WATER MANAGEMENT/WATER QUALITY
RESERVOIR OPERATIONAL SUMMARIES

U.S. Army Engineer District, Pittsburgh
Corps of Engineers
Pittsburgh, PA

1996

Foreword. The purpose of this document is limited to updating and summarizing major water management/water quality objectives, concerns, and operations at the sixteen reservoir projects operated by the U.S. Army Corps of Engineers within the Pittsburgh District. In order to keep these summaries condensed and manageable, it was not possible to fully develop or even mention numerous pertinent but minor topics, or many very important but infrequent special operations made during emergency flood, drought, spill, etc. situations. The summary format utilized does not allow an opportunity to fully explore all of the legal, structural, institutional, or safety related constraints which must be considered in operating these projects. Also, neither water management/water quality operations at the District's twenty-three navigation dams, nor at reservoirs operated by others in coordination with the District, are addressed in this report.

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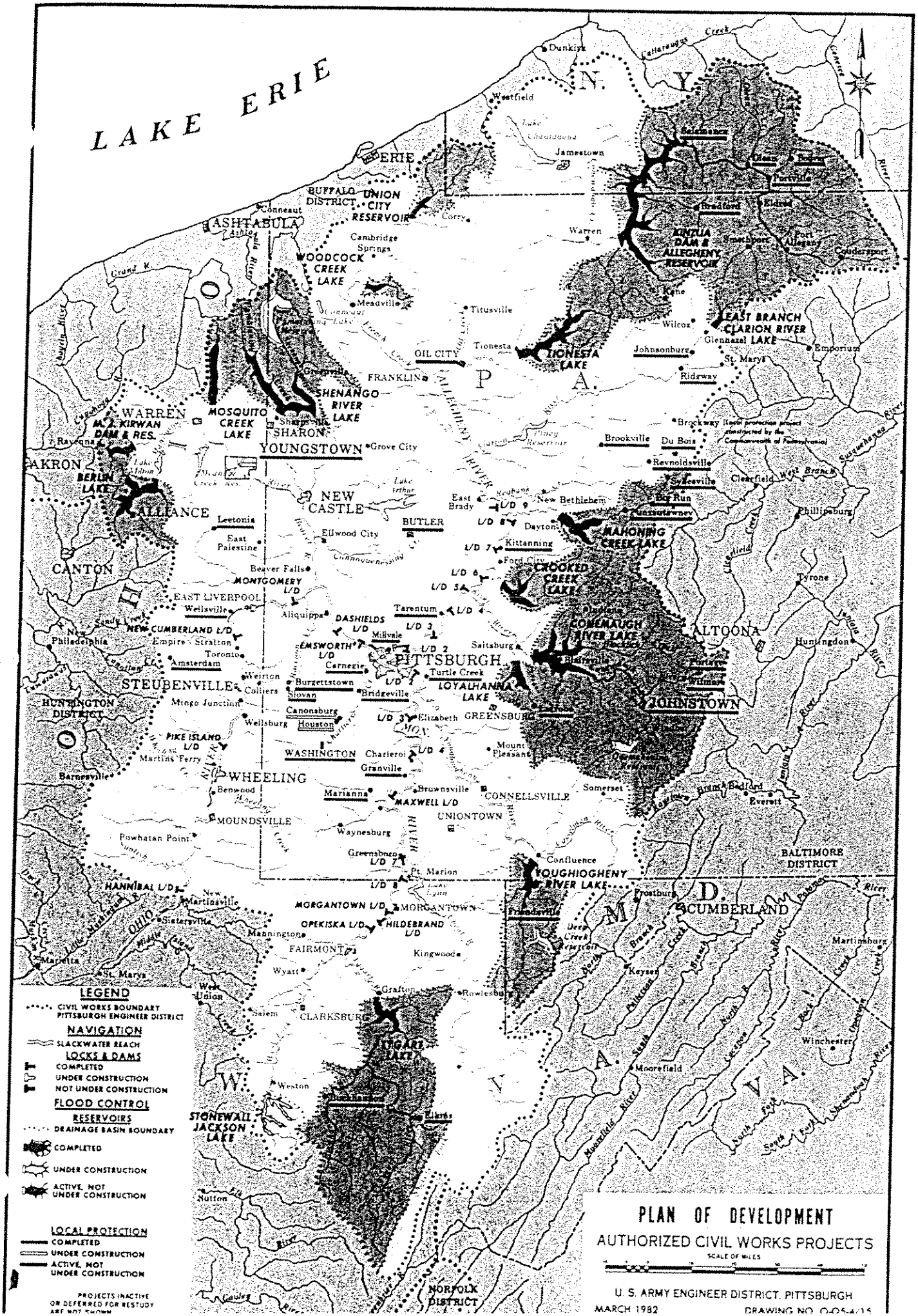
TABLE OF CONTENTS


LAKE ERIE
N. Y.
P A.
O H I O
W. V A.
M D.
ERIE
BUFFALO DISTRICT
UNION CITY RESERVOIR
ASHTABULA
WOODCOCK CREEK LAKE
KINZUA DAM & ALLEGHENY RESERVOIR
EAST BRANCH CLARION RIVER LAKE
TIONESTA LAKE
SHENANGO RIVER LAKE
MOSQUITO CREEK LAKE
M.J. KIRWAN DAM & RES.
BERLIN LAKE
YOUNGSTOWN
AKRON
ALLIANCE
WARREN
SHARON
NEW CASTLE
BUTLER
CANTON
MAHONING CREEK LAKE
CROOKED CREEK LAKE
MONTGOMERY L/D
DASHIELDS L/D
EMSWORTH L/D
NEW CUMBERLAND L/D
PITTSBURGH
ALTOONA
JOHNSTOWN
STEUBENVILLE
HUNTINGTON DISTRICT
LOYALHANNA LAKE
CONEMAUGH RIVER LAKE
PIKE ISLAND L/D
WASHINGTON
WHEELING
MAXWELL L/D
CONNELLSVILLE
UNIONTOWN
MOUNDSVILLE
GREENSBURG
YOUGHIOGHENY RIVER LAKE
BALTIMORE DISTRICT
CUMBERLAND
HANNIBAL L/D
MORGANTOWN L/D
OPEKISKA L/D
HILDEBRAND L/D
MORGANTOWN
FAIRMONT
CLARKSBURG
TYGART LAKE
STONEWALL JACKSON LAKE
NORFOLK DISTRICT
LEGEND
CIVIL WORKS BOUNDARY PITTSBURGH ENGINEER DISTRICT
NAVIGATION
SLACKWATER REACH
LOCKS & DAMS
COMPLETED
UNDER CONSTRUCTION
NOT UNDER CONSTRUCTION
FLOOD CONTROL
RESERVOIRS
DRAINAGE BASIN BOUNDARY
COMPLETED
UNDER CONSTRUCTION
ACTIVE, NOT UNDER CONSTRUCTION
LOCAL PROTECTION
COMPLETED
UNDER CONSTRUCTION
ACTIVE, NOT UNDER CONSTRUCTION
PROJECTS INACTIVE OR DEFERRED FOR RESTUDY ARE NOT SHOWN
PLAN OF DEVELOPMENT
AUTHORIZED CIVIL WORKS PROJECTS
SCALE OF MILES
U. S. ARMY ENGINEER DISTRICT, PITTSBURGH
MARCH 1982
DRAWING NO. O-O5-4/15

MICHAEL J. KIRWAN RESERVOIR

A. Water Management.

1. Authorized Purposes. Flood control along the West Branch Mahoning, Mahoning, Beaver and upper Ohio River valleys, low flow augmentation for water quality, and water supply.

2. Water Management Background.

a. Drainage Area. 80.5 square miles

b. Impoundment. 2,650 surface acres and 56,700 acre-feet of storage at a maximum summer conservation pool elevation of 985.5 feet NGVD.

c. Outlet Works. Selective withdrawal with intakes at invert elevations 936 (flood), 939, 956, and 972 feet NGVD.

3. Commitments.

- Kirwan, Berlin-Milton, Mosquito Creek, and Shenango Lakes are operated together to control flooding in the Beaver-Mahoning River valley. Along with nine reservoirs in the Allegheny River basin and three reservoirs in the Monongahela River basin, the Beaver-Mahoning basin reservoirs reduce flooding along the upper Ohio River valley.

- A 1.5 MGD water supply commitment to the Ravenna Arsenal Military Reservation (not currently withdrawing).

- The water quality storage in Michael J. Kirwan Reservoir is owned by Mahoning and Trumball Counties, Ohio, and managed at their request for low flow augmentation. In order to achieve downstream water quality objectives, Kirwan and Berlin-Milton Lakes are operated together to meet minimum USEPA established flow requirements for the Mahoning at Leavittsburg, Ohio. The minimum scheduled flow at Leavittsburg varies from 145 cfs (winter) to 310 cfs (summer). Flow deficiencies are augmented 64% by Berlin-Milton and 36% by Kirwan. Mosquito Creek Lake provides additional flow augmentation below Leavittsburg. At Youngstown, Ohio, the minimum schedule varies from 225 cfs (winter) to 480 cfs (summer).

- The ODNR has requested that, when possible, the Michael J. Kirwan Reservoir contribution to the Leavittsburg flow augmentation be increased above its scheduled 36% to stabilize pool elevations and prolong the recreation season at Berlin Lake.

B. Water Quality Conditions.

- Kirwan Lake can be characterized as a warm, shallow, and

moderately to highly productive reservoir which undergoes thermal and chemical stratification during the summer months.

- Kirwan Lake can become anaerobic, less than or equal to 1 mg/l dissolved oxygen, in the deeper strata of the lake during summer stratification. Heavy metals and nutrients tend to accumulate in the hypolimnion, but do not have an adverse impact on the overall lake quality. Retention reduces mean and maximum inflow iron concentrations, but occasional high manganese and nutrient concentrations can be passed downstream.

- Selective withdrawal control of downstream water quality is achieved primarily by utilizing the invert elevation 956 feet NGVD gate during the summer season, and the invert elevation 972 feet NGVD gate whenever additional discharge capacity is required. Discharge of hypolimnetic water from the lower gates can degrade downstream water quality and is avoided.

- Biological productivity can be very high in the upper reservoir, decreasing in the lower reaches. Despite high productivity, taste and odor problems which occur at nearby Pymatuning and Shenango Lakes have not occurred at Kirwan Lake.

- Basin geology and land use patterns contribute large amounts of heavy metals and nutrients to runoff, and a recent increase in oil and gas drilling activities has apparently contributed to a trend towards increased mineralization of its inflows. A general demineralization of West Branch Mahoning River due to impoundment is evident between the inflow and the outflow. Both mean and maximum turbidity, conductivity, suspended solids, total hardness and total iron are reduced. Mean and maximum total phosphorus and oxidized nitrogen are also reduced during retention, but outflow ammonia-nitrogen, Kjeldahl nitrogen, and manganese are significantly increased relative to the inflow.

- The primary value of Kirwan Lake releases is related to dilution of downstream thermal, industrial, and domestic wastes in the lower Mahoning River. The Mahoning River valley is densely populated, especially in the Warren-Youngstown area. A total of 600,000 persons reside in the relatively small (1,132.8 square miles) Mahoning basin. Heavy industrial and commercial development flanks the river on both banks.

C. Operational Evaluations. There is intense competition in the Mahoning River basin for flood control, water supply, and water quality storage. In addition, there is an extremely high demand for recreational storage. Annually the District experiences approximately five million recreation man-days at its three Mahoning River basin reservoir projects. District operations must continually balance these complex, changing and competing needs.

D. Operational Initiatives. There is an urgent need for system

level modeling of the operation of the Mahoning River basin reservoir system.

BERLIN LAKE

A. WATER MANAGEMENT.

1. Authorized Purposes. Flood control along the Mahoning, Beaver and upper Ohio River valleys, low flow augmentation for water quality, and water supply.

2. Water Management Background.

- Drainage Area. 249 square miles

- Impoundment. 3,590 surface acres and 58,300 acre-feet of storage at a maximum summer conservation pool elevation of 1,024.7 feet NGVD.

- Outlet Works. Bottom withdrawal through three 36-inch gate valves with intakes at invert elevation 956.5 feet NGVD, and there are four crest gates at invert elevation 1,014 feet NGVD.

3. Commitments. Berlin-Milton, Mosquito Creek, Kirwan, and Shenango Lakes work together to control flooding in the Beaver-Mahoning River valley. Along with nine reservoirs in the Allegheny River basin and three reservoirs in the Monongahela River basin, the Beaver-Mahoning basin reservoirs reduce flooding along the upper Ohio River.

- A water supply diversion commitment of up to 34 MGD to the Mahoning Valley Sanitary Districts' Meander Creek Reservoir (presently 2-3 MGD are actually being withdrawn).

- A water use contract and coordination with the city of Alliance, Ohio, for 367 acres of the Berlin Lake pool, for Deer Creek Lake, a water supply sub-impoundment.

- Coordination of water supply storage and release from Walborn Reservoir in the Berlin Lake tributary drainage basin.

- An agreement with the State of Ohio where the Corps of Engineers recommends the operations and daily gate settings for Milton Dam, located just 7.7 miles downstream of Berlin Dam.

- In order to meet downstream water quality objectives, Berlin-Milton Lakes, and Kirwan Reservoir are operated together to meet minimum USEPA established flow requirements for the Mahoning River at Leavittsburg, Ohio. The minimum scheduled flow at Leavittsburg varies from 145 cfs (winter) to 310 cfs (summer). Flow deficiencies are augmented 64% by Berlin-Milton and 36% by Kirwan. Mosquito Creek Lake provides

additional flow augmentation below Leavittsburg. At Youngstown, Ohio, the minimum schedule varies from 225 cfs (winter) to 480 cfs (summer).

- The crest gates may be utilized during extreme emergencies. Because of their potential to produce downstream gas supersaturation problems, however, use of these gates is generally avoided.

- When possible, the ODNR has requested that the Berlin Lake contribution to the Leavittsburg schedule be reduced and the Kirwan contribution increased, to stabilize pool elevations and prolong the recreation season at Berlin Lake.

- The ODNR considers Berlin Lake to be the best inland walleye fishery in Ohio. In addition, they collect walleye eggs from Berlin Lake each spring for incubation at the ODNR Akron Hatchery. The walleye fry produced are then distributed to impoundments across the state. The District is committed to avoidance of sudden drawdowns during a portion of the spring to facilitate both walleye spawning success and the collection of ripe brood walleyes by ODNR for their hatchery stock.

- Because of past problems with high mortality of walleyes passing through the dam, especially during the period from December to April, we are now committed to avoid sudden openings of the sluices, and total openings of any single gate at the project.

- Previously, at the request of the ODNR, the District attempted to draw the pool down to elevation 1,004 feet NGVD each winter in order to flush silt from gravel walleye spawning beds. However, the ODNR has reexamined this operation and now no longer believes that it is necessary.

C. Water Quality Conditions.

- Berlin Lake can be characterized as a warm, moderate to highly productive reservoir which stratifies thermally and chemically during the summer. Inflow quality is generally good, and the chemical characteristics of the reservoir water pose no constraints on operation of the lake.

- Overall, the lake can be considered biologically productive. The upper reach of the lake is eutrophic. Productivity is somewhat less in the lower portion of the lake. Despite high productivity, the occasional taste and odor problems identified at nearby Shenango and Mosquito Creek lakes have not been documented at Berlin Lake.

- Pool and outflow quality is generally good, and water quality

does not pose any restrictions on operation of this project. Oxygen depletion and heavy metal accumulation in the hypolimnion occur during summer stratification, but do not have an adverse impact on overall lake water quality. High summer hypolimnetic iron concentrations are occasionally passed downstream through releases from Berlin Dam.

- There have been several fire/spill incidents in the immediate vicinity of the project that involved massive quantities of pesticides, and there are several hazardous waste contaminated sites near the lake.

- The most significant positive effect of Berlin Lake releases on instream flows is related to dilution of downstream thermal, industrial, and domestic wastes in the lower Mahoning River. The Mahoning River valley is densely populated, especially in the Warren-Youngstown area. A total of 600,000 persons reside in the relatively small (1,132.8 square miles) Mahoning basin. Heavy industrial and commercial development flanks the river on both banks.

D. Operational Evaluation. There is intense competition in the Mahoning River basin for flood control, water supply, and water storage. In addition, there is an extremely high demand for recreational storage. Annually the District experiences approximately five million recreation man-days at its three Mahoning River basin projects. District operations must continually balance these complex, changing and competing needs.

E. Operational Initiatives. There is an urgent need for system level modeling of the operation of the Mahoning River basin reservoir system.

MOSQUITO CREEK LAKE

A. Water Management.

1. Authorized Purposes. Flood control along the Mosquito Creek, Mahoning, Beaver, and upper Ohio River valleys, low flow augmentation for water quality, and water supply.

2. Water Management Background.

- Drainage Area. 97.4 square miles

- Impoundment. 7,850 surface acres and 80,400 acre-feet of storage at a maximum summer conservation pool elevation of 901.4 feet NGVD.

- Outlet Works. Bottom withdrawal with flood and water supply/low flow intakes at invert elevations 875 and 885 feet NGVD, respectively.

3. Commitments.

- Mosquito Creek Lake, Berlin-Milton Lakes, and Michael J. Kirwan Reservoir are operated as a system to control flooding in the Mahoning River Valley. These Mahoning Basin impoundments and Shenango River Lake provide flood protection in the Beaver River Valley. Along with nine reservoirs in the Allegheny River Basin and three reservoirs in the Monongahela River Basin, the Mahoning-Beaver River Basin reservoirs reduce Ohio River flood stages.

- Similarly, the Mahoning River Basin reservoirs are operated as a system to provide downstream low flow augmentation and water quality control. The principal control points for these operations are flow at Leavittsburg, Ohio and both flow and water temperature at Youngstown, Ohio. The minimum scheduled flow at Leavittsburg varies along a curve from 145 cfs in the winter to 310 cfs in the summer. Usually 64% of the flow deficiency at Leavittsburg is augmented from Berlin-Milton Lakes and 36% by M.J. Kirwan Reservoir. At Youngstown, Ohio, minimum scheduled flows range from 225 cfs in the winter to 480 cfs in July. Flow deficiencies not provided by Berlin-Milton and Kirwan Reservoirs are made up by Mosquito Creek augmentation. The maximum regulated water temperature at Youngstown ranges from 67 degrees in January to 98 degrees in late July.

- Because it is such a large and shallow impoundment, evaporation losses are very significant at Mosquito Creek Lake, and these losses must be factored into the operational schedule.

- Although Shenango River Lake is operated for low flow augmentation independently of the Mahoning River system, climatic conditions are similar over these two relatively small and adjacent drainage basins. Therefore, the two schedules are highly complementary, and substantial additional water quality mitigation of Mahoning River pollution occurs in the Beaver River below the confluence of the Shenango River.

- A 16 MGD water supply commitment to the city of Warren, Ohio.

C. Water Quality Conditions.

- Moderate and unstable thermal and chemical stratification typically develops in Mosquito Creek Lake during the summer months. Total iron, total manganese, total phosphorus, ammonia, and Kjeldahl nitrogen concentrations tend to increase with depth. Mosquito Creek Lake can become anaerobic (less than 1.0 mg/l dissolved oxygen) below 15 feet, and near the sediment-water interface at lesser depths by late summer. However, since these oxygen deficient waters are isolated in the hypolimnion, they are not normally perceived as a serious in-pool water quality problem.

- Primary biological production in the lake is high and algae related taste and odor problems have been experienced.

- Low flow releases of good quality water from Mosquito Creek Lake are a significant factor in dilution of downstream thermal, industrial and domestic wastes in the Mahoning River. The Mahoning River valley is densely populated, especially in the Warren-Youngstown area. A total of 600,000 persons reside in the relatively small (1,132.8 square miles) Mahoning basin. Heavy industrial and commercial development flanks the river on both banks.

D. Operational Evaluation. There is intense competition in the Mahoning River basin for flood control, water supply, and water quality storage. In addition, there is an extremely high demand for recreational storage. Annually the District experiences approximately five million recreation man-days at its three Mahoning River basin reservoir projects. District operations must continually balance these complex, changing, and competing needs.

E. Operational Initiatives. There is an urgent need for system level modeling of the operation of the Mahoning River basin reservoir system.

SHENANGO RIVER LAKE

A. Water Management.

1. Authorized Purposes. Flood control along the Shenango, Beaver, and upper Ohio River valleys, low flow augmentation for water quality, and to provide recreation and conservation of fish and wildlife.

2. Water Management Background.

- Drainage Area. 589 square miles

- Impoundment. 3,560 surface acres and 29,900 acre-feet of storage at a maximum summer conservation pool elevation of 896 feet NGVD.

- Outlet Works. Bottom withdrawal through seven intakes at invert elevation 871 feet NGVD.

3. Commitments.

- The Beaver River basin is controlled by four Corps of Engineers reservoirs: Berlin, Michael J. Kirwan, Mosquito, and Shenango Lakes. These reservoirs reduce flood stages in the Mahoning, Shenango, and Beaver Rivers, and along with nine reservoirs in the Allegheny River basin and three reservoirs in the Monongahela River basin, provide for flood stage reductions along the upper Ohio River.

- Shenango Lake is also operated in conjunction with Pymatuning Lake, a 188,000 acre-foot (at summer conservation pool elevation 1,008 feet NGVD) Commonwealth of Pennsylvania flood control and low flow augmentation reservoir located at mile 63.4 on the Shenango River. A closely coordinated operation plan between the PADNR and the Corps of Engineers ensures that the two reservoirs complement each other in the dual roles of flood control and low flow regulation.

- Shenango Lake augments streamflow in the warm low flow season, benefitting water quality in the Shenango River. Along with Berlin, Michael J. Kirwan, and Mosquito Lakes which augment low flow in the Mahoning River to control thermal, industrial, and domestic pollution, the four Corps of Engineers' reservoirs in the Beaver-Mahoning significantly improve water quality in the Beaver and upper Ohio Rivers.

- Bankfull releases from the Shenango Dam are reduced during the growing season to protect downstream agricultural areas.

B. Water Quality Conditions.

- Shenango River Lake can be characterized as a warm and highly productive reservoir which stratifies thermally and chemically during the summer months. Anoxia develops below 15 feet and hypolimnetic iron and manganese concentrations as high as 15,255 and 3,800 ug/l, respectively, can accumulate by late summer. Both the Shenango River and Pymatuning Creek inflows contribute high quantities of nutrients and heavy metals to the lake.

- Basin geology and land use contribute large amounts of nutrients and heavy metals to basin runoff. Algae problems in Shenango Lake are compounded by massive export of algae from Pymatuning Lake to the Shenango River arm of Shenango Lake.

- Shenango Lake is a highly productive impoundment. Late summer blue-green algae blooms and occasional spring taste and odor problems that may be related to Anabaena blooms seasonally occur in the lake. Algae concentrations have occasionally reached nuisance levels in the lake, interfering with recreation and aesthetics, tainting fish flesh, and increasing activated carbon treatment and expenses for water users downstream of the project. Taste and odor problems have affected municipal water supplies in Sharon, New Castle, and as far downstream as Beaver Falls, PA, near the mouth of the Beaver River.

- While the entire Shenango River basin can be characterized as nutrient rich, and the taste and odor problems are complex, the presently available data suggests that the problems originate in Pymatuning Lake and may be compounded by sewage from Greenville, PA, and the impoundment of the Shenango River by Shenango Dam. Extensive wetlands on the Little Shenango River and Pymatuning Creek are also likely contributing factors.

- Large numbers of waterfowl which congregate near the swimming beach can cause a localized sanitary problem in the beach area.

- There is a serious raw sewage problem in the Pymatuning Creek Arm near Kinsman, Ohio.

- The District has reclaimed and regularly monitors a large hazardous waste dump on project lands.

- Low flow regulation schedules for Shenango Lake are set up primarily to meet the demands of municipal and industrial growth at Sharon, PA. The adopted 250 cfs scheduled minimum summer flow at Sharon, PA, provided by Shenango Lake augmentation of Pymatuning Lake releases, effectively mitigates

sewage and industrial waste loading from Sharon to the confluence of the Mahoning at New Castle, PA. Substantial improvement of the Beaver River has resulted from the reduction of the sewage load imposed by New Castle at the head of the Beaver River, and by dilution of the severely thermal, domestic, and industrial waste polluted Mahoning River. The positive effect of Shenango Lake and the three other Corps of Engineers' reservoirs in the Beaver-Mahoning basin are evident throughout the entire length of the Beaver River and into the upper Ohio River.

C. Operational Evaluation. Prior investigations have demonstrated that there are no feasible structural or operational solutions to either the severe lake eutrophication, or the periodic discharge of waters with elevated iron concentration problems at Shenango River Lake. Abatement of these problems would require changes in land use patterns in the tributary drainage basin of the project. However, there is an apparent long-term trend towards improving inflow water quality, with a subsequent trend towards moderation of the water quality problems experienced at the project.

D. Operational Initiatives. Opportunities for operational initiatives are limited at this time, and the District is now emphasizing monitoring and trend analyses.

STONEWALL JACKSON LAKE

A. Water Management.

1. Authorized Purposes. Flood control along the West Fork, Monongahela, and upper Ohio River valleys, low flow augmentation for water quality, and recreation.

2. Water Management Background.

- Drainage Area 102 square miles

- Impoundment. 2,530 surface acres and 48,000 acre-feet of storage at a maximum summer pool elevation of 1,073.2 feet NGVD.

- Outlet Works. Three flood control sluices at invert elevation 1017.5 feet NGVD, and moveable low flow intakes in two towers capable of withdrawing from any elevation between 1,038 and 1,082 feet NGVD.

3. Commitments.

- Operated in coordination with other Monongahela River basin reservoir projects to achieve flood reduction objectives.

- Provides low flow augmentation to moderate domestic, industrial, and mineral extraction activity related pollution along the West Fork and Monongahela Rivers. This augmentation is particularly effective in controlling domestic pollution below the communities of Weston, Clarksburg, and Fairmont, West Virginia, and in moderating the impacts of polluted drainage from abandoned bituminous coal mines in the lower West Fork River basin.

- In coordination with Tygart River Lake, Stonewall Jackson Lake is operated to assure a minimum flow of 420 cfs in the upper Monongahela River at Opekiska L/D (340 cfs from Tygart River Lake and 80 cfs from Stonewall Jackson Lake).

- A hydropower generation agreement with Monongahela Power.

- Maintain downstream water temperatures to approximate pre-impoundment thermal regime.

- Downstream whitewater recreation has been added as an authorized project purpose.

B. Water Quality Conditions.

- Stonewall Jackson Lake is a relatively warm and shallow impoundment which develops very strong and highly persistent

thermal and chemical stratification patterns during the summer and late into the autumn months.

- Very high concentrations of iron, manganese, and hydrogen sulfide accumulate in the chemically reduced and anoxic hypolimnetic waters of this impoundment during the season of summer thermal and chemical stratification. This creates problems and trade off situations for the District in our attempts to meet downstream temperature regulation and water quality objectives.

- Commitments to maximize hydropower generation at Stonewall Jackson Dam also highly complicate the District's ability to meet downstream water temperature and water quality objectives.

- Unauthorized downstream withdrawals for community water supply and for cooling water for steam electric generation diminish the effectiveness of operations to augment the West Fork River for water quality. The utility withdrawing the augmentation for cooling water has an alternative water supply source, Stonecoal Lake, but since Stonewall Jackson Lake became operational they have diverted a portion of the Stonecoal Lake storage to recreation with apparent state approval.

- There is intense competition for the water quality storage in Stonewall Jackson Lake from in-pool recreational interests.

- A downstream water supply dam (Bendale Dam) which was previously planned to be removed before Stonewall Jackson Dam became operational, creates a high tailwater situation at Stonewall Jackson Dam. The high tailwater both interferes with hydropower production and limits the District's ability to reaerate the turbine discharge and maintain desirable downstream dissolved oxygen concentrations.

C. Operational Evaluation. There is intense competition for water quality, domestic and industrial water supply, and recreation storage at Stonewall Jackson Lake.

D. Operational Initiatives. There is an urgent need to model the impacts of Stonewall Jackson Dam discharges on downstream water quality. The results of such a modeling effort would be useful in on going negotiations on the use of storage at the project.

TYGART RIVER LAKE

A. Water Management.

1. Authorized Purposes. Flood reduction along the lower Tygart, Monongahela, and upper Ohio River valleys, and low flow augmentation, and navigation.

2. Water Management Background.

- Drainage Area. 1,184 square miles
- Impoundment. 1,750 surface acres and 109,600 acre-feet of storage at a maximum summer conservation pool elevation of 1,094 feet NGVD.
- Outlet Works. Bottom withdrawal with eight floodgates and two low flow intakes (now inoperative) at invert elevations of 995.0 and 991.75 feet NGVD, respectively.

3. Commitments.

- Operated in coordination with other Monongahela River basin reservoir projects to achieve flood reduction objectives.
- Informal water supply agreement with the city of Grafton, WV, which includes multi-level intakes in Tygart Dam.
- Up to an 800 cfs flow limit, maintain a minimum 2:1 flow ratio between the Tygart River downstream of the dam and both Three Forks Creek and the West Fork River, both acid mine drainage (AMD) degraded.
- Additional augmentation during especially severe Three Forks Creek AMD events.
- Augmentation to prevent West Fork River backwaters from degrading the Fairmont, WV water supply.
- In coordination with Stonewall Jackson Lake, Tygart Lake is operated to assure a minimum flow of 420 cfs in the upper Monongahela River at Opekiska L/D (340 cfs from Tygart River Lake and 80 cfs from Stonewall Jackson Lake).
- FERC has issued a still active license for non-Federal hydropower development at Tygart Dam.
- By informal agreement with WVDNR, try to keep the winter pool elevation above 1,030 feet NGVD to allow access to the lake from their Doe Run boat ramp.

B. Water Quality Conditions.

- Tygart River Lake is a deep, warm impoundment which chemically and thermally stratifies during the summer season, and which is negatively influenced by acid mine drainage (AMD) pollution.

- AMD pollution from bituminous coal mines in the tributary drainage basin degrades the waters of Tygart River Lake. The acidity chronically suppresses primary biological production in the lake, and in turn limits the fishery and recreational potential of the project.

- As a result of AMD, a reduction in the alkalinity and buffering capacity of waters stored in Tygart River Lake and discharged from the dam limits the effectiveness of operations to augment flows downstream of the dam for mitigation of the impacts of additional sources of AMD.

- Discrete acidic slug flows can traverse the reservoir as spring overflows, summer interflows, or autumn underflows. Overflow and interflow slugs are typically well mixed and diluted prior to discharge. In autumn, inflows cool before the reservoir and this denser water travels as a distinct underflow in the reservoir. With bottom withdrawal, the retention time of an underflow is short and mixing is not thorough. If the underflow is acidic, depressed pH and highly ferrous outflows can be discharged.

- When discharges from Tygart Dam are low, and there have been antecedent dry conditions where acid wastes have accumulated in mines in the Three Forks Creek drainage basin, short duration, high intensity storms can very quickly result in extremely acidic and destructive shock flows entering the Tygart River downstream of Tygart Dam.

- Under certain flow conditions, AMD degraded waters from the West Fork River can back up into the Tygart River arm of the pool of Opekiska L/D on the Monongahela River. The West Fork River AMD then degrades the water supply of the city of Fairmont, West Virginia, located on the lower Tygart River.

- Pool fluctuation can impact warmwater fish reproduction in shoals by alternately flooding and drying eggs.

- Erosion from fluctuating pool levels on steep slopes preclude establishment of submerged aquatic vegetation and limit fish spawning, waterfowl, and other aquatic life habitat.

C. Operational Evaluation. With a structural modification, selective withdrawal options could be used to control underflow currents and produce a more consistent quality discharge. However, the existing bottom withdrawal provides an acceptable

means for the partial mitigation of acid slugs without sacrificing reservoir water quality. Withdrawal from a higher elevation during the summer would not only create downstream pH depressions, but acid interflows could penetrate the reservoir at a higher elevation and impact on sensitive surface strata.

Increased winter storage would provide more water for mitigation of the degraded inflows. This option, however, conflicts with flood control storage requirements and dam safety concerns.

Effective operations can neutralize the acidic load from Three Forks Creek and prevent West Fork River waters from backing up into the lower Tygart River. At present, the District attempts to control both problems by maintaining a summer season minimum flow ratio of 2:1 between the Tygart Dam discharge and the flow of Three Forks Creek, and also between the Tygart Dam discharge and the flow of the West Fork River at Enterprise, West Virginia. In addition, the District maintains a remote sensing, continuously reporting water quality monitoring station on lower Three Forks Creek. However, since short duration, high intensity storms promote every sudden episode of acidic drainage in the Three Forks Creek watershed, Tygart Dam can not always succeed in maintaining the desired 2:1 flow ratio due to operational response time.

The loss of use of the two flow valves at Tygart Dam is a potential constraint to water quality operations.

D. Operational Initiatives. The most logical solution to AMD related problems in the Tygart River drainage basin would be to abate the AMD pollution at its source. The District received authorization through the Water Resource Development Act (WRDA) to study water resource problems in the basin that resulted in a 1995 reconnaissance level report to abate AMD from the single greatest AMD source in the Tygart River drainage basin, Grassy Run, by construction of a successive alkalinity-producing system (SAPS) passive AMD treatment system on Grassy Run. This reconnaissance subsequently proceded to a 1996 feasibility study. Another WRDA funded study is now being planned to examine potential passive treatment of AMD sources on Fords Run, Sandy Creek, and Three Forks Creek.

A Section 1135 Environmental Restoration Project is now being considered to partially mitigate for the negative impacts of fluctuating pool elevations in Tygart Lake. This proposed project involves construction of a small subimpoundment on a tributary of the impoundment, Doe Run, where a stable pool could be maintained. Stable pool conditions in the sub-impoundment would promote the growth of aquatic plants which could serve as fish spawning and nursery areas, and provide habitat for waterfowl and other forms of aquatic life.

YOUGHIOGHENY RIVER LAKE

Water Management.

1. Authorized Purposes. Flood control along the Youghiogheny, lower Monongahela, and upper Ohio River valleys, and low-flow augmentation for water quality.

2. Water Management Background.

   - Drainage Area. 434 square miles

   - Impoundment. 2,840 surface acres and 154,500 acre-feet of storage at a maximum summer conservation pool elevation of 1,439 feet NGVD.

   - Outlet Works. Wheel gate controlled bottom withdrawal with intake at invert elevation 1,316.24 feet NGVD and a tunnel bifurcation to a hydropower plant.

3. Commitments.

   - Operated in coordination with other Monongahela River basin reservoir projects to achieve flood protection objectives.

   - Low flow augmentation for water quality which effectively moderates the influence of acid mine drainage pollution along the Youghiogheny River, and domestic, industrial, and thermal pollution degradation in the lower Monongahela River.

   - Water temperature control to maintain a very valuable cold-water fishery. The first 25-mile long reach of the Youghiogheny River below the dam is officially "approved trout water" intensely managed by the Pennsylvania Fish and Boat Commission. While water temperatures become marginal for a quality coldwater fishery downstream of Connellsville, Pennsylvania, an informal trout fishery nonetheless also exists in the lower 49-mile long length of the Youghiogheny River, which is maintained by private sportsmans' groups.

   - Post-authorized for whitewater recreation and is operated to maintain one of the nation's most heavily utilized whitewater recreation rivers, which supports in excess of 250,000 commercial rafting trips per year.

   - Periodically, high releases are sustained for a week to accommodate National Whitewater Championship events.

   - Non-Federal (7 MW) run-of-river hydropower at Youghiogheny Dam.

B. Water Quality Conditions.

- The reservoir can be characterized as a clear, oligotrophic, and relatively cool impoundment that is well aerated to considerable depths year round. Because of adequate oxygen levels and cool temperatures, this project supports an important two-story reservoir fishery and a popular year-round cold water tailrace fishery. Inflow quality is generally very good.

- On the basis of nutrient, phytoplankton, and transparency data, Youghiogheny River Lake is considered oligotrophic and phosphorus limited. The trophic state of the lake results from low nutrient contributions from typically nutrient poor streams of the Appalachian region.

- Fluctuating pool levels and lake morphology limit suitable spawning sites for fish.

- Acid mine drainage contributed by the Casselman River is the principal cause of water quality degradation below Youghiogheny Dam. Flood control and spring filling operations can intensify the effect by reducing the flow of high quality outflow water.

- Massive fish mortality can sporadically occur when fish pass through the outlet tunnel during the winter months.

- Summer low flow releases of cool, well aerated water support an important coldwater tailrace fishery, but the most significant water quality benefit attributed to Youghiogheny River Lake is related to the low flow augmentation of the Youghiogheny and lower Monongahela rivers. Excess runoff stored in the spring is gradually released during the summer and autumn low flow periods, when severe acid slugs can occur from the Casselman River, an acid mine drainage polluted stream which enters the Youghiogheny River about 1.2 miles downstream of the dam. Low flow releases from this project are also very effective in improving water quality in the lower Monongahela River.

C. Operational Evaluation. Over the years Youghiogheny River Lake operations have been highly successful. In recent years, however, the degree of acid mine drainage pollution from the Casselman River has declined and, simultaneously, water supply needs have increased in the region. Therefore, it is now both appropriate and possible that a portion of the project's water quality storage could be reallocated for water supply purposes.

D. Operational Initiatives. In cooperation with the Pennsylvania Fish and Boat Commission, a netting barrier solution to the winter entrainment of fish and associated discharge trauma mortality problem is being investigated.

A model is being prepared to examine the possibility of reallocation of some water quality storage at the project to water supply storage.

WOODCOCK CREEK LAKE

A. Water Management.

1. Authorized Purposes. Flood control along the Woodcock, French Creek, and Allegheny River valleys, low flow augmentation for water quality, and recreation.

2. Water Management Background.

- Drainage Area. 45.7 square miles
- Impoundment. 333 surface acres and 4,930 acre feet of storage at a maximum summer conservation pool elevation of 1,181 feet NGVD.
- Outlet Works. Selective withdrawal with intakes at invert elevations 1,138, 1,157.5, and 1,167 feet NGVD.

3. Commitments.

- Operated to achieve flood reduction objectives.
- The water quality regulation of Woodcock Creek Dam is based on USEPA recommendations. The primary objective of maintaining a 5 mg/l dissolved oxygen minimum in French Creek at Meadville is consistently met by low flow releases from this project.
- Woodcock Creek Lake, along with Union City Dam, provides significant flood protection in French Creek, and to a lesser degree, downstream in the Allegheny and upper Ohio rivers. Since the Union City project has no permanent storage, low flow augmentation in French Creek is provided solely by Woodcock Creek Lake. Acid mine drainage mitigation in the lower Allegheny River is also an aspect of Woodcock Creek Lake flow regulation. However, augmentation from this project would not normally exceed 3% of the total Allegheny River water quality augmentation. Because water quality storage is limited in Woodcock Creek Lake, French Creek commitments are given priority. However, low flow periods in French Creek usually coincide with low flow in the Allegheny River, so the present release schedule for Meadville approximates what would be a desirable schedule for the Allegheny River.
- In accordance with recommendations from the Pennsylvania Fish Commission, the project is operated to achieve outflow water temperatures which conform closely with the annual pre-impoundment water temperature regime.

- When practical, pool elevations and outflow rates can be stabilized for maintenance, fish spawning, and recreation. For example, there is a put-and-take outflow trout fishery at Woodcock Dam, and the District attempts to maintain a low to intermediate discharge during the spring trout season. There is also an effort to maintain stable pool elevations in the summer for the benefit of bathers at the Crawford County swimming beach.

B. Water Quality Conditions. Woodcock Creek Lake can be characterized as a warm, shallow, and highly biologically productive impoundment that is thermally and chemically stratified during the summer months. The impoundment periodically experiences intense algae blooms that create nuisance odors.

C. Operational Evaluation. While summer season hypolimnetic iron, manganese, and hydrogen sulfide concentrations are chronically very high, downstream discharge water quality is effectively controlled by careful use of the project's selective withdrawal intake structure.

D. Operational Initiatives. Continue monitoring any existing operations to prevent water quality problems from developing.

UNION CITY RESERVOIR

A. Water Management.

1. Authorized Purposes. Flood control along the French Creek and Allegheny River valleys.

2. Water Management Background.

- Drainage Area. 222 square miles
- Impoundment. 5 surface acres and 20 acre feet of storage at a minimum pool elevation of 1,210 feet NGVD.
- Outlet Works. Uncontrolled conduit through dam at invert elevation 1,210 feet NGVD, and a 1,255-foot NGVD invert elevation spillway slot.

3. Commitments.

- Operated to achieve flood protection objectives.

B. Water Quality Conditions. Union City Reservoir is a dry bed detention reservoir. With essentially no permanent storage, the effects of impoundment are minimized. During brief periods when flood waters are stored, some reduction in turbidity and solids levels is achieved. During those very infrequent occasions when the pool is high for a prolonged period in the growing season, in-pool anoxia can develop due to decay of flooded vegetation. The outflow, however, is always well aerated.

C. Operational Evaluation and Initiatives. As a dry bed detention reservoir, there is little or no opportunity for operational initiatives to improve water quality.

ALLEGHENY RESERVOIR/KINZUA DAM

A. Water Management.

1. Authorized Purposes. Flood control along the Allegheny and Ohio River valleys, and low-flow augmentation for water quality.

2. Water Management Background.

- Drainage Area. 2,180 square miles

- Impoundment. 12,080 surface acres and 573,000 acre feet of storage at a maximum summer conservation pool elevation of 1,328 feet NGVD.

- Outlet Works. Selective withdrawal, with flood control and water quality intakes at invert elevations 1,205 and 1,300 feet NGVD, respectively. There are also pumped-storage (380 MW capacity) hydropower intakes and outlets at invert elevations 1,289.5 and 1,226 feet NGVD.

3. Commitments.

- Operated in coordination with other Allegheny River basin project to achieve flood reduction objectives.

- Allegheny Reservoir, along with Conemaugh River Lake and to a lesser extent Loyalhanna Creek Lake and other reservoirs, plays the major role in diluting and neutralizing the acid mine drainage pollution load in the lower Allegheny River. When flow contribution from the Kiskiminetas River exceeds about 15% of the total Allegheny River flow, serious water quality degradation can occur in the lower Allegheny River. The success of water quality management in the Allegheny River depends on the ability to store acidic and metal polluted flood waters behind Conemaugh Dam until increased flows from Allegheny Reservoir are available in the lower Allegheny River. Loyalhanna Lake, which has an outflow quality higher than Conemaugh's, can sometimes provide some initial minor dilution of Conemaugh Dam outflows.

- Pennsylvania Electric Company and Cleveland Electric Illuminating Company, for operation of the Seneca Pumped Storage Hydroelectric Generating Station.

- Discharge water temperature control to maintain a cool and cold water tailwater fishery, and to supply cold water for the Seneca National fish hatchery.

- Operated to maintain a low water schedule for the lower Allegheny River at Natrona, Pennsylvania.

- Cooperation on numerous topics with the Allegheny National Forest, appropriate state agencies, and the Seneca Nation Indians.

- Some success has been achieved at times in regulating the outflow from Kinzua Dam to control ice jamming and subsequent backwater flooding in the middle reaches of the Allegheny River, especially near Franklin and Oil City, Pennsylvania.

- In June 1994 the project was very successfully utilized to flush an intense blue-green algae bloom from the lower Allegheny River. This bloom created a buoyant biological turbidity in the finished waters of ten treatment plants serving about 1.1 million customers, and lead to concerns about a potential outbreak of Cryptosporidium disease.

- The large amount of storage available in the project gives it a high potential for use in flushing or moving spills, and contingency operations to move contaminants in the Allegheny and Ohio rivers have been considered during numerous spill emergencies. There are other numerous commitments involving pool level and outflow control for maintenance, recreation, river and lake fishing and fish spawning, downstream muskrat trapping, and other purposes.

B. Water Quality Conditions.

- Inflow, lake, and outflow water quality at Allegheny Reservoir are generally very good. The lake can be characterized as a deep, well-buffered, and moderately productive impoundment where thermal and chemical stratification develops during the summer season.

- Hydropower pump-back flows disrupt thermal stratification near the dam and cool the outflow.

- Oilfield drainage pollution (approximately 20,000 old wells in the tributary drainage) is evident in many of the inflow streams. Oil and brine discharges from "burping" oil wells both submerged in the reservoir and on tributary drainages can also cause occasional problems, especially when nearby drilling operations are pressurizing the fields.

- While the impoundment previously experienced massive late summer blue-green algae blooms, most likely triggered by a fertilizer manufacturing plant effluent in Olean, New York, primary biological productivity has in recent years declined so drastically that the productivity of the lake fishery has significantly diminished.

- During the winter months fish, especially walleye and sometimes yellow perch, are entrained in the outlet works and discharged.

Rapid decompression occurs upon discharge, resulting in a high mortality rate.

- Steep slopes and fluctuating water levels in the lake adversely effect adjacent wetlands and fish spawning habitat.

C. Operational Evaluation. With trends towards declining acid mine drainage pollution in the lower Allegheny River, it is likely that a portion of Allegheny Reservoir's authorized water quality storage might become available for reallocation to water supply, recreation, fish and wildlife conservation, or other uses.

D. Operational Initiatives.

- Several Section 1135 wetland construction scenarios are being investigated at Allegheny Reservoir to mitigate damage to wetland and shoreline habitats caused by the fluctuation of the project's pool.

- After experimentation indicated that fish entrainment is reduced when a modestly elevated winter pool is maintained, the District initiated a policy to maintain a higher winter pool when feasible.

- At the request of State and Federal resource agencies, the Pittsburgh District contracted the Waterways Experiment Station (WES) to model feasible operational and structural methods of achieving a warmer summer discharge from Kinzua Dam. WES recommended that power maintenance shutdowns be rescheduled for periods other than April to August. In addition, attachment of risers to two of the lower level flood control sluices, at an estimated cost of three to four million dollars, could result in significant summer outflow warming. This proposal, however, was later rejected on the grounds that while the existing trout, walleye, and esocid tailwater fishery was different from the pre-project smallmouth bass fishery, it was nonetheless of excellent quality, highly desirable, and should be maintained.

TIONESTA LAKE

A. Water Management.

1. Authorized Purposes. Flood control along the lower Tionesta Creek, and Allegheny and upper Ohio River valleys.

2. Water Management Background.

- Drainage Area. 478 square miles

- Impoundment. 480 surface acres and 7,800 acre feet of storage at a normal minimum pool elevation of 1,085 feet NGVD.

- Outlet Works. Bottom withdrawal with three flood control and two low flow intakes at invert elevations 1,052 and 1,057 feet NGVD, respectively.

3. Commitments.

- Operated in coordination with other Allegheny River basin reservoir projects to achieve flood reduction objectives.

- Tionesta Lake has no authorized water quality storage. However, because high quality water can usually be expected from the Tionesta Lake outflow, the discharge can sometimes be increased so as to reach the lower Allegheny River coincident with increased flows in the acidic Kiskiminetas River. However, releases of this dilution water require the timely presence of excess storage in Tionesta Lake. These dilution operations are purely incidental to the routine regulation of Tionesta Lake, and the overall effect of this project on water quality management in the lower Allegheny River is therefore considered to be minor.

- When conditions permit, the pool and/or outflow is stabilized for recreation.

- The pool is held at elevation 1,089 to 1,090 feet NGVD during the summer to improve recreation and to allow improved boating access from the Nebraska Bridge Recreation Area.

- In recent years the elevated pool has been extended through the hunting season.

- The pool is drawndown to elevation 1,085 during winter to prevent sediment buildup at the boating accesses.

B. Water Quality Conditions.

- Tionesta Lake can be characterized as a clear, moderately

productive, and lightly mineralized and buffered reservoir which undergoes weak thermal and chemical stratification during the summer months. Inflow quality is generally very good.

- Acid mine drainage from Coon Creek, a tributary entering the reservoir about five miles upstream of the dam, is normally mixed and diluted in the lake or outflow and only rarely poses a threat to lake or outflow water quality.

- Sedimentation in the upper portion of the lake interferes with recreation and has degraded some habitat.

C. Operational Evaluation and Initiatives. In 1995 the pool was drawndown during a winter high flow period and accumulated fine sediments were scoured from the upper portion of the lake.

EAST BRANCH CLARION RIVER LAKE

A. Water Management.

1. Authorized Purposes. Flood reduction along the East Branch Clarion, Clarion, Allegheny, and Ohio River valleys, and low flow augmentation for water quality.

2. Water Management Background.

- Drainage Area. 72.4 square miles
- Impoundment. 1,160 surface acres and 64,300 acre feet of storage at a maximum summer conservation pool elevation of 1,670 feet NGVD.
- Outlet Works. Selective withdrawal with intakes at invert elevations 1,531, 1,552, 1,620, and 1,641 feet NGVD.

3. Commitments.

- Operated to achieve flood protection objectives.
- East Branch Clarion River Lake is operated to provide low flow augmentation for water quality in the East Branch Clarion, Allegheny, and upper Ohio rivers. The principal water quality targets are paper mill wastes in the upper Clarion River and acid mine drainage from bituminous coal mines in the lower Clarion River.
- The low flow augmentation schedule supports an important canoeing industry along the length of the Clarion River (more than a dozen commercial canoe liveries). Pulsed releases are also made annually for a canoe race in the East Branch Clarion River.
- Stabilization of pool and/or outflow for maintenance, recreation, etc. For instance, the District attempts to maintain a stable low to moderate outflow on the first day of Pennsylvania trout season every April.
- Discharge water temperatures are provided to support a tailwater trout fishery.
- When possible, slightly elevated flows are maintained for one weekend in May annually to provide recommended conditions for a flyfishing tournament which attracts about a thousand participants.
- The selective withdrawal system is utilized to moderate inpool acid mine drainage problems when possible, and to provide water temperatures to support a three story fishery:

a surface cool/warmwater fishery for smallmouth bass, walleye, and panfish; an intermediate depth coldwater trout fishery; and a deep, very cold lake trout fishery.

- Besides normally scheduled flow augmentation for water quality, the District periodically provides special discharges to dilute paper mill wastes when Willamette Industries flushes their waste holding/finishing ponds into the Clarion River.

B. Water Quality Conditions.

- East Branch Clarion River Lake can be characterized as a clear, cool, acidic, and oligotrophic impoundment that is well aerated to considerable depths year round. Acid mine drainage (AMD) is the principal water quality problem in the basin, and East Branch Lake was at one time referred to locally as the "Dead Sea" of Elk County. In 1969, a lime neutralization plant was built on Swamp Creek, the principal source of AMD in the basin tributary to the lake, with a corresponding improvement in the lake and outflow water quality.

- pH depressions in the lake and outflow can result from the discharge of acid slugs originating from AMD degraded inflow streams. Swamp Creek is the principal source of acidic inflows particularly when the lime neutralization plant is overloaded or not functioning.

- Natural acidity, acid deposition, and acid mine drainage (AMD) pollution from bituminous coal mines in the tributary drainage basin degrade the waters of the lake. The acidity chronically suppresses primary biological production in the lake, and in turn limits the fishery and recreational potential of the project.

- A reduction in the alkalinity and buffering capacity of waters stored in East Branch Clarion River Lake and discharged from the dam limits the effectiveness of operations to augment flows downstream of the dam for mitigation of the impacts of additional sources of AMD.

- Pool fluctuations can impact fish reproduction by alternately flooding and dessicating shoals.

- Erosion from fluctuating pool levels on steep slopes precludes establishment of submerged aquatic vegetation which limits habitat for aquatic life.

C. Operational Evaluations and Initiatives.

- Piney Dam peaking hydroelectric generation operations have interfered with authorized East Branch Clarion River Dam

operations to control acid mine drainage pollution in the lower Clarion River. Therefore, the District has coordinated with the Pennsylvania Electric Company (Pennelec), FERC, and other appropriate resource agencies to develop a spillage schedule for Piney Dam. We are now cooperating with Pennelec and others to evaluate the success of this initiative.

- Under certain hydrologic conditions the Swamp Creek limer can be overwhelmed by acid mine drainage. These events have the potential to severely degrade the lake and frustrate operations to control downstream AMD. Therefore, the District coordinates with PADEP on the operation of the Swamp Creek limer, and cooperates with Willamette Industries to monitor outflow and downstream water quality. On several recent occasions when AMD problems in the lake have intensified, we have limed (soda ash briquet) the impoundment as an emergency measure.

- Local sportsmans' organizations and lumber, paper, and mineral extraction industries are volunteering to try to moderate acidity loads to the lake from secondary sources by use of limestone sands in tributaries to the impoundment. The District is working to facilitate these efforts.

- Low primary productivity problems in the impoundment have been very successfully addressed by an ongoing lake fertilization program.

- A small sub-impoundment was constructed in 1995 to help offset some of the pool fluctuation problems.

MAHONING CREEK LAKE

A. Water Management.

1. Authorized Purposes. Flood reduction along the Mahoning Creek, and Allegheny and upper Ohio River valleys.

2. Water Management Background.

- Drainage Area. 340 square miles
- Impoundment. 300 surface acres and 9,500 acre feet of storage at a summer recreation pool elevation of 1,098 NGVD.
- Outlet Works. Bottom withdrawal with flood control intakes and two low flow intakes at invert elevations 1,015, and 1,021 and 1,025 feet NGVD, respectively.

3. Commitments.

- Operated in coordination with other Allegheny River reservoir projects to achieve flood protection objectives.
- Originally operated year round for a minimum pool elevation of 1,075 feet NGVD, the Mahoning Creek Lake storage schedule was modified in 1980 to provide for recreation by raising the summer pool to elevation 1,098 feet NGVD.
- Until recently, acid mine drainage pollution of tributaries that enter Mahoning Creek downstream of the dam imposed serious constraints on the Mahoning Creek Dam operations such as shutdowns for inspection and/or maintenance. In the past it was necessary for the District to lime neutralize one major downstream AMD polluted tributary, Pine Run, during shutdowns. However, mine drainage pollution in these tributaries has now diminished and these sources no longer pose a substantial threat to downstream water quality during low discharge operations.
- Mahoning Creek has no authorized water quality storage. However, because high quality water can usually be expected from the Mahoning Lake outflow, the discharge can sometimes be increased so as to reach the lower Allegheny River coincident with increased flows in the acidic Kiskiminetas River. However, releases of this dilution water require the timely presence of excess storage in Mahoning Creek Lake. These dilution operations are purely incidental to the routine regulation of Mahoning Creek Lake, and the overall effect of this project on water quality management, except for autumnal drawdown of the recreation pool, is therefore considered to be minor.

- As conditions permit, the pool and/or outflow is stabilized for recreation.

B. Water Quality Conditions.

- Mahoning Creek Lake can be characterized as a moderately productive impoundment which undergoes weak thermal and chemical stratification during the summer months.

- Previously influenced by moderate acid mine drainage pollution, the acidity of project waters has been gradually decreasing and the alkalinity has been increasing. There have been no detected violations of State minimum pH standards at the outflow of the Mahoning Creek Dam since 1982.

- While chemical and oil spills from a nearby upstream railroad were previously a chronic problem at the project, improved safety and management of these materials in the watershed has greatly benefited project waters in recent years. Since 1986, no significant documentated chemical or oil spills, or unexplained fish kills, have been reported in project waters.

- The improved water quality and the increase in summer pool elevations in 1980 have been accompanied by increased biological productivity and diversity in the lake and the outflow waters. Increases in previously depressed phytoplankton and invertebrate populations had lead to similar increases at higher trophic levels and to an improved fishery.

- Sedimentation in the upper portion of the lake interferes with recreation and has degraded some habitat.

C. Operational Evaluation and Initiatives. The District will continue to monitor improving project water quality and to seek methods to further refine operations.

CROOKED CREEK LAKE

A. Water Management.

1. Authorized Purposes. Flood reduction along the Crooked Creek, and Allegheny and upper Ohio River valleys.

2. Water Management Background.

- Drainage Area. 277 square miles
- Impoundment. 470 surface acres and 6,890 acre feet of storage at a normal minimum pool elevation of 840 feet NGVD.
- Outlet Works. Bottom withdrawal with flood control and low-flow intakes at invert elevations of 809 and 814 feet NGVD, respectively.

3. Commitments.

- Operated in coordination with other Allegheny River basin reservoir projects to achieve flood protection.
- Crooked Creek has no authorized water quality storage. However, because high quality water can usually be expected from the Crooked Creek Lake outflow, the discharge can sometimes be increased so as to reach the lower Allegheny River coincident with increased flows in the acidic Kiskiminetas River. However, releases of this dilution water require the timely presence of excess storage in Crooked Creek Lake. These dilution operations are purely incidental to the routine regulation of Crooked Creek Lake, and the overall effect of this project on water quality management in the lower Allegheny River is therefore considered to be minor.
- As conditions permit, the pool and/or outflow is normally stabilized for recreation.
- The lake is now operated for a year round pool elevation of 845.0-845.5 feet NGVD to increase recreational opportunities.

B. Water Quality Conditions.

- Previously degraded by acid mine drainage, Crooked Creek Lake can be characterized as a small, somewhat mineralized reservoir with a circumneutral pH. Formation of weak, relatively unstable thermal and chemical stratification occurs during the summer months.
- In recent years dense nuisance level growths of the submersed aquatic plant Myriophyllum have spread throughout the lake.

- Bacteriological contamination from increasing larger flocks of residence Canada geese have caused problems at the swimming beach.

- The improved water quality has been accompanied by increased biological productivity and diversity in the lake and the outflow waters. Increases in previously depressed phytoplankton and invertebrate populations have lead to similar increases at higher trophic levels and to a highly improved fishery.

- Sedimentation in the upper portion of the lake interferes with recreation and has degraded some habitat.

C. Operational Evaluation and Initiatives. The District will continue to monitor improving project water quality and to seek methods to refine operations.

CONEMAUGH RIVER LAKE

A. Water Management.

1. Authorized Purposes. Flood control along the lower Conemaugh, Kiskiminetas, Allegheny and upper Ohio River valleys.

2. Water Management Background.

- Drainage Area. 1,351 square miles
- Impoundment. 800 surface acres and 5,140 acre feet of storage at a minimum pool elevation of 900 feet NGVD.
- Outlet Works. Bottom withdrawal with flood and low-flow intakes at invert elevations 860 and 873 feet NGVD, respectively. Also, there is a gated intake to a hydropower tunnel at invert elevation 858.5 feet NGVD.

3. Commitments.

- Operated in coordination with other Allegheny River basin reservoir projects to achieve flood protection objectives.
- Conemaugh River Lake is a part of a system of nine Corps of Engineers' reservoirs in the Allegheny River basin. Conemaugh River, in conjunction with seven other Corps of Engineers' projects in the basin (Union City Reservoir is excluded), is operated to control adverse acid mine drainage impacts on the lower Allegheny River. This is accomplished principally by preventing the percentage flow contribution of acid mine drainage degraded Kiskiminetas River water to the Allegheny River water to the Allegheny River from becoming excessive.
- A non-Federal hydropower station (14,000 KW capacity) is operated as a run-of-river project, with a minimum flow of 25 cfs bypass flow maintained through the gates of the dam. Hydropower discharges are subservient to the District's flood control and water quality system operations.
- The hydropower licensees are required to maintain a minimum of 5.0 mg/l downstream DO concentration at all times. An additional license requirement is that if water quality at the reservoir improves to the extent that reproducing populations of sport fish are evident in the Conemaugh River below the dam, or the mean annual outflow pH reaches 6.0, the 25 cfs minimum release from the dam will be increased to the Q7-10 flow (240 cfs) or natural inflow, whichever is less. Q7-10 flow signifies the minimum consecutive seven-day average streamflow with a ten year recurrence interval.

- When first constructed, Conemaugh River Lake was maintained at a normal minimum pool elevation of 880 feet NGVD. At this elevation, the dam impounded 4,000 acre-feet of water, with a surface area of 300 acres, along a narrow 6.6-mile-long slackwater reach.

  Sedimentation problems, seriously aggravated by erosion from extensive surface mining operations in its tributary drainage basin, forced the District to gradually increase the minimum pool elevation of 900 feet NGVD. At present, based on 1982 sedimentation survey data, the lake has a surface area of 800 acres and a capacity of 5,140 acre-feet at its new minimum pool elevation of 900 feet NGVD.

B. Water Quality Conditions.

- Conemaugh River Lake and most of its major tributaries are grossly degraded by acid mine drainage from bitumous coal mines. While in the past the impoundment has received significant industrial wastes from a major primary metals manufacturing complex and other industrial sources, as well as domestic wastes from communities in the basin, all of these sources of pollution have been largely overshadowed by the enormity of the acid mine drainage pollution in the basin.

- While the extent and degree of acid mine drainage pollution problems in the Conemaugh River basin are staggering, conditions were previously much worse, and trends toward improvement appear to have accelerated very significantly in recent years.

  Water quality conditions were so hostile that no fish or other aquatic life could survive in the lake or downstream in the Kiskiminetas River. Periodic spectacular fish kills, in at least one instance involving more than a million fish, also occurred when shock loads of Conemaugh River acid rolled downstream into the lower Allegheny and upper Ohio Rivers. These acid-heavy metal shock load pollution incidents also adversely affected the domestic water supplies of 1.1 million persons who used waters drawn from the lower Allegheny River by ten water treatment plants.

- While still degraded by acid mine drainage, the water quality of the Conemaugh River has been improving for at least the past 25 years and aquatic life has now begun to return to its waters.

- The first macroscopic organism to be reported in significant numbers in the reservoir were the acid tolerant larvae of the flood plain mosquito Aedes vexans. Nuisance level outbreaks of the mosquito were first reported from the Smith's Bottoms area of the reservoir in 1979, requiring drainage improvement

measures and reservoir operations for control. The absence of fish and other biological controls probably contributed to the intensity of the mosquito problem.

By 1986, there were reports that some fish were being observed below the dam and at points downstream in the Conemaugh and Kiskiminetas Rivers. Since this time a marginal tailwater fishery has developed.

- A lake fishery also has begun to develop. This lake fishery, however, is almost exclusively confined to two tributary embayments that were inundated after the reservoir pool elevation was increased from 890 to 900 feet NGVD in 1989. These two tributaries are Aultmans Run and Spruce Run. Spruce Run is not measurably influenced by acid mine drainage. Aultmans Run is highly mineralized from mine drainage, but its pH is circumneutral. The water quality of these tributaries affects the water within their respective embayments, and these embayments tend to have superior water quality relative to the generally acidic main lake.

  It appears that there is sufficient water quality and forage production in the bays for sport fish maintenance and growth, whereas in the main lake water quality is still only barely sufficient to provide sportfish maintenance and survival. Unfortunately, the surface areas of these two embayment fisheries is less than one percent of total lake surface area (Aultmans Run Bay is about four acres and Spruce Run Bay is about two acres).

- Another water quality concern at Conemaugh River Lake involves 11,600 tons of radioactive contaminated materials, containing approximately six tons of uranium oxide (1.5 curies of uranium 238), which was dumped on nine acres near the Burrel Township upstream border of the project between late 1956 and early 1957. Remedial work on this site was recently initiated and completed by the U.S. Department of Energy under the Uranium Mill Tailings Remedial Action Act to minimize or eliminate potential hazards resulting from possible exposure to these materials. Another potential uranium contamination problem from a Westinghouse facility located on the banks of the lake that formerly processed weapons grade fuel is now being investigated.

- The Japanese knotweed growing at Conemaugh River Lake merits special comment. Japanese knotweed is an obnoxious east Asian invader which has become established along the banks of the Conemaugh River and many other larger streams of the upper Ohio River drainage basin in recent decades. Other than being attractive to honey bees and Japanese beetles, it has little or no wildlife value. There are other problems associated with Japanese knotweed since it grows so tall and is so abundant.

The dry, light, very buoyant, chambered, and bamboo-like stems (it is also locally known as Mexican bamboo) of previous years of Japanese knotweed growth accumulate as a thick litter along banks. When the pool is raised during flood control operations, these buoyant stems float out of their thickets and can cover the surface of the lake, from bank to bank, as huge, dense rafts of floating debris. These debris rafts also contain a mixture of logs and trash, creating a serious trash removal problem at the hydropower intake and hazardous boating conditions.

- Conemaugh River Lake has experienced severe sedimentation problems. Much of the accumulated sediment in the lake is located immediately upstream of the dam. The sediment, deposited since construction of the dam, exceeds 30 feet in thickness in the lower three miles of the reservoir. With the exception of a relatively narrow channel, virtually the entire reservoir from the dam upstream to the junction of Blacklick Creek, approximately nine miles, has now shoaled to elevation 890 or higher. Sedimentation within the lake typically results in a clarified discharge and improved downstream water quality. There have been several occasions, however, when high discharges at relatively low pools have been necessary. This has resulted in large volumes of the accumulated sediment near the dam breaking loose and creating downstream mud waves. These mud waves have adversely affected the Saltsburg municipal water supply.

C. Operational Evaluation.

- From a water management/water quality perspective, Conemaugh River Lake is an extraordinarily complex project, which is now in a very rapid state of transition. The range and number of problems, challenges, and opportunities developing at this time are so great as to defy the brief summarization format of this document. Therefore, it will only be possible to highlight a small fraction of the potential beneficial operations which could be made at this project.

- The improving water quality of Conemaugh River Lake could at some point make Allegheny River basin reservoir systems operations for water quality obsolete, and perhaps free some reservoir storage now dedicated to water quality for water supply, recreation, or other purposes. In terms of acidity control, existing flow schedules may now already provide excess flow augmentaion. However, the existing system operation might still be necessary to control hardness, iron, manganese, and other parameters along the lower Allegheny and upper Ohio Rivers. The need exists for the District to closely examine the impacts of Conemaugh River Lake releases on the water quality of the lower Allegheny River. This reexamination of the system operation will require application of sophisticated

river/reservoir modeling tools, and because of recent and dramatic changes in Conemaugh River water quality, will have to be implemented in the near futher.

- Increased storage in the lake would buffer the impacts of short term extremes in inflow water quality, and increased hydraulic retention times would allow for more efficient settling of flocs of ferric hydroxides, and floccing and settling of colloidal ferric hydroxides.

- Increasing the pool elevation and hydraulic retention time of the reservoir would cause even a higher percentage of the silt load contributed to the lake by its tributary drainage basin to be trapped within the lake. However, at a higher pool elevation, a much higher percentage of the silt load would settle out in the upstream reaches of the impoundment, where it would not interfere with the operation of the dam or eventually incur additional very expensive dredging control.

- The topography of the lands surrounding Conemaugh River Lake includes flood plain areas which were just barely inundated by the ten foot increase in the minimum reservoir pool elevation from 890 to 900 feet NGVD in 1989. The increased pool flooded at least several hundred acres of land to depths of less than two feet, which very quickly became vegetated with wetland species of plants. The expansive new wetlands at the project have attracted abundant wildlife including resident and migratory ducks and geese, herons, cormorants, and wading birds. The rather sudden and spectacualr increase in valuable wetland habitat and wetland associated wildlife at the project since 1989 has yet to be adequately documented, and any change from current operations should be sensitive to this issue, since additional increases in the pool elevation might possibly result in a net decrease in wetland area and quality. Project operations, which may only involve minor pool elevation manipulations, should be investigated to manage and maintain these wetlands, encourage diversity, and optimize their quality for wildlife.

- Data collected by the District suggests that during high flows, the Bow Ridge loop portion of the lake can fill with relatively good quality, lower acidity water. During lower flows, a large portion of higher acidity inflow waters appear to be intercepted by the hydropower plant intake, and diverted away from the loop.

Therefore, before triggering the requirement for an increased Conemaugh Dam minimum flow discharge (from 25 cfs to 240 cfs as previously described), water resource agencies should carefully review and consider benefits to the fishery realized from the existing operation. Especially pertinent is the moderation of water quality extremes in the Bow Ridge loop of the reservoir,

and the tailwaters of the dam. If the water quality of the lake continues to improve, the value of the loop refuge would diminish. However, as long as the reservoir is influenced by periodic slugs of acid, it might be in the best interest of the resource to maintain the existing operation.

D. Operational Initiatives.

- The District is at present concluding an investigation of a proposal to increase the reservoir pool elevation of Conemaugh River Lake for the purpose of increasing recreation opportunities in the impoundment. Previous consideration of such an increase in the pool elevation of Conemaugh River Lake indicated that a summer season increase from a minimum pool elevation of 900 to 904 feet NGVD would possibly be feasible without severly compromising flood control operations or disruption of other existing project uses. Pool elevations higher than 904 feet NGVD, however, could negatively impact wetlands and abundant early industrial period cultural resources at the project.

- Plans and studies are now in progress to achieve a solution to the sedimentation problem at the project, which interfers with and limits operations. Part of the solution would involve dredging silt from the reservoir for a distance of 500 feet upstream of the dam.

- The most logical solution to AMD related problems in the Conemaugh River basin would be to abate the AMD pollution at its source. The District previously received authorization through WRDA to study AMD in the basin. AS a result of this study, ORP is now in the process of developing a successive alkalinity producing system (SAPS), passive AMD treatment project at the mouth of the Webster Mine Discharge, on the South Branch of the Blacklick Creek. Abatement of this source should result in a 5% decrease in acidity at Conemaugh Dam.

LOYALHANNA LAKE

A. Water Management.

1. Authorized Purposes. Flood reduction along lower Loyalhanna Creek and the Kiskiminetas, Allegheny and upper Ohio River valleys.

2. Water Management Background.

- Drainage Area. 290 square miles
- Impoundment. 480 surface acres and 5,685 acre feet of storage at a minimum recreation pool elevation of 921 feet NGVD.
- Outlet Works. Bottom withdrawal with sluices and a low-flow intake at invert elevations 878 and 889 feet NGVD, respectively.

3. Commitments.

- Operated in coordination with other District reservoir projects to achieve flood control objectives.
- Operated in coordination with other Allegheny River basin reservoir projects to control the impacts of acid mine drainage (AMD) pollution from the Kiskiminetas River on the Allegheny River.
- Assures continuous discharge to neutralize and dilute a very severely AMD degraded downstream tributary, Getty Run, to moderate pollution and protect the lower Loyalhanna Creek fishery. When discharge from the dam must be interrupted for maintenance, inspection, or other reasons, the District has temporarily lime neutralized Getty Run.
- When conditions permit, the pool and outflow can be stabilized for recreation, maintenance, etc. For example, the normal minimum pool elevation, during the recreation season, is held at 921-922 feet NGVD, adding 240 acres to the normal 910 feet NGVD minimum pool area to facilitate boating and other water based recreation.

B. Water Quality Conditions.

- Acid mine drainage is the principle water quality problem in the Loyalhanna Creek basin. Previously, Loyalhanna Lake was severly degraded by AMD, however, reclamation efforts have resulted in substantial water quality improvement in the lake and outflow. Despite overall improved inflow water quality, acid inflows are still frequently observed at this project.

Besides acidity, the inflow contributes large amounts of iron, and occasional high concentrations of suspended iron oxides give the lake a turbid yellow color.

- Due to limitations imposed by occasional acid inflows, high turbidity and low retention time, primary production in Loyalhanna Lake is low. The fishery, though improving over the past few years, is limited by the low productivity.

- Outflow water quality, while generally good, reflects the occasional AMD degradation of the inflow, lake, and outflow has steadily improved over the past decade, violations of Pennsylvania State Water Quality Standards are occasionally observed in the outflow. These violations, however, are much more moderate than the inflow.

- Combined sewer overflows and sewage diversions from an old and underdesigned sewage treatment plant in Latrobe, Pennsylvania, as well as regionally poor rural residential septic systems all contribute to a bacteriological contamination problem at the project, which has lead to the closing of the swimming beach.

D. Operational Evaluation and Initiatives. Acid mine drainage reclamation and improved sewage treatment are the most viable alternatives for improving water quality in Loyalhanna Lake. There is a linkage between the two issues in that there is little incentive to invest funds to improve sewage treatment that would ultimately be discharged to acid dead waters. The District is coordinating with and encouraging State initiatives on both of these problems by emphasizing increasing recreational usage at the project and growing regional recreational needs.