RICHARD D. LAMM
Governor

C.J. KUIPER
State Engineer

DIVISION OF WATER RESOURCES

Department of Natural Resources
1313 Sherman Street - Room 818
Denver, Colorado 80203
Administration (303) 839-3581
Ground Water (303) 839-3587

June 28, 1979

Consolidated Home Supply Ditch
and Reservoir Company
3225 South County Road 31
Loveland, CO 80537

Re: Lonetree Reservoir Dam (CO 01734)
W. Div. 1 W. Dist. 4

Gentlemen:

Enclosed is a copy of the final Phase I inspection report on Lonetree Reservoir Dam prepared by Bovay Engineers, Inc. in accordance with U.S. Government Contract No. DACW45-78-C-0023 with the State of Colorado under the National Dam Safety Program. We request that you implement the recommendations enumerated in this report.

Please submit a tentative schedule for accomplishing the requested work to our office by August 31, 1979.

Very truly yours,

William R. Smith

William R. Smith
Acting State Engineer

WRS/SMD/pjl

Enclosure

cc: Colonel V. D. Stipo
Jim Clark, Div. Eng. (w/enclosure)
John Schurer

SUMMARY OF ASSESSMENT AND RECOMMENDATIONS

LONETREE DAM AND DIKE

LARIMER COUNTY, COLORADO
I.D. NO.: CO 01734
HAZARD CATEGORY: 1
INSPECTION ON 20 OCTOBER 1978

Lonetree Dam, Dike, and Reservoir are off-stream facilities. Drainage below these facilities crosses farmlands and eventually reaches the Big Thompson River. The embankments for the dam and dike appear to be in good condition. Based on precipitation values in National Weather Service's Technical Paper 38 and in the Bureau of Reclamation's "Design of Small Dams," 2nd Edition, the dam, spillway, and dike can accommodate the probable maximum flood without overtopping the dam or dike; however, the earthen spillway would be eroded by a spill produced by such a flow and would release some water stored below the spillway crest. The amount and rate of such an uncontrolled release would depend on the degree of erosion.

The spillway channel makes a turn of approximately 90 degrees just beyond the spillway crest. This part of the channel is largely in sandstone and except for the sharp turn is free from obstructions. Work to improve the channel below this area has been delayed by right-of-way problems.

The outlet works for Lonetree Dam have operated satisfactorily for several years. However, some seepage was observed coming into the outlet conduit through the masonry (rock) lining at sections under the Home Supply Canal. There are no guard gates on the outlet works to facilitate repair and maintenance of the operating gates. Because there is no wasteway below the dam, the reservoir can only be evacuated by releasing water onto the farmlands served by the project.

The embankments for the dam and dike have recently been brought up to grade (28.5) using material cut to form the new spillway and the channel immediately below the spillway weir. Some of the disturbed area is lacking protective grass covering.

Because of the above factors and the potential loss of life and property damage, the following recommendations should be implemented:

a. Replace or modify the present spillway weir to provide an erosion-resistant structure.

b. Consider placing the Home Supply Canal in a siphon under the spillway to protect it from damage during a spill and to minimize the possibility of canal water contributing to failure of the dike in this area.

c. Monitor seepage into the masonry- (rock) lined outlet conduit with a full head of water in the Home Supply Canal and the reservoir extension channel.

d. Install one or more piezometers on the downstream side of the crest of the dam above the outlet works to assist in detection of possible increases of seepage into or along the conduit.

e. If seepage into the conduit has the potential for piping, consideration should be given to lining the canal across the dam.

f. Have gates for the outlet inspected and tested by a qualified engineer and submit a report of the findings to the office of the State Engineer.

g. Consider the installation of a guard gate to permit inspection, repair, and maintenance of the operating gates without draining the reservoir.

h. Prepare plans for evacuating the reservoir in the event of an emergency so that water released through the outlet works would do minimal damage. The plan should consider a wasteway structure and channel leading to Ryan Gulch. It may be possible to hasten evacuation by pumping from the reservoir into the spillway channel.

i. Provide for the re-establishment as soon as possible of a protective grass cover on areas of the embankment recently disturbed by construction.

j. Because it is difficult to visualize the nature of the damage that would be done if the dike should fail, it is recommended that a survey and flood study be made to determine the areas that would be innundated.

k. Prepare written procedures for making emergency repairs and for warning people below the dam and dike of an impending emergency. Train key personnel for properly carrying out this work. Provide adequate back-up personnel trained to substitute for others who might not be available when needed.

George B. Wallace

Phase I Inspection Report

National Dam Safety Program
Lonetree Dam

Larimer County

Identification Number CO 01734

Owned by

Consolidated Home Supply Ditch and Reservoir Company

Prepared for

State of Colorado

Division of Water Resources

And

U.S. Army Corps of Engineers

Omaha District

Final Report

Inspected 20 October 1978

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BOVAY

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BOVAY

SUMMARY OF ASSESSMENT AND RECOMMENDATIONS

LONETREE DAM AND DIKE

LARIMER COUNTY, COLORADO
I.D. NO.: CO 01734
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George B. Wallace

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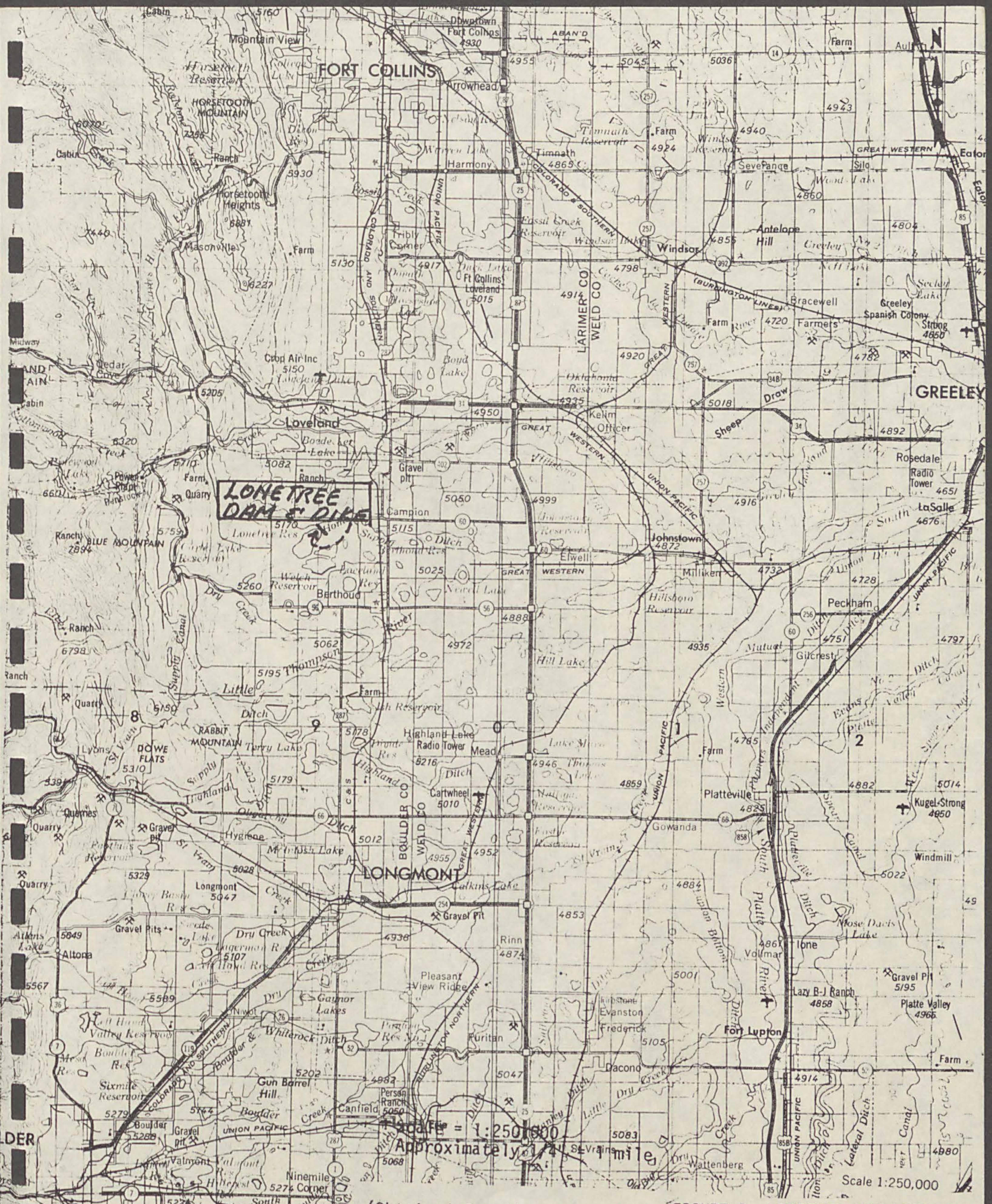
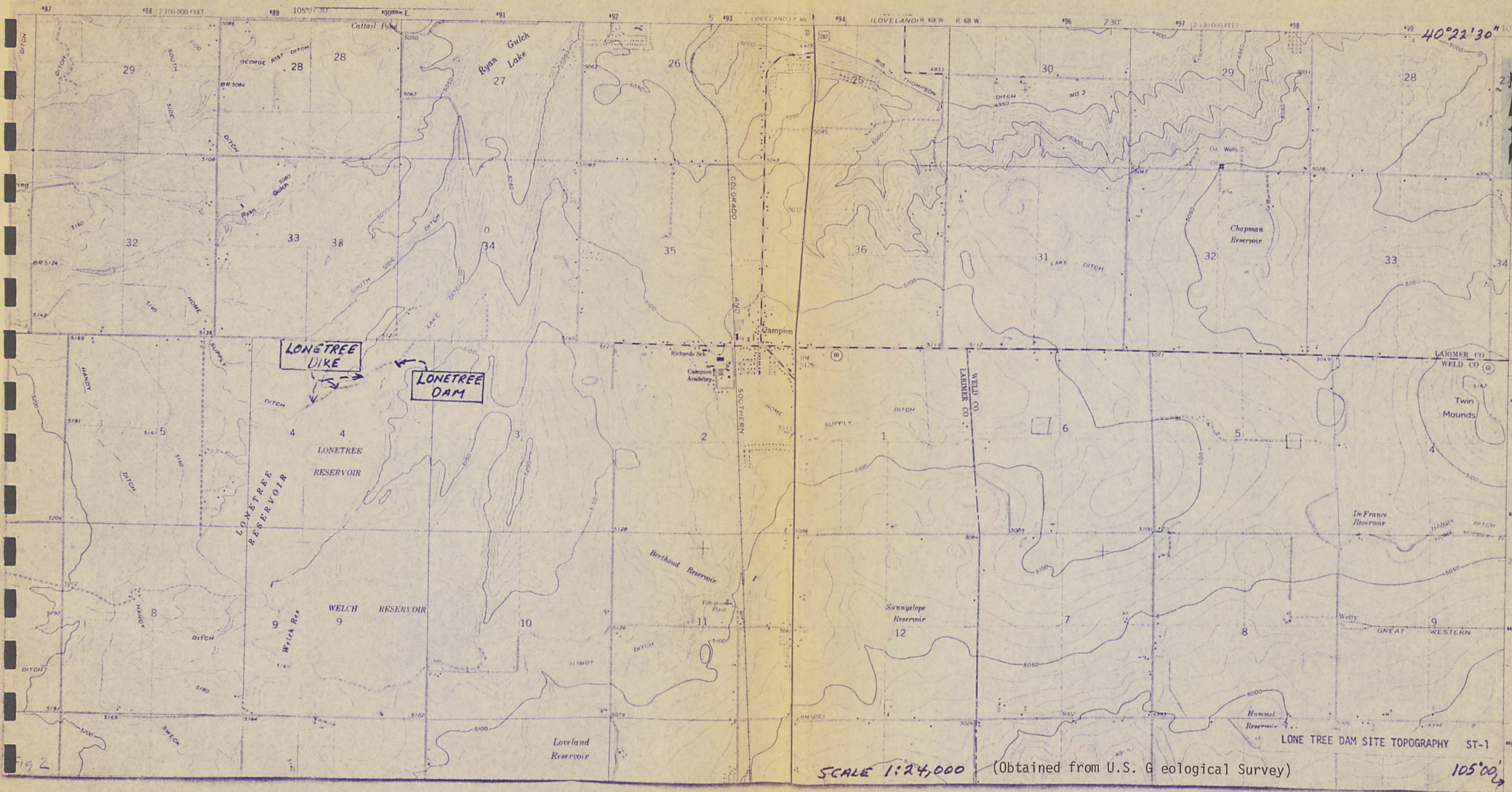


(Obtained from U.S. Geological Survey)

FIGURE 1 LONETREE DAM LOCATION MAP

LM-1



40°22'30"
LONETREE DIKE
LONETREE DAM
LONETREE RESERVOIR
WELCH RESERVOIR
Welch Res
Ryan Gulch
Cattail Pond
Lake
Campion
Richards Sch
Campion Academy
COLORADO AND SOUTHERN
Berthoud Reservoir
Loveland Reservoir
Sunnyslope Reservoir
Chapman Reservoir
De France Reservoir
Hummel Reservoir
Twin Mounds
LARIMER CO
WELD CO
HANDY DITCH
HOME SUPPLY DITCH
SOUTH SIDE DITCH
GREAT WESTERN
BIG THOMPSON
LONE TREE DAM SITE TOPOGRAPHY ST-1
SCALE 1:24,000
(Obtained from U.S. Geological Survey)
105°00'
Fig 2

FIGURE 2 ST-1

Dam: Lonetree Dam
State: Colorado
ID Number: CO 01734
Hazard Category: 1

PERTINENT DATA NO. 1

A. Embankment

Type: Earthfill with concrete facing
Crest Length, Feet: 165
Crest Width, Feet: 20 (minimum), 53 (maximum)
Crest Elevation, Feet, MSL: 28.5 (5135.5)*
Height, Feet: 28.5 (structural)
Volume of Fill, C.Y.: Unknown

B. Spillway

Type: Largely rock cut with small amount of rolled fill on right side (6 to 8 inches deep)
Location: 2500 feet upstream from dam along supply canal
Weir Crest Elevation, Feet, MSL: 25.0 gage (5132.0)*
Weir Bottom Width, Feet: 950
Length, Feet: 1150 (length of channel improvements)

C. Outlet Works

Inlet Type: Two cast-iron gates 24" x 36" each
Conduit Type: Masonry tunnel, concrete pipe and corrugated metal pipe
Conduit Length, Feet: 236
Conduit Diameter, Inches: 48" PCP (36 feet) above gates; 43" x 48" masonry arch tunnel (140 feet) and 60" CMP below gate (60 feet)
Stilling Basin Type: None
Outlet Invert Elevation, Feet MSL: 0 (5107.0)*
Normal Operation Discharge, CFS: 200 cfs from lake, 50 to 100 cfs from river ditch.

D. Reservoir

Type of Storage	Storage Volume Acre-Feet	Elevation MSL	Surface Area in Acres
Irrigation	9,300	5132.0* (25.0 gage)	500
Irrigation plus Surcharge	11,100	5135.5 (28.5 gage)	600

*Based on USGS Quad Sheet showing high water at elevation 5132.0.

Drainage Basin: Six square miles

Dam: Lonetree Outer Dike*
State: Colorado
ID Number: CO 01734
Hazard Category: 1

PERTINENT DATA NO. 2

A. Embankment

Type: Earthfill
Crest Length, Feet: Approximately 7100
Crest Width, Feet: 10 to 20 (varies)
Crest Elevation, Feet, MSL: 28.5 (5135.5)*
Height, Feet: 11.0 (maximum)
Volume of Fill, C.Y.: Unknown

B. Spillway (See Pertinent Data No. 1)

C. Outlet Works (See Pertinent Data No. 1)

D. Reservoir

Type of Storage	Storage Volume Acre-Feet	Elevation MSL	Surface Area in Acres
Irrigation	3500	5132.0*	500

*Left bank of Home Supply Canal. Properties of Inner Dike are not given since it does not contain the reservoir water when either diversion gate is open or when spillway is operating.

1. GENERAL.

a. Authority. The National Dam Inspection Act (Public Law 92-367, 1972) provides for the National Inventory and Inspection Program by the U.S. Army Corps of Engineers. Under this act, the Corps has an agreement with the State of Colorado to have some dams within the State inspected by private consultants. Under this agreement, the State of Colorado Department of Natural Resources -Division of Water Resources (State Engineer) awarded Contract Number C154083, dated 5 July 1978, to Bovay Engineers, Inc., to inspect nine (Area II) dams. Lonetree Dam was inspected under an Addendum to that contract dated 26 September 1978.

b. Purpose of Inspection. The visual inspection of Lonetree Dam was made on 20 October 1978. One inspection team member returned on 3 November 1978, with equipment necessary to inspect the interior of the outlet conduit. The purpose of the inspections was to make a general assessment as to the structural integrity and operational adequacy of the dam embankment and its appurtenant structures.

c. Scope of Report. This report summarizes available pertinent data relating to the project; presents a summary of visual observations made during the field inspection; presents an evaluation of the hydrologic and hydraulic conditions and an evaluation as to the structural adequacy of the various project features; and assesses the general condition of the dam with respect to safety.

2. PROJECT DESCRIPTION. A narrative description of the project is presented in this section. A pictorial description is given in Appendix B.

a. Location. Lonetree Dam, Dike, and Reservoir are in Larimer County, Colorado, Section 4, Township 4N, Range 69W of the 6th Principal Meridian. As shown in Figure 1, it is accessible by way of U.S. Highway 287 to Campion, Colorado, then west on the county road about two miles. Figure 2 shows the topography at the dam site.

b. Purpose of Dam. Lonetree Reservoir is an off-channel irrigation reservoir used to irrigate land east of Campion, Colorado. The eastern boundary of the project is near the town of Johnstown.

c. Size and Hazard Classification. Lonetree Dam is classified under the Corps of Engineers' size category as intermediate since its storage is 9300 acre-feet. The height of the dam is 28.5 feet. Since failure of the dam could cause loss of life and extensive property damage, a hazard potential classification of "1" has been assigned to the project by the state of Colorado. If the dam should suddenly fail the reservoir water would overtop the Lake Ditch Canal below the dam. It is possible that water would enter Ryan Gulch; however, a detailed survey and routing is necessary to determine the area that would be innundated by catastrophic failure of the dam.

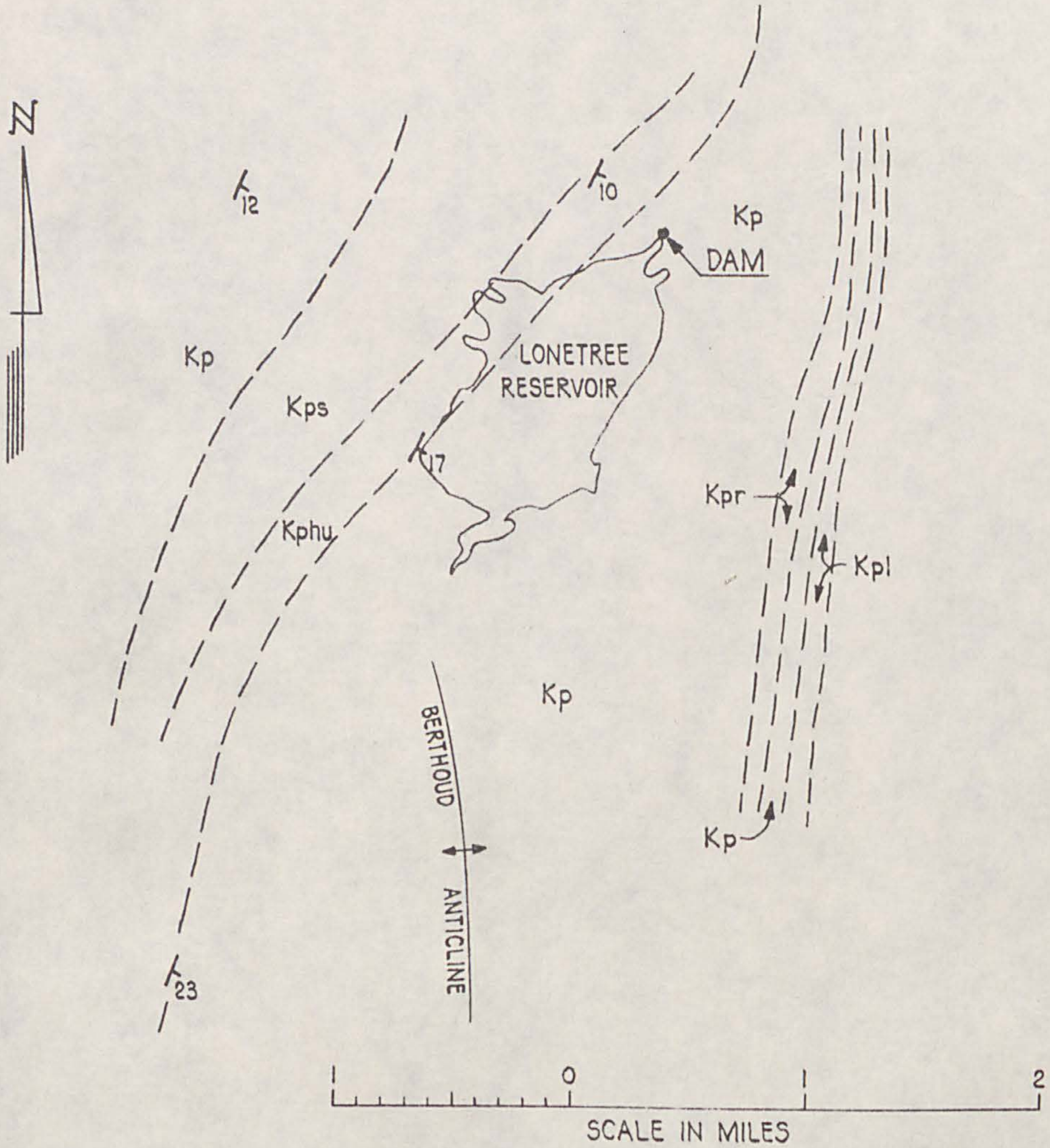
Lonetree Dike is classified under the Corps of Engineers' guidelines as intermediate since its storage is about 3500 acre-feet and its maximum height is 11 feet. If the dike should fail from overtopping, the top 11 feet of reservoir water might be released to Ryan Gulch and eventually to the Big Thompson River. At least one inhabited house and several small buildings lie within the path of flow and would be subjected to severe damage if the dike should fail. Two smaller reservoirs adjacent to Ryan Gulch would be affected by failure of the dike. It is difficult to visualize the nature of the damage that would be done if the dike should fail and it is recommended that a survey and flood study be made to determine the areas that would be innundated.

d. Basin Description. Lonetree Dam forms an off-channel reservoir in Larimer County about three miles northwest of Berthoud, Colorado. The dam at latitude 40° 20' 37" north, longitude 105° 07' 30" west, has a natural runoff drainage area of six square miles as outlined on Plate 1, Appendix D. Watershed terrain is gently rolling agricultural land rising westward from the reservoir at about 4132.0 feet elevation to steep north-south oriented ridges of rock outcrops with average top elevation 5800.0 feet approximately three miles from the reservoir. Defined stream channels are present only in the western third of the watershed. Most of the runoff from the area will follow an overland flow pattern into swales. Soils are clay loams and loams. About 75 percent of the basin is cropland, the rest pasture and range with fair vegetative cover. Residential development is present on the western edge of the reservoir.

A probable maximum flood has been computed by procedures given in "Design of Small Dams," 2nd Edition. In accordance with criteria established by the office of the State Engineer for watersheds below 8000 feet west of the 105° Meridian and east of the Continental Divide, index precipitation was obtained from a chart in U.S. Weather Bureau Technical Paper No. 40 which indicates 21.5 inches as probable maximum six-hour, 10-square mile precipitation. Runoff from the design rainstorm was computed using runoff Curve Number 84, Antecedent Moisture Condition II and a minimum loss rate of 0.12 inch per hour. A probable maximum thunderstorm flood was also computed using as index a one-hour point rainfall value of 12.0 inches, Runoff Curve Number 75 and a minimum loss rate of 0.03 inch per 15 minutes.

e. Geology and Soils. The Pierre Shale which crops out at Lonetree Dam represents sediments of over 8000-feet-thick marine shale laid down during a widespread invasion of Late Cretaceous seas (about 110 million years ago). Alternating retreats and advance of these seas resulted in deposition of interbeds of both relatively thick and thin sandstone/siltstone units in the predominately shale formation. The Hygiene Sandstone Member, which is exposed in the reservoir rim represents one of these units. Deposition essentially ceased in the damsite area as the seas retreated eastward as the Rocky Mountains rose to the west. The elevation of these mountains tilted the sediments eastward. The beds at the damsite dip about 15° to the east-southeast. The present topography represents the result of erosion of the Pierre Shale and younger sediments during and subsequent to glacial activity in the mountains west of the site. Figure 3 shows the geologic units in the Lonetree Dam and Reservoir area.

At the dam outlet, dark gray, thin-bedded shale crops out in the 28-foot-deep approach channel. Bed thickness is less than 0.03 feet which is reflected by the fine talus of broken material on the cut slopes. Jointing, other than along bedding planes, is not well developed.



LEGEND

Kp - PIERRE SHALE
Kpl - LARIMER SANDSTONE MEMBER
Kpr - ROCKY RIDGE SANDSTONE MEMBER
Kphu - HYGIENE SANDSTONE MEMBER, UPPER PART
Kps - HYGIENE SANDSTONE MEMBER, LOWER PART (SILTSTONE)
17 - STRIKE AND DIP OF BEDS

(Prepared for Bovay Engineers, Inc.,
by Lynn A. Brown, E.G., P.E.,
Consulting Engineering Geologist)

GEOLOGIC MAP FOR LONETREE DAM

FIGURE 3

Along the north dike area, at both the lower ditch diversion and the emergency spillway discharge channel, fine-grained sandstone crops out. The sandstone is poorly cemented and is easily broken. Bedding in the sandstone averages about 0.05 feet thick and its planes provide a prominent erosional feature in the diversion flow cuts into the reservoir. Bedding planes of this sandstone (Hygiene Member) form the invert of most of the emergency spillway crest and discharge channel.

A natural basin forms the gently sloping reservoir limits for the most part. The Home Supply Canal embankment acts as a dike on the north side of the reservoir. As shown on the geologic map (Figure 3) the bedrock in the reservoir is both shale and sandstone mantled by a relatively thin veneer of mainly residual silty clay and silty sand. The soil zone gradually grades into fresh bedrock.

The dam is in Zone 1 of the seismic zone map of the United States. Earthquake events normally do not present a hazard to projects located in Zone 1. Plate 2, Appendix D, shows the location of the dam relative to recorded events.

f. Embankments

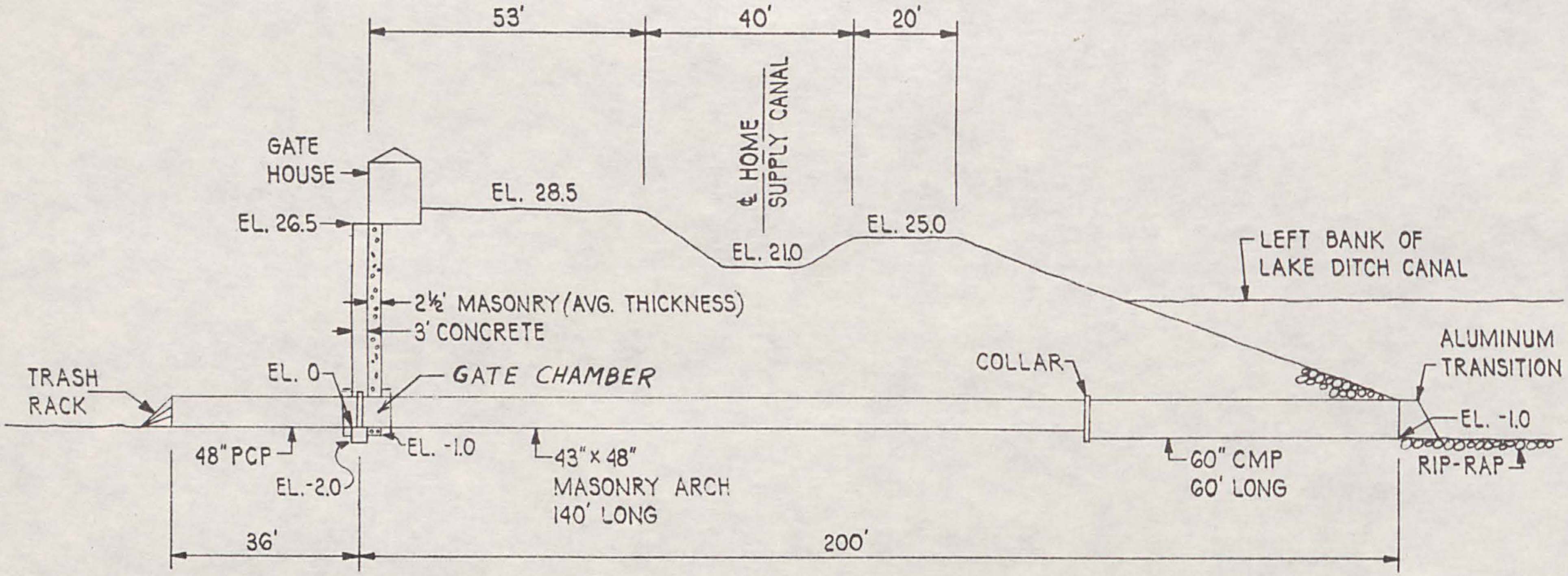
(1) Lonetree Dam. The dam forms a barrier between Lonetree Reservoir and the Lake Ditch Canal. It spans a reservoir extension channel with a bottom width of about 15 feet and sides sloping approximately 1 Horizontal to 1 Vertical. The channel, shown in Photo No. 1, was excavated in shale to bring the reservoir waters to a damsite where the topography and location were favorable for constructing an outlet works that could:

(a) Release water from the reservoir into the Lake Ditch Canal at an elevation that would permit utilization of all of the allowable storage at a location where the canal could be constructed economically, i.e., balanced cut and fill.

(b) Pass under the Home Supply Canal without greatly extending the length of the conduit and avoid construction of an expensive siphon or overchute to affect the crossing of the high-level Home Supply Canal over the lower-level Lake Ditch Canal.

A sketch of a section through the embankment along the centerline of the outlet works is shown in Figure 4. The Home Supply Canal diagonally crosses the embankment as shown in Plate 4, Appendix C.

No drawings or construction records on the dam and outlet works are available. The dam may have been constructed by leaving a shale plug embankment between the terminus of the reservoir channel and the beginning of the Lake Ditch Canal and driving a tunnel through the plug for the outlet conduit. However, W. R. Keirnes who has been associated with this project for many years believes that it is more likely that the outlet was constructed using cut and cover methods. Regardless of which of these two methods was used, compacted fill was placed over the outlet and adjacent area to raise the crest of the dam to elevation 28.5 (gage).



(Prepared for Bovay Engineers, Inc.,
by George B. Wallace, P.E.)

SKETCH OF SECTION THROUGH OUTLET WORKS FOR LONETREE DAM
(DIMENSIONS ESTIMATED BY VISUAL OBSERVATIONS AND PACING)

FIGURE 4

A masonry wall was constructed on the upstream face to serve as a water barrier and headwall for the outlet gates and conduit. The wall is approximately two feet thick at the top and three feet at the base. The upstream face was vertical and the downstream face was slightly battered.

Although the masonry blocks were mortared, the wall was not sufficiently watertight. As a result, a concrete wall about three feet thick was cast against the masonry wall. This wall was reportedly keyed into the hard shale about two feet below the outlet invert. The top of the concrete wall is at elevation 26.5, two feet below the crest of the embankment. The length of the concrete wall is 53' 4". The length of the embankment crest is about 165 feet. The crest of the embankment runs from the barrier wall constructed on top of the check in the Home Supply Canal at Station 0+70, on a line approximately normal to the centerline of the outlet works, to the 28.5 (gage) natural ground contour on the right abutment. The left abutment ties into the shale mass forming the left bank of the reservoir extension channel and the right bank of the Home Supply Canal. The barrier wall shown in Photo No. 7 extends beyond the check sidewalls and one end ties into the crest of the dam near the left abutment and the other ties into the crest of Lonetree Dike formed by the left bank of the Home Supply Canal. When the spillway is operating the check, concrete barrier, and downstream bank of the Home Supply Canal become an effective part of the dam in containing the water in the reservoir and spillway channel. However, because of their limited service and height they will be referred to as the outer dike and discussed further in the next subsection.

Photo No. 1, Appendix B, shows the upstream face and Photo No. 2 shows the downstream face of Lonetree Dam. The crest of the dam is shown in Photo No. 7.

(2) Lonetree Dike. The banks of the Home Supply Canal function with the dam across the reservoir extension channel to contain the reservoir waters from Station 0+70 to Station 67+70 where the reservoir rim is at or above the crest of the dam. The right bank of the Home Supply Canal forms an inner dike and the left bank forms an outer dike. However, the inner dike is penetrated by two channels from diversion structures at Stations 31+50 and 50+00. The diversions are controlled by stop logs, as shown in Photo No. 8, that cannot be counted on to effectively contain the reservoir when it is full. Furthermore, water passing over the spillway would immediately flood the Home Supply Canal and require the outer dike on either side of the spillway to contain the flow. The outer dike must also contain the water carried by the Home Supply Canal for normal deliveries to the reservoir and to the farms served by the canal that lie below the reservoir. Failure of the outer dike would damage properties below the canal whereas failure of the inner dike alone would not. For these reasons the outer dike must be considered as the governing containment dike as far as safety is concerned. The use of the word dike throughout the rest of this report refers to fill sections on the left bank of the Home Supply Canal between Station 0+70 and Station 67+70.

The height of the dike above the natural ground at its toe varies from a few inches to 11 feet. Fill has recently been added to about one mile of the dike to provide a minimum crest elevation of 28.5. Details of this work are shown in Plates 4 through 6, Appendix C. Typical cross sections of the dike are shown on Plates 7 and 8, Appendix C.

PVC drain pipe and crushed rock drains were installed below the toe of the dike between Stations 35+00 and 48+00. The dike was constructed on a marsh between these stations. Prior to installing the drains seepage through the embankment exited on the slope above the toe of the dike. The drains have effectively lowered the seepage line to the level of the drains. Discharges from the drains flow north along a natural drainage course.

g. Spillway. Recent construction has provided a 950-foot-wide uncontrolled emergency spillway, shown in Photo No. 5, with a crest elevation of 25.0 (gage). As shown on Plate 5, Appendix C, the spillway crest is located on the dike between Station 25+50 and 35+00. If the reservoir rises above elevation 25.0 (gage) it would spill over the right bank of the Home Supply Canal, innundate the diversion structure at Station 31+50, flood the canal to the barrier at Station 0+70, then discharge over the spillway crest. Outflow exiting from the spillway crest would turn sharply to the left in a broad channel about 1100 feet long cut largely in sandstone rock. From the end of the constructed channel the flow would enter Ryan Gulch. After passing through Ryan Gulch Lake, shown in Photo No. 6, about three miles north of the spillway, the discharge would continue northward to the Big Thompson River. An inhabited farmhouse, shown in Photo No. 6, and several small buildings lie within the flood path and would be subjected to severe damage by a large spill.

h. Outlet Works. The outlet works include an intake-trashrack structure located in the reservoir extention channel about 36 feet in front of the dam. A 48-inch diameter concrete pipe connects the intake to a concrete box attached to the concrete wall on the upstream face of the dam. One end of the box structure is open and this connects with a gate chamber within the concrete wall. The chamber contains two 24" by 36" cast-iron Armco slide gates positioned about 12 inches downstream from the upstream face of the concrete wall. Stainless steel gate stems rise to the top of the wall through pipe sleeves embedded in the concrete. The stems enter the gate control house on top of the wall shown in Photo No. 1, Appendix B. The hoists shown in Photo No. 3 are used to control the flow into the Lake Ditch Canal. The invert elevation of the outlet conduit at the end of the gate chamber is at elevation 0 (gage). For a distance of 140 feet downstream from the gate chamber the outlet conduit is a wood-masonry lined tunnel. The flat floor of the tunnel is constructed with laminated timbers long enough to support the masonry walls and roof and provide a clear inside width of four feet. The height along the centerline is three feet seven inches. Above the springline the roof arches on a two-foot radius. The masonry blocks are joined by mortar to improve the load bearing capacity and water tightness of the lining. However, leakage between the wood floor and masonry walls prompted the installation of a 0.125-inch aluminum plate over the floor. It was fastened to the laminated wood floor with 3/8" x 3-1/2" cadminum plated lag screws and lapped two inches at the joints. Mortar was used to seal the plate to the masonry walls.

Immediately downstream from the gate a curved steel baffle was placed at the entrance to the masonry lined tunnel. This was installed to distribute the discharge from gates which tended to jet along the floor and lower sidewall at partial or single gate openings.

To enable the crest of the dam to be raised to elevation 28.5 and accommodate the resulting increase in width of the embankment, the length of the outlet conduit was increased by adding 60 feet of 14 gauge, 60-inch-diameter corrugated aluminum pipe to the end of the masonry tunnel. A reinforced concrete encasement cast around the aluminum pipe and anchored to the masonry wall was used to connect the two types of conduits. A flared aluminum transition, attached to the end of the aluminum conduit, was provided to smooth the flow of releases into the Lake Ditch Canal. Riprap protects the canal invert and side slopes immediately below the transition.

3. CONSTRUCTION HISTORY. Lonetree Dam was constructed with the masonry wall upstream face during 1881 and 1882. The Home Supply Canal was constructed during this same period on the north side of the reservoir. The project planners took advantage of a natural lake basin to provide much of the storage for the project. The capacity of the natural basin was increased by construction of the supply canal which diverts water from the Big Thompson River to the reservoir. The diversion structure on the Big Thompson is shown in Photo No. 9. As previously mentioned the embankment for the supply canal serves as a dike to raise the reservoir level enough to permit usable storage of about 9300 acre-feet. The supply canal feeds the reservoir at two inlets, one at Station 31+50 and the other at Station 50+00. After the last delivery to the reservoir the supply canal crosses over Lonetree Dam and furnishes irrigation water to higher farm land before it joins the Lake Ditch Canal about five miles below the reservoir.

Because of leakage through the masonry wall on the upstream face it was reinforced with a concrete wall constructed in 1920. The new wall was cast against and bonded to the old masonry wall. The project was then operated without any significant new construction until 1960 when two new outlet gates were installed. This was followed by construction of the present intake structure and 48-inch precast concrete pipe joining it to the gate chamber. This work and a new concrete wing wall extention for the upstream face along the left bank of the reservoir was completed in 1967.

In 1976 leakage between the timber floor and masonry walls of the outlet was stopped by installation of an aluminum plate over the floor as described in Section 2.h. About this same time the masonry conduit was extended by adding 60 feet of 60-inch corrugated aluminum pipe.

A major construction contract was awarded in 1977 to Frontier Construction Company of Hygene, Colorado, to construct a spillway and raise the crest of the dike to a minimum elevation of 28.5 gage. The design and construction control for this work was by Bruns Engineering, Inc., of Longmont, Colorado. This work was the result of a letter from the State Engineer, dated November 19, 1973, advising the Consolidated Home Supply and Ditch Company that the dam did not meet safety requirements and restricting storage to a level five feet below the top of the concrete wall on the upstream face of the dam (elevation 21.5 gage). The letter is shown as Plate 1, Appendix E. A report on the construction which was essentially completed on December 19, 1977, is shown as Plate 2, Appendix E. Some minor cleanup and dressing of the embankment was not completed until March 1978.

4. OPERATION AND MAINTENANCE HISTORY. Operation and maintenance records for Lonetree Dam were not made available. However, W. R. Keirne, present secretary and former manager of Consolidated Home Supply and Ditch Company, gave the inspection team a briefing on how the project has been operated.

The reservoir is filled during the winter and early spring months by diversion from the Big Thompson River by the facilities shown in Photo No. 9, Appendix B. The diversion dam is located about eight miles WNW from Lonetree Dam. Releases are measured to the reservoir by the Parshall flume shown in the upper view of Photo No. 10. About four miles below this structure a wasteway with floodgates has been provided. During the flood of 1965 these gates were opened sending excess water down the dry creek to the Big Thompson River, thus protecting the supply canal and reservoir. There are no wasteways below Lonetree Dam and, therefore, no way to drain the reservoir in the event of an emergency except to release water onto the farms served by the project.

The Home Supply Canal can carry up to 350 cfs. Diversions from the Home Supply Canal to the reservoir are made by the structures shown in Photo No. 8. The upper diversion structure can divert up to 250 cfs to the reservoir. Usually this is sufficient so the lower diversion structure is seldom used. However, with both structures operating, the full capacity of the supply canal could be diverted into the reservoir.

Most repair and maintenance work has been carried out by contract rather than by force-account. The company retains Ken Dickey as their project engineer on a part-time basis. Ken Bruns, Inc., of Longmont, Colorado, was recently engaged to prepare the plans shown in Plates 4 through 8 of Appendix C. The history on major repair work and modifications to the project is presented in Section 3. The new emergency spillway described in that section has not yet been tested. There are no instruments in the dam, dike, or spillway sections.

5. OPERATION AND MAINTENANCE PROCEDURES. The primary use for the water stored in Lonetree Reservoir is to supplement direct flow rights from the Home Supply Canal to the 20,000 acres of farmland served by the Consolidated Home Supply and Ditch Company. About 250 stockholders are served by the Company through 100 turnouts from the Home Supply and Lake Ditch canals.

To operate and maintain the system the Company employs three people during the irrigation season to tend the gates and maintain the canals. Two of these people are retained during the off-season for small repairs and other maintenance work. As previously mentioned, major repairs and modifications are done by contracts. Three people are employed in the office during the irrigation season.

Releases of about 125 cfs to the stockholders start in May and build up to 250 cfs in June. Of this about 200 cfs is released from the reservoir and delivered via the Lake Ditch Canal. The remaining 50 cfs is supplied directly by the Home Supply Canal. This canal crosses Lonetree Dam and serves lands that are above the Lake Ditch Canal. In September the releases are reduced again to about 100 cfs and terminated in late October. Releases to the system must be carefully coordinated with the farmers. Since there are no wasteways below the dam all of the releases must be disposed of on the farmland.

Charles Benton is the current manager of the system. He has the responsibility of directing emergency operations if needed. The procedures would include shutting off the flows into and out of the reservoir and opening the flood gates to waste surplus water into Dry Creek. No written emergency plans have been prepared.

6. INSPECTION.

a. General. Inspection was made on 20 October 1978 by the following individuals:

George B. Wallace, P.E.	Principal Engineer, Bovay Engineers, Inc., Inspection Team Leader (Dams and Foundations)
Melvin A. Jabara, P.E.	Consulting Engineer, Bovay Engineers, Inc., (Spillways and Outlet Works)
Lynn A. Brown, E.G., P.E.	Consulting Engineering Geologist, Bovay Engineers, Inc., (Geology and Soils)
Donald L. Miller	Consulting Hydrologist, Bovay Engineers, Inc., (Hydrology)

The inspection team was accompanied by the following representatives of Consolidated Home Supply and Ditch Company:

W. R. Keirnes	Secretary and former Manager
Kenneth Dickey	Engineer
Robert Lebsack	Board Member

b. Reservoir. The pool elevation at the time of inspection was gate height 7.0 feet or 18 feet below the spillway. Trees line short segments on the north and northeast side of the reservoir. No slide potential was observed along the reservoir boundary.

c. Lonetree Dam.

(1) Crest. The crest surface was well graded. There were no cracks or other signs of instability.

(2) Upstream Face. The surface appeared to be in excellent condition. A few spots of minor spalling were noted along construction joints. Overall, the face showed minimal effects to weathering.

(3) Downstream Face. No seeps, depressions, or objectionable bulges were noted, however the reservoir was very low. There is ample riprap around the outlet and grass on the remaining slope. There were no signs of significant erosion.

(4) Abutments. The wing walls and concrete step benches appear to be in good condition as do the embankment contacts with the abutments. The Pierre Shale comprises the foundation and abutment rock and is fragmented from exposure to wetting and drying cycles over the years. The slightly steeper than 1 Horizontal to 1 Vertical rock cuts adjacent to the wing walls appear stable.

d. Lonetree Dike.

(1) Crest. The crest shows no signs of cracking, misalignment, or settlement.

(2) Upstream Slope. The slopes are relatively gentle and, in part, grass covered. A few large diameter trees (10+ inches) are near or on the upstream slope of the inner dike but these do not affect the safety of the outer containment dike. No erosion of the slopes was noted.

(3) Downstream Slope. The relatively bare slopes (except for some sage brush, etc.) showed no erosion. This, in part, may be due to the fact that construction has only recently been completed. No evidence of seepage was noted.

e. Outlet Works. The trashrack and inlet structures were submerged and could not be inspected. The gate hoists shown in Photo No. 3, Appendix B, were inspected and appeared to be in good condition. Mr. Keirnes of Consolidated Home Supply and Ditch Company was reluctant to operate the gates but assured the inspection team that the gates had performed properly during the irrigation season. There are no guard gates.

The outlet conduit was entered from the downstream end. The aluminum transition and 60-inch-diameter corrugated aluminum pipe appeared to be in good condition except for dents in the crown and sidewalls as shown in Photo No. 3. The masonry walls also appeared to be in good condition and free from any significant displacements. The masonry arch had been plastered but some of the plaster has spalled, as shown in Photo No. 3.

Some seepage was noted coming through the masonry walls under the Home Supply Canal, although the canal was dry at the time of the inspection.

The aluminum sheeting, attached to the timber floor with cadmium plated lag screws, was in very good condition. The aluminum transition at the downstream end of the outlet and the riprap surrounding the transition, shown in Photo No. 2, were also in good condition.

The metal baffles or fins described in Section 2 blocked close inspection of the outlet slide gates. The fins, shown in Photo No. 3, were positioned immediately downstream from the gates to smooth out the flow when only one gate is open or when one or both gates are only partially opened.

f. Spillway. The spillway crest was cut and filled to gage height 25.0 in 1977. Details of the crest construction are shown on Plate 5, Appendix C. The crest is both compacted fill and bedrock (sandstone). The bedrock was relatively smooth (bedding planes) and its excavation to the present level was reported to be "difficult" during construction. A few inches of rolled fill were required in portions of the crest to maintain the desired crest elevation. The fill consisted of broken Pierre Shale.

No cracking was seen in the fill section. The discharge channel for about 900 feet below the spillway crest was excavated in rock and will direct any future spillway flow away from the adjacent embankment-dike section.

7. HYDROLOGIC AND HYDRAULIC EVALUATION. A probable maximum flood hydrograph, peak discharge 25,400 cfs, 16-hour volume 5150 acre-feet, is presented on Plate 3, Appendix D. A hydrograph of one-half this probable maximum flood is presented on Plate 4, Appendix D. A probable maximum thunderstorm flood hydrograph, peak discharge 31,500 cfs, five-hour volume 3600 acre-feet, is presented on Plate 5, Appendix D.

The above floods have been computed by procedures given in "Design of Small Dams," 2nd Edition. Data for the six-square-mile area watershed pertinent to these procedures are given on Plate 6, Sheets 1, 2, and 3, Appendix D. Probable maximum precipitation values obtained from an index value of 21.5 inches for 10 square miles from U.S. Weather Bureau Technical Paper No. 40 are listed on Plate 7, Appendix D. A 12-hour design storm of 19.1 inches gave a runoff volume of 16.11 inches, 5150 acre-feet, after deducting losses indicated by Runoff Curve Number 84, Antecedent Moisture Condition II, and using a minimum loss rate of 0.12 inch per hour. Data for plotting the incremental triangular runoff hydrographs are also listed on Plate 7, Appendix D. Ordinates of the probable maximum flood are listed on Plate 3, Appendix D. These ordinates were divided by two and the result plotted as one-half probable maximum flood, Plate 4, Appendix D.

Probable maximum thunderstorm point rainfall of 12.0 inches was read for the location of Lonetree Dam from Figure 20, "Design of Small Dams," 2nd Edition. Applying an area adjustment of 0.92 read from Figure 21, "Design of Small Dams," 2nd Edition, and values in Table 2, page 52, "Design of Small Dams," 2nd Edition, a three-hour storm of 14.74 inches was obtained. Subtracting losses given by Runoff Curve Number 75 and a minimum loss rate of 0.03 inch per 15 minutes gave a runoff volume of 11.27 inches, 3600 acre-feet. Computations are shown on Plate 7, Appendix D. Summation of the ordinates of incremental triangular 15-minute runoff hydrographs plotted from the data listed on Plate 8, Appendix D, gave the ordinates of the probable maximum thunderstorm flood shown on Plate 5, Appendix D.

Results of the technical hydraulic analyses for the floods described above are presented on Plates 9 through 12, Appendix D. The spillway discharge curve, shown on Plate 9, was constructed using tabulated discharge values contained in the files of the State Engineer. The reservoir storage curve shown on Plate 10 was also constructed using tabulated storage values above the spillway crest contained on the files of the State Engineer. Routing of the above floods through the Lonetree reservoir and spillway are shown on Plates 11 and 12. They indicate that neither the one-half probable maximum flood nor the probable maximum thunderstorm flood would cause the dam or dike which impounds the reservoir to be overtopped. Routing results are as follows:

One-Half Probable Maximum Flood (Based on TP 40)	- Maximum discharge = 6970 cfs - Maximum Res. W.S. Elev. 5134.0, (Gage 27.0 ft.)
Probable Maximum Thunderstorm Flood (Based on DSD)	- Maximum discharge = 15,100 cfs - Maximum Res. W.S. Elev. 5135.4, (Gage 28.4 ft.)

In addition to the studies described above, a computer analysis was performed using Hydrologic Program 723-C1-410 furnished by the Corps of Engineers. This computer program develops a PMP flood hydrograph and routes the flood through the dam. The program determines the spillway capacity and the extent of overtopping in the event overtopping occurs as a result of inadequate spillway capacity and/or surcharge storage capacity. The PMP input was determined from Technical Paper No. 38.

The computer program has various input options for determining the flood hydrograph and routing the flood through the dam. A known hydrograph or a synthetic hydrograph by Snyder's method are options. Since known hydrograph ordinate data were not readily available, Snyder's method was used. The parameters C_p and C_t are variables affected by the size and shape of the drainage basin and the duration of the unit hydrograph. Values of C_p and C_t of 0.81 and 0.32 were used for Lonetree Dam. These, along with other parameters, are shown on Plate 13, Appendix D, Listing of Card Input Data. Considering basin differences, the values of C_p and C_t for Lonetree Dam compare favorably with data developed by the Corps for the Cherry Creek Dam (0.84 and 0.51, respectively). The AW50=47 and AW75=28.5 coefficients used for the Cherry Creek Dam hydrograph widths were used for this analysis as they appear to be the best data available. The resulting hydrograph is shown in Plate 14.

Other options in the program include methods of routing through the dam. The broad-crested weir formula option for the spillway and embankment appeared best in view of dimensional data acquired from on-site inspection and construction drawings.

A summary of the results from the hydrologic and hydraulic analyses based on Technical Paper No. 38 is shown on Plate 15. The peak discharge from the probable maximum flood is 17,961 cfs. The total inflow volume is 6512 acre-feet for the full PMF and 3266 acre-feet for the one-half PMF. The maximum reservoir elevation that would be produced by the PMF is 5134.4 which is 1.1 feet below the crest of the dam and its adjacent dike.

From the standpoint of dam safety, the hydrologic design of a dam aims at avoiding overtopping. Overtopping is especially dangerous for an earth dam because the downrush of waters over the crest will erode the dam face and, if continued long enough, will breach the dam embankment and release all the stored water suddenly into the downstream flood plain. The safe hydrologic design of a dam calls for a spillway discharge capability, in combination with an embankment crest height, that can handle a very large and exceedingly rare flood without overtopping.

The Corps of Engineers designs its dams to safely pass the probable maximum flood that is estimated could be generated from the upstream watershed. This is the generally accepted criteria for major dams throughout the world, and is the standard for dam safety where overtopping would pose any threat to human life. Although dams that do not fully meet this Corps standard will not be evaluated as "unsafe," the Corps considers any dam located in a high hazard potential area to be seriously inadequate if it cannot pass one-half of the probable maximum flood without overtopping. However, the State Engineer requires that such dams must be able to also pass the probable maximum flood derived by using the USBR "Design of Small Dams" criteria without overtopping the dam. Since the severity of the probable maximum flood based on Technical Paper No. 38 equals that of the general storm based on Figure 17, "Design of Small Dams," and since it has been shown that Lonetree Dam is high enough to accommodate the former flood it, therefore, meets the State Engineer's hydrologic design requirements. (See Section 8 regarding spillway structural evaluation.)

8. STRUCTURAL AND GEOTECHNICAL EVALUATION.

a. General. Visual inspection, available design data, construction records and history, and operational procedures provide the basis for the following evaluation of the structural stability of the Lonetree Dam and Dike.

b. Embankments. The embankments appear to be in good condition. They have been recently "dressed" and brought up to grade. There are no significant depressions, bulges, seeps, or rodent holes.

Some areas with fresh cuts or fills have little or no protective grass cover. However, these areas have been seeded and good cover should be re-established next year. There is no riprap on the upstream face of the outer dike but it is protected from wave action by the inner dike (right bank of Home Supply Canal) which has flat, gentle slopes on the reservoir side. Trees on the upstream side of the inner dike do not affect the safety of the project. Containment of the reservoir is by the outer dike and Lonetree Dam.

The tile drains downstream of the maximum embankment section effectively drain the marshy area near the upper diversion. The negligible flow in the drains suggests that the above mentioned marshy area was not the result of reservoir seepage but rather seepage from the Home Supply Canal.

Seepage from the Home Supply Canal into the underlying outlet works where the canal crosses Lonetree Dam should be carefully observed. If the seepage increases sufficiently to cause piping it would endanger Lonetree Dam. The seepage could probably be stopped by lining the canal across the dam.

c. Outlet Works. The outlet works have been seasonally tested for operational adequacy. No abnormal settlements or displacements were observed in the conduit although the corrugated metal pipe in the downstream sections was dented in several places. The masonry walls and arch appear to be structurally sound but probably are not watertight. The new aluminum plate on the timber floor of the conduit is in excellent condition.

The condition of the operating slide gates could not be determined for reasons previously mentioned. They were closed during the inspection and were reasonably watertight under the low reservoir head existing at that time. No guard gates exist which makes inspection and maintenance of the operating gates difficult.

There was no evidence of piping along the conduit. Except for the baffles installed immediately below the slide gate there are no obstructions in the conduit or in the channel (canal) below the outlet.

Except for potential leakage through the masonry walls of the conduit, the outlet works are adequate under the current operating procedures.

d. Spillway. Both the probable maximum flood general storm and the probable maximum thunderstorm flood would overtop the earthen spillway weir and cause serious erosion. A significantly greater volume of water would be released from the reservoir because of this and the potential for damage to lands below would be increased accordingly.

The channel immediately below the spillway crest is largely cut in sandstone and is free from obstructions. Further downstream the channel is not so well defined. Improvements that were to be made in this area under the recent contract for construction of the spillway were not made because of right-of-way problems.

9. ASSESSMENT AND RECOMMENDATIONS.

a. The Emergency Spillway. Based on precipitation values in the National Weather Service's Technical Paper No. 38 and the Bureau of Reclamation "Design of Small Dams," 2nd Edition, the dam, spillway and dike can accommodate the probable maximum flood without overtopping the dam or dike. However, the earthen spillway weir would erode under a spill caused by such an event and release additional water to the flood plain below the dam. Water that might enter the Home Supply Canal during a flood would also add to this problem. Placing the canal in a siphon under the spillway sections, which has been suggested, would contain the canal flow but would not prevent release of water from the reservoir due to erosion of the crest. For this reason it is recommended that the earthen spillway weir be replaced with an erosion-resistant structure.

b. Embankments. The grade along the embankments is reasonably uniform and at a minimum elevation of 5135.5 (gage 28.5). This height is sufficient to contain the probable maximum flood with the present spillway without overtopping.

Drains installed to control seepage and improve stability of the dike appear to be functioning very well. Seepage from the Home Supply Canal into the masonry lined conduit of the outlet works for Lonetree Dam should be checked frequently during the next irrigation season. This can be done by closing the gates to the outlet works and entering the conduit from the downstream end. The inspection should be made with a full head flowing down the Home Supply Canal. If any signs of piping are noted, consideration should be given to lining the canal across Lonetree Dam. It is recommended that one or more well-point piezometers be installed on the downstream side of the crest. The level of the water surface in the piezometers should periodically be compared to the reservoir level to assist in detection of possible increases of seepage into or along the outlet conduit.

c. Maintenance. A protective grass cover should be established on areas disturbed by recent construction.

The outlet gates should be inspected and tested by a qualified engineer. Consideration should be given to installing a guard gate at the intake structure to permit routine inspection and maintenance of the operating gate.

d. Lonetree Dike. Because it is difficult to visualize the nature of the damage that would be done if the dike should fail, it is recommended that a survey and flood study be made to determine the areas that would be innundated.

Procedures for making emergency repairs and for warning people below the dam in the event of an impending emergency should be in writing. Key personnel for carrying out this work should be properly trained along with adequate back-up personnel to substitute for others who might not be available when needed.

APPENDIX A

INSPECTION CHECKLISTS

No. 1 Lonetree Dam

No. 2 Lonetree Dike

PHASE I

INSPECTION CHECKLIST No. 1

NAME OF DAM: Lonetree Dam*
STATE: Colorado
COUNTY: Larimer
INVENTORY NO.: CO 01734
HAZARD CATEGORY: 1
TYPE OF DAM: Concrete (gravity)
*See Checklist Number 2 for Lonetree Dike

OWNER: Consolidated Home Supply Ditch and Reservoir Company
DATE INSPECTED: 20 October 1978
WEATHER: Partly cloudy
TEMPERATURE: 75°F (24°C)
POOL ELEVATION: 7.0 gage (5114.0)**
TAILWATER ELEVATION: NA

DIRECTIONS: Mark an "X" in the YES or NO column.
If an item does not apply, write "NA" in the REMARKS column.

ITEM	YES	NO	REMARKS
1. CREST.			
a. Any visual settlements?		X	
b. Misalignment?		X	
c. Cracking?		X	
2. UPSTREAM SLOPE.			
a. Adequate grass cover?			N/A Concrete facing
b. Any erosion?		X	
c. Are trees growing on slope?			N/A
d. Longitudinal cracks?		X	Not significant
e. Transverse cracks?		X	Not sigificant
f. Adequate riprap protection?			N/A
g. Any stone deterioration?			N/A
h. Visual depressions or bulges?		X	
i. Visual settlements?		X	
3. DOWNSTREAM SLOPE.			
a. Adequate grass cover?	X		
b. Any erosion?		X	
c. Are trees growing on slope?		X	
d. Longitudinal cracks?		X	
e. Transverse cracks?		X	
f. Visual depressions or bulges?		X	
g. Visual settlements?		X	
h. Is the toe drain dry?			N/A None provided
i. Are the relief wells flowing?			N/A None provided
j. Are boils present at the toe?		X	
k. Is seepage present?		X	
4. ABUTMENT CONTACTS.			
a. Any erosion?		X	Minor breakdown of shale rock
b. Visual differential movement?		X	
c. Any cracks noted?		X	
d. Is seepage present?		X	W.S. very low (gage 7)
5. INTAKE STRUCTURE.			Not visible - under three feet of
a. Do concrete surfaces show:		X	/water
(1) Spalling?			
(2) Cracking?			
(3) Erosion?			
(4) Scaling?			
(5) Exposed reinforcement?			
(6) Other?			
b. Do the joints show:			
(1) Displacement or offset?			
(2) Loss of joint material?			
(3) Leakage?			

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APPENDIX A

** MSL elevations based on spillway at 5132 as estimated from USGS Quad Sheet

ITEM	YES	NO	REMARKS
c. Metal appurtenances:			
(1) Corrosion present?			
(2) Breakage present?			
(3) Anchor system secure?			
6. CONDUIT.			
a. Is the conduit concrete?	X		Concrete and masonry (see Section 2)
b. Do concrete surfaces show:		X	Not visible - under water
(1) Spalling?			
(2) Cracking?			
(3) Erosion?			
(4) Scaling?			
(5) Exposed reinforcement?			
(6) Other?			
c. Do the joints show:			
(1) Displacement or offset?			
(2) Loss of joint material?			
(3) Leakage?			
d. Is the conduit metal?		X	Aluminum sheeting on wood invert
(1) Corrosion present?			/masonry walls - initial 35 feet
(2) Protective coatings adequate?			/of precast concrete pipe.
(3) Is the conduit misaligned?			Not visible
7. STILLING BASIN.		X	None provided
a. Do concrete surfaces show:			N/A
(1) Spalling?			N/A
(2) Cracking?			N/A
(3) Erosion?			N/A
(4) Scaling?			N/A
(5) Other?			N/A
(6) Exposed reinforcement?			N/A
b. Do the joints show:			N/A
(1) Displacement or offset?			N/A
(2) Loss of joint material?			N/A
(3) Leakage?			N/A
c. Do the energy dissipators show:			N/A
(1) Signs of deterioration?			N/A
(2) Are they covered with debris?			N/A
(3) Other?			N/A
d. Is the channel:			The channel discharges into Lake
(1) Eroding or backcutting?		X	/Ditch Canal
(2) Sloughing?		X	
(3) Obstructed?		X	
e. Is released water:			
(1) Undercutting the outlet?		X	
(2) Eroding the embankment?		X	
8. SPILLWAY.			Gage height - 25.0
a. Does spillway concrete show:		X	No concrete provided
(1) Spalling?			N/A
(2) Cracking?			N/A
(3) Erosion?			N/A
(4) Scaling?			N/A
(5) Other?			N/A
(6) Exposed reinforcement?			N/A
b. Do the joints show:			N/A
(1) Displacement or offset?			N/A
(2) Loss of joint material?			N/A
(3) Leakage?			N/A

ITEM	YES	NO	REMARKS
c. Do the energy dissipators show:			N/A
(1) Signs of deterioration?			N/A
(2) Are they covered with debris?			N/A
(3) Other?			
d. Is the spillway earth cut?	X		Mostly cut, some in rock, but
(1) Are slopes eroding?		X	/part fill. (No spill - it would
(2) Are slopes sloughing?			/erode during large spill.)
(3) Other?			
e. Is the channel:			
(1) Eroding or backcutting?		X	No spill
(2) Obstructed?		X	
f. Has released water:			
(1) Eroded the embankment?		X	
(2) Undercut the outlet?		X	
(3) Other?			
g. Is weir in good condition?			No weir provided (N/A)
h. Is control at the weir?			N/A
9. GATES.			
a. Are the flood gates:		X	
(1) Broken or bent?			N/A
(2) Corroded or rusted?			N/A
(3) Periodically maintained?			N/A
(4) Operational?			N/A
(5) Date last operated.			N/A
b. Is there a low level gate?	X		Two 24" x 36" cast-iron gates
c. Is the low-level gate operational?	X		Last operated 10 October 1978
10. RESERVOIR CONTROL.			
a. Recent upstream development?		X	
b. Slides in reservoir area?		X	
c. Change in reservoir operation?		X	
d. Large impoundment upstream?	X		Hertha Reservoir
11. INSTRUMENTATION.			
a. List type(s) of instrumentation.			None provided
b. In good condition?			" "
c. Read periodically?			" "
d. Is data available?			" "

Other comments: See Checklist No. 2 for Lonetree Dike. Approximately 9300 acre-feet are stored behind the concrete dam and an additional 2000 acre-feet are stored below the outlet to the dam. This was a natural lake which has been enlarged by building the supply canal embankment on the low side of the reservoir which also serves as a dike to contain additional storage in the reservoir.

This dam was inspected by:

George B. Wallace, P.E. — Principal Engineer, Bovay Engineers, Inc., Inspection Team Leader (Dams and Foundations)

George B. Wallace

Melvin A. Jabara, P.E. — Consulting Engineer, Bovay Engineers, Inc., (Spillways and Outlet Works)

Melvin A. Jabara

Lynn A. Brown, E.G., P.E. — Consulting Engineering Geologist, Bovay Engineers, Inc., (Geology and Soils)

Lynn A. Brown

Donald L. Miller — Consulting Hydrologist, Bovay Engineers, Inc., (Hydrology)

Donald L. Miller

PHASE I

INSPECTION CHECKLIST No. 2

NAME OF DAM: Lonetree Dike
STATE: Colorado
COUNTY: Larimer
INVENTORY NO.: CO 01734
HAZARD CATEGORY: 1
TYPE OF DAM: Earth

OWNER: Consolidated Home Supply Ditch and Reservoir Company
DATE INSPECTED: 20 October 1978
WEATHER: Partly cloudy
TEMPERATURE: 75°F (24°C)
POOL ELEVATION: 7.0 gage (5114.0)
TAILWATER ELEVATION: NA

DIRECTIONS: Mark an "X" in the YES or NO column.
If an item does not apply, write "NA" in the REMARKS column.

ITEM	YES	NO	REMARKS
1. CREST.			
a. Any visual settlements?		X	Embankment raised to elevation
b. Misalignment?		X	/28.5 in March 1978.
c. Cracking?		X	
2. UPSTREAM SLOPE.			
a. Adequate grass cover?	X		
b. Any erosion?		X	
c. Are trees growing on slope?	X		Some +6 inches in diameter -
d. Longitudinal cracks?		X	/several large trees (+12 inches)
e. Transverse cracks?		X	/just below slope in reservoir.
f. Adequate riprap protection?	X		See Section 2
g. Any stone deterioration?			N/A
h. Visual depressions or bulges?	X		Undulations not to settlements
i. Visual settlements?		X	/on slides (See Section 2)
3. DOWNSTREAM SLOPE.			
a. Adequate grass cover?		X	At stations where embankment was
b. Any erosion?		X	/raised there is no cover, however,
c. Are trees growing on slope?		X	/large rock placed on downstream
d. Longitudinal cracks?		X	/slopes have prevented erosion to
e. Transverse cracks?		X	/date.
f. Visual depressions or bulges?		X	
g. Visual settlements?		X	
h. Is the toe drain dry?		X	Flowing about one gpm±
i. Are the relief wells flowing?			N/A, none provided
j. Are boils present at the toe?		X	
k. Is seepage present?		X	
4. ABUTMENT CONTACTS.			
a. Any erosion?		X	Abutments are not well defined on
b. Visual differential movement?		X	/this dam.
c. Any cracks noted?		X	
d. Is seepage present?		X	
5. INTAKE STRUCTURE.			
a. Do concrete surfaces show:			See Checklist No. 1
(1) Spalling?			" " " "
(2) Cracking?			" " " "
(3) Erosion?			" " " "
(4) Scaling?			" " " "
(5) Exposed reinforcement?			" " " "
(6) Other?			" " " "
b. Do the joints show:			" " " "
(1) Displacement or offset?			" " " "
(2) Loss of joint material?			" " " "
(3) Leakage?			" " " "

ITEM	YES	NO	REMARKS
c. Metal appurtenances?			See Checklist No. 1
(1) Corrosion present?			" " " "
(2) Breakage present?			" " " "
(3) Anchor system secure?			" " " "
6. CONDUIT.			" " " "
a. Is the conduit concrete?			" " " "
b. Do concrete surfaces show:			" " " "
(1) Spalling?			" " " "
(2) Cracking?			" " " "
(3) Erosion?			" " " "
(4) Scaling?			" " " "
(5) Exposed reinforcement?			" " " "
(6) Other?			" " " "
c. Do the joints show:			" " " "
(1) Displacement or offset?			" " " "
(2) Loss of joint material?			" " " "
(3) Leakage?			" " " "
d. Is the conduit metal?			" " " "
(1) Corrosion present?			" " " "
(2) Protective coatings adequate?			" " " "
(3) Is the conduit misaligned?			" " " "
7. STILLING BASIN.			" " " "
a. Do concrete surfaces show:			" " " "
(1) Spalling?			" " " "
(2) Cracking?			" " " "
(3) Erosion?			" " " "
(4) Scaling?			" " " "
(5) Other?			" " " "
(6) Exposed reinforcement?			" " " "
b. Do the joints show:			" " " "
(1) Displacement or offset?			" " " "
(2) Loss of joint material?			" " " "
(3) Leakage?			" " " "
c. Do the energy dissipators show:			" " " "
(1) Signs of deterioration?			" " " "
(2) Are they covered with debris?			" " " "
(3) Other?			" " " "
d. Is the channel:			" " " "
(1) Eroding or backcutting?			" " " "
(2) Sloughing?			" " " "
(3) Obstructed?			" " " "
e. Is released water:			" " " "
(1) Undercutting the outlet?			" " " "
(2) Eroding the embankment?			" " " "
8. SPILLWAY.			" " " "
a. Does spillway concrete show:			" " " "
(1) Spalling?			" " " "
(2) Cracking?			" " " "
(3) Erosion?			" " " "
(4) Scaling?			" " " "
(5) Other?			" " " "
(6) Exposed reinforcement?			" " " "
b. Do the joints show:			" " " "
(1) Displacement or offset?			" " " "
(2) Loss of joint material?			" " " "
(3) Leakage?			" " " "

ITEM	YES	NO	REMARKS
c. Do the energy dissipators show:			See Checklist No. 1
(1) Signs of deterioration?		X	" " " "
(2) Are they covered with debris?		X	" " " "
(3) Other?		X	" " " "
d. Is the spillway earth cut?			" " " "
(1) Are slopes eroding?		X	" " " "
(2) Are slopes sloughing?		X	" " " "
(3) Other?		X	" " " "
e. Is the channel:			" " " "
(1) Eroding or backcutting?		X	" " " "
(2) Obstructed?		X	" " " "
f. Has released water:			" " " "
(1) Eroded the embankment?		X	" " " "
(2) Undercut the outlet?		X	" " " "
(3) Other?		X	" " " "
g. Is weir in good condition?	X		" " " "
h. Is control at the weir?	X		" " " "
9. GATES.			" " " "
a. Are the flood gates:			" " " "
(1) Broken or bent?		X	" " " "
(2) Corroded or rusted?		X	" " " "
(3) Periodically maintained?	X		" " " "
(4) Operational?	X		" " " "
(5) Date last operated.			" " " "
b. Is there a low level gate?			" " " "
c. Is the low-level gate operational?	X		" " " "
10. RESERVOIR CONTROL.			" " " "
a. Recent upstream development?		X	" " " "
b. Slides in reservoir area?		X	" " " "
c. Change in reservoir operation?			" " " "
d. Large impoundment upstream?		X	" " " "
11. INSTRUMENTATION.			None provided
a. List type(s) of instrumentation.			N/A
b. In good condition?	X		N/A
c. Read periodically?	X		N/A
d. Is data available?	X		N/A

Other comments:

Approximately 3500 acre-feet are stored above toe of maximum dike section (between gage 17.5 and 25.0).

This dam was inspected by:

George B. Wallace, P.E. — Principal Engineer, Bovay Engineers, Inc., Inspection Team Leader (Dams and Foundations)
George B. Wallace

Melvin A. Jabara, P.E. — Consulting Engineer, Bovay Engineers, Inc., (Spillways and Outlets)
Melvin A. Jabara

Lynn A. Brown, E.G., P.E. — Consulting Engineering Geologist, Bovay Engineers, Inc., (Geology and Soils)
Lynn A. Brown

Donald L. Miller — Consulting Hydrologist, Bovay Engineers, Inc., (Hydrology)
Donald L. Miller

APPENDIX B

PHOTOGRAPHS

Photo No. 1	Upstream face of Lonetree Dam and Reservoir extension V channel, 10/20/78
Photo No. 2	Downstream face and outlet for Lonetree Dam, 10/20/78
Photo No. 3	Outlet works for Lonetree Dam, 11/3/78
Photo No. 4	Lonetree Dike and Home Supply Canal, 10/20/78
Photo No. 5	Uncontrolled spillway, largely cut from shallow sandstone bedrock, Lonetree Dam, 10/20/78
Photo No. 6	Spillway channel (Ryan Gulch) for Lonetree Dam, 10/20/78
Photo No. 7	Check structure in Home Supply Canal (River Ditch) at Station 0+50, 10/20/78
Photo No. 8	Diversions from Home Supply Canal (River Ditch) to Lonetree Reservoir, 10/20/78
Photo No. 9	Diversion dam on Big Thompson River and diversion for Home Supply Canal, 10/20/78
Photo No. 10	Measuring for Home Supply Canal feeding Lonetree Reservoir, 10/20/78

Concrete structure was placed against old masonry dam which is backed up with earth embankment as shown on Plate 2, Appendix D

Looking upstream from top of dam. Intake structure is under water near branches in foreground.

Concrete surface appeared to be in good condition. No serious structural cracks were observed. Metal house protects gate hoists. Vertical pipe extending down from house contains staff gage for measuring elevation of reservoir.

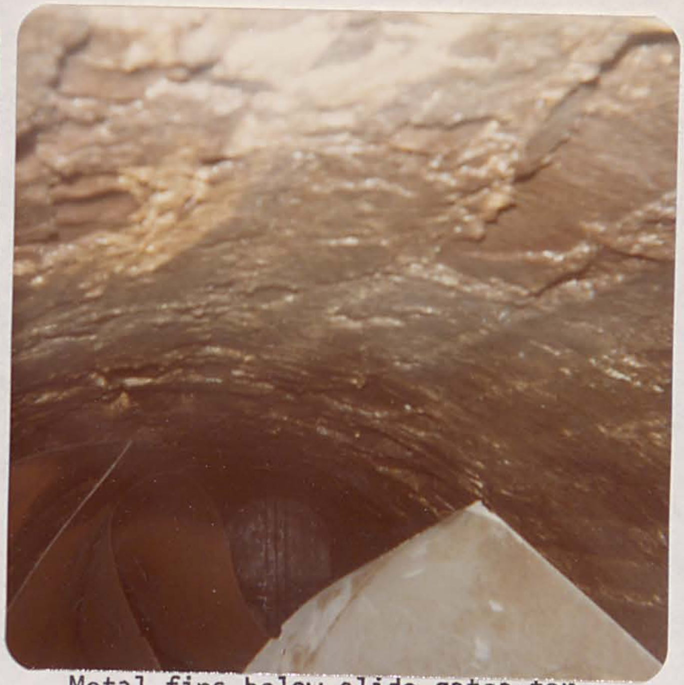
Photo No. 1 Upstream face of Lonetree Dam and Reservoir extension V channel, 10/20/78

Downstream face of Lonetree Dam below metal gate house resting on top of dam in background. Parshall flume in foreground measures discharge from outlet into Lake Ditch Canal.

New seven-foot-long aluminum transition attached to a 60-foot-long, five-foot-diameter 14-gauge corrugated aluminum pipe extension to old 140-foot-long masonry arch tunnel

Photo No. 2 Downstream face and outlet for Lonetree Dam, 10/20/78

Gate hoists operate two 24" x 36"
Armco slide gates



Metal fins below slide gates for
improving flow characteristics

Masonry arch conduit 3'7" high,
5' wide, 140' long

Corrugated aluminum extension
5' diameter, 60' long, added to
masonry conduit in 1978

Photo No. 3   Outlet works for Lonetree Dam, 11/3/78

Maximum section--11 feet between crest and downstream toe of dam

Tile drains under embankment have stabilized this old marshy area

Typical section of dike which includes the Home Supply Canal and its banks and side slopes. Base of trees on right side of photo are below high water line of Lonetree reservoir.

Photo No. 4   Lonetree dike and Home Supply Canal, 10/20/78

Spillway is about 1150 feet in length. Sandstone crest is about 950 feet wide. Elevation is 25.0 gage, 3.5 feet below crest of dike.

More distant view of spillway cut. Note swale to left of spillway. This is beginning of Ryan Gulch which would carry spill to Big Thompson River.

Photo No. 5 Uncontrolled spillway, largely cut from shallow sandstone bedrock, Lonetree Dam, 10/20/78

View from left side of spillway crest. Note house in flood plain and Ryan Gulch Lake in background.

Ryan Gulch Lake would receive spill from Lonetree. Buildings in background are on outskirts of Loveland, Colorado.

Photo No. 6   Spillway channel (Ryan Gulch)
for Lonetree Dam, 10/20/78

Metal gate house sits on Lonetree Dam. Outlet from dam to Lake Ditch Canal runs under Home Supply Canal. Crest of dam runs from barrier wall on top of check structure to contour 28.5 on right abutment.

Concrete barrier wall was added to check structure to retain water spilling from Lonetree Reservoir into the Home Supply Canal. The barrier is 3.5 feet above spillway crest.

Photo No. 7 Check structure in Home Supply Canal (River Ditch) at Station 0+50, 10/20/78

Lower diversion structure at Station 31+50 is in spillway reach as shown on Plate 5, Appendix D

Looking from supply canal to reservoir. Note gentle slope between canal reservoir and water surface.

Upper diversion structure at Station 51+50. This diversion will handle 200 cfs. The supply canal can carry 350 cfs. When it does both diversion structures are used to fill the reservoir.

Photo No. 8 Diversions from Home Supply Canal (River Ditch) to Lonetree Reservoir, 10/20/78

Masonry arch diversion dam supplies water to Home Supply Canal from right side of river. Structure withstood the 1965 flood.

Intake for Home Supply Canal. Note wasteway back to river in foreground.

Photo No. 9 Diversion dam on Big Thompson River and diversion for Home Supply Canal, 10/20/78

Parshall flume just below intake structure measures flow going to Lonetree Reservoir

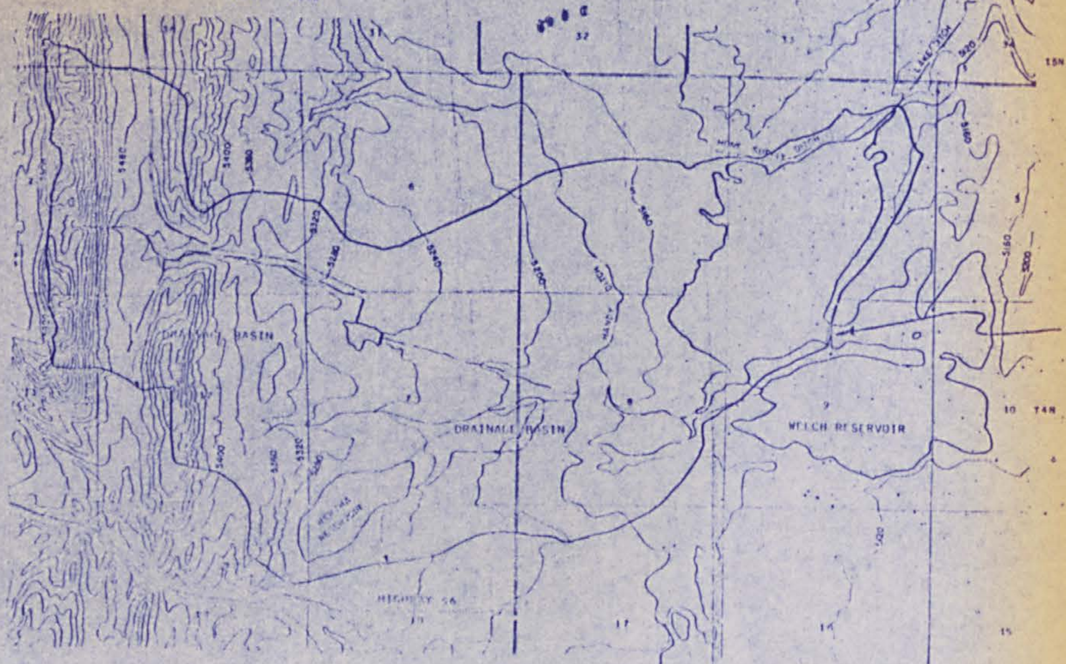
Parshall flume just downstream from Lonetree Dam measures flow in Home Supply Canal going past Lonetree Reservoir. Wasteway in front of flume can divert water to Lake Ditch Canal.

Photo No. 10 Measuring for Home Supply Canal feeding Lonetree Reservoir, 10/20/78

APPENDIX C

PLANS, SECTIONS, AND DETAILS

Plate 1	General Layout of Lonetree Reservoir, Dam, and Dike
Plate 2	Plan and Section of Lonetree Dam
Plate 3	Plan, Profile, and Section of Outlet Works for Lonetree Dam
Plate 4	Plan and Profile: Stations 4+00 to 14+00; and Reservoir Capacity Curve and Outlet Discharge Curve
Plate 5	Plan and Profile: Stations 23+00 to 50+00, and Spillway Discharge Curve
Plate 6	Plan and Profile: Stations 50+00 to 68+00 (end)
Plate 7	Cross Sections for Lonetree Dike: Stations 2+00, 1+00, 2+67, 40+00, and 44+00
Plate 8	Cross Sections for Lonetree Dike: Stations 26+00, 28+00, 30+00, 32+00, 36+00, and 37+00
Plate 9	Plan and Cross Section of River Canal Control Structure Showing New Barrier Wall



LOCATION SKETCH
SCALE 1" = 2000'

DRAINAGE BASIN AREA ≈ 6.0 MI.²
LONETREE RESERVOIR SURFACE ≈ 501 ACRES
TO CONVERT TO U.S.G.S. ELEVATIONS - ADD 5107.12 TO GAGE ROD READING

SOILS LOG

- TOPSOIL
- CLAY
- SANDY CLAY
- WEATHERED SANDSTONE
- SANDSTONE BEDROCK

PLANS FOR THE REPAIR OF LONETREE RESERVOIR DAM

LOCATED IN SECTIONS 4,5,8,9
T4N, R69W, OF THE 6TH P.M.
LARIMER COUNTY, COLORADO
WATER DIVISION NO. 1
WATER DISTRICT NO. 4

I HEREBY CERTIFY THAT THESE PLANS FOR THE REPAIR OF THE LONETREE RESERVOIR DAM, WERE PREPARED BY ME OR UNDER MY DIRECT SUPERVISION FOR THE OWNERS THEREOF.

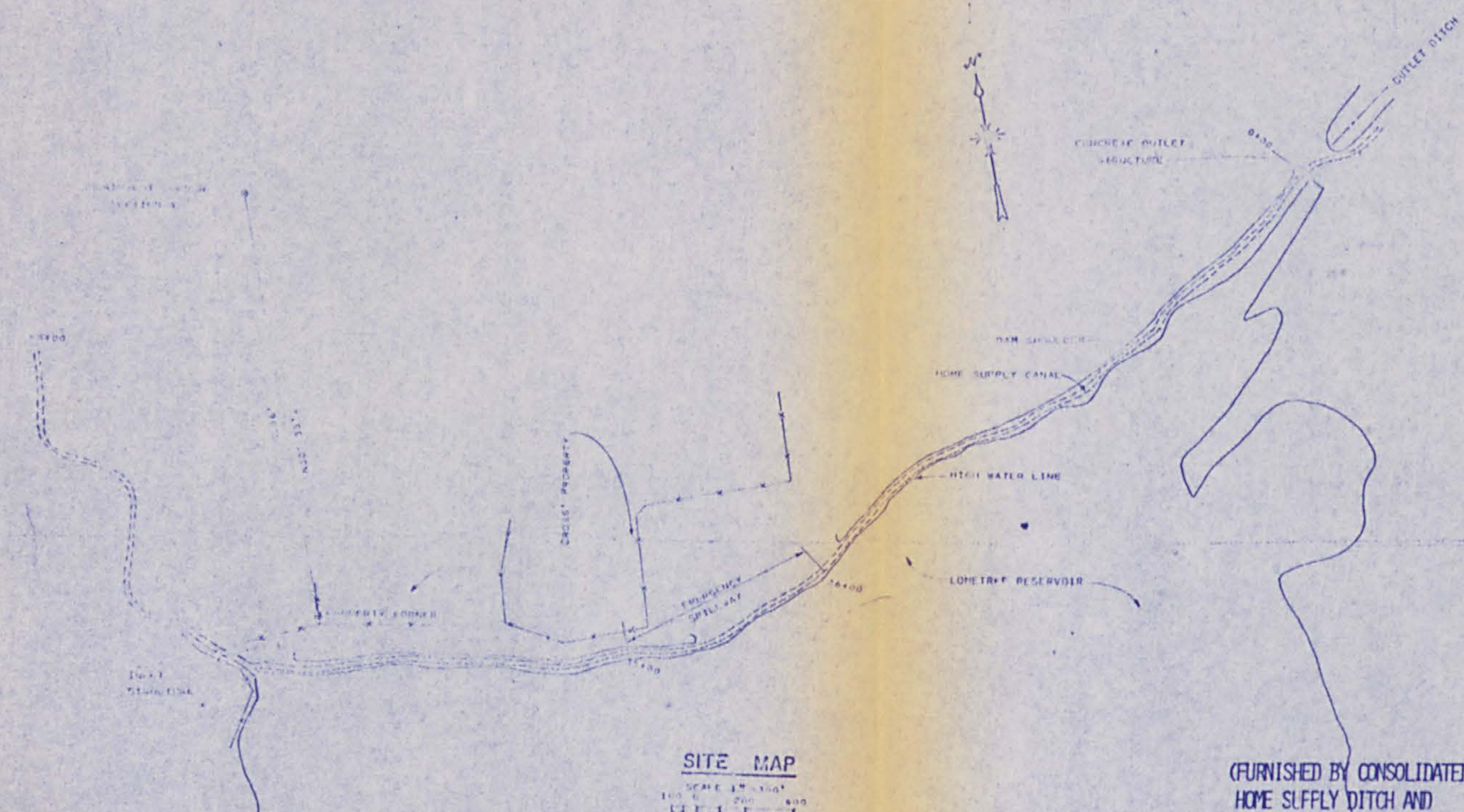
KENNETH L. BIGGS, P.E.

THE CONSOLIDATED HOME SUPPLY DITCH AND RESERVOIR COMPANY, WHOSE POST OFFICE ADDRESS IS C/O MR. W. R. ..., STAR ROUTE, BOX 450 LOVELAND, COLORADO ... ACCEPT AND APPROVE THESE PLANS FOR THE REPAIR OF THE LONETREE RESERVOIR ...
BY:

APPROVED ON THE 30TH ...

STATE OF COLORADO
DIVISION OF WATER RESOURCES

PLANS REVIEWED BY ...
APPROVAL RECOMMENDED BY ...



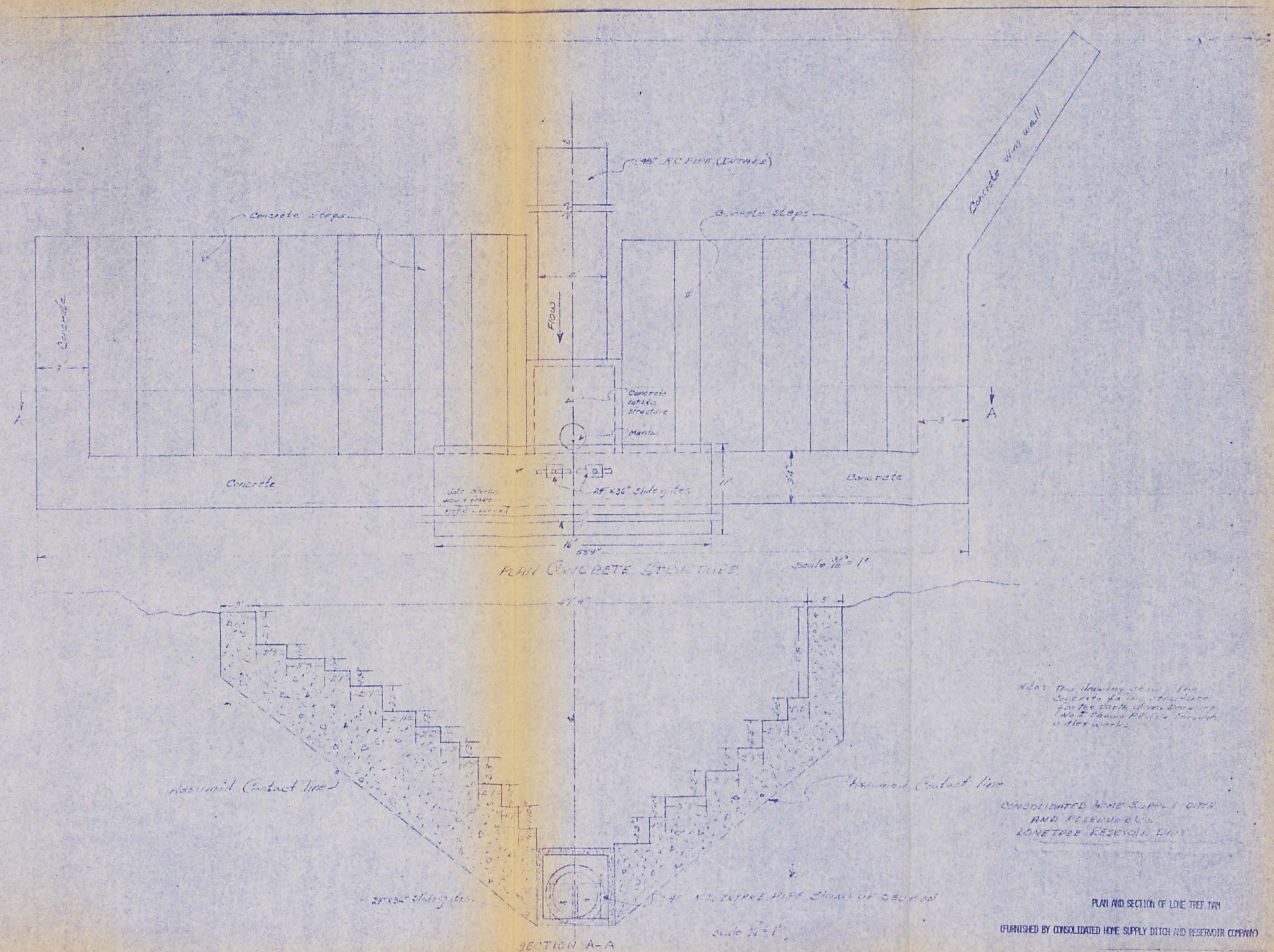
SITE MAP
SCALE 1" = 400'

(FURNISHED BY CONSOLIDATED HOME SUPPLY DITCH AND RESERVOIR COMPANY)

GENERAL LAYOUT OF LONE TREE RESERVOIR, DAM AND DIKE

LONETREE RESERVOIR DAM LAYOUT

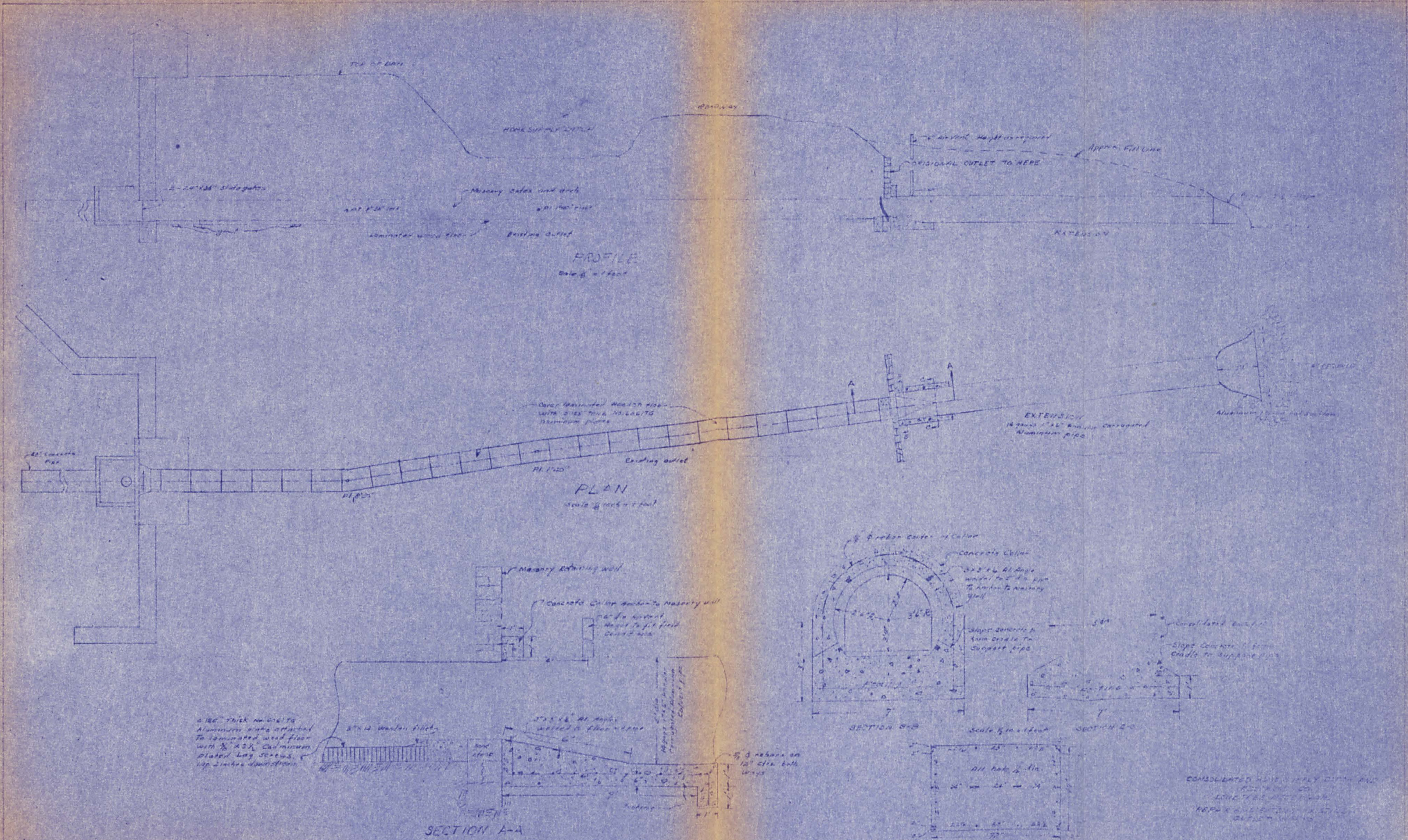
C-1482 PLATE 1 - APPENDIX C



PLAN AND SECTION OF LONE TREE DAM

(FURNISHED BY CONSOLIDATED HOME SUPPLY DITCH AND RESERVOIR COMPANY)

PLATE 2 - APPENDIX C



PLAN, PROFILE AND SECTION OF OUTLET WORKS FOR LONE TREE DAM

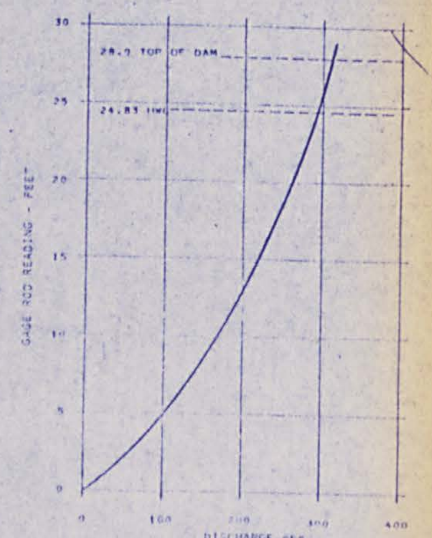
(FURNISHED BY CONSOLIDATED HOPE SUPPLY DITCH AND RESERVOIR COMPANY)

PLATE 3 - APPENDIX C

STORAGE CAPACITY TABLE

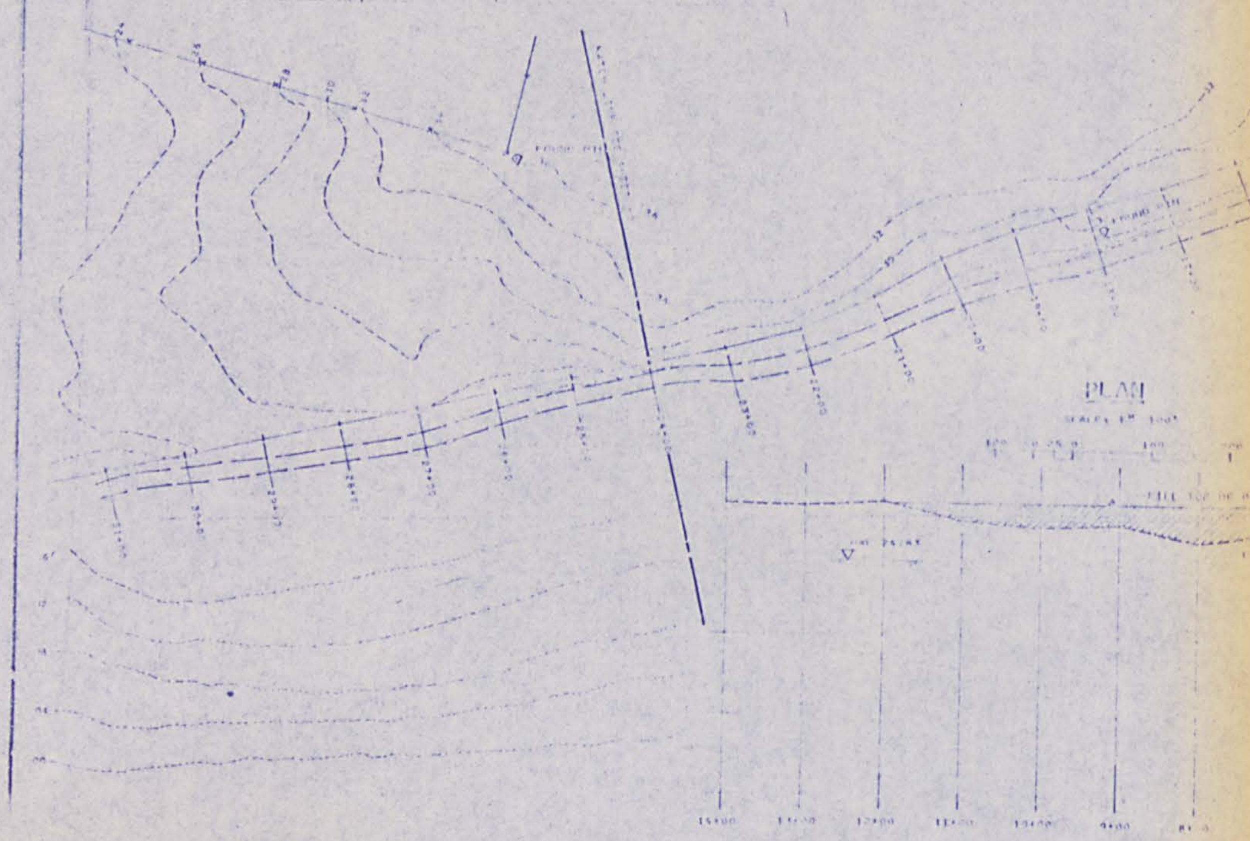
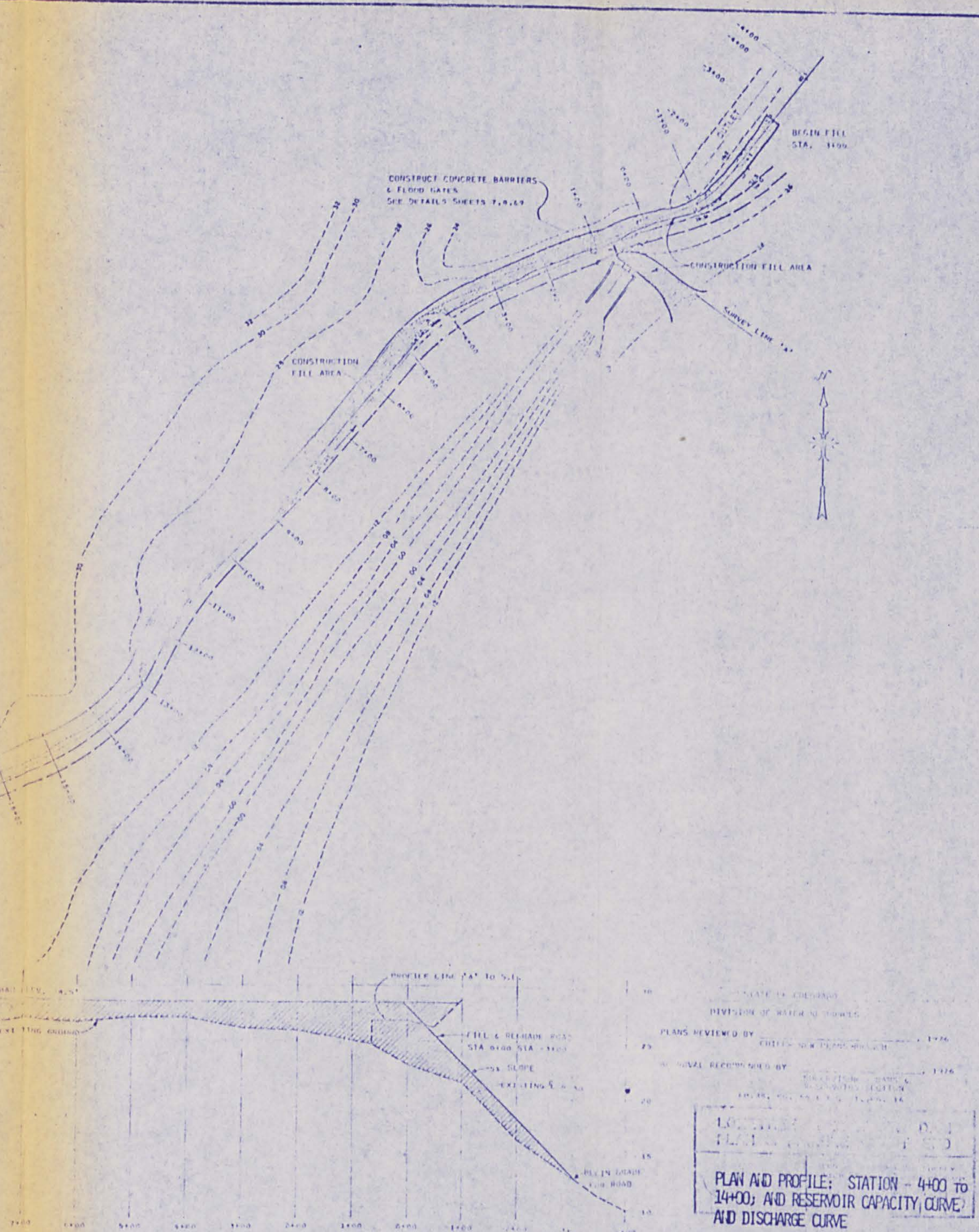
GAGE ROD DEPTH IN FEET	CAPACITY IN A.C. FEET
0	0
1	255.8
2	521.7
3	797.5
4	1083.4
5	1379.6
6	1686.1
7	2052.2
8	2377.1
9	2660.9
10	3002.1
11	[illegible]
12	[illegible]
13	[illegible]
14	4446.1
15	4828.3
16	5220.0
17	5621.7
18	6034.3
19	[illegible]
20	[illegible]
21	7353.6
22	[illegible]
23	8281.5
24	8769.3
25	9267.6

NOTE: TAKEN FROM SOIL CONSERVATION PLANS DATED 7-74, WHICH WAS TAKEN FROM "OFFICIAL RESURVEY OF LONE-TREE RESERVOIR" DATED APRIL 24, 1951 SIGNED BY R.C. HINDERLIDER, STATE ENGINEER FILE # C568



ESTIMATED OUTLET CAPACITY

REFERENCE: ESTIMATED FROM SCS PLANS DATED 7-74

STATE OF COLORADO

DIVISION OF WATER RESOURCES

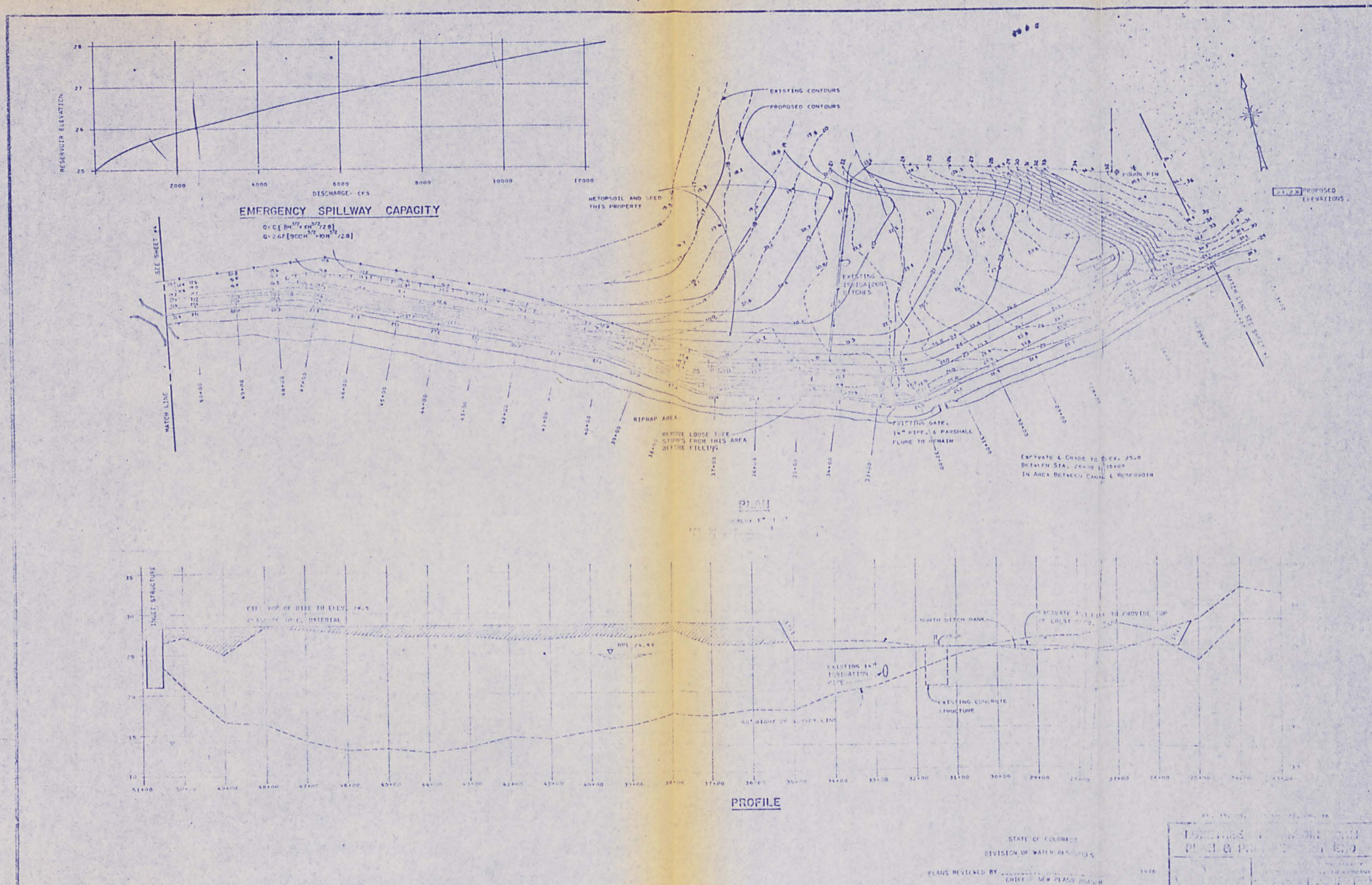
PLANS REVIEWED BY ______, 1976

APPROVAL RECOMMENDED BY ______, 1976

PLAN AND PROFILE: STATION - 4+00 TO 14+00; AND RESERVOIR CAPACITY CURVE AND DISCHARGE CURVE

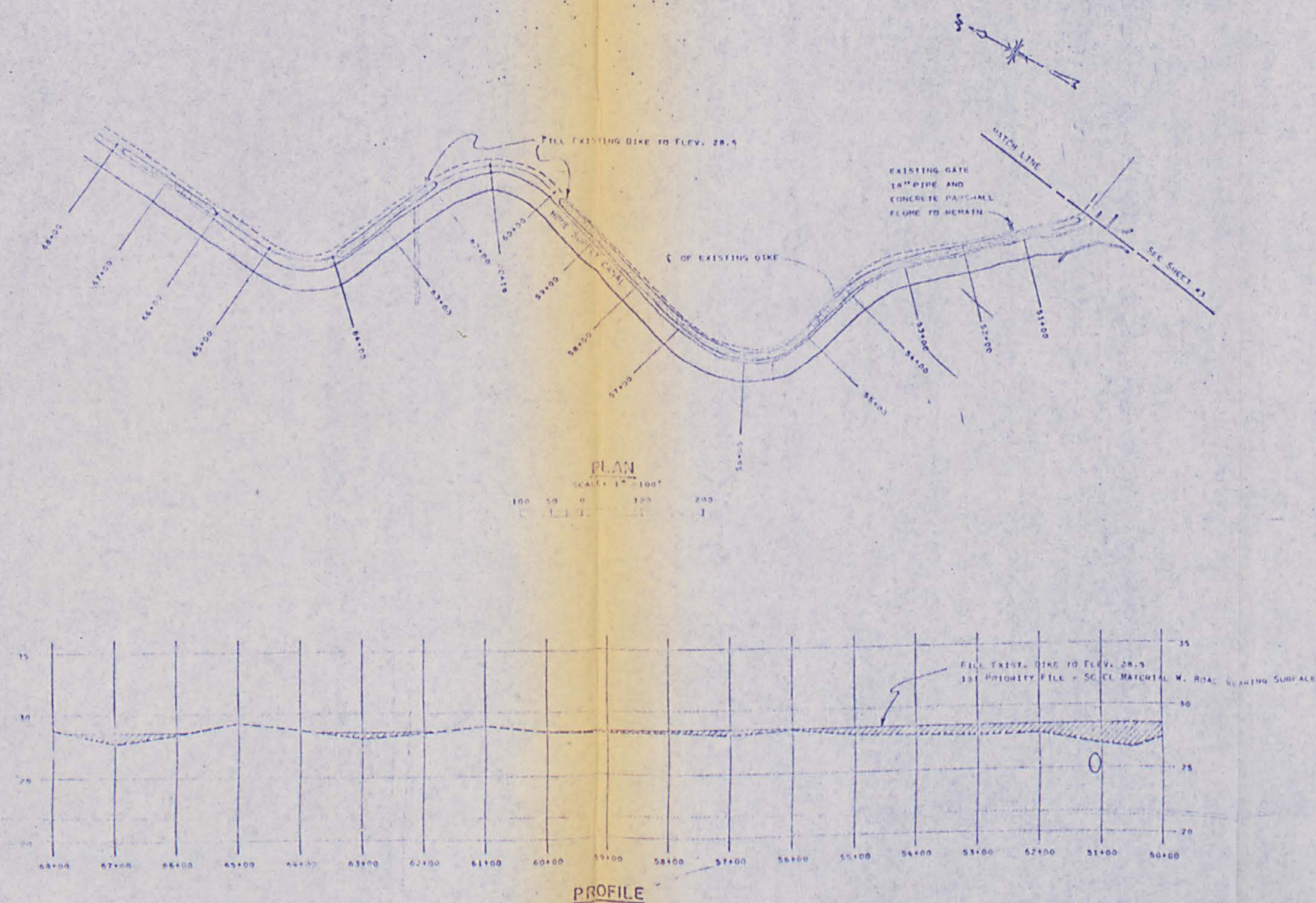
(FURNISHED BY CONSOLIDATED HOME SUPPLY DITCH AND RESERVOIR COMPANY)

C-1482 PLATE 4 - APPENDIX C



PLAN AND PROFILE: STATION 23+00 TO 50+00, AND SPILLWAY DISCHARGE CURVE

(FURNISHED BY CONSOLIDATED HOME SUPPLY DITCH AND RESERVOIR COMPANY) C-1482 PLATE 5 - APPENDIX C



STATE OF COLORADO
DIVISION OF WATER RESOURCES

PLANS REVIEWED BY ______________________, 1976
CHIEF - NEW PLANS BRANCH

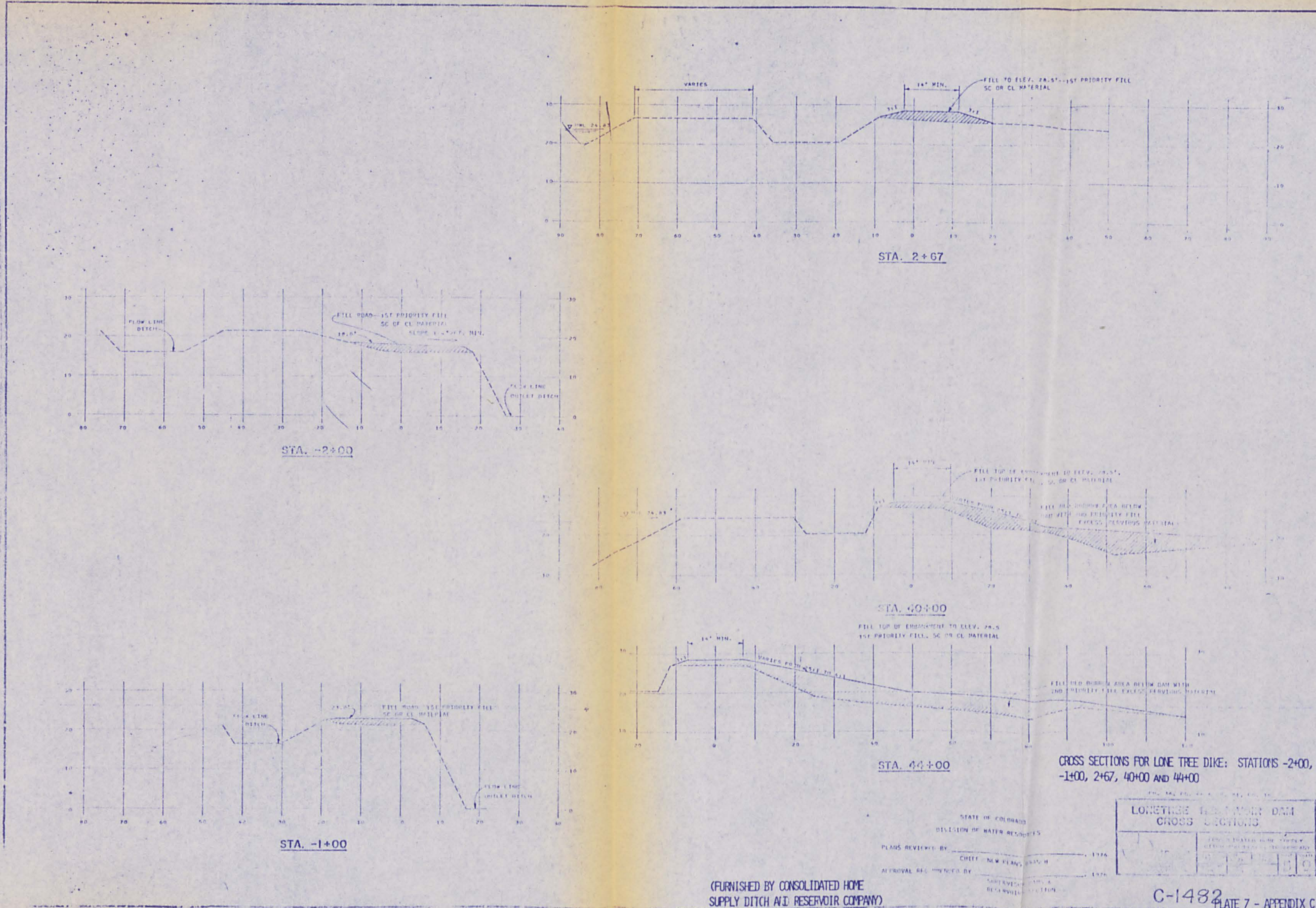
APPROVAL RECOMMENDED BY ______________________, 1976
SUPERVISOR DAMS & RESERVOIRS SECTION

LONETREE RESERVOIR DAM
PLAN & PROFILE - WEST END

PLAN AND PROFILE: STATION 50+00 TO 68+00 (END)

C-1482 PLATE 6 - APPENDIX C

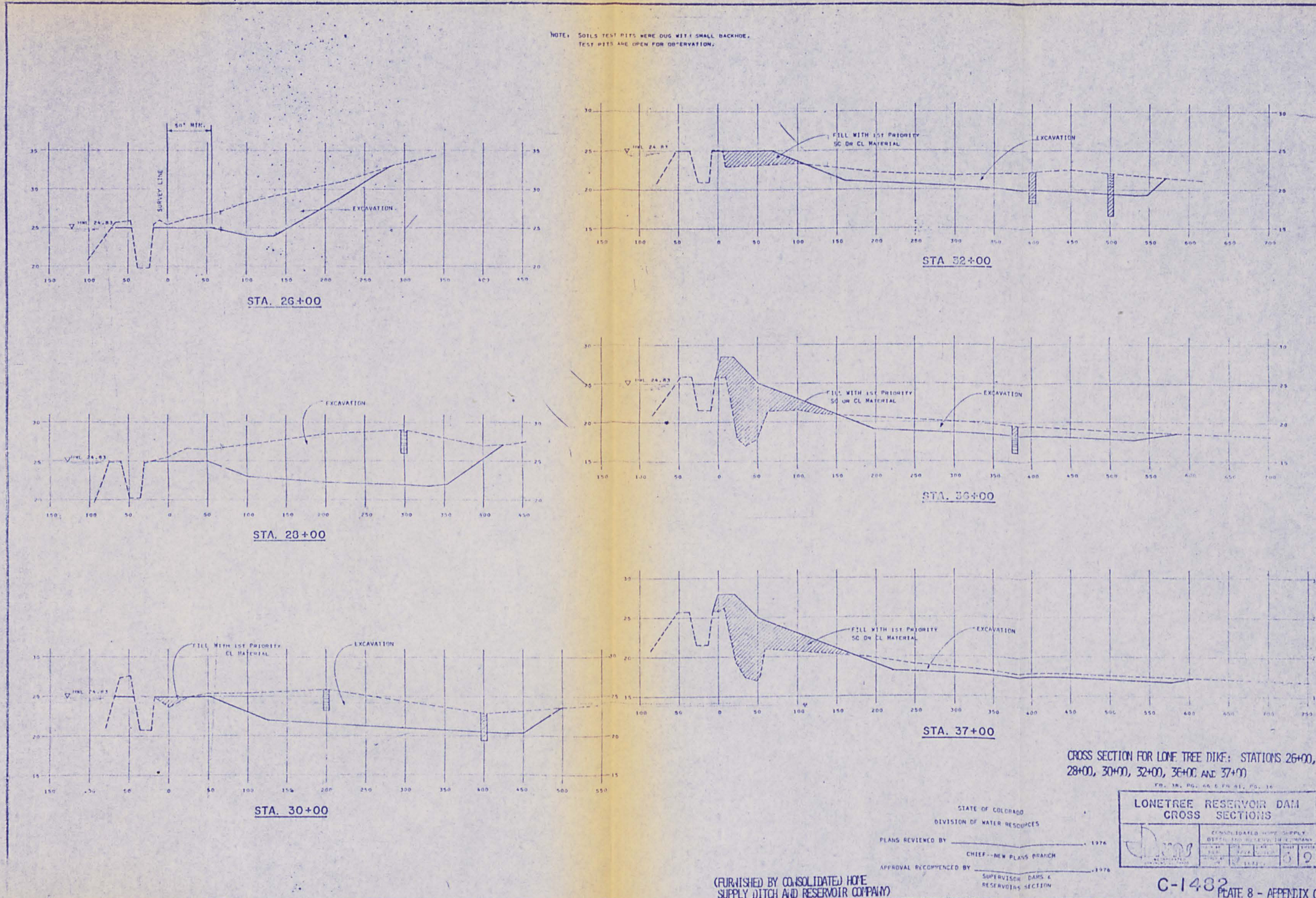
(FURNISHED BY CONSOLIDATED HOME SUPPLY DITCH AND RESERVOIR COMPANY)



CROSS SECTIONS FOR LONE TREE DIKE: STATIONS -2+00, -1+00, 2+67, 40+00 AND 44+00

(FURNISHED BY CONSOLIDATED HOME SUPPLY DITCH AND RESERVOIR COMPANY)

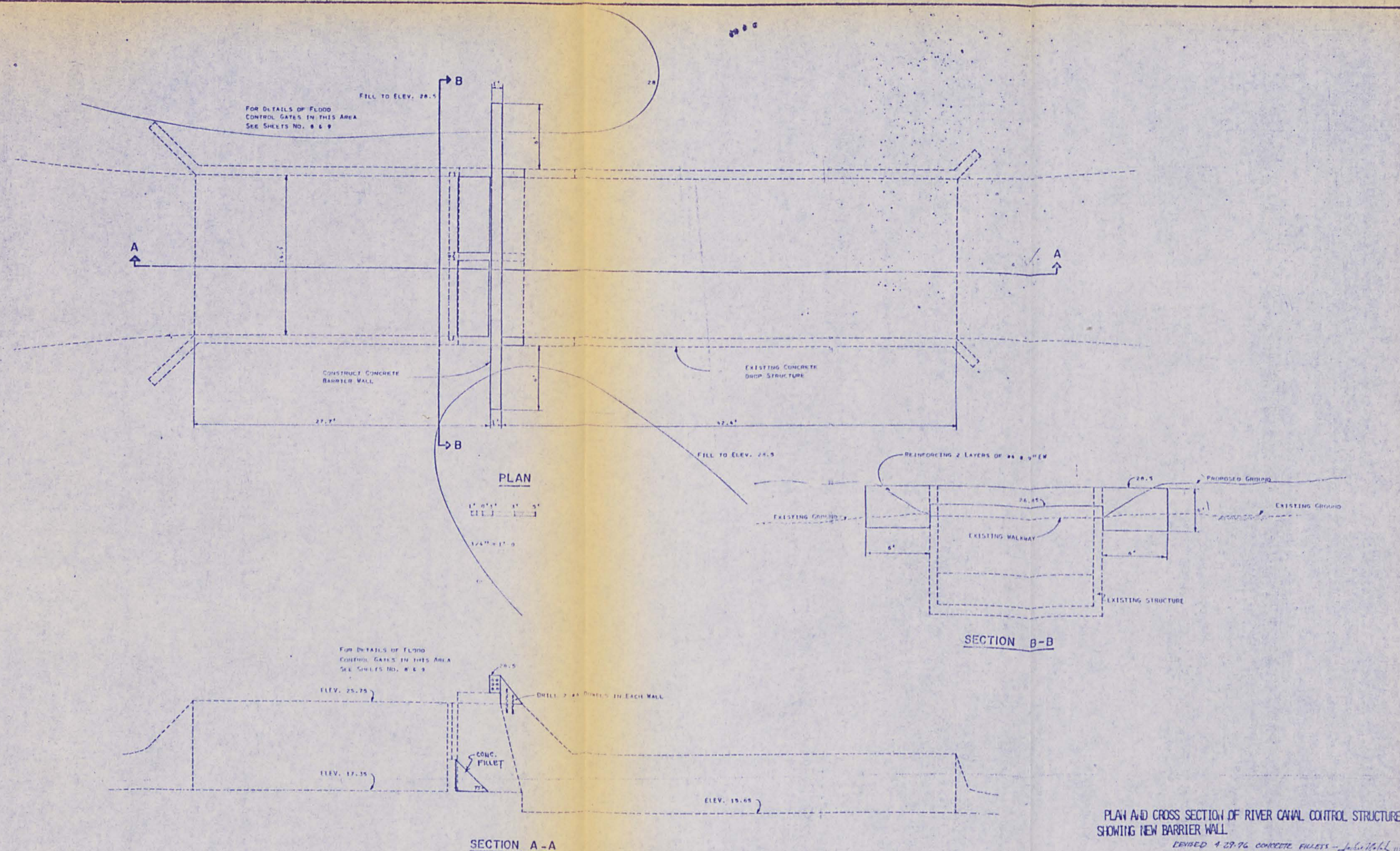
PLATE 7 - APPENDIX C



CROSS SECTION FOR LONE TREE DIKE: STATIONS 26+00, 28+00, 30+00, 32+00, 36+00 AND 37+00

(FURNISHED BY CONSOLIDATED HOME SUPPLY DITCH AND RESERVOIR COMPANY)

PLATE 8 - APPENDIX C



PLAN AND CROSS SECTION OF RIVER CANAL CONTROL STRUCTURE SHOWING NEW BARRIER WALL

REVISED 4-29-76 CONCRETE FILLETS

STATE OF COLORADO
DIVISION OF WATER RESOURCES

PLANS REVIEWED BY ________________, 1976
CHIEF - NEW PLANS BRANCH

APPROVAL RECOMMENDED BY ________________, 1976
SUPERVISOR DAMS & RESERVOIRS SECTION

LONETREE RESERVOIR DAM
CONCRETE BARRIER WALL

CONSOLIDATED HOME SUPPLY DITCH AND RESERVOIR COMPANY

SHEET 7 OF 9

(FURNISHED BY CONSOLIDATED HOME SUPPLY DITCH AND RESERVOIR COMPANY)

C-1482

PLATE 9 - APPENDIX C

APPENDIX D

AVAILABLE ENGINEERING DATA

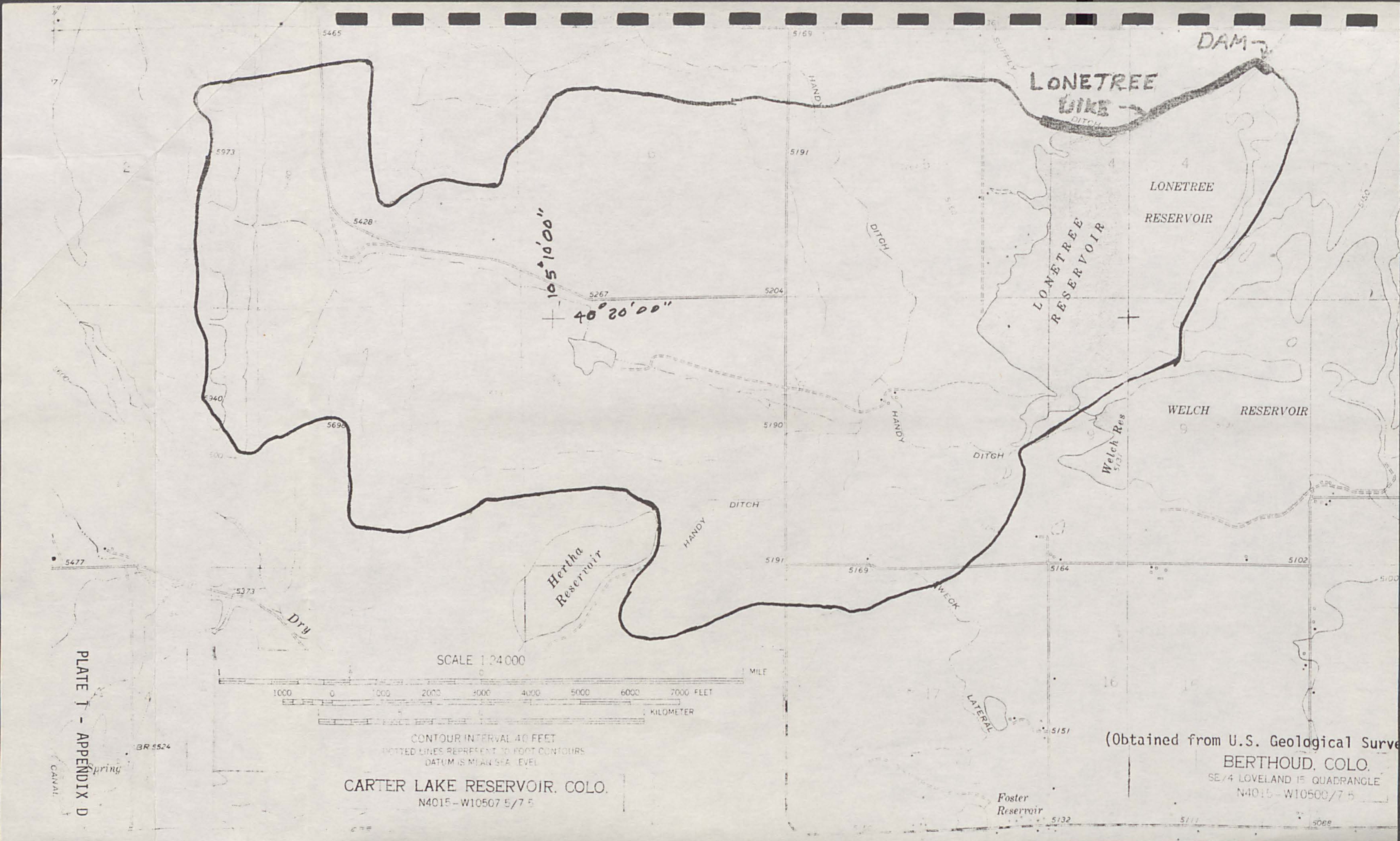


PLATE I - APPENDIX D

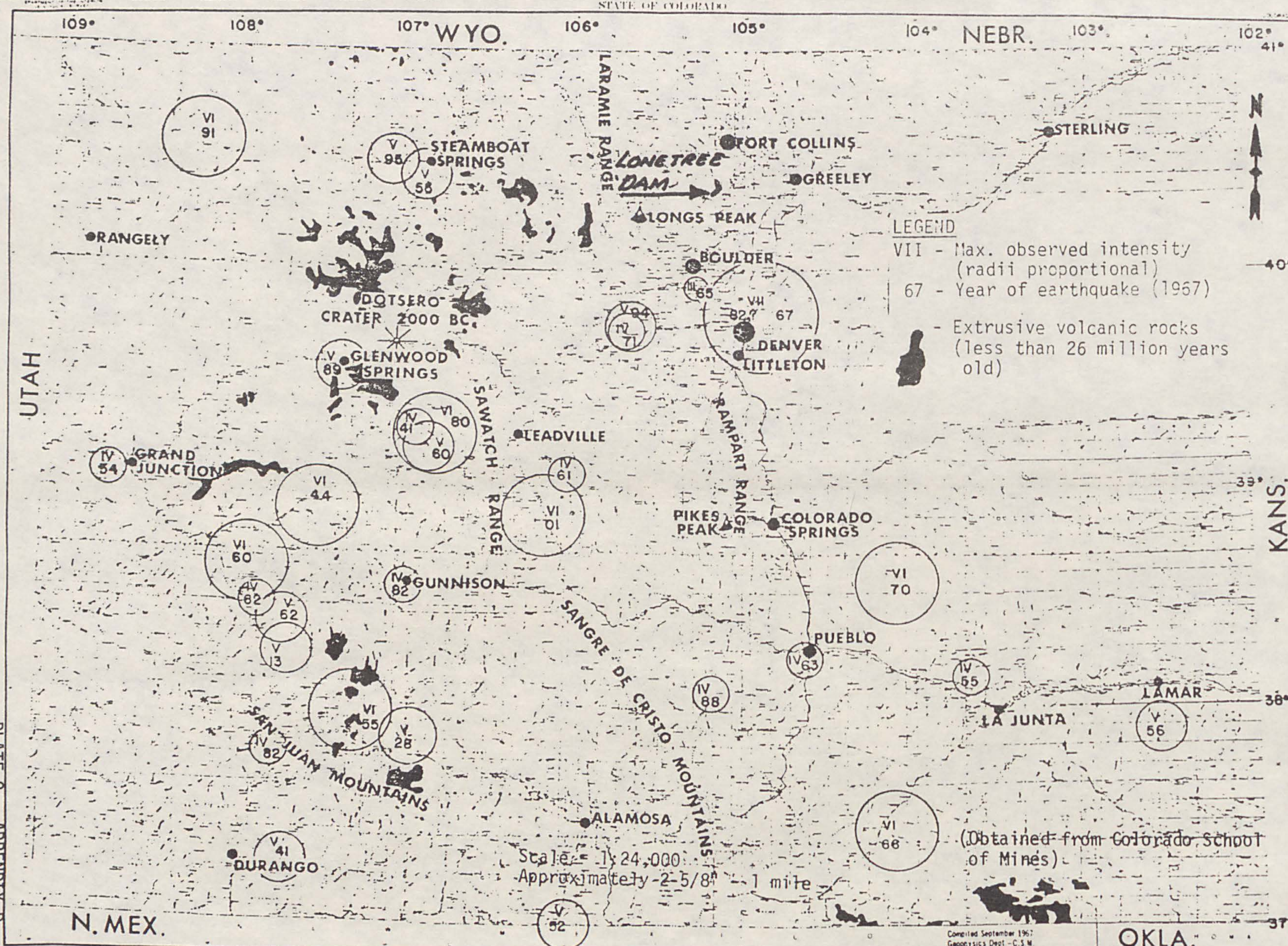
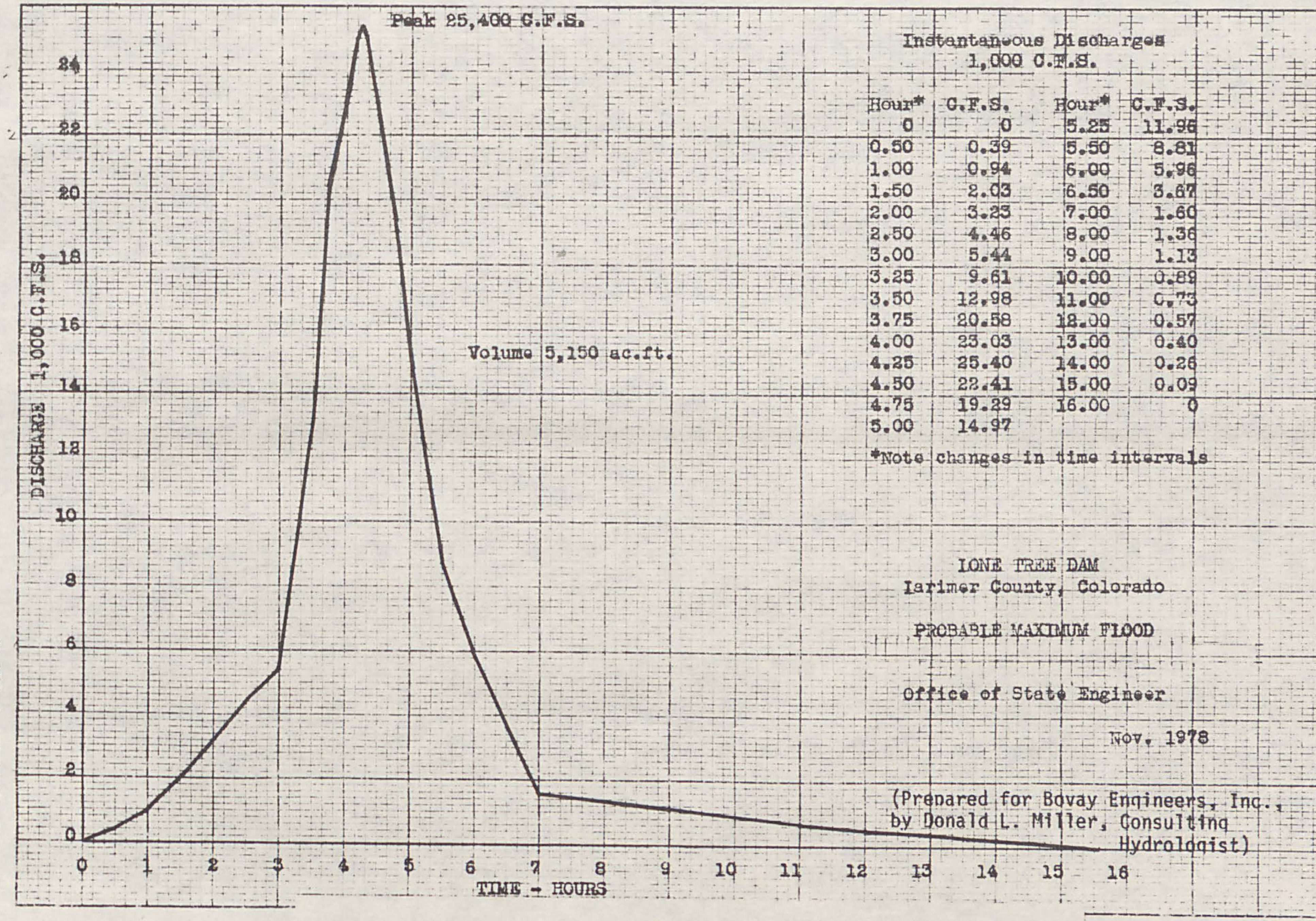


PLATE 2 - APPENDIX D

PLATE 3-APPENDIX D



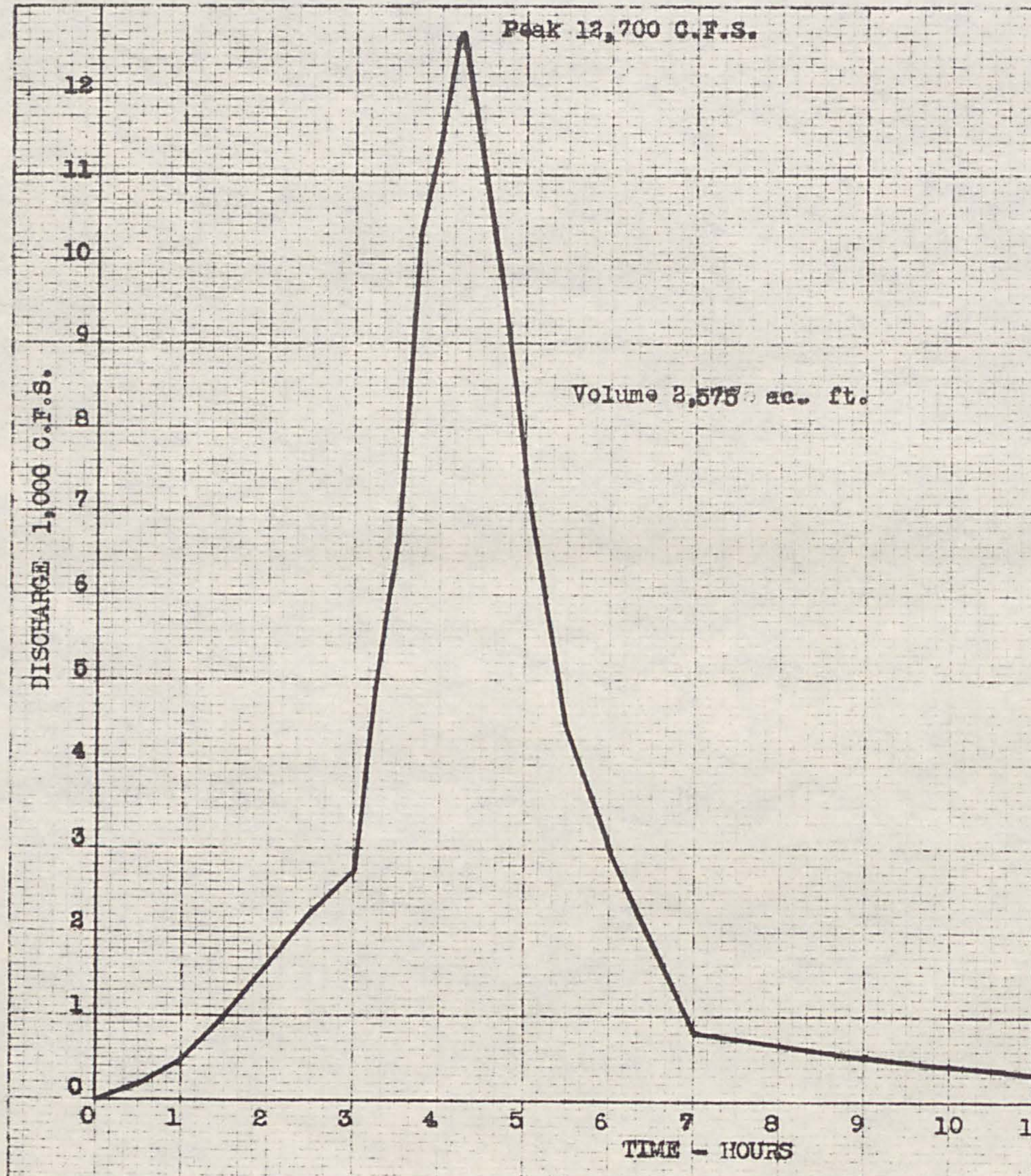
Instantaneous Discharges
1,000 C.F.S.

Hour*	C.F.S.	Hour*	C.F.S.
0	0	5.25	11.96
0.50	0.39	5.50	8.81
1.00	0.94	6.00	5.96
1.50	2.03	6.50	3.67
2.00	3.23	7.00	1.60
2.50	4.46	8.00	1.36
3.00	5.44	9.00	1.13
3.25	9.61	10.00	0.89
3.50	12.98	11.00	0.73
3.75	20.58	12.00	0.57
4.00	23.03	13.00	0.40
4.25	25.40	14.00	0.26
4.50	22.41	15.00	0.09
4.75	19.29	16.00	0
5.00	14.97		

*Note changes in time intervals

PROBABLE MAXIMUM FLOOD HYDROGRAPH BASED ON TECHNICAL PAPER NO. 40

K+E 12 X 20 TO THE INCH 46 1973
7 X 10 INCHES MADE IN U.S.A.
KEUFFEL & ESSER CO.



Instantaneous Discharges
1,000 C.F.S.

Hour*	C.F.S.	Hour*	C.F.S.
0	0	5.25	5.98
0.50	0.20	5.50	4.41
1.00	0.47	6.00	2.98
1.50	1.02	6.50	1.84
2.00	1.62	7.00	0.80
2.50	2.23	8.00	0.68
3.00	2.72	9.00	0.57
3.25	4.81	10.00	0.45
3.50	6.49	11.00	0.37
3.75	10.29	12.00	0.29
4.00	11.52	13.00	0.20
4.25	12.70	14.00	0.13
4.50	11.21	15.00	0.05
4.75	9.65	16.00	0
5.00	7.49		

*Note changes in time intervals

LONE TREE DAM
Larimer County, Colorado

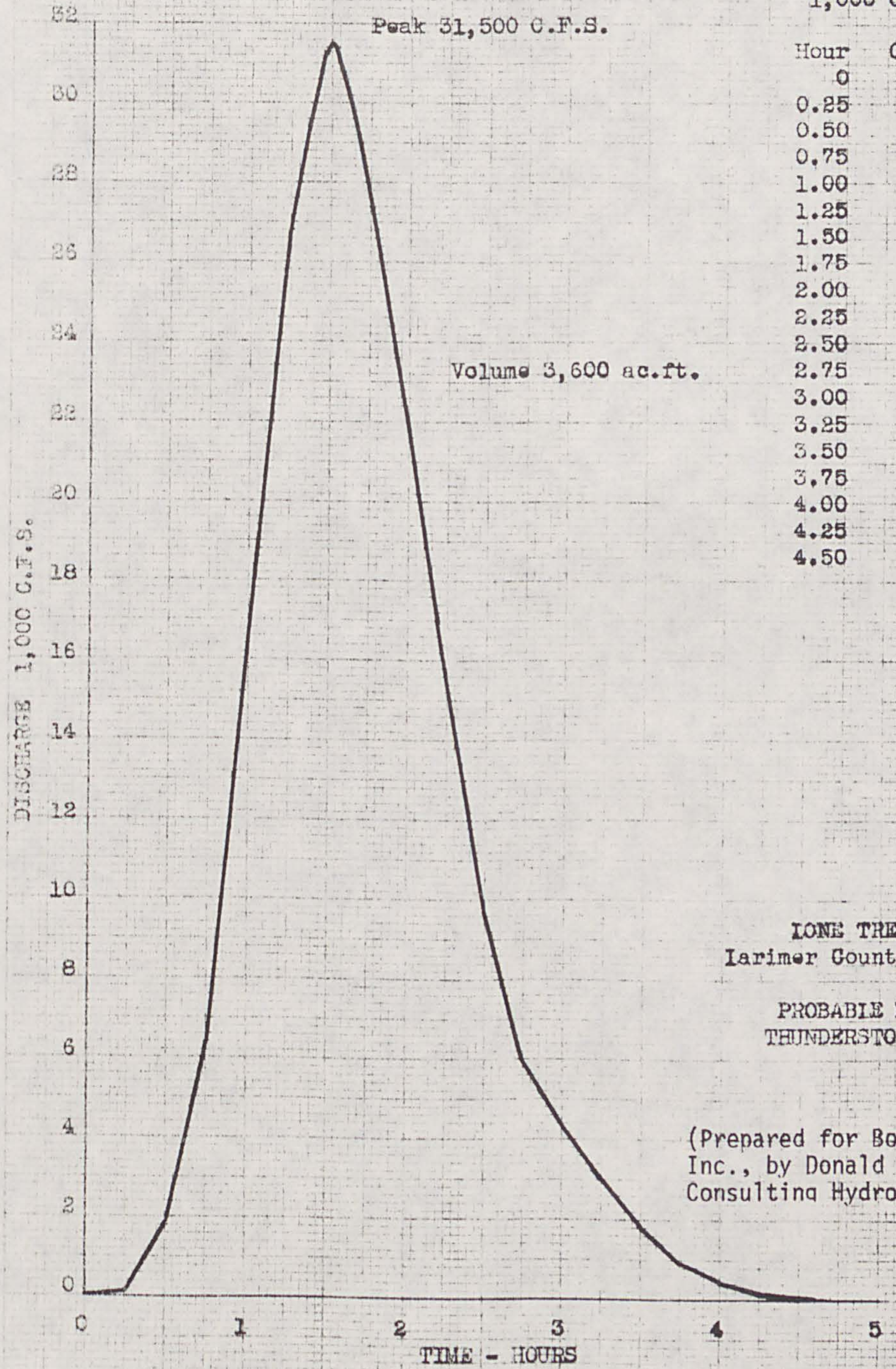
ONE-HALF
MAXIMUM PROBABLE FLOOD

Nov. 1978

(Prepared for Bovay Engineers, Inc., by
Donald L. Miller, Consulting Hydrologist)

PLATE 4-APPENDIX D

ONE-HALF PROBABLE MAXIMUM FLOOD HYDROGRAPH BASED ON TECHNICAL PAPER NO. 40



Instantaneous Discharges
1,000 C.F.S.

Hour	C.F.S.
0	0
0.25	0.15
0.50	1.82
0.75	6.25
1.00	16.58
1.25	26.80
1.50	31.50
1.75	27.39
2.00	21.78
2.25	15.35
2.50	9.46
2.75	5.94
3.00	4.34
3.25	3.00
3.50	1.82
3.75	0.97
4.00	0.44
4.25	0.16
4.50	0.04

LONE TREE DAM
Larimer County, Colorado

PROBABLE MAXIMUM
THUNDERSTORM FLOOD

Nov. 1978

(Prepared for Bovay Engineers, Inc., by Donald L. Miller, Consulting Hydrologist)

Data Pertinent to Procedures of "Design of Small Dams," 2nd Edition

1. Location: Larimer County, Colorado

   a. West of 105° Meridian, east of Continental Divide, and below 8000-foot contour.

      (1) Office of State Engineer Criteria direct use of precipitation values from U.S. Weather Bureau Hydromet. Report No. 33.

      (2) Procedures in "Design of Small Dams," 2nd Edition, for east of 105° Meridian will be used.

   b. Precipitation value from U.S. Weather Bureau Technical Paper No. 40, "Probable Maximum 6-Hour Precipitation for 10 square miles," gives same values as Hydromet. Report 33 and covers subject watershed.

      (1) For Lonetree Dam, T.P. 40 indicates 21.5 inches as PMP, 6-Hour, 10 square miles.

   c. Criteria of office of State Engineer require evaluation of Probable Maximum Thunderstorm Flood by Design of Small Dams," 2nd Edition, procedures for watersheds west of 105° Meridian.

      (1) Location is in Zone III, Figure 20, p. 53, DSD, 2nd Ed.

      (2) Probable Maximum 1-hour Point Rainfall is 12.0 inches. (Figure 20, DSD, 2nd Ed.)

2. Drainage Area: 6.0 square miles

3. Estimate of Rainfall Runoff

   a. Soils: Clay loams, loams and rock outcrops

   b. "Soil Survey Map, Fort Collins area, Series 1927, No. 27, indicates B and D soil groups. Group C would be representative." Statement from files of office of State Engineer.

   c. Estimate of Curve Number AMC II

Land Use 1/	Hydrologic Condition	% of Area 1/	CN for Group C 2/	Wtd CN
Row crop, SR	Good	10	85	8.5
Small grain, SR	Good	45	83	37.4
Pasture	Fair	25	79	19.8
Fallow, SR		20	91	18.2
				83.9 Use 84

1/ From 1974 study by Bruns, Inc., Longmont Colorado
2/ Accepted as applicable from Field Inspection 20 October 1978

   d. Minimum loss rate: 0.12 inch/hour

3. Estimate of Rainfall Runoff (Continued)

   e. Thunderstorm Runoff Curve Number 75. Minimum loss rate 0.03 inch per 15 minutes. (Table A-9, p. 544, DSD, 2nd ed, grass, less than 50 percent cover density.)

4. Time of Concentration. (Figure 30, p. 71, DSD, 2nd ed.)

   a. Length of longest watercourse from head of reservoir to divide: L = 3.7 miles

   b. Elevation difference: H = 5,800 - 5,130, H = 670 feet

   c. $T_c = \left[\frac{11.9(L)^3}{H}\right]^{0.385}$ $T_c = 0.96$ hr

5. Unitgraph Data (Figure 29, page 69)

   D = time interval

   T_p = time to peak of hydrograph

   T_b = base time of hydrograph

   Q_p = peak discharge for 1 inch of runoff

   a. For most intense 6-hour period of rain, use 1/2-hour unitgraph

   $T_p = \frac{D}{2} + 0.6\ T_c$ $T_p = \frac{0.5}{2} + 0.6\ (0.96)$ $T_p = 0.83$ hr
   Use $T_p = 0.8$ hr.

   $T_b = 2.67\ T_p$ $T_b = 2.14$ hr

   $Q_p = \frac{(484)\ AQ}{T_p}$ $Q_p = \frac{(484)(6.0)(1.0)}{0.8}$ $Q_p = 3,630$ cfs

   b. For 2nd 6-hour period, use 6-hour unitgraph

   $T_p = \frac{6}{2} + 0.6\ T_c$ $T_p = 3.58$ hr

   $T_b = 2.67\ T_p$ $T_b = 9.56$ hr

   $Q_p = \frac{(484)(6.0)(1.0)}{3.58}$ $Q_p = 811$ cfs

5. Unitgraph Data (continued)

c. For thunderstorm, use 15-minute unitgraph

$T_p = \frac{0.25}{2} + 0.6\ T_c$ $\qquad T_p = 0.70$ hr

$T_b = 2.67\ T_p$ $\qquad T_b = 1.87$ hr

$Q_p = \frac{(484)(6.0)(1.0)}{0.70}$ $\qquad Q_p = 4{,}149$ cfs

(Prepared for Bovay Engineers, Inc., by Donald L. Miller, Consulting Hydrologist)

LONE TREE DAM
Probable Maximum Precipitation
U.S. Weather Bureau Technical Paper No. 40

Dam Location: Larimer County, Colorado. Lat. 40° 20' 37" N, Long. 105° 07' 30" W
Probable Maximum 6-hour 10-square-mile precipitation is 21.5 inches
Area is in Zone 4, Design of Small Dams, 2nd Ed. Figure 15, p. 48
Drainage Area: 6.0 square miles

Probable Maximum Precipitation Extension (Fig. 16, p. 49, DSD, 2nd Ed.

Time, hours	6	12	24	48
% of 6-hr, 10 sq. mi. precip.	100	111	118	126
Total PMP	21.5	23.9	25.4	27.1
Adjustment for storm fit. (0.8) (p. 48, DSD, 2nd ed)	17.2	19.1	20.3	21.7

Time Hours	% of 6-hour rain 1/	PMP		Arranged PMP 2/		Direct Runoff 3/		Increm. loss inch	Increm. runoff inch	Unitgraph peak cfs	Increm. runoff peak, cfs	Plotting Table		
		Accum. P, inch	Increm. P, inch	Increm. P, inch	Accum. P, inch	Accum. inch	Increm. Inch					Begin hour	Peak hour	End hour
0.5									0.18	3,630	653	0	0.8	2.14
1.0	49	8.4	8.4	1.4	1.4	0.36	0.36	1.04	0.18	3,630	653	0.5	1.3	2.64
1.5									0.54	3,630	1,960	1.0	1.8	3.14
2.0	64	11.0	2.6	1.5	2.9	1.44	1.08	0.42	0.54	3,630	1,960	1.5	2.3	3.64
2.5									0.82	3,630	2,977	2.0	2.8	4.14
3.0	75	12.9	1.9	1.9	4.8	3.09	1.65	0.25	0.83	3,630	2,977	2.5	3.3	4.64
3.5									4.04	3,630	14,665	3.0	3.8	5.14
4.0	84	14.4	1.5	8.4	13.2	11.17	8.08	0.32	4.04	3,630	14,665	3.5	4.3	5.64
4.5									1.24	3,630	4,501	4.0	4.8	6.14
5.0	92	15.8	1.4	2.6	15.8	13.65	2.48	0.12 4/	1.24	3,630	4,501	4.5	5.3	6.64
5.5									0.64	3,630	2,323	5.0	5.8	7.14
6.0	100	17.2	1.4	1.4	17.2	14.93	1.28	0.12	0.64	3,630	2,323	5.5	6.3	7.64
12.0		19.1	1.9	1.9	19.1	16.11	1.18	0.72	1.18	811	957	6.0	9.58	15.56

1/ Curve Zone C, Fig. 18, p. 51, Design of Small Dams, 2nd Ed.
2/ Design of Small Dams, 2nd ed., p. 76, Example 1, 3c.
3/ CN 84, minimum loss rate 0.12 inch per hour
4/ Minimum loss rate applies.

(Prepared for Bovay Engineers, Inc., by
Donald L. Miller, Consulting Hydrologist)

LONE TREE DAM

Probable Maximum Thunderstorm - Design of Small Dams, 2nd Ed.
PMTS 1-hour, point rainfall = 12.0 inches. (Figure 20, p. 53, DSD, 2nd edition)
Area Adjustment = 0.92   1-hour, 6.0 sq. mi. rain - 11.0 inches (Fig. 21)

Time hour	% of 1-hour rain 1/	PMTS		Arranged P 2/		Direct Runoff 3/		Increm. loss inch	Increm. peak 4/ cfs	Plotting Table 5/		
		Accum. P, inch	Increm. P, inch	Increm. P, inch	Accum. P, inch	Accum. inch	Increm. inch			Begin hour	Peak hour	End hour
0.25	48	5.28	5.28	1.32	1.32	0.11	0.11	1.21	456	0	0.70	1.87
0.50	71	7.81	2.53	1.87	3.19	1.09	0.99	0.89	4,108	0.25	0.95	2.12
0.75	88	9.68	1.87	2.53	5.72	3.04	1.95	0.58	8,090	0.50	1.20	2.37
1.00	100	11.00	1.32	5.28	11.00	7.81	4.77	0.51	19,791	0.75	1.45	2.62
1.25	110	12.10	1.10	1.10	12.10	8.85	1.04	0.06	4,315	1.00	1.70	2.87
1.50	117	12.87	0.77	0.77	12.87	9.58	0.73	0.04	3,029	1.25	1.95	3.12
1.75	122	13.42	0.55	0.55	13.42	10.10	0.52	0.03 6/	2,157	1.50	2.20	3.37
2.00	126	13.86	0.44	0.44	13.86	10.51	0.41	0.03	1,701	1.75	2.45	3.62
2.25	129	14.19	0.33	0.33	14.19	10.81	0.30	0.03	1,245	2.00	2.70	3.87
2.50	131.5	14.47	0.28	0.28	14.47	11.06	0.25	0.03	1,037	2.25	2.95	4.12
2.75	133	14.63	0.16	0.16	14.63	11.19	0.13	0.03	539	2.50	3.20	4.37
3.00	134	14.74	0.11	0.11	14.74	11.27	0.08	0.03	332	2.75	3.45	4.62

1/ Table 2, p. 52, DSD, 2nd ed., values for Zone III.
2/ Table A-8, Appendix A, and page 87, DSD, 2nd Ed.
3/ CN 75, minimum loss rate 0.03 inch per 15 minutes.
4/ 0.25-hour unitgraph peak of 4,149 cfs times incremental runoff, inches
5/ T_p = 0.70 hour, T_b = 1.87 hour.
6/ Minimum loss rate applies.

(Prepared for Bovay Engineers, Inc., by
Donald L. Miller, Consulting Hydrologist)

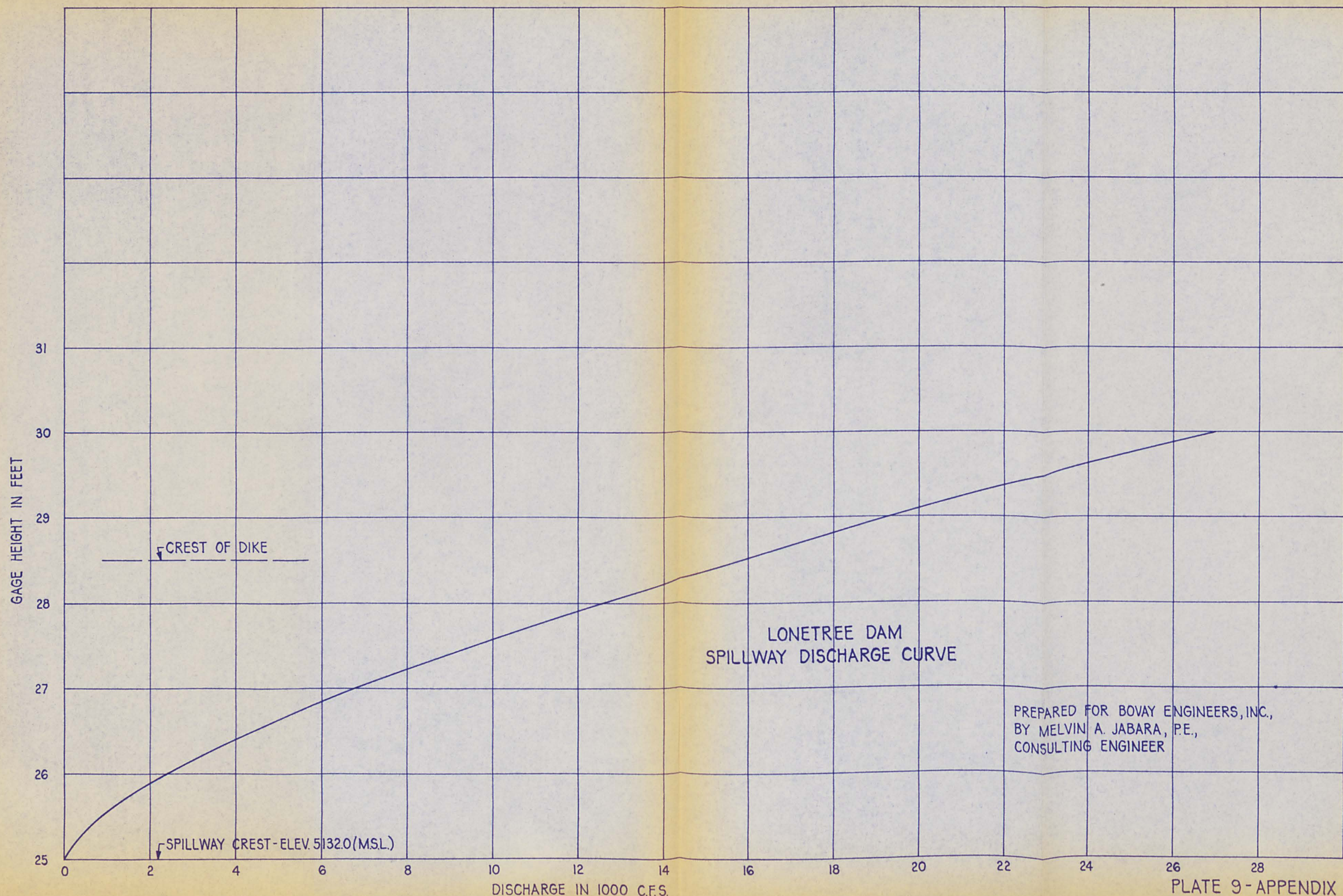


PLATE 9 - APPENDIX D

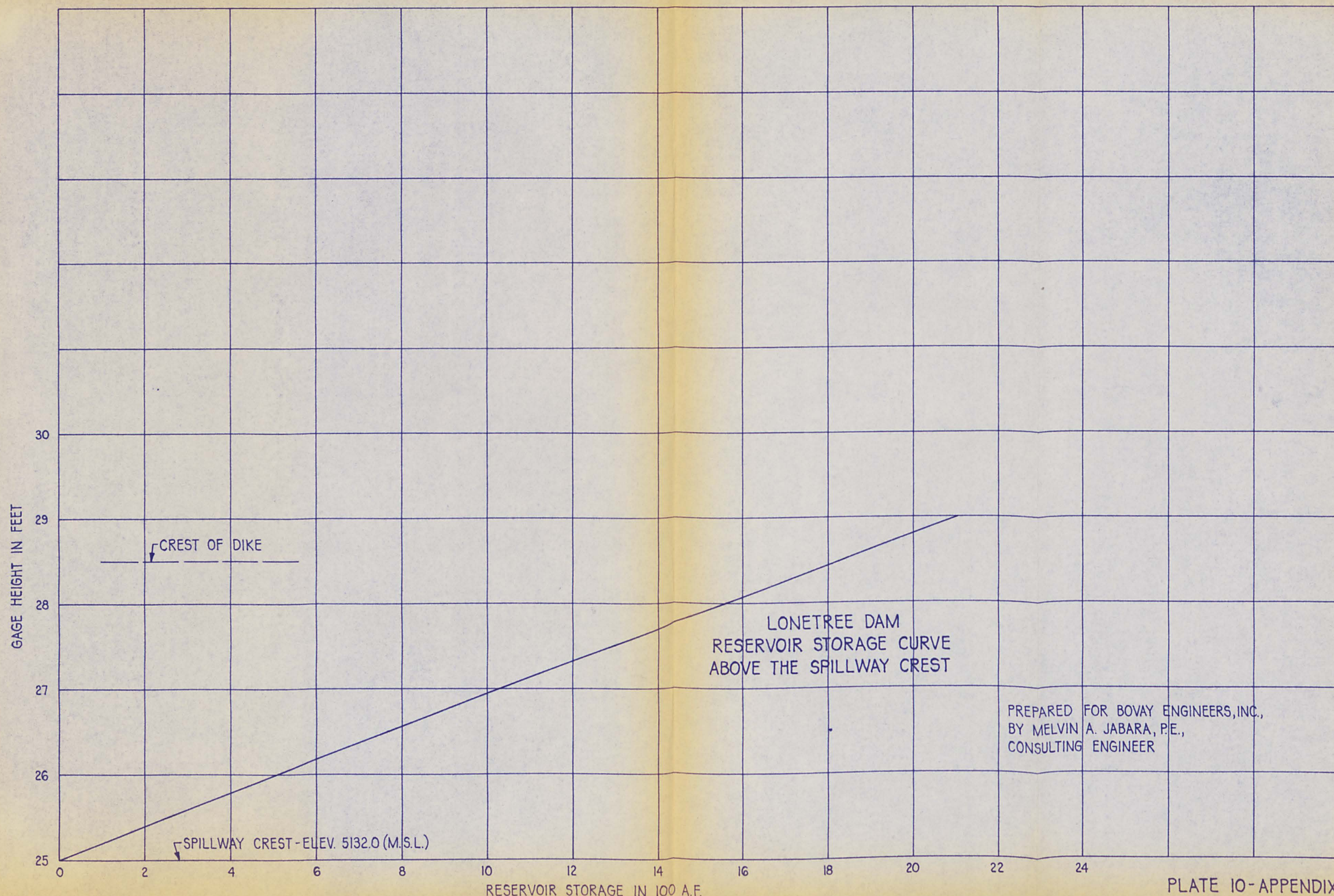


PLATE 10 - APPENDIX D

LONETREE DAM
SPILLWAY
ROUTING OF ONE-HALF PROBABLE MAXIMUM FLOOD

Time Hours	Inflow CFS	Avg. Inflow CFS	Inflow AF	Discharge CFS	Discharge AF	To Storage AF	Total Storage Above Spwy Crest AF	Res. W.S. Gage Ht. Feet
0	0						0	25.0
		100	4.1	22	.9	3.2		
.50	200						3.2	25.02
		335	13.9	24	1.0	12.9		
1.00	470						16.1	25.03
		745	31.0	50	2.0	29.0		
1.50	1,020						45.1	25.08
		1,320	55.0	180	7.0	48.0		
2.00	1,620						93.1	25.18
		1,925	80.2	390	16.2	64.0		
2.50	2,230						157.1	25.3
		2,475	103.1	725	30.2	72.9		
3.00	2,720						230.0	25.45
		3,765	78.4	980	20.4	58.0		
3.25	4,810						288.0	25.55
		5,650	117.7	1,500	31.2	86.5		
3.50	6,490						374.5	25.73
		8,390	174.7	2,300	47.9	126.8		
3.75	10,290						501.3	25.97
		10,905	227.1	3,440	71.6	155.5		
4.00	11,520						656.8	26.27
		12,110	252.2	4,730	98.5	153.7		
4.25	12,700						810.5	26.57
		11,955	249.0	5,800	120.8	128.2		
4.50	11,210						938.7	26.8
		10,430	217.2	6,660	138.7	78.5		
4.75	9,650						1,017.2	26.97
		8,570	178.5	6,970	145.2	33.3		
5.00	7,490						1,050.5	27.03
		6,735	140.3					
5.25	5,980							
		5,195	108.2					

Reservoir Begins to Recede
Max Q = 6970 cfs
Max Res. W.S. Elev. Gage 27.03

(Prepared for Bovay Engineers, Inc., by
Melvin A. Jabara, P.E., Consulting Engineer)

LONETREE DAM
SPILLWAY
ROUTING OF PROBABLE MAXIMUM THUNDERSTORM FLOOD

Time Hours	Inflow CFS	Avg. Inflow CFS	Inflow AF	Discharge CFS	Discharge AF	To Storage AF	Total Storage Above Spwy Crest AF	Res. W.S. Gage Ht. Feet
0	0						0	25.0
		75	1.5	20	.4	1.1	1.1	25.01
.25	150							
		985	20.5	35	.7	19.8	20.9	25.06
.50	1,820							
		4,035	84.0	250	5.2	78.8	99.7	25.2
.75	6,250							
		11,415	237.8	1,120	23.3	214.5	314.2	25.62
1.00	16,580							
		21,690	451.8	3,750	78.1	373.7	687.9	26.35
1.25	26,800							
		29,150	607.2	7,850	163.5	443.7	1131.6	27.2
1.50	31,500							
		29,445	613.4	11,950	248.9	364.5	1496.1	27.9
1.75	27,390							
		24,585	512.1	14,400	300.0	212.1	1708.2	28.27
2.00	21,780							
		18,565	386.7	15,100	314.5	72.2	1780.4	28.4
2.25	15,350							
		12,405	258.4					
2.50	9,460							
		7,700	160.4					
2.75	5,940							
		5,140	107.0					
3.00	4,340							

Reservoir Begins to Recede
Max Q = 15,100 cfs
Max Res. W.S. Elev. Gage 28.4

(Prepared for Bovay Engineers, Inc.,
by Melvin A. Jabara, P.E.,
Consulting Engineer)

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****************************************************************************************************
HYDROLOGIC ANALYSIS OF DAMS- CLARON L KOONTZ, USCE KCD, PHONE   816-374-3651 OR 8-758-3651 (FTS) PROGRAM DATE    1AUG78
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        ******************** LISTING OF CARD INPUT DATA ******************** PAGE   1


        BEGIN JOB
        HYDROLOGIC ANALYSIS OF LONETREE DAM,LARIMER COUNTY,COLORADO
        IDENTIFICATION NUMBER CO 01734,BOVAY ENGINEERS JOB NO. 1672-COC,FEB.1979
        SUPPLEMENT TO ≠PHASE 1 INSPECTION REPORT,NATIONAL DAM SAFETY PROGRAM
        LONETREE DAM,OCTOBER,1978
        FOR THE STATE OF COLORADO AND U.S.ARMY CORPS OF ENGINEERS,OMAHA DISTRICT
              0.25       6.0    5132.0        80                                                   80
        SNYDER↑S UNIT HYDROGRAPH DATA
              3.67      1.52      0.81       6.0                0.32        47      28.5
        PMP STORM DATA
             100.0     202.4     212.0      12.5                0.12
        ADD IN HYDROGRAPH OF 300CFS(BASE FLOW)
               300       300       300       300       300       300       300       300       300       300
               300       300       300       300       300       300       300       300       300       300
               300       300       300       300       300       300       300       300       300       300
               300       300       300       300       300       300       300       300       300       300
               300       300       300       300       300       300       300       300       300       300
               300       300       300       300       300       300       300       300       300       300
               300       300       300       300       300       300       300       300       300       300
               300       300       300       300       300       300       300       300       300       300
        ELEVATION/CAPACITY IN ACRE-FEET
               4.0        21
            5131.9         0    5132.5       250    5133.0       500    5133.5       750    5134.0      1025
            5134.5      1275    5135.0      1550    5135.5      1825    5136.0      2100    5136.5      2350
            5137.0      2625    5137.5      2900    5138.0      3150    5138.5      3412    5139.0      3675
            5139.5      3938    5140.0      4200    5140.5      4463    5141.0      4725    5141.5      4988
            5142.0      5250
        SPILLWAY RATING BY BROAD-CRESTED WEIR FORMULA
               3.0              5132.0       950        10      2.63
        TOP OF DAM RATING BY BROAD-CRESTED WEIR FORMULA
               3.0              5135.5      7265        40      2.63                 3.0      0.03      2.63
        NO OUTLET RATING
               0.0
        BEGIN JOB
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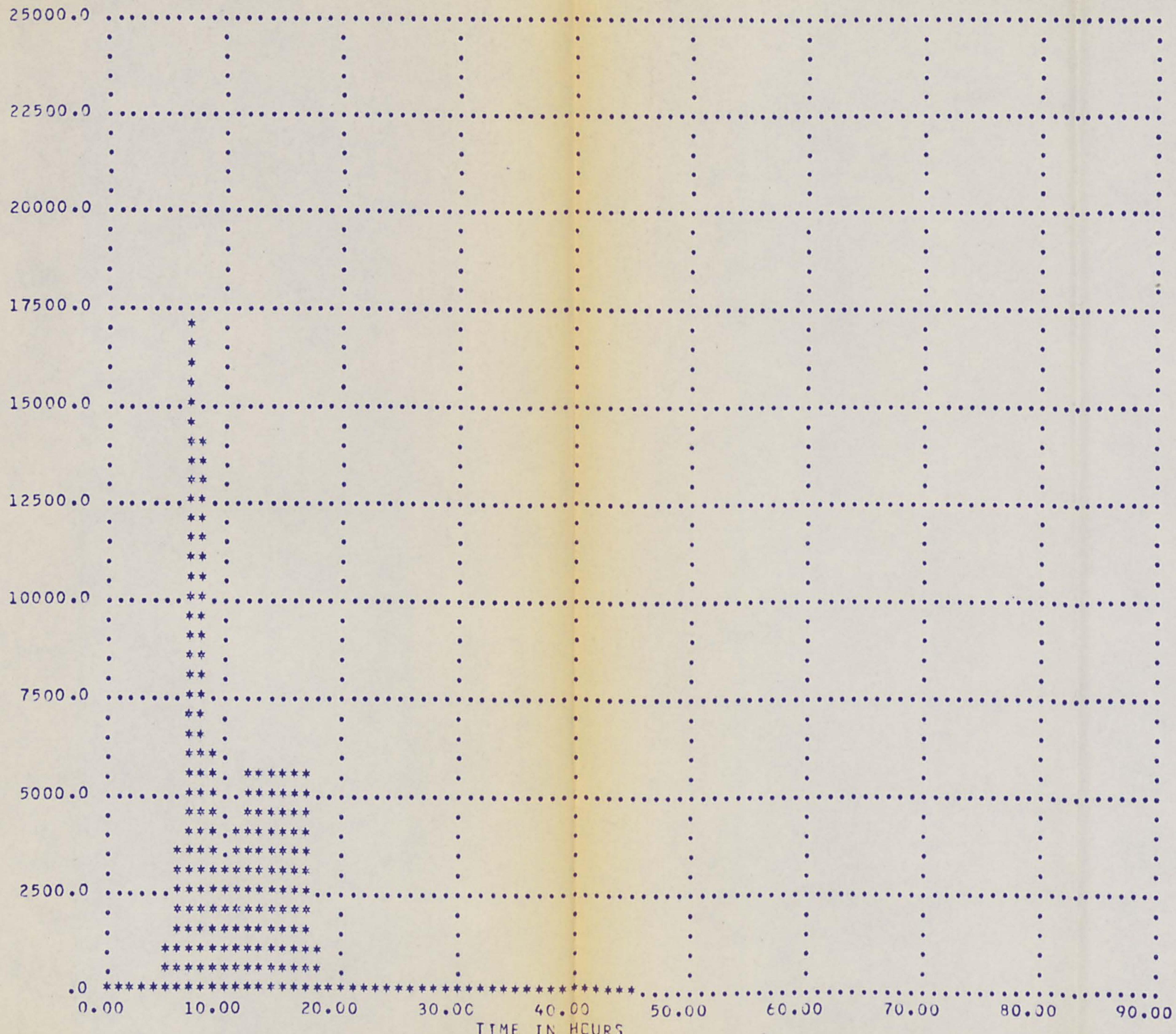
(Corps of Engineers Program No. 723-C1-410
Input by J. E. Lloyd, P.E., Bovay Engineers, Inc.)

Listing of Card Input Data



TOTAL (COMBINED) INFLOW HYDROGRAPH FOR LAKE ROUTING
HYDROLOGIC ANALYSIS OF LONETREE DAM, LARIMER COUNTY, COLORADO

(Corps of Engineers Program No. 723-C1-410
Input by J. E. Lloyd, P.E., Bovay Engineers, Inc.)

Inflow Probable Maximum Flood Hydrograph Based on TP 38

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DAM INSPECTION HYDROLOGIC ANALYSIS - SUMMARY TABLE

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HYDROLOGIC ANALYSIS OF LONETREE DAM,LARIMER COUNTY,COLORADO
IDENTIFICATION NUMBER CO 01734,BOVAY ENGINEERS JOB NO. 1672-COC,FEB.1979
SUPPLEMENT TO ≠PHASE 1 INSPECTION REPORT,NATIONAL DAM SAFETY PROGRAM
LONETREE DAM,OCTOBER,1978
FOR THE STATE OF COLORADO AND U.S.ARMY CORPS OF ENGINEERS,OMAHA DISTRICT

SYNDERS .250 HOUR UNIT HYDROGRAPH DATA AND PARAMETERS

DURATION HOURS	DA SQ-MI	L MILES	LCA MILES	CP	CT	QP C.F.S	TP HOURS	W50 HOURS	W75 HOURS	UNIT VOL AC-FT
.250	6.00	3.67	1.52	.810	.320	5418.2	.54	.36	.22	320.00

PROBABLE MAXIMUM STORM PRECIPITATION AND RUNOFF CHARACTERISTICS

PMP INDEX	RAIN FACTOR	DISTRIBUTION IN PERCENT OF PMP 6-HR	12-HR	18-HR	24-HR	INT-LOS INCHES	INF-RATE INCH/HR	VOLUME IN INCHES RAIN	LOSS	EXCESS
12.50	.800	100.00	202.40	207.96	212.00	0.00	.12	21.20	2.40	18.80

-- LAKE INFLOW HYDROGRAPH ORDINATES --

PROBABLE MAXIMUM FLOOD PLUS LOCAL HYDROGRAPH ORDINATES IN CFS AT .250 HOUR INTERVALS BEGINNING AT ZERO TIME

300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0
300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0	300.0
300.0	666.2	1484.0	1705.2	2378.4	2822.8	3417.7	4062.5	5239.4	8099.0	15643.1	17961.0
14943.9	12949.1	11326.3	9314.7	6901.3	5262.0	4515.3	4086.1	3622.3	3346.8	3203.2	3032.0
2811.2	3202.3	4236.1	4916.0	5415.6	5807.0	6090.0	6243.3	6288.6	6288.6	6288.6	6288.6
6288.6	6288.6	6288.6	6288.6	6288.6	6288.6	6288.6	6288.6	6288.6	6288.6	6288.6	6288.6
6288.6	5662.2	3837.1	2644.0	1779.9	1113.5	644.7	373.5	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

-- LAKE AND DAM INFORMATION --

BEGINNING POOL ELEV FT,MSL	OUTLET INVERT FT,MSL	BOTTOM OF LAKE FT,MSL	SPILLWAY CREST FT,MSL	SPILLWAY CREST WIDTH FEET	TOP OF DAM ELEVATION FT,MSL	TOP OF DAM LENGTH FEET	HEIGHT OF DAM FEET	DOWNSTREAM SLOPE OF DAM	N-VALVE ON DS SLOPE	COEF OF FLOW OVER DAM
5132.00	0.00	5131.90	5132.00	950.0	5135.50	7265.0	3.6	1V ON 3.00H	.030	2.63

------------------------ SUMMARY OF FLOOD ROUTINGS OF INFLOW HYDROGRAPH THROUGH THE LAKE ------------------------

ROUTING NUMBER	PERCENT OF LAKE INFLOW HYDROGRAPH	TOTAL INFLOW VOLUME AC-FT	MAXIMUM LAKE ELEVATION FT,MSL	DEPTH OF LAKE OVER TOP OF DAM FEET	ESTIMATED VELOCITIES CREST FPS	TOE FPS	INITIAL TIME TO OVER TOP HOUR	TOTAL TIME OVER DAM HOURS	VOLUME SPILLED OVER DAM AC-FT	MAXIMUM DISCHARGE FROM DAM CFS
1	100.0	6512.	5134.45	-1.05	0.00	0.00	0.00	0.00	0.0	9733.0

(Corps of Engineers Program No. 723-C1-410
Input by J. E. Lloyd, P.E., Bovay Engineers, Inc.)

Summary of Hydrologic Analyses Based on TP 38

APPENDIX E

CORRESPONDENCE

Plate 1	Letter dated November 19, 1973, from State Engineer C. J. Kuiper to W. R. Keirnes, Consolidated Home Supply and Ditch Company
Plate 2	Letter dated March 6, 1978, and attached report from Ken Dickey, P.E., Bruns Incorporated, to Division of Water Resources, Department of Natural Resources

November 19, 1973

Mr. W. R. Keirnes, Manager
Consolidated Home Supply
and Ditch Company
Star Route, Box 450
Loveland, CO 80537

J.T.S.

Re: Lonetree Reservoir Dam
S4, T4N, R69W, 6PM
I.D. 1 W.D. 4

Dear Mr. Keirnes:

As you are aware, a member of our Dams and Reservoir Branch inspected Lonetree Dam with you in April of this year. The inspection was made in accordance with chapter 148-5-7 of the Colorado Revised Statutes 1963, as amended. The statute reads, "The state engineer shall annually determine the amount of water which it is safe to impound in the several reservoirs within this state and it shall be unlawful for the owners of any reservoir to store in said reservoir water in excess of the amount so determined by the state engineer to be safe".

The inspection revealed that the dam does not meet our requirements for safe storage. The major deficiency is the lack of adequate freeboard at the normal operating level of the reservoir. Freeboard is the distance between the maximum possible reservoir level and the crest of the structure/s that contain the reservoir.

Related to this freeboard is the need for an emergency spillway. It appeared that water could be run out via the ditch which parallels the reservoir on the north side. The amount of water released, of course, is controlled by the capacity of the ditch. You indicated that the reservoir could also spill on the north side of the reservoir near the canal outlet. It appeared that this would occur with only 1 foot of freeboard at the northeast outlet

The provision for ensuring that a structure has adequate freeboard is controlled by requiring that all dams have an adequate emergency spillway with at least 5 feet of freeboard. There are instances where less freeboard is allowed, but it must be shown that no adverse conditions could occur.

Because the dam does not have sufficient freeboard, we are hereby restricting the storage in the reservoir to a level which is 5 feet below the top of the concrete headwall at the outlet. This should be at approximately gage 21.6 feet and provide 4 to 5 feet of reservoir freeboard at the north dike.

Chapter 148-5-5 of the statutes relates, "No reservoir of a capacity of more than 1,000 acre-feet or having a dam or embankment in excess of 10 feet in vertical height or having a surface area at high water line in excess of 20 acres shall hereafter be constructed in this state except that the plans and specifications shall have first been approved by the state engineer and filed in his office...". The Attorney General has determined that the statute applies to the repair and maintenance of dams in the interest of public safety.

In order to get the restriction removed, and be able to store your full decreed amount of water in this dam, the following needs to be done:

You should engage a professional engineer registered in the State of Colorado to prepare plans for the restoration of the freeboard, i.e., the renovation of the dam should provide an emergency spillway capable of bypassing the probable maximum flood safely and have a freeboard of at least 5 feet. Spillway floodflows may encroach on the freeboard up to the crest of the dam. done 3' allowed?

Your engineer should prepare his plans and specifications in accordance with our "Manual of Rules and Regulations", which is enclosed.

You mentioned that the renovation of the outlet structure in 1958 and 1959 was done with the approval of the state engineer, but we do not find any record of it. When we have no plans on file, we normally request that the owner provide us with detailed plans of the dam and it appurtenances to aid us in the surveillance of the dam in accordance with the statutes. If you have documents or copies of plans and specifications on any part of the dam that have the state engineer's approval, we would appreciate getting a copy of them.

It would be very desirable if the engineer would investigate any existing portion of the dam and appurtenances that will be an integral part of the impounding features, to determine their condition. If they are found unacceptable, they should also be renovated to an acceptable condition.

Therefore, the final plan of the reconstruction of the dam and appurtenances shall show sufficient details in accordance with our manual so these plans are representative of the dam as a whole.

It is emphasized again that in the interim, the reservoir is restricted to a level 5 feet below the concrete headwall at the northeast outlet works. In accord with article 148-5-14 it is the owners responsibility to carry out this restriction within ten days of receipt of written notice. This restriction will be enforced by our Water Commissioner, who will be notified by a copy of this letter.

If you have any questions, please contact our Dams and Reservoir Branch.

Very truly yours,

C. J. Kuiper
State Engineer

CJK:AEP:cat

Enclosure

cc: W. [illegible] [illegible]ilkinson
Lloyd Plewitt

(Furnished by State of Colorado)

File.
Lone Tree
1-4

BRUNS
INCORPORATED

March 6, 1978

Division of Water Resources
Department of Natural Resources
1313 Sherman Street; Room 818
Denver, Colorado 80203

RE: Consolidated Home Supply Ditch and Reservoir Company; Repairs to Lonetree Dam.

Dear Sir:

The work as set forth in the revised Specifications as prepared by Bruns Incorporated under their job #2-1671-2 regarding the subject dam was completed under my supervision and inspection.

The flood control gates in the Home Supply ditch near the outlet of the reservoir or the syphon, to replace the open ditch to the cross property, are not included in this contract.

The work was completed as specified in a very satisfactory and workman-like manner.

The contractor had excellent personnel and good equipment. The job superintendent was anxious to do a good job and was eager to comply with my requests.

Attached hereto, for your convenience, is a report that I prepared at the conclusion of the job.

Very truly yours,

Ken Dickey

Ken Dickey-P.E.

KD:skb
Enclosures

(Furnished by State of Colorado)

Plate 2-Appendix E

CONSULTING ENGINEERS . PLANNERS . SURVEYORS
1035 COFFMAN STREET . LONGMONT, COLORADO 80501 PHONE 303 776-8610 / Metro 534-8822

CONSOLIDATED HOME SUPPLY DITCH AND RESERVOIR COMPANY
Repairs on Lonetree Reservoir Dam

In order to meet safety requirements as set forth in the Federal Safety of Dams Law it was necessay that certain work be performed at Lonetree Reservoir.

Inspections were performed by personnel of the Dams Section of the State Engineer's Office, determining in their judgement, the work required to update the facilities to meet todays standards as set forth under the Federal Law. This must be completed regardless of cost or the storage will be reduced to store the flood water in case of a flood. This work included the construction of a spillway in the vicinity of the east inlet check structure to the reservoir and automatic flood control gates to be installed in the check structure of the Home Supply Ditch located at the Reservoir outlet works. The gates are to be float operated to control the flow in the ditch beyond this point in case a flood of this magnitude should occur. A siphon to replace the open ditch to the Cross property will be installed at a later date. Neither the flood control gates or the siphon is included in this contract.

The work in this contract includes clearing and grubbing trees and stump removal, stripping spillway and fill areas, stripping toe and back slope of dam, installation of a toe drain, concrete barrier wall and excavation and fill.

All phases of the engineering were performed by Bruns Incorporated, 1035 Coffman St., Longmont, Colo. 80501.

Notice for invation to bid the above work was published in the local news papers on Oct. 11, 1977, with bid opening to be in the Bruns office at 11:00 A. M. on Oct. 21.

Five bids were received with the bid being awarded to Frontier of Hygene, Colo. 80533, on Nov. 1.

The Contractor started work on Nov. 14. The first work started was clearing and grubbing of trees and stump removal along the north toe of the dam west of Station 34+00. After the stump removal all areas were stripped including the sod within the spillway. When the cattails were removed it was found that the origional excavation, years ago, had been to shale bedrock. This condition existed to about 400 feet from the west end of the cattail area, where top soil was encountered over the shale. Also, seepage in this area was evident from the dam and from the field to the north. Thus it was necessary to install two one and one half inch crushed rock drains, one to the north edge of the cattail area and one along the toe of the dam. They were joined at the east end to form one drain leading into the 6" PVC pipe drain. The double crushed rock drain was not anticipated during the investigations and thus the over run of the estimated cost. The area between the two drains was filled with shale placed in 8" to 12" lifts and equipment rolled for compaction. This should be considered a semi-pervious material that will permit seepage between the two drains. Loose shale fill was placed about three feet thick over the drains before equipment was permitted to pass over them to eliminated damage. Beginning at station 34+00, a 6" PVC pipe toe drain embedded in a 3' x 3' trench filled with three quarter inch crushed rock was installed to about station 43+50, the location of the existing 6" drain to the pond to the north. The 6" toe drain pipe was attached to this pipe to assure drainage. The 6" PVC toe drain pipe coming from the west was attached to the west 6" drain pipe, station 43+70* leading to the pond. A 1½" crushed rock drain connects the two 6" PVC toe drain pipes to assure drainage if either of the pipes going to the pond should become plugged. See attached drawing for the location of these drains. With this work completed the entire area west of station 35+50, from the dam to the north property fence to station 50+00 became available of the disposal of the excavated material from the spillway cut.

The area from station 29+50 to station 35+50 was prepared for compacted fill, since it is part of the overflow section of the spillway. This work consisted of stripping all humus material, scarifying the origional ground surface and wetting prior to the placement of fill material. The northwest section of the spillway area contained suitable impervious material for compacted fill. This material was bone dry and required much wetting and scarificaton while being placed. Lifts were 6" to 9" thick placed in a horizontal plane and compacted by a double drum 5' x 5' sheeps foot roller pulled by a D-8 Cat. equipped with a scarifier. Due to the extreme dryness of the material some laminations in the moisture conditions may exist. This should not be serious since the maximum fill in a very small area is less than 8'. The rest of the fill will vary from 3' to 0'. Due to the minimum amount of fill and the shallow depth, soil anaylysis and optimum moisture was not determined in the laboratory. Compaction was achieved by experience and visual inspection. No settlement is expected, and the area should grass over in a short time to form a non-erosive surfac.

While this work was progressing the dam between the Home Supply Ditch and the Reservoir was lowered to elevation 25.

Since the cut to the west of the check structure was minimal the material was used to flatten the south slope of the dam. It was not necessary to disturb the origional riprap in this area, since it was below elevation 25. When elevation 25 was reached shale material was placed on the dam slope and also the south bank of the ditch to prevent erosion. The same proceedure was used east of the check structure with the exception, the excavated material was hauled to the disposal area. It was necessary to push some of the riprap to a lower level to meet the required elevation to 25. Here again, shale fragments were used over the existing riprap and the south bank of the ditch to prevent erosion.

The material used to raise the dam to elevation 28.5 west of the spillway consisted of the shale material as excavated from from the spillway area. It was transported by rubber tired 21 cubic yard elevating scrapers and deposited in 6" to 8" lifts. This material was not wetted and rolled with the sheep foot roller since the maximum fill did not exceed 1.8', most being less than one foot. Compaction was obtained by grading into smooth layers and compacted by the travel of the scrapers. Since it is possible that this fill could settle a little the top elevation varies from 29 to 29.5 instead of the required 28.5. The larger shale fragments were bladed to the ditch side of the dam to afford protection from erosion. This proceedure was used to raise the embankment where required from the check structure east to the outlet of the reservoir. Since the fill at the outlet was between 3' and 4', the shaley material was wetted, bladed and compacted by the travel of the elevating scrapers. Here again the top of the embankment was0.5' to 1.0' above elevation 28,5. The area around the gate house was stripped, scarified and wetted prior to the placement of the fill. The same proceedure as used in the spillway was used here to achieve the desired compaction. The elevation of this embankment here again is 0.5 to 1.0' above elevation 28.5.

The concrete cutoff wall and fillets were completed in a workmanlike manner. However, when the fill was being placed around the gate house the grader caught the south end of the wall damaging the south half severly. The damaged portion and the supporting fillet were completely removed and replaced at the Contractor's expense.

The above work including tree removal was completed while the excavation of the spillway continued. The excavated material, which was about 95% shale, was placed to the north of the dam west of station 35+50. The cattail area was completely filled and the dam supported on the north side to the west inlet structure. The area just west of station 35+50 to station 39+00 was filled nearly to the north property line. This was done in the event the State Engineer ever requires the completion of the spillway as originally designed.. Also, a water barrier was constructed at the west end of the spillway to prevent the flow from turning west before it reaches the ground to the north.

The weathered shale in the spillway area could be ripped by scarifiers on the grader or a D-8 Cat. However, the vast majority had to be ripped by a single tooth ripper pulled by a D-8 Cat. Some areas were very hard and required several passes to loosen it sufficiently for loading into the haulage equipment.

The work was completed on Dec. 19, with most of the equipment being moved out on this date. One elevating scraper was parked near the outlet of the reservoir for removal later in the week.

In conclusion, the Contractor performed all work in a workmanlike manner with good personel and equipment. Some days were cold and windy but this did not slow down progress. Fortunately the weather cooperated while the compacted fill and the concrete barrier were being placed. The entire construction area was cleaned up and left in a very presentable condition. The tree and stump storage area is not to pleasing to look at, but it is no fault of the Contractor. The Contractor cooperated in every way which was greatly appreciated.

The spillway as constructed should function in a satisfactorily manner and no further work should be required.

The following is a list of equipment used to perform this work:

No.	Description
1.	John Deer 3¼ cu. yd. loader.
2.	Cat. elevating scrapers No. 621.
2.	D-8 Cats. with 18 cu. yd. carryalls.
1.	Cat. motor grader No. 140 G
1.	D-8 Cat. with 46A ripper.
1.	D-8 Cat. used as a pusher for loading.
1.	1000 gal. water wagon.
1.	5' x 5' 2 drum sheep foot roller.
1.	Water pump.
1.	Dragline 1 cu. yd.
1.	966 Cat. loader
2.	Mack-Diesel tandem dump trucks - 13 cu. yd.
1.	Air compresser - trailer mounted.
1.	Low-boy for transportaion of equipment.

Submitted by,

Ken Dickey