CESWL-CO-L DEPARTMENT OF THE ARMY SWLOM-1130-2-36
Little Rock District, Corps of Engineers
P.O. Box 867
Little Rock, Arkansas 72203-0867

Office Memorandum
No. 1130-2-36 21 September 1993

Project Operations
RESTRICTED AREAS FOR HAZARDOUS WATERS
AT DAMS AND OTHER CIVIL WORKS STRUCTURES

Contents Paragraph

1. Purpose. This Operational Management Plan (OMP) establishes restricted areas upstream and downstream of locks, dams, and powerhouses. Information pertains to restricted area limits, markings and signs, buoys, audible warning devices, and plans for rescue of persons from restricted areas.

2. Applicability. This policy applies to all Little Rock District locks, dams, and powerhouses.

3. Reference. This Operational Management Plan is a requirement of ER 1130-2-341, "Restricted Areas for Hazardous Waters at Dams and Other Civil Works Structures," dated 1 Feb 91.

4. Objective. This document establishes guidance preventing public access to certain hazardous waters areas near Little Rock District locks, dams, and powerhouses. The restricted area boundaries are determined from information contained in the appendices of the enabling regulation and applied to specific sites through a classification system. Sufficient guidelines will be established to make the limits of these restricted areas evident to a prudent, safety conscious, and informed public. Plan objectives will be implemented by 1 Feb 98.

5. Categories.

a. Category I. Medium head flood control dams with powerhouses.

(1) Experience: Water releases from spillway or powerhouses create increased flows of water and turbulence downstream. Regardless of the origin of the discharge, upstream areas remain largely unaffected, while downstream areas are significantly affected. Sites in this category are Beaver, Bull Shoals, Greers Ferry, Norfork, and Table Rock.

(2) Dangers: Potential dangers upstream exist in possible vortices or flow through the dam during maximum discharge spillway operations. More than 95 percent of waters released from the dam pass through the powerhouse turbines. Although powerhouse operations do not affect upstream surface areas, they do have an effect on downstream areas in much the same way as spillway releases. Downstream areas near the dam are affected by increased water flow rates, water depths, and turbulence.

b. Category II. Arkansas River Navigation Locks and Dams.

(1) Experience: Water releases from spillway or powerhouse create increased flows of water upstream and downstream and increase turbulence downstream. Releases and changes in release rates increase flows in the Arkansas River, but only increase water elevations dramatically after rainfall events or major releases from dams upstream.

(2) Dangers: Potential dangers upstream exist in currents drawing boats and persons in the water to and through the spillway. Downstream areas are turbulent and currents increase during spillway, lock, and powerhouse discharges and dangers may be experienced by boaters, and other users. Bank fishermen on rip rap dikes and revetment structures may be separated from egress by rising waters. At Emmett Sanders Lock and Dam, the split elevation spillway sill causes a back eddy at certain flow conditions.

c. Category III. Flood control dams.

(1) Experience: Releases from conduit gates create increased flows of water downstream and increase turbulence, but only increase water elevations dramatically during large flood releases. Upstream areas are largely unaffected. Sites in this category are Blue Mountain, Clearwater, DeQueen, Dierks, Gillham, and Nimrod.

(2) Dangers: Potential danger upstream exists in small vortices at the outlet works tower that might draw persons below the water's surface during maximum discharge operations. Downstream areas are turbulent and currents increase during discharges and dangers may be experienced by boaters and other users. Specific hazards include downstream bank fishermen being separated from egress, and possible inundation of roadways normally used to depart the area.

d. Category IV. Millwood.

(1) Experience: Releases from spillway and sluice gates create increased flows of water upstream and downstream and increase turbulence downstream. Releases and increases in release rates elevate flows in the Little River, but only increase water elevations dramatically after rainfall events.

(2) Dangers: Potential danger upstream exists in currents drawing boats and persons in the water to and through the spillway. Downstream areas are turbulent and currents increase during spillway discharges, and dangers may be experienced by boaters, and other users. Bank fishermen downstream may be separated from egress by rising waters and possible inundation of roadways normally used to depart the area.

6. Policy.

a. Category I. Medium head flood control dams with powerhouses. Hydraulic lines are established in Appendix A, Category I. Other restricted area considerations are listed below.

(1) Operational Restricted Areas. Downstream restricted areas are established at the maximum limit of the hydraulic line or existing restricted area, whichever is more distant from the dam.

(2) Operational No Wake Zone. A no wake zone is established bank to bank, immediately upstream and a minimum of 100 feet from the structure or at existing log boom/buoy line, whichever is more distant from the dam.

(3) Corps Standard Signs. Signs will be strategically placed immediately downstream from the dam and powerhouse restricted area to be easily seen by fishermen, boaters, and other users pertaining to dangers and explaining the meaning of horn signals. Illuminated signs will be placed on the upstream face of the dam to identify the restricted area at powerhouse

intakes. Signs will be placed along the shoreline restricting swimming, wading, and diving in the no wake zone.

(4) Buoy Line. A no wake zone will be established by continuous or noncontinuous buoy line at 100 feet from the structure or extended upstream to existing log boom or restricted area, whichever is more distant from the dam. Buoys will be placed to identify restricted areas immediately upstream of powerhouse intakes. Buoys will meet Corps standards and will be placed in accordance with the uniform state waterway system.

(5) Horns. A horn(s) will sound when a powerhouse unit initially discharges water and when increases are made. Reliability of the horn(s) will be assured by redundant or acoustical confirmation system. A horn will sound when water is initially discharged through the spillway and when increases are made. Visual inspection of the immediate area will be made before spillway discharges begin.

(6) Direct Telephone Communication to Powerhouse. Direct telephone communication to powerhouse control room operator will be established for emergencies. Closed circuit public telephone terminal will be placed in a conspicuous location along with operating instructions and other pertinent information.

(7) Rescue Plan. The Resident Engineer/Manager will submit a plan for the rescue of persons from dam restricted areas to the Chief, Construction-Operations Division, for approval. The plan will address at least these issues: personnel, equipment, training needed, and guidance pertaining to conditions that would warrant rescue of persons in restricted areas by others.

b. Category II. Arkansas River Navigation Locks and Dams. Hydraulic lines are established in Appendix A, Category II. Other restricted area considerations are listed below.

(1) Operational Restricted Areas. Restricted areas are established at the maximum limit of the hydraulic line or existing restricted area whichever is more distant from the dam.

(2) Corps Standard Signs. Signs will be strategically placed immediately downstream from the dam and/or powerhouse restricted area to be easily seen by bank fishermen, boaters, and other users pertaining to dangers and explaining the meaning of horn and/or siren signals. Illuminated Restricted Area signs will be placed on the downstream face of all dams and at the lock, side discharge point (Dardanelle and Ozark). At locks that discharge within the lock walls, a lock entry instruction sign

will be posted below the restricted area in the downstream lock approach at a location determined by Chief, Navigation and Maintenance Branch. Likewise, all locks will post a lock entry instruction sign above the restricted area in the upstream lock approach at a location determined by Chief, Navigation and Maintenance Branch.

(3) Buoys. Buoys will be placed to identify the restricted area at locks with side discharge (Dardanelle and Ozark). Buoys will meet Corps standards and will be placed in accordance with the uniform state waterway system.

(4) Horns and Sirens. A horn(s) will sound when a powerhouse unit initially discharges water and when increases are made. Reliability of the horn(s) will be assured by redundant or acoustical confirmation system. A siren(s) will sound when water is initially discharged through the spillway and when increases and lock discharges are made. Visual inspection of the immediate area will be made before spillway and lock discharges begin.

(5) Warning Light. A flashing red strobe light activated when siren sounds will be placed with illuminated sign at lock side discharge point (Dardanelle and Ozark).

(6) Direct Telephone Communication to Powerhouse. Direct telephone communication to powerhouse control room operator will be established for emergencies. Closed circuit public telephone terminal will be placed in a conspicuous location along with operating instructions and other pertinent information.

(7) Rescue Plan. The Resident Engineer/Manager will submit a plan for the rescue of persons from dam restricted areas to the Chief, Construction-Operations Division, for approval. The plan will address at least these issues: personnel, equipment, training needed, and guidance pertaining to conditions that would warrant rescue of persons in restricted areas by others.

c. Category III. Flood control dams. Hydraulic lines are established in Appendix A, Category III. Other restricted area considerations are listed below.

(1) Operational Restricted Areas. Restricted areas are established at the maximum limit of the hydraulic line or existing restricted area, whichever is more distant from the structure.

(2) Corps Standard Signs. Signs will be strategically placed immediately downstream from the dam restricted area to be easily seen by fishermen, boaters, and other users pertaining to dangers and explaining the meaning of siren signals. Signs will be placed along the shoreline restricting swimming, wading, and diving at the minimum limits of the hydraulic line or at existing restricted areas whichever is more distant from the structure.

(3) Buoy Line. Upstream restricted area will be established by continuous or noncontinuous buoy line at hydraulic line or existing log boom whichever is further from the dam. Buoys will meet Corps standards and will be placed in accordance with the uniform state waterway system.

(4) Sirens. A siren(s) will sound when water is initially discharged through the conduit and when increases are made. Visual inspection of the immediate area will be made before discharges begin.

(5) Rescue Plan. The Resident Engineer/Manager will submit a plan for the rescue of persons from dam restricted areas to the Chief, Construction-Operations Division for approval. The plan will address at least these issues: personnel, equipment, training needed, and guidance pertaining to conditions that would warrant rescue of persons in restricted areas by others.

d. Category IV. Millwood. Hydraulic lines are established in Appendix A, Category IV. Other restricted area considerations are listed below.

(1) Operational Restricted Areas. Restricted areas are established at the maximum limit of the hydraulic line or existing restricted area, whichever is more distant from the dam.

(2) Corps Standard Signs. Signs will be strategically placed immediately downstream from the dam restricted area to be easily seen by fishermen, boaters, and other users pertaining to dangers and explaining the meaning of siren signals. No boating, swimming, and wading signs will be placed on the shoreline at the minimum limits of the hydraulic line or at existing buoy line, whichever is more distant from the dam.

(3) Buoy Lines. Restricted area will be established by continuous or non-continuous buoy lines at hydraulic line or existing log booms, whichever is greater. Buoys will meet Corps standards and will be placed in accordance with the uniform state waterway system.

(4) Sirens. A siren(s) will sound when water is initially discharged through the spillway or sluice and when increases are made. Visual inspection of the immediate area will be made before discharges begin.

(5) Rescue Plan. The Resident Engineer/Manager will submit a plan for the rescue of persons from dam restricted areas to the Chief, Construction-Operations Division, for approval. The plan will address at least these issues: personnel, equipment and training needed, and guidance pertaining to conditions that would warrant rescue of persons in restricted areas by others.

e. General. The following general elements and initiatives are a part of the multi-media solution for restricted area information.

(1) Brochure. A downstream discharge warning/ restricted areas brochure will be developed for public distribution.

(2) Public Presentations. Programs will be made available to area schools, clubs, and civic groups explaining hazards of discharges/restricted areas, and informational and preventive measures taken by the Corps of Engineers for public protection will be publicized.

(3) Lake Maps. Lake maps will be revised to include discharge hazard/restricted areas information.

(4) Public Information. Downstream hazards/ restricted areas information will be provided to the Arkansas Game and Fish Commission and Missouri Department of Conservation for inclusion on their printed materials. Similar information will be provided upon request to any agency, organization, municipality, media outlet or other local government entity desiring to provide this information to the public.

7. Responsibilities. It is the responsibility of the Chief, Construction-Operations Division, to implement this SOP.

DAVID R. RUF
Colonel, Corps of Engineers
District Engineer

Appendix
App A

DISTRIBUTION A

APPENDIX A

CATEGORY I

BEAVER, BULL SHOALS, GREERS FERRY, NORFORK, TABLE ROCK

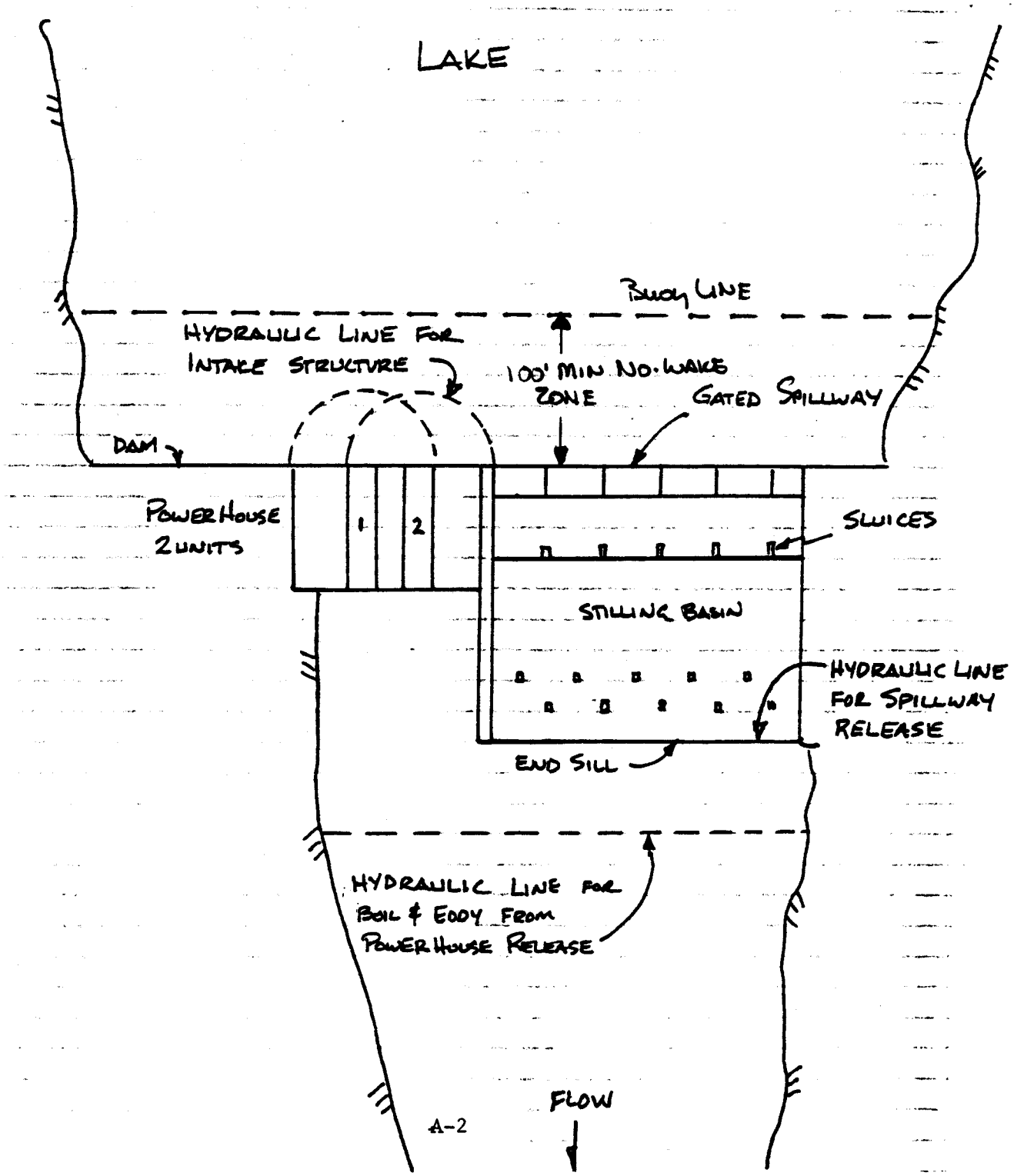
Page ____ of ____

SUBJECT RESTRICTED AREAS FOR HAZARDOUS WATERS

COMPUTATION TYPICAL HYDRAULIC LINE LOCATIONS FILE NO. _____

COMPUTED BY _____ DATE 2/21/92 CHECKED BY _____ DATE _____

CATEGORY I :



Restricted Areas For Hazardous Waters
HYDRAULIC LINE

The following is the determination of the Hydraulic Line based on Appendix A of ER 1130-2-341, dated 1 February 1991.

Beaver Lake - Type of Project: Flood Control and Hydroelectric.

1. Flow Criteria.

   a. Navigation Locks and Dams. N/A.

   b. Flood Control and Storage Dams.

      Non- Damaging Flow: Q = 50,000 cfs

   c. Hydroelectric/Intakes.

      Maximum Hydropower Release: Q = 9,000 cfs
      Est. One-Year Discharge: Q = 8,000 cfs

DESIGN FLOW Q = 9,000 CFS

2. Upstream of Structures.

   a. Navigation, Flood Control/Storage Projects. The design flow is made through the turbines, if the release was made through the spillway gates there would not be a drawdown or any surface velocities.

   b. Hydroelectric/Intakes. There is not a drawdown or surface velocities upstream, but set hydraulic line at a distance equal to twice the width of the structure intake (2 x 32 ft = 64 ft).

HYDRAULIC LINE 64 FEET FROM TURBINE INTAKE STRUCTURE

3. Downstream of Structures.

   a. Navigation, Flood Control/Storage Projects. If design flow is made through the spillway, the length of the hydraulic jump would be about 108 feet and contained in the stilling basin.

   b. Hydroelectric/Outlets. Visual inspection and project personnel indicate that the initial boil and eddy limits which would be dangerous extend approximately 100 feet downstream of the stilling basin's end sill. A weak eddy extends about 300 feet downstream.

HYDRAULIC LINE 100 FEET FROM PROJECT STRUCTURE

Restricted Areas For Hazardous Waters
HYDRAULIC LINE

The following is the determination of the Hydraulic Line based on Appendix A of ER 1130-2-341, dated 1 February 1991.

Bull Shoals Lake - Type of Project: Flood Control and Hydroelectric.

1. Flow Criteria.

   a. Navigation Locks and Dams. N/A.

   b. Flood Control and Storage Dams.

      Non- Damaging Flow: Q = 30,000 cfs

   c. Hydroelectric/Intakes.

      Maximum Hydropower Release: Q = 25,700 cfs
      Est. One-Year Discharge: Q = 22,400 cfs

DESIGN FLOW Q = 25,700 CFS

2. Upstream of Structures.

   a. Navigation, Flood Control/Storage Projects. The spillway crest is above the top of the conservation pool, so release would be made through low conduits with no effects to the surface.

   b. Hydroelectric/Intakes. There is not a drawdown or surface velocities upstream, but set hydraulic line at a distance equal to twice the width of the structure intake (2 x 30 ft = 60 ft).

HYDRAULIC LINE 60 FEET FROM TURBINE INTAKE STRUCTURE

3. Downstream of Structures.

   a. Navigation, Flood Control/Storage Projects. Seven of the sixteen conduits would be used and the stilling basin would contain hydraulic jump.

   b. Hydroelectric/Outlets. Visual inspection and project personnel indicate that boil and eddy limits which would be dangerous extend approximately 100 feet downstream of the stilling basin's end sill. A weak eddy extends about 600 feet downstream.

HYDRAULIC LINE 100 FEET FROM PROJECT STRUCTURE

Restricted Areas For Hazardous Waters
HYDRAULIC LINE

The following is the determination of the Hydraulic Line based on Appendix A of ER 1130-2-341, dated 1 February 1991.

Greers Ferry - Type of Project: Flood Control and Hydroelectric.

1. Flow Criteria.

   a. Navigation Locks and Dams. N/A.

   b. Flood Control and Storage Dams.

   Bankfull Flow: Q = 15,000 cfs
   Customary Flow: Q = 10,000 cfs

   c. Hydroelectric/Intakes.

   Maximum Hydropower Release: Q = 7,900 cfs
   Est. One-Year Discharge: Q = 6,900 cfs

DESIGN FLOW Q = 7,900 CFS

2. Upstream of Structures.

   a. Navigation, Flood Control/Storage Projects. The design flow is made through the turbines, if the release was made through the spillway gates there would not be a drawdown or any surface velocities.

   b. Hydroelectric/Intakes. There is not a drawdown or surface velocities upstream, but set hydraulic line at a distance equal to twice the width of the structure intake (2 x 34.5 ft = 69 ft).

HYDRAULIC LINE 70 FEET FROM TURBINE INTAKE STRUCTURE

3. Downstream of Structures.

   a. Navigation, Flood Control/Storage Projects. If design flow is made through the spillway, the length of the hydraulic jump would be about 144 feet and contained in the stilling basin.

   b. Hydroelectric/Outlets. Visual inspection and project personnel indicate that boil and eddy limits extend approximately 200 feet downstream of the stilling basin's end sill.

HYDRAULIC LINE 200 FEET FROM PROJECT STRUCTURE

Restricted Areas For Hazardous Waters
HYDRAULIC LINE

The following is the determination of the Hydraulic Line based on Appendix A of ER 1130-2-341, dated 1 February 1991.

Norfork Lake - Type of Project: Flood Control and Hydroelectric.

1. Flow Criteria.

   a. Navigation Locks and Dams. N/A.

   b. Flood Control and Storage Dams.

      Non- Damaging Flow: Q = 10,000 cfs

   c. Hydroelectric/Intakes.

      Maximum Hydropower Release: Q = 6,200 cfs
      Est. One-Year Discharge: Q = 5,400 cfs

DESIGN FLOW Q = 6,200 CFS

2. Upstream of Structures.

   a. Navigation, Flood Control/Storage Projects. The spillway crest is at the conservation pool, so the release could be made through low conduits. No surface effects would exist.

   b. Hydroelectric/Intakes. There is not a drawdown or surface velocities upstream, but set hydraulic line at a distance equal to twice the width of the structure intake (2 x 30 ft = 60 ft).

HYDRAULIC LINE 60 FEET FROM TURBINE INTAKE STRUCTURE

3. Downstream of Structures.

   a. Navigation, Flood Control/Storage Projects. If design flow is made through the spillway or low conduits, the hydraulic jump would be contained in the stilling basin.

   b. Hydroelectric/Outlets. Visual inspection and project personnel indicate that the initial boil and eddy limits which would be dangerous extend approximately 100 feet downstream of the stilling basin's end sill. A weak eddy extends downstream about 400 feet.

HYDRAULIC LINE 100 FEET FROM PROJECT STRUCTURE

Restricted Areas For Hazardous Waters
HYDRAULIC LINE

The following is the determination of the Hydraulic Line based on Appendix A of ER 1130-2-341, dated 1 February 1991.

Table Rock Lake - Type of Project: Flood Control and Hydroelectric.

1. Flow Criteria.

   a. Navigation Locks and Dams. N/A.

   b. Flood Control and Storage Dams.

      Non- Damaging Flow: Q = 20,000 cfs

   c. Hydroelectric/Intakes.

      Maximum Hydropower Release: Q = 15,400 cfs
      Est. One-Year Discharge: Q = 13,400 cfs

DESIGN FLOW Q = 15,400 CFS

2. Upstream of Structures.

   a. Navigation, Flood Control/Storage Projects. If the design flow is made through the spillway gates there would not be a drawdown or any surface velocities.

   b. Hydroelectric/Intakes. There is not a drawdown or surface velocities upstream, but set hydraulic line at a distance equal to twice the width of the structure intake (2 x 30 ft = 60 ft).

HYDRAULIC LINE 60 FEET FROM TURBINE INTAKE STRUCTURE

3. Downstream of Structures.

   a. Navigation, Flood Control/Storage Projects. If design flow is made through the spillway, the length of the hydraulic jump would be about 120 feet and contained in the stilling basin.

   b. Hydroelectric/Outlets. Visual inspection and project personnel indicate that the boil and eddy limits which would be dangerous extend approximately 100 feet downstream of the stilling basin's end sill. A weak eddy extends about 500 feet downstream.

HYDRAULIC LINE 100 FEET FROM PROJECT STRUCTURE

LEAVE BLANK

CATEGORY II

NORRELL, LOCK #2, WILBUR D. MILLS DAM, JOE HARDIN, EMMETT SANDERS, LOCK AND DAM #5, DAVID D. TERRY, MURRAY, TOAD SUCK FERRY, ARTHUR V. ORMOND, DARDANELLE, OZARK, AND JAMES W. TRIMBLE

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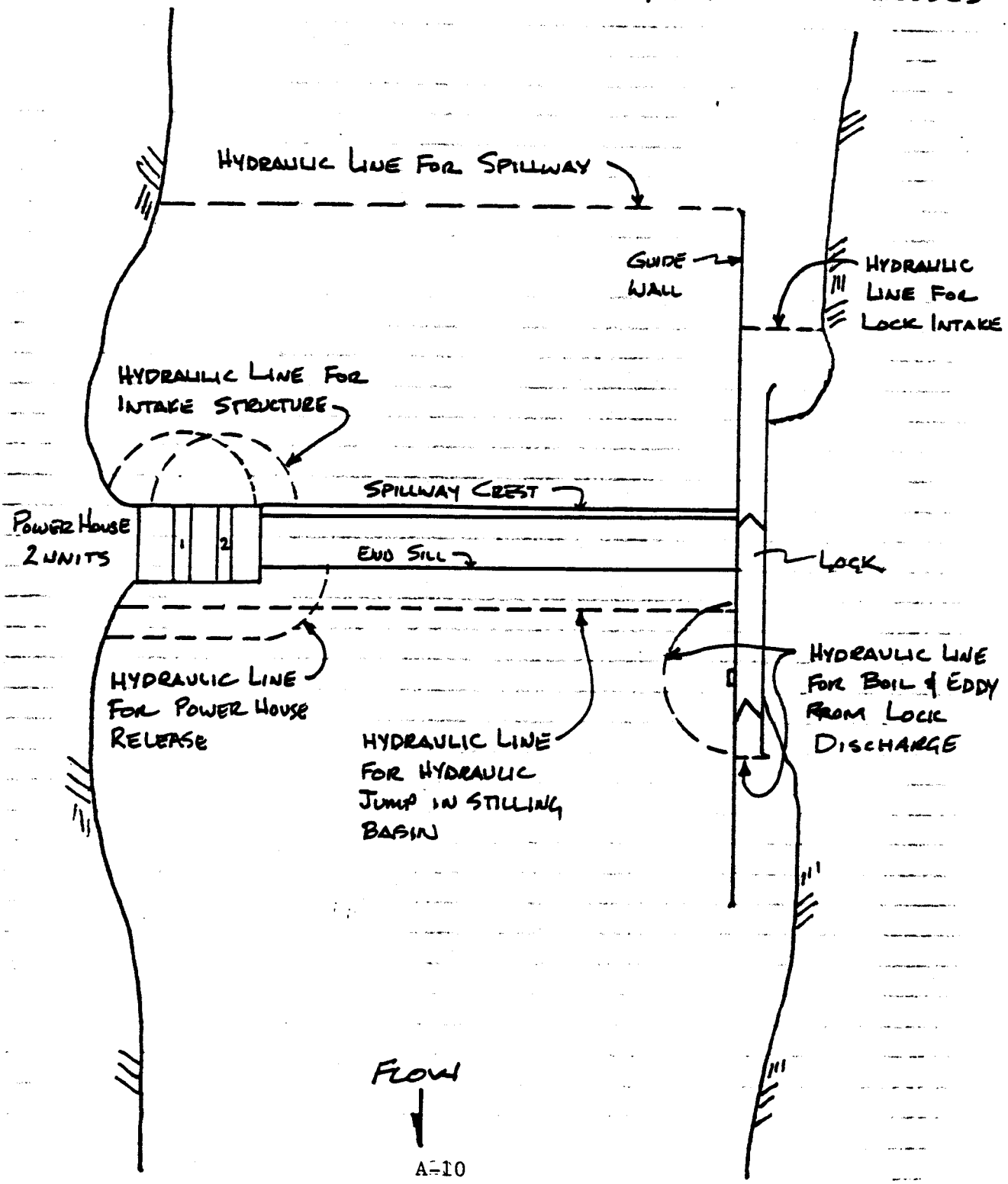
SUBJECT RESTRICTED AREAS FOR HAZARDOUS WATERS

COMPUTATION TYPICAL HYDRAULIC LINE LOCATION FILE NO. ____

COMPUTED BY ____ DATE ____ CHECKED BY ____ DATE ____

CATEGORY II : ARKANSAS RIVER NAVIGATION LOCK & DAMS W/ & W/O POWER HOUSES



Restricted Areas For Hazardous Waters
HYDRAULIC LINE

The following is a summary of the hydraulic line determinations based on Appendix A of ER 1130-2-341, dated 1 February 1991.

Norrell Lock and Dam - Type of Project: Navigation Locks and Dams.

1. Flow Criteria.

   a. Navigation Locks and Dams.

PROJECT	O.H.W. Q CFS	MAX. NAV. Q CFS	ADVISORY CFS
Norrell Lock and Dam	N.A.	N.A.	N.A.

   b. Flood Control and Storage Dams. N/A.

   c. Hydroelectric/Intakes. N/A.

DESIGN FLOW NOT APPLICABLE / LOCKAGE ONLY

2. Upstream of Structures.

   a. Navigation Locks and Dams.

1&2) This project site is located in a man-made canal that connects the Arkansas River and the White River at the lower end of the McClellan-Kerr Arkansas River Navigation System. The project is in a slack water and/or backwater environment and is not exposed to actual river flow. This project has a standard size lock (same as the rest of the river locks) and a navigation pass (ungated weir). Lockage causes a flow over the weir that has a depth less than one foot. Hydraulic line has been seen to occur at a distance upstream equal to about three times the head on the crest of the dam.

HYDRAULIC LINE 3 FEET UPSTREAM OF WEIR

3) Intake manifolds are located on the inside of the lock guide walls with the openings extending upstream to about station 59+67. Intake passage opening extends over about 100 feet. The hydraulic line will be set upstream a distance at least twice the water passage opening (2 X 100 feet = 200 feet). The end of the lock guide wall is about 250 feet upstream at station 62+17.

HYDRAULIC LINE LOCATED AT END OF LOCK'S LONG GUIDE WALL

b. Hydroelectric/Intakes. N/A.

3. Downstream of Structures.

a. Navigation Locks and Dams.

1&2) Lock #2 releases that go over the weir of the navigation pass are so minor that the only hazard would be to downstream waders.

HYDRAULIC LINE AT DOWNSTREAM END OF RIP RAP

3) The lock discharges that create boils and eddies are contained in the navigation channel inside the lock guide walls and are the most hazardous at low flows. The hydraulic line will be set beyond these limits.

HYDRAULIC LINE AT END OF SHORT GUIDE WALL WITHIN LOCK WALL

b. Hydroelectric/Outlets. N/A.

Restricted Areas For Hazardous Waters
HYDRAULIC LINE

The following is a summary of the hydraulic line determinations based on Appendix A of ER 1130-2-341, dated 1 February 1991.

Lock # 2 - Type of Project: Navigation Locks and Dams.

1. Flow Criteria.

   a. Navigation Locks and Dams.

PROJECT	O.H.W. Q CFS	MAX. NAV. Q CFS	ADVISORY CFS
Lock # 2	N.A.	N.A.	N.A.

   b. Flood Control and Storage Dams. N/A.

   c. Hydroelectric/Intakes. N/A.

DESIGN FLOW NOT APPLICABLE / LOCKAGE ONLY

2. Upstream of Structures.

   a. Navigation Locks and Dams.

1&2) This project site is located in a man-made canal that connects the Arkansas River and the White River at the lower end of the McClellan-Kerr Arkansas River Navigation System. The project is in a slack water and/or backwater environment and is not exposed to actual river flow. This project has a standard size lock (same as the rest of the river locks).

HYDRAULIC LINE NOT APPLICABLE

3) Intake manifolds are located on the inside of the lock guide walls with the openings extending upstream. Intake passage opening extends over about 100 feet. The hydraulic line will be set upstream a distance at least twice the water passage opening (2 X 100 feet = 200 feet). The end of the lock guide wall is about 250 feet upstream.

HYDRAULIC LINE LOCATED AT END OF LOCK'S LONG GUIDE WALL

b. Hydroelectric/Intakes. N/A.

3. Downstream of Structures.

a. Navigation Locks and Dams.

1&2) Releases are only through lockage.

HYDRAULIC LINE NOT APPLICABLE

3) The lock discharges that create boils and eddies are contained in the navigation channel inside the lock guide walls and are the most hazardous at low flows. The hydraulic line will be set beyond these limits.

HYDRAULIC LINE AT END OF SHORT GUIDE WALL WITHIN LOCK WALL

b. Hydroelectric/Outlets. N/A.

Restricted Areas For Hazardous Waters
HYDRAULIC LINE

The following is the determination of the Hydraulic Line based on Appendix A of ER 1130-2-341, dated 1 February 1991.

Wilbur D. Mills Dam - Type of Project: Navigation Locks and Dams.

1. Flow Criteria.

   a. Navigation Locks and Dams.

PROJECT	O.H.W. Q CFS	MAX. NAV. Q CFS	ADVISORY CFS
Wilbur D. Mills Dam	85,000	350,000	70,000

   b. Flood Control and Storage Dams. N/A.

   c. Hydroelectric/Intakes. N/A.

DESIGN FLOW Q = 85,000 CFS

2. Upstream of Structures.

   a. Navigation Locks and Dams.

1&2) WES Technical Reports No. H-69-3 "Navigation Conditions at Lock and Dam No. 7, Arkansas River", H-70-8 "Lock and Dam No. 13, Arkansas River Navigation Project" and H-68-8 "Navigation Conditions at Lock and Dam No. 3, Arkansas River and Oklahoma" indicate very little if any drawdown would occur as long as the gates are controlling the pool elevations. Since this is a river situation, any flow will be towards the structure. The flow was about 29,500 cfs during the committee site visit and the conditions on the upstream face of the dam did not appear dangerous to a small craft. Since there is some constriction of the channel due to the non-overflow embankment the hydraulic line will be set based on a one to one ratio of the constriction.

HYDRAULIC LINE 435 FEET UPSTREAM OF DAM

3) No Lock.

   b. Hydroelectric/Intakes. N/A.

3. Downstream of Structures.

a. Navigation Locks and Dams.

1&2) WES Technical Report No. 2-655 "Spillway For Typical Low-Head Navigation Dam, Arkansas River, Arkansas" shows that the structure stilling basin was designed to contain the hydraulic jump for all flows. Based on flow regime, a weak or oscillating jump occurs within a maximum length of 240 feet or about 180 feet downstream of end sill. At low flows, uneven gate settings will set up eddies downstream of the stilling basin which could extend an undetermined distance downstream. Based on project records over the last ten years, this does not seem to be a problem.

HYDRAULIC LINE 180 FEET DOWNSTREAM OF END SILL

3) No Lock.

b. Hydroelectric/Outlets. N/A.

Restricted Areas For Hazardous Waters
HYDRAULIC LINE

The following is the determination of the Hydraulic Line based on Appendix A of ER 1130-2-341, dated 1 February 1991.

Lock and Dam #3 - Type of Project: Navigation Locks and Dams.

1. Flow Criteria.

   a. Navigation Locks and Dams.

PROJECT	O.H.W. Q CFS	MAX. NAV. Q CFS	ADVISORY CFS
Lock and Dam #3	85,000	350,000	70,000

   b. Flood Control and Storage Dams. N/A.

   c. Hydroelectric/Intakes. N/A.

DESIGN FLOW Q = 85,000 CFS

2. Upstream of Structures.

   a. Navigation Locks and Dams.

1&2) WES Technical Reports No. H-69-3 "Navigation Conditions at Lock and Dam No. 7, Arkansas River", H-70-8 "Lock and Dam No. 13, Arkansas River Navigation Project" and H-68-8 "Navigation Conditions at Lock and Dam No. 3, Arkansas River and Oklahoma" indicate very little if any drawdown would occur as long as the gates are controlling the pool elevations. Since this is a river situation, any flow will be towards the structure. The flow was about 70,000 cfs during the committee site visit and the conditions on the upstream face of the dam did not appear dangerous to a small craft. Since there is some constriction of the channel due to the upstream lock guide wall the hydraulic line will be set at that location.

HYDRAULIC LINE LOCATED AT END OF LOCK'S LONG GUIDE WALL

3) Intake manifolds are located on the inside of the lock guide walls with the openings extending about 100 feet upstream of the axis of the dams. The hydraulic line will be set upstream a distance at least twice the water passage opening (2 X 100 feet

= 200 feet). Intake location extends about 100 feet upstream of axis of dam.

HYDRAULIC LINE 300 FEET UPSTREAM OF DAM'S AXIS WITHIN LOCK WALL

b. Hydroelectric/Intakes. N/A.

3. Downstream of Structures.

a. Navigation Locks and Dams.

1&2) WES Technical Report No. 2-655 "Spillway For Typical Low-Head Navigation Dam, Arkansas River, Arkansas" shows that the structure stilling basin was designed to contain the hydraulic jump for all flows. Based on flow regime, an undular or weak jump occurs within a maximum length of 180 feet or about 140 feet downstream of end sill. At low flows, uneven gate settings will set up eddies downstream of the stilling basin which could extend an undetermined distance downstream. Based on project records over the last ten years, this does not seem to be a problem.

HYDRAULIC LINE 140 FEET DOWNSTREAM OF END SILL

3) The lock discharges that create boils and eddies are contained in the navigation channel inside the lock guide walls and are the most hazardous at low flows. The hydraulic line will be set beyond these limits.

HYDRAULIC LINE AT END OF SHORT GUIDE WALL WITHIN LOCK WALL

b. Hydroelectric/Outlets. N/A.

Restricted Areas For Hazardous Waters
HYDRAULIC LINE

The following is the determination of the Hydraulic Line based on Appendix A of ER 1130-2-341, dated 1 February 1991.

Emmett Sanders Lock and Dam - Type of Project: Navigation Locks and Dams.

1. Flow Criteria.

   a. Navigation Locks and Dams.

PROJECT	O.H.W. Q CFS	MAX. NAV. Q CFS	ADVISORY CFS
Emmett Sanders	60,000	350,000	70,000

   b. Flood Control and Storage Dams. N/A.

   c. Hydroelectric/Intakes. N/A.

DESIGN FLOW Q = 60,000 CFS

2. Upstream of Structures.

   a. Navigation Locks and Dams.

1&2) WES Technical Reports No. H-69-3 "Navigation Conditions at Lock and Dam No. 7, Arkansas River", H-70-8 "Lock and Dam No. 13, Arkansas River Navigation Project" and H-68-8 "Navigation Conditions at Lock and Dam No. 3, Arkansas River and Oklahoma" indicate very little if any drawdown would occur as long as the gates are controlling the pool elevations. Since this is a river situation, any flow will be towards the structure. The location of this dam is at a crossing and flow is trained to the navigation channel with a split sill configuration. The flow was about 70,000 cfs during the committee site visit and the conditions on the upstream face of the dam did not appear dangerous to a small craft. Since there is some constriction of the channel due to the upstream lock guide wall the hydraulic line will be set at that location.

HYDRAULIC LINE LOCATED AT END OF LOCK'S LONG GUIDE WALL

3) Intake manifolds are located on the inside of the lock guide walls with the openings extending about 100 feet upstream

of the axis of the dams. The hydraulic line will be set upstream a distance at least twice the water passage opening (2 X 100 feet = 200 feet). Intake location extends about 100 feet upstream of axis of dam.

HYDRAULIC LINE 300 FEET UPSTREAM OF DAM'S AXIS WITHIN LOCK WALL

b. Hydroelectric/Intakes. N/A.

3. Downstream of Structures.

a. Navigation Locks and Dams.

1&2) WES Technical Report No. 2-655 "Spillway For Typical Low-Head Navigation Dam, Arkansas River, Arkansas" shows that the structure stilling basin was designed to contain the hydraulic jump for all flows. Based on flow regime and due to the split flow, a strong return eddy is set up at the design flow. This was witnessed during the site visit. Project personnel say the most dangerous flow is at about 40,000 cfs. Based on aerial photos, sand bar formations, channel width and project personnel, the strong eddy extends about 800 feet downstream.

HYDRAULIC LINE 800 FEET DOWNSTREAM OF END SILL

3) The lock discharges that create boils and eddies are contained in the navigation channel inside the lock guide walls and are the most hazardous at low flows. The hydraulic line will be set beyond these limits.

HYDRAULIC LINE AT END OF SHORT GUIDE WALL WITHIN LOCK WALL

b. Hydroelectric/Outlets. N/A.

Restricted Areas For Hazardous Waters
HYDRAULIC LINE

The following is the determination of the Hydraulic Line based on Appendix A of ER 1130-2-341, dated 1 February 1991.

Lock and Dam #5 - Type of Project: Navigation Locks and Dams.

1. Flow Criteria.

   a. Navigation Locks and Dams.

PROJECT	O.H.W. Q CFS	MAX. NAV. Q CFS	ADVISORY CFS
Lock and Dam #5	80,000	410,000	70,000

   b. Flood Control and Storage Dams. N/A.

   c. Hydroelectric/Intakes. N/A.

DESIGN FLOW Q = 80,000 CFS

2. Upstream of Structures.

   a. Navigation Locks and Dams.

1&2) WES Technical Reports No. H-69-3 "Navigation Conditions at Lock and Dam No. 7, Arkansas River", H-70-8 "Lock and Dam No. 13, Arkansas River Navigation Project" and H-68-8 "Navigation Conditions at Lock and Dam No. 3, Arkansas River and Oklahoma" indicate very little if any drawdown would occur as long as the gates are controlling the pool elevations. Since this is a river situation, any flow will be towards the structure. The flow was about 75,000 cfs during the committee site visit and the conditions on the upstream face of the dam did not appear dangerous to a small craft. Since there is some constriction of the channel due to the upstream lock guide wall the hydraulic line will be set at that location.

HYDRAULIC LINE LOCATED AT END OF LOCK'S LONG GUIDE WALL

3) Intake manifolds are located on the inside of the lock guide walls with the openings extending about 100 feet upstream of the axis of the dams. The hydraulic line will be set upstream a distance at least twice the water passage opening (2 X 100 feet

= 200 feet). Intake location extends about 100 feet upstream of axis of dam.

HYDRAULIC LINE 300 FEET UPSTREAM OF DAM'S AXIS WITHIN LOCK WALL

b. Hydroelectric/Intakes. N/A.

3. Downstream of Structures.

a. Navigation Locks and Dams.

1&2) WES Technical Report No. 2-655 "Spillway For Typical Low-Head Navigation Dam, Arkansas River, Arkansas" shows that the structure stilling basin was designed to contain the hydraulic jump for all flows. Based on flow regime, an undular or weak jump occurs within a maximum length of 210 feet or about 170 feet downstream of end sill. At low flows, uneven gate settings will set up eddies downstream of the stilling basin which could extend an undetermined distance downstream. Based on project records over the last ten years, this does not seem to be a problem.

HYDRAULIC LINE 170 FEET DOWNSTREAM OF END SILL

3) The lock discharges that create boils and eddies are contained in the navigation channel inside the lock guide walls and are the most hazardous at low flows. The hydraulic line will be set beyond these limits.

HYDRAULIC LINE AT END OF SHORT GUIDE WALL WITHIN LOCK WALL

b. Hydroelectric/Outlets. N/A.

Restricted Areas For Hazardous Waters
HYDRAULIC LINE

The following is the determination of the Hydraulic Line based on Appendix A of ER 1130-2-341, dated 1 February 1991.

David D. Terry - Type of Project: Navigation Locks and Dams.

1. Flow Criteria.

a. Navigation Locks and Dams.

PROJECT	O.H.W. Q CFS	MAX. NAV. Q CFS	ADVISORY CFS
David D. Terry	90,000	415,000	70,000

b. Flood Control and Storage Dams. N/A.

c. Hydroelectric/Intakes. N/A.

DESIGN FLOW Q = 90,000 CFS

2. Upstream of Structures.

a. Navigation Locks and Dams.

1&2) WES Technical Reports No. H-69-3 "Navigation Conditions at Lock and Dam No. 7, Arkansas River", H-70-8 "Lock and Dam No. 13, Arkansas River Navigation Project" and H-68-8 "Navigation Conditions at Lock and Dam No. 3, Arkansas River and Oklahoma" indicate very little if any drawdown would occur as long as the gates are controlling the pool elevations. Since this is a river situation, any flow will be towards the structure. The flow was 75,000 cfs during the committee site visit and the conditions on the upstream face of the dam did not appear dangerous to a small craft. Since there is some constriction of the channel due to the upstream lock guide wall the hydraulic line will be set at that location.

HYDRAULIC LINE LOCATED AT END OF LOCK'S LONG GUIDE WALL

3) Intake manifolds are located on the inside of the lock guide walls with the openings extending about 100 feet upstream of the axis of the dams. The hydraulic line will be set upstream a distance at least twice the water passage opening (2 X 100 feet

= 200 feet). Intake location extends about 100 feet upstream of axis of dam.

HYDRAULIC LINE 300 FEET UPSTREAM OF DAM'S AXIS WITHIN LOCK WALL

b. Hydroelectric/Intakes. N/A.

3. Downstream of Structures.

a. Navigation Locks and Dams.

1&2) WES Technical Report No. 2-655 "Spillway For Typical Low-Head Navigation Dam, Arkansas River, Arkansas" shows that the structure stilling basin was designed to contain the hydraulic jump for all flows. Based on flow regime, an undular or weak jump occurs within a maximum length of 191 feet or about 150 feet downstream of end sill. At low flows, uneven gate settings will set up eddies downstream of the stilling basin which could extend an undetermined distance downstream. Based on project records over the last ten years, this does not seem to be a problem.

HYDRAULIC LINE 150 FEET DOWNSTREAM OF END SILL

3) The lock discharges that create boils and eddies are contained in the navigation channel inside the lock guide walls and are the most hazardous at low flows. The hydraulic line will be set beyond these limits.

HYDRAULIC LINE AT END OF SHORT GUIDE WALL WITHIN LOCK WALL

b. Hydroelectric/Outlets. N/A.

Restricted Areas For Hazardous Waters
HYDRAULIC LINE

The following is the determination of the Hydraulic Line based on Appendix A of ER 1130-2-341, dated 1 February 1991.

Murray Lock and Dam - Type of Project: Navigation Locks and Dams with Hydropower Plant.

1. Flow Criteria.

a. Navigation Locks and Dams.

PROJECT	O.H.W. Q CFS	MAX. NAV. Q CFS	ADVISORY CFS
Murray Lock and Dam	70,000	350,000	70,000

b. Flood Control and Storage Dams. N/A.

c. Hydroelectric/Intakes. Maximum discharge for the two units is about 39,000 cfs.

DESIGN FLOW Q = 70,000 CFS

2. Upstream of Structures.

a. Navigation Locks and Dams.

1&2) WES Technical Reports No. H-69-3 "Navigation Conditions at Lock and Dam No. 7, Arkansas River", H-70-8 "Lock and Dam No. 13, Arkansas River Navigation Project" and H-68-8 "Navigation Conditions at Lock and Dam No. 3, Arkansas River and Oklahoma" indicate very little if any drawdown would occur as long as the gates are controlling the pool elevations. Since this is a river situation, any flow will be towards the structure. The flow was 109,000 cfs during the committee site visit and the conditions on the upstream face of the dam did not appear dangerous to a small craft. Since there is some constriction of the channel due to the structure and upstream lock guide wall, the hydraulic line will be set at that location.

HYDRAULIC LINE LOCATED AT END OF LOCK'S LONG GUIDE WALL

3) Intake manifolds are located on the inside of the lock guide walls with the openings extending about 100 feet upstream of the axis of the dams. The hydraulic line will be set upstream

a distance at least twice the water passage opening (2 X 100 feet = 200 feet). Intake location extends about 100 feet upstream of axis of dam.

HYDRAULIC LINE 300 FEET UPSTREAM OF DAM'S AXIS WITHIN LOCK WALL

b. Hydroelectric/Intakes. The City of North Little Rock owns and operates a run of the river hydropower plant on the left bank of the river. Vorticies can form at the face of the intake which could pull small objects under, but they are not powerful enough to affect a small boat. Set hydraulic line at twice the width of the structure's intake (2 X 44 feet = 88 feet)

HYDRAULIC LINE 88 FEET FROM POWERHOUSE INTAKE

3. Downstream of Structures.

a. Navigation Locks and Dams.

1&2) WES Technical Report No. 2-655 "Spillway For Typical Low-Head Navigation Dam, Arkansas River, Arkansas" shows that the structure stilling basin was designed to contain the hydraulic jump for all flows. Based on flow regime, a weak jump occurs within a maximum length of 300 feet or about 260 feet downstream of the end sill. At low flows, uneven gate settings will set up eddies downstream of the stilling basin which could extend an undetermined distance downstream. Based on project records over the last ten years, this does not seem to be a problem.

HYDRAULIC LINE 260 FEET DOWNSTREAM OF END SILL

3) The lock discharges that create boils and eddies are contained in the navigation channel inside the lock guide walls and are the most hazardous at low flows. The hydraulic line will be set beyond these limits.

HYDRAULIC LINE AT END OF SHORT GUIDE WALL WITHIN LOCK WALL

b. Hydroelectric/Outlets. Eddies on each side of the channel extend about 200 feet

HYDRAULIC LINE 200 FEET DOWNSTREAM OF POWERHOUSE OUTLET

Restricted Areas For Hazardous Waters
HYDRAULIC LINE

The following is the determination of the Hydraulic Line based on Appendix A of ER 1130-2-341, dated 1 February 1991.

Toad Suck Ferry - Type of Project: Navigation Locks and Dams.

1. Flow Criteria.

   a. Navigation Locks and Dams.

PROJECT	O.H.W. Q CFS	MAX. NAV. Q CFS	ADVISORY CFS
Toad Suck Ferry	90,000	220,000	70,000

   b. Flood Control and Storage Dams. N/A.

   c. Hydroelectric/Intakes. N/A.

DESIGN FLOW Q = 90,000 CFS

2. Upstream of Structures.

   a. Navigation Locks and Dams.

1&2) WES Technical Reports No. H-69-3 "Navigation Conditions at Lock and Dam No. 7, Arkansas River", H-70-8 "Lock and Dam No. 13, Arkansas River Navigation Project" and H-68-8 "Navigation Conditions at Lock and Dam No. 3, Arkansas River and Oklahoma" indicate very little if any drawdown would occur as long as the gates are controlling the pool elevations. However, this project is the first to go to open river which happens at a flow of about 90,000 cfs. Since this is a river situation, any flow will be towards the structure. The flow was 110,000 cfs during the committee site visit and the project was at open river. Since there is some constriction of the channel due to the structure and upstream lock guide wall, the hydraulic line will be set at that location.

HYDRAULIC LINE LOCATED AT END OF LOCK'S LONG GUIDE WALL

3) Intake manifolds are located on the inside of the lock guide walls with the openings extending about 100 feet upstream of the axis of the dams. The hydraulic line will be set upstream a distance at least twice the water passage opening (2 X 100 feet

= 200 feet). Intake location extends about 100 feet upstream of axis of dam.

HYDRAULIC LINE 300 FEET UPSTREAM OF DAM'S AXIS WITHIN LOCK WALL

b. Hydroelectric/Intakes. N/A.

3. Downstream of Structures.

a. Navigation Locks and Dams.

1&2) WES Technical Report No. 2-655 "Spillway For Typical Low-Head Navigation Dam, Arkansas River, Arkansas" shows that the structure stilling basin was designed to contain the hydraulic jump for all flows. Based on flow regime, an undular or weak jump occurs within a maximum length of 320 feet or about 280 feet downstream of the end sill. At low flows, uneven gate settings will set up eddies downstream of the stilling basin which could extend an undetermined distance downstream. Based on project records over the last ten years, this does not seem to be a problem.

HYDRAULIC LINE 280 FEET DOWNSTREAM OF END SILL

3) The lock discharges that create boils and eddies are contained in the navigation channel inside the lock guide walls and are the most hazardous at low flows. The hydraulic line will be set beyond these limits.

HYDRAULIC LINE AT END OF SHORT GUIDE WALL WITHIN LOCK WALL

b. Hydroelectric/Outlets. N/A.

Restricted Areas For Hazardous Waters
HYDRAULIC LINE

The following is the determination of the Hydraulic Line based on Appendix A of ER 1130-2-341, dated 1 February 1991.

Arthur V. Ormand - Type of Project: Navigation Locks and Dams with Hydropower Plant.

1. Flow Criteria.

a. Navigation Locks and Dams.

PROJECT	O.H.W. Q CFS	MAX. NAV. Q CFS	ADVISORY CFS
Arthur V. Ormand	100,000	200,000	70,000

b. Flood Control and Storage Dams. N/A.

c. Hydroelectric/Intakes. Presently under construction with an estimated maximum discharge of about 32,000 cfs.

DESIGN FLOW Q = 100,000 CFS

2. Upstream of Structures.

a. Navigation Locks and Dams.

1&2) WES Technical Reports No. H-69-3 "Navigation Conditions at Lock and Dam No. 7, Arkansas River", H-70-8 "Lock and Dam No. 13, Arkansas River Navigation Project" and H-68-8 "Navigation Conditions at Lock and Dam No. 3, Arkansas River and Oklahoma" indicate very little if any drawdown would occur as long as the gates are controlling the pool elevations. Since this is a river situation, any flow will be towards the structure. The flow was about 23,000 cfs during the committee site visit and the conditions on the upstream face of the dam did not appear dangerous to a small craft. Since there is some constriction of the channel due to the structure and upstream lock guide wall, the hydraulic line will be set at that location.

HYDRAULIC LINE LOCATED AT END OF LOCK'S LONG GUIDE WALL

3) Intake manifolds are located on the inside of the lock guide walls with the openings extending about 100 feet upstream of the axis of the dams. The hydraulic line will be set upstream

a distance at least twice the water passage opening (2 X 100 feet = 200 feet). Intake location extends about 100 feet upstream of axis of dam.

HYDRAULIC LINE 300 FEET UPSTREAM OF DAM'S AXIS WITHIN LOCK WALL

b. Hydroelectric/Intakes. Arkansas Electric Cooperative Corporation (AECC) is having the hydropower plant built on the left bank of the river. Although this plant is not completed, set hydraulic line at twice the width of the structure's intake (2 X 54 feet = 108 feet)

HYDRAULIC LINE 108 FEET FROM POWERHOUSE INTAKE

3. Downstream of Structures.

a. Navigation Locks and Dams.

1&2) WES Technical Report No. 2-655 "Spillway For Typical Low-Head Navigation Dam, Arkansas River, Arkansas" shows that the structure stilling basin was designed to contain the hydraulic jump for all flows. Based on flow regime, an undular or weak jump occurs within a maximum length of 280 feet or about 240 feet downstream of the end sill. At low flows, uneven gate settings will set up eddies downstream of the stilling basin which could extend an undetermined distance downstream. Based on project records over the last ten years, this does not seem to be a problem.

HYDRAULIC LINE 240 FEET DOWNSTREAM OF END SILL

3) The lock discharges that create boils and eddies are contained in the navigation channel inside the lock guide walls and are the most hazardous at low flows. The hydraulic line will be set beyond these limits.

HYDRAULIC LINE AT END OF SHORT GUIDE WALL WITHIN LOCK WALL

b. Hydroelectric/Outlets. This is not known at this time.

HYDRAULIC LINE IS NOT KNOWN AT THIS TIME

Restricted Areas For Hazardous Waters
HYDRAULIC LINE

The following is the determination of the Hydraulic Line based on Appendix A of ER 1130-2-341, dated 1 February 1991.

Dardanelle Lock and Dam - Type of Project: Navigation Locks and Dams with Hydropower Plant.

1. Flow Criteria.

a. Navigation Locks and Dams.

PROJECT	O.H.W. Q CFS	MAX. NAV. Q CFS	ADVISORY CFS
Dardanelle Lock and Dam	100,000	240,000	70,000

b. Flood Control and Storage Dams. N/A.

c. Hydroelectric/Intakes. Maximum discharge for the hydroelectric plant is about 50,000 cfs.

DESIGN FLOW Q = 100,000 CFS

2. Upstream of Structures.

a. Navigation Locks and Dams.

1&2) WES Technical Reports No. H-69-3 "Navigation Conditions at Lock and Dam No. 7, Arkansas River", H-70-8 "Lock and Dam No. 13, Arkansas River Navigation Project" and H-68-8 "Navigation Conditions at Lock and Dam No. 3, Arkansas River and Oklahoma" indicate very little if any drawdown would occur as long as the gates are controlling the pool elevations. Since this is a river situation, any flow will be towards the structure. The flow was about 21,000 cfs during the committee site visit and the conditions on the upstream face of the dam did not appear dangerous to a small craft. Since there is some constriction of the channel due to the structure and upstream lock guide wall, the hydraulic line will be set at that location.

HYDRAULIC LINE LOCATED AT END OF LOCK'S LONG GUIDE WALL

3) Intake manifolds are located on the inside of the lock guide walls with the openings extending about 150 feet upstream of the axis of the dam. The hydraulic line will be set upstream

a distance at least twice the water passage opening (2 X 150 feet = 300 feet). Intake location extends about 150 feet upstream of axis of dam.

HYDRAULIC LINE 450 FEET UPSTREAM OF DAM'S AXIS WITHIN LOCK WALL

b. Hydroelectric/Intakes. Southwest Power Administration (SWPA) operates a run of the river hydropower plant on the right bank of the river. Vorticies can form at the face of the intake which could pull small objects under, but they are not powerful enough to affect a small boat. Set hydraulic line at twice the width of the structure's intake (2 X 50 feet = 100 feet).

HYDRAULIC LINE 100 FEET FROM POWERHOUSE INTAKE

3. Downstream of Structures.

a. Navigation Locks and Dams.

1&2) WES Technical Report No. 2-655 "Spillway For Typical Low-Head Navigation Dam, Arkansas River, Arkansas" shows that the structure stilling basin was designed to contain the hydraulic jump for all flows. Based on flow regime, an ocillating jump occurs within a maximum length of 190 feet or about 150 feet downstream of the end sill. At low flows, uneven gate settings will set up eddies downstream of the stilling basin which could extend an undetermined distance downstream. Based on project records over the last ten years, this does not seem to be a problem.

HYDRAULIC LINE 150 FEET DOWNSTREAM OF END SILL

3) The lock discharges that create boils and eddies are to the river side of the lock guide wall and are the most hazardous at low flows. The hydraulic line will be set beyond these limits.

HYDRAULIC LINE 300 FEET FROM OUTLET

b. Hydroelectric/Outlets. Boils and eddies extend about 200 feet downstream.

HYDRAULIC LINE 200 FEET DOWNSTREAM OF POWERHOUSE OUTLET
Restricted Areas For Hazardous Waters
HYDRAULIC LINE

Restricted Areas For Hazardous Waters
HYDRAULIC LINE

The following is the determination of the Hydraulic Line based on Appendix A of ER 1130-2-341, dated 1 February 1991.

Ozark Lock and Dam - Type of Project: Navigation Locks and Dams with Hydropower Plant.

1. Flow Criteria.

a. Navigation Locks and Dams.

PROJECT	O.H.W. Q CFS	MAX. NAV. Q CFS	ADVISORY CFS
Ozark Lock and Dam	75,000	260,000	70,000

b. Flood Control and Storage Dams. N/A.

c. Hydroelectric/Intakes. Maximum discharge for the hydroelectric plant is about 65,000 cfs.

DESIGN FLOW Q = 75,000 CFS

2. Upstream of Structures.

a. Navigation Locks and Dams.

1&2) WES Technical Reports No. H-69-3 "Navigation Conditions at Lock and Dam No. 7, Arkansas River", H-70-8 "Lock and Dam No. 13, Arkansas River Navigation Project" and H-68-8 "Navigation Conditions at Lock and Dam No. 3, Arkansas River and Oklahoma" indicate very little if any drawdown would occur as long as the gates are controlling the pool elevations. Since this is a river situation, any flow will be towards the structure. The flow was about 32,000 cfs during the committee site visit and all flow was through the powerhouse. Since there is some constriction of the channel due to the structure and upstream lock guide wall, the hydraulic line will be set at that location.

HYDRAULIC LINE LOCATED AT END OF LOCK'S LONG GUIDE WALL

3) Intake manifolds are located on the inside of the lock guide walls with the openings extending about 120 feet upstream of the axis of the dam. The hydraulic line will be set upstream

a distance at least twice the water passage opening (2 X 120 feet = 2400 feet). Intake location extends about 120 feet upstream of axis of dam.

HYDRAULIC LINE 360 FEET UPSTREAM OF DAM'S AXIS WITHIN LOCK WALL

b. Hydroelectric/Intakes. Southwest Power Administration (SWPA) operates a run of the river hydropower plant on the right bank of the river. Vorticies can form at the face of the intake which could pull small objects under, but they are not powerful enough to affect a small boat. Set hydraulic line at twice the width of the structure's intake (2 X 50 feet = 100 feet).

HYDRAULIC LINE 100 FEET FROM POWERHOUSE INTAKE

3. Downstream of Structures.

a. Navigation Locks and Dams.

1&2) WES Technical Report No. 2-655 "Spillway For Typical Low-Head Navigation Dam, Arkansas River, Arkansas" shows that the structure stilling basin was designed to contain the hydraulic jump for all flows. Based on flow regime, an oscillating jump occurs within a maximum length of 250 feet or about 210 feet downstream of the end sill. At low flows, uneven gate settings will set up eddies downstream of the stilling basin which could extend an undetermined distance downstream. Based on project records over the last ten years, this does not seem to be a problem.

HYDRAULIC LINE 210 FEET DOWNSTREAM OF END SILL

3) The lock discharges that create boils and eddies are to the river side of the lock guide wall and are the most hazardous at low flows. The hydraulic line will be set beyond these limits.

HYDRAULIC LINE 300 FEET FROM OUTLET

b. Hydroelectric/Outlets. Boils and eddies extend about 200 feet downstream.

HYDRAULIC LINE 200 FEET DOWNSTREAM OF POWERHOUSE OUTLET

Restricted Areas For Hazardous Waters
HYDRAULIC LINE

The following is the determination of the Hydraulic Line based on Appendix A of ER 1130-2-341, dated 1 February 1991.

James W. Trimble - Type of Project: Navigation Locks and Dams with Hydropower Plant.

1. Flow Criteria.

a. Navigation Locks and Dams.

PROJECT	O.H.W. Q CFS	MAX. NAV. Q CFS	ADVISORY CFS
James W. Trimble	75,000	245,000	70,000

b. Flood Control and Storage Dams. N/A.

c. Hydroelectric/Intakes. Maximum discharge for the hydropower plant is about 32,000 cfs.

DESIGN FLOW Q = 75,000 CFS

2. Upstream of Structures.

a. Navigation Locks and Dams.

1&2) WES Technical Reports No. H-69-3 "Navigation Conditions at Lock and Dam No. 7, Arkansas River", H-70-8 "Lock and Dam No. 13, Arkansas River Navigation Project" and H-68-8 "Navigation Conditions at Lock and Dam No. 3, Arkansas River and Oklahoma" indicate very little if any drawdown would occur as long as the gates are controlling the pool elevations. Since this is a river situation, any flow will be towards the structure. The flow was 39,000 cfs during the committee site visit with most of the flow being released by the powerhouse. Since there is some constriction of the channel due to the structure and upstream lock guide wall, the hydraulic line will be set at that location.

HYDRAULIC LINE LOCATED AT END OF LOCK'S LONG GUIDE WALL

3) Intake manifolds are located on the inside of the lock guide walls with the openings extending about 100 feet upstream of the axis of the dams. The hydraulic line will be set upstream

a distance at least twice the water passage opening (2 X 100 feet = 200 feet). Intake location extends about 100 feet upstream of axis of dam.

HYDRAULIC LINE 300 FEET UPSTREAM OF DAM'S AXIS WITHIN LOCK WALL

b. Hydroelectric/Intakes. The Arkansas Electric Cooperative Corporation owns and operates a run of the river hydropower plant on the left bank of the river. Set hydraulic line at twice the width of the structure's intake (2 X 44 feet = 88 feet)

HYDRAULIC LINE 88 FEET FROM POWERHOUSE INTAKE

3. Downstream of Structures.

a. Navigation Locks and Dams.

1&2) WES Technical Report No. 2-655 "Spillway For Typical Low-Head Navigation Dam, Arkansas River, Arkansas" shows that the structure stilling basin was designed to contain the hydraulic jump for all flows. Based on flow regime, an undular or weak jump occurs within a maximum length of 170 feet or about 130 feet downstream of the end sill. At low flows, uneven gate settings will set up eddies downstream of the stilling basin which could extend an undetermined distance downstream. Based on project records over the last ten years, this does not seem to be a problem.

HYDRAULIC LINE 130 FEET DOWNSTREAM OF END SILL

3) The lock discharges that create boils and eddies are contained in the navigation channel inside the lock guide walls and are the most hazardous at low flows. The hydraulic line will be set beyond these limits.

HYDRAULIC LINE AT END OF SHORT GUIDE WALL WITHIN LOCK WALL

b. Hydroelectric/Outlets. Based on the findings at the Murray Hydropower Plant, boils and eddies will extend about 200 feet.

HYDRAULIC LINE 200 FEET DOWNSTREAM OF POWERHOUSE OUTLET

CATEGORY III

BLUE MOUNTAIN, CLEARWATER, DEQUEEN, DIERKS, GILLHAM, NIMROD

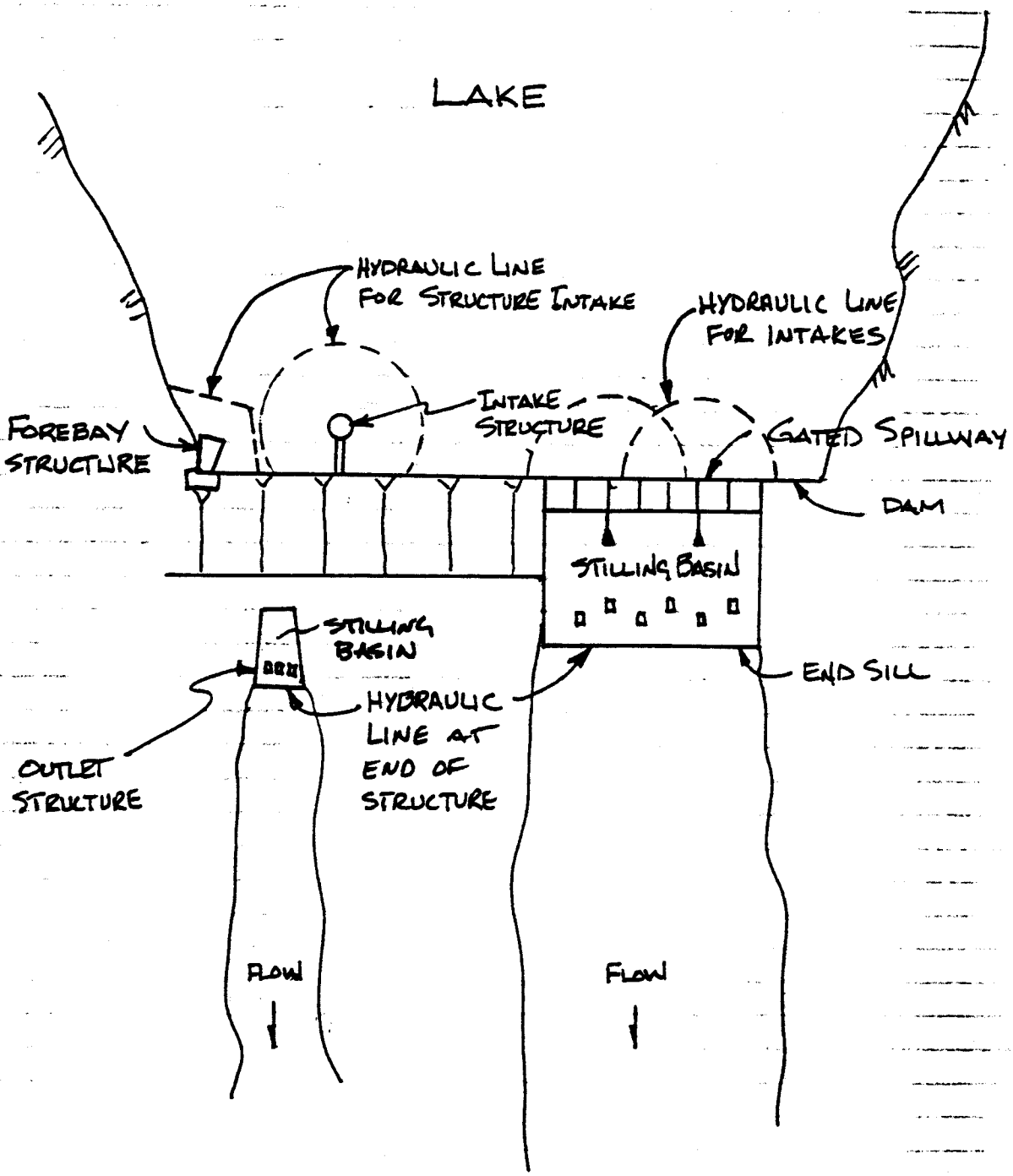
Page ____ of ____

SUBJECT RESTRICTED AREAS FOR HAZARDOUS WATERS

COMPUTATION TYPICAL HYDRAULIC LINE LOCATIONS FILE NO. ____

COMPUTED BY GAR DATE 7/31/92 CHECKED BY ____ DATE ____

CATEGORY III:



Restricted Areas For Hazardous Waters
HYDRAULIC LINE

The following is the determination of the Hydraulic Line based on Appendix A of ER 1130-2-341, dated 1 February 1991.

Blue Mountain Lake - Type of Project: Flood Control/Storage with Intake.

1. Flow Criteria.

   a. Navigation Locks and Dams. N/A.

   b. Flood Control and Storage Dams.

      Bankfull Flow: Q = 3,500 cfs
      Customary Flow: Q = 2,500 cfs

   c. Hydroelectric/Intakes.

      One-Year Flow: Estimated Q = 1,700 cfs

DESIGN FLOW Q = 2,500 cfs

2. Upstream of Structures.

   a. Navigation, Flood Control/Storage Projects. Design flow is released through intake structure.

   b. Hydroelectric/Intakes. Surface velocities, although they were not seen at the time of the committee's visit, are noticeable at design flow. The intake has a forebay that extends about 95 feet from the intake. Set the hydraulic line at a distance equal to twice the width of the structure intake (2 X 20 feet = 40 feet).

HYDRAULIC LINE 40 FEET FROM FOREBAY STRUCTURE

3. Downstream of Structures.

   a. Navigation, Flood Control/Storage Projects. N/A.

   b. Hydroelectric/Outlets. Releases at time of the inspection were about 300 cfs and all flow appeared headed downstream at the end of the outlet basin structure. Visual inspection showed no eddies.

HYDRAULIC LINE DOWNSTREAM END OF OUTLET STRUCTURE

Restricted Areas For Hazardous Waters
HYDRAULIC LINE

The following is the determination of the Hydraulic Line based on Appendix A of ER 1130-2-341, dated 1 February 1991.

Clearwater Lake - Type of Project: Flood Control/Storage with Intake.

1. Flow Criteria.

   a. Navigation Locks and Dams. N/A.

   b. Flood Control and Storage Dams.

      Bankfull Flow: Q = 4,000 cfs
      Customary Flow: Q = 2,000 cfs

   c. Hydroelectric/Intakes.

      One-Year Flow: Estimated Q = 2,000 cfs

DESIGN FLOW Q = 2,000 cfs

2. Upstream of Structures.

   a. Navigation, Flood Control/Storage Projects. Design flow is released through intake structure.

   b. Hydroelectric/Intakes. Surface velocities, although they were not seen at the time of the committee's visit, are noticeable at design flow. The intake has a forebay that extends about 120 feet from the intake. Set the hydraulic line at a distance equal to twice the width of the structure intake (2 X 23 feet = 46 feet).

HYDRAULIC LINE 46 FEET FROM FOREBAY STRUCTURE

3. Downstream of Structures.

   a. Navigation, Flood Control/Storage Projects. N/A.

   b. Hydroelectric/Outlets. Releases at time of the inspection were about 180 cfs and all flow appeared headed downstream at the end of the outlet basin structure. Visual inspection showed no eddies.

HYDRAULIC LINE DOWNSTREAM END OF OUTLET STRUCTURE

Restricted Areas For Hazardous Waters
HYDRAULIC LINE

The following is the determination of the Hydraulic Line based on Appendix A of ER 1130-2-341, dated 1 February 1991.

DeQueen Lake - Type of Project: Flood Control/Storage with Intake.

1. Flow Criteria.

   a. Navigation Locks and Dams. N/A.

   b. Flood Control and Storage Dams.

      Bankfull Flow: Q = 2,000 cfs
      Customary Flow: Q = 2,000 cfs

   c. Hydroelectric/Intakes.

      One-Year Flow: Not Available.

DESIGN FLOW Q = 2,000 CFS

2. Upstream of Structures.

   a. Navigation, Flood Control/Storage Projects. N/A.

   b. Hydroelectric/Intakes. There are no visible surface effects, but set the hydraulic line at a distance equal to twice the width of the structure intake (2 X 32 feet = 64 feet).

HYDRAULIC LINE 64 FEET FROM STRUCTURE INTAKE

3. Downstream of Structures.

   a. Navigation, Flood Control/Storage Projects. N/A.

   b. Hydroelectric/Outlets. Releases at the time of the inspection were 1850 cfs into the outlet basin and all flow appeared headed downstream at the end of the outlet basin structure. Visual inspection showed no eddies.

HYDRAULIC LINE DOWNSTREAM END OF OUTLET STRUCTURE

Restricted Areas For Hazardous Waters
HYDRAULIC LINE

The following is the determination of the Hydraulic Line based on Appendix A of ER 1130-2-341, dated 1 February 1991.

Dierks Lake - Type of Project: Flood Control/Storage with Intake.

1. Flow Criteria.

   a. Navigation Locks and Dams. N/A.

   b. Flood Control and Storage Dams.

      Bankfull Flow: Q = 1,000 cfs
      Customary Flow: Q = 1,000 cfs

   c. Hydroelectric/Intakes.

      One-year Flow: Not Available.

DESIGN FLOW Q = 1,000 CFS

2. Upstream of Structures.

   a. Navigation, Flood Control/Storage Projects. Flood releases are made through an intake structure.

   b. Hydroelectric/Intakes. Personnel indicate no surface effects, but set the hydraulic line at a distance equal to twice the width of the structure intake (2 X 14 feet = 28 feet).

HYDRAULIC LINE 28 FEET FROM STRUCTURE INTAKE

3. Downstream of Structures.

   a. Navigation, Flood Control/Storage Projects. Flood releases are made through a conduit into a stilling basin.

   b. Hydroelectric/Outlets. Releases at time of the inspection were 6 cfs into the outlet basin. Based on project personnel, all flow appears headed downstream at the end of the outlet basin structure when they release 1000 cfs. Visual inspection showed a small eddy dowstream on left bank about 400 feet downstream of the outlet structure, but project personnel say that it is not dangerous at design flow.

HYDRAULIC LINE DOWNSTREAM END OF OUTLET STRUCTURE

Restricted Areas For Hazardous Waters
HYDRAULIC LINE

The following is the determination of the Hydraulic Line based on Appendix A of ER 1130-2-341, dated 1 February 1991.

Gillham Lake - Type of Project: Flood Control/Storage with Intake.

1. Flow Criteria.

   a. Navigation Locks and Dams. N/A.

   b. Flood Control and Storage Dams.

      Bankfull Flow: Q = 3,000 cfs
      Customary Flow: Q = 3,000 cfs

   c. Hydroelectric/Intakes.

      One-Year Flow: Not Available.

DESIGN FLOW Q = 3,000 CFS

2. Upstream of Structures.

   a. Navigation, Flood Control/Storage Projects. N/A.

   b. Hydroelectric/Intakes. A small whirlpool forms at the face of the intake at large releases, but it does not appear very strong. Set the hydraulic line at a distance equal to twice the width of the structure intake (2 X 16 feet = 32 feet).

HYDRAULIC LINE 32 FEET FROM STRUCTURE INTAKE

3. Downstream of Structures.

   a. Navigation, Flood Control/Storage Projects. N/A.

   b. Hydroelectric/Outlets. Releases at time of the inspection were 2850 cfs into the outlet basin and all flow appeared headed downstream at the end of the outlet basin structure. Visual inspection showed no eddies.

HYDRAULIC LINE DOWNSTREAM END OF OUTLET STRUCTURE

Restricted Areas For Hazardous Waters
HYDRAULIC LINE

The following is the determination of the Hydraulic Line based on Appendix A of ER 1130-2-341, dated 1 February 1991.

Nimrod Lake - Type of Project: Flood Control/Storage with Intake.

1. Flow Criteria.

   a. Navigation Locks and Dams. N/A.

   b. Flood Control and Storage Dams.

      Bankfull Flow: Q = 5,000 cfs
      Customary Flow: Q = 1,800 cfs

   c. Hydroelectric/Intakes.

      One-Year Flow: Estimated Q = 4,000 cfs

DESIGN FLOW Q = 4,000 cfs

2. Upstream of Structures.

   a. Navigation, Flood Control/Storage Projects. Design flow is released through submerged intakes in the dam face.

   b. Hydroelectric/Intakes. There are no visible surface effects as design flow is made through submerged intakes to Howell-Bunger valves and conduits. Set the hydraulic line at a distance equal to twice the width of the structure intake (2 X 5 feet = 10 feet for Howell-Bunger intakes and 2 X 14 feet = 28 feet for intakes to conduits).

HYDRAULIC LINE 10 AND 28 FEET FROM INTAKES

3. Downstream of Structures.

   a. Navigation, Flood Control/Storage Projects. N/A.

   b. Hydroelectric/Outlets. The release at the time of the inspection was about 360 cfs through the Howell-Bunger valves and all flow appeared headed downstream at the end of the outlet basin structure. Visual inspection showed no eddies.

HYDRAULIC LINE DOWNSTREAM END OF OUTLET STRUCTURE

Category IV

Millwood

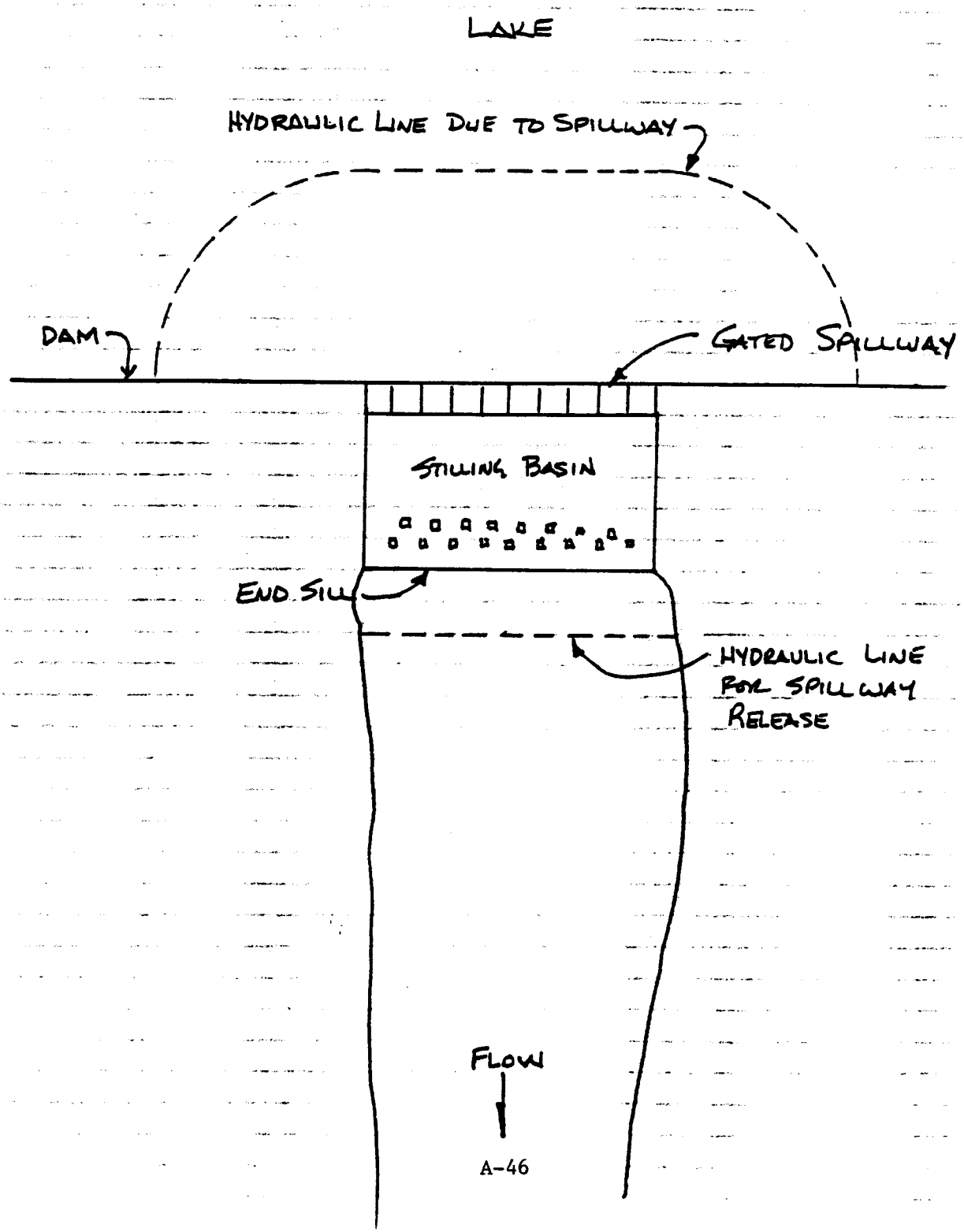
Page ____ of ____

SUBJECT RESTRICTED AREAS FOR HAZARDOUS WATERS

COMPUTATION TYPICAL HYDRAULIC LINE LOCATIONS FILE NO. ____

COMPUTED BY ____ DATE 7/31/92 CHECKED BY ____ DATE ____

CATEGORY IV :



Restricted Areas For Hazardous Waters
HYDRAULIC LINE

The following is the determination of the Hydraulic Line based on Appendix A of ER 1130-2-341, dated 1 February 1991.

Millwood Lake - Type of Project: Flood Control and Storage Dams.

1. Flow Criteria.

   a. Navigation Locks and Dams. N/A.

   b. Flood Control and Storage Dams.

      Bankfull Flow: Q = 60,000 cfs
      Customary Flow: Q = 25,000 cfs

   c. Hydroelectric/Intakes. N/A.

DESIGN FLOW Q = 25,000 CFS

2. Upstream of Structures.

   a. Navigation, Flood Control/Storage Projects. The upstream approach to the spillway is very shallow and during releases there can be significant surface velocities. An HEC-2 model was constructed to determine the magnitude of these velocities. At the time of the site visit, flow through the structure was about 16,000 cfs and a noticeable velocity existed at the buoy line about 400 feet upstream of the dam. The hydraulic line location was based on where the HEC-2 model showed the velocities to be half of what it showed at the present buoy line location.

   b. Hydroelectric/Intakes. N/A.

HYDRAULIC LINE 1200 FEET FROM THE SPILLWAY

3. Downstream of Structures.

   a. Navigation, Flood Control/Storage Projects. Releases at the time of the inspection were about 16,000 cfs into the stilling basin and all flow appeared headed downstream at the end sill of the structure. A hydraulic jump would occur within a maximum length of 200 feet or about 120 feet from the end sill. Low flow eddy can extend several hundred feet downstream.

   b. Hydroelectric/Outlets. N/A.

HYDRAULIC LINE 120 FEET DOWNSTREAM OF END SILL

LEAVE BLANK

CATEGORY IV

MILLWOOD

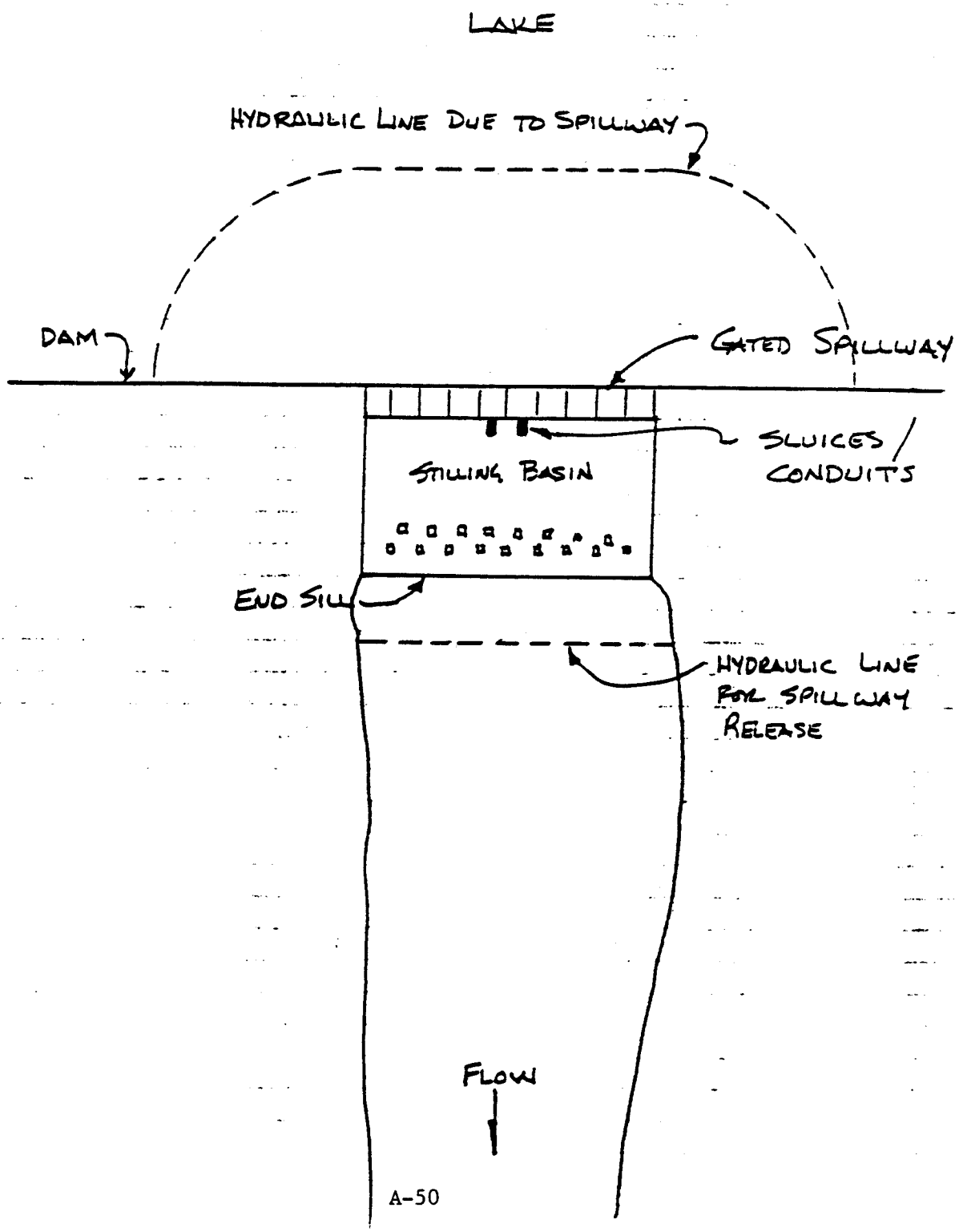
Page ____ of ____

SUBJECT RESTRICTED AREAS FOR HAZARDOUS WATERS

COMPUTATION TYPICAL HYDRAULIC LINE LOCATIONS FILE NO. ____

COMPUTED BY ____ DATE 7/31/92 CHECKED BY ____ DATE ____

CATEGORY IV : MILLWOOD



Restricted Areas For Hazardous Waters
HYDRAULIC LINE

The following is a summary of the hydraulic line determinations based on Appendix A of ER 1130-2-341, dated 1 February 1991.

Millwood Lake - Type of Project: Flood Control and Storage Dams.

1. Flow Criteria.

   a. Navigation Locks and Dams. N/A.

   b. Flood Control and Storage Dams.

   Bankfull Flow: Q = 60,000 CFS
   Customary Flow: Q = 25,000 CFS

   c. Hydroelectric/Intakes. N/A.

DESIGN FLOW Q = 25,000 CFS

2. Upstream of Structures.

   a. Navigation, Flood Control/Storage Projects. The upstream approach to the spillway is very shallow and during releases there can be significant surface velocities. An HEC-2 model was constructed to determine the magnitude of these velocities. At the time of the site visit, flow through the structure was about 16,000 cfs and a noticeable velocity existed at the buoy line about 400 feet upstream of the dam. The hydraulic line location is set where the HEC-2 model velocities are half of what they are at the present buoy line location.

   b. Hydroelectric/Intakes. N/A.

HYDRAULIC LINE 1200 FEET FROM THE SPILLWAY

3. Downstream of Structures.

   a. Navigation, Flood Control/Storage Projects. Releases at the time of the inspection were about 16,000 cfs into the stilling basin and all flow appeared headed downstream at the end sill of the structure. A hydraulic jump would occur within a maximum length of 200 feet or about 120 feet from the end sill. Low flow eddy can extend several hundred feet downstream.

   b. Hydroelectric/Outlets. N/A.

HYDRAULIC LINE 120 FEET DOWNSTREAM OF END SILL

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