SECTION 1135 DETAILED PROJECT REPORT
AND
ENVIRONMENTAL ASSESSMENT

MM-280 discharge as seen from Tyson Road - 2007

February 2011

Executive Summary

The Muskingum Mine 280 (MM-280) Project is being conducted under the authority of Section 1135 of the Water Resources Development Act of 1986, as amended, which provides the authority to modify existing U.S. Army USACE of Engineers (USACE) projects to restore the environment and construct new projects to restore areas degraded by USACE projects. The local sponsor is the Muskingum Water Conservancy District (MWCD). The project area is between Tyson Road and Wills Creek Lake in Adams Township, Muskingum County, Ohio.

The purpose of the project is to effectively restore the degraded structure, function, and dynamic processes of the Wills Creek Lake aquatic ecosystem, adjacent to the MM-280 outfall, to a less degraded, more natural condition. Approximately 8.5 acres of aquatic habitat, including riparian, wetland, and embayment, has been impaired from acid mine drainage (AMD) emanating from the MM-280 mine workings. In addition to reducing flood storage from precipitate settling into the lake, the AMD also severely impacts recreational angling.

Description of Ecosystem Problem

The *Biological and Water Quality Study of Wills Creek and Selected Tributaries* (Ohio Environmental Protection Agency [EPA], 1995) report concluded the following concerning the current condition of Wills Creek Lake:

- *The pervasive habitat limitations, primarily sedimentation of the substrate, continue to suppress the full biological potential of Wills Creek. The upper 50.0 miles are in non- or partial attainment of the warm water habitat (WWH) ecoregional biocriteria, and this is largely due to a combination of a heavy sediment bedload related to mine drainage and agricultural runoff, low stream gradient and past channel modifications.*

Full attainment of the biological criteria was observed in the lower 5.0 miles, where improved instream habitat conditions were available.

- *A Section 1135 Preliminary Restoration Plan (PRP), located in* ***Appendix A,*** *and prepared by the USACE identified AMD discharges in the vicinity of Wills Creek Lake, which have contributed to the serious decline both in the aquatic habitat and organisms in the receiving waters of Wills Creek Lake. Primarily, AMD discharged in the study area emanates from a deep mine complex MM-280 and approximately four acres of associated gob pile (spoil) along the south shoreline of Wills Creek Lake, approximately 4.0 miles upstream of Wills Creek Dam.*

- *The PRP identified the principal deleterious effect upon lake water quality as that of acidification. Secondary impacts include the accumulation of extensive sediment deposits in the lake surrounding the discharge. The impaired water quality and physical habitat near the AMD discharges combine to greatly reduce the abundance and diversity of the aquatic life in the area.*

Projected habitat restoration outputs consist of approximately 8.5 acres including riparian, wetland, and embayment. In addition, the incidental reclamation of the gob pile would provide 4 acres of terrestrial or upland habitat improvement. To accomplish this goal, several alternative measures to abate the AMD were considered. Only one alternative measure was found that would reasonably and effectively meet the project objectives.

This ecosystem restoration report and its appendices have presented an in-depth analysis of existing conditions at MM-280. To restore the habitat that has been severely degraded by decades of sedimentation stemming from AMD would require ongoing ecosystem treatment. The treatment options carefully considered in this report, if

implemented, would restore aquatic and upland habitat, and improve the overall ecological, recreational, and aesthetic characteristics of the area. In addition, a substantial public safety situation would be averted by minimizing the risk of another mine-related incident that could affect a public roadway or area utilized by the general public.

The only plan identified that would meet the goals and objectives of the project includes treatment of AMD using settling pond and wetlands. The wetland/pond sizing was evaluated incrementally to provide the most cost effective plan. As part of this plan, reclamation of the spoil pile would be incidental by using material removed during construction of the discharge treatment system in lieu of off-site disposal. No significant adverse impacts would be expected resulting from implementation of this plan.

The local sponsor, MWCD, would be required to pay for 25 percent of the total project costs, either in cash or as "in kind" services. For the MM-280 project, the preliminary estimated total project cost is $2,657,500, of which $1,867,200 is for construction (October 2009). Therefore, the estimated Federal cost is $1,993,125 and the estimated non-Federal cost is $664,375. Annual cost of operation and maintenance is $15,000, and would be the responsibility of the local sponsor.

The implementation of the recommended plan of development is the joint responsibility of the USACE, representing the federal government, and the MWCD. If a Project Partnership Agreement (PPA) is executed between the MWCD and the USACE, it is anticipated that the USACE would complete the detailed design and plans and specifications for the project on a cost shared basis as described above and provide federal funds for project construction and manage the construction of the project.

This Detailed Project Report and Environmental Assessment fulfills the USACE reporting requirements for feasibility level reports as well requirements of the National Environmental Policy Act (NEPA).

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1.0 Introduction

Wills Creek Lake water quality suffers from deleterious acid mine drainage (AMD) emanating from the abandoned Muskingum Mine (MM) 280 workings. AMD from this mine working, along Tyson Road, has resulted in decline both in the aquatic habitat and organisms from a blanketing of metals precipitate in the lake. Improving the water quality of this embayment of Wills Creek Lake would require achieving and maintaining near neutral pH (≥6.5) from the mine discharge and precipitating deleterious metals (principally iron) prior to the water entering the lake. This Detailed Project Report and Environmental Assessment (DPR-EA) documents historic and existing conditions and forecasts future "without-project" and "with-project" conditions. The future without-project conditions form the basis for which alternatives are formulated and impacts are assessed. Evaluation of the formulated alternatives determines which alternative effectively generates the highest level of ecosystem benefits for the least cost. Additionally, the alternatives analysis establishes which plan minimizes environmental impacts to the area during construction. The culmination of the alternative analyses identifies the most cost-effective plan, known as the National Ecosystem Restoration (NER) Plan.

2.0 Background

The Muskingum Watershed Conservancy District (MWCD) was created for the purpose of developing a plan for flood control, water conservation, and water use in the Muskingum River Basin. The official plan was prepared by the U.S. Army Corps of Engineers (USACE) and was approved by the Conservancy District on 19 November 1934. The system, as constructed, included 14 reservoirs. Ten of the 14 Muskingum River Basin reservoirs create lakes with a total surface area of 16,000 acres. These lakes and adjacent lands, in excess of 35,000 acres, are managed for public use by the MWCD in cooperation with the State of Ohio and the USACE.

The original 14 Muskingum Reservoir system, including Wills Creek Lake, was authorized for flood control and allied purposes by the Official Plan for the Muskingum Reservoir System prepared by the USACE, and approved on 19 November 1934 by the MWCD. The Public Works Administration approved the general project plan developed by the MWCD and allocated funds to the USACE to aid in financing the construction of the project.

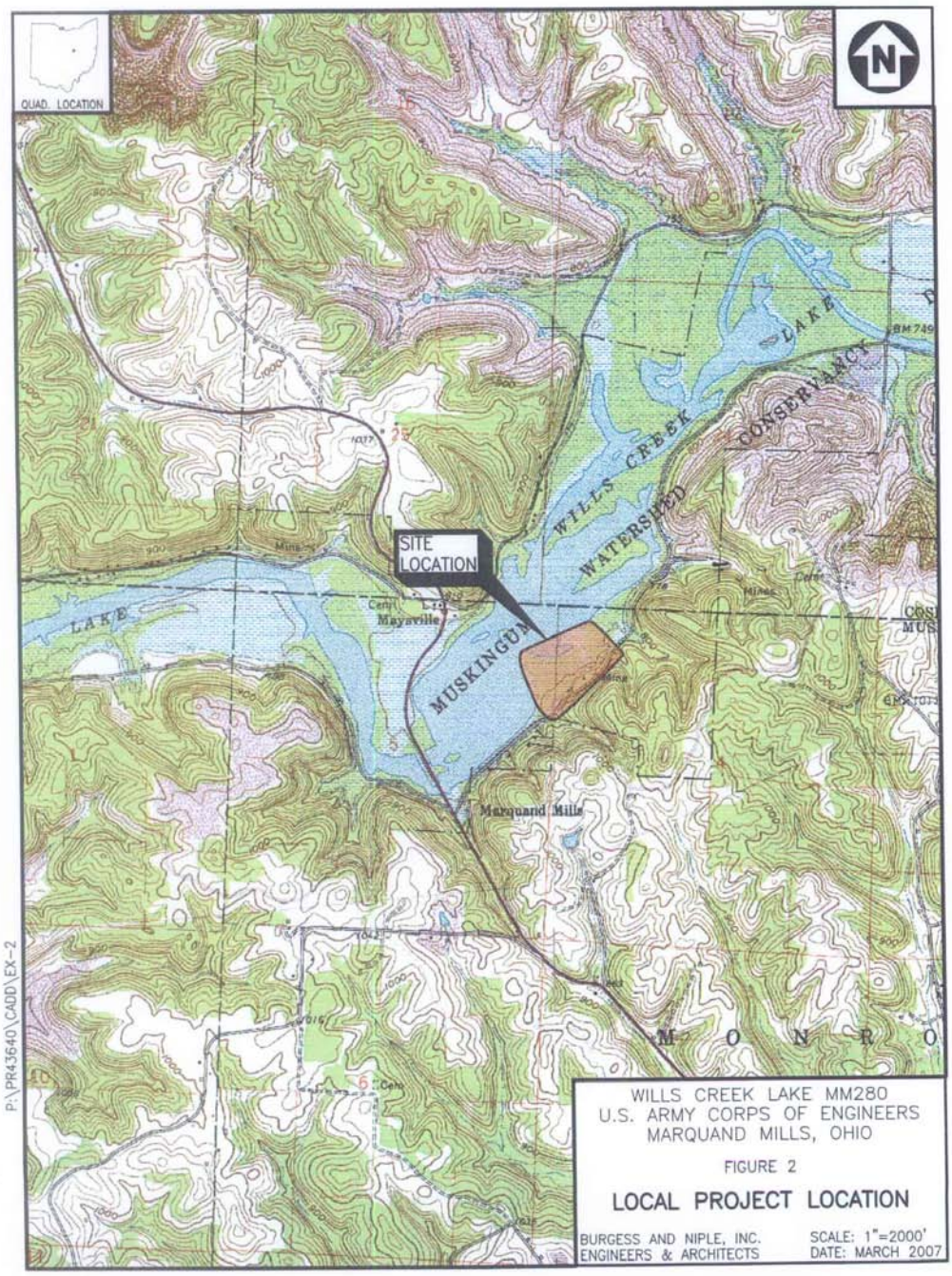
The Flood Control Act of 1939 contained a provision that the Muskingum River Basin dams and reservoirs, then owned by the MWCD, be included in the comprehensive flood control plan for the Ohio River Basin. Since that date the operation and maintenance of the Muskingum Reservoir system has been the responsibility of the USACE. Wills Creek Lake was authorized for flood control and allied purposes in a comprehensive plan for the Muskingum River Basin and the Ohio River Basin. Project purposes are: flood control, general recreation, and fish and wildlife conservation.

After the official plan for the original 14 reservoir system was prepared by the USACE and approved by the MWCD, the MWCD began acquiring lands, rights-of-way, and flood easements. Fee title for the lands required specifically for the construction of the 14 dams and appurtenant structures was conveyed to the United States. However, the Attorney General of Ohio determined that the MWCD could not convey fee simple title of reservoir lands to the United States, so the United States accepted flowage easements over lands acquired in fee by the MWCD for purposes other than construction. The United States acquired flowage easements directly from the remaining property owners where easements only were required. The land acquisition program was not completed until June 1953.

Wills Creek is operated primarily for flood damage reduction. The lake is approximately 900 acres in size. A 9-foot high concrete ogee control weir at the entrance to the intake structure maintains an average lake level of 742.0 feet above mean sea level (msl). The spillway is located at Elevation 779 feet msl. The lake drains 842 square

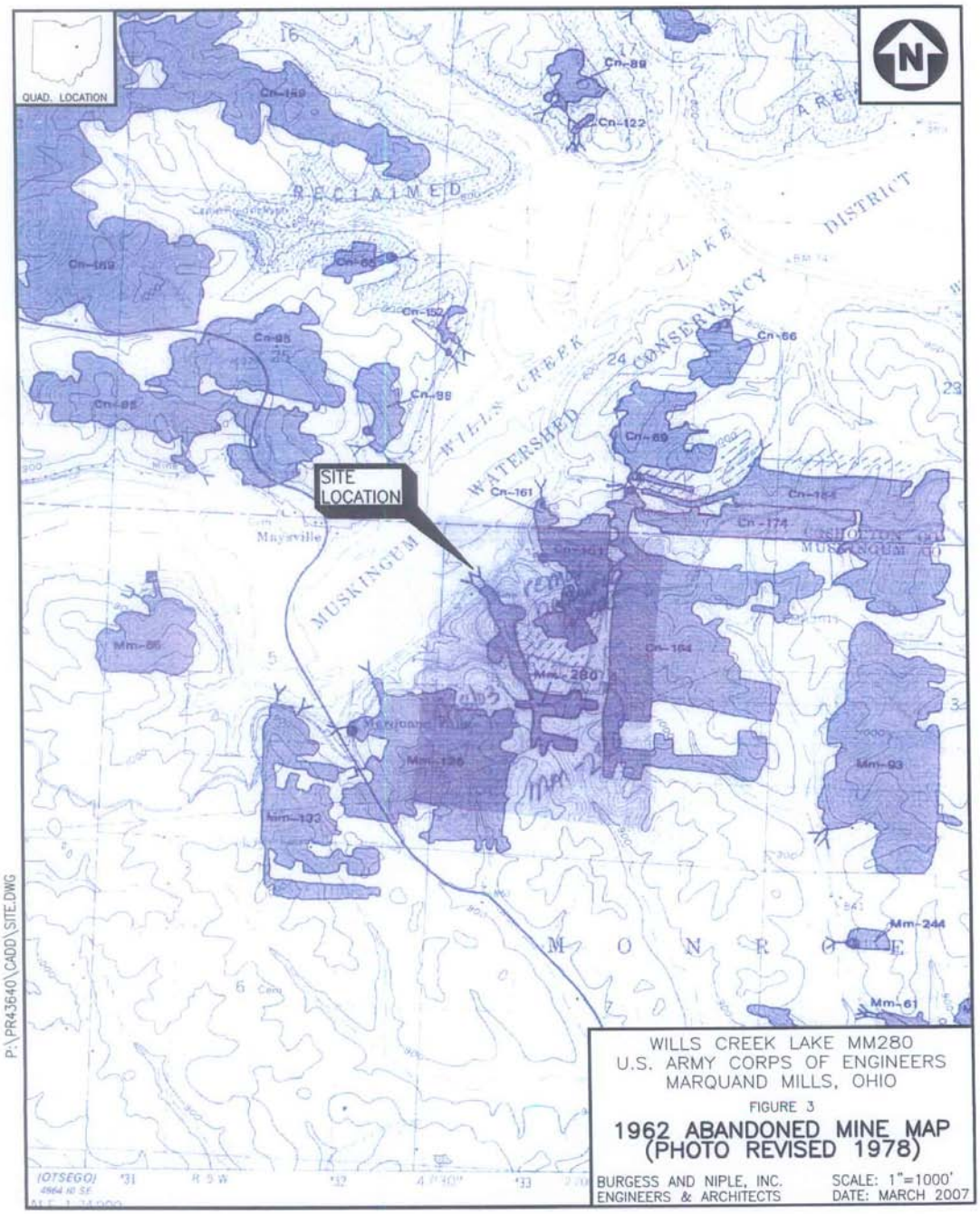
miles, with a net uncontrolled area of 565 square miles. Water is released from the dam through an outlet structure designed to release water from the top of the reservoir, with a minimum pool maintained by a control weir. At the time of construction the streambed elevation of the dam was 720 feet msl compared to 727 feet msl in 1986.

The study area for this evaluation is on the south side of Wills Creek Lake along Tyson Road, approximately 0.6 mile east of State Route (SR) 83, and approximately 13.0 miles north of New Concord, Ohio. **Figures 1 and 2** show the regional and local project location. At this site, AMD from the MM-280 mine complex flows onto an upland area below the mine adit and ultimately into the lake.



According to historical aerial photographs, topographical maps, and surveys, the earliest use of the subject site, dating back to at least 1958, appears to have been coal mining. Mason Mine 280 (MM-280) was operated until 1965 when mining operations

ceased and the mine was abandoned. A mine survey dated January 16, 1965 clearly depicts an underground mine complex with several structures erected on the subject site.



According to a 1962 (Photo-revised 1978) Ohio Geological Survey Abandoned Underground Mine map (**Figure 3**), there are at least three other underground mines adjacent to this site. These include: CN-161 to the north, CN-164 to the east, and MM-125 to the southwest. **Figure 3** represents the Abandoned Underground Mine map for the area. The areas to the east of the site are almost completely forested.

In addition, an approximately 1-acre coal spoil (gob) pile is located adjacent to the MM-280 discharge and within the flood control pool of Wills Creek Lake. This spoil pile was created during the historic mining activities at MM-280. The spoil pile is a barren mound of reject material. The spoil pile is contributing, minimally, to the aquatic and terrestrial habitat decline of the area predominantly due to surface water runoff coming in contact with acid-generating pyritic material within the spoil pile, thus creating a low pH environment.

2.1 Description of the AMD Formation Process

Pyrite (FeS_2) is the mineral predominantly responsible for AMD formation. The oxidation and hydrolysis of pyrite is an acid-producing process. Variable concentrations of the sulfides of iron and the oxides and carbonates of manganese and other metals are found in coal seams, the strata surrounding the coal, and surface mine spoil. Iron is more commonly present as FeS_2 and sometimes as pyrrhotite (FeS), while manganese occurs as the carbonate rhodochrosite ($MnCO_3$) (Hammer, 1989).

Effluent guidelines established under the federal Clean Water Act (CWA) for the coal mining point source category call for average monthly limits on iron and manganese of 3.5 and 2.0milligrams per liter (mg/l), respectively, with a minimum limit of 6.0 pH units. The EPA found that the toxic metals arsenic, chromium, copper, lead, mercury, nickel, selenium, and zinc were reduced to acceptable levels whenever manganese was reduced to 2.0 mg/l or less (Weideman, 1982).

As can be seen by the following chemistry of pyrite weathering, oxidation, and hydrolysis (Stumm and Morgan, 1996), the process generates large quantities of hydrogen ions, which contribute to low pH.

$$Fe\ S_2(s) + 7/2\ O_2 + H_2O \rightarrow Fe^{2+} + 2SO_4^{2-} + 2H^+ \qquad (1)$$

$$Fe^{2+} + 1/4\ O_2 + H^+ \rightarrow Fe^{3+} + 1/2\ H_2O \qquad (2)$$

$$Fe^{3+} + 3H_2O \rightarrow Fe\ (OH)_3 + 3H^+ \qquad (3)$$

$$Fe\ S_2 + 14\ Fe^{3+} + 8H_2O \rightarrow 15\ Fe^{2+} + 2SO_4^{2-} + 16H^+ \qquad (4)$$

In addition to or in the absence of oxygen from the atmosphere, sulfide mineral oxidation can still take place biologically and can be the principal cause of AMD (Silver, 1989). *Thiobacillus ferrooxidans* are the most common bacteria associated with biological mineral oxidation and accelerate the conversion of ferrous iron to ferric iron. Dissolved Oxygen (DO) in the water or metallic oxides can be the oxidant in situations where oxygen from the air is not present.

Manganese exists in mine drainage as $MnCO_3$ (Mn^{2+}). $MnCO_3$ reacts with the hydrogen ion (H^+) produced from pyritic oxidation, according to the following reaction (Hammer, 1989).

$$MnCO_3 + 2H^+ \rightarrow Mn^{2+} + H_2O + CO_2$$

In the presence of oxygen, Mn^{2+} is oxidized and also produces hydrogen ions (Benifield *et al*., 1982). As greater quantities of iron and manganese are precipitated, the pH is reduced.

If water and oxygen infiltrate through pyrite-bearing material, then some AMD will be produced. The chemistry of the resultant AMD depends on several possible influences: the concentration of FeS_2, the amount of manganese or other metals existing,

the quantity of oxygen, the presence of metal oxidizing bacteria, and the flow of water through the material. Each AMD site must, therefore, be individually characterized by evaluation of the AMD chemistry, site hydrology, topography, and geology prior to designing a method to best treat the acid water.

3.0 Study Authority

The MM-280 Project is being conducted under the authority of Section 1135 of the Water Resources Development Act of 1986 (WRDA 1996), as amended, which provides the authority to modify existing USACE projects to restore the environment and construct new projects to restore areas degraded by USACE projects. The proposed project would be constructed on land within flowage easement of the US Government and owned and managed by the MWCD.

4.0 Purpose and Need for Agency Action

The purpose of the project is to effectively restore the degraded structure, function, and dynamic processes of the Wills Creek Lake aquatic ecosystem, adjacent to the MM-280 outfall, to a less degraded, more natural condition. Approximately 10 acres of aquatic habitat, including riparian, wetland, and embayment, has been impaired from acid mine drainage (AMD) emanating from the MM-280 mine workings. In addition to reducing flood storage from precipitate settling into the lake, the AMD also severely impacts aquatic habitat and recreational angling.

5.0 Prior Studies, Reports, and Existing Projects

The *Wills Creek Linton Township Road Project* report was completed in July 1999 by USACE, Huntington District. This study, also under the authority of Section 1135 of WRDA 1996, recommended treatment of AMD using an aerobic wetland. The project was constructed in partnership with Ohio Department of Natural Resources, and

continues to effectively abate AMD from the Linton Road mine site. The net outcome of this project was restoration of 10 acres of generalized warm-water habitat of Wills Creek Lake. Although the problems the Linton Road project addressed were similar to the issues addressed herein, they are entirely independent and separable.

The *Biological and Water Quality Study of Wills Creek and Selected Tributaries* (Ohio Environmental Protection Agency [EPA], 1995) report concluded the following concerning the current condition of Wills Creek Lake:

- *The pervasive habitat limitations, primarily sedimentation of the substrate, continue to suppress the full biological potential of Wills Creek. The upper 50.0 miles are in non- or partial attainment of the warm water habitat (WWH) ecoregional biocriteria, and this is largely due to a combination of a heavy sediment bedload related to mine drainage and agricultural runoff, low stream gradient and past channel modifications. Full attainment of the biological criteria was observed in the lower 5.0 miles, where improved instream habitat conditions were available.*

A draft report completed by the USACE Huntington District (1991) entitled *Muskingum Basin Water Quality* indicated the following concerning water quality for Wills Creek Lake:

- *Waters entering Wills Creek had remained there for about three days. Thermal stratification is virtually nonexistent, although temperature does decrease with depth. Specific conductance indicates that there are no density layers. The lake at times appears to be more of a river than a lake. There is a noticeable current. The tailwaters mirror the headwaters as well as the lake.*

- *Dissolved Oxygen (DO) concentrations remain fairly constant throughout the water column during the winter months, but decrease as a function of depth during the summer. DO concentrations indicate Wills Creek Lake has the properties of a lake near the dam. Stratification becomes apparent in June and later into September. Using the 5.0 milligrams per liter (mg/l) DO limit to define the epilimnion, about 50 percent of the lake for the first 4.0 miles above the dam is available for fishing. From that point upstream the reservoir resembles a river. DO at the headwaters is good, but has a wide range indicating an intermittent demand. The tailwaters have higher concentrations of DO averaging 8.5 mg/l, but again a wide range is evident, indicating an intermittent demand. There are no long-term trends indicating a change in DO.*

- *Wills Creek is potentially productive as indicated by Chlorophyll A concentrations, which is limited by the short residence time. Nutrients are phosphorous-limited, but phosphorous is above laboratory detection limits in the lake. The reservoir near the dam releases nutrients from the lakebed, which extend through the epilimnion since there is no thermocline to stop the mixing. The tailwaters mirror the lake surface as expected from a surface-level release.*

- *The pH at Wills Creek is always between 7.0 and 8.0 units. The tailwaters mirror the headwaters as expected. Long-term trends indicate no apparent change in pH in the watershed. Alkalinity, an indicator of buffer capacity, is sufficient for the watershed, with numbers exceeding 50 mg/l calcium carbonate ($CaCO_3$). There are no indications of a long-term pattern. Hardness levels are high and are increasing. The watershed is classified as very hard. The increase in hardness parallels an increase in total solids, which is not unexpected since the watershed is changing from farming activities to mining activities. The increase in total solids is*

causing an increase in dissolved solids as verified by higher specific conductance readings. Another indicator of the change is sulfate concentrations which are around 200 mg/l, which are expected from a watershed that used to be farming and is now active in strip coal mining.

- *Iron at Wills Creek typically exceeds the standard of 1 mg/l and it is not uncommon for iron to exceed 2 mg/l. Iron is high in the surrounding areas as well as in the headwaters. One of many marshes adjacent to the reservoir was found to have iron exceeding 100 mg/l. It was also high in aluminum, antimony, zinc, manganese, nickel, sulfate, and sodium as well as iron. Long-term trends indicate no change in iron concentrations in the watershed over the past 13 years. Iron is considered high enough to affect fish populations.*

- *Manganese in Wills Creek has increased considerably over the past 13-year period. Historical data indicates manganese was below 0.5 mg/l in the headwaters and increased slightly in the tailwaters, but it remained below the 1.0-mg/l standard. More recent data indicates manganese exceeds 0.5 mg/l and at times exceeds 1.0 mg/l in the headwaters. The higher concentrations are carried through to the tailwaters, but with a slight reduction. Manganese concentrations are considered high enough to have an effect on fish populations.*

- *There are cation$^{(+)}$ and anion$^{(-)}$ imbalances. The water is classified as calcium sulfate, which is not unexpected from a watershed with mining.*

In addition, a water quality study was conducted in February 2004 to determine the dissolved oxygen (DO) content of the MM-280 mine pool. This study involved the installation of a gas trap to the mine discharge to inhibit the introduction of ambient outside air from entering the mine. This technique served to allow a better representation

of actual DO within the mine pool. Successive DO measurements were analyzed over a period of several weeks to allow the effects of the gas trap to initiate. Once equilibrium was obtained within the mine pool, the study was halted and the data was analyzed. In general, the data indicates a stable temperature and pH regime within the mine pool, and confirmed the presence of low DO within the mine pool as well.

6.0 Plan Formulation

6.1 Existing Conditions

In 1989, a new mine seal and two discharge pipes were installed to collect AMD from the MM-280 mine and direct the discharge to an open drainage course. The new mine seal and discharge pipes were constructed subsequent to a major mine blowout in which Tyson Road was damaged and serious environmental degradation occurred resulting from AMD precipitate. This mine seal consists of two layers of concrete block covered with Gunite® on both sides of the block. The discharge pipes are 18-inch diameter polyethylene pipe, each approximately 90 feet long from the mine seals to the concrete discharge headwall. AMD from the pipe outfalls discharges into an open single channel that flows into various braided channels and ultimately into a ponded embayment where significant deposition of AMD precipitates have and are continuing to accumulate. Water flows from the embayment through a final open channel to its entrance into Wills Creek Reservoir, approximately 0.2 mile from the pipe outfalls. **Appendix A** contains photographs of the project area.

Sampling and analysis of water discharged from MM-280 was performed several times. Objectives of the discharge water sampling were to: (1) characterize the water discharging from the MM-280 outfall, (2) supplement and support existing water quality data, (3) test potential treatment options, and (4) estimate possible sediment loads that would occur in a settling pond as a result of treatment.

Water quality data is available from five sampling events: 1995; Fall 1999 and Spring 2000; September 8, 2003; February 2004; and June 26, 2007 and July 26, 2007. Details of the above events are outlined below, with a discussion of the results to follow in Section 6.1.1.

- **1995** – Four water quality samples were collected by ODNR of the discharge water in 1995, one each in May, August, September, and October. A copy of the ODNR memorandum summarizing the sampling data is included in **Appendix B** and the laboratory results are discussed in the following section. No narrative is supplied in the memorandum (Socotch, 2002) as to the method of sample collection during the 1995 sampling event. Flow rate was not collected during that sampling event.

- **Fall 1999 and Spring 2000** – The ODNR Division of Mineral Resources Management (DMRM) collected water quality samples from the MM-280 outfall in the Fall of 1999 and in the Spring of 2000. An ISCO continuous water sampler was installed slightly downstream of the outflow pipe to MM-280 in September 1999. The ISCO sampler was able to hold up to 24, 500-milliliter (ml) polyethylene bottles, and included an YSI Multiprobe for collection of field parameters, which consisted of DO, pH, conductivity, and temperature measurements. According to the ODNR DMRM memorandum (Socotch, 2002), the system was also designed to include Flowlink software for measurements and calculations and a Plasti-Fab V-trapezoidal flume for flows. Problems with the flume and flow meter were encountered at the beginning of the sampling event (September 1999), so flow measurements were not available for all collection events.

  Two to three samples per day were collected from early September 1999 through November 21, 1999. The flow meter and probe were temporarily

removed at the end of November until the following spring, due to fear of vandalism during deer hunting season, and possible damage due to the cold winter temperatures. Once sampling was resumed April 11, 2000, only one sample per day was collected. As with the fall sampling event, the samples were collected with the ISCO continuous sampler.

Approximately 160 water quality samples were collected during the 1999 to 2000 sampling event.

- **September 8, 2003** – A Burgess & Niple, Inc. (B&N) representative visited the site on September 8, 2003 to collect water samples from the MM-280 outfall. Water discharging from the outfall was collected directly from the west pipe and submitted to American Analytical Laboratories, Inc. (AAL) of Columbus, Ohio for analysis of total alkalinity, acidity, sulfate, pH, iron, manganese, aluminum, calcium, and magnesium content.

  Additionally, approximately five gallons of water was also collected for informal bench tests. The water was collected in five separate disposable plastic one-gallon containers. In the field, approximately 600 ml of water was then slowly transferred into 14 separate one-quart Mason® jars, so as to reduce potential aeration of the water. One jar was designated as a control sample and had no additives or agitation applied. The second jar was vigorously shaken for approximately 45 seconds to aerate the water; it had no additives mixed into the water. The remaining jars were subjected to various additions of Mississippi lime or a three percent hydrogen peroxide solution. In addition, some jars were vigorously agitated (shaken with lids on) and some were gently stirred to just mix in the additives to allow comparison of the two levels of aeration. **Table 1.0** lists the combinations of additives and agitation.

Table 1.0

September 2003 Bench Scale Treatment Alternatives

Jar No.	Treatment Description
1	Control – no additives or agitation
2	Agitate only
3	1 teaspoon lime + agitation
4	1 teaspoon lime, no agitation
5	1 tablespoon lime + agitation
6	1 tablespoon lime, no agitation
7	1 teaspoon hydrogen peroxide + agitation
8	1 teaspoon hydrogen peroxide, no agitation
9	1 tablespoon hydrogen peroxide + agitation
10	1 tablespoon hydrogen peroxide, no agitation
11	2 tablespoons lime + agitation
12	2 tablespoons lime, no agitation
13	2 tablespoons hydrogen peroxide + agitation
14	2 tablespoons hydrogen peroxide, no agitation

The sample jars were left undisturbed for the next hour at the mine site. Changes were noted every 15 minutes. The jars were then returned to B&N for continuing observation over the next several days. When the samples appeared to have stopped reacting, samples were collected from four of the jars using disposable syringes, and placed in the appropriate preserved and unpreserved laboratory bottles. Samples were submitted to AAL and analyzed for the same constituents as the original raw water sample collected on September 8, 2003.

- **February 2004** – In February 2004, the outfall pipe was cleaned and a trap was installed at the discharge end of the west pipe, while the east pipe was plugged with sediment and was left in this condition. The discharge pipe was initially cleaned of all precipitate buildup by Enviro-Flow of Zanesville, Ohio on February 3, 2004. Once the pipe was cleaned, Thompson Mining of Zanesville, Ohio modified the discharge pipe by adding a trap to the pipe on February 11, 2004. The purpose of the modified outfall was to eliminate the pathway for oxygen to enter the discharge pipe and therefore eliminate the potential of aerating the mine discharge. Samples from the discharge of the modified outfall were considered to better represent the quality of water inside the mine before it has the chance to be aerated from oxygen that would otherwise enter the pipe.

  Immediately following the "gas trap" installation on February 11, 2004, field parameters (pH, DO, and temperature) were measured and recorded. Subsequent sampling of the gas trap outflow was completed on February 17, 19, 23, and 26, 2004. For these four events, field parameters were measured and a sample was submitted each day to the ODNR Cambridge, Ohio laboratory for analysis of AMD parameters. Samples were collected from the modified outflow to determine the actual DO value of the discharge water as it exits the mine without being artificially oxygenated by air exiting the mine through the discharge pipe.

  In addition, on February 11, 2004, nine samples of spoil pile material were collected and submitted to Sturm Environmental Services of Bridgeport, West Virginia for acid-base accounting (ABA) analysis. Three locations were sampled and were identified as TP1, TP2, and TP3. At each location, samples were collected at three depths: (1) from the top foot of material, (2) from a depth of about 4 to 6 feet, and (3) from a depth of 6 to

8 feet. Pits were excavated using a backhoe, samples were collected from the backhoe bucket, and the pits were refilled at the conclusion of sampling. TP1 and TP2 were near the northeast and northwest sections of the spoil pile, respectively. TP3 was from the south-central area of the spoil pile.

- **June 26, 2007 and July 26, 2007 -**Four water samples were collected on each day from the following four sample locations: (1) discharge pipe, (2) downstream at the weir, (3) mid stream, and (4) embayment. Each sample was analyzed for AMD analytes. In addition, field readings, DO, pH, and ferrous iron were collected on July 26, 2007 at each sampling location. These sampling events were completed to determine special effects on iron concentrations and speciation, as well as pH levels, as the discharge water flows toward the lake and generate DO and undergo hydrolysis.

6.1.1 Sampling Results

1995 - ODNR's May 2002 Memorandum (Socotch, 2002) summarizes the laboratory analysis data from the four MM-280 discharge samples collected in 1995. **Table 2-2** provides that data.

Table 2-2

1995 Analytical Data Summary

Parameter	Date				
	5/22/95	**8/1/95**	**9/1/95**	**10/4/95**	**Average**
pH (S.U.)	4.7	5.3	3.1	4.4	4.3
Acidity (as $CaCO_3$)	522	1,043	344	395	576
Alkalinity (as $CaCO_3$)	-0-	-0-	-0-	-0-	-0-
Cond (umhos/cm)	2,540	2,900	2,620	2,890	2,737
Total Dissolved Solids (TDS) (mg/l)	2,584	2,852	2,765	2,788	2,747
Sulfate (SO^4) (mg/l)	1,267	1,672	1,355	1,690	1,496
Chloride (Cl) (mg/l)	9	10	46	13	19.5
Total Calcium (mg/l)	179	240	202	260	220
Total Magnesium (mg/l)	46.2	52	55	58	53
Total Sodium (mg/l)	176.5	280	230	230	229
Total Potassium (mg/l)	19.8	16.9	12.7	17.5	16.7
Total Iron (mg/l)	35.1	290	204	289	204
Total Manganese(mg/l)	3.77	3.86	3.02	4.25	3.72
Total Aluminum (mg/l)	8.8	3.92	0.4	7.76	5.2
Hardness (mg/l)	733	758	669	893	763

umhos/cm- micronhos.centimeter S.U. – Standard Units

- **Fall 1999 and Spring 2000** - Flow data from the Fall 1999 and Spring 2000 sampling event was an integral part in determining potential AMD treatment options. Field-measured data from the field monitoring

equipment installed by ODNR is summarized in **Table 2-3. Table 2-4** summarizes the results of the laboratory analyses of these samples, as provided in ODNR's May 20, 2002 memorandum.

Table 2-3

1999-2000 Field Measured Data Summary

Item	Flow Rate (gpm)	pH (S.U.)	DO (mg/l)	Cond. (mS/cm)	Temp. (° F)
Maximum	460	6.4	20	2.98	54.7
Average	69	5.8	3.9	2.71	53.9
Minimum	8	4.3	0	2.14	52.3
Standard Deviation	53.07	0.62	5.1	0.20	0.53
Average + 1 Std. Dev.	122	6.4	9.0	2.90	54.4
Average + 2 Std. Dev.	175	7.0	14.1	3.10	55.0

gpm - gallons per minute
S.U. - Standard Units
° F – degree Fahrenheit
mS/cm – microSiemens/cm = micromhos/cm

Table 2-4
1999-2000 Laboratory Data Summary

	Monthly Average				
Parameter	**Sept/Oct**	Nov	**Apr/May**	**Jun/Jul**	**Average**
pH (S.U.)	5.8	5.7	4.1	3.9	4.8
Acidity (as $CaCO_3$)	395	419	410	368	398
Alkalinity (as $CaCO_3$)	-0-	-0-	-0-	-0-	-0-
Conductivity (umhos/cm)	2,475	2,500	2,460	2,485	2,480
Sulfate (SO4) (mg/l)	1,715	1,705	1,580	1,505	1,626
Total Sodium (mg/l)	230	230	182	185	229
Total Iron (mg/l)	257	255	224	172	207
Total Manganese (mg/l)	3.7	3.8	3.5	3.0	3.5
Total Aluminum (mg/l)	3.7	3.5	3.1	2.0	3.1

Results indicate that field and laboratory parameters are fairly consistent between the 1995 and 1999/2000 sampling events with the exception of acidity, which was lower in 1999/2000 than it was in 1995.

The 1999/2000 monitoring flow rates from MM-280 were found to be highly variable, with a minimum of 8 gallons per minute (gpm), a maximum of 460 gpm, and an average discharge rate of 69 gpm. Flow rates can vary from rates below 50 gpm to well over 200 gpm in a time period of only a few hours. This variability in flow rate may result from interconnection of MM-280 to other nearby abandoned mines that allow high water in adjacent mines to flow into MM-280 during high water periods in the mines. Based on the 5 months of flow data available, it appears that flows from MM-280 in the spring may be in the range of 150 to 200 gpm for several days at a time. Flows for the remainder of the year appear to generally be at or less than the average flow of 69 gpm, with frequent, short-term flows that exceed that amount.

- **September 8, 2003** - Based on results from the bench analysis procedures identified in **Table 2-1**, five water samples were submitted to the laboratory in September 8, 2003 for analysis, specifically: (J1) raw water immediately after sample collection, (J2) raw water with agitation, (J7) water with 1 teaspoon of hydrogen peroxide and agitation, (J3) water with 1 teaspoon of lime and agitation, and (J11) water with 2 tablespoons of lime and agitation. Results of the laboratory analysis are summarized in **Table 2-5**.

Table 2-5
September 8, 2003 Bench Scale Test Results

Description	Right Outlet Pipe (J1)	Jar 2	Jar 7	Jar 3	Jar 11
Total Alkalinity (mg/l)	<1	<1	<1	236	530
Acidity (mg/l)	360	350	310	<1	<1
Sulfate (mg/l)	1,000	1,300	1,300	966	1,000
pH (S.U.)	5.68	3.71	3.02	11.54	11.84
Iron (mg/l)	219	139	39	<0.03	0.054
Manganese (mg/l)	2.19	2.21	2.17	<0.02	<0.02
Aluminum (mg/l)	1.9	0.934	1.8	<0.05	<0.05
Calcium (mg/l)	196	194	195	323	457
Magnesium (mg/l)	42.5	40.5	40.3	2.52	0.29

Analytical results from the raw water sample collected on September 8, 2003 indicate the analytical parameters are still relatively consistent with those taken in previous sampling events, except for pH that increased and acidity and sulfate which both decreased. These changes may result from long-term changes that occur naturally as continued weathering of the acid-forming minerals occurs over time.

Bench scale tests reveal several results that assist in evaluating potential remedial measures, specifically:

Jar 2: With just agitation of the water and no addition of lime or hydrogen peroxide, total alkalinity, acidity, manganese, calcium, and magnesium stay fairly consistent with the raw water results. However, sulfate concentrations increase slightly from 1,000 mg/l to 1,300 mg/l, pH decreases from 5.68 S.U. to 3.71 S.U., iron decreases from 219 mg/l to 139 mg/l, and aluminum concentrations decrease from 1.9 mg/l to 0.934 mg/l.

Jar 7: Results of the addition of 1 teaspoon of hydrogen peroxide to agitated water had similar results to that of just the agitated water. However, pH further decreased to 3.02 S.U. and iron decreased to 39 mg/l. This result indicates the additional positive effect that a strong oxidizing agent will have in precipitating iron from MM-280 discharge water.

Jar 3: The addition of lime to water followed by agitation had the most significant effects on the AMD. With the addition of 1 teaspoon of lime, total alkalinity increased from non-detect (<1 mg/l) to 236 mg/l; acidity decreased from 360 mg/l to non-detect (<1 mg/l), and pH increased from 5.68 S.U. in the water collected directly from the outlet pipe to 11.54 S.U. Sulfate concentrations decreased slightly, from 1,000 mg/l to 966 mg/l. Iron, manganese, and aluminum concentrations were all below detection limits (<0.03 mg/l, <0.02 mg/l, and <0.05 mg/l, respectively) in the treated water. Magnesium concentrations decreased from 42.5 mg/l to 2.52 mg/l; and the calcium concentrations increased from 196 mg/l to 323 mg/l. Compared to the hydrogen peroxide addition, this treatment method was more effective in removing iron, along with other metals, but resulted in excessive pH adjustment.

Jar 11: With the addition of two tablespoons of lime to agitated water, total alkalinity continued to increase (530 mg/l) from the raw water result (<1 mg/l), and acidity, manganese, and aluminum were all below detection limits, and iron was near its detection limit. The pH was similar to the previous addition of lime at 11.84 S.U., magnesium continued to decrease (0.29 mg/l), and calcium continued to increase (457 mg/l). As was the case for the previous lime addition alternative, this alternative was very effective in removing all metals from the AMD; however, pH adjustment was excessive.

Along with the analytical results, observations of floc accumulation in each of the jars were noted over the course of 5 days prior to the collection of samples for water quality analysis. At the end of 5 days, little precipitate had accumulated in Jar 2 that had only been agitated. Approximately 1.5 centimeter (cm) of floc was measured after 5 days in the Jar 7 where one teaspoon of lime had been added and the sample agitated. At the end of 5 days, a 0.5 cm of floc was measured in the Jar 3 in which one teaspoon of hydrogen peroxide had been added; and 1 cm of floc was measured in the Jar 11 in which two tablespoons of lime had been added. Both jars had been agitated after the addition of each compound.

- **February 2004** – Following installation of the gas trap on February 11, 2004, water discharge from the gas trap was sampled. On February 11, only field parameters of pH, DO, and temperature were measured. On February 17, 19, 23, and 26, a B&N Environmental Scientist returned to the site to measure field parameters of pH, DO, temperature, and oxidation-reduction potential (ORP), and to collect one sample per day for laboratory analysis of AMD parameters. The samples were submitted to ODNR's laboratory in Cambridge, Ohio for analysis. Results of the field and laboratory analyses are summarized below in **Table 2-6.**

Table 2-6
February 2004 Field Sampling Data Results

	Install	JC 01	JC 02	JC 03	JC 04
	2/11/2004	2/17/2004	2/19/2004	2/23/2004	2/26/2004
FIELD ANALYSIS RESULTS					
Dissolved Oxygen (DO) (mg/l)	3.70	1.92	1.33	0.95	0.15
pH (S.U.)	5.60	5.64	5.66	5.49	5.60
Temperature (deg. C)	12.3	12.2	12.3	12.5	12.5
Oxidation-Reduction Potential (ORP) (mv)	***	21	56	76	-17
LABORATORY RESULTS					
Acidity (mg/l)	--	354	315	294	368
Alkalinity (mg/l)	--	8.55	19.40	7.17	14.9
Conductivity (mS/cm)	--	1,870	2,020	1,900	2,120
Total Dissolved Solids (TDS) (mg/l)	--	1,670	1,800	1,650	1,880
Total Suspended Solids (TSS) (mg/l)	--	17	21	19	18
Total Solids (TS) (mg/l)	--	1,687	1,821	1,669	1,898
Sulfate (mg/l)	--	1,078	1,185	1,037	1,202
Chloride (mg/l)	--	7.55	8.82	7.82	8.92
Calcium (mg/l)	--	160	176	155	178
Magnesium (mg/l)	--	43.4	43.4	43	44.3
Sodium (mg/l)	--	117	146	112	145
Potassium (mg/l)	--	9.03	10.00	9.70	10.3
Iron, Total (mg/l)	--	162	178	155	184
Ferrous Iron (mg/l)	--	104	126	113	160
Ferric Iron (mg/l)	--	58	52	42	24
Manganese (mg/l)	--	2.72	2.91	3.03	2.97
Aluminum (mg/l)	--	4.37	3.16	4.34	3.24
Hardness as $CaCO_3$ (mg/l)	--	578	618	563	627

***ORP not analyzed on install date
Field sampling and analysis by B&N
Laboratory analysis by ODNR's Cambridge Environmental Laboratory.

The field data show relatively consistent pH and temperature measurements throughout the series of monitoring events. DO decreased consistently for the five monitoring events, beginning with a measured value of 3.70 mg/l and ending with a value of 0.15 mg/l. This decrease in DO is consistent with the hypothesis that the water in the mine is anoxic,

but the higher DO level previously measured from the mine discharge resulted from oxygenation through the open end of the discharge pipe. The gas trap effectively sealed the end of the discharge pipe, preventing oxygen from being introduced into the mine pool.

ORP varied during the course of the monitoring events, beginning at 21 millivolts (mv), increasing to 76 mv, and finally decreasing to –17 mv for the final monitoring date, corresponding to the lowest DO value. The negative ORP value is consistent with the very low DO for the final monitoring date because the lack of oxygen would place the water in a reducing state.

The laboratory analysis data show that total iron ranged from 155 mg/l to 184 mg/l. Ferrous iron (Fe^{+2}) accounted for 64 percent to 87 percent of the total iron, which is consistent with the relatively low DO values. In addition, the final day's result of 87 percent ferrous iron occurred on the day when DO was at its lowest level (0.15 mg/l) and ORP had a negative value (-17 mv). The high percentages of ferrous iron (greater than 60 percent) existed for the entire period of sampling, suggesting that anoxic conditions exist in the mine.

Acidity ranged from 294 mg/l to 368 mg/l, which is considered a moderate to moderately high range. Acidity is contributed by ferrous and ferric iron, aluminum, manganese, and pH. Ferrous iron is the primary contributor of acidity in the MM-280 discharge, accounting for approximately 50 to 77 percent of the total acidity. Ferric iron accounts for approximately 17 to 42 percent of the total acidity, with total acidity from both iron forms accounting for 92 to 94 percent of total acidity. The remaining total acidity comes from aluminum, manganese, and pH contributions.

Some alkalinity is present, ranging from 7.17 mg/l to 19.4 mg/l, indicating the discharge water has some buffering capacity. The existence of buffering capacity is supported by the slightly acidic pH values (around 5.6 S.U.) along with the presence of both calcium and magnesium.

While some manganese and aluminum were reported, their concentrations were relatively constant and are not significantly high.

6.1.2 Spoil Pile Acid Base Accounting (ABA)

The ABA conducted on spoil show that all samples, except TP2 at 1 foot and TP2 at 4 to 6 feet, need additional buffering through lime addition for neutralization and sustaining plant growth. TP2 at 1 foot and TP2 at 4 to 6 feet both have excess neutralization potential, as demonstrated by their slight to moderate results from the fizz test and also by their excess $CaCO_3$ reported for pyritic sulfur analyses.

- **June and July 2007-** The June and July 2007 data appears very similar to the February 2004 data; however, as expected, the water appears to exhibit an increase in DO and appears to begin oxidizing to ferric iron rather rapidly. Retention time appears to be the driving factor in allowing the ferric iron to convert. The flowing stream channel does not appear to allow sufficient time for the ferric iron to completely oxidize and precipitate as ferric hydroxide. In addition, there appears to be some alkaline buffering occurring, given the pH does not appear to decrease significantly through hydrolysis of the iron as anticipated. The pH at the embayment, furthest downstream, actually exhibits a slight increase from the discharge pH. The raw data values are expressed below in **Table 2-7**.

Table 2-7
June and July 2007 Results

FIELD/LAB ANALYSIS RESULTS	Pipe 6/26	Weir 6/26	Mid 6/26	Embayment 6/27	Pipe 7/26	Weir 7/26	Mid 7/26	Embayment 7/26
Dissolved Oxygen (DO) (mg/l) (Field)					2.15	9.76	9.74	9.34
pH (S.U.)	5.71	6.30	6.12	6.01	5.54	6.03	5.91	5.9
Acidity (mg/l)	231	206	224	211	237	215	213	217
Alkalinity (mg/l)	70.3	29.60	12.30	7.76	55.7	36.8	13.6	9.4
Conductivity (mS/cm)	2350	2280	2220	2270	2180	2140	2140	2160
Total Dissolved Solids (TDS) (mg/l)	1820	1790	1760	1730	1900	1950	1910	1920
Total Suspended Solids (TSS) (mg/l)	13.0	54	33	59	4	39	40	20
Total Solids (TS) (mg/l)	1833	1844	1793	1789	1904	1989	1950	1940
Sulfate (mg/l)	1140	1142	1145	1128	1196	1225	1205	1223
Chloride (mg/l)	9.9	8.9	10.6	8.5	7.43	7.6	7.46	7.32
Calcium (mg/l)	188	191	189	188	196	199	204	206
Magnesium (mg/l)	41.4	42.4	42.6	43.3	44.6	44.7	44.4	45.7
Sodium (mg/l)	162	162	165	161	177	183	183	182
Potassium (mg/l)	10.4	10.4	10.5	10.4	11	11	11.1	11
Iron, Total (mg/l)	153	144	127	121	172	162	141	136
Ferrous Iron (mg/l) (LAB)	117	119	102	96	161	145	130	118
Ferrous Iron (mg/l) (Field)	--	--	--	--	75	50	37.5	37.5
Ferric Iron (mg/l) (Lab)	36.0	25.0	25.0	25.0	11	17	11	18
Ferric Iron (mg/l) (Field)	--	--	--	--	97	112	103.5	98.5
Manganese (mg/l)	2.5	2.6	2.6	2.6	2.76	2.75	2.75	2.79
Aluminum (mg/l)	1.6	1.5	1.6	1.7	1.92	1.35	1.06	1.18
Hardness as CaCO3 (mg/l)	640	651	647	648	673	681	692	703

Field sampling and analysis by B&N
Laboratory analysis by ODNR's Cambridge Environmental Laboratory.

To summarize surface water sample results are evaluated in terms of their impacts to Wills Creek Lake. Impacts to Wills Creek Lake are defined according to their net acidity or alkalinity:

- Very acid – net acidity >300 mg/l
- Moderately acid – 100 mg/l ≤ net acidity ≤ 300 mg/l
- Weakly acid – 0 mg/l ≤ net acidity < 100 mg/l
- Weakly alkaline – net alkalinity < 80 mg/l
- Strongly alkaline – net alkalinity > 80 mg/l.

According to **Tables 2-2 through 2-6**, acidity generally ranged from 300 mg/l to over 1,000 mg/l with an average acidity of 430 mg/l. Based on these results, discharge from MM-280 to Wills Creek Lake would be considered very acid. However; the newer 2007 data, Table 2-7, indicates acidity near 200 mg/l, which would be considered moderately acid.

Alkalinity was reported from 0 mg/l to a maximum of 19.4 mg/l, consequently the MM-280 discharge is considered to be very weakly alkaline.

Total manganese averaged 3.3 mg/l; total aluminum averaged 3.9 mg/l; and pH averaged 5.0 S.U.

6.2 Future Without Project Condition

The without project condition is defined as the most likely condition expected to exist in the future in the absence of a project to remediate AMD degradation of the aquatic environment of Wills Creek Lake and adjacent terrestrial habitat. Absent the proposed action, the habitats within the MM-280 area and downstream in Wills Creek

Lake would continue to degrade and sediment would continue to slowly accumulate in the lake thus decreasing overall habitat quantity and quality. In place of open water, shallow sediment beds of metal precipitates will continue to increase and extend downstream to areas not currently impacted. As current processes continue unabated, biotic processes in the MM-280 area would eventually decline to a point at which the current, limited conditions, for survival and reproduction of terrestrial and aquatic life, would cease to exist. Under these conditions, the flows from MM-280 would form narrow, braided channels in the area that is now open lake. In addition, the area of the abandoned spoil pile would continue to exhibit a "moonscape" type appearance and would not allow vegetation to establish, due to the limited depth of soils and the low pH of those limited soils. However impacts to the aquatic environment from the spoil pile appear to be minimal compared to the MM-280 discharge. The progression of sedimentation and loss of open water habitat would likely take years to occur. A reference of what the lake area around MM-280 would eventually replicate is depicted in the view of the upland area around the discharge, as seen from the Tyson Road photograph on the cover of this report.

6.3 Planning Constraints

This report considers all practicable treatments for meeting the project goal - *to effectively restore the degraded structure, function, and dynamic processes of the Wills Creek Lake aquatic ecosystem, adjacent to the MM-280 outfall, to a less degraded, more natural condition.*

The following constraints were applied to formulation of alternatives:

- Alternative plans must provide for improvement of the aquatic ecosystem of Wills Creek Lake or adjacent habitats.
- Alternative plans must be formulated using USACE planning guidance.
- Alternative plans must be formulated to minimize operation and maintenance costs.

- Non-federal sponsor must have capability of sharing 25 percent of total project cost, providing all Lands Easements, Rights-of-Way, and Relocations (LERRD), and assuming all operation and maintenance cost and responsibility.

The planning objective is defined by the aforementioned project purpose and constraints. The objective of the project is to provide habitat restoration outputs consisting of restoration of 0.8 acres of wetland completely destroyed from AMD precipitates, restoration of 6.2 acres of wetland impacted from AMD and runoff of the gob pile, and enhancement of an embayment of Wills Creek Lake comprising approximately 1.5 acres of generalized warm water lake habitat, using a cost-effective approach and within the planning constraints.

6.4 Alternative plans

The purpose of the MM280 project is to restore approximately 8.5 acres including riparian, wetland, and embayment. To accomplish this, impacts from AMD must be abated. Dissolved metals and acidity have been identified as the major constituents of AMD from the site. In order to remove dissolved metals, pH needs to be maintained at a minimum of at least 3.5 units. Once this pH level is maintained, the water needs to be aerated and retained long enough to allow for the metals to oxidize and precipitate.

Since the development of the initial Section 1135 Preliminary Restoration Plan (PRP), several alternative measures to restore and preserve the immediate open water aquatic and terrestrial habitat around MM-280 were considered. This section of the report examines the alternatives that are reasonably available to improve the physical, and to a lesser degree, the chemical conditions of the MM-280 site and Wills Creek Lake, based on information obtained during field investigations and data from prior studies. Although numerous other means to abate AMD exist, the following alternatives are considered the most viable restoration methods for the site based on the chemical and physical properties of the discharge. Alternative measures are presented for abating the

mine's discharge only All of the alternative measures initially considered during the plan formulation process are described below.

6.4.1 Ecosystem Restoration Treatment Measures

Projected habitat restoration outputs consist of approximately 10 acres aquatic habitat, including riparian, wetland, and embayment, as well as four acres of terrestrial or upland habitat. To accomplish this goal, several alternative measures are available. With respect to treating the flows of the mine discharge, the following alternative measures are initially considered: **1) Anoxic Limestone Drains; 2) Mine Inundation; 3) Steel Slag Leach Beds; and 4) Wetlands**. Each of these measures would require a settling pond for retention of metals precipitate. These alternative measures and the screening process are discussed below.

6.4.2 Initial Screening of Alternative Measures

The aforementioned measures to treat AMD were initially considered prior to characterization of the existing environment from water sampling, as described in Section 6.1 *Existing Conditions*. The initial screening of alternative measures was made based on these sampling results.

AMD Treatment

Anoxic Limestone Drains (ALD) are trenches of buried limestone into which acid water is diverted. With limestone dissolution, the net result is an increase in water pH and alkalinity. There are many water quality parameters that must be accounted for if an ALD is to add alkalinity for long time periods, including flow rate, DO content (<1 or 2 mg/l), acidity and alkalinity, ferric and ferrous iron concentrations, and aluminum concentrations (Skousen, 1995). If the parameters are all within specified ranges, an ALD should function properly (Hedin and Nairn, 1992). Once pH of the AMD has been

raised and upon exiting the ALD, the water is aerated and metal oxidation, hydrolysis, and precipitation can proceed in an aerobic pond or wetland. However, if certain parameters (for example, oxidation state) are not maintained within specified ranges, the ALD may clog with flocculent metals precipitate or suspended solids and the limestone may become coated with oxidized metals precipitate (armored) and therefore not fully function as intended. In addition, varied flow rates may not provide enough residence time to impart alkalinity or increase pH sufficiently to become effective treatment systems. Because of the extremely varied flows measured at the MM-280 outfall, ALDs were not considered an effective alternative measure. The frequent 300 gpm flow rates measured at the discharge would not provide enough residence time for the effluent to be adequately treated prior to entering the sedimentation pond and wetland cell, which has the potential for overwhelming the wetland and rendering it inoperable. The associated costs of maintenance on the wetland would also be too great if this scenario occurs. In addition, if the ALD is designed to handle high flow rates, the lower flow rates that occur would allow for sediment deposition within the ALD thereby increasing the possibility of clogging and a consequently a "blowout" when higher flows return. Therefore, ALDs were dropped from further consideration.

Mine Inundation. Flooding, or complete inundation, of underground mine works liberates alkalinity existing in strata overlying the mine by increasing the volume of saturated strata in contact with mine water and by increasing the residence time of the water so that geochemical equilibrium can be attained. Further, complete mine inundation through effective sealing can improve water quality by reducing air contact with pyritic material. The principal drawback to inundation treatments is the potential for mine blowouts. The size and nature of the underground MM-280 mine complex is not well understood; therefore, the possibility of a reoccurrence of a mine blow-out could result from sealing and flooding of the mine workings. Because of this and the potential to endanger the public and environmental resources this alternative measure was eliminated from detailed consideration.

Slag Leach Beds. Directing non-impacted water through a constructed slag leach bed will increase the alkalinity of the water. This alkaline water can then be combined with AMD to raise the pH of the AMD, thereby facilitating precipitation of metal either in a settling pond or wetland. This alternative requires a source of "clean" water in sufficient and consistent supply to allow effective AMD treatment. Steel slag leach beds were not considered a viable alternative measure because of the lack of a sufficient and sustainable supply of non-impacted water. Therefore, this alternative was dismissed from detailed consideration.

Wetlands. Both aerobic and anaerobic wetlands were considered, as follows:

Aerobic wetlands treat AMD by the adsorption of metals to organic materials and by providing residence time of the water, which allows for precipitation of metals that have been oxidized or reduced by microbial reactions in the wetland. Anaerobic wetlands are constructed by placing a layer of limestone or other alkaline material in the bottom of the wetland and covering with a layer of organic material. Wetlands may be inoculated with soil from a functioning wetland to accelerate microbial function. Wetland species would be seeded and/or transplanted into the organic substrate. Wetlands are used when water has net acidity.

Aerobic wetlands treat AMD by the adsorption of metals to organic materials and by providing residence time of the water, which allows for precipitation of metals that have been oxidized or reduced by microbial reactions in the wetland. The discharge from the wetlands would have net alkalinity and therefore metals would precipitate, typically in a settling pond, before entering the downstream environment. Wetland species are planted in these systems for aesthetics and to add some organic matter, but the organic matter is not necessary to the function of the system. Aerobic wetlands offer the advantage of operational reliability while requiring minimal operational control. Aerobic wetlands would be effective to treat the AMD from the MM-280 and were carried forward for detailed consideration in formulation of final plans.

Anaerobic wetlands are typically used in conjunction with anoxic limestone drains or other systems with low dissolved oxygen (< 2 mg/l). Because the AMD does not have consistently low dissolved oxygen, and that aerobic wetlands are less costly to construct than anaerobic wetlands and would meet the goals of the project, anaerobic wetlands were eliminated from further consideration.

Summary of Initial Screening of Alternative Measures

Only one alternative measure to address AMD was deemed appropriate to carry forward through for detailed consideration. **Table 6-1** summarizes this screening process of alternative measures.

Table 6-1
Initial Screening of Available Alternative Measures

Alternative Measure	**Effectiveness**	**Disposition**
	AMD Treatment	
Anoxic Limestone Drains	Dissolved oxygen too high. Metal may clog ALD.	Dismissed
Mine Inundation	Uncertainties with mine pool. Danger of mine blow-out.	Dismissed
Slag Leach Beds.	Lack of certain required "clean" water supply.	Dismissed
Wetlands		
Aerobic Wetlands	Would add necessary alkalinity.	**Retained**
Anaerobic Wetlands	More costly, greater operation and maintenance than aerobic wetlands.	Dismissed

6.5 Alternative Plans

Based on alternative measures available that would best address the project objectives, only one was identified. The proposed action would use aerobic wetlands along with the requisite settling pond. In addition to this alternative, the No Action alternative was also evaluated.

6.5.1 Alternative 1 - No Action

Under the No Action alternative, federal and cost-shared funds would not be expended to address the AMD discharges and impacts associated with the spoil pile on Will's Creek Lake.

6.5.2 Alternative 2 – Sedimentation Ponds/Wetland Treatment Cells

Under Alternative 2, a settling pond would be used to provide residence time for dissolved metals from metal hydroxide precipitates; therefore, promoting consolidation of small particles into larger particles and settling via gravitational forces. The resulting, less dense material (water) would be allowed to flow out of the settling pond. Wetlands would then be used to collect water from the settling pond to polish the water prior to its discharge to Wills Creek Lake, and impart additional alkalinity from natural chemical functions. Hydrophytic vegetation would be planted in the wetland system for aesthetics and to add some organic matter to assist in the biological sulfate reduction. In addition Alternative 2 would entail the following elements:

- Conversion of the existing and temporary mine adit seal and discharge pipes to a permanent structure to keep anoxic conditions within the mine pool.
- Re-grading and limestone lining of open channel(s) from the discharge pipe outlet to the settling pond.
- Material excavated during construction of the wetlands and settling pond would be disposed of on the spoil pile, which would eliminate need for developing a disposal area off-site and incidentally provided for reclamation of the spoil pile. Some soil amendments (such as lime) may be necessary to the excavated material to provide suitable material to support vegetation. Further, it is anticipated that the surface of the spoil pile would be graded to lessen the steep slope on the north side to approximately 3H:1V, to encourage surface drainage rather than allow

infiltration. The surface, approximately the top two feet, of the refuse would be amended with lime to reduce the potential for AMD generation from water that infiltrates into the refuse. A vegetated soil cover would be needed to discourage recharge into zones of pyritic backfill and therefore additionally reduce acid loads and potentially improve water quality to Wills Creek.

- Periodic removal of precipitates from the sedimentation pond and wetland would be needed under Alternative 2 as an operation and maintenance requirement. It is assumed that the removed precipitate would be disposed off-site at a licensed landfill. In addition, periodic inspections of the project would be required to fully successful function.

The formulated alternative plan was evaluated using the USACE *Environmental Sustainability Standardized Output Measurement Process*. A detailed description of this process is provided in the Standardized Output Measurement Process section of this DPR-EA is located in Section 7.4. Using this process, Standard Output Units (SOUs) for the baseline and current conditions; "without project"; and "with project" conditions at future times are developed. SOUs were developed for future periods of 25 years and 50 years after project implementation.

6.6 Environmental Consequences of the Alternatives

The environmental consequences of the proposed action and the No Action alternative are presented in this section.

Wills Creek Lake is situated in the Ohio Counties of Coshocton, Guernsey, and Muskingum, approximately 55.0 miles east of Columbus, Ohio (**Figure 1**). The proposed restoration project (study area) is located in Monroe Township along the south shoreline, approximately 4.0 miles above the Wills Creek Lake dam (**Figure 2**) and north of SR 83, along the west side of Tyson Road. The study area consists of an approximate 31-acre sub-catchment area of Wills Creek Lake. Located within the sub-catchment is the

previously referenced AMD discharge from deep mine MM-280, and the approximately 4-acre impacted spoil area.

The Wills Creek sub-basin lies in the southeast corner of the Muskingum River basin. There are three impoundments in the sub-basin: Wills Creek Lake, Senecaville Lake, and Salt Fork Lake. The Wills Creek catchment includes 853 square miles (m^2), of which Senecaville Lake controls 118 m^2 and Salt Fork Lake controls 159 m^2. The Wills Creek sub-basin is the third largest tributary to the Muskingum River. The main stream of Wills Creek is 81.0 miles long and is formed by the confluence of Buffalo Creek and Buffalo Fork in southern Guernsey County.

Wills Creek and its tributaries lie within the Allegheny (Kanawha) Plateau section of the Appalachian Plateau Province. The region is characterized by a hilly, maturely dissected topography with broad flat valleys. Floodplains and terraces are prominent features. The total relief for the basin is approximately 685 feet, with uplands rising to about 1,400 feet. Bedrock formations of the basin belong to the Pottsville and Allegheny series of the Pennsylvania age. The bedrock consists of horizontal shale, sandstone, limestone, and coal. Sandstone and shale constitute 95 percent of the thickness.

6.6.1 Land Use

Land use in the general Wills Creek Watershed is approximately 4 percent urban, 16 percent cropland, 23 percent pastureland, and 50 percent forest. Although a substantial area of the Wills Creek sub-basin is composed of forestland, over 34,000 acres are grazed by domestic livestock, making it the most highly grazed of any watershed in Ohio. Un-reclaimed surface mines, underground mines, and spoil account for a small portion of the surface acreage in the study area; however, they are scattered throughout the headwater streams and along the main stream of Wills Creek.

In the immediate vicinity of the project area, landforms are a combination of

wooded upland and flat lowland areas adjacent to Wills Creek Lake. The lowland areas generally are vegetated with grasses and shrubs, but some areas are significantly affected and barren due to AMD from MM-280 and the nearby spoil pile. Remnants of former mining operations are located west of the MM-280 discharge.

Impacts from implementation of the proposed action would generally improve land use. Specifically, reclamation of the spoil pile would reduce that un-reclaimed mine acreage of the basin. The proposed action would require the removal and disposal of metals precipitate as routine operation and maintenance of the project. It is anticipated that disposal of this material would be in an approved landfill, perhaps as daily cover. However, under the No Action alternative this material would continue to infill Wills Creek Lake.

6.6.2 Wetlands

Throughout the Wills Creek watershed there are numerous wetland complexes, which primarily occupy the adjacent floodplains of Wills Creek. A National Wetlands Inventory (NWI) map for the U.S. Geological Survey (USGS) *Wills Creek* quadrangle was reviewed to identify potential wetlands within the proposed project area. Wetlands habitat presence and locations were based on the *Muskingum County Soil Surve*, NWI map for Wills Creek, and site investigations. The *Muskingum County Soil Survey* identifies the Melvin silt loam, frequently flooded (Me) soil type to be mapped along the majority of the site. Melvin silt loam, frequently flooded is also listed as a hydric soil on the County Soils List. Using the aforementioned information, boundaries of wetlands and wetland complexes were demarcated on high-resolution aerial photography to compute wetland area as well as areas affected by AMD.

The NWI map depicting the site indicates there is one area of permanently and artificially flooded lacustrine open water habitat with unknown bottom structure (L1OWKH) west of the site (Wills Creek Lake). There are two palustrine areas that are

forested with deciduous broad-leaf scrub-shrub type vegetation (PFO/SS1Y) on the northeast section and approximate center of the site.

A total of 7.0 acres of wetlands were identified within the project area using the method listed above. A copy of the NWI map and a photographic illustration showing wetland boundaries and MAD impacted area is included in **Appendix C**.

The proposed action would restore approximately 0.8 acres of wetland habitat within a currently barren area of the south shoreline of Wills Creek Lake. It is also anticipated with the resulting reduction in metals precipitation and sedimentation from the MM-280 discharge, an additional 6.2 acres of wetlands would be afforded the opportunity to reestablish and also contribute to the overall increase in flora and fauna of the area. In addition, due to the availability of access to the site from various locations and extensive upland areas for construction, it is not anticipated that wetlands existing on the site would be impacted though either equipment staging or movement or by filling due to construction in implementing the proposed action.

The wetlands already impacted by the AMD will most likely not restore themselves due to the massive loading of precipitate and unfavorable growing conditions. Any currently un-impacted wetlands will eventually be subject to the same fate if the AMD is left unabated.

6.6.3 Aquatic Resources and Water Quality

Fishing opportunities exist at the project site in Wills Creek Lake and tailwaters. The ODNR Division of Wildlife manages the lake fishery and stocks saugeye in the lake annually. It is believed fish readily pass through the dam structure to provide additional tail-water angling opportunities. In fact, angling pressure is greater in the tail-water than in the main lake. Public fisherman access is very limited at the lake. In addition to saugeye, sport fish commonly sought in the lake include black bass and crappie. Pan-fish

and catfish are also available. However, sedimentation has considerably reduced the available lake habitat.

Freshwater bivalves have been observed within Wills Creek Lake. Shoreline inspections above the dam revealed many living and fresh dead bivalves. The Muskingum River Basin historically contained one of the most diverse bivalve communities within Ohio. The deeply entrenched character of the Wills Creek watershed precludes the effective hand collecting of these organisms. No brailing surveys are known to have been conducted along Wills Creek.

Section 5 of this report details water quality characteristics of Wills Creek Lake

Under the proposed action, metals precipitation from the MM280 discharge to Wills Creek Lake would be virtually eliminated. The wetland treatment cells would also impart alkalinity to the discharge water via natural biological processes; therefore, both aquatic habitat benefits and water quality improvement are expected.

No Action would in the long term result in the continued loss of the embayment area of the lake.

6.6.4 Terrestrial Habitat

The vegetated terrestrial/upland habitat within the MM-280 project area consists primarily of a mixed hardwood forest and herbaceous vegetation. A large portion of the upland project area consists of four acres impacted by a one-acre spoil pile that is all but devoid of vegetation. In addition, an area of ferric hydroxide precipitate is located adjacent to the spoil pile, just below the MM-280 discharge pipes. This area also lacks vegetative growth, due to the presence of long-term AMD impacts.

The upland habitat that would be impacted by the proposed action has already

been adversely affected by a large quantity of metals precipitate, approximately 7,000 cubic yards (cy), from the MM-280 discharge and from spoiling of material over one acre. No effects on terrestrial habitat outside of the construction work limits would occur. Therefore, no significant adverse impacts to terrestrial resources would occur. The proposed action would accrue positive benefits to terrestrial environment from reclamation of the spoil pile.

No Action would result in upland areas near the discharge to continue to be overtaken by metals precipitate and consequent habitat loss. In addition, the spoil pile area would not be expected to improve due to the lack of available soils and low pH conditions.

6.6.5 Vegetation

A vegetative survey of the proposed project area was conducted on Friday, August 29, 2003 and Thursday, September 4, 2003. The purpose of this survey was to compile a list of plant species present within the MM-280 proposed project area habitat and adjacent habitats. The vegetative survey was accomplished by establishing two transects through the site in order to obtain a representation of all habitat types present within the proposed project area. Whenever a new or seemingly new habitat was encountered, a sample plot was conducted. The sample plot was delineated by extending a radius of 15 feet from the center of the habitat. All vegetative species within that plot were identified. A total of 18 sample plots, identified as T1A through T1E and T2A through T2M, were recorded throughout the proposed project area. The vegetative species within each plot were separated into three subclasses: trees, shrubs/vines, and herbaceous plants. All species in the first plot were recorded. Only the species that had not previously been identified were recorded for all subsequent plots.

A total of 115 vegetative species were identified throughout the proposed project area. A total of 27 different species of trees were identified in the project area. This

accounts for 23.4 percent of the total vegetative community. A total of 11 different species of shrubs/vines were identified, which accounted for 9.6 percent of the vegetative community. The herbaceous subclass comprised the largest number of species. This subclass had 77 different species identified which accounts for the remaining 67 percent of all vegetative species within the proposed project area.

The area that would be disturbed in construction of the proposed project has highly-stressed vegetation due to mineralization of the soils. The area that would be disturbed in construction of the proposed project has highly-stressed vegetation due to mineralization of the soils. No significant impact to vegetation would therefore be expected from the proposed project. In addition, under the No Action Alternative little improvement or change to vegetation would be anticipated due to continuation of AMD.

6.6.6 Wildlife Resources

Because of the degraded nature of the terrestrial and aquatic environment of the proposed project area, wildlife resources are limited. Therefore, no impacts to wildlife resources would be expected under the proposed action.

Thomas K. Pauley, PhD conducted a qualitative herpetological survey for the MM-280 project site and surrounding area. A total of ten sites were established within the MM-280 study area. Two sites were utilized as non-impacted reference sites and eight study sites were established within obvious impacted areas. The survey was conducted June 9 through June 11, 2003.

The methods utilized to complete the survey included ground searches for amphibians and reptiles by visual scans and turning over cover objects on the forest floor. Amphibian larvae were inventoried by sampling with nets and commercial minnow traps. Aquatic turtles were inventoried with traps and by searching for basking turtles using optical spotting devices. All traps were set for two night time events and one daytime

event totaling a combined 36 hours.

Dr. Pauley's report, submitted November 3, 2003, cites several sources that indicate both amphibians and reptiles are particularly sensitive to environmental pollutants involving AMD by limiting successful reproduction. Dr. Pauley also points out that amphibians native to the Wills Creek area cannot tolerate pH values below 4.0.

Findings and conclusions from the herpetological survey completed by Dr. Pauley indicate species diversity at the MM-280 site is below that which is expected at sites not impacted. Habitat degradation, including siltation, has appeared to impact herpetological species within the MM-280 area. The opinion expressed by Dr. Pauley of the number and diversity of amphibians observed in the MM-280 study area were limited by impacts of AMD and previous mining activities. The amphibian species that were identified in the study area were those species representative of disturbed areas. However, adult anurans were found in several sites, so recruitment and establishment of amphibians to the embayment should proceed, provided treatment of the AMD occurs. It should be noted that Dr. Pauley states because the findings are representative of a short-term qualitative study, no statistically relevant conclusions can be drawn from the results. A copy of the herpetological survey is included in **Appendix D**. Because of the degraded habitat value of the project area, impacts to wildlife would be minor with implementation of the proposed project. Under the no action alternative habitat value would not be expected to improve and therefore no change to wildlife resources would be expected.

6.6.7 Threatened and Endangered Species

Information on the occurrence of federally and state listed endangered or threatened species and their critical habitats, occurring on or within a 1.0-mile radius of the proposed project area was obtained from the USFWS and the ODNR Division of Natural Areas and Preserves (DNAP).

A letter dated August 6, 2003 (**Appendix B**) from Ms. Marleen Kromer of ODNR-DNAP, indicated a rare plant, hairy pinweed (*Lechea villosa*), was identified in 1968 within 1.0 mile south of the site. This plant was recorded in a sandpit, 1.0 mile east of SR 76 at Wills Creek Bridge. The letter states "there are no known proposed state nature preserves or scenic rivers at the site." ODNR is not aware of any unique geologic features, breeding or non-breeding animal concentrations, champion trees, or state parks, forests or wildlife areas within a 1.0-mile radius of the project area.

A letter dated October 2, 2003 (**Appendix B**) from Mary Knapp, PhD, with the USFWS, indicated the project area lies within the range of the federally endangered Indiana bat (*Myotis sodalis*). Typical habitat for the Indiana bat includes: dead or live trees with exfoliating bark, split tree trunk and/or branches or cavities which may be used for maternity roost nests. Stream corridors, riparian areas, and upland woodlots, which provide forage sites, are also listed as habitat types for the Indiana bat. The project site does include some of the above mentioned habitat types for the Indiana bat. Due to these existing habitat types and the range of the Indiana bats, the possibility of Indiana bat occurring within the project area does exist. Therefore, mist net survey would be necessary should tree clearing not be accomplished during the dormant (non-roosting) season. Although the bald eagle is no longer a listed species, it remains protected under the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act. An active, as of 2003, Bald Eagle nest was identified near the confluence of Wills Creek and the Muskingum River, approximately 5.0 miles west of the site. Due to its distance from the project site, this nest should not be affected by the proposed activities.

The USFWS also indicated that the project lies within the range of three federally endangered mussel species: the clubshell mussel (*Pleurobema clava*), purple catspaw pearly mussel (*Epioblasma obliquata)*, and the fanshell mussel (*Cyprogenia stegaria*). However, the only impacts to waters are those areas seriously degraded from metals precipitate and therefore currently have no habitat value for mussels. Further, the USFWS indicates that because the project would include habitat enhancement for these species,

the project would likely have a beneficial effect on these species.

Neither of the alternatives would cause any impacts to federally listed, threatened or endangered species or their habitat or state listed species of concern. Letters from the USFWS and the ODNR, regarding federally listed and State listed species, respectively, are contained in **Appendix B**. Since this coordination there have been no changes at the project area that would require further consultation.

6.6.8 Recreation

Wills Creek Lake contains various public access points located at the dam, a concrete boat launch, and along the shores of the impoundment on Tyson Road. These access points are primarily utilized by hunters and fisherman. Because no access fees are required to utilize the lake and the general public is not required to register at the boat launch or access points, no demographic data was readily available at the time of the completion of this DPR-EA. However, based upon conversations with USACE and MWCD personnel, the aquatic portions around MM-280 are not utilized as much as the area around the dam, 4.0 miles downstream. This is presumably due to deleterious water quality and the associated reduction in game species inhabiting the lake due to AMD outfalls. The terrestrial upland portions of the area appear to be rather heavily utilized during the spring, fall, and winter hunting seasons for turkey, deer, and waterfowl.

It is expected that this alternative would serve to enhance future recreational opportunities by restoring wildlife and fisheries habitat. Therefore, no significant adverse impacts to recreation would be expected under the proposed action.

Under the No Action alternative the effects from AMD to the lake would be expected to result in additional loss of recreational opportunities.

6.6.9 Prime Farmlands

Prime farmland is land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops, and is also available for these uses. Prime farmland could be cropland, pastureland, rangeland, forestland or other land, but not urban built-up land or water. It has the soil quality, growing season, and moisture supply needed to economically produce sustained high yields of crops when treated and managed, including water management according to acceptable farming methods. In general, prime farmlands have an adequate and dependable water supply from precipitation or irrigation, a favorable temperature and growing season, acceptable alkalinity, acceptable salt and sodium content, and few or no rocks. They are permeable to water and air and are not excessively erodible or saturated with water for long periods of time and do not flood frequently or are protected from flooding. The *Soil Survey of Muskingum County* was examined and compared with a list of prime farmland soils obtained from the Natural Resources Conservation Service (NRCS) office in Muskingum County. Based upon the soil surveys and information obtained from the NRCS, the majority of the project site is mapped Melvin silt loam, frequently flooded (Me). This soil type is identified by the NRCS as a prime farmland soil type drained and either protected from flooding or not frequently flooded during the growing season. A copy of the soil survey map and Prime Farmland information is included in **Appendix E**.

Although soils mapping of the site includes a prime farmland soil type, the entire area is severely physically and chemically degraded from the effects of AMD. Therefore, the lands that would be affected under the proposed action do not meet the definition of prime farmland.

6.6.10 Noise

Wills Creek Lake is rural and noise levels are typically low, with the exception of semi-trucks entering and exiting a sand and gravel mining operation located off of SR 83, northwest of the site. Noise impacts from the proposed action would limited to duration of construction and would be emitted from diesel-powered heavy equipment. The closest receptors to the construction area are homes approximately one mile away. Noise generated by construction equipment and activities would therefore fall well below annoyance levels, particularly for daytime averages.[1] Due to substantial distance from receivers, intermittent nature of noises and additional buffering from the rolling topography and vegetation, noise impacts of the alternative plan would not be significant.

No impacts due to noise would occur with the No Action Alternative.

6.6.11 Air Quality

According to the U.S. EPA, air quality in the Wills Creek area is in attainment for all ambient criteria pollutants, which include ozone, particulates, sulfur dioxides, nitrogen oxides, carbon monoxide, and volatile organic compounds (VOCs). The Wills Creek area is predominantly rural with one major population and industrial manufacturing center (Coshocton) located approximately 7.0 miles northwest of the site. Land use in the immediate area around the site is primarily wooded with some commercial and industrial development.

The proposed action would involve construction equipment including a diesel excavator, a diesel dozer, and two off-highway dump trucks. The total PM2.5 emissions from these sources is estimated to be 0.49 tons/year using 2008 emissions factors from the USEPA NONROAD model. Also using this data, estimates for Ozone would be 9.46

[1] Daytime interior threshold of 67 dBA Leq (A-weighted equivalent sound level) measured over a period of one hour. Calculations based on US Department of Labor, OSHA, TED 01-00-015 [TED 1-0.15A], Chapter 5, Noise and Hearing Conservation, Noise and Health Effects, The Physics of Sound, Appendix I:A-3. Sound Propagation

tons/year of NOx and 0.58 tons/year of VOC. The proposed action is therefore exempt from making a conformity determination, since estimated emissions from construction equipment would be far below the *de minimis* standards of 100 tons/year, which are the minimum threshold for which a conformity determination must be performed. Therefore, no significant impacts to air quality would be expected from the proposed action.

No impact to air quality would occur with the No Action Alternative.

6.6.12 Hazardous and Toxic and Radiological Waste (HTRW)

In September 2003, a Phase I Environmental Site Assessment (ESA) was completed for the MM-280 site. USACE policy requires environmental site clearance concerning hazardous, toxic, and radiological waste (HTRW) to prevent future environmental liability through real estate chain of title and worker safety. ESAs identify any environmental impacts that may have occurred or currently exist in a given project area. To complete an ESA, on-site investigations are conducted and numerous databases and records are consulted to determine the potential for toxic materials to be present on project lands. The Phase I ESA for the MM-280 project concluded no recognized environmental conditions (RECs) are present in the project area and that additional HTRW or ESAs investigations are not warranted. For more detail, consult **Appendix F**, which contains the text of the 2003 ESA completed for the MM-280 project.

The precipitate that must be removed as part of maintenance of the proposed project would be primarily ferric hydroxide, which is not hazardous. No significant HTRW issues are expected under either the proposed action or the No Action alternatives.

6.6.13 Cultural Resources

A preliminary cultural research survey was completed to determine the presence of previously recorded archaeological sites within the project area. Only two archaeological sites are recorded in the Wills Creek Reservoir. Site 33CS38 is located in the pool area and Site 33MU61 is located near the dam. According to the Cultural Resource Reconnaissance Survey (CRAI, 2003), included in **Appendix G**, no evidence was found for aboveground prehistoric or historic structures, and the potential for in-ground and buried sites is considered low in the project area. Therefore, no adverse effect to historic properties would be expected under either the proposed action or the No Action alternatives.

6.6.14 Socio-Economic Conditions

Like many rural areas in Ohio, the counties associated with the Wills Creek area increased in population during the 1970s only to see a decline during the 1980s. The 1990s again witnessed a modest increase in growth throughout the watershed. Unemployment rates throughout the watershed have been above the average for the state and nation. The unemployment figures are partly attributable to the closing of major mining operations in the area. Educational levels are likewise below those for the rest of the state. Approximately 80 percent of the persons living in the watershed who are 25 years of age or older are high school graduates, compared to the 87 percent for the state as a whole.

Muskingum County occupies approximately 665 square miles and has an estimated population of 85,000. Zanesville is the county seat. Muskingum County is largely rural. Manufacturing accounts for approximately 25 percent of employment in Muskingum County. The retail sector, healthcare, and local government also provide significant employment. Longaberger Co., AK Steel, 5 B’s Inc., and Lear Corp. are major manufacturing employers in the c. Genesis Health Care System, Muskingum

College, and Zanesville Board of Education are also major employers. Unemployment reported for 2002 was 6.4 percent, slightly higher than the state average. Per capita income for 2001 was approximately $24,000. Approximately 80 percent of the population consist of high school graduates or have more advanced degrees. About 14 percent of the population of Muskingum County is 65 years or older. Muskingum County has also experienced steady net-in migration since approximately 1970 (Ohio Department of Development [ODOD], 2003).

Coshocton County occupies about 564 square miles and has an estimated population of 37,000. The city of Coshocton is the county seat. Although wooded and agricultural land account for the majority of land use in the watershed, manufacturing is the largest employer on a countywide basis, accounting for 31 percent of total employment. Healthcare and social assistance is the second largest employment sector, accounting for approximately 14 percent, followed by local government at 11 percent. General services (i.e., retail, hotels, etc.) are also significant employers in the county. Major manufacturers include: AK Steel, Kraft Foods, Ansell Limited, and Smurfit-Stone Container Corp. American Electric Power, Coshocton Board of Education, and Coshocton Memorial Hospital are other principal employers of the county. The county unemployment rate, as of the year 2002 was 6.9 percent, a little higher than the state rate of 6.1 percent. Per capita income as of 2001 was about $22,000. Approximately 79 percent of the population consist of high school graduates or have more advanced degrees. About 14 percent of the county population is 65 or older. Coshocton County has experienced consistent net-in migration since 1999 (ODOD, 2003).

Because of the relatively limited amount of construction required to implement the proposed action, little input into the socio-economics of the area would be expected. Employment opportunities may, in the short term, be provided during construction if the selected construction firm incorporates local personnel to complete the project. The project, once completed, will not increase employment opportunities within the local area. The project will not require the relocation of any residential, commercial or

industrial structures or businesses. Because of the minor economic input of the proposed action, no significant impacts to the socio-economics of the area are therefore anticipated.

6.6.15 Environmental Justice

Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Population and Low-Income Populations* (Executive Order, 1994), directs federal agencies to identify and address disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority populations and low-income populations. When conducting National Environmental Policy Act (NEPA) evaluations, the USACE incorporates environmental justice considerations into both the technical analyses and the public involvement in accordance with EPA and Council on Environmental Quality guidance (CEQ, 1997).

The CEQ guidance defines "minority" as individual(s) who are members of the following population groups: American Indian or Alaskan native, Asian or Pacific Islander, Black, not of Hispanic origin, and Hispanic (CEQ, 1997). The Council defines these groups as minority populations when either the minority population of the affected area exceeds 50 percent or the percentage of minority population in the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographical analysis.

Low-income populations are identified using statistical poverty thresholds from the Bureau of the Census Current Population Reports, Series P-60 on Income and Poverty (USBC, 2000). In identifying low income populations, a community may be considered either as a group of individuals living in geographic proximity to one another, or a set of individuals (such as migrant workers or Native Americans), where either type of group experiences common conditions of environmental exposure or effect. The threshold for the 2000 census was an income of $17,761 for a family of four (USBC, 2000). This threshold is a weighted average based on family size and ages of the family members.

The two spreadsheets below show the percentage of population by race and percent of families below the poverty level for the country, state, county, and local township near MM-280.

POPULATION RACE-CENSUS 2000

	PERCENTAGE OF POPULATION BY RACE					
Location	**White**	**Black/African American**	**Asian**	**Native Hawaiian / Pacific Islander**	**Latino/ Hispanic**	**Two or More Races**
United States[(a)]	80.4	12.8	4.2	0.2	14.1	1.5
Ohio[(a)]	85.2	11.9	1.4	0.0	2.2	1.2
Muskingum County[(a)]	93.8	4.1	0.3	0.0	0.60	1.5
Monroe Township	96.5	1.1	--	--	--	1.1

[(a)]= 2004 Data

PERSONS BELOW POVERTY LEVEL-CENSUS 2000

Location	Percent Below Poverty Level
United States, 2003	12.5
Ohio, 2003	10.6
Muskingum County, 2003	13.1
Monroe Township, 1999	7.4

As noted in the above spreadsheets, the immediate project area's minority and low income populations are well below the national, state, and county averages. For example, the percent minority population for Monroe Township is about 2 percent. The

percent minority populations for the country, state, and county are approximately 33 percent, 15 percent, and 6.2 percent, respectively. Similar statistics hold for the percentage of individuals below the poverty level, i.e., 7.4 percent for the Monroe Township, versus 12.5 percent, 10.6 percent, and 13.1 percent for the country, state, and county, respectively.

A proposal must have potential for disproportionately high and adverse human health or environmental effects on low-income populations, minority populations, and Indian tribes in order to have Environmental Justice impacts. The project area is not used by any such groups for subsistence fishing or hunting, and the proposed project is not expected to involve the release of hazardous, toxic, or radioactive materials to which minority or low-income populations could be exposed. In addition the project would not require the construction of or the relocation of roads, utilities, businesses, or residences. Based upon the above, this project will not have any disproportionately high and/or adverse human health or environmental effects on low-income populations, minority populations, or Indian tribes. The project would benefit low-income and minority residents the same as all other segments of the population by increasing the terrestrial and aquatic productivity and lifespan of Wills Creek Lake.

6.6.16 Transportation

Muskingum and Coshocton Counties have an intricate network of roadways, primarily rural state and county routes, which are utilized for commercial and residential purposes. As shown on the general location maps, **Figures 1 and 2**, the primary artery that carries traffic through the central portion of the county is the U.S. Route (USR) 70 running east/west. In addition to this primary highway, three secondary routes also afford access to the area and include State Route 83 and 93, and Township Road (TR) 145 (Tyson Road).

The most heavily used highways near the MM-280 project area are SR 83

(Coshocton Road) and Tyson Road (TR 145), located southwest and immediately east of the site, respectively. Coshocton Road is oriented north-south and Tyson Road is oriented southwest-northeast and connects Coshocton Road to SR 93.

Coshocton Road and SR 93 are both two-lane blacktop roads and are frequently utilized by commercial traffic. Tyson Road is a gravel one-lane rural route and is infrequently traveled by motorized vehicles other than local traffic, which is minimal.

Relative to typical construction projects, very little construction material would be transported to the project site. However, resealing the mine entrance would close Tyson Road for several days, possibly weeks. Because traffic flow along Tyson Road is very light, only minor impacts from road closure would be anticipated.

6.6.17 Aesthetics

Determining the aesthetic quality and character of a given area is subjective and dependent upon personal views and biases. However, there are some obvious characteristics of degraded aesthetic character most would agree upon, such as areas that have been impacted by industry that have not been reclaimed or restored.

The Wills Creek Lake area immediately around MM-280 is located amidst rural residential land and transportation corridor development and is a popular hunting area for local residents; however, due to a decline in water quality over the years from historic mining activities, quality game fish species are not as abundant as most would like; therefore, public fishing is less than desirable and public use has diminished. Because of the highly visible nature of MM-280 from Tyson Road, as seen on the cover of this report, and ongoing sedimentation from MM-280, the area of open water around the outfall has declined since its initial construction in the 1930s, and transformed into a relatively shallow, turbid, iron-stained area that has little to no biotic integrity, functional, or aesthetic value.

Shrub/scrub and invasive species, which would eventually manifest at MM-280 if no action is taken to restore the upland and lowland habitat, typically gives the area a sterile lifeless appearance. Without intervention to restore open water and terrestrial habitat, the area would eventually succumb to the process of sedimentation and acidification from an aesthetic standpoint. Impacts to the aesthetics of the area from implementation of the proposed action would therefore be considered positive.

6.6.18 Floodplains

The AMD discharge outlet of the mine is at approximately 760 feet msl, which is about a 50 percent pool recurrence elevation. The one-percent recurrence pool elevation Wills Creek Lake is elevation is 776 feet msl. Therefore, the entire MM-280 project area is within the flood storage pool of Wills Creek Lake. However, under the proposed action no additional material would be placed within the project area; and therefore no effect on floodplains would occur.

6.7 Cumulative Impacts

The regulations of the Council of Environmental Quality for implementing the NEPA define cumulative effects as, "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency, federal or non-federal, or person undertakes such other actions (40 Code of Federal Regulations [CFR] §1508.7)." Cumulative effects assessments focus upon the beneficial and adverse impacts past, present and potential future actions could have on the ecosystem and human community being affected by an action.

In simple terms, a cumulative effects analysis considers the impacts of a proposed action in relation to what else is occurring, has occurred, or potentially may occur in a

given project area. To keep a cumulative effect analysis meaningful, bounds must be set to establish a reasonable timeframe and impact area. For this project the impact area considered is the immediate MM-280 discharge area, spoil pile, lake embayment, and downstream area of Wills Creek Lake.

For the MM-280 project, past actions relate to the original deep mining activities occurring in the late 1950s through 1965. This deep mining activity contributed to the degraded water quality and sedimentation within the MM-280/Wills Creek Lake area. The remnants of these activities are continuing to occur at the present time. In addition, Wills Creek Linton Township Road Project must also be considered *(See Section 5.0 Prior Studies*). This report has described how accumulated sediment and metals precipitate from past mining activities has adversely affected the lake's aquatic ecosystem, as well as riparian corridors, and wetland and upland habitats. Present actions relate to the effects of project construction which were previously described. Reasonably foreseeable future actions refer to those actions that could occur within the MM-280 area or upstream within the Wills Creek basin.

Utilizing the 11-step process developed by the CEQ, no issues were identified that would be deemed significant and thus require cumulative effects analysis beyond Step 1 as no potential for significant impacts from the proposed project or No Action alternative would be expected.

7.0 Cost Effectiveness and Incremental Cost Analyses

7.1 Introduction

The USACE Planning Regulations (ER 1105-2-100) require all water resource development projects be evaluated in terms of acceptability, completeness, effectiveness, and efficiency. In addition, ecosystem restoration projects require evaluation on the basis of cost effectiveness and incremental cost analyses of the possible alternatives and the

significance of ecosystem outputs (environmental benefits). Specifically, cost effectiveness analysis is concerned with evaluating the efficiency of alternative means of producing outputs (environmental benefits); incremental cost analysis is concerned with identifying and displaying variations in cost for the production of different benefit levels. These analyses help decision makers to determine the "best buy" alternative plan.

Through the formulation of alternatives, only one plan was identified that would restore the habitats effected by MM-280 discharges. One method of restoration was identified that meets the project objectives. Restoration measures are formed by analyzing different scales of the method, wetland creation with sedimentation ponds. Three scales were investigated in addition to the No Action alternative, each of them referring to a linear addition of amount of materials and labor dedicated to wetland restoration.

Because only one alternative was identified that would meet the objectives of the project, Cost Effectiveness/Incremental Analyses (CE/ICA[2]) procedure is not relevant with respect to plan selection. However, the size, or scale, of the features of the proposed action, settling ponds/wetlands, were selected based on use of CE/ICA.

7.2 Other Issues Affecting Decision Making

Under the no action alternative, or not to construct the selected abatement alternative for the mine discharge, the potential exists for the mine discharge to clog and result in another catastrophic blow-out, which has occurred in the past. Another blow-out would most likely impact the current township road (Tyson Road) overlying the discharge piping. A blow-out to Tyson Road is considered an important public safety concern and must be seriously considered when making a final decision on alternative selection. Likewise, the inherent instability of spoil piles in general presents a risk to anyone utilizing the area. While the risk is admittedly less than the risk to Tyson Road, spoil pile subsidence cannot be predicted. The period of expected increased usage of the

[2] USACE Planning Guidance Notebook, Engineer Regulation 1105-2-100, Appendix E, E-36.

area, primarily for hunting, is expected to occur in the fall/winter months. The fall/winter months experience increased precipitation and freeze-thaw sequences, as compared to the rest of the year, which increases the risk of collapse and/or subsidence.

7.4 Project Benefits

Standardized Output Measurement Process

The Great Lakes and Ohio River Division (LRD) has developed an environmental investment strategy to allow documentation of the value added by a particular ecosystem restoration project. This tool, which standardizes project outputs, allows a numerical comparison of the ecosystem value of project alternatives. However, because only one plan was identified that would meet project goals and objectives this analysis is presented as a means for LRD to prioritize ecosystem projects, as appropriate, based on the projects benefits.

Project Outputs

The standardized process uses acres of habitat as habitat measure. Because no new acreage of a particular habitat type would be created, quality of habitat improved provides the most meaningful of project outputs. Therefore, this model assumes a set number of acres are present and the total acres would not change. However, present acreage would be expected to develop into better quality habitat. The existing main stem of Wills Creek Lake would not exhibit an immediate water quality improvement by construction of the proposed action. What would dramatically change immediately after project construction is wetland and upland habitat quality in and around the mine discharge and the embayment. Secondarily, the main stem would most likely experience an improvement in water quality; however, this increase is expected to occur incrementally and over a longer period of time due to various AMD inputs from upstream and downstream sources that were not part of the scope of this project. Hence, the use of

surface acres of the main stem as a habitat parameter to compare the effectiveness of alternatives would be meaningless because the overall quality of the lake would remain virtually the same after project completion as before.

Quality will be measured by assigning a standardized index score (SI), to each habitat type. The SI will be set at a baseline level and extrapolated over the lifetime of the project. This unit of measure will allow comparison of the increase in quality generated by various treatment options and will be utilized to compare projected habitat changes over time as well as the ecosystem outputs and their costs.

Standardized Index (SI)

A standardized index is based upon best professional judgment and uses a scale of zero to ten, where zero represents complete habitat degradation and ten represents optimal habitat. This number would change over time as the newly restored habitat matures.

As stated, the 0.8 acre wetland area to be restored by the project is currently blanketed by metals precipitate, principally iron. Further, the discharge from MM-280 mine continues to deposit flocculate in this area. Current habitat value of this area is so poor that it supports little life and is essentially devoid of vegetation. For example, a common wetlands species such as the Green Heron, would not directly utilize this area. This area would have an SI of 0. The 6.2 acres wetland complex that would be improved by the project does have some habitat value, even though it is compromised by persistent precipitation of flocculate. Overall, the total wetlands to be affected by the project (7.0 acres) were considered to have an SI of 2.

The embayment area to be restored by the project has little to no life. Again, persistent precipitation of iron flocculate several disrupts life cycles of benthic organisms, plankton and vegetation thus rendered this are devoid of life. Species that would use this area, such as the belted kingfisher, would likely not currently be found because of lack of

food in the embayment. Although the habitat suitability based on the USFWS habitat model[3] for the kingfisher may indicate a fairly high value, this model does not reflect the effects of AMD on the food-chain. Therefore, the Standardize Index value for this impacted embayment is considered to have an SI of 0.

The riparian fringe of the embayment is similarly degraded as the 6.2 acre wetlands complex and therefore carries the same SI of 2.

Significance Factor (SF)

Significance considers habitat attributes such as relative abundance or rareness, natural, undisturbed habitat, status of how habitat changes over time, connectivity to other habitat corridors, fragmentation, or barriers that limit habitat, and biodiversity.

Levels of significance range from a low of one to a high of five, and are defined below in Table 4-3.

Table 4-3
Definition of Significance Factors

Significance Factor	Significance Factor Rating
National/International	5
Regional	4
State/Tribal	3
Local	2
Common	1

Normally, the significance factor does not change, and once assigned it remains constant throughout the analysis. Wetlands are generally considered to be of regional significance and therefore given an SF of 4 for this analysis. Open water, such as the

[3] Biological Report 82(10.87) August 1985 HABITAT SUITABILITY INDEX MODELS: BELTED KINGFISHER, Bart L. Prose, Colorado Cooperative Wildlife Research Unit, Colorado State University, Fish and Wildlife Service, U.S. Department of the Interior, Washington, DC

subject embayment of Wills Creek is more of local significance due to relative abundance of these habitats, and therefore has an SF of 2. The floodplain, or gob pile and adjacent project area, has little terrestrial value and was assigned an SF of 1.

Standardized Output Units (SOUs)

The SOU is obtained by multiplying the amount of habitat (acre-feet of aquatic habitat) times the Standardized Index times the Significance Factor.

Acre of a habitat ***x*** SI ***x*** SF = SOU

The Future without Project Condition (Fw/oPC) and the Future with Project Condition (Fw/PC) will be based on projected shifts in each habitat's area and quality through the life of the project. For the MM-280 project, an SOU is produced for the base or current year, one at 25 years and one at 50 years for both the Fw/PC and the Fw/oPC. The values are time averaged to yield a single average SOU value for each alternative. Although the projection of ecosystem succession is not an exact science, projections can nevertheless be made. The following tables and paragraphs compare future without and future with project conditions and their associated SOUs.

SOU - Future Without Project Conditions

Table 4-4
Current Baseline Condition*

Habitat Type	Acres	SI (0-10)	SF (1-5)	SOU (Acres x SI x SF)
Wetlands	7	2	4	56.0
Reservoir (embayment)	1.5	0	2	0.0
TOTAL	8.5			56

*Acreage value is approximate for reservoir (embayment).

The "future without project condition" in 25 years shown below in **Table 4-5** anticipates continued sedimentation with a commensurate loss of terrestrial and open water habitat, and degradation of the remaining aquatic habitat; however, SOU's are expected to remain the same over the next 25 years. Due to the already highly degraded nature of the site, overall quality is not expected to decline at a rate that reveals noticeable changes as compared to baseline conditions during the next 25 years.

Table 4-5
Estimated Future Without Project Condition in 25 Years
(Year 2032)

Habitat Type	Acres	SI (0-10)	SF (1-5)	SOU (Acres x SI x SF)	Comments
Wetlands	7	2	4	56.0	Wetland habitat would increase slightly as iron oxide turns to soil.
Reservoir (embayment)	1.5	0	2	0.0	The embayment would most likely get worse.
TOTAL	8.5			56.0	

Table 4-6 below represents what future without project condition of the lake would be in 50 years if nothing were done to restore the aquatic habitat. It is anticipated with no effort to abate the current aquatic and terrestrial degradation; the SOU's would actually increase slightly due to iron oxide deposition from the outfall forming into hydric soil resulting in an overall wetland SI increase.

Table 4-6
Estimated Future Without Project Condition in 50 Years
(Year 2057)

Habitat Type	Acres	SI (0-10)	SF (1-5)	SOU (Acres x SI x SF)	Comments
Wetlands	7	3	4	84.0	The wetlands may improve slightly as some of the iron precipitate transitions to soil.
Reservoir (embayment)	1.5	0	2	0.0	No change.
TOTAL	8.5			84.0	Slight increase due to slight wetland quality increase.

SOU – Future With Project Conditions

The same analysis used for the "future without project condition" (Fw/oPC) is used to determine the SOU for the "future with project condition" (FwPC) to show the degree of improvement with the project in place over baseline conditions and over time. The same timeframes will be used for the "with project conditions", i.e., 25 and 50 years. The underlying understanding of the wetland restoration measure is that increasing areal extent and quality of the wetlands results in an increase in wetland habitat as well as a net decrease in downstream sedimentation rates. Both relationships are relatively linear until a saturation point is reached. In other words, increasing the area and hydraulic effectiveness of a wetland as a sediment retention basin results in a decrease in downstream sedimentation until the point is reached at where there is no significant excess sediment yield. At that point, adding more wetlands does not add any additional incremental benefit to the downstream channel because all the sediment has already been removed. This phenomenon is demonstrated such that the habitat units evaluated in this study "saturate" at a certain scale of wetland restoration.

Similarly, restoration of the wetlands themselves, since they are area-limited, can only increase effectively to a point. Once the restoration effort has been applied to the entire available area, the restoration benefits sharply decrease. The major impact of wetland restoration is realized through hydrogeomorphic modifications and general revegetation to the system, creating a physical baseline and seed bed that drives future development. Once that level of restoration is reached, adding more plants or more features does very little to increase the quality of wetlands. This phenomenon has been demonstrated in a controlled field experiment where heavily planted and "restored" versus unplanted wetlands were allowed to undergo natural succession for decades. Both the treatment and control otherwise had similar hydrology, soils, and morphology. The more "restored" wetlands showed higher habitat indicators earlier in the experiment, but many of the differences began to converge after a decade (Mitsch et al. 2005). In this study, this phenomenon is demonstrated by saturation in the end value of the restored wetlands for different restoration scales. The highest restoration scale has a higher up-front habitat value, but it converges with the moderately scale of restoration in the long term. Alternative are based on scales, or factors, of 0 to 1.5 with Scale 1 as the base line (using one-half the available area for the wetlands), Scale 2 utilizing all available area, and Scale 3 using 1.5 times the area available for the wetlands.

Table 4-7 shows what the SOUs would be in 25 years after the complete ecological restoration project is constructed.

Table 4-7
Future With Project Condition

	Riparian	Wetlands	Reservoir	Floodplain	Total SOU (acres*SI*SF)
acres	0.5	8	1.5	4	
SF	2	4	2	1	
SI values for each alternative measure over 25, 50 years and yearly average					
Baseline	3	2	0	0	
wo25	3	2	0	0	
wo50	3	3	0	0	
wo average	3	2.33	0	0	
Baseline acres*SI*SF	3	65.3	0	0	**68.3**
1scale25	4.5	3.5	3	4.5	
1scale50	5.5	5	3.5	4.5	
1scale avg	5.0	4.25	3.25	4.5	
1 scale acres*SI*SF	4.3	98	6.5	12	**120.83**
2scale25	6	5	6	9	
2scale50	8	7	7	9	
2scale avg					
2scale acres*SI*SF	5.67	130.67	13	24	**173**
3scale25	6	6	6	9	
3scale50	8	7	7	9	
3scale avg	7	6.5	6.5	9	
3scale acres*SI*SF	5.67	140	13	24	**182.7**

Cost

The costs for the three alternative scales were developed off of a single feasibility-level construction cost estimate (October 2009) by applying factors of 1, 2, and 3 to the materials and labor portions of the restoration effort for each scale respectively. Fixed costs included mobilization and demobilization costs, construction of haul roads, and the

feasibility study. Feasibility study costs are sunk costs and therefore not included in the analysis. Operation and Maintenance (O&M) costs were calculated at $15,000 for Scale 2 using AMDTREAT[4] software. The O&M costs for Scales 1 and 3 were then scaled accordingly but weighted toward the smaller end of the scale due to the higher fixed costs of mobilizing to effect sediment removal.

Table 4-8

Annual Costs for Restoration Scales

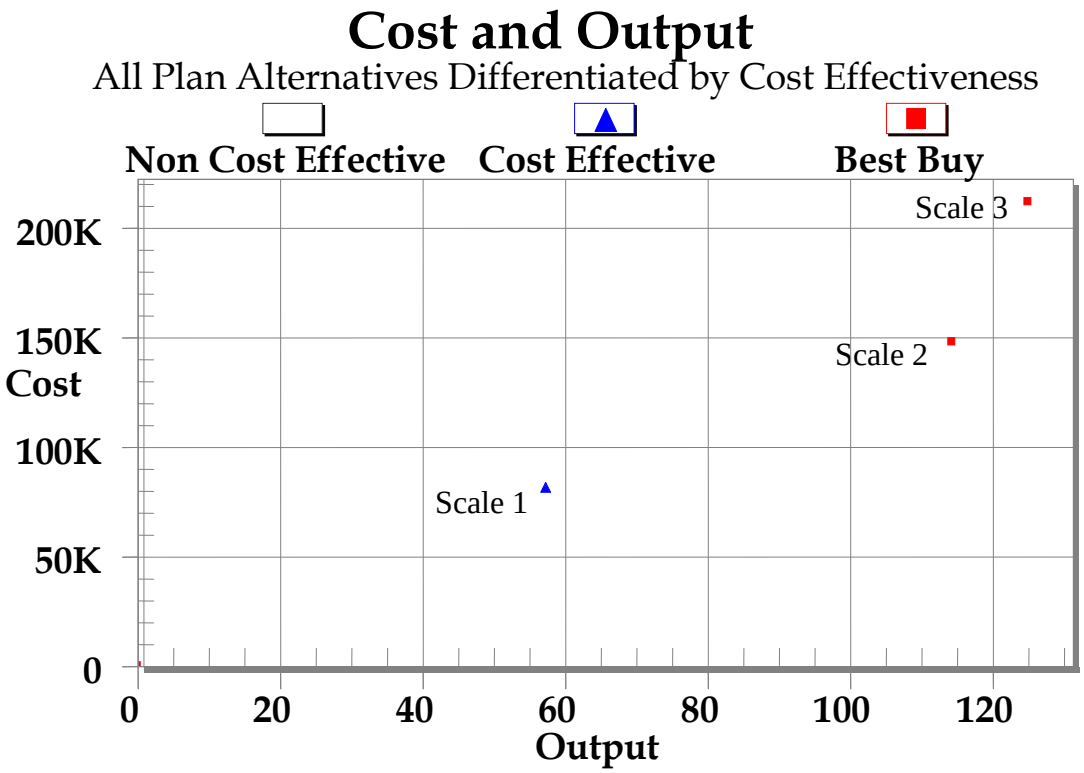
Project Scale	cost	annual cost	O&M	total annual cost
No Action	$0	$0	$0	$0
Scale 1	$1,374,155	$73,823	$8,000	$81,823
Scale 2	$2,471,814	$132,791	$15,000	$147,791
Scale 3	$3,569,473	$191,760	$20,000	$211,760

Cost Effectiveness Incremental Cost analysis (CEICA)

Cost effectiveness analysis combines all combinations and permutations measures and compares them to the "without project" conditions to identify combinations that represent the project alternatives that are most cost effective. When these combinations are plotted on a cost versus benefit graph, the lower-rightmost options along the scatter plot are the most cost effective. Moving up on the plot increases cost, and moving left decreases benefits. A computer package (IWR Plan) was used to find all project combinations and identify the cost effective plans.

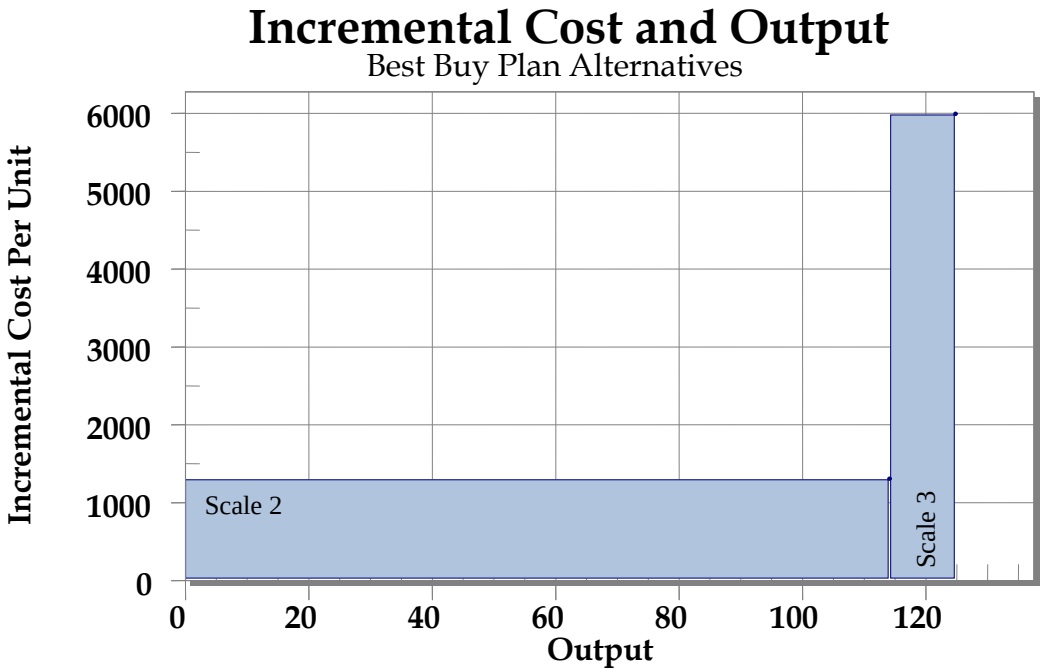
[4] AMDTreat was developed as a cooperative effort by the Office of Surface Mining Reclamation and Enforcement (OSM), the Pennsylvania Department of Environmental Protection and the West Virginia Department of Environmental Protection and is public domain.

Table 4-9



The cost effective plan is the restoration scale that results in the greatest ecological benefit for the least incremental cost. At each incremental increase, the planner should ask whether that increase is "worth it" for meeting project objectives and budgetary constraints. The planning and guidance criteria of completeness, efficiency, effectiveness, and acceptability, will be used to help determine the need and value of a more expensive project increment. Figure 5 and Table 4-10 give two different ways of visualizing the incremental relationship between cost and benefit in the Best Buy plans.

Figure 5



There is no single formula for choosing the Best Buy plan that is "worth the cost." In addition to considering the financial capabilities of the involved agencies, the Corps' planning and guidance criteria require considering the four criteria of acceptability, efficiency, effectiveness, and completeness.

Table 4-10

Relationship Between Costs and Benefits for Best-Buy Scales

Alternative	Output	Cost	Cost/ habitat unit	Incremental cost	Incremental output	Incremental cost per output
No action	77.7	0	0			
Scale 2	192	148,000	1293	148,000	114	1293
Scale 3	202.7	212,000	1694	64,000	10.7	5798

Efficiency

Efficiency is the extent to which the alternative plan is cost effective, considering opportunity costs as well as monetary costs. From a standpoint of cost-benefit values, the

No Action alternative is the most efficient because it has no additional cost or work to implement. Similarly, Alternative Scale 1 is the most cost effective of the action proposals, and each subsequent alternative becomes less efficient because it provides less incremental benefit per incremental cost increase.

Completeness

Completeness is the extent to which a plan accounts for all necessary investments and actions. A complete alternative is well thought out and requires minimum output from outside factors beyond the control of the planner. The No Action plan is the most incomplete plan because it relies completely on outside forces to make any positive habitat benefits. Although it is theoretically more efficient to let nature do the work, there is a lot of risk in predicting sediment deposition. Sediment may not become deposited where intended or
at the predicted rate and the benefits may not be realized. All three scales of the wetland/settling pond alternative have the same level of completeness.

Effectiveness

Effectiveness is the extent to which the plan achieves the project goals. An effective plan is responsive to people's needs while achieving the planning objectives. The No Action plan is the least effective plan because it does not achieve any planning objectives, nor is it responsive to stakeholder needs. The three alternative scales achieve the planning objectives in their respective orders.

Acceptability

Acceptability is the workability or ease of implementation of the plan with respect to implementation and satisfaction of the sponsor. The No Action alternative is the least acceptable because the unacceptable current conditions have moved the Sponsor to advocate the proposed study. Alternative Scale 2 would be the most acceptable because it best utilizses available topography for construction of the restoration features and

would therefore require least disturbance while maximizing available discharge detention time.

Selected plan –"Best Buy"

Alternative Scale 2 is a best buy plan. It is the most efficient of all the restoration plans, it is complete, effective, and the most acceptable plan. Because it is the lowest-cost best buy plan that meets the project goals it is considered the NER plan and is also the preferred alternative.

8.0 Recommended Plan

8.1 Plan Description

The recommended plan is Alternative 2 which includes a settling pond and wetlands for amelioration of AMD. Included in this plan is the reclamation of the spoil pile as part of soil disposal. A conceptual design drawing for the proposed action, as well as conceptual renderings of post construction compared to present conditions, are presented in **Appendix H.** Following are details of the proposed plan. The proposed plan would enhance wetlands impacted from AMD. The proposed plan would not create additional wetland acreage within the lake embayment or below the current discharge and spoil pile that was not present prior to mining activities. The diversity and productivity of these degraded wetlands and aquatic areas would dramatically increase by eliminating continued sedimentation and allowing the growth of a more diverse wetland plant community.

The sediment removed from the project area in order to construct the discharge treatment system would be placed as part of spoil pile reclamation. It is anticipated that seedlings would be planted in order to reestablish a functional riparian corridor between the upland and lowland areas. In addition, natural biotic processes are expected to assist in restoring the environmental site conditions once acidification and siltation are abated.

The current discharge headwall and piping would be removed and replaced by newer and more resilient materials that would ensure constant drainage and anoxic conditions. In addition, a water tight access port would be constructed into the mine pool area that would allow periodic inspection and maintenance of the mine pool discharge location.

8.2 Environmental Impact Avoidance Considerations

A formal wetland delineation would be performed according to the USACE *Technical Report Y-87-1*, prior to commencing construction activities. The delineation would serve to accurately identify existing wetlands so that Best Management Practices (BMPs) can be instituted to protect these areas during construction. The site is within the range of the Indiana bat, and has suitable roosting habitat. Therefore, mist net survey would be necessary should tree clearing not be accomplished during the dormant (non-roosting) season.

Within the project area, the proposed project would help protect existing wetlands. To maintain the integrity of these wetlands during construction, a barrier constructed of siltation fabric would be placed across the edge of each wetland and the lake shore to prevent additional siltation resulting from construction activities.

8.3 Plan Implementation

As part of this Section 1135 project, the local sponsor would be required to pay for 25 percent of the total project costs, either in cash or as “in kind” benefits. For the MM-280 project, the preliminary estimated total project cost is $2,657,500, of which $1,867,200 is for construction (October 2009). Therefore, the estimated Federal cost is $1,993,125 and the estimated non-Federal cost is $664,375. Annual cost of operation and maintenance is $15,000, and would be the responsibility of the local sponsor.

The primary local governmental body associated with the project is the Muskingum Water Conservancy District. The MWCD has a high level of interest in the project, and is fully expected to do so throughout the life of the project. In their role as non-Federal sponsor for the project, MWCD participated in preliminary discussions concerning their legal capability to sponsor the project. MWCD owns all lands required to implement the project. A Project Partnership Agreement (PPA) specifying the responsibilities of the two parties must be consummated prior to the initiation of construction.

The implementation of the recommended plan of development is the joint responsibility of the USACE of Engineers (representing the Federal government) and the MWCD. If a PPA is executed between the MWCD and the USACE, it is anticipated that the USACE (on a cost shared basis as described above) would complete the detailed design and plans and specifications for the project, provide Federal funds for project construction and manage the construction of the project.

8.4 Operation and Maintenance (O&M)

As required under the Section 1135 program, the O&M of the project would be a responsibility of the local sponsor. The sponsor would be responsible for 100 percent of this cost for the life of the project. To maintain the system after construction, the local sponsor would have to regularly remove sediment as it accumulates in the settling pond and wetlands and in the discharge clean-out structure.

The local sponsor would need to monitor the wetland vegetation planted within the embayment, and seedlings in riparian areas. Areas experiencing a high level of mortality may need to be replaced. It is estimated that there would be an annual failure of 10 percent of the vegetation planted for at least two years. This vegetation would have to be replaced until it establishes. Sediment (metals precipitate) removal would be the only

permanent maintenance activity.

Average annual O&M costs for the Selected Plan were estimated at $15,000 annually using AMDTREAT[5] software. Estimated maintenance costs were calculated at 3.5 percent of active, passive, ancillary and capital costs. . This includes mobilization, labor, and sludge disposal in an approved landfill. It should be noted that these costs were determined at an estimated worst case scenario for budgetary purposes. Costs could fluctuate, depending on altering flow rates and chemical composition of the mine water over the 50-year period. In addition, annual costs could be decreased significantly by investigating alternative uses for the iron oxide produced by the treatment system.

9.0 Conclusions

This ecosystem restoration report and its appendices have presented an in-depth analysis of existing conditions at MM-280. To restore the habitat that has been severely degraded by decades of sedimentation stemming from AMD requires on-going ecosystem treatment. The treatment options carefully considered in this report, if implemented, would restore aquatic, wetland and upland habitat, and improve the overall ecological, recreational, and aesthetic characteristics of the area. Incidentally, a substantial public safety situation would be averted by minimizing the risk of another mine related incident that could affect a public roadway.

Alternative 2, which includes treatment of AMD using settling pond and wetlands and reclamation of the spoil pile, as part of soil disposal, with material removed during construction of the discharge treatment system would be the most cost effective plan. No significant adverse impacts would be expected resulting from implementation of this plan. This plan would be considered the National Ecosystem Restoration Plan.

[5] AMDTreat was developed as a cooperative effort by the Office of Surface Mining Reclamation and Enforcement (OSM), the Pennsylvania Department of Environmental Protection and the West Virginia Department of Environmental Protection and is public domain.

10.0 References

Mitsch, W. J., Zhang, L, Anderson C. J., Altor, A. E., and Hernandez, M. E., 2005. Creating Riverine Wetlands: Ecological succession, nutrient retention, and pulsing effects. Ecological Engineering 25:5 pp510-527

11.0 List of Preparers

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