A. Pollution Sources

I. Major Sources:

a. Use the procedures discussed in the individual source reports as the means to reduce the flow of acid mine drainage from the major sources in the Chartiers Creek Drainage Basin. These procedures are generally:

I) Improving the drainage through unreclaimed or randomly reclaimed strip mine areas
2) Sealing the updip mine entries
3) Sealing open mine shafts
4) Restoring surface drainage in sink hole or subsided areas 5) Installing watertight mine seals

b. The specific recommendations, cost analysis and estimated percentage of flow reduction for each of the 43 major sources are presented in Appendix AI of this report. The major sources are grouped according to major tributaries rather than priority number for the convenience of the reader. Index Sheets in Appendix AI locate the 43 major sources. The Cost Analysis section of this report shows source number, percentage of pollution, method of abatement, estimated cost, and estimated percentage of flow reduction.

2. Minor Sources:

a. To further reduce the amount of acid water in the tributaries of Chartiers Creek, it is recommended that some of the minor sources be abated. These isolated minor sources are closely associated with unreclaimed or randomly reclaimed strip mines. Improvement of drainage through such strip mines in most cases would probably eliminate the minor sources.

b. A tabulation of these strip mines and associated minor sources, as well as cost estimates for abatement procedures, is included in the Cost Analysis Section of this report and Appendix CH.

3. <u>Deep Mine Dumps:</u>

a. Bury and then revegetate all mine dumps in accordance with the Land and Water Conservation and Reclamation Act as amended by HB 561 (1969 session). The mine dumps can be eliminated by:

I) Using the material as backfill in strip mines

2) Grading at their present locations and covering with suitable non-combustible soil and rock materials

3) Using the material as backfill in low areas near major traffic routes in order to create areas suitable for industrial development. Since these materials are usually combustible and contain expansive sulfide minerals, a minimum of 15 ft. of non-combustible and non-expansive soil and/or rock material should be placed on the dump material. Mine dump material as well as other borrow material used for this purpose must be compacted to a minimum of 95% of the maximum density-optimum moisture content of the modified Proctor.

b. Extinguish the burning mine dumps in accordance with the various methods available, such as excavation, burying, capping, etc. Each burning dump should be surveyed to determine the most feasible method.

c. If all the mine dumps are to be removed and buried, a master plan study which recognizes the potential future land use of the area should be prepared to provide the most efficient and economical method to dispose of the mine dumps.

B. <u>Surface Drainage</u>

1. Improve the natural drainage through the strip mines in the Chartiers Creek Drainage Basin as a method of reducing the flow of water entering the deep mines. This recommendation is based on:

a. The strip mines are located on private property and therefore reclamation of the strip mines is not at this time (January, 1970) permitted by the laws of the Commonwealth.

b. This method is not as effective as total reclamation but should reduce the flow of water entering the exposed deep mines and coal outcrops.

c. Improvement of the drainage through the strip mines will add unpolluted water to the streams which should increase the natural alkalinity of the streams and neutralize some of the acidity.

2. If the public laws of the Commonwealth are changed and it becomes lawful to restore strip mines on private property, then substitute strip mining reclamation for the recommendation given in Item B-I.

3. Backfill the sink holes created by mine subsidence as discussed in the individual source abatement recommendations. Some natural stream channels have been interrupted by the occurrence of mine subsidence, and stream flows enter into the sink holes and underlying deep mines. There is a direct connection between the loss of the natural surface waters in stream channels due to sink holes and the slugging effect of some of the sources. When the sink holes have been backfilled to within 2 ft. of the natural grade, mix bentonite with the backfill material and compact a 1 ft. layer on top of the fill. Complete the backfilling of the sink holes to grade with the recommended material. This procedure is an attempt to reduce the seepage through the backfill.

4. Construct impervious seals in the entries of deep mines which are located structurally updip from the point of discharge to reduce the volume of water entering the mine. A tabulation of the observed mine openings, based on our field study, is included in Appendix CII. The locations of these observed mine openings are shown on the Inventory Maps included in Appendix BII.

5. Open mine shafts should be filled to eliminate the natural percolation of ground water into the deep mines. The excavation of these mine and air shafts has interrupted the lateral flow channels of the ground water and has diverted the flow into the deep mines. Flows of up to 30 gpm were observed in one case (source 4971) to enter open air shafts. The drainage into mine shafts is also considered as a cause of the rapid flows which cause slugging of some of the sources. The locations of mine shafts are shown on the Inventory Maps included in Appendix 811 and tabulated in Appendix CII.

C. Subsurface Drainage

I. A pollution study should be conducted in the portions of the Racoon Creek and Montour Run Drainage Basins from which subsurface flows drain into the Chartiers Creek Drainage Basin. Correctional methods for these updip sources should be undertaken to prevent additional pollution and slugging in certain portions of the Chartiers Creek Drainage Basin.

2. The possibility of pumping sources 4971 and 4967 across Millers Run into the abandoned mines south of the sources should be investigated. The subsurface data indicates that the water should flow into the basin formed by the Nineveh Syncline which is about 230 ft. lower in elevation than the sources. The water injected into these mines from sources 4971 and 4967 would begin to flood the abandoned mine workings to the south and based on the geologic data, it would flow down dip to the south and possibly be trapped underground permanently.

A complete engineering study on the possibility of pumping sources 4971 and 4967 underground should be performed. Geologically and economically this method of abatement seems to offer a possible solution to controlling the high iron and high volume of water discharge at this source without treatment.

D. Pollution Abatement

1. In-Situ Treatment (Future Research Work):

a. Reduce pollution by in-situ treatment of the acid mine water in the underground mines by the use of neutralization agents. This method will eliminate the use of mine sealing, which would result in the development of a hydraulic head which may cause discharge of acid mine water in other areas of the basin. An additional benefit of in-situ treatment would be the elimination of the problem of sludge disposal usually associated with surface neutralization plants.

b. The use of in-situ treatment seems advisable at sources 4971, 4967, 6005, 6034-6035, 4041, 4810 and 4834, all of which contribute more than 500 lbs. per day acid and have an average iron concentration of more than 25 ppm.

c. The in-situ neutralization of sources 4971 and 4967 should be considered as a principal method of abatement in addition to surface restoration, because these sources are primarily areas of deep mines with little acreage disturbed by stripping; therefore, the discharge of these sources is due to the percolation of ground water into the vast underground mines. Injecting the water from these sources into adjacent mines, as discussed previously, if feasible, would be less costly.

d. Another in-situ method of abatement would be to place watertight seals at sources 4971 and 4967. Breakout of the mine acid water would probably occur along Mohawk Valley and Dolphin Run; however, the quality of the water may be improved.

e. Injection of neutralizing material in the mine west of sources 6034 and 6035 should precipitate the iron out into the mine. Sources 6034-6035 are variable in the alkalinity versus acidity ratio, and at times the alkalinity of the water exceeds the acidity. These sources have a high iron concentration (over 50 ppm). The pH of the sources averages about 6, suggesting a flooded condition of the two mines. The high iron water breaks out in the bank of Coal Run and west of Lynch Ponds. Injection of neutralizing material should raise the pH of the flooded mine pool and precipitate the iron in the mines. A research project similar to this is now in progress at the Monarch Shaft of the Duquesne Light Company, Allegheny County, Pennsylvania.

f. Additional engineering studies should be made to determine the feasibility of in-situ neutralization at sources 4971, 4967, 4810, 4834, 6034-6035 and 6005 using non-commercial slag and/or fly ash as the neutralizing agent. Slag and/or fly ash are very readily obtainable in the Pittsburgh area. Both the steel industry and public utilities pay to have these materials removed from their sites. It would appear that if disposal of this material into a deep mine could lower industrial disposal cost, industries would surely cooperate on such a venture. The engineering study should not only consider the economics of the injection method, but should also determine if an impervious barrier within the mine would occur and result in the blowout of a large volume of mine drainage water.

2. Plant Treatment:

a. Low Iron Sources (under 25 ppm):

1) Maximum abatement can be achieved by neutralizing low-iron discharges by the rotating drum method, after performing the other recommended abatement methods to reduce the flow to a minimum.

2) Some major sources have discharges with low (average less than 25 ppm) iron concentration. These sources have an average acid load greater than 500 lbs. per day. The following is a summary of these sources showing their average pH, iron concentration and abatement priority:

Source	Priority No.,	pH	Iron (ppm)
4805	4	3.4	9
4951	5	3.0	10
4952	5	3.0	10
6048	6	3.2	5
4962	7	3.7	3
4963	7	3.5	15
4801	8	3.0	15
4802	8	3.0	12
4654-4655	10	3.0	3
4055	12	3.5	17
4956	17	5.0	3
4957	17	3.0	7

3) A rotating drum filled with limestone through which acid water could pass should be sufficient to neutralize the acidity of the water. The rotating type mechanism is suggested because the abrasion of the limestone during rotation should provide fresh limestone surfaces and some lime powder for the neutralization. The abrasion should also prevent the build-up of iron deposits on the limestone.

b. High Iron Sources (over 50 ppm):

I) Maximum abatement of high iron sources (4971-4967,'6034-6035, 4810, 4834 and 6005) will require construction of surface treatment facilities with sludge ponds similar to those being used on active mine source 4138. Before determining the capacity of a plant, all other recommended abatement procedures should be accomplished. This is to reduce the flow of these sources to a minimum.

2) Construction of a combination of facilities to treat both sewage from the surrounding communities and the high iron discharges from the mines simultaneously may be feasible. This would involve a high initial cost for the plant but could reduce the yearly operation cost.

E. Hydrologic-Year Study

I. Post-construction studies which include collection and analysis of water samples and inspection of the improved channels and drainage facilities should be conducted for a period of two years after completion of the construction at the various sources. Data collected during this period of time would:

a. Verify theoretical assumptions of changes in water quality expected due to the remedial measures. The program would use as base data the readings obtained during Phases I, II and III of this survey.

b. Provide data as to the pounds per day of acid load which must be removed by further abatement measures or treatment to provide good quality water in the Chartiers Creek Drainage Basin.

2. The areas in which construction has taken place should be checked at least every six months to establish whether any new source of pollution occurs as a result of the changes made in the drainage patterns. During this inspection, the minor sources would also be visited to note the effect on them of the correctional methods performed on the major sources.

F. Land Reclamation

I. Determine the feasibility of filling all the abandoned deep mine workings with fly ash and/or non-commercial slag and coal refuse materials. This could result in the following benefits by providing:

a. A substantial reduction in pollution from acid mine drainage by reducing the flow into and through the mines.

b. In-situ neutralization at some sources due to the natural alkalinity of these materials.

c. A large area for disposal of industrial waste materials.

d. A reduction in the risk of damage due to mine subsidence, thus increasing the amount of land suitable for development and increasing the property values of the area. Although this would be an added benefit, it should not be considered the primary basis for undertaking the project.

2. The most suitable areas for this type of a program are the deep mines located north of North Branch Robinsons Run and along Campbells Run. These areas are the smaller, isolated, deep-mined areas of the basin. Most of these areas are isolated on three sides by stripping operations. This is an advantage, because a feasibility pilot project could be performed and the discharge and quality of water could be checked to detect any undesirable effects. If such undesirable effects do occur, then only a very small area would be affected.

3. An alternative suggestion to total filling of the mine would be partial filling of the main haulageways with coarse aggregate slag, thus retaining some degree of porosity and permeability to the flow of water through these passageways and yet neutralizing, or partially neutralizing, the acid water in-situ. In the case of subsidence, the flow of water could continue through the permeable materials, but there is a risk that this would result in a blockage at a later date.

4. Should the filling of mines prove feasible, consideration could be given to the construction of a pipeline for transportation of the fly ash material to the various sites.