the concrete channel.

Based on the estimated design flow of 1,000 gpm, a rectangular weir installed within the concrete outlet structure with a 3' wide crest would have a head of about 0.4' using the Francis Formula for a fully contracted weir. Note that due to the design of the concrete outlet structure and adjustable weir, the conditions for the weir are neither fully contracted nor fully suppressed, but rather partially contracted. The differences between the contracted and suppressed weir conditions yield calculated flow differences of about 2% at about 700 gpm and approach 8% for calculated flows around 4,300 gpm. Measurements taken 06/16/05 with a temporary "test weir" were: L = 3.33' (weir length) and H = 0.25' (height of water above weir measured at stilling well). The calculated flow using the Francis Formula: $3.33\ H^{1.5}(L-0.2H)$ was about 613 gpm (+/- about 2%).

Based on the weir flow calculations and mine pool measurements, a 3.0' wide, sharp-crested, rectangular-notch weir was installed in the Primary Drain. The notch was cut into ½" Tivar installed on the upstream face of the stainless steel stoplogs. Using the 1,000-gpm, design flow and calculated required head, by setting the crest of the weir at 1044.5', the projected target mine pool elevation of about 1046.2' at the EWS would not be exceeded. (Note: If all stoplogs were inserted, the crest of the weir would be about 1047.5'. The Secondary Drain with an overflow pipe invert at about 1048' would discharge as the mine pool at the EWS reached the pre-"blowout" elevation of about 1049', as reported for Borehole #7 drilled in 1980.) Assuming that the delta between the EWS and Primary Drain is maintained at 1.3' as noted above, at a flow rate of 1,000 gpm with a water depth of 0.4' at the weir (difference of pool and crest elevations), the water elevation at the EWS will be 1046.2'. The measured depth from the center hole on the manhole cover at the EWS is projected to be about 5.5'. This weir has a total maximum measurable depth of 1.3' that results in a maximum measurable flow of about 6,000 gpm. Any discharge over and above this volume will be flowing above the weir and additional calculations would be needed to estimate flow; however, this situation is highly unlikely.

Secondary Drain Design: The Secondary Drain was included to provide access for mine pool elevation monitoring and for future pumping if needed. The Secondary Drain was also installed to provide an outlet for the mine pool should the Primary Drain be compromised or other significant hydrologic changes occur within the mine. The top of the riser is protected by a concrete manhole with an access cover secured by bolts. The cover has a single 1" perforation at the center to allow manual water level measurements and venting of gases, if present.

An 18" riser pipe diameter was chosen to facilitate a typical intake basket (reportedly, ~12 inches in diameter) for an 8" diesel pump suction line and to allow a reasonable annulus for flow within the riser. An 18" overflow pipe was included in the design to provide a "safety relief" for the mine pool. From a 45° WYE installed near the bottom of the riser, the 18" overflow pipe with 45° elbow was then installed in order to direct overflow to a constructed channel and eventually to "Miller Run".

During the April 2005 investigation phase, as noted on the attached "Mine Pool Response by Discharging at Primary Drain" graph, the delta between the EWS ("blowout") and the Secondary Drain ranged from 0.8' to 1.3', which was less than the delta between the EWS and Primary Drain. For this reason, the overflow pipe crest elevation was set at 1048'. If the mine pool elevation would rise at the EWS to about 1049', approximately 3' below the surface at the EWS, the Secondary Drain is projected to discharge. The overflow pipe diameter was chosen to provide sufficient carrying capacity within the pipe at minimal flow depths for the given pipe gradient. The pipe and subsequent channel gradients were limited to about 1% based on topographic constraints as well as significant shallow subsurface water encountered during the installation of the culvert under the access road.

Secondary Drain Hydraulic Capacity: The vertical riser was perforated with 1" holes, 0.4' on-center, from the bottom of the riser extending upward 6'. There are approximately two hundred 1" holes. Approximately 0.2' of head is required to pass about 1,000 gpm. This riser is connected to an 18" overflow pipe installed at a ~1% slope. A flow depth of about 0.4' within the pipe would be needed to convey 1,000 gpm.

Early Warning System Design: This component of the permanent solution allows for continued monitoring of the mine pool elevation at the "blowout" location, as well as an additional "safety relief" point that will function as an Early Warning System in the unlikely event that the mine pool elevation rises to ground level. The "blowout" was cleaned to the maximum extent practicable with a rubber-tired backhoe. A 15" SDR35 riser, with 1" and 1 1/8" perforations (about 50% of each) on 6" centers spaced both vertically and horizontally, was set into the void. A short piece of 6" SDR35 pipe perforated with five 5/8" holes every 6" was inserted "back into" the mine void as feasible and connected to the 15" riser below design water elevation. PADOT #3, non-calcareous, aggregate was placed around the pipe to the level of the bottom of the sidewalk. The top of the riser is protected with a cast-iron manhole access cover set in concrete with bolted lid. The lid has been perforated with seven 1" holes to allow water level measurements. In addition to monitoring, this perforated cover will allow water to discharge in a highly visible area of a residential section of McDonald Borough. If this were to occur, the local residents would be able to alert the proper authorities to implement corrective measures.

Continued Mine Pool Elevation Monitoring: Post-construction monitoring on 06/16/05, with the "Test Weir" installed at the Primary Drain, indicated that the delta between the EWS and the Secondary Drain was greater than the delta between the EWS and the Primary Drain. With a mine pool elevation of 1044.1' established by the "Test Weir" at the Primary Drain, the recharge to the Secondary Drain had been decreased. Stoplogs have since been added to raise the mine pool at the Primary Drain to the proposed design elevation of 1044.9'.

As previously noted, in order to monitor the mine pool elevation manually at the EWS, Secondary Drain, and Primary Drain, 1" holes were provided in the cast-iron lids covering, and securing access to, the risers.

To provide the ability to monitor on a more continuous basis, dataloggers are to be installed at the EWS and the Primary Drain. The depth to water measurements collected at the EWS may be downloaded periodically to evaluate the impact of precipitation events and to show evidence of unwanted mine pool elevation changes under a densely populated residential area. To complement the datalogger at the EWS, the datalogger installed within a stilling well located in the concrete outlet structure of the Primary Drain will not only provide water level information for the underground mine pool in the area of the Primary Drain but also provide measurements that may be used to calculate flows in conjunction with the weir-type outlet. Comparison of the information collected by both dataloggers may also be used to graph the hydraulic gradient of the mine pool relative to the EWS and Primary Drain to aid in documenting significant hydrologic changes.

As of the writing of this report, the installed facilities have functioned as designed and installed.