NICKLE PLATE ABANDONED MINE POOL “BLOWOUT” WASHINGTON AND ALLEGHENY COUNTIES, PENNSYLVANIA[1]

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Abstract. On 01/25/05, a 10,000-gpm “blowout” of the century-old Nickle Plate Mine (Pittsburgh coalbed) occurred in a public sidewalk about 12 miles southwest of downtown Pittsburgh, PA. The US Office of Surface Mining, first responder, installed diesel pumps and drain lines along public streets to control and convey the discharge to a nearby stream. On 02/22/05, the Pennsylvania Department of Environmental Protection, Bureau of Abandoned Mine Reclamation issued a 90-day emergency contract to Environmentally Innovative Solutions, LLC to provide a permanent control. With numerous partners (federal, state, local agencies; local residents and businesses), property access, stream and mine pool water quality data, historical mine mapping, and other pertinent site information were acquired.

Nine options were developed and evaluated. Paramount in design considerations was public health and safety followed by effectiveness, reliability, community and environmental impact, long-term maintenance requirements, installation cost, and aiding future work including grouting to address mine subsidence issues and treatment of the abandoned mine drainage. Piezometers and test pits were installed in city streets, private driveways, and on undeveloped property and mine pool response tests were conducted. After data evaluation, the mine pool was manipulated to discharge about ½-mile northeast of the “blowout” on undeveloped land to an AMD-degraded receiving stream. By 05/20/05, a primary gravity drain, a secondary drain, and an early warning system at the “blowout” had been completed. Subsequent monitoring confirms the facilities are functioning as designed.

Additional Key Words: public-private partnership, emergency contract.

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Introduction

Statement of Problem

At approximately 2:00 pm (EST) on 01/25/05, while utility workers were using hand-tools to determine the location of what was thought to be a water main leak, a catastrophic "blowout" of an abandoned mine pool occurred. The confined conditions within the Nickle Plate Mine created a "geyser" with an estimated flow rate of 10,000 gpm. The "blowout" location was at 135 Liberty Street, along the sidewalk, in McDonald Borough, Washington County, PA.

The Nickle Plate Mine (ca. 1890s thru 1930s) in the Pittsburgh coalbed (Pittsburgh Fm., Monongahela Gp.) underlies more than a thousand acres and, based on interpretation of available underground mine mapping, is interconnected with upgradient abandoned underground and surface mines. At the "blowout", the downdip mine workings, enlarged by roof collapse, were less than 10 feet below the ground surface.

"First Response"

The initial responders, McDonald Borough Fire & Police Departments, Borough Council, PA Department of Environmental Protection (PA DEP) Emergency Response team, and other local fire departments, constructed sandbag dikes, closed local streets, evacuated residents and assisted others with flooding issues. (See Fig. 1.) The PA DEP and the US Department of Interior Office

Figure 1. "Blowout" of the abandoned Nickle Plate Mine pool. Note flooding of Liberty Street, McDonald, PA. (01/25/05)

of Surface Mining Pittsburgh Office (OSM) agreed that OSM would provide the short-term response and that the PA DEP Bureau of Abandoned Mine Reclamation (BAMR) would address the issue long term.

Through the efforts of OSM, by 3:30 am (EST) on 1/26/05, an 8-inch and a 12-inch pump, both with about 1000 feet of discharge hose, had been installed to convey the degraded mine drainage to the nearest watercourse of adequate size. (The watercourse then enters Robinson Run, a stream devoid of aquatic life with total Fe and Al content generally exceeding 40 mg/l and 20 mg/l, respectively.) By 2/15/05, the 12-inch pump was removed as the estimated flow rate decreased to ~4,000 gpm. By 2/18/05, OSM had installed two piezometers to monitor the mine pool.

Approach to Long-Term Solution (Objectives)

On 2/22/05, a "90-Day" Emergency Contract EP 3555440000-05-01 was issued by BAMR to Environmentally Innovative Solutions LLC (EIS) to:

- Continue pumping at the "blowout" until implementation of a permanent solution;
- Develop cooperative efforts with local government, businesses, and residents;
- Compile and evaluate all available, relevant, historical data;
- Develop a monitoring program to include the installation of piezometers;
- Evaluate monitoring data collected daily by BAMR;
- Determine and evaluate options;
- Design and construct an effective, economical, permanent or long-term solution to control the mine pool with minimal impact to the community.

The BAMR approach stressed that open lines of communication were to be established among all agencies and stakeholders. Throughout the project frequent (often daily) updates were provided to the news media and/or representatives of McDonald Borough for dissemination to concerned local residents. The ability to contact the project team on a 24-hour per day basis was also provided. While BAMR's proactive approach placed an additional obligation on project managers, the open exchange of information and ideas resulted in the emergence and expeditious implementation of solutions.

One of the first tasks was to install and to monitor piezometers in order to characterize the mine pool. With an ongoing compilation of historical data (including abandoned mine maps provided by a local landowner/coal operator) and with construction and continual revision of a Bed Map with contours (2-foot interval) drawn at the Pittsburgh coalbed/seathearth contact, the team worked with PA One Call to try to locate underground utilities and with the McDonald Borough Council and property owners for access and to avoid historical features (such as brick streets). Fourteen air-rotary boreholes were completed by McKay & Gould Drilling (Darlington, PA) with eight piezometers installed into mine workings (7 in voids) from 03/09-11/05 in or near the streets of McDonald. (See Fig. 2.) All boreholes and piezometers were located by the BAMR survey crew. On 03/23/05, pumping at the "blowout" was suspended and a 24-Hour Mine Pool Response Test was conducted by BAMR and EIS with water levels measured at specified intervals at the "blowout" and within the piezometers, including two installed by OSM.

A map depicting the water level change (0.1 foot contour interval) was constructed to indicate possible mine discharge relocation areas.

Figure 2. Piezometers installed as part of hydrogeologic investigation. (03/10/05-photo by Rich Beam, BAMR)

On 03/31/05, nine options were presented to BAMR regarding implementation of a permanent facility to control the mine pool through gravity drainage. One option "suggested", by comparing the historical underground mine mapping, Bed Map, and 24-Hour Mine Pool Response Test, was to control the mine drainage in an area about ½-mile northeast of the "blowout". This undeveloped area offered a number of potential advantages including (1) minimal impact to the local community, (2) lower construction costs due to the lack of infrastructure typically associated with densely-populated areas, and (3) available construction area for the future implementation of a passive treatment system. (Construction area for future treatment facilities was not available at the location of all other options.) Based on a consensus with BAMR, this option was further evaluated. BAMR reviewed the Pennsylvania Natural Diversity Index database which indicated that there were no threatened or endangered species. The receiving stream was determined to have existing impacts from historical mining and the proposed temporary pumping activities would result in only short-term and minor impacts. No historical or cultural resources were noted. In addition, wildlife, vegetation, air quality, and noise resources were reviewed with anticipated impacts deemed short-term to moderate.

Landowner permission was received to install and monitor piezometers and test pits and to construct the necessary facilities, if the option was deemed feasible. On 04/01/05 and 04/05/05, thirteen boreholes were drilled with five additional piezometers installed (3 in voids) which were located by the BAMR survey crew. The site was inspected for subsidence features and siphons were installed to drain existing impounded degraded surface water. On 04/08/05, four test pits were excavated and pumping at the "blowout" was suspended. On 04/09/05, pumping was conducted and then a temporary gravity drain was installed at Test Pit 1. Subsequent monitoring of the piezometers, Test Pit 2 and the "blowout", indicated successful control of the elevation of the mine pool at the "blowout". (See Fig. 3.) Monitoring on 04/09/06 and 04/13/06, a period without precipitation events, indicated the difference in elevation of the mine pool at the "blowout" and at Test Pit 1 was 1.6 to 1.3 feet, respectively.

Figure 3. Test pits excavated with pumping conducted to determine favorable locations for Primary and Secondary Drains. (04/08/05)

BAMR continued frequent inspections and daily monitoring. Initially, the mine pool was to be maintained at an elevation to allow perpetual inundation while providing an adequate amount of "freeboard" to inhibit any unplanned discharge at the "blowout" location. BAMR also considered maintaining inundation of the underground mine workings in order to reduce weathering of the remaining pillars, as significant portions of the community (numerous dwellings, public roads, and utilities) were less than 35 feet above the mine workings. Drilling indicated, however, small local "rolls" in the coal with a difference in elevation of up to nine feet within a few hundred feet horizontally. A consensus was reached between BAMR and EIS that the goal was to maintain the mine pool at the "blowout" about five feet below ground surface.

The data collected during continuous pumping at the "blowout" (24 hrs/day; 7 days/wk) as the mine pool elevation was being lowered ~0.1 ft/day from 03/04/05 to 03/16/05 (only short interruptions for minor maintenance and refueling) was analyzed in order to develop the target design flow rate for the permanent solution. Based on this information, the target design flow rate was estimated to be about 1,000 gpm.

A "design-build" proposal with cost estimate was submitted to BAMR for review on 04/18/05. On 04/26/05, BAMR provided comments to EIS and, on 04/27/05, a pre-construction meeting was held and measures were taken to protect adjoining property from rising water levels in the receiving watercourse. On 04/29/05, the final design proposal was submitted to Bruce Leavitt, PE, PG, Consulting Hydrogeologist, for review and, based on a consensus among BAMR, Leavitt, EIS, and the property owner, the permanent facilities were installed.

General Description of Permanent Facilities

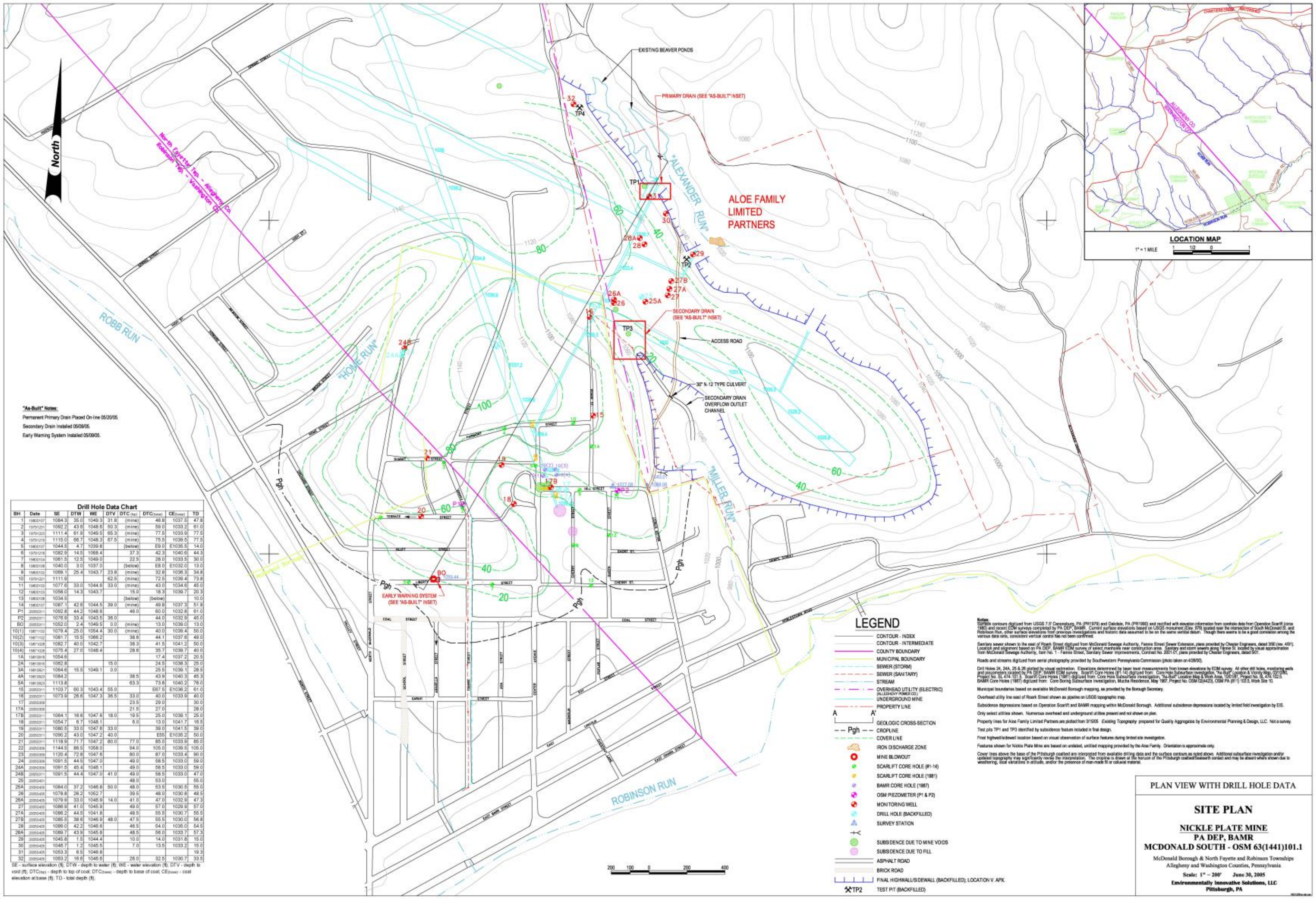
Paramount to site design considerations was public health and safety followed by effectiveness, community and environmental impact, long-term maintenance requirements, sustainability, reliability, installation cost, and finally, aiding future work including grouting to address mine subsidence issues and treatment of the discharge. In order to provide redundancy ("back-up"), three hydrologically-related facilities at difference locations were constructed as listed in Table 1.

Table 1. Permanent Facilities

Facility (Designed & Built)	**Location** Receiving Stream (quality) Municipality, County Latitude/Longitude
Primary Drain (05/02/05 - 05/05/05) (05/13/05 - 05/19/05)	**Aloe Family Ltd. Partners property** "Alexander Run" (AMD degraded) North Fayette Twp., Allegheny Co. 40.37844774/-80.23009914
Secondary Drain (05/06/05 - 05/09/05)	**Aloe Family Ltd. Partners property** "Miller Run" (AMD degraded) North Fayette Twp., Allegheny Co. 40.37631529/-80.23032449
Early Warning System (05/06/05 - 05/09/05)	**135 Liberty Street (at "blowout")** Robb Run (minimal degradation) McDonald Boro., Washington Co. 40.37269150/-80.23388143

Primary Drain

Design. The Primary Drain is installed at the location of Test Pit 1, which was excavated in a subsidence feature. Based on reorienting, revising and interpreting historical underground mapping, Test Pit 1 was in the vicinity of a backfilled drift entry.



Drill Hole Data Chart

BH	Date	SE	DTW	WE	DTV	DTC(top)	DTC(base)	CE(base)	TD
1	19800107	1084.3	35.0	1049.3	31.8	(mine)	46.8	1037.5	47.8
2	19791231	1092.2	43.6	1048.6	50.3	(mine)	59.0	1033.2	61.0
3	19791220	1111.4	61.9	1049.5	65.3	(mine)	77.5	1033.9	77.5
4	19791219	1115.0	66.7	1048.3	67.5	(mine)	75.5	1039.5	77.5
5	19800107	1044.5	4.7	1039.8		(below)	E9.0	E1035.5	14.0
6	19791218	1082.9	14.5	1068.4		37.3	42.3	1040.6	44.3
7	19800104	1061.5	12.5	1049.0		22.5	28.0	1033.5	30.0
8	19800108	1040.0	3.0	1037.0		(below)	E8.0	E1032.0	13.0
9	19800102	1069.1	25.4	1043.7	23.8	(mine)	32.8	1036.3	34.8
10	19791221	1111.9			62.5	(mine)	72.5	1039.4	73.8
11	19800102	1077.6	33.0	1044.6	33.0	(mine)	43.0	1034.6	45.0
12	19800103	1058.0	14.3	1043.7		15.0	18.3	1039.7	20.3
13	19800108	1034.5				(below)	(below)		10.0
14	19800107	1087.1	42.6	1044.5	39.0	(mine)	49.8	1037.3	51.8
P1	20050311	1092.8	44.2	1048.6		46.0	60.0	1032.8	61.0
P2	20050311	1076.9	33.4	1043.5	36.0		44.0	1032.9	45.0
BO	20050311	1052.0	2.4	1049.5	0.0	(mine)	13.0	1039.0	13.0
10(1)	19871102	1079.4	25.0	1054.4	30.0	(mine)	40.0	1039.4	50.0
10(2)	19871102	1081.7	15.5	1066.2		38.6	44.1	1037.6	49.0
10(3)	19871028	1082.7	40.0	1042.7		38.3	41.5	1041.2	50.0
10(4)	19871028	1075.4	27.0	1048.4		28.6	35.7	1039.7	40.0
1A	19810918	1054.6					17.4	1037.2	20.5
2A	19810916	1062.8			15.0		24.5	1038.3	25.0
3A	19810921	1064.6	15.5	1049.1	0.0		25.5	1039.1	28.5
4A	19810923	1084.2				38.5	43.9	1040.3	45.3
5A	19810923	1113.8				63.3	73.6	1040.2	76.0
15	20050311	1103.7	60.3	1043.4	55.0		E67.5	E1036.2	61.0
16	20050311	1073.9	26.6	1047.3	36.5	33.0	40.0	1033.9	40.0
17	20050309					23.5	29.0		30.0
17A	20050309					21.5	27.0		28.0
17B	20050311	1064.1	16.6	1047.6	18.0	19.5	25.0	1039.1	25.0
18	20050311	1054.7	6.7	1048.1		6.0	13.0	1041.7	16.5
19	20050311	1080.5	33.0	1047.6	33.0		39.0	1041.5	39.0
20	20050311	1090.2	43.0	1047.2	40.0		E55	E1035.2	50.0
21	20050311	1118.9	71.7	1047.2	80.0	77.0	85.0	1033.9	85.0
22	20050309	1144.5	86.5	1058.0		94.0	105.0	1039.5	105.0
23	20050309	1120.4	72.8	1047.6		80.0	87.0	1033.4	90.0
24	20050309	1091.5	44.5	1047.0		49.0	58.5	1033.0	59.0
24A	20050309	1091.5	45.4	1046.1		49.0	58.5	1033.0	59.0
24B	20050311	1091.5	44.4	1047.0	41.0	49.0	58.5	1033.0	47.0
25	20050401					48.0	53.0		55.0
25A	20050405	1084.0	37.2	1046.8	50.0	48.0	53.5	1030.5	55.0
26	20050405	1078.8	26.2	1052.7		39.5	48.0	1030.8	48.5
26A	20050405	1079.9	33.0	1046.9	14.0	41.0	47.0	1032.9	47.3
27	20050406	1086.9	41.0	1045.9		49.0	57.0	1029.9	57.0
27A	20050406	1086.2	44.5	1041.8		48.5	55.5	1030.7	55.5
27B	20050406	1085.5	38.6	1046.9	48.0	47.5	55.5	1030.0	56.8
28	20050405	1089.0	42.2	1046.6		46.5	54.0	1035.0	54.5
28A	20050405	1089.7	43.9	1045.8		48.5	56.0	1033.7	57.3
29	20050406	1045.8	1.5	1044.4		10.0	14.0	1031.8	15.0
30	20050405	1046.7	1.2	1045.5		7.0	13.5	1033.2	15.0
31	20050405	1053.3	6.5	1046.8					19.3
32	20050405	1063.2	16.6	1046.6		26.0	32.5	1030.7	33.5

SE - surface elevation (ft); DTW - depth to water (ft); WE - water elevation (ft); DTV - depth to void (ft); DTC(top) - depth to top of coal; DTC(base) - depth to base of coal; CE(base) - coal elevation at base (ft); TD - total depth (ft).

At the inlet, flow is intercepted and conveyed by the following three components: (1) three, 8” perforated pipes placed about 26 feet into the mine void, (2) an 18” perforated vertical riser with 18” perforated barrel, and (3) a non-calcareous, R-4, (6” average diameter) rock drain. The vertical riser allows monitoring and access for future pumping, if needed, and is protected by a concrete manhole with a bolted access cover, having a single 1” perforation to allow for manual water level measurements and venting of gases, if present. The inlet area was backfilled with R-4 rock with geotextile fabric used for layer separation of select onsite fill. Where appropriate, the area was graded and revegetated.

At the outlet, a rectangular concrete structure (4’W x 5’H x 13’L) set on two concrete footers with wing-walls to function as “anti-seep” features, included a “weir-like” water level control feature to facilitate limited mine pool elevation manipulation (maximum ~5’) as well as relatively accurate flow rate estimations. A concrete lid (6’W x 9’L) deters unauthorized entry. Locking and hinged grating was placed immediately above the weir for access to manipulate the mine pool, if needed, as well has continued monitoring. A stilling well with datalogger facilitates water level measurements and a riprap-lined (R-4) channel conveys the discharge to a previously degraded stream. (See Fig. 4.)

Figure 4. Primary Drain online May 20, 2005. (06/16/05)

Hydraulic Capacity. Each of the three pipes extended into the mine void has two sections (~13' ea) perforated with a row (along pipe circumference) of five holes (1" dia.) every 6½" (~240 perforations/pipe; ~720 perforations total). Each of the runs is plumbed to about 60 feet of solid pipe which extends 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 (base elevation ~1034'; top elevation ~1048') is perforated with 48 rows of seven, 1" perforations every 3½" (~336 perforations). Assuming a design mine pool elevation at the Primary Drain of 1044.9', ~260 perforations in the vertical riser are within the mine pool. 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 to 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 concrete outlet structure.

Based on the estimated design flow of 1,000 gpm, a 3.0-foot wide, sharp-crested, rectangular-notch weir installed within the concrete outlet structure 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 are neither fully contracted nor fully suppressed, but rather partially contracted yielding calculated flow differences of ~2% at ~700 gpm which approach 8% for calculated flows ~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: $3.33H^{1.5}(L-0.2H)$ was about 613 gpm (+/- about 2%).

The weir notch was cut into ½-inch Tivar installed on the upstream face of stainless-steel stoplogs, and, by using the 1,000-gpm design flow and calculated required head for the targeted mine pool elevation at 1046.2' at the "blowout", the crest of the weir was set at 1044.5'. (Note: With insertion of all stoplogs, the crest of the weir would be about 1047.5'. The Secondary Drain with an overflow pipe invert at about 1048' would discharge prior to flowing from the "blowout".) The weir has a total maximum measurable depth of 1.3' for a maximum measurable flow rate of ~6,000 gpm. Flows in excess will be above the weir and additional calculations would be needed to estimate flow rate. Monitoring of the flow rate at the Primary Drain is ongoing. Figure 5 depicts the variations in flow rates.

The water quality within the Nickle Plate Mine is also variable and appears to be related to residence time, flow path, availability of oxygen, and other factors. Water quality monitoring of the Primary Drain effluent has not been evaluated to date; however, based on preliminary sampling conducted 10/05/05 and 11/21/05, the drainage had the following general characteristics: 4.7 pH, 180 mg/l acidity, 60 mg/l total Fe, 3 mg/l total Mn, 10 mg/l total Al, and 950 mg/l sulfates.

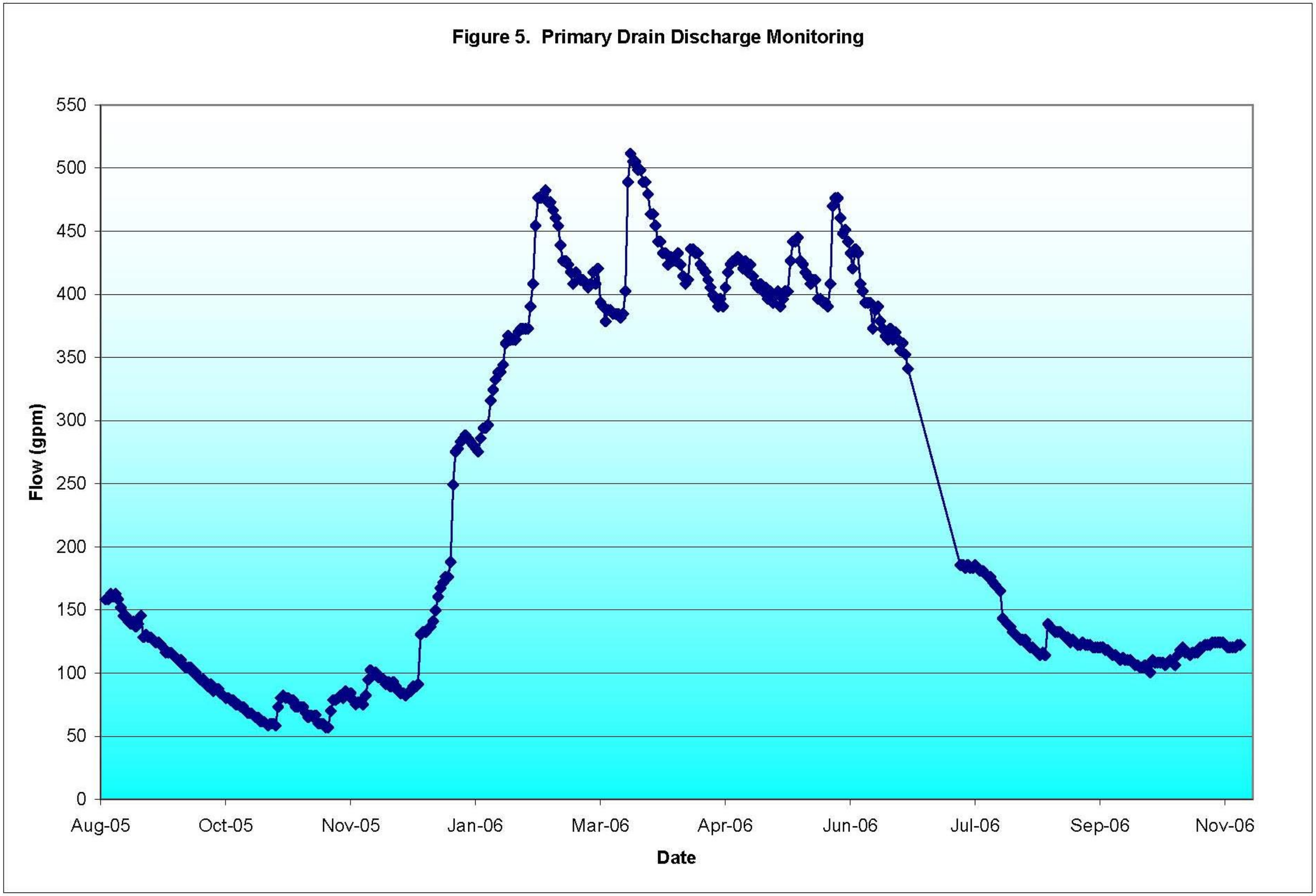


Figure 5. Primary Drain Discharge Monitoring
550
500
450
400
350
300
250
200
150
100
50
0
Flow (gpm)
Aug-05
Oct-05
Nov-05
Jan-06
Mar-06
Apr-06
Jun-06
Jul-06
Sep-06
Nov-06
Date

Secondary Drain

Design. The Secondary Drain, constructed in Test Pit 3 which was located in a subsidence depression that actively conveyed surface water into the mine, not only allows access for monitoring of the mine pool and for future pumping, if needed, but also provides an outlet for mine pool drainage 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. (See Fig. 6.)

Figure 6. Subsidence depression intercepting “Miller Run” prior to Test Pit 3 excavation. (03/03/05)

A riser pipe with an 18” diameter was selected in order to facilitate a typical intake basket (~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”, a stream historically degraded by AMD. (See Fig. 7.)

Figure 7. Construction of Secondary Drain. Geotextile used for layer separation of aggregate and backfill. (04/13/05)

During the April 2005 investigation phase, the difference in elevation between the "blowout" and the Secondary Drain ranged from 0.8' to 1.3', which was less than the difference between the "blowout" and Primary Drain. For this reason, the overflow pipe crest elevation was set at 1048'. If the mine pool elevation would rise at the "blowout" to ~1049', about 3' below the ground surface at the "blowout", the Secondary Drain is expected to discharge. The overflow pipe diameter was selected 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 encountering significant shallow subsurface water during installation of the access road culvert.

Hydraulic Capacity. The vertical riser was perforated with 1" holes, 0.4' on-center, from the bottom of the riser extending upward 6' (~200 holes). Approximately 0.2' of head is required to pass about 1,000 gpm. With 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 allows for continued monitoring (datalogger installed) of the mine pool elevation at the "blowout" location, as well as an additional "safety relief" point that will discharge in the unlikely event that the mine pool elevation rises to ground level. After removing debris to the 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 section (~6'L) 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 grade and the sidewalk was reconstructed. The top of the riser is protected with a cast-iron manhole access cover set in concrete with bolted lid. The lid was perforated with seven 1" holes to allow manual 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, local residents would be able to alert the proper authorities to implement corrective measures. (See Fig. 8 and 9.)

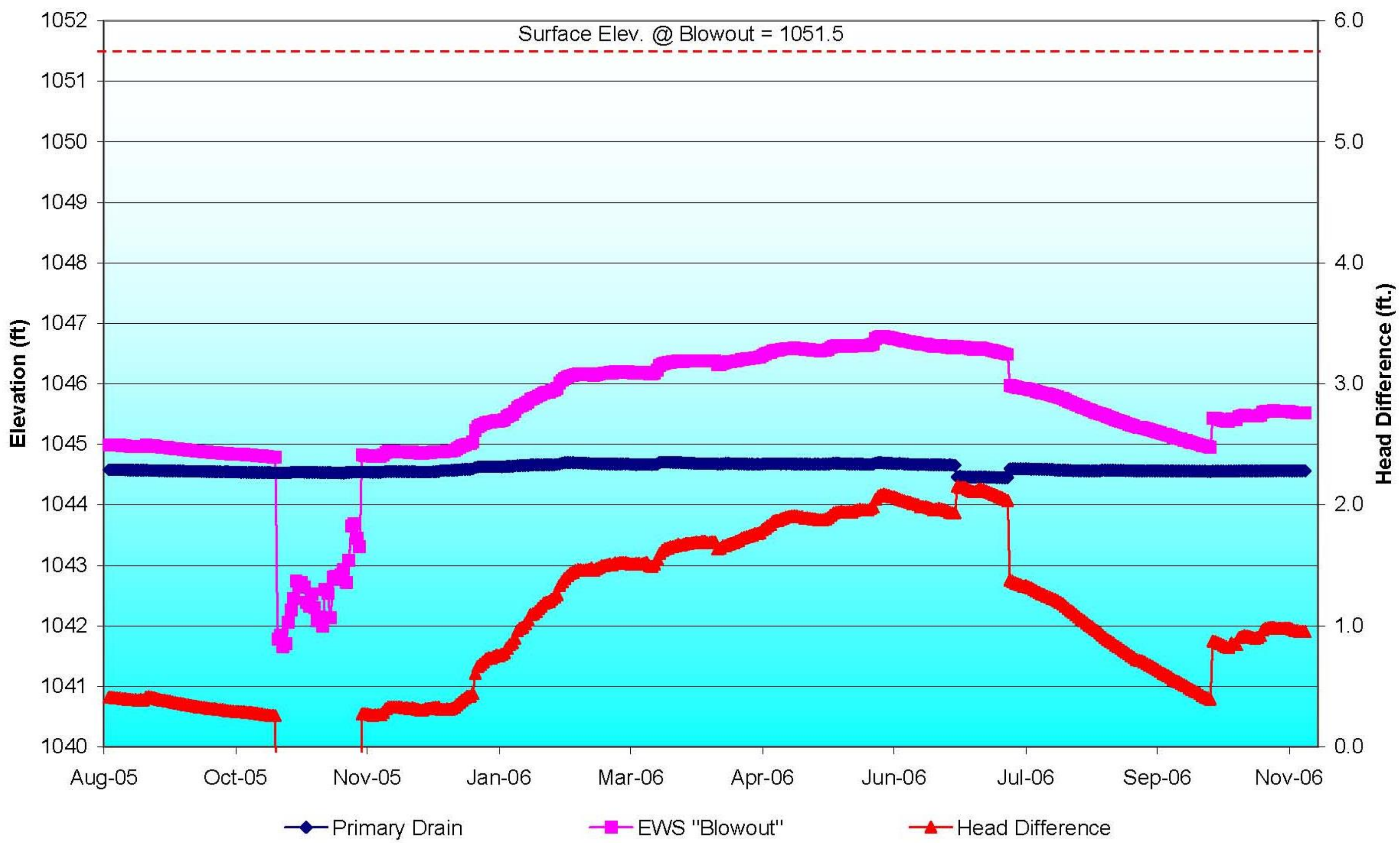
Figure 8. Local resident and subcontractor Dave Menke assists in the installation of the Early Warning System at the "blowout". (05/09/05)

Figure 9. View of the manhole cover of the Early Warning System in the repaired sidewalk. (06/10/05)

Summary

The cause of the “blowout” at McDonald is unknown; however, Hurricane Ivan (09/2004) is expected to have been an influence. Since implementation (over 2 years), all systems appear to be functioning. (See Fig. 10.) The contract cost for project completion including compilation of historic data, installation of piezometers, mine pool response tests, community outreach, and “design-build” of facilities was about $400,000. Monitoring by BAMR is continuing. To date, no maintenance has been required at the Primary Drain or the “blowout”. The only maintenance was the removal of sediment (shoveled by hand) washed from upland areas that had accumulated at the pipe outlet of the Secondary Drain in 06/2006. Passive treatment is planned for the abandoned mine discharge in 2008/2009.

Figure 10. McDonald Mine Pool Elevation Monitoring



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