TVA 64 (08-4-59)

UNITED STATES GOVERNMENT

Memorandum

TENNESSEE VALLEY AUTHORITY

TO : Mr. L. J. Van Mol, General Manager, 411 NSB

FROM : G. P. Palo, Chief Engineer, 607 UB

DATE : December 1, 1961

SUBJECT: REPORT ON FAILURE OF WHEELER LOCK

Approximately 436 feet of the land wall of the navigation lock at the multipurpose Wheeler project failed on June 2, 1961. The 60- by 360-foot lock, with a maximum lift of 52 feet, was part of a 650-mile waterway. A new 110- by 600-foot lock was under construction adjacent to the old lock and between it and the north riverbank. At the time of the failure a large tow, traveling upstream, had just cleared the lock so the upstream miter gate was open and the downstream miter gate closed. The water in the chamber was at elevation 555.8--near its normal maximum level.

Water cascaded over the miter sill into the lock chamber for almost four days until the needle dam could be placed to close off the upstream end of the lock. Soon after the failure, the reservoir was lowered from elevation 555.8 to elevation 549.0 to facilitate the placing of the needle dam and to reduce the head on the remaining structures. A cofferdam between the downstream approach walls was closed on June 11 and by June 15 the new and the old lock areas were unwatered. Immediately thereafter, to increase the safety of the north nonoverflow dam, foundation relief drain holes were drilled into the rock and part of the concrete for the upstream miter sill for the new navigation lock was placed against the downstream face of the dam.

It was promptly agreed that we should employ independent consultants capable of making an impartial and authoritative investigation of the failure. We were fortunate in obtaining as consulting geologist Dr. Frank A. Nickell, San Mateo, California, and as consulting engineers Mr. Lee G. Warren, Asheville, North Carolina, and Dr. John B. Wilbur, Hancock, New Hampshire.

These consultants visited the project on June 18-20, August 19-21, and October 27-29, 1961, to make on-site investigations and to review information and data accumulated by this office.

The investigation disclosed that the failure of the land wall was due to sliding along a thin seam of clay, varying in thickness from one-sixteenth to three-eighths of an inch, located in a shale band in the foundation a short distance below the base of the lock wall. This seam is described in Appendix D of this report. The sequence of events leading to this conclusion is described in the following paragraphs.

Foundation investigations prior to start of construction of the new lock had included 20 NX diamond drill holes, 3-inches in diameter, at spaced intervals along the center line of each wall of the proposed new lock and three 36-inch diameter holes made with a calyx drill. The cores of the NX holes were logged by an experienced geologist in the presence of the drillers. The calyx holes were examined by a number of persons including geologists and engineers of wide experience. This examination was made by going down into the holes and inspecting the rock faces.

No record of the clay seam has been found in the reports on the original lock construction. In the new investigations before construction no evidence of the clay seam showed up in the cores of any of the NX holes and the visual inspection of the faces of the calyx holes likewise failed to reveal its existence. The clay seam was too thin to show up in the NX holes. It was not detected in the calyx holes because it has the same color as the contiguous shale and both the shale and the seam were recessed by the grinding action of the chilled shot used as the cutting medium. Accordingly, the stability of the existing land wall was evaluated on the assumption that the cores from the drill holes correctly reflected the condition of the underlying foundation, and the steps taken in constructing the new lock were predicated on the stability of the old lock wall as thus evaluated.

After the failure two weeks elapsed until the area was sufficiently unwatered so that the failure could be established as sliding within the foundation rock. During this period consideration was given to many conceivable causes including not only major weakness in the foundation or the lock wall but also such possibilities as sabotage, earthquake, and barges striking the wall. When, upon unwatering, failure was found to be sliding within the shale band, all other causes were eliminated either as nonexistent or not of major significance and effort was concentrated on learning why the shale band had so much less shearing strength than had been expected on the basis of investigations made in advance of construction.

Foundation inspection in mid-June provided no clue to the reason for the unusual weakness of the shale band and it was decided that structural tests would be essential to learn the reason for its inadequate strength. The first step in this program was laboratory testing. The results showed strengths much above that needed to have withstood failure, but the techniques available for cutting the test samples from the foundation could not obtain a short section near the base of the shale band. It was therefore decided to attempt structural tests on the rock in place.

While steps were being taken for field tests of the strength of the foundation, rock excavation to levels below the shale band was going on in areas of the lock walls and in a 36-inch pilot hole needed to initiate excavation for the main lock discharge structure. Early in September some of these areas were pumped dry and an engineer inspecting a rock face which exposed the shale band found the thin seam of plastic clay. Steps were taken immediately to determine the extent of this clay. New 36-inch calyx holes, noted in the consultants' report, were a part of this investigation. These foundation checks, combined with facts already available, established that:

(1) The plastic clay seam existed essentially throughout the lock area.

(2) The clay seam was so nearly in a plane and so nearly horizontal that it could easily lubricate and be a sliding surface for the rock immediately above and below.

(3) Under the walls of the old lock the clay seam was at an elevation which made it particularly critical during excavation for the new lock.

This information established the reason for the failure. Accordingly, further steps to field test the strength of the shale band were dropped and the consultants were reconvened to discuss the new information and to prepare their final report.

The report of the consultants dated October 29, 1961, is attached. It is supplemented by appendices and exhibits of TVA with factual information obtained both before and after the failure. The report describes the reasons for the failure of the land wall and also describes how the two locks, each of which will include portions of the original lock and dam, are being constructed so as to be safe from sliding.

G. P. Palo

GPP:EW
Attachment

TENNESSEE VALLEY AUTHORITY

Office of the Chief Engineer

Report No. 3-480

REPORT ON WHEELER LOCK FAILURE

Knoxville, Tennessee

November 1961

REPORT ON WHEELER LOCK FAILURE

TENNESSEE VALLEY AUTHORITY

OFFICE OF THE CHIEF ENGINEER

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Exhibits

Wilson Dam, Alabama
October 29, 1961

Mr. G. P. Palo
Chief Engineer
Tennessee Valley Authority
Knoxville, Tennessee

REPORT ON WHEELER LOCK FAILURE

Introduction

The project at Wheeler Dam had a lock for navigation on the right or north side of the river. This lock was completed under the direction of the U. S. Corps of Engineers and put into operation by December 1, 1936. The lock operated without significant difficulty over the years since completion.

At 9:20 p.m. on June 2, 1961, when traffic was being handled normally through the lock, a sudden failure of the land wall occurred. The collapsed portion of the wall extended for a distance of 436 feet, and included the massive block of the downstream miter gate with a portion of the adjoining, lower guide wall. There was no disturbance or failure in connection with the river wall of the original lock. In consequence of this failure all river traffic, previously handled at Wheeler Dam, was interrupted.

The Tennessee Valley Authority immediately undertook investigations to determine the cause of failure and to formulate plans for reconstruction of the original lock and for continued construction of the larger, second lock located just north of the wall that failed. The Tennessee Valley Authority secured services of F. A. Nickell, geologist, Lee G. Warren, and J. B. Wilbur, engineers, as consultants to investigate and determine causes of failure. The site and progress of removal of structures that had failed, and progress in building of the new locks were inspected by these consultants on three occasions, namely, June 18-20, August 19-21, and October 27-29 (1961). During the periods between inspections by the consultants, the staff of the Tennessee Valley Authority carried out a program of additional exploration of foundation rock for both lock areas and compiled all evidence obtainable, by inspection, that might be significant in explanation of causes of failure.

Studies have now been continued to a stage at which the consultants consider that the causes of failure can be established, and replacement of lock facilities can be safely carried out.

Evidence of Failure

The staff of the Tennessee Valley Authority has assembled all observations and discussions that could be documented in order to describe the sequence of events occurring at time of failure of the lock wall.

The evidence assembled indicates that failure originated in the land wall, starting with the pintle block (No. 12), and seems to have resulted simultaneously in the collapse of the guide wall immediately downstream; this failure progressed therefrom rapidly upstream with successive failure of adjoining blocks up to, but not affecting block No. 1, for a combined length of land wall of 436 feet.

Exhibits 1* through 16

The failure, as indicated by observation and by evidence provided in the position of the several blocks of the land wall, involved lateral movement in a northerly direction (away from the river) for a distance of about 30 feet. Many of the blocks between Nos. 12 to 3 exhibited both a component of movement in an oblique downstream direction as well as rotation so that the downstream, landside corner of each block came to rest farther from its original position than did the upstream landside corner of the same block.

The tearing of the lock gates from sockets and restraining devices, the overturning, breaking and cracking of individual concrete blocks, the effects of impact due to movement of the concrete blocks against bedrock of the new lock channel being constructed on the landside of this collapsed wall, as well as the disturbance in bedrock noted in proximity to the non-overflow section of Wheeler Dam have been, as mentioned, extensively documented, photographed, and investigated.

Appendixes A and B
Exhibit 17

The physical demonstrations of failure indicated by evidence provided in position of the displaced blocks of the landside wall can be summarized as follows:

(a) Blocks 2 to 6 slid northward, but portions of individual blocks near the interior of the lock chamber remained in their original position.

(b) Blocks 7 to 11 slid in a northerly direction, mostly intact.

(c) Block 12 (pintle block) also moved northerly but had a greater component in an oblique downstream direction.

(d) Smaller blocks of the guide wall (Nos. 13 to 15) downstream of the pintle block (No. 12) broke extensively during disturbance and movement.

*Marginal references added by TVA to facilitate detailed study of report.

Available Reports and Information

There has been placed at our disposal a substantial amount of information.

This information includes drawings prepared in connection with design and construction of the original lock. These data, regarding investigations, interpretation and plans for the original lock, are contained in reports prepared by the U. S. Corps of Engineers. The interpretation of conditions and general adequacy of design in conjunction with construction procedures, apparently were adequate, inasmuch as the lock operated satisfactorily with no more than normal maintenance up to the time of failure.

Exhibits 1A, 19 and 20
Appendix C

The Tennessee Valley Authority had approval of plans for the construction of a larger, second lock located on the north side of the existing lock, in order to handle increased volume of river traffic. In preparation for the construction of the second lock, a program of foundation investigations had been carried out, including twenty NX diamond drill holes at spaced intervals along the center line of each wall for the proposed new lock, and three 36-inch calyx holes, one in the lock chamber near the dam and the others at points opposite the downstream pintle block, one on the river side and the other on the land side. The cores obtained from both NX and calyx holes were logged and results correlated for interpretation of features in, and nature of the rock in the foundation area beneath the proposed new lock. The calyx holes were inspected visually, and descriptions of observations were prepared to show the foundation features.

Exhibit 18
Appendix D

After the failure occurred, the Tennessee Valley Authority and the consultants recognized that conditions in the foundation should be investigated further. As a result, a systematic study and mapping of all observable bedrock features and structures were carried out. Two 36-inch calyx holes were drilled on the river side of the river wall of the original lock. A pilot, 36-inch calyx hole was drilled to a depth of 60 feet at the site of the river outlet of water to be discharged from the new lock; a 24-foot shaft to a depth of 40 feet was available for inspection where this pilot hole had been drilled.

The bedrock features revealed by this investigation have been correlated and some laboratory tests have been made on specific features in bedrock, having relation to causes of failure. Information regarding external conditions that might be connected with failure were examined, including the seismic records of stations at St. Louis and Cape Girardeau, Missouri.

Appendixes
E and G

Causes of Failure

The observations made at the time of failure, the movement involved in the various blocks of the landside wall, crack patterns that were carefully mapped and correlated within the individual blocks of concrete, all combined with results of geological studies regarding the foundation problems, clearly show that the failure was due to sliding of the landside wall along a weak zone in the near-surface levels of foundation rock underneath this structure.

Geological studies and drill holes show that the Ft. Payne formation at the site consists of limestone, argillaceous to crystalline, fine to somewhat coarse-grained, with a shale layer of average thickness, 0.5 ft., at a shallow depth below the base for the full length of collapsed wall. Shaley partings occasionally are found between otherwise normal succession of limestone layers. It was known from both earlier and more recent geological studies, and confirmed by our observations, that the rock layers in the area concerned have a gentle downstream and oblique dip into the hill (northwest) of about 1-1/2 degrees. Observations on the ground and in calyx holes indicated that in addition to bedding structure there are joint patterns, the most conspicuous of which also has a northwesterly trend and a vertical dip. The combination of vertical joint systems with flat-lying bedding structures allows a small amount of ground water movement at various depths throughout the foundation area.

The consultants recognize, and the staff of the Tennessee Valley Authority had indicated, the existence of the shale band (0.5 ft. average thickness) at a level slightly below the general foundation of the collapsed wall. It was clearly seen that sliding occurred on a very smooth surface near the base of this shaley band.

When the original lock was built, an open trench was excavated adjacent to the toe of the landside wall in anticipation that ultimately an additional lock would be built, adjoining the original structure. This open trench was slightly deepened and widened in the early stages of construction for the second lock. Excavation involved blasting which, while carried out with great care, had some disturbing effect on rock surrounding this trench. The records indicate that prior to failure construction progress had not reached the stage when the trench would be unwatered and cleared of debris by the Tennessee Valley Authority, and bedrock features that might have been exposed within this trench were not seen.

Exhibit 24
Appendix F

The failure, occurring after a long period of successful operation, would indicate that the design and construction of the original lock carried out by the United States Corps of Engineers were adequate for the bedrock conditions involved for that original structure. The collapse of the wall, by movement along the shale band in the course of construction for the second lock, is related to a change of stability conditions of bedrock due to the operations in new construction; and, these changes include the deepening and widening of the trench at the toe of the collapsed wall which in some measure diminished the rock support.

The shale band is recognizable from other rock immediately adjoining it, according to the core recovered from NX drill holes. The almost complete core recovery, however, did not reveal any unusual weakness within the shale member. The shale appeared to have adequate physical strength to carry the loads imposed by the concrete wall that failed.

Recent 36-inch diameter calyx holes show, near the base of the shale band, a seam of clay about 1/16 to 3/8 inches in thickness, plastic in character, with virtually no frictional resistance to sliding. This clay seam, with careful search, is likewise seen in trenches now excavated and unwatered for walls both to replace the collapsed wall and for those of the new lock, and in the 24-foot shaft for river outlet, in a corresponding position near the base of the concerned shale band. This seam corresponds in dip to that of the bedding in bedrock, about 1-1/2 degrees, in a northwesterly direction. The clay seam lies below the base of the keys for blocks No.'s 8 to 12; is at levels similar to the base of keys for blocks No.'s 6 and 7; and in general, is above the base of keys for blocks No.'s 2 to 5.

A film of grout on the surface of failure under some blocks corresponded in position to this clay seam. We believe that failure occurred by movement along this clay seam. The failure apparently started with movement out of place of the pintle block (No. 12), where forces, concentrated by the miter gate, seemingly were adequate to move this block out of position. Progressive failure of each successive block in an upstream direction then followed.

We have reviewed the information available from the investigations for the original lock and the results of studies carried out by the Tennessee Valley Authority in preparation for construction of the new lock. It is obvious that at no time did observations and studies completed bring to the attention of engineers concerned the existence, or importance therefrom, of the clay seam in the shale band, although the shale band itself had been recognized in all of the studies made for both the old and new locks. The trench, deepened later in preparation of footing for final design of the common wall with the new lock, was not unwatered, and observations of bedrock features thus were not made. The inspection of 36-inch diameter calyx holes, drilled prior to the failure, indicated to the geological observers the presence and width of the shale band in question. However, due to irregularities in the wall of the holes, the thin seam of clay was not observed. The presence of the critical, soft seam escaped recognition at any time during construction of the original and of the new locks.

The engineers, in design of the common wall of the new lock, evaluated the stability of the existing landside wall of the old lock before it collapsed. Based on cores recovered from the 20 NX drill holes, and using normal physical strengths for the shale itself, they reached a conclusion that the contemplated additional excavation for the existing trench along the toe of the landside wall was permissible. Exhibit 23

The causes of the failure, therefore, can be summarized as due to the presence of the shale band, which also had a plastic, thin seam of clay near its base that escaped recognition, and to the resultant deficiency in the physical competency of the shale band.

The seismological stations at Cape Girardeau and at St. Louis recorded a microseism roughly corresponding to the time of failure. The interpretation, based on travel time and time of occurrence, shows that the origin of this shock lay in a general direction toward Wheeler Dam.

Design and Construction of the Two New Locks

The consultants have examined the general plans prepared for replacement of the original river lock, which will be extended in length 40 feet, and of the new lock with total length of 600 feet, being built adjoining and to the north of the area of the original lock. The conditions that resulted in failure of the original lock are eliminated in the design and construction of the two new locks at Wheeler Dam. The new footings for the confining walls of the chambers are placed on rock everywhere below the base of the shale band wherein failure by sliding occurred. All of the pintle blocks for the new locks at the downstream end are designed more conservatively and are founded on rock below the shale band to provide a substantially increased factor of safety. The removal of most of the concrete of the original lock, including the river wall which contained numerous crack patterns and was seated for a considerable portion of its length on or slightly above the shale band, eliminates this wall and its degree of stability from any future concern. The design and construction of these two new locks conform to requirements as to the section of walls and as to the depth of excavation regarding acceptable foundation rock, including: Exhibit 25 Exhibits 21 and 22

(a) The common wall between the two new locks for the distance involved of the total length of lock replacing the original lock will have a combined base of about one and one-half times that of the landside wall that failed, and will be seated throughout this length below the shale band;

(b) The part of the central wall beyond the miter block of the new river lock will have a gravity section and be founded on bedrock below the shale band throughout. It will be more stable also because of increased crest width and resultant additional weight compared to those of the landside wall that failed. The miter block of the river wall for the new second lock will be increased in width and length for a larger degree of safety to receive stresses from the miter gate attached to it;

(c) The land wall of the new and longer second lock will be seated on rock throughout, below the shale band. This longer land wall has massive resistance against sliding northward, with the second lock in operation, due to the support provided by the vertical wall of rock excavated along the base of the hill and against which the concrete toe of this new land wall abuts. The rock of the hill will be adequately drained to prevent accumulation of water from whatever source which might develop excessive unbalanced lateral force against the land wall when the longer second lock chamber is empty;

(d) The base of the river wall of the lock replacing the original lock will be seated on bedrock below the shale layer and the pintle block of this riverside wall in its length and new position will be enlarged both as to width and in direction paralleling the lock for greater security against stresses developed by the attached miter gate, and everywhere will be founded on rock below the shale band;

(e) The walls of the two new locks are designed with conservative uplift assumptions over the entire base, and furthermore have more than the usual gravity section by virtue of crest width so that foundation drainage does not appear to be necessary. For cases when one lock is filled and the other is empty, the rock below the walls will be grouted under gravity pressure by holes carried to a depth of 15 feet below the concrete base of the walls, in order to seal to this depth existing cracks in rock which may pass water. In obvious places of vertical joints cutting across the rock below the individual blocks, special grout pipes sealed in these joints will be used;

(f) The design plan calls for a grout curtain below the heel of each wall to a depth of 30 feet, and the rock to be grouted under controlled pressures according to results obtained;

(g) In the non-overflow section of Wheeler Dam where the approach to the upstream miter gate of the second and longer lock will be located, the construction completed and plans contemplated will adequately insure stability of this portion of dam and miter sill, where shock effects from failure of the landside wall of the original lock may have been felt. The construction program includes drainage holes below the concerned section of Wheeler Dam, drilled into bedrock, a substantial additional mass of concrete for the miter sill which will rest upon the downstream face of the dam and upon rock at the toe for a distance in a downstream direction of about 60 feet, and this new mass of concrete includes in its downstream end a concrete key 15 feet wide carrying below the shale band, in addition to prestressed anchor bars inserted into holes drilled into bedrock in an upstream direction;

(h) Preparation of the bedrock and removal of the concrete blocks in proximity to the non-overflow section of Wheeler Dam by blasting are being done in a careful manner to avoid any disturbance either of the foundation bedrock or the dam itself;

(i) The remnant concrete blocks of the original lock, adjoining the upstream pintle block within the dam, according to design will be supported against outward sliding on the land side by the mass of concrete of the second pintle block, and on the river side by toe support provided by the non-overflow section of the main dam and by rock of the excavation for the riverside block. The support against inward sliding of the blocks of the river lock will be increased by a concrete slab between opposing walls on the floor of the chamber;

(j) The discharge tunnel will be lined with concrete as also the connecting 24-foot shaft in the river channel. Rock behind the lining in the tunnel and shaft will be carefully grouted under low pressure to seal the surface of contact between rock and concrete; Exhibit 25

(k) The filling conduits to be excavated through the existing dam will be excavated carefully in a manner that will avoid disturbance of the dam;

(l) Excavation of the hill, along a vertical face, has been done in a careful manner so as not to disturb the underlying bedrock against which the hillside wall of the second lock will rest. The wall is not designed against substantial rock load; however, this hill does not show signs of instability and is considered safe with drainage to be provided.

We are informed that 10 per cent of the concrete for the new river lock has been placed and that 95 per cent of the old concrete in the river lock has been removed. The consultants are impressed with the thoroughness of work and effort made by the personnel of the Tennessee Valley Authority in the investigation of causes of failure and in preparation of plans for reconstruction.

Frank A. Nickell
Frank A. Nickell

Lee G. Warren
Lee G. Warren

John B. Wilbur
John B. Wilbur

SAINT LOUIS UNIVERSITY
"FIRST WEST OF THE MISSISSIPPI"

INSTITUTE OF TECHNOLOGY
DEPARTMENT OF GEOPHYSICS
AND GEOPHYSICAL ENGINEERING

3621 OLIVE STREET
SAINT LOUIS 8, MISSOURI

June 26, 1961

NOTED BY
BERLEN C. MONEYMAKER

Mr. Berlen C. Moneymaker
Tennessee Valley Authority
Knoxville, Tennessee

Dear Mr. Moneymaker:

In reply to your letter of June 20, 1961. We recorded the following disturbance at our seismograph stations on June 2, 1961.

Cape Girardeau, Missouri, slight disturbance $09^h21^m00^s$ central standard time, second phase $09^h21^m22.3^s$. This disturbance was recorded in St. Louis at $09^h21^m49^s$. The vibrations are too small to distinguish phases and interpret so that from these records it is not possible to do more than say the disturbance was closer to Cape Girardeau than to St. Louis.

At Cape Girardeau a similar disturbance was recorded at $11^h38^m26^s$ p.m. (central standard time).

If I can be of additional help to you in this matter please let me know.

Sincerely yours,

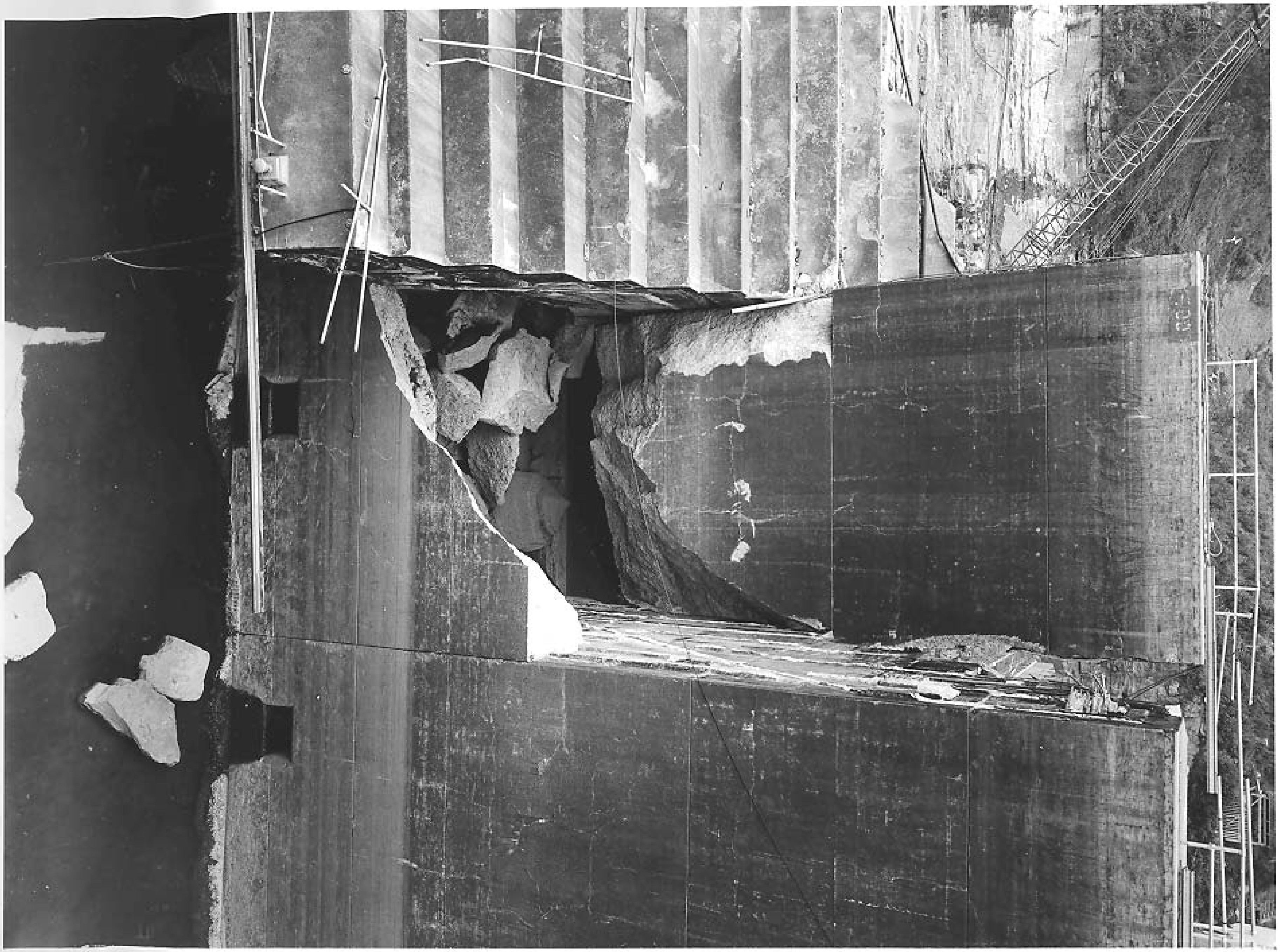
Ross R. Heinrich

Ross R. Heinrich

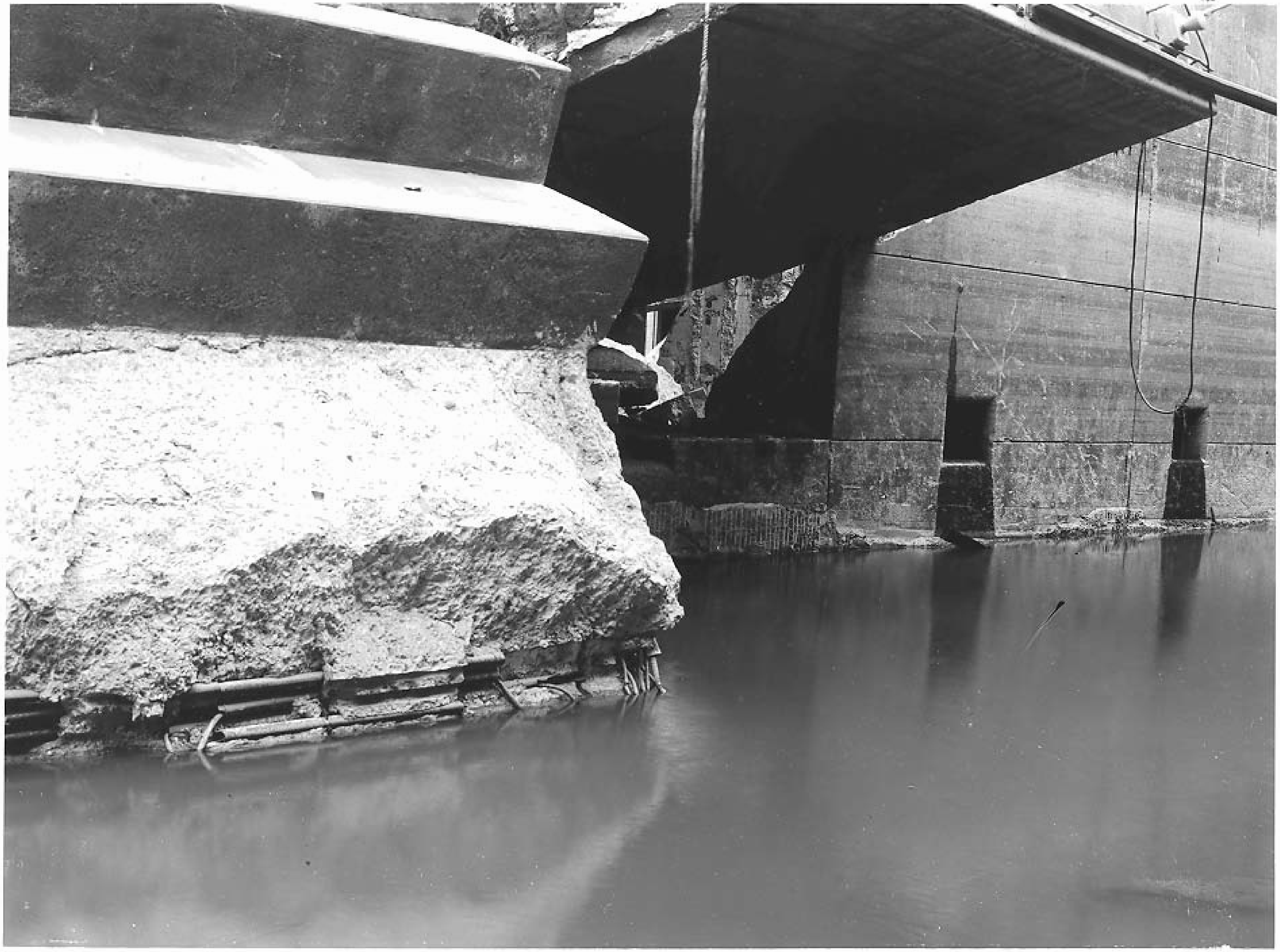
BCM:ASB
6/ 28/61 (4) G. P. Palo, 602 UB

WHEELER LOCK Tennessee Valley Authority 3L1084 June 14, 1961 C.Quillen, Wilson Dam	Auxiliary lock land wall from upper gate.

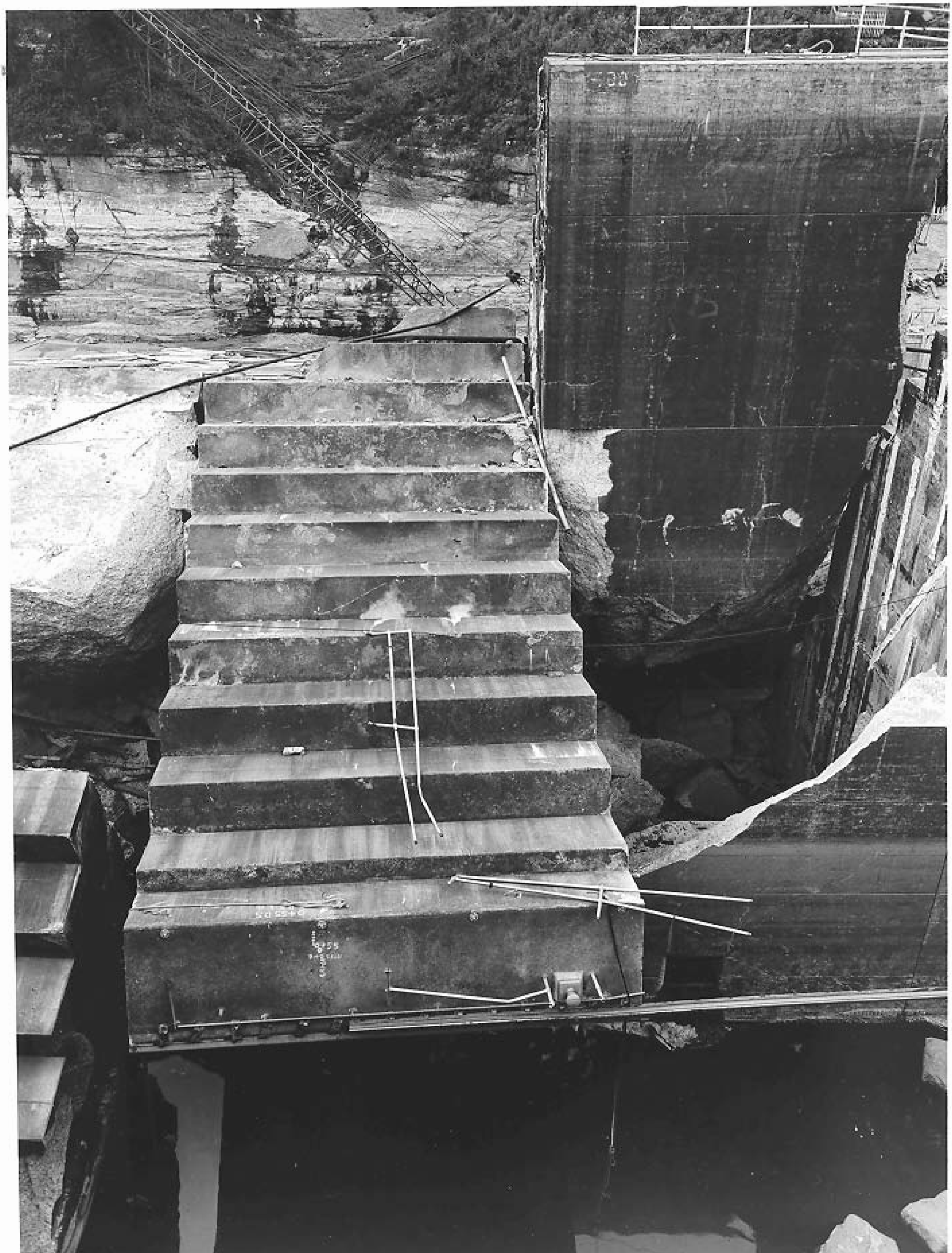
WHEELER LOCK Tennessee Valley Authority 3L1082 June 14, 1961 C. Quillen, Wilson Dam	Auxiliary lock blocks 6 through 1.



WHEELER LOCK Tennessee Valley Authority 3L1160 July 6, 1961	Auxiliary lock, blocks 3, 2, and 1.



WHEELER LOCK Tennessee Valley Authority 3L1117 June 16, 1961 C. Quillen, Wilson Dam	Auxiliary lock blocks 4, 3, 2, and 1.



WHEELER LOCK
Tennessee Valley Authority
3L1159 July 6, 1961
C. Quillen. Wilson Dam

Auxiliary lock, blocks 4, 3, and 2.

WHEELER LOCK
Tennessee Valley Authority
311158 July 6, 1961
C. Quillen, Wilson Dam

Auxiliary lock, blocks 6, 5, and 4.

WHEELER LOCK Tennessee Valley Authority 3L1081 June 14, 1961 C. Quillen, Wilson Dam	Auxiliary lock blocks 8 through 4.

WHEELER LOCK
Tennessee Valley Authority
3L1157 July 6, 1961
C. Quillen Wilson Dam

Auxiliary lock, blocks 8, 7, and 6.

WHEELER LOCK
Tennessee Valley Authority
3L1155 July 6, 1961
C. Quillen, Wilson Dam

Auxiliary lock, blocks 9, 8, and 7.

WHEELER LOCK Tennessee Valley Authority 3L1115 June 16, 1961 C. Quillen, Wilson Dam	Auxiliary lock land wall from elevation 490 (block 9 at left).

WHEELER LOCK
Tennessee Valley Authority
3L1153 July 6, 1961
C. Quillen, Wilson Dam

Auxiliary lock, blocks 10, 9, and 8.

Auxiliary lock, blocks 12, 11, and 10.

WHEELER LOCK
Tennessee Valley Authority
311152 July 6, 1961
C. Quillen, Wilson Dam

WHEELER LOCK Tennessee Valley Authority 3L1131 June 28, 1961 C. Quillen, Wilson Dam	Auxiliary lock area, downstream from block 12 (looking northwest).

WHEELER LOCK Tennessee Valley Authority 3L1078 June 14, 1961	Auxiliary lock blocks 14, 13, and 12.

WHEELER LOCK
Tennessee Valley Authority
3L1162 July 6, 1961
C.Quillen, Wilson Dam

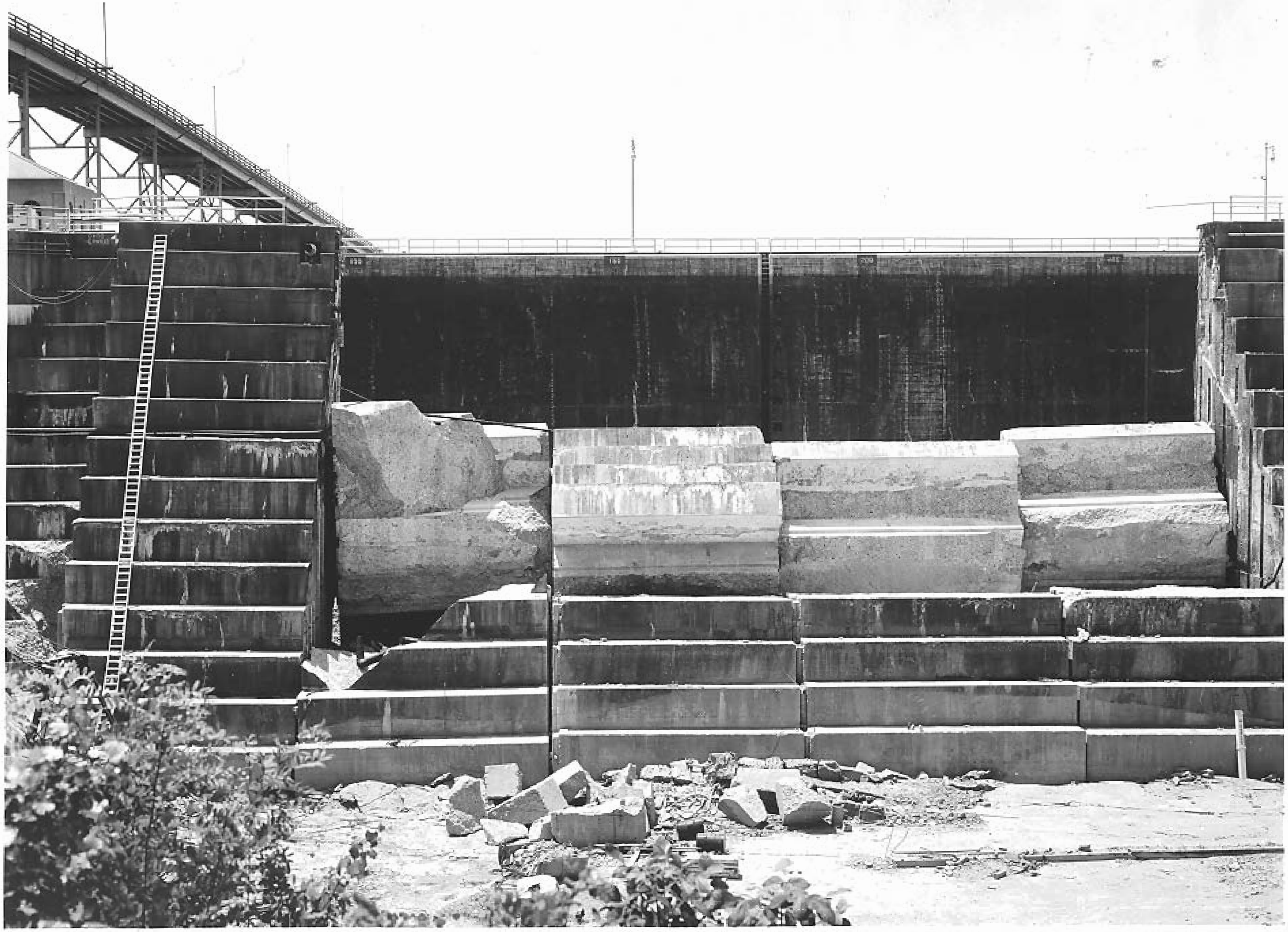
Auxiliary lock, looking downstream from dam non-overflow section.

WHEELER LOCK
Tennessee Valley Authority
3L1135 July 5, 1961
C. Quillen, Wilson Dam

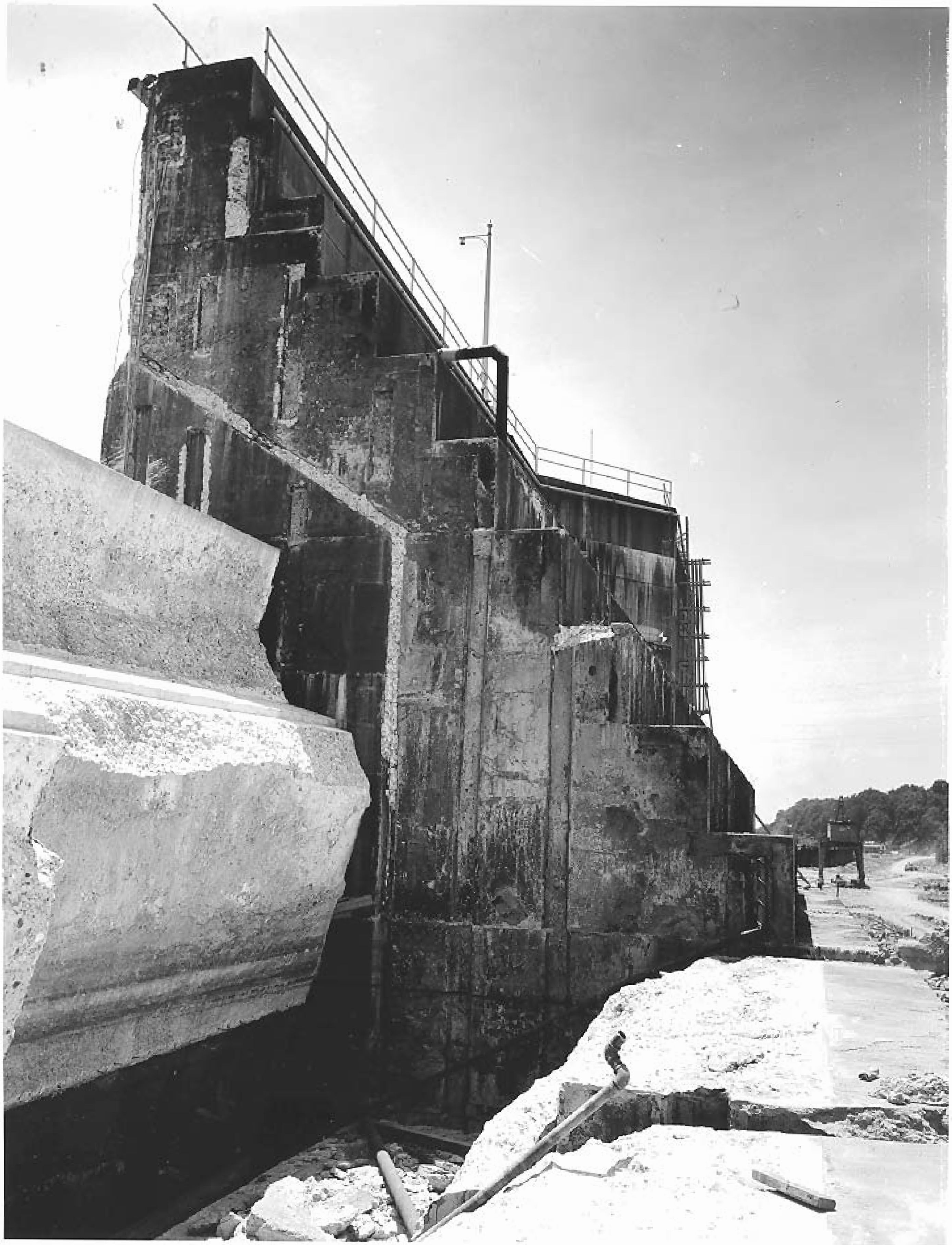
Auxiliary lock, portion of downstream face of block 2.

WHEELER LOCK Tennessee Valley Authority 3L1134 July 5, 1961 C. Quillen, Wilson Dam	Auxiliary lock, lock upstream at blocks 2, 3, and 4.

WHEELER LOCK Tennessee Valley Authority 3L1136 July 5, 1961 C. Quillen, Wilson Dam	Auxiliary lock, blocks 3, 4, and 5.

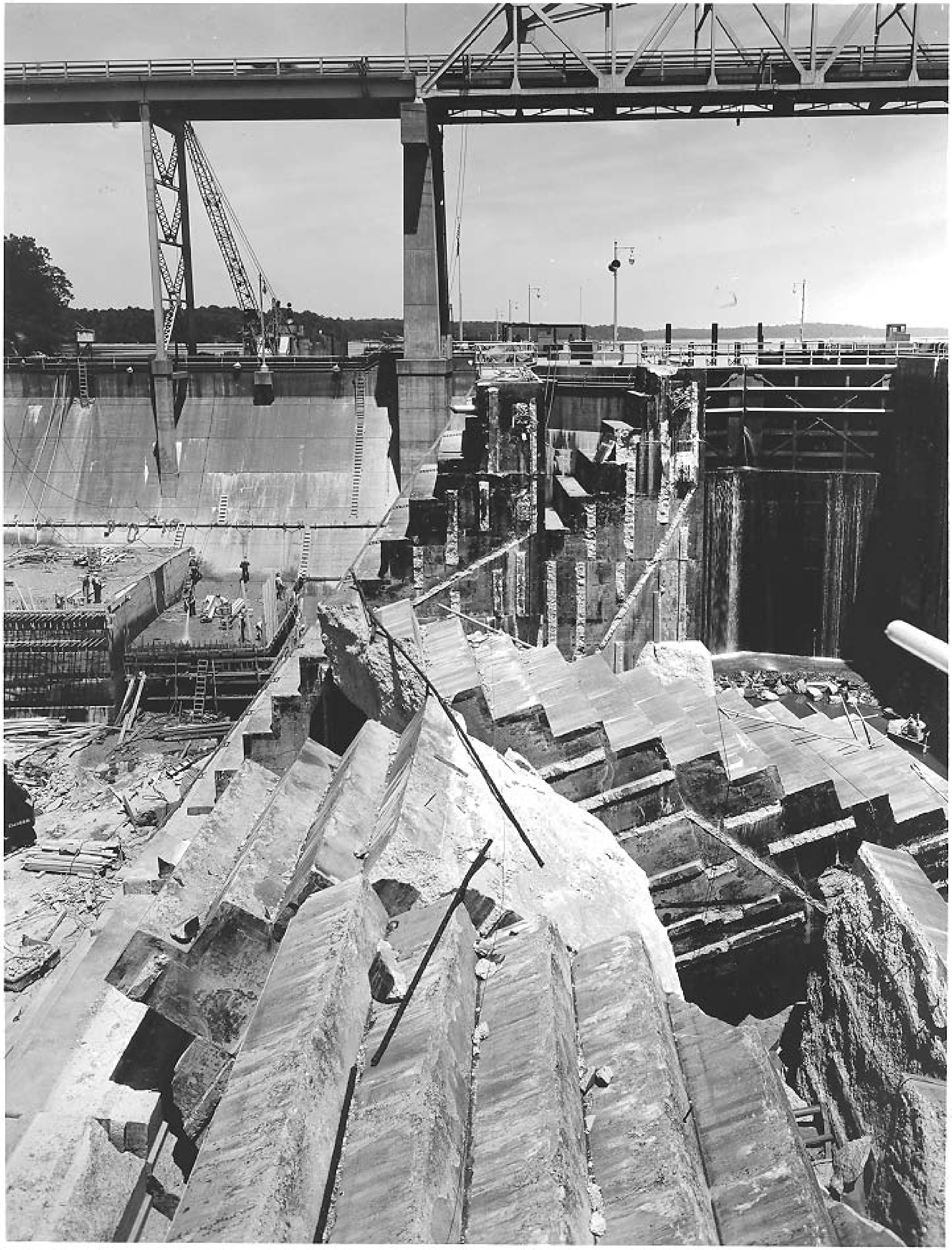


WHEELER LOCK Tennessee Valley Authority 3L1125 June 28, 1961 C. Quillen, Wilson Dam	Auxiliary lock, blocks 2 through 6.



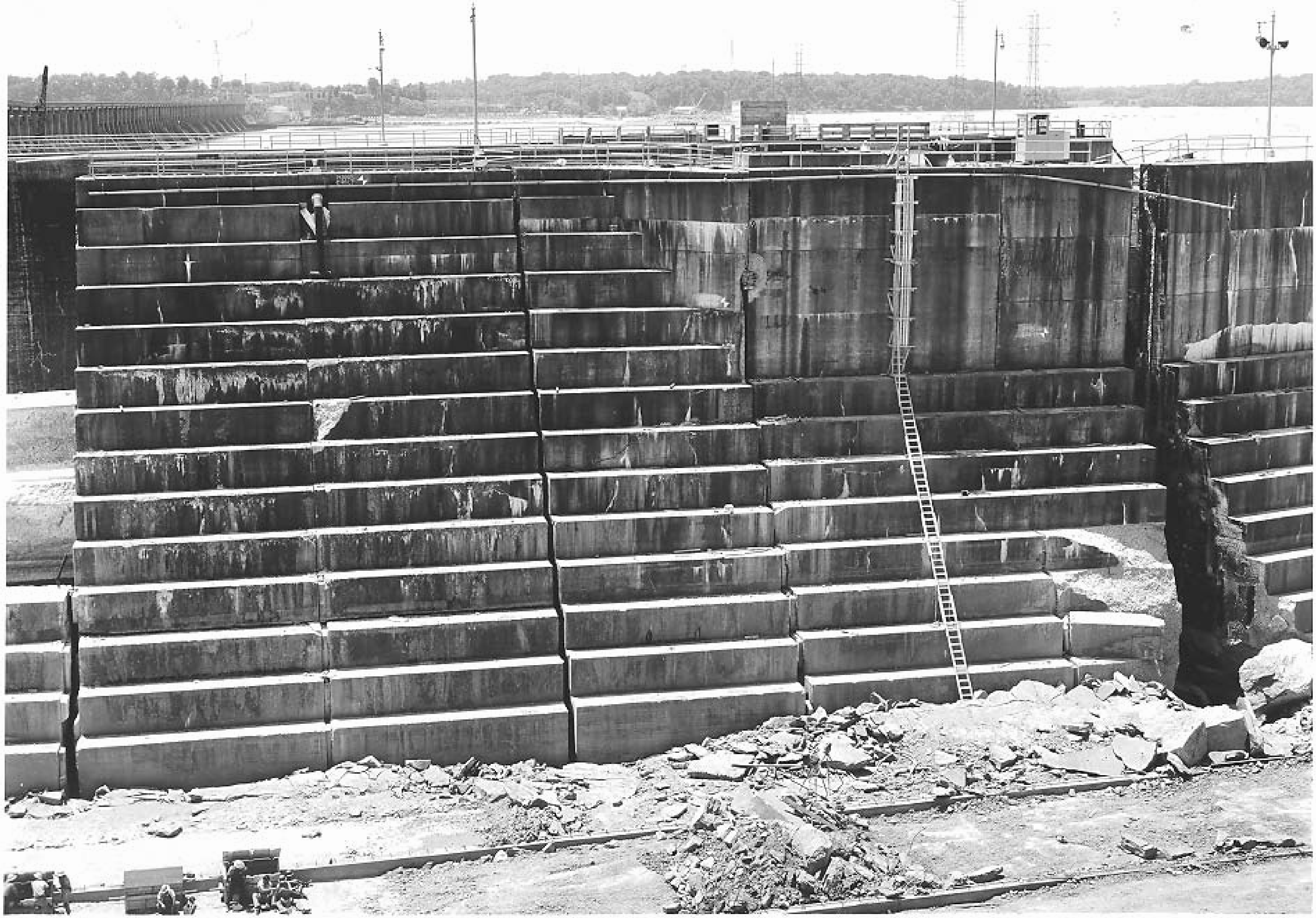
WHEELER LOCK
Tennessee Valley Authority
311137 July 5, 1961
C. Quillen, Wilson Dam

Auxiliary lock, upstream face of block 7.



Auxiliary lock, looking upstream from top of block 7.

WHEELER LOCK
Tennessee Valley Authority
3L1133 July 5, 1961
C. Quillen, Wilson Dam



WHEELER LOCK Tennessee Valley Authority 3L1126 June 28, 1961 C. Quillen, Wilson Dam	Auxiliary lock, blocks 7 through 12.

WHEELER LOCK Tennessee Valley Authority 3L1127 June 28, 1961 C. Quillen, Wilson Dam	Auxiliary lock, block 12 and area downstream.

WHEELER LOCK Tennessee Valley Authority 3L1141 July 5, 1961 C. Quillen, Wilson Dam	Auxiliary lock, concrete fragments downstream from block 12.

WHEELER LOCK
Tennessee Valley Authority
3L1143 . July 5, 1961
C. Quillen, Wilson Dam

Auxiliary lock, concrete fragments downstream from block 12.

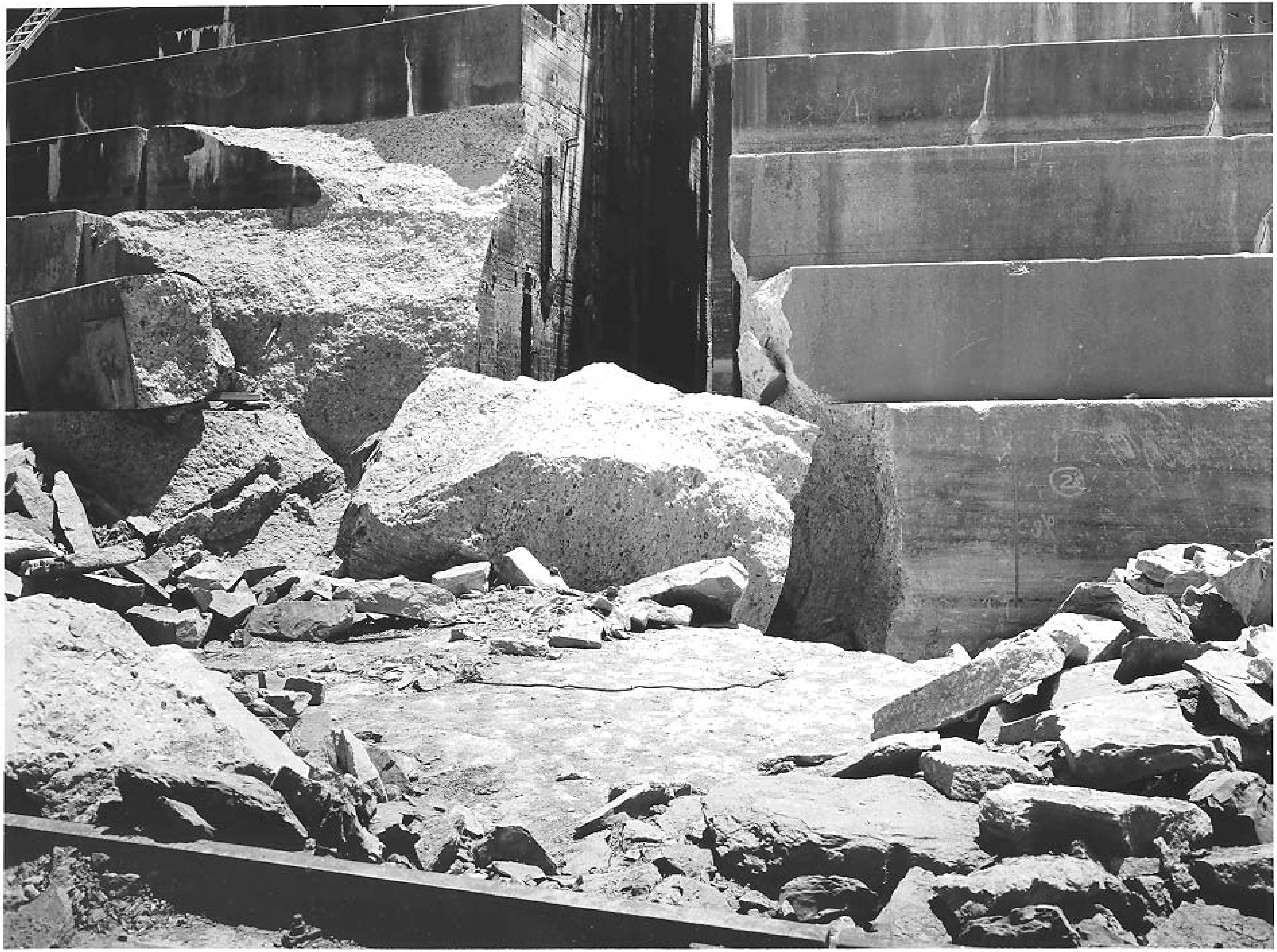
WHEELER LOCK
Tennessee Valley Authority
3L1142 July 5, 1961
C.Quillen, Wilson Dam

Auxiliary lock, gate leaf and guide wall (looking downstream).

WHEELER LOCK Tennessee Valley Authority 3L1129 June 28, 1961 C.Quillen, Wilson Dam	Auxiliary lock, collapsed land wall (looking upstream).

Auxiliary lock, blocks 12 and 11.

WHEELER LOCK
Tennessee Valley Authority
3L1151 July 6, 1961
C. Quillen, Wilson Dam



WHEELER LOCK Tennessee Valley Authority 3L1147 July 5, 1961 C. Quillen, Wilson Dam	Auxiliary lock, blocks 11 and 12, north side.

WHEELER LOCK Tennessee Valley Authority 3L1104 June 15, 1961 C. Quillen, Wilson Dam	Auxiliary lock blocks 11 and 12, looking south.

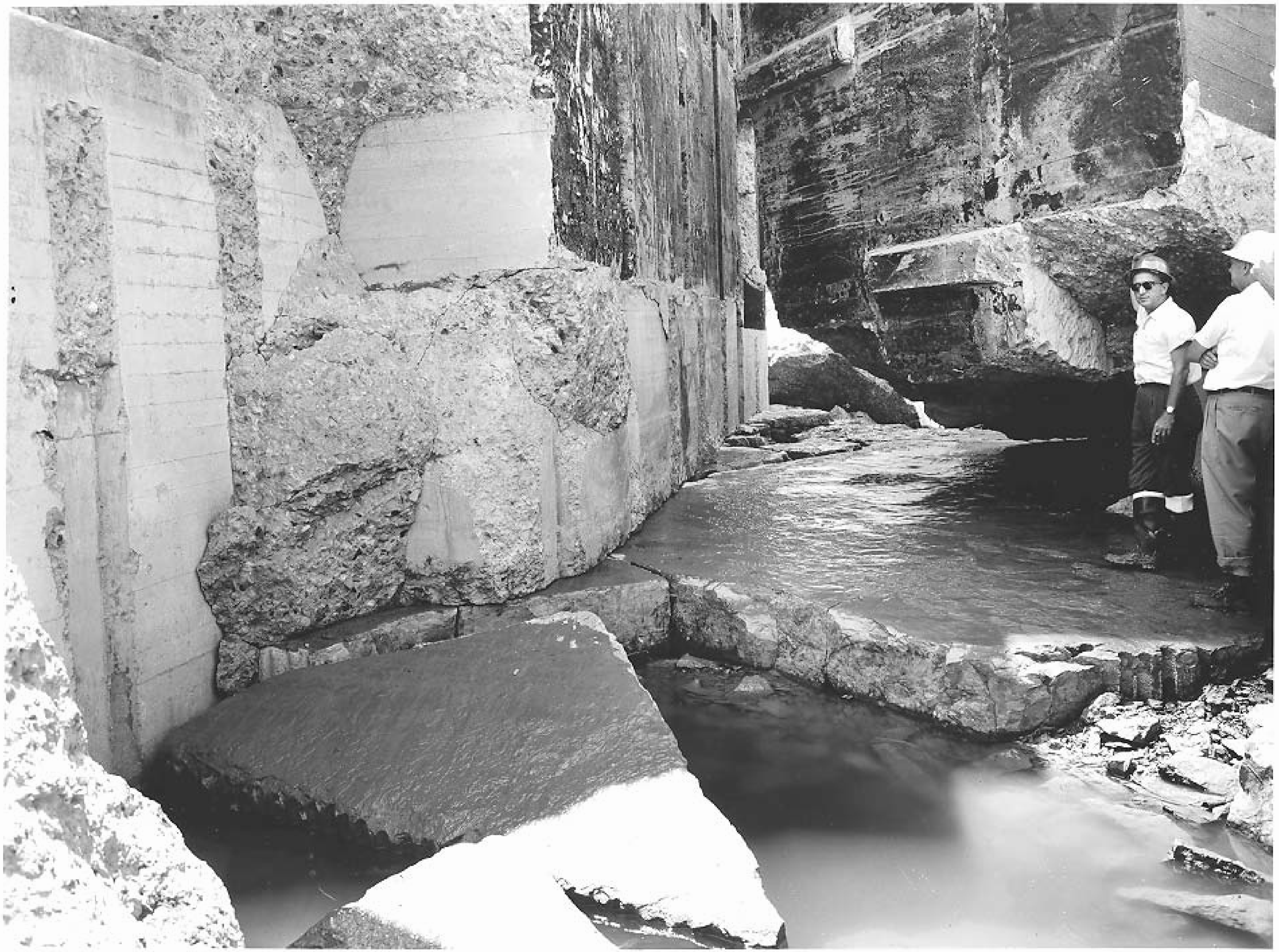
WHEELER LOCK Tennessee Valley Authority 3L1105 June 15, 1961 C. Quillen. Wilson Dam	Auxiliary lock bottom of block 12 (upstream side).

Auxiliary lock, block 12, north side.

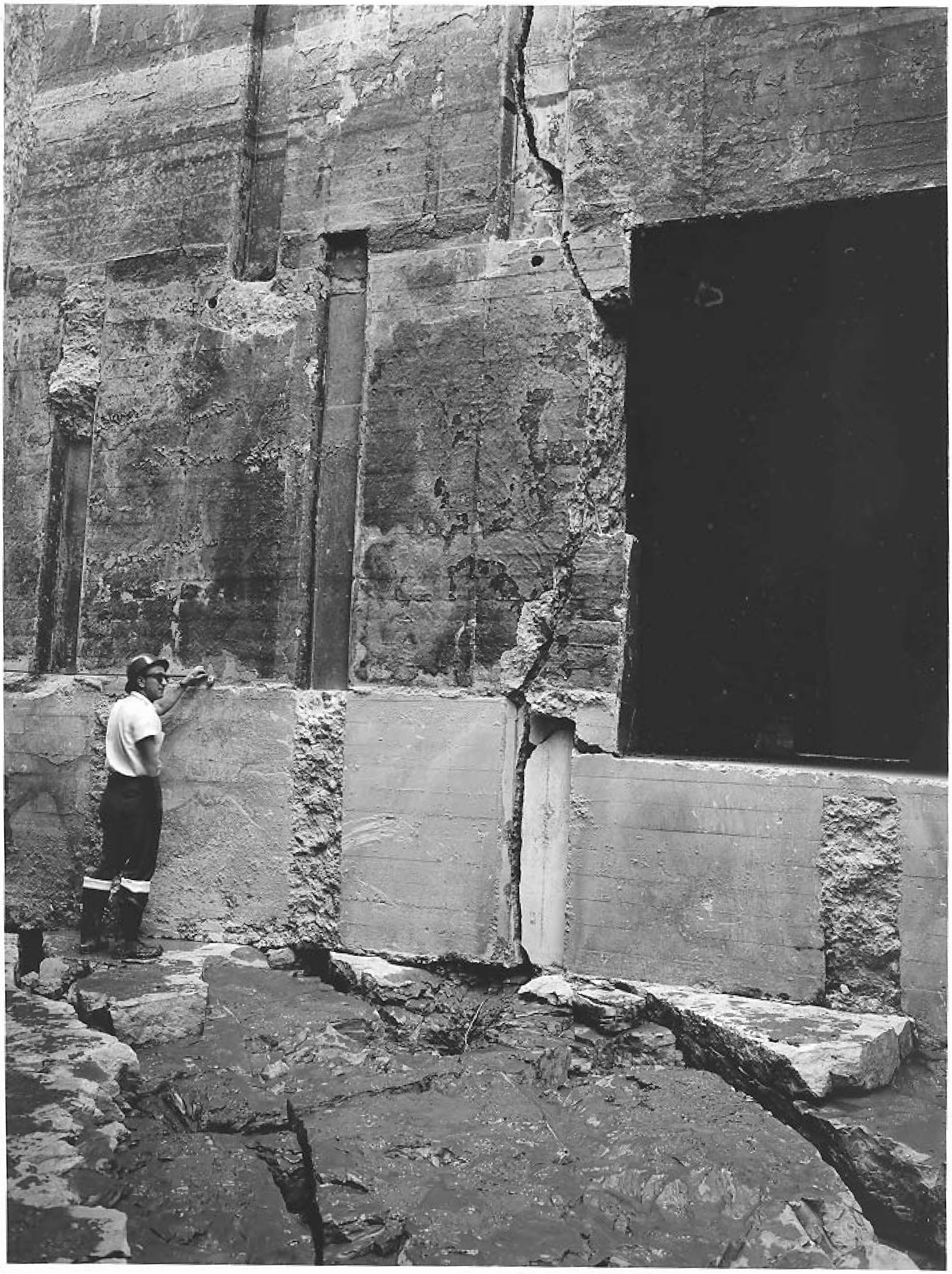
WHEELER LOCK
Tennessee Valley Authority
3L1149 July 5, 1961
C. Quillen, Wilson Dam

WHEELER LOCK
Tennessee Valley Authority
3L1106 June 15, 1961
C. Quillen, Wilson Dam

Auxiliary lock, northwest corner of block 12.

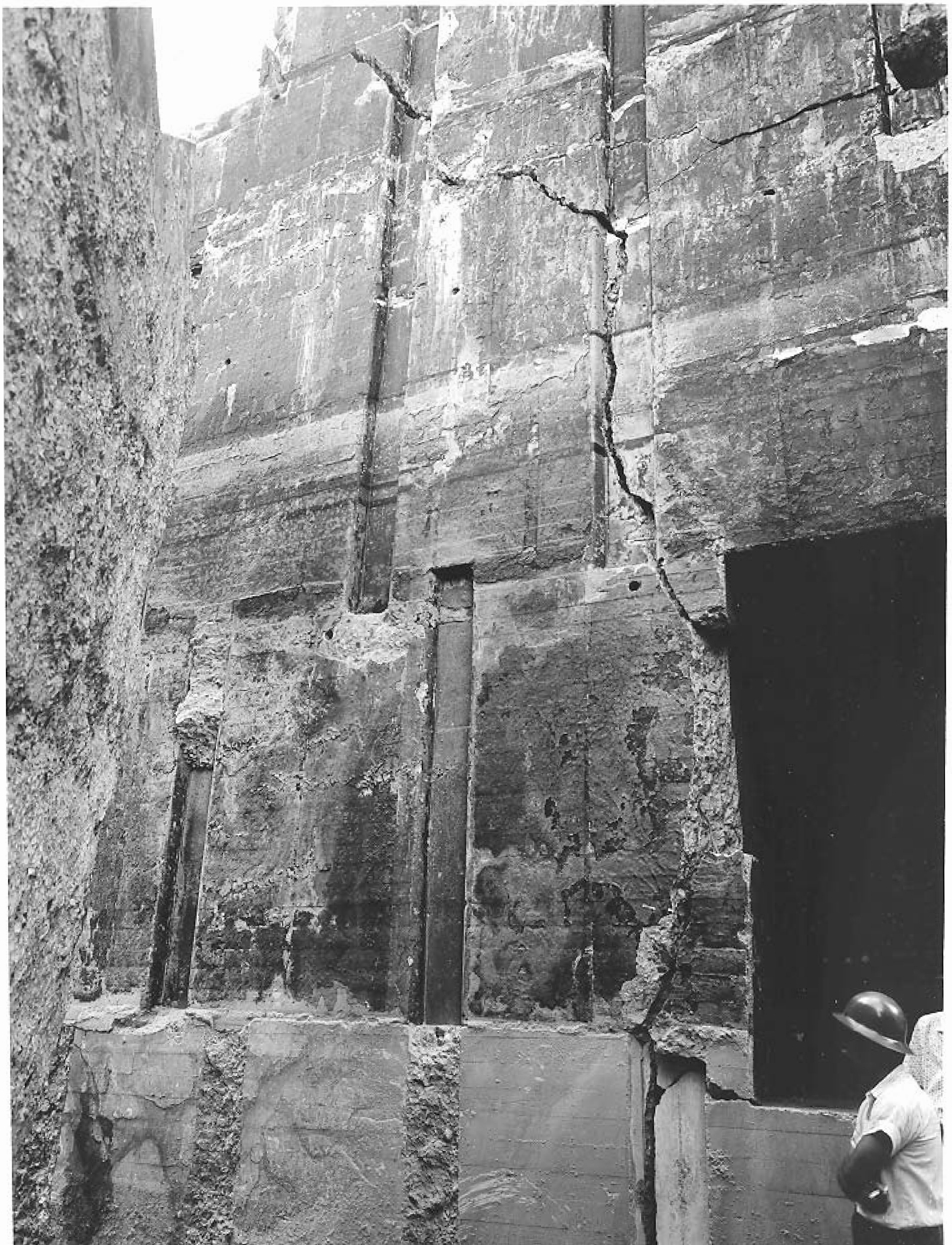


WHEELER LOCK Tennessee Valley Authority 3L1107 June 15, 1961 C. Quillen, Wilson Dam	Auxiliary lock bottom of block 12 (downstream side).



Auxiliary lock block 12, looking upstream.

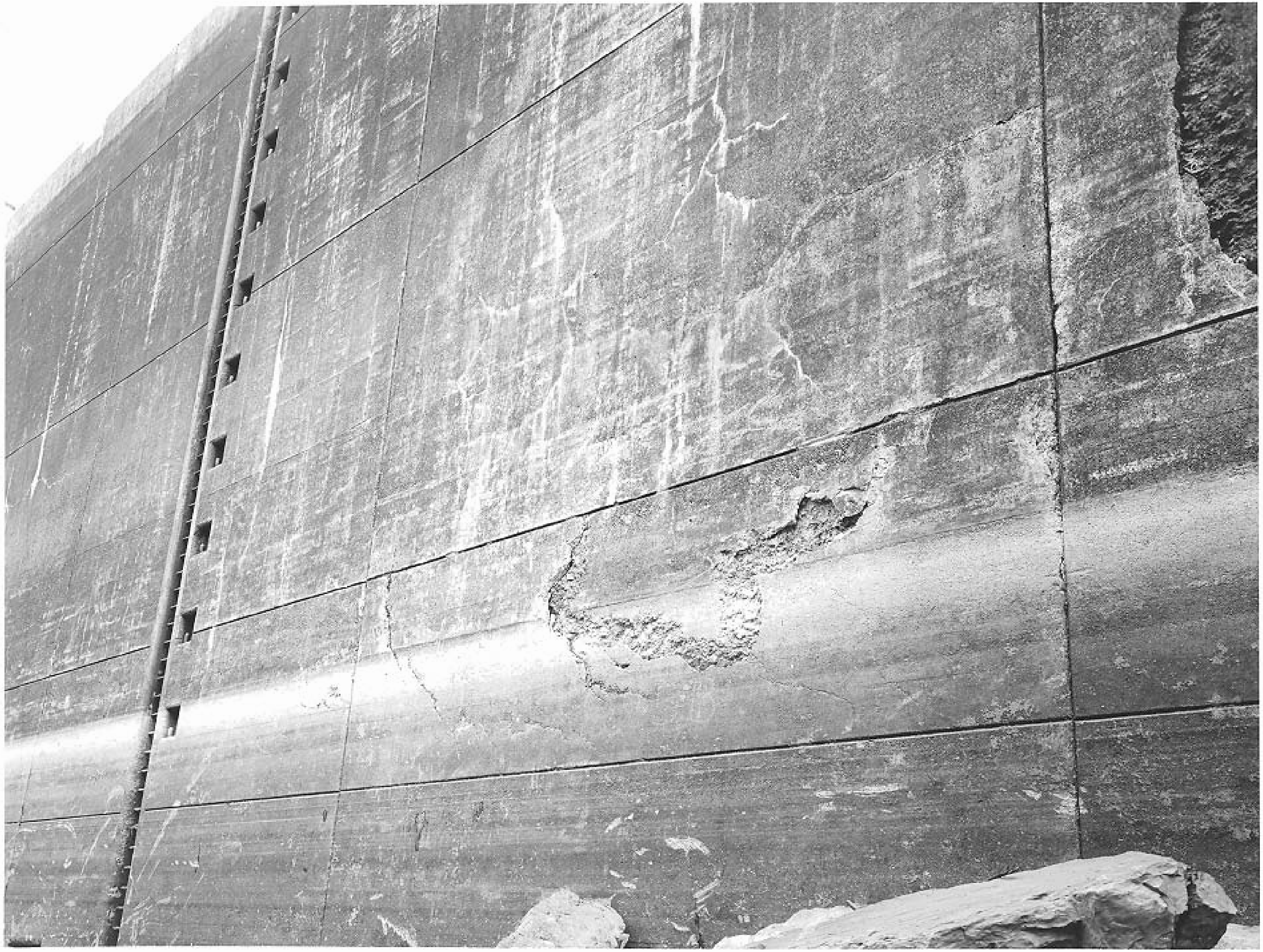
WHEELER LOCK
Tennessee Valley Authority
31L109 June 15, 1961
C. Quillen, Wilson Dam



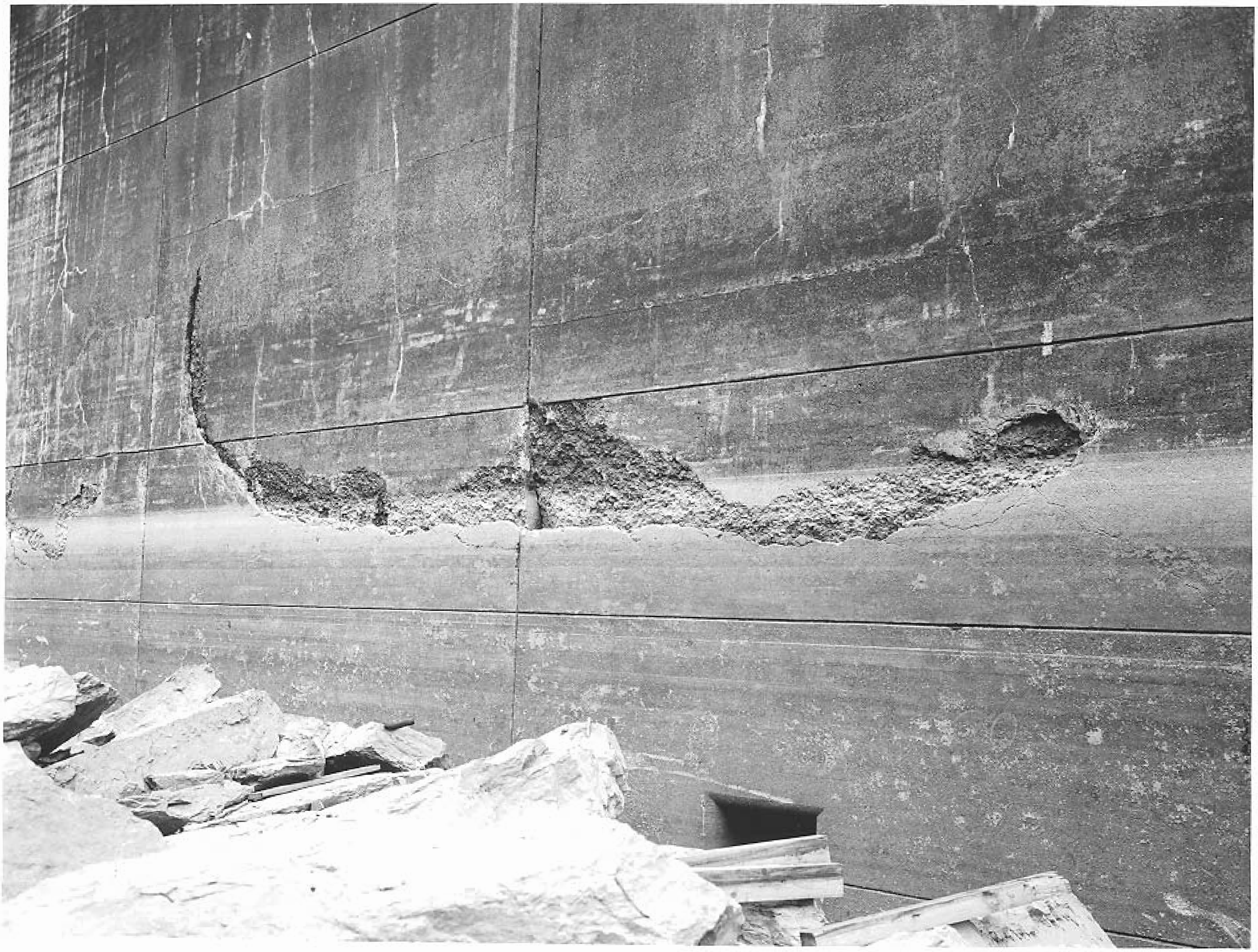
WHEELER LOCK
Tennessee Valley Authority
311108 June 15, 1961
C. Quillen, Wilson Dam

Auxiliary lock block 12, looking upstream.

WHEELER LOCK Tennessee Valley Authority 3L1110 June 15, 1961 C.Quillen, Wilson Dam	Auxiliary lock downstream face and culvert in block 12.



WHEELER LOCK Tennessee Valley Authority 3L1114 June 16, 1961 C.Quillen, Wilson Dam	Auxiliary lock, crack in block 58.



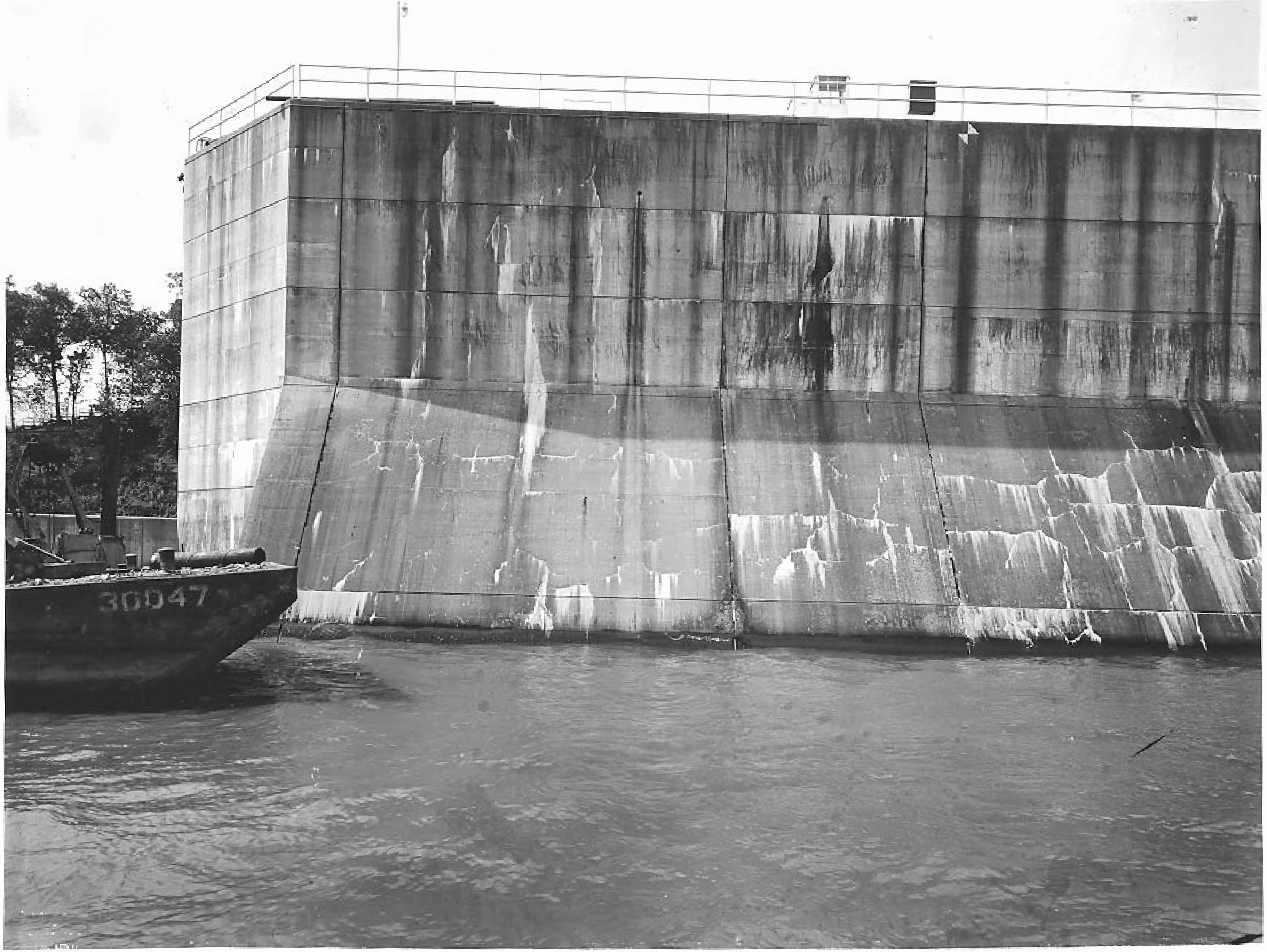
WHEELER LOCK Tennessee Valley Authority 3L1113 June 16, 1961 C.Quillen, Wilson Dam	Auxiliary lock, crack in blocks 59 and 60 (river wall).

WHEELER LOCK Tennessee Valley Authority 3L1091 June 15, 1961 C.Quillen, Wilson Dam	Auxiliary lock river wall blocks 53, 54, and 55.

WHEELER LOCK Tennessee Valley Authority 3L1092 June 15, 1961 C.Quillen, Wilson Dam	Auxiliary lock river wall blocks 55, 56, 57, and 58.

WHEELER LOCK Tennessee Valley Authority 3L1094 June 15, 1961 C.Quillen, Wilson Dam	Auxiliary lock river wall blocks 58, 59, 60, 61, and 62.

WHEELER LOCK Tennessee Valley Authority 3L1096 June 15, 1961 C.Quillen, Wilson Dam	Auxiliary lock river wall blocks 60, 61, 62, 63, and 64.



WHEELER LOCK Tennessee Valley Authority 3L1097 June 15, 1961 C.Quillen, Wilson Dam	Auxiliary lock river wall blocks 62, 63, 64, and 65.

TENNESSEE VALLEY AUTHORITY

Office of Chief Engineer

APPENDIX A

DESCRIPTION OF COLLAPSED LAND WALL

WHEELER LOCK

Knoxville, Tennessee

November 1961

August 9, 1961

EXISTING WHEELER LOCK

DESCRIPTION OF COLLAPSED LAND WALL

AS OF JULY 7, 1961, FROM DETAILED INSPECTION AT SITE

The following is a general description of the visual condition, block by block, of the collapsed land wall shown on exhibits 1 through 16 and photographs in appendix B.

Block numbers used are those assigned by field force, not those on original construction drawings. Block 1 is the second block below the upper gate, which did not move, and blocks are numbered consecutively downstream, the downstream gate block being No. 12.

Blocks which are described as moved back came to rest with toe of wall against the north or land side of the trench excavated for the new lock river wall.

Cracks in the concrete of all blocks are shown on exhibits 1 through 16. In this description, cracks will be mentioned in blocks 12, 11, and 9 which are obviously due to load acting on the blocks from the downstream gate or from load transmitted from one block to another. In other blocks some keys in monolith joints were sheared off, and the front wall of the culvert was sheared off horizontally or the culvert floor was broken through vertically, involving possible load transmittal from block to block. Other breaks described were caused by the weight of the blocks when they fell on the foundation or on pieces of rock or dislodged concrete which were washed down by the rushing water in the lock chamber, coming to rest where the toppling blocks could fall on them.

The character of joints in the blocks is significant to the way the blocks were broken. All monolith joints were provided with 12- by 5-inch vertical keys. The joints were painted heavily with asphalt above elevation 493 to a thickness of about 1/8 inch.

Indications are that the chamber wall blocks were built as follows. The rock foundation was at elevation 488. At the heel and toe, key trenches 6 feet wide were excavated 4 feet into the rock and filled with concrete along with the base concrete pour to elevation 493. A vertical construction joint was introduced at 30 feet from the lock face, from elevation 493 to 511, with three horizontal 12- by 5-inch keys on the joint but no roughening for bond. The base width was 37 feet, and concrete was placed up to elevation 496 behind the vertical 30-foot joint to this base width. Then additional concrete was placed to the 53-foot block width up to elevation 496 with a vertical, unkeyed, unbonded construction joint at the 37-foot point. Then concrete was placed across this joint up to elevatic.. 511 to make the finished back shape.

The vertical jointing in these blocks indicates a change in design plans during construction. In all blocks concrete above elevation 511 was placed across the 30-foot vertical joint below.

The disrupted block 14 of the lower guide wall indicates that it was built as follows: The rock foundation was generally about elevation 488, the same as for the chamber wall. At the heel, but not at the toe, a trench 4 feet wide was excavated 2 feet into the rock and filled with concrete along with the base concrete pour to elevation 492, the floor of the culvert. At the back wall of the culvert a vertical construction joint without bonding provisions was introduced from rock to the culvert floor. A 4-foot-thick vertical wall was placed just behind the culvert from rock to elevation 502, the culvert roof. The 4-foot front wall of the culvert was placed from culvert floor to roof. A 4-foot lift of concrete was placed across these walls to elevation 506 to form the culvert roof. This construction resulted in the culvert's being surrounded by 4-foot slabs, with a smooth vertical face 4 feet behind the culvert from rock to elevation 506. Then, apparently from a change in plans, concrete was placed from rock to elevation 506 behind this face to make the finished back shape, with no bonding on the vertical joint. Concrete above elevation 506 was placed across the vertical joint below. Another vertical joint was introduced 5 feet behind the lock face from elevation 506 to 520. All vertical joints had no keys or bonding provisions. Parts of blocks 13 and 15 were similarly jointed. Horizontal construction joints in all blocks generally had rough 12- by 5-inch longitudinal keys 4 to 5 feet on centers. The joints were treated by cement "grout" slushing, frequently quite heavy, sometimes with excess cement. In many places the joints show lack of scarifying or green-cutting in preparation for a succeeding lift, and many keys indicate an excess of grout remaining in keyways, these features combining to lessen shear resistance.

The concrete was made with river gravel. In general, the concrete quality can be called fair to good for mass concrete.

The front and back faces of all blocks in both land and river walls have a general random pattern of old surface cracks a few feet in length. These cracks can usually be seen in the photographs from traces of efflorescence on them. In the following description these minor cracks will normally not be mentioned.

Block 1

This block did not move from its original position. It is reported that surveys show the downstream end actually moved back 3/16 inch. The chamber face shows nothing significant beyond minor surface cracking typical of all blocks in both the river and the land walls.

On the back of the block a large segment was broken off the downstream corner by block 2 moving back. The break extends from elevation 521 down to rock, angling on the downstream end from the 521-526 vertical step to the 496-501 step. The entire back step elevation 496 and below broke off. All the lower steps to and including elevation 521 broke angularly back to near the center of the block. A small corner is broken off the 546-551 step, and additional corners at 526 and 531, where block 2 is in contact with and is supported by block 1.

Block 2

The heel key is in its original position with front culvert wall on it.

The front wall of the culvert to elevation 502 is in its original position with only the downstream upper corner broken off. Elevation 502 joint sheared off at the downstream end. The face of block broke off diagonally from this corner to elevation 521 construction joint about 10 feet from upstream end, the break sloping back to the culvert roof.

The culvert floor is intact in its original position with a vertical break at the back from rock to culvert floor.

The remainder of the block moved back and is still standing, supported by jamming on unmoved block 1 and on toppled block 3. Without these supports the block would topple forward as did blocks 3 to 6.

The back wall of the culvert is intact in the moved position and the culvert roof practically so, with the meeting back joint tight and sound.

The front face of the block is badly spalled from elevation 502 to 531.

The standing portion of the block is unbroken and looks intact from the back, and has no significant cracks.

Block 3

The entire heel key in to the culvert is in its original position up to elevation 493 with only the downstream upper corner broken off. Elevation 493 joint sheared off.

The culvert floor broke vertically near the front from rock to the culvert floor. The entire block behind this break moved back, with the culvert floor and back wall essentially intact in the moved position. The culvert floor broke again vertically at the back down to rock.

The front wall of the culvert sheared off at the joints elevations 493 and 502 and broke vertically at the port into two pieces. The upstream half turned upside down and moved back about 20 feet. The downstream half turned over so lock face is up and slid back about 20 feet.

The main part of the block that moved back broke off in a varying fashion. For about 10 feet at the downstream end it broke back from the culvert roof to elevation 511 as described below for block 5. The remainder broke roughly at elevation 502 out to the back face. The culvert roof is intact on the toppled block. The block toppled and slid forward, coming to rest on rubble below and on the downstream corner of the top of the front culvert wall of block 2. This upper part of the block from elevation 502 to top 560 is intact and projects upward and far out over the chamber floor.

Block 4

This block moved back with the adjacent blocks, but did not topple forward until 2 days after the rest of the wall.

The heel key has a small part of its upstream end and a little in the trench bottom in its original position; the rest of it is gone. The face of the block is generally spalled from elevation 502 to 531.

The culvert floor broke vertically near the front from rock to the culvert floor. The entire block behind this break moved back, with the culvert floor and back wall intact in the moved position. The culvert floor broke transversely near the upstream end.

The front wall of the culvert sheared off at joints elevations 493 and 502 and broke vertically at the port into two pieces. The downstream half moved back about 20 feet and tilted back at about 45 degrees and is now the main support for the toppled block. The upstream half turned lock face up and slid back about 20 feet.

The main part of the block that moved back broke and toppled forward. It broke at the level of the culvert roof elevation 502 back 6 feet, then diagonally to the vertical construction joint at 30 feet from the lock face, then separated on the vertical joint above elevation 508±, then separated out to the back face on construction joint elevation 511. The culvert roof is intact on the toppled block. The toppled block fell on rubble of rock and broken concrete below it, breaking again at construction joint 531 and again at elevation 556, and coming to rest on the chamber floor.

Block 5

The heel key is essentially gone from its original position. The downstream half is lying under toppled block 6. The upstream half turned lock face up and slid back about 20 feet.

The culvert floor broke vertically along the center of culvert from rock to the culvert floor. The entire block behind this break moved back, with the culvert floor and back wall intact in the moved position.

The front wall of the culvert sheared off at joints elevations 493 and 502, turned over so the lock face is upward and slid back intact about 25 feet. When the upper part of the block toppled and fell on the wall, the wall was broken through at the wall port near the downstream end.

The main part of the block that moved back broke and toppled forward. It broke at the level of the culvert roof back to the vertical construction joint, separated on the vertical joint up to elevation 508±, then diagonally out to the back face at elevation 511. The culvert roof is intact on the toppled block. The toppled block slid down on the culvert floor and the rubble in front of it, then broke again diagonally from elevation 531 upstream to 546 downstream, coming to rest face down on the rubble on the chamber floor.

Block 6

The entire heel key is intact in its original position up to elevation 493, including a small corner of culvert floor at the downstream end.

The concrete from elevation 488 to 493 broke essentially vertically at the back of the key. The monolith joint in the key is tight between blocks 6 and 7.

The culvert floor broke vertically at the front from rock to the culvert floor. The entire block behind this break moved back, with the culvert floor and back wall intact in the moved position.

The condition of the rest of the block is identical with that described for block 5, except that the break in the upper part of the block occurred at the shelf at elevation 541. Also, the upper part separated on construction joint elevation 549 and the piece above 549 broke into two pieces vertically. The entire assembly above elevation 541 was moved about 25 feet downstream.

Block 7

The entire heel key is intact in its original position up to elevation 493. The concrete from elevation 488 to 493 broke vertically at the back of the key from elevation 488 to 491± and then sloping toward lock face to elevation 493 joint which sheared off. The monolith joint in the key is tight between blocks 7 and 8.

The remaining entire block moved back as a unit. The culvert floor, back wall, and roof are complete but cracked. The back wall has a new crack at the roof line, no displacement. The floor is broken vertically at the front corner down to rock.

The front wall of the culvert broke completely through horizontally at construction joints elevations 493 and 502, the culvert roof. The wall broke into two pieces by a vertical break through it at the upstream edge of the wall port. The downstream half remains in place, displaced several inches toward chamber at top. The upstream half split diagonally from the front edge of culvert floor to the lock face at elevation 502. The inner piece slid into the culvert, the outer piece fell into the lock chamber with lock face up. This break could have been caused by toppling block 6. There are deep spalls over the entire block face below elevation 511.

The face of this block shows several major cracks. There are old cracks all across the block at elevations 522 and 556. At elevation 541 there is a construction joint with an old ragged appearance; the joint could be loose. Near the downstream end there is a vertical spalling-type crack angling back from the face toward the monolith joint from elevation 522 to 541. Below elevation 537 the crack developed from an old crack; from elevation 537 to 541 the crack is new; above elevation 541 a 5-foot-high spall popped off.

The back of the standing block shows a horizontal break at step elevation 506, otherwise no significant cracks.

Block 8

The heel key broke off irregularly. The upstream half is in its original position, complete below rock elevation 488, then sloping toward lock face to elevation 493 joint which sheared off. The downstream few feet moved back intact with the block. The portion between has a varying diagonal break from down in key trench to joint elevation 493. This block might be cited as showing most nearly a typical diagonal tension break near the base.

The remaining entire block moved back as a unit and remains standing. The culvert floor, back wall, and roof are complete but cracked and broken. The back wall has a new crack at the roof line, no displacement. The floor is broken vertically at the front corner down to rock. The front wall portion below elevation 492 moved out toward chamber, leaving over a foot of open break at the floor level. The front wall below top elevation 502 apparently started to fall out and stopped. The top of it is displaced over a foot at the front corner of culvert roof. With the deep lock face spalls above elevation 502, there is little bearing area left at elevation 502 at the front of culvert, daylight showing through in places.

The front wall of the culvert broke completely through horizontally for the full length of the block at construction joint elevation 502. The construction joint elevation 493 broke completely through for the upstream half of the block, but remained tight and unbroken over the downstream half. The wall broke into two pieces by a vertical break through it at the downstream edge of the wall port. There are bad spalls over the entire block face from elevation 511 to rock.

The face of the block has an old crack at elevation 522 all across the block, otherwise no significant cracks.

The back of the standing block shows a horizontal break at step elevation 506, otherwise no significant cracks. Three steps have small upstream corners broken off.

In front of blocks 8 and 9 the top 3-foot-thick layer of the rock of the lock chamber floor moved about 1 foot out over the heel trench, suggesting that it bonded to the wall and tried to move with it.

Block 9

The entire block moved back as a unit, including all of the heel key. The key cracked diagonally from elevation 490 at the downstream end to elevation 484 at about 12 feet from the upstream end.

The culvert floor, walls, and roof are complete but cracked and broken. The back corner of the roof has a 3-inch open break starting upward toward the back of block. The back corner of the floor has a 1/2-inch crack starting vertically downward. The front corner of the floor has an open break varying from 6 inches upstream to 12 inches downstream. At the culvert roof the front wall shows a 3-inch offset toward the chamber on the elevation 502 joint, similar but less than block 8.

The front wall of the culvert is essentially intact below elevation 502; the bottom joint elevation 493 is tight and unbroken; the top joint elevation 502 is broken completely through the wall for the full length of the block. There are bad spalls on the block face above and below the joint at elevation 502.

The block has a 1-foot bulkhead slot 2 feet wider than the culvert, from the culvert floor to the top of the block, at the downstream block joint;

the bulkhead fell and closes the culvert. About 1948 a floating mooring bitt recess was drilled into the block behind the lock face at about 5 feet from the downstream end. The corner of the block is broken completely loose, cracking open for the full height from the near corner of the bulkhead slot to the back of the circular mooring bitt recess. (The face slot of the mooring bitt recess was provided with curved steel armor, set in with concrete backing. Above elevation 520± this concrete backing surprisingly is sound and tight to armor and wall.)

The face of the block shows only old minor surface cracking.

The back of the block has a new crack all across the block. It is just above the elevation 526 step across the downstream half of block, then angles down to just above the 521 step and extends to the upstream end of block. The downstream corner spalled off from elevation 521 to 549. Otherwise, the back shows no significant cracks.

Block 10 - The Downstream Valve Block

The entire block moved back intact, including the entire heel key. There are no breaks in the heel key or on the outside face of the front wall of the culvert.

In the culvert the valve is jammed in closed position by differential wall movements. There is a 1-inch crack in the front corner of the floor, starting vertically down. There are old narrow cracks in the front and back corners of the roof, the back one proceeding vertically upward in the corner of the valve pit. The back wall of the valve pit has an old horizontal crack at elevation 511± and a new spalling one at elevation 509±.

The face of the block is completely free of any cracks. The back of the block shows only old minor surface cracking.

Block 11

The entire block moved back intact, including the entire heel key. There are no breaks in the heel key or on the outside face of the front wall of the culvert.

In the culvert there are indications of movement along an old crack in the front corner of the roof. There is a new 1/4-inch vertical crack in the front culvert face at 8 feet from the upstream end of block. There is a new 1/2-inch crack in the culvert floor from the above wall crack to the upstream end of block, along the front of culvert. In the back wall of culvert the elevation 493 joint shows an old crack with signs of old movement, the upper portion translated upstream 1/16 inch with respect to the lower portion. In the bulkhead slot at the upstream end of block, there is a crack across the downstream face of the slot, from elevation 511 at the front to 514 at the back.

This block has a horizontal construction joint elevation 516. On the chamber face there is a crack across the entire face of block, along the elevation 516 joint from the downstream end to the center of block, then angling down to the elevation 511 joint at the upstream end of gate recess, then roughly following elevation 511.

On the back of the block the downstream portion of all steps elevation 511 and below were broken off. The back of the block shows no significant cracks.

Block 12 - The Downstream Gate Block

The entire block moved back intact, including the entire heel key. There was some deep spalling on the face of the heel key below elevation 490. (See block 13.)

There are several bad cracks in the culvert. In the front wall: an old surface hair crack 5 feet upstream of the center of block became a 1-inch vertical break, the wall upstream of the break offset back 1 inch; a new roughly horizontal crack along the wall 3 feet above the floor in the downstream portion, branching down into two vertical ones near the center of block, all steeply vertical and of spalling nature, the wall below the crack offset back 3/4 inch; the joint at roof is loose upstream of the vertical crack, tight downstream; the bottom corner with floor is intact throughout the block. In the back wall: a new 1/4-inch vertical break near the center of the block. In the floor: a 2-inch diagonal break from the downstream back corner to the 1-inch crack in the front wall; a 1-inch break along the back corner of culvert from the upstream end to the center of block, then angling out to meet the 2-inch break. In the roof: a 2-inch diagonal break similar to the floor break from downstream back corner to the front wall break; an old transverse crack near the center of block now open 1/8 inch.

There is a new horizontal crack across the chamber face of the block, from elevation 516 at the upstream end to 511 at the downstream end, corresponding to breaks in the ends of block. There are two new vertical cracks a few feet apart near the center of the gate recess on the front face of block from the above crack down to rock. There are no horizontal cracks on the face in the heel key or the front wall of the culvert. The horizontal joint at culvert floor elevation 492 appears loose upstream of the vertical cracks, but not displaced.

There are bad breaks in both ends of block 12. Across the upstream end there is an open break from elevation 516 at the face to 521 at the back, with the block above the break offset about 3 inches downstream. Also at the back corner of the culvert a 1/4-inch crack angling back and down; and from the face of block at elevation 494, a 1-1/2-inch break angling back and down for 5 feet, then vertically to rock. Across the downstream end there is a 3-inch open break angling from elevation 521 at the back down to the rear upper corner of the culvert, offset like the upstream break, and from this break a horizontal 1/2-inch crack out to the face of block at elevation 511, with a small offset. Also a 2-inch break from the back wall of the culvert going down to rock. The front corner of the block below elevation 511 spalled off.

On the back of the block there is a break at the elevation 521 step corresponding to the main breaks visible on the ends. There is an old small crack wandering all across the block at about elevation 533. There is an old vertical crack, now open about 1/2 inch, from elevation 531 down to rock at the center of block.

Roughness in the floor of blocks 11 and 12 shows that the culvert back wall was first cast straight and parallel to the lock face, then was removed and a new wall cast to make the culvert angle alignment.

Lower Miter Sill

The miter sill was placed independently of the lock walls with a vertical construction joint at each wall.

The joint at the river wall has long been open, now open 1/2 inch.

The joint at the land wall separated essentially cleanly and the wall moved away, leaving the sill intact.

The upstream edge of the sill and the fixtures for the gate seat were broken off when the gate went out.

The top surface of the sill was not checked for cracks.

Block 13

Blocks 13, 14, and 15 collapsed, moving generally backward and downstream, then breaking up on the interior construction joints and falling forward.

In block 13 the heel key is largely intact to elevation 492 in its original position except 10 feet of the upstream end. This piece toppled back and is lying lock face up about 25 feet back and 10 feet downstream. The deeply spalled out piece of the block 12 key is just upstream of this piece and lying the same.

The culvert floor is intact in its original position where the key remains; the upstream end broke off.

The front wall of the culvert is shattered and gone.

The 7-foot-thick back buttress wall at the upstream end of the block broke off from the main block cleanly from rock up to elevation 516 and toppled downstream.

The main portion of the block broke cleanly on three horizontal construction joints, elevations 502 (the culvert roof), 516, and 536.

The piece below elevation 502 is not identifiable.

The piece above elevation 536 to top 560 is gone. It is the piece lying face down across the channel downstream of the present lock.

The main block above elevation 502 moved back, then toppled forward, breaking at elevations 516 and 536. The piece from elevation 516 to 536 is lying face down on the rock as it fell. The piece from elevation 502 to 516 is lying face down downstream of block 12, rotated about 45 degrees counterclockwise, presumably by the water rushing through the break.

Block 14

The heel key is buried under rubble of large rocks but is believed to be intact up to elevation 492 since blocks 13 and 15 are so.

The entire block moved back, then toppled forward, breaking cleanly on the interior vertical and horizontal joints described in the earlier general description. This resulted in slabs as follows:

Front wall of culvert, 10 by 4 feet, elevation 492 to 502
Back wall of culvert 14 by 4 feet, elevation 488 to 502
Back of block, 18 by 7 feet, elevation 488 to 506
Roof slab of culvert, 16 by 4 feet, elevation 502 to 506
Face of lock over culvert, 14 by 5 feet, elevation 506 to 520

The front wall of culvert was not located. The face slab over culvert is lying downstream in area of new lock. The other slabs are lying in approximately proper position in the toppled block.

The upper part of the block broke through to the back at elevation 526 when it fell, the pieces remaining together. The 7-foot back piece of the block from rock to elevation 506 broke vertically near its center when the block fell.

Block 15

The culvert ends 6.5 feet into this block with a wall port at the end. The heel key, culvert floor, and front wall of culvert are intact in original position to elevation 502.

The main downstream portion of the block has a width of 14 feet, the upstream 11.5 feet has a width of 23 feet enclosing the culvert portion, making a back buttress.

The portion downstream of the culvert is intact from key bottom to elevation 502 in its original position. The 11.5-foot buttress broke off from the rest of the block and fell downstream and back.

The main block above elevation 502 broke into indescribable pieces which were scattered by the rushing water, some lying 100 feet downstream in the new lock area.

Block 16

This is the first block of the lower guide wall. The wall was originally built to elevation 512. In 1955 additional concrete was placed to raise the wall to elevation 518.

The horizontal construction joint in block 16 at elevation 512 was completely broken off when the block was hit by the miter gate which is now leaning on this block and block 17. The downstream 13 feet of this top lift is tipped backward and caught under the gate. The rest of the lift was carried downstream into the new lock area and broken up.

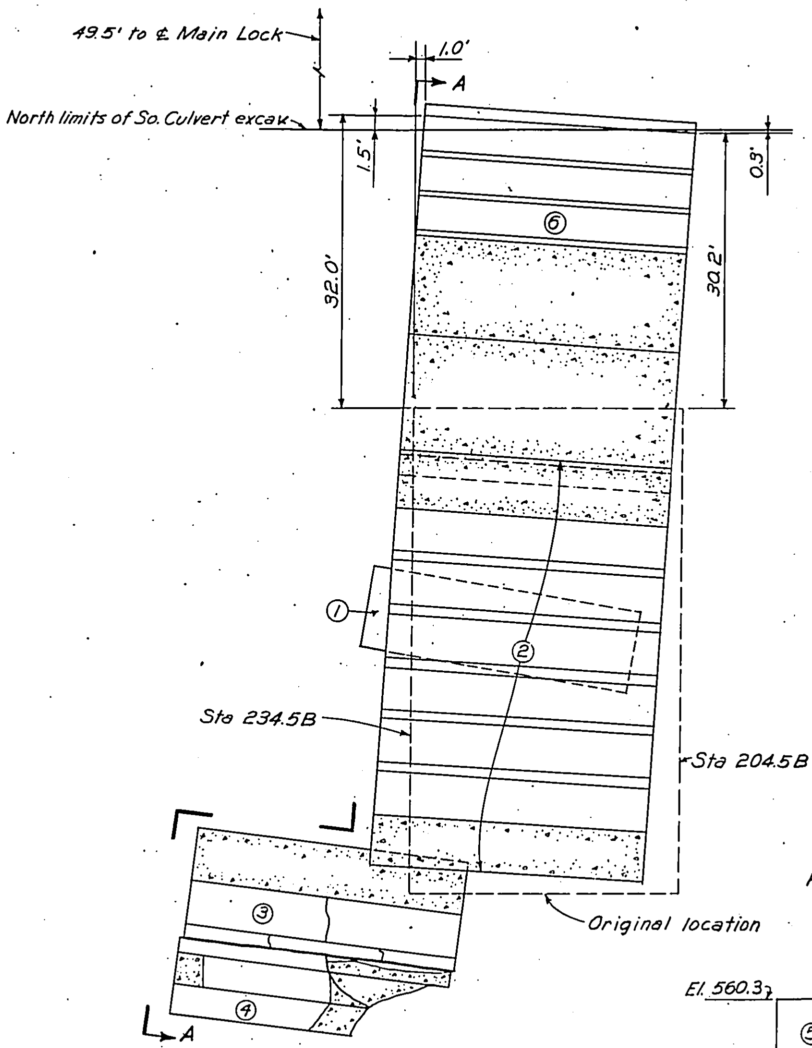
The only other obvious damage to this block is that the upstream portion of the step from elevation 499 to 504 was broken off.

Block 17

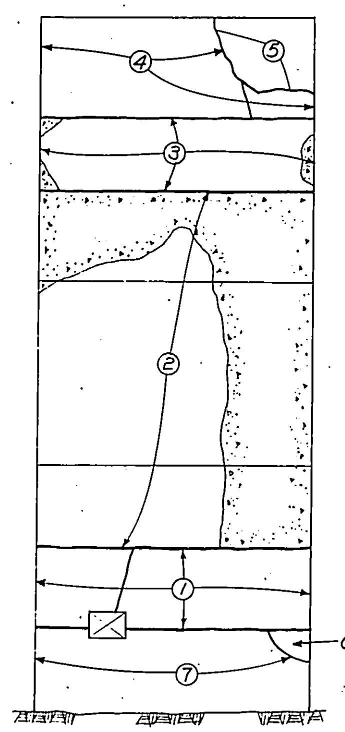
A piece of the upstream end of the added lift from elevation 512 to 518 was broken off. Otherwise, there was no obvious damage to this block.

Block 17 and the other guide wall blocks downstream from it have recently been reinforced to serve as a cofferdam wall. Holes were drilled behind the lock face of wall through the concrete and into rock. Reinforcing bars were mortared into the holes, complete to the top of the wall.

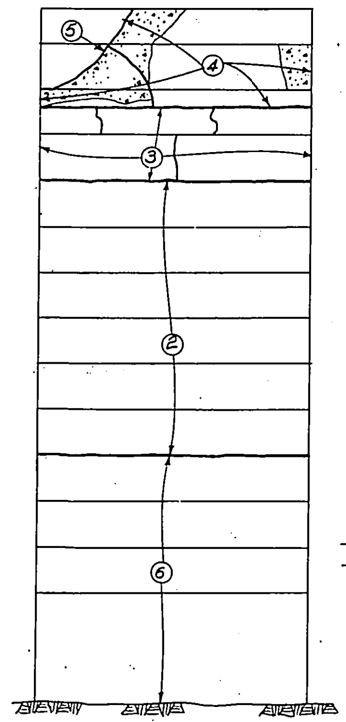
None of these blocks show any obvious defects.



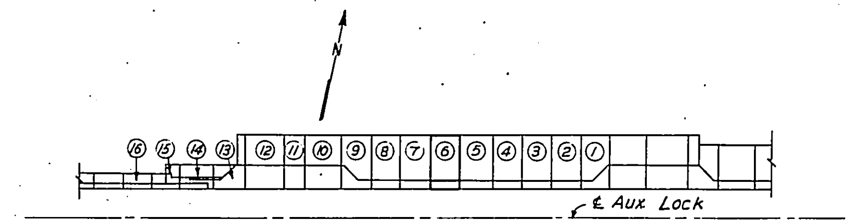
PLAN



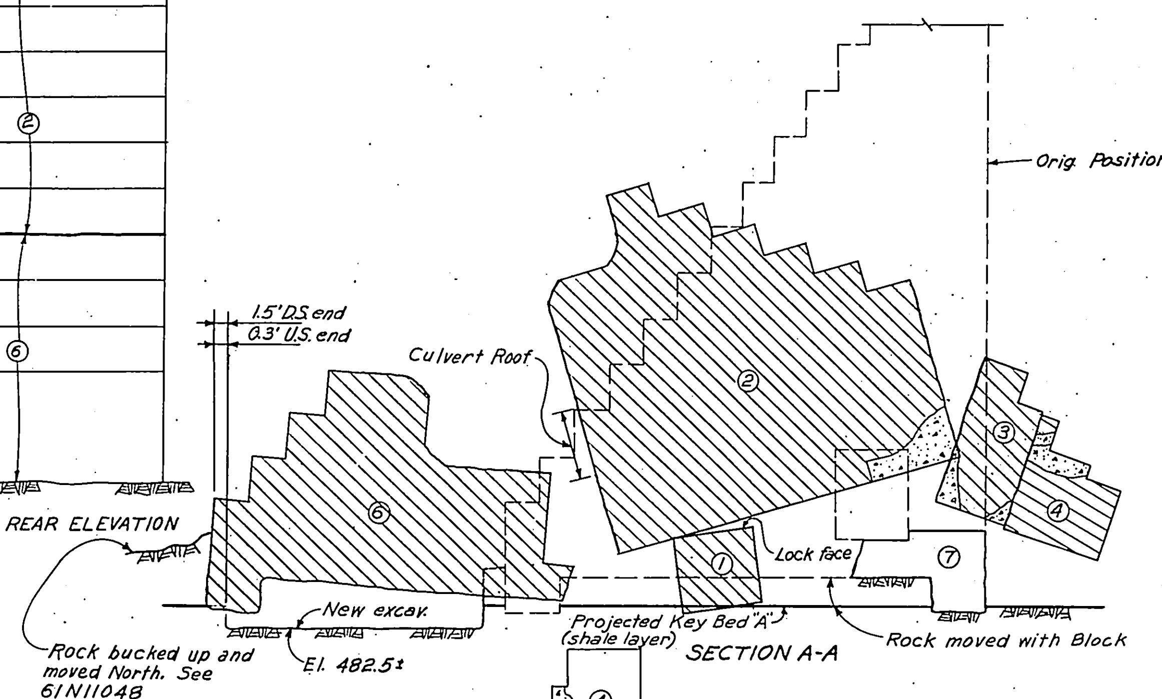
RECONSTRUCTED FRONT ELEVATION



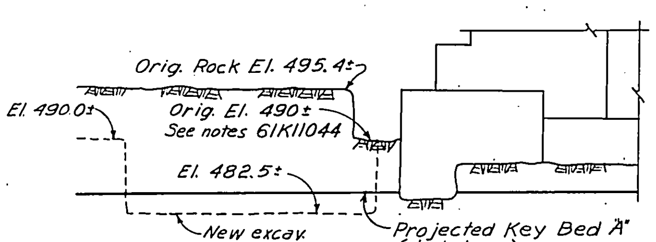
RECONSTRUCTED REAR ELEVATION



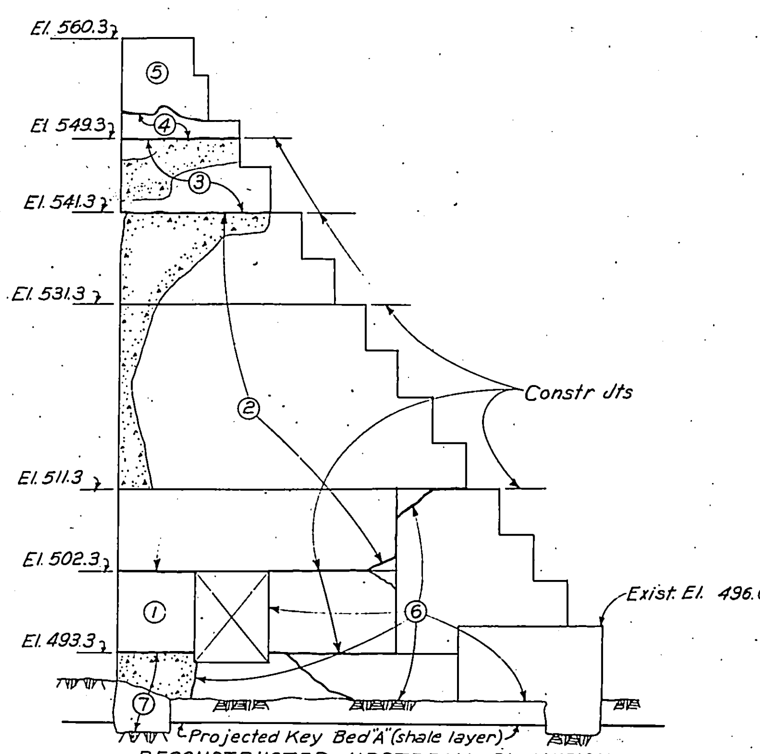
KEY PLAN - NORTH WALL
Scale: 1" = 100'



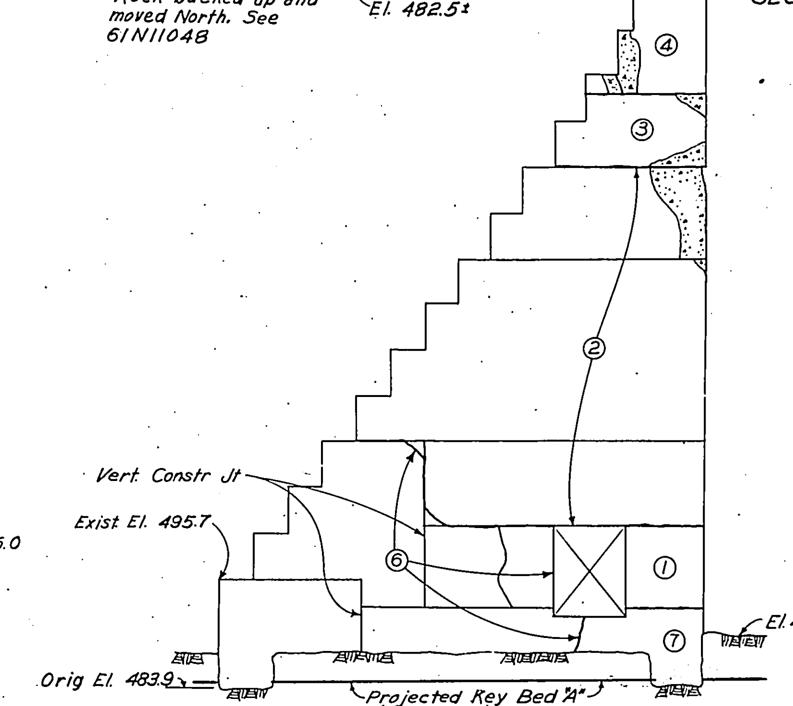
SECTION A-A



DOWNSTREAM ELEVATION SHOWING ROCK



RECONSTRUCTED UPSTREAM ELEVATION



RECONSTRUCTED DOWNSTREAM ELEVATION

Notes:
Existing location shown by "PLAN" and by A-A. Section A-A is the existing downstream elevation, and the Upstream Elevation is opposite hand and similar.

A majority of the spalled pieces are laying under the block.

All elevations shown are Design Elevations except those indicated as "Orig.", "Exist", or pertaining to new excav.

⑤ Existing location approx. Sta 516.5B and 25' North of ℄ Aux. Lock, beside the North Gate leaf of the lower gate.
⑦ In original position

Ref. Dwg 61K11044

Scale: 3/32" = 1'-0" except as noted

REV NO.	DATE	MADE	CHKD	SUPV	INSP	SUBM	RECM
2	8-29-61	JNS					
	Add Info						
1	7-31-61	JNS					
	Add Dim and Rock info						

DSGN. .... SUPV. ....
DRWN. JNS .... INSP. ....
CHKD. ....
TRCD. .... ENGINEER J. N. Stallins
COMP. ....

AUXILIARY LOCK

EXISTING CONDITION
BLOCK 6
NORTH WALL

WHEELER PROJECT
TENNESSEE VALLEY AUTHORITY
DIVISION OF CONSTRUCTION

SUBMITTED	RECOMMENDED	APPROVED
W. T. Webb	H. L. Bond Jr.	W. [illegible]

FIELD OFFICE | 7-13-61 | 3 | PC | 4 | 61K11059 R2

RECORD DRAWING AS CONSTRUCTED

TENNESSEE VALLEY AUTHORITY

Office of Chief Engineer

APPENDIX B

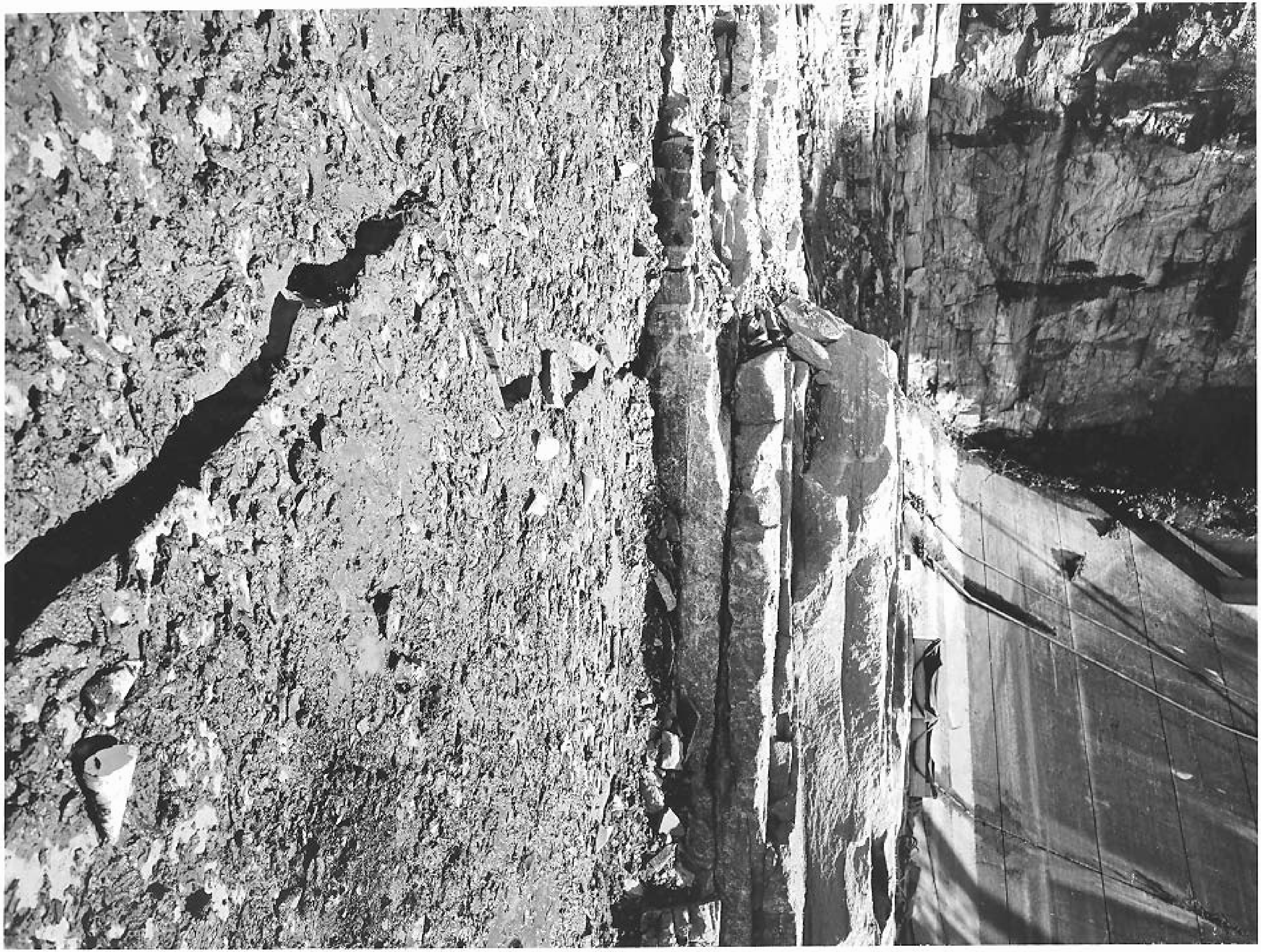
PHOTOGRAPHS OF WHEELER LOCK AND AREA

AFTER FAILURE

Knoxville, Tennessee

November 1961

Wheeler Lock and Dam
Looking Upstream



WHEELER LOCK Tennessee Valley Authority 3L1100 June 15, 1961 C.Quillen, Wilson Dam	Looking upstream at crack in rock.

WHEELER LOCK Tennessee Valley Authority 3L1098 June 15, 1961 C.Quillen, Wilson Dam	Looking east at line drill holes at southwest corner of upper miter sill ledge.

WHEELER LOCK Tennessee Valley Authority 3L1099 June 15, 1961 C.Quillen, Wilson Dam	Looking south at line drill holes on north face of upper miter sill ledge.

WHEELER LOCK
Tennessee Valley Authority
3L1103 June 15, 1961
C. Quillen, Wilson Dam

Looking downstream at crack in rock.

WHEELER LOCK
Tennessee Valley Authority
3L1102 June 15, 1961

Looking downstream at crack in rock. Note crane runway reinforcing.

TENNESSEE VALLEY AUTHORITY

Office of Chief Engineer

APPENDIX C

FOUNDATION INVESTIGATION

LOCK MONOLITHS NOS. 1 - 72, INCLUSIVE

GENERAL JOE WHEELER LOCK AND DAM

TENNESSEE RIVER

Datum: All elevations given in the consultants' report, in appendix A, on TVA drawings in the appendixes, and in the exhibits have been adjusted to that of the U.S.C. & G.S. 1929 adjustment. Elevations given on all Corps drawings, etc., in this report are 0.3 foot lower based on the 1912 datum.

Knoxville, Tennessee

November 1961

FOUNDATION INVESTIGATION

LOCK MONOLITHS NOS. 1 - 72, INCLUSIVE

GENERAL JOE WHEELER LOCK AND DAM

TENNESSEE RIVER

FOUNDATION INVESTIGATION, LOCK MONOLITHS NOS. 1-72, INCLUSIVE,

GENERAL JOE WHEELER LOCK AND DAM, TENNESSEE RIVER.

1. General procedure.—Paragraph 1-07 of the specifications called for the drilling of test holes in advance of excavating operations. This matter was discussed with the contractor, and due to the depth of rock cut, which in some instances was 17 feet to the bottom of the keyway, it was considered advisable to proceed with excavation to theoretical grades and proceed from there with foundation investigation. This decision was reached after a thorough study of the core borings; and, because of the specifications limiting the test holes to 20 feet, in a 17-foot cut of rock only 3 feet of the test hole would be a sample of the actual foundations. However, as the contractor started excavation in the deepest cut, which was at the lower gate bays, a careful study was made of the foundation as excavating operations advanced, and from Sta. 55A land wall, where the foundation steps up, to Sta. 430A, test holes were drilled ahead of rock removal because only a two or three-foot cut was required. In no case was it necessary to go deeper than theoretical grades except at the lower guide wall where a 2' x 4' keyway was added; in Monolith No. 81 of the cut-off wall where the rock broke in vertical seams; and a few places where rock was loosened or shattered due to heavy blasting.

2. Test holes.—After the rock cut was made and just before the foundation was prepared, a minimum of two ten-foot and one twenty-foot test and grout holes were drilled. A log of the holes was kept, and a description of the actual conditions encountered is outlined on attached plan. In cases where it was thought necessary, additional holes were drilled and all holes piped above the foundation pour for grouting.

3. General description of foundation conditions:

(a) Lower Guide Wall - Monoliths Nos. 1 to 11, inclusive, Sta. 453.5B to Sta. 800B.

The overburden consisted of approximately 82 per cent mud and silt and 18 per cent loose, flat rock, varying in depth from 3 inches to 1.5 feet. The average natural rock elevation sloped from elevation 492± in Monolith No. 1 to Elevation 495± in Monolith No. 11. The river face of the rock was channeled and the rock shot out to an average elevation of 437.7±. Rock was removed to a line five feet back of the land side of the wall to prevent blasting next to the concrete during construction of a future main lock. Due to the fact that this section of the wall may be used as a cofferdam for the main lock, and because the foundation generally was flat and level, it was decided to add a small keyway for stability and additional seal. Therefore, a 2' x 4' keyway was added from Sta. 800B to the 4' x 6' keyway in Monolith No. 12. Photographs Nos. 77, 48, and 63 are typical foundation views for this section of the wall.

The foundation proper consisted of a hard, fine grained, blue limestone underlaying a coarse grained, gray limestone on the surface. Small deposits of quartzite were found. In some instances where the limestone was hard and flintlike, the rock shattered badly from blasting. See Photograph No. 7. The rock lay in stratas from 6 inches to 4 feet thick, separated by close, tight seams. A 2-inch test hole, 20 feet deep, was drilled in Monoliths Nos. 1 to 11, inclusive, but no grouting was considered necessary for this section of wall. The attached general layout sheet shows the log of test holes and seams encountered. In Monoliths Nos. 1 and 2 a small amount of surface water ran under the forms above the lock face rock ledge. This seepage was pocketed in the upstream end of the keyway and removed with a pump until the concrete being placed reached an elevation above the rock ledge and sealed off this flow. No seepage water through open seams in the rock was encountered.

(b) Land Wall Proper - Monoliths Nos. 12 to 27, inclusive, Sta. 453.5B to Sta. 56.0A.

The overburden for this section of wall consists of approximately 85 per cent muck and silt and 15 per cent loose slab rock and boulders, varying from 6 inches to 3 feet in depth. The average natural rock elevation was from elevation 493.7± to elevation 496.2±. The river face of the wall and a line 5 feet from the landside of the wall were channeled and the rock removed to elevation 483.8±. The wall was later widened and an additional keyway added on the back side of the wall. In Monolith No. 12 the surface of the rock was a hard, close grained limestone with a few close horizontal seams. The bottom of the foundation was a harder, finer grained flintlike, blue limestone with small deposits of quartzite specked about its surface. The bottom of the keyway was similar to the bed. A 20-foot test hole revealed a dry hole and a satisfactory foundation. In Monoliths Nos. 13 and 14 the rock was similar to that in Monolith No. 12. In the foreground of Photograph No. 3, Monolith No. 13, is a large vertical seam. To the right of this is another. These seams are tight and appear to be well sealed. The rock, being very brittle, was shattered by blasting and shot holes are visible in Photograph No. 5. Test and grout holes shown on the attached sheet were grouted at a later date.

In Monoliths Nos. 15, 16 and 17, the original rock surface was found to be a comparatively level, hard and coarse grained, gray limestone. The foundation proper was of a harder, finer grained, blue limestone. Being somewhat brittle, the rock was shattered as can be noted in Photograph No. 27, of Monolith No. 15. Several seams were discovered by test hole drilling, but later grouting operations showed these seams to be tight and, in general, the holes indicated a hard strata of blue limestone with no seepage.

The foundation for Monoliths Nos. 18, 19, and 20 was practically the same kind of limestone as encountered in Monoliths Nos. 15, 16, and 17, except possibly not as brittle. Straight, vertical faces on the keyways were maintained as shown on Photographs No. 60 and No. 133, while the rock surface was even and level. No seepage was apparent through seams, and test holes revealed a hard, tight foundation.

The foundation for the remainder of this section of wall, Monoliths Nos. 21 to 25, inclusive, consisted of a surface stone of gray, chalklike, coarse grained limestone, changing into a finer, blue, close grained limestone, in some cases very brittle and laying in sheets as shown in Photograph No. 102. The rock was very brittle and hard, and several keyway faces were lost in blasting.

In Monoliths Nos. 26 and 27, the rock was similar to that encountered in Monoliths Nos. 18 and 19. The keyway faces were maintained and a level foundation was obtained, as shown on Photographs Nos. 119 and 120. No seepage water was encountered and test holes revealed very few wet seams. All holes were grouted and results indicated a good, tight foundation.

(c) Upper Guide Wall - Monoliths Nos. 28 to 37, inclusive, and Monolith No. 72. Sta. 56.0A to 450.0A.

The overburden consisted of approximately 90 per cent mud and silt and 10 per cent flat, slab rock, varying in depth from 6 inches to 1.5 feet. The natural rock sloped from elevation 495.7± in Monolith No. 28, to elevation 498.0± in Monolith No. 37. Because of the shallow cut to the foundation base, and because of vertical cracks exposed on the natural rock surface, it was thought best to investigate the foundation before drilling and blasting. Test holes ten feet deep were drilled on the center line of the wall on 50-foot centers, and it was found that a satisfactory foundation could be secured at elevation 492.0±.

The foundation material was a hard, gray, coarse grained limestone at the surface, changing to a finer grained, blue limestone at the bed.

In Monoliths Nos. 28 to 33, inclusive, and Monolith No. 72, quite a few seams were discovered, as shown on the accompanying sketch. Vertical faces were maintained on the keyway, but the rock surface was inclined to be a bit scaly, as shown in Photograph No. 162. In Monolith No. 28, where the foundation steps up to elevation 492 from elevation 488, quite a bit of the corner of the keyway was loosened by blasting, and it was necessary to remove it. Test and grout holes were piped above the foundation pour and grouted at a later date.

In Monoliths Nos. 34 to 37, inclusive, the general appearance of the rock was the same as in the remainder of the wall, except possibly not as scaly and brittle. See Photograph No. 222. Test and grout holes were piped above the foundation pour and grouted in such cases as were considered necessary.

(d) Upper Guard Wall and River Wall Proper - Monoliths Nos. 48 to 65, inclusive, Sta. 131.0A to 449.58B.

From Monoliths Nos. 48 to 55, inclusive, the overburden consisted of approximately 85 per cent mud and silt and 15 per cent flat, slab rock. In Monoliths Nos. 56 to 65, inclusive, the percentage of slab rock ran as high, in some cases, as 50 per cent, the remainder of the overburden being mud and silt with a few patches of gravel. The natural rock elevation sloped from elevation 496.3± in Monolith No. 48 to elevation 493.2± in Monolith No. 65. Both river and land faces of the wall were channeled and the wall widened due to changes in design, but no keyway added on the river side of the wall as in the case of the land wall.

In Monoliths Nos. 48 and 49, the foundation bed consisted of a fine grained, blue limestone. An excellent foundation was obtained for both blocks. However, in Monolith No. 49, where the foundation steps down from elevation 492 to elevation 488, the rock was shattered somewhat by blasting. Test holes drilled in Monolith No. 49 revealed two seams which are visible in Photograph No. 181 of Monolith No. 50. The seams were dry, however, and subsequent grouting operations proved them to be fairly tight. Photograph No. 181 also shows the excellent foundation obtained for Monolith No. 50, and the vertical faces obtained on the keyways. As also noted in the same photograph, the rock lay in layers from 2 to 4 feet in thickness.

In Monoliths Nos. 50 to 56, inclusive, during excavating operations, the rock broke to a seam approximately .5 feet to one foot below theoretical grade. Rock was removed to this seam, as shown in Photograph No. 130. Another seam was discovered in the bottom of the keyway, 4± feet below the foundation proper. Test holes revealed further seams, but as all holes were dry and seams apparently tight, the foundation was considered satisfactory. The foundation for this section of wall was probably the poorest encountered on the entire job.

In Monolith No. 57, the foundation was stepped back above the seam, and a better grade of rock was apparent. Note absence of seam in keyway picture No. 86, of Monolith No. 58, and step in foundation of Monolith No. 57 in Photograph No. 87. The foundation proper was a hard, blue grained limestone. The foundation material for Monoliths Nos. 59, 60, and 61 was a brittle, flintlike limestone, that was easily shattered by blasting.

In Monolith No. 59 a large corner of the keyway was lost as the rock broke to a vertical seam shown in Photograph No. 81. The vertical seam remaining in the foundation was tight and the rock solid. Test and grout holes were piped above the foundation pour and grouted at a later date.

The foundation for Monoliths Nos. 62 to 65, inclusive, was a hard, blue grained limestone and laying in horizontal stratas. Vertical keyway faces were maintained and a very satisfactory foundation obtained. See Photograph No. 18.

(e) Lower Guard Wall - Monoliths Nos. 66 to 71, inclusive, Sta. 449.53B to Sta. 645.0B.

A shallow overburden, consisting largely of river mud combined with a small percentage of large, loose, flat, soft limestone boulders, was removed from the surface of a hard, coarse grained limestone rock. The natural rock elevation was practically level at an elevation of 495.5±. The foundation proper was a hard, fine grained, blue, flintlike limestone, that shattered from blasting. Fairly good vertical faces were maintained, however. A 2-inch test hole was drilled in each of the monoliths but as this section of wall is not subject to a hydrostatic head, grouting was not considered necessary. A view typical of the condition as existed is shown on Photograph No. 53. The top of the vertical face illustrated is natural rock. No water seepage was encountered in the entire section of wall.

(f) Lower Miter and Emergency Sills - Monoliths Nos. 42 and 43.

The foundation material was a hard, gray, coarse grained limestone rock at the surface, which changed to a finer grained, brittle, blue limestone at the bed. The rock structure was hard, dense, and free from open seams and seepage. Vertical faces were maintained except at the walls where the rock face was broken due to heavy blasting for the walls proper. The vertical face broken on the upstream side of the miter sill, as shown in Photograph No. 237, was due to the change in design of the sills as excavation for the original sill was under way when the change was made. Test and grout holes in both sills revealed no seepage or seams, but were piped above the foundation for grouting. During grouting operations water was pumped through the relief drains in both sills to keep them open.

(g) Upper Miter and Emergency Sills - Monoliths Nos. 40 and 41.

The rock structure was a hard, coarse grained limestone at the surface and a finer grained, blue limestone at the bed, providing an excellent foundation for the sills. Due to the depth of the upstream rock cut, the channeling was made in two steps. The first drilling was from natural rock to elevation 483.0±, but the rock broke approximately .8 foot deeper due to a seam at that point. The upstream face was then stepped in 8± inches, and drilled to elevation 464.0±, to the bottom of the keyway. The upper cut contained several seams that can be seen in Photograph No. 241, and these seams are at approximately the same elevation as those found in the upper guide wall foundations. However, the foundation proper was good, test holes all dry and without seams except Nos. 1 and 2, where a wet seam was hit approximately 10 feet below the foundation bed. These two holes discharged no seepage water.

A portion of the downstream face broke out to the seam at the foundation level, as shown in Photograph No. 243. This rock was removed outside the sill proper and the remaining space filled with concrete to elevation 490.0, the level of the lock chamber. The foundation bed is illustrated in Photograph No. 246. Test and grout holes were drilled and grouted, as shown on the attached sketch. During grouting operations water was pumped through the relief drains to insure their clearance.

4. Grouting.—All grout and test holes were piped to the top of the foundation pour and into the lock tunnel; therefore, all grouting operations were conducted at a later date. A small air driven pump was used for grouting and if excessive grouting had been required this pump would have been impractical as only cement and water mixtures could be pumped. The amount of grout used in most cases was very small, however, and a mixture of sand, cement, and water not necessary.

5. Recommendations.—No additional steps are recommended to protect this structure from seepage.

C. E. Perry,
Major, Cops of Engineers,
District Engineer.

Incls.
Dwgs. 02-L3-10/12, 6530
Photographs 3, 5, 7, 18, 27, 48, 58, 60, 63, 61, 86, 87, 102, 119, 120, 130, 133, 162, 181, 222, 237, 241, 243, and 246.

U. S. Engineer Office,
Nashville, Tennessee.
February 15, 1935.


MON. Nº13
TENN. RIVER - CHATT. DIST.
LOCK & DAM Nº 3 -- 60 ft. LOCK
Land Wall Mon. Nº 13
Downstream View
April 21, 1933 Photo Nº 3

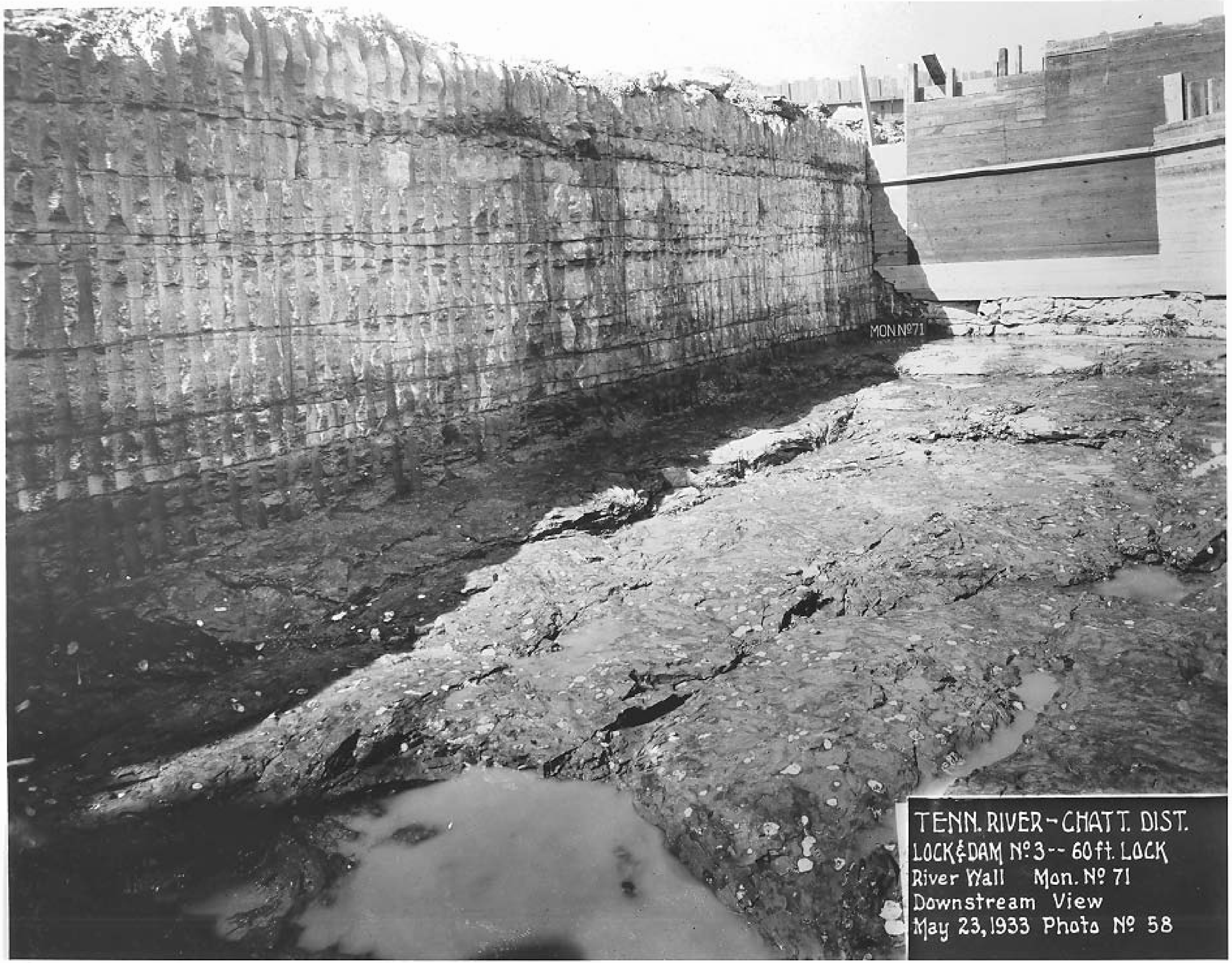

MON. Nº 13
TENN. RIVER - CHATT. DIST
LOCK & DAM Nº 3 -- 60 ft. LOCK
Land Wall Mon. Nº 13
Downstream View
April 21, 1933 Photo Nº 5


Mon Nº 10
TENN. RIVER - CHATT. DIST.
LOCK & DAM Nº 3 -- 60 ft. LOCK
Land Wall Mon. Nº 10
Downstream View
April 24, 1933 Photo Nº 7

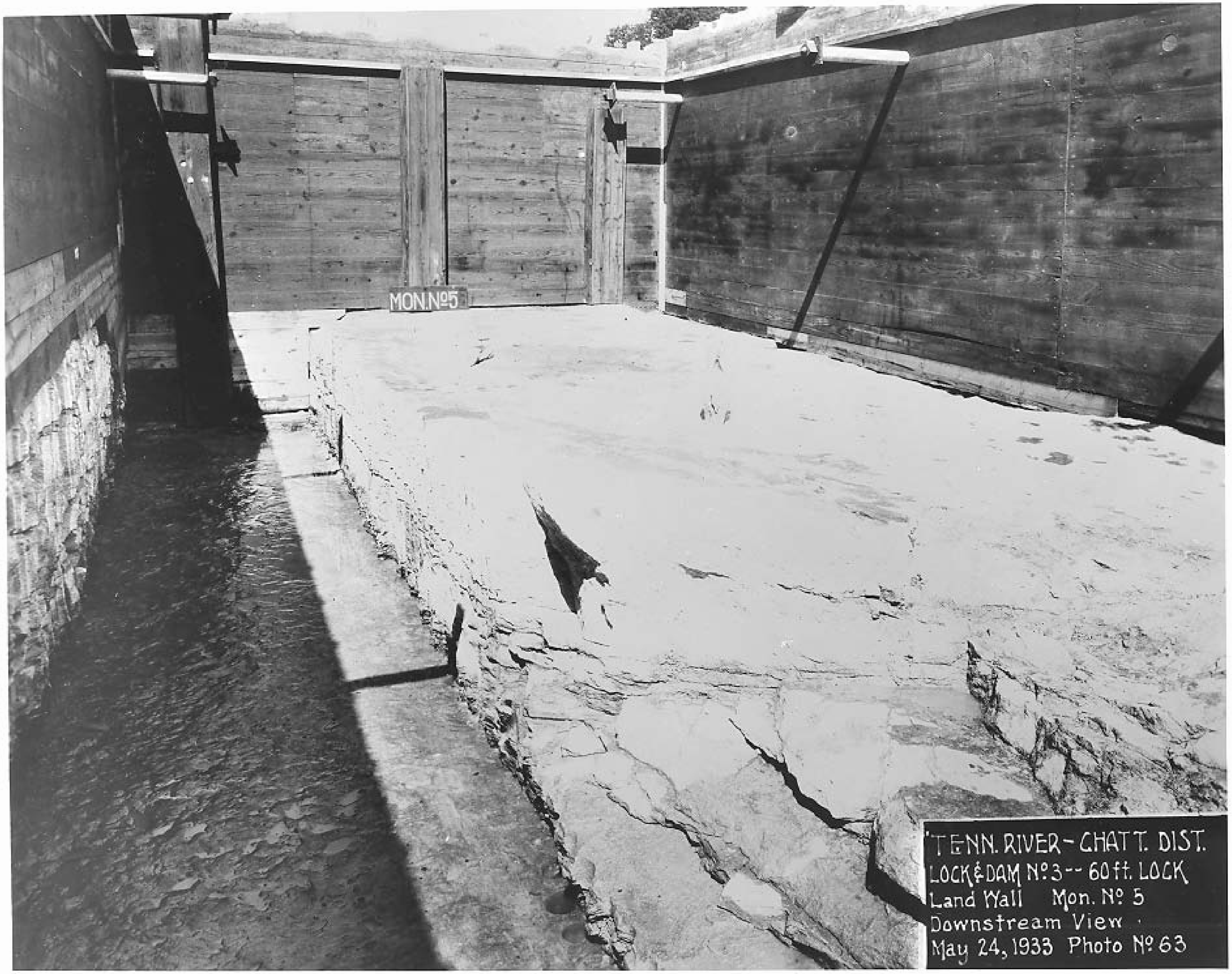

MON. Nº 64
TENN. RIVER - CHATT. DIST.
LOCK & DAM Nº 3 -- 60 ft. LOCK
River Wall Mon. Nº 64
Riverside
April 29, 1933 Photo Nº 18


MON.Nº15
TENN. RIVER - CHATT. DIST.
LOCK & DAM Nº 3 -- 60 ft. LOCK
Land Wall Mon. Nº 15
Downstream View
May 4, 1933 Photo Nº 27


MON. Nº7
TENN. RIVER - CHATT. DIST.
LOCK & DAM Nº 3 -- 60 ft. LOCK
Land Wall Mon. Nº 7
Upstream View
May 12, 1933 Photo Nº 48

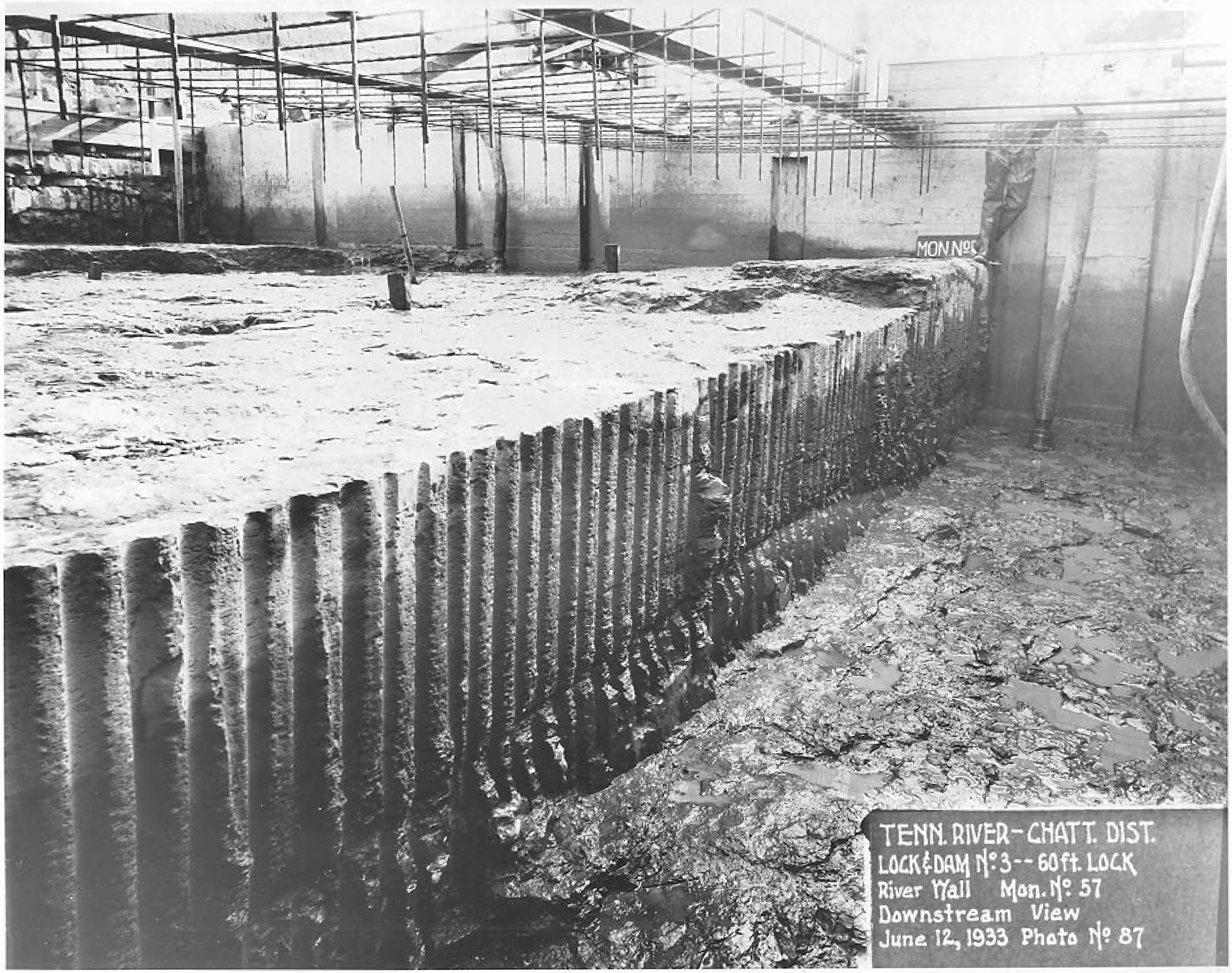

MON No 71
TENN. RIVER - CHATT. DIST.
LOCK & DAM No 3 -- 60 ft. LOCK
River Wall Mon. No 71
Downstream View
May 23, 1933 Photo No 58

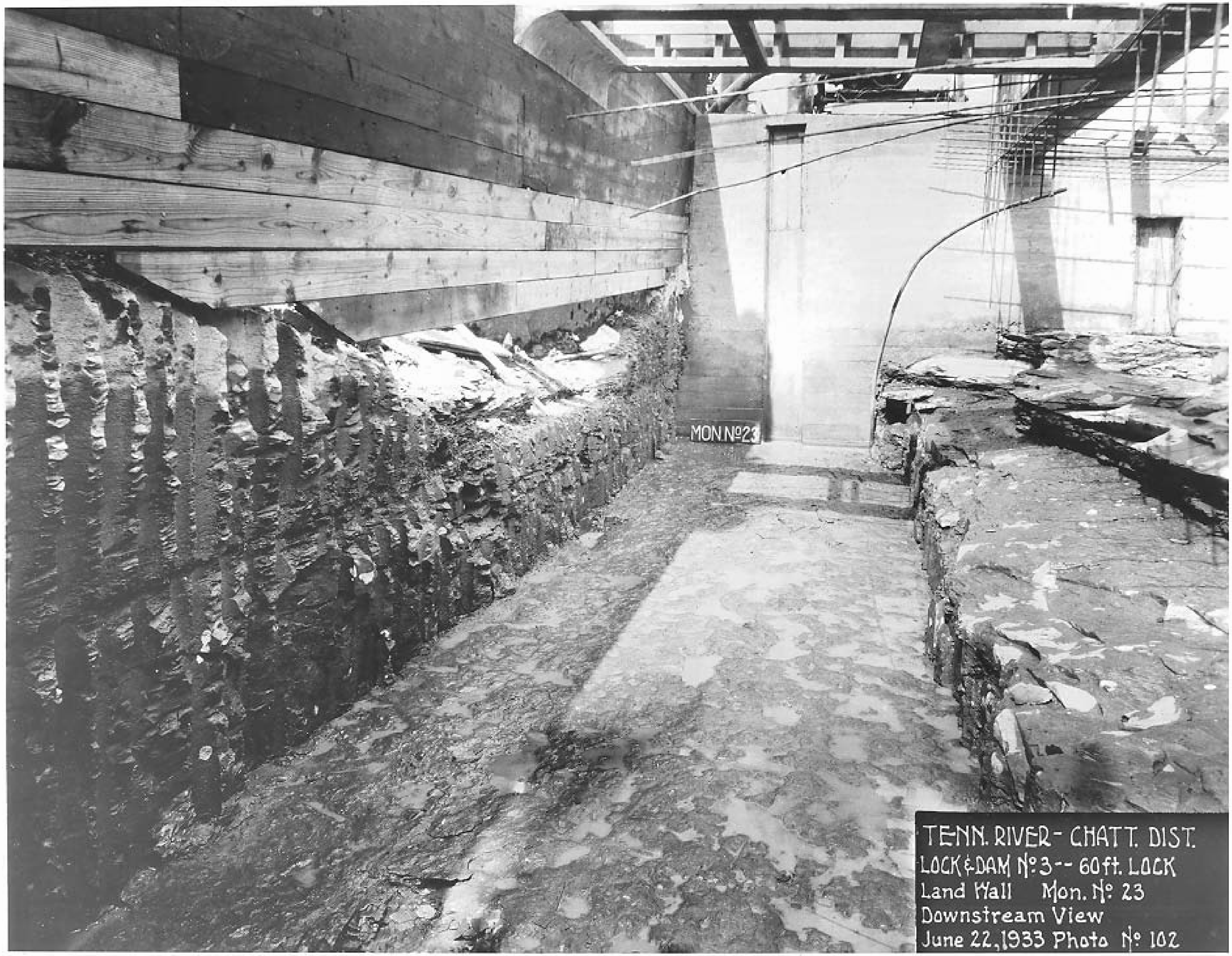

MON. №18
TENN. RIVER - CHATT. DIST.
LOCK & DAM №3 -- 60 ft. LOCK
Land Wall Mon. № 18
Downstream View
May 24, 1933 Photo № 60


MON. No 5
TENN. RIVER - CHATT. DIST.
LOCK & DAM No 3 -- 60 ft. LOCK
Land Wall Mon. No 5
Downstream View
May 24, 1933 Photo No 63

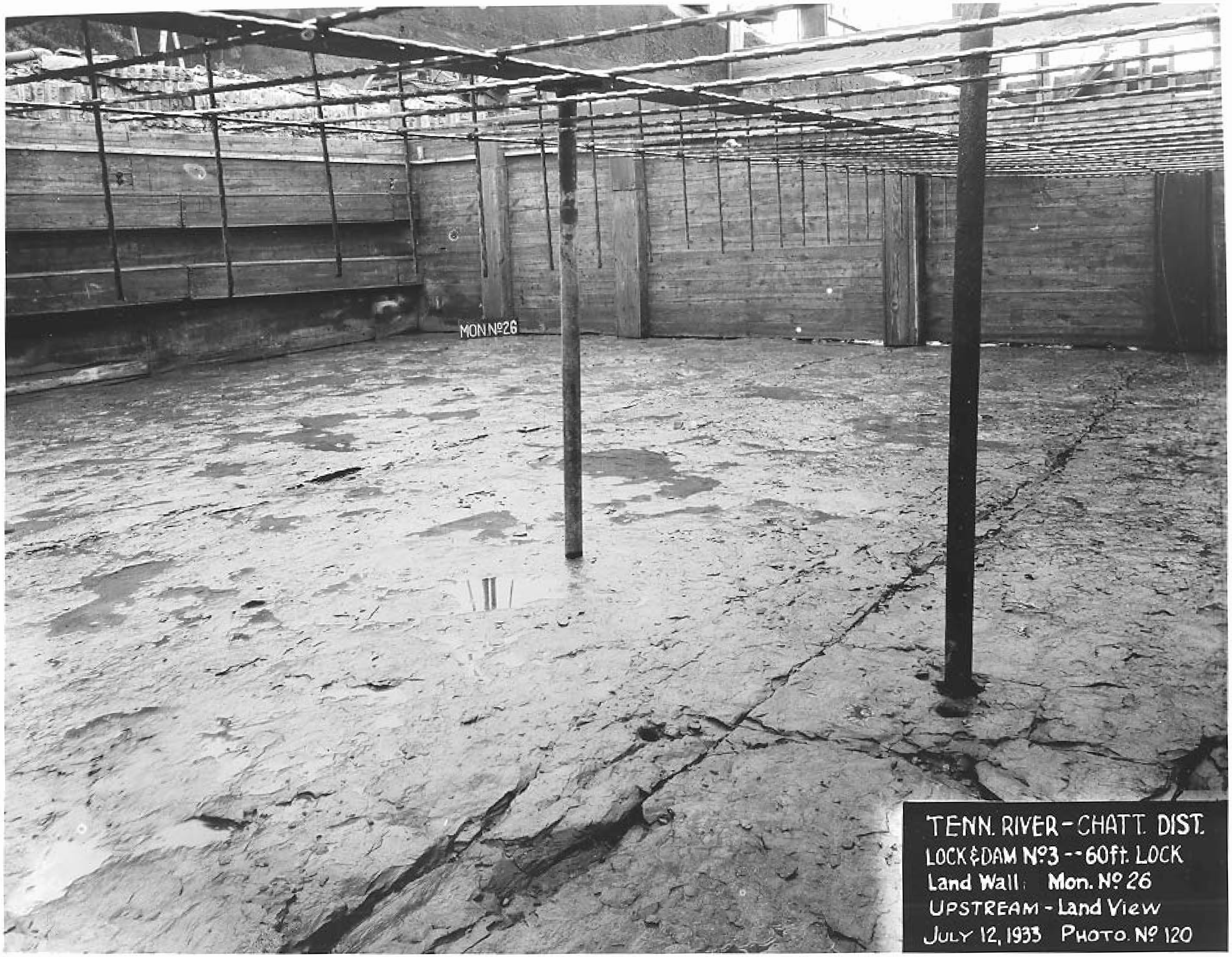

MON. Nº59
TENN. RIVER - CHATT. DIST.
LOCK & DAM Nº 3 -- 60 ft. LOCK
River Wall Mon. Nº 59
Upstream View
June 3, 1933 Photo Nº 81


MON Nº 58
TENN. RIVER - CHATT. DIST.
LOCK & DAM Nº 3 -- 60 ft. LOCK
River Wall Mon. Nº 58
Upstream View
June 7, 1933 Photo Nº 86


MON No.
TENN. RIVER - CHATT. DIST.
LOCK & DAM No 3 -- 60 ft. LOCK
River Wall Mon. No 57
Downstream View
June 12, 1933 Photo No 87


MON Nº23
TENN. RIVER - CHATT. DIST.
LOCK & DAM Nº 3 -- 60 ft. LOCK
Land Wall Mon. Nº 23
Downstream View
June 22, 1933 Photo Nº 102

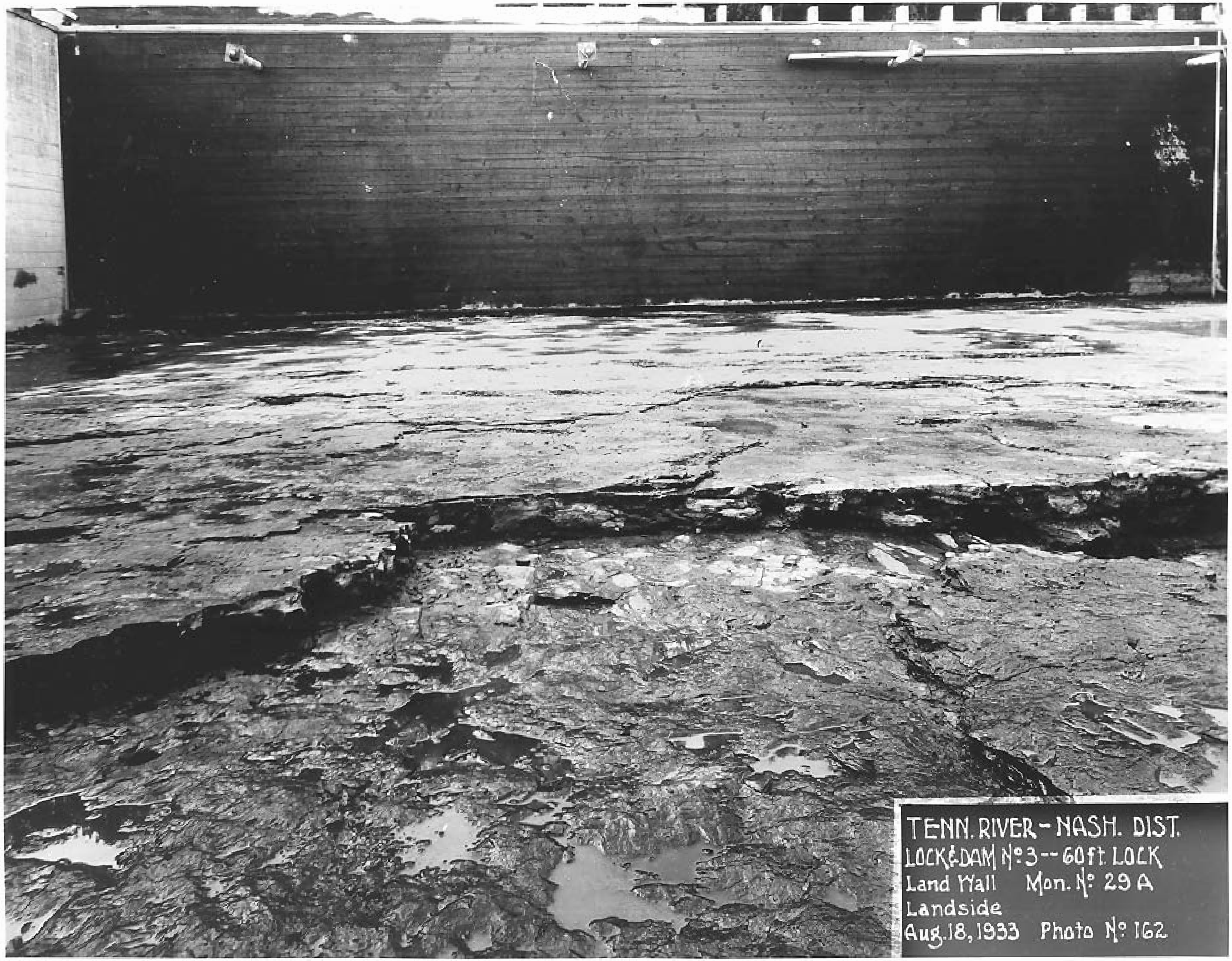

TENN. RIVER - CHATT. DIST.
LOCK & DAM Nº 3 -- 60 ft. LOCK
Land Wall Mon. Nº 26
UPSTREAM
JULY 12, 1933 PHOTO. Nº 119

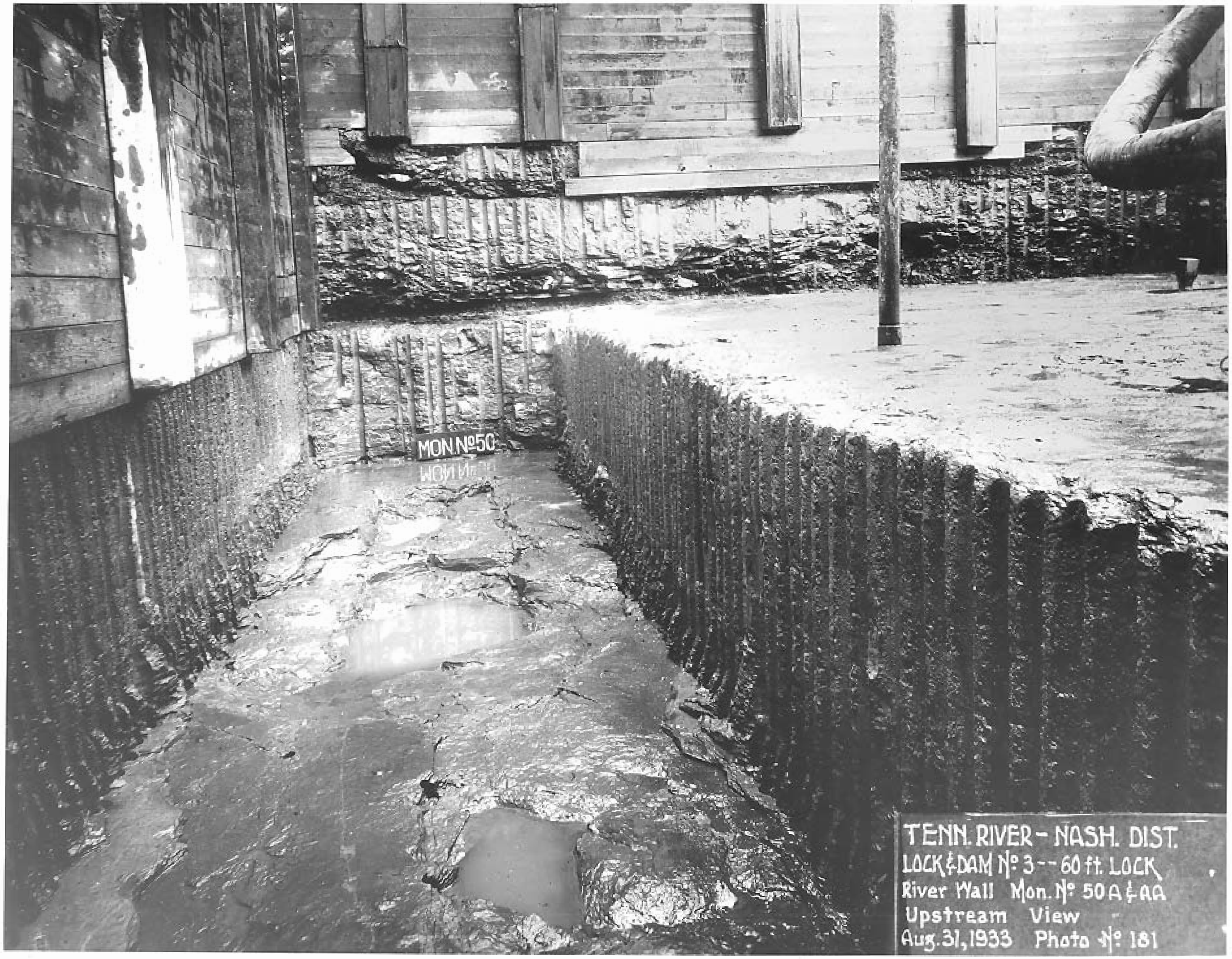


MON Nº26
TENN. RIVER - CHATT. DIST.
LOCK & DAM Nº3 -- 60ft. LOCK
Land Wall: Mon. Nº 26
UPSTREAM - Land View
JULY 12, 1933 PHOTO. Nº 120


TENN. RIVER - CHATT. DIST.
LOCK & DAM Nº 3 - - 60 ft. LOCK
River Wall Mon. Nº 51A
UPSTREAM - River View
JULY 21, 1933 PHOTO Nº 130


TENN. RIVER - CHATT. DIST.
LOCK & DAM No. 3 -- 60 ft. LOCK
Land Wall Mon. No. 18 AA
Upstream View
July 26, 1933 Photo No. 133

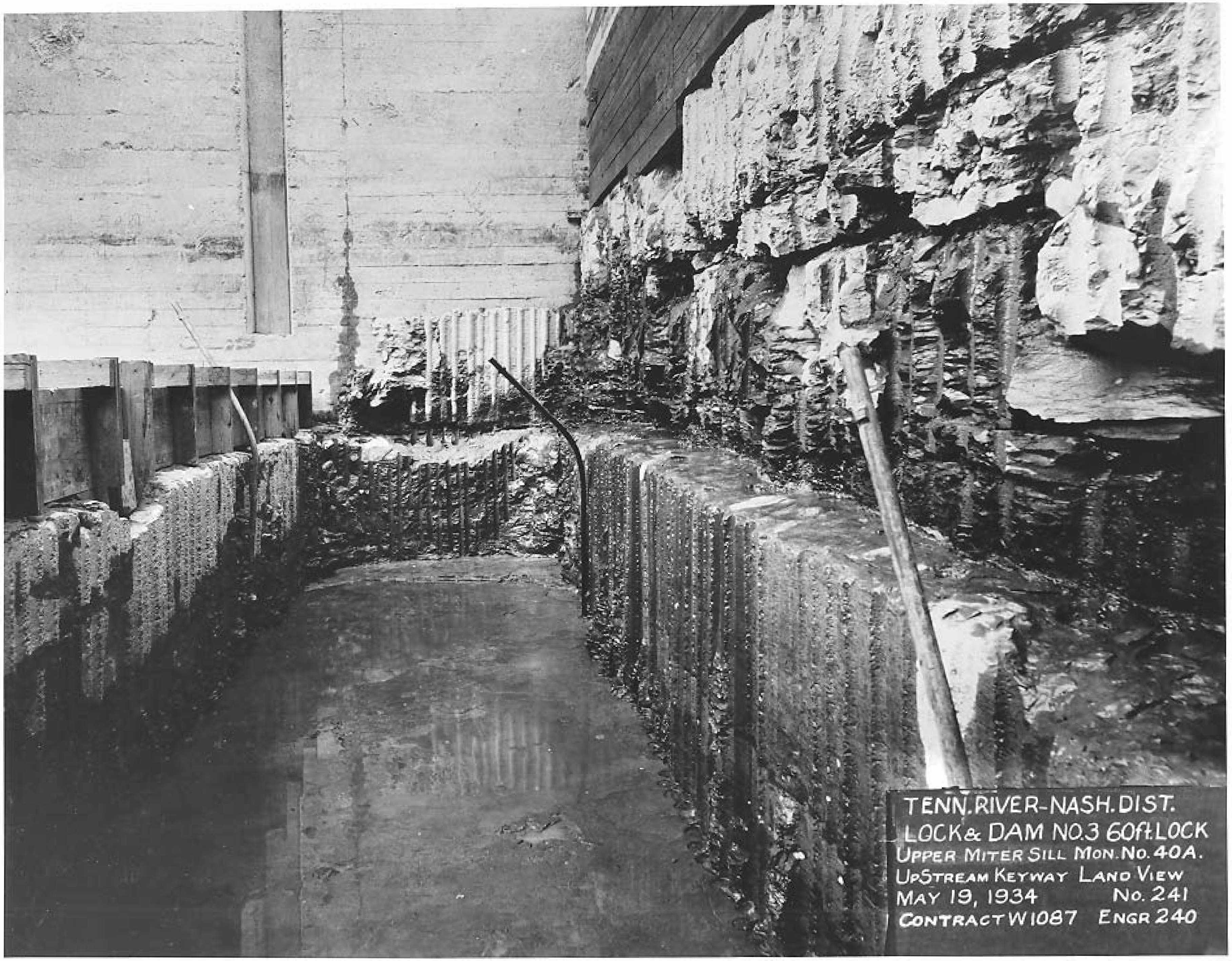

TENN. RIVER - NASH. DIST.
LOCK & DAM No. 3 -- 60 ft. LOCK
Land Wall Mon. No. 29 A
Landside
Aug. 18, 1933 Photo No. 162



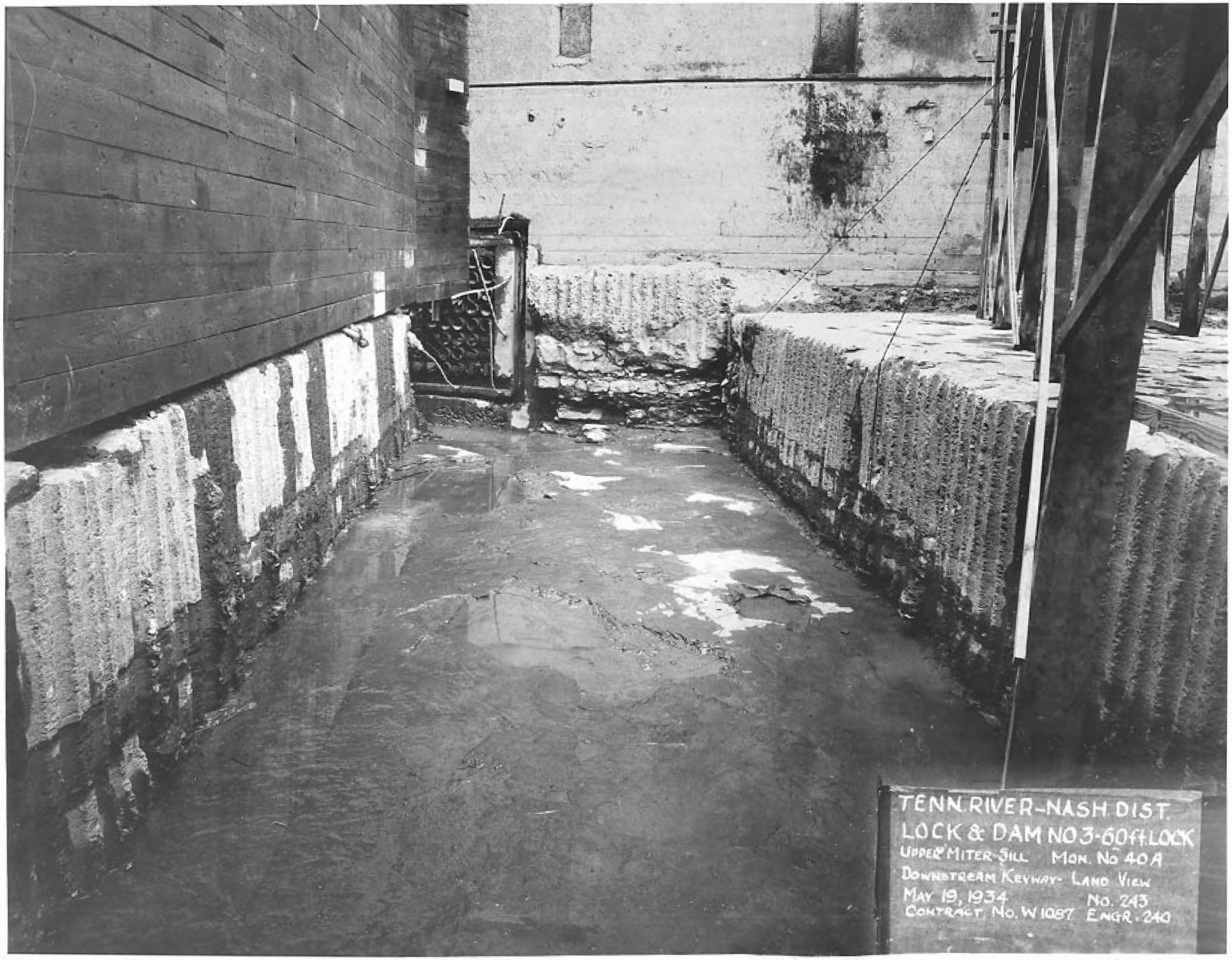
MON. Nº 50
TENN. RIVER - NASH. DIST.
LOCK & DAM Nº 3 -- 60 ft. LOCK
River Wall Mon. Nº 50 A & AA
Upstream View
Aug. 31, 1933 Photo Nº 181

MON No. 3?
TENN. RIVER - NASH. DIST.
LOCK & DAM No. 3 - 60 ft. LOCK.
Land Wall Mon. No. 35A
River View
Date - Jan 5, 1934 No. 222
CONTRACT W1087-ENG.240

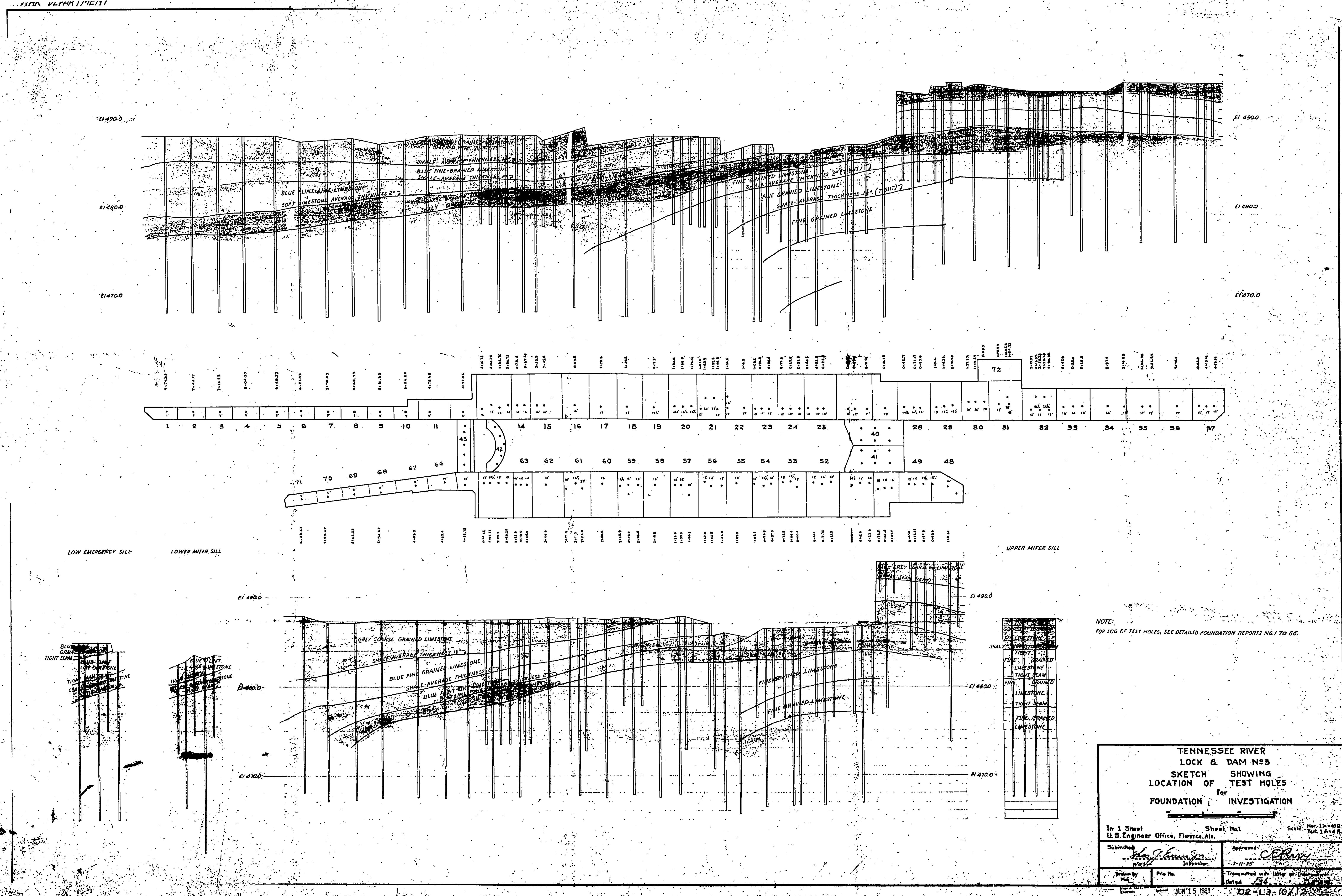

TENN. RIVER-NASH. DIST.
LOCK & DAM NO.3 60ft LOCK
LAND VIEW MON. No. 42A
DATE-MAR. 31, 1934 No. 237
CONTRACT No. W1087 ENG. 240.



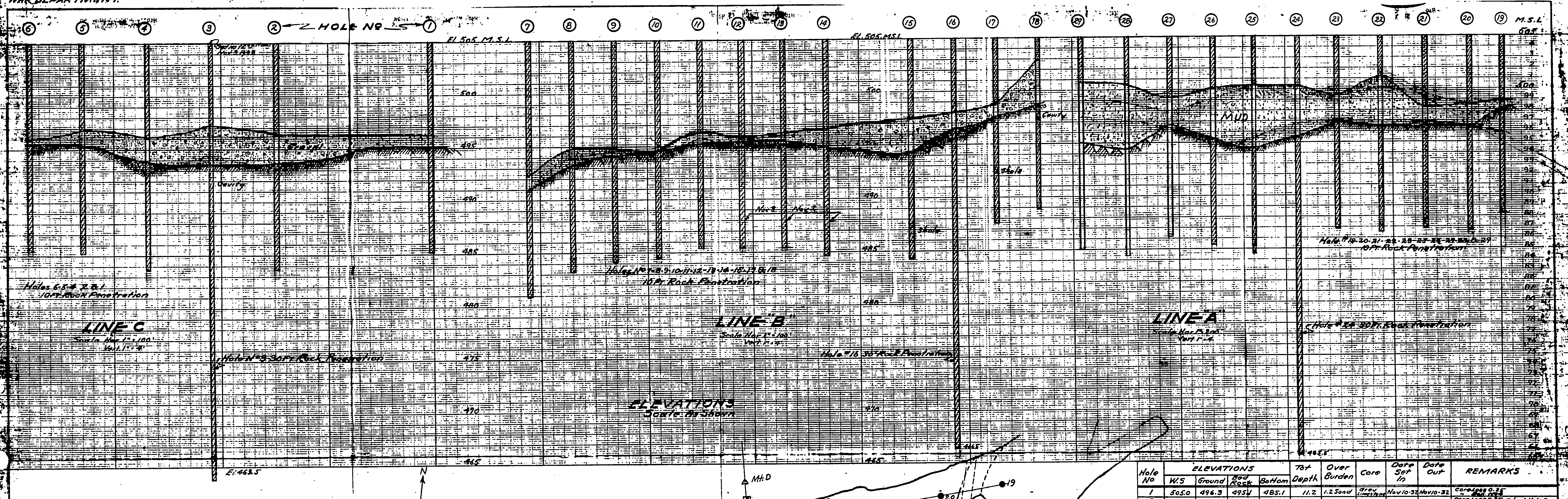
TENN. RIVER-NASH. DIST.
LOCK & DAM NO.3 60ft. LOCK
UPPER MITER SILL MON. No. 40A.
UPSTREAM KEYWAY LAND VIEW
MAY 19, 1934 No. 241
CONTRACT W1087 ENGR 240

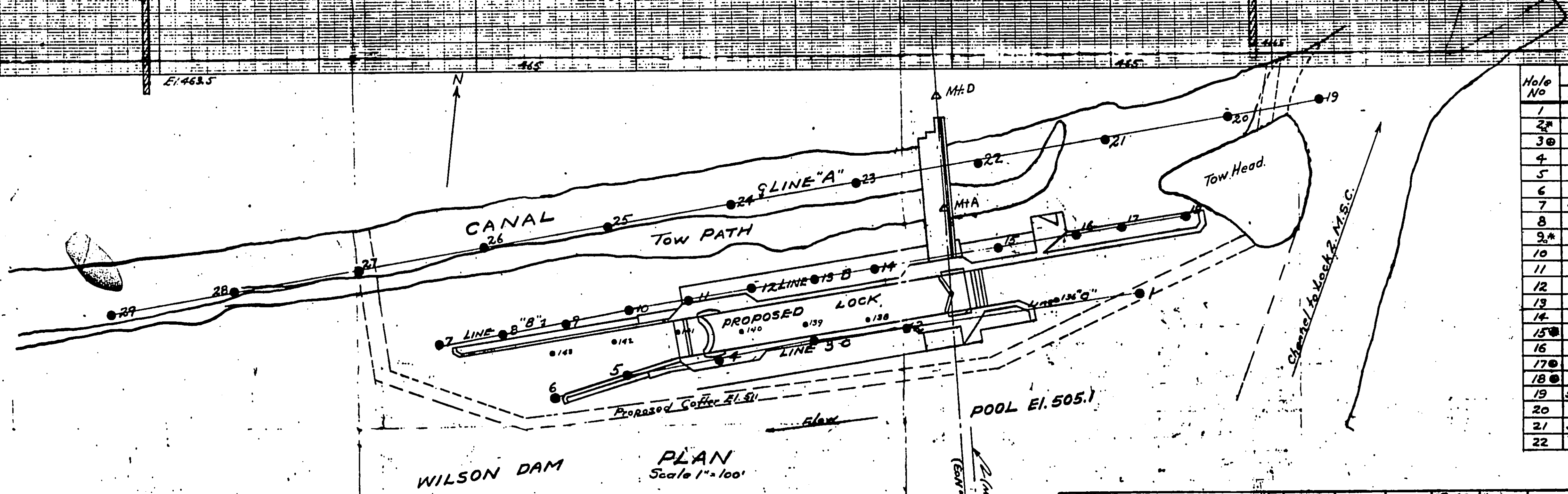

TENN. RIVER-NASH. DIST.
LOCK & DAM NO 3-60 ft. LOCK
UPPER MITER-SILL MON. NO 40A
DOWNSTREAM KEYWAY- LAND VIEW
MAY 19, 1934 NO. 243
CONTRACT. NO. W 1087 ENGR. 240


TENN. RIVER-NASH. DIST.
LOCK & DAM No 3-60 ft. LOCK.
UPPER MITER SILL- MON. NO. 41A
DOWNSTREAM VIEW
MAY 23, 1934 NO. 246
CONTRACT NO. W1087 - ENGR. 240


WAR DEPARTMENT
El 490.0
El 480.0
El 470.0
BLUE FLINT-LIKE LIMESTONE
SOFT LIMESTONE AVERAGE THICKNESS 2"?
SHALE-AVERAGE THICKNESS
BLUE FINE-GRAINED LIMESTONE
FINE GRAINED LIMESTONE
SHALE-AVERAGE THICKNESS
FINE GRAINED LIMESTONE
SHALE-AVERAGE THICKNESS 1/2" (TIGHT)?
FINE GRAINED LIMESTONE
LOW EMERGENCY SILL
LOWER MITER SILL
UPPER MITER SILL
GREY COARSE GRAINED LIMESTONE
SHALE-AVERAGE THICKNESS 1"
BLUE FINE GRAINED LIMESTONE
SHALE-AVERAGE THICKNESS
FINE GRAINED LIMESTONE
FINE GRAINED LIMESTONE
TIGHT SEAM
NOTE:
FOR LOG OF TEST HOLES, SEE DETAILED FOUNDATION REPORTS NO. 1 TO 66.
TENNESSEE RIVER
LOCK & DAM No 3
SKETCH SHOWING
LOCATION OF TEST HOLES
for
FOUNDATION INVESTIGATION
In 1 Sheet
Sheet No. 1
Scale: Hor. 1 in = 40 ft. Vert. 1 in = 4 ft.
U.S. Engineer Office, Florence, Ala.
Submitted
Inspector.
Approved
2-11-35
Drawn by
File No.
Transmitted with letter or indorsement
Dated
JUN 15 1981
D2-L3-10/12

WAR DEPARTMENT





Hole No	ELEVATIONS W.S	ELEVATIONS Ground	ELEVATIONS Bed Rock	ELEVATIONS Bottom	Tot Depth	Over Burden	Core	Date Set In	Date Out	REMARKS
1	505.0	496.3	495.1	485.1	11.2	1.2 Sand	Grey Limestone	Nov 10-32	Nov 10-32	Core Loss 0.25 " Box No 4
2*	"	496.3	493.7	483.7	12.6	2.6 "	"	" 9 "	" 9 "	Core Loss 0.25 *Lost Hole 2 " Box No 4
3⊕	"	497.2	493.5	463.5	33.7	3.7 "	Hard L.Stone	" 3 "	" 4 "	Core Loss 0.75 ⊕ Cavity " Box No 2 Top 490-Bt 489.7
4	"	496.1	493.8	483.8	12.3	2.3 "	Grey L.Stone	" 5 "	" 5 "	Core Loss 0.1 " Box No 2
5	505.1	496.8	495.2	485.2	11.6	1.6 "	G.L.S. & Flint	" 7 "	" 7 "	Core Loss 0.15 " Box No 2
6	505.0	496.0	495.5	485.5	10.5	0.5 "	Grey L.Stone	" 8 "	" 8 "	Core Loss 0.55 " Box No 4
7	504.9	492.3	490.9	480.9	11.4	1.4	"	" 14 "	" 14 "	Core Loss 1.1 " Box No 8
8	"	494.9	493.2	483.2	11.7	1.7	"	" 14 "	" 14 "	Core Loss 0.9 Box No 6
9*	505.1	494.4	494.1	484.1	10.3	0.3 Rotten Rock	Grey L.Stone	" 12 "	" 12 "	Core Loss 1.3 *Lost Hole No 9 " Box No 6
10	505.0	494.6	494.6	484.6	10.0	0.0	"	" 8 "	" 8 "	Core Loss 0.0 " Box No 3
11	"	496.3	495.3	485.3	11.0	1.0' Fine Sand	"	" 3 "	" 3 "	Core Loss 0.0 " Box 1
12	"	495.9	495.4	485.4	10.5	0.5 Fine Sand	"	" 3 "	" 3 "	Core Loss 0.0 " Box No 1
13	"	496.4	495.4	485.4	11.0	1.0 "	"	" 3 "	" 3 "	Core Loss 0.0 " Box 1
14	"	496.7	494.6	484.6	12.1	2.7 "	"	" 2 "	" 2 "	Core Loss 0.0 " Box No 1
15●	"	497.6	494.3	484.3	13.3	3.3 "	"	" 4 "	" 4 "	Core Loss 0.0 Shale 487.1 " Box 3 486.8
16	"	498.1	496.5	466.5	31.6	1.6 "	"	" 10 "	" 11 "	Core Loss 0.3 Box No 6
17●	"	499.0	497.5	487.5	11.5	1.5 "	"	" 5 "	" 5 "	Core Loss 0.1 ● Cavity Box No 3 Top 492.4
18●	"	502.8	498.9	488.9	13.9	3.9 "	"	" 7 "	" 7 "	Core Loss 0.8 ● Cavity " Box No 3 Top [illegible]
19	504.9	498.7	498.2	488.2	10.0	0.7	"	15	15	Core Loss 0.7 " Box No 8
20	505.0	498.5	496.7	486.7	11.8	1.8 "	"	" 10 "	" 10 "	Core Loss 0.3 " Box 4
21	505.0	498.2	496.9	486.9	11.3	1.3 Mud	"	" 15	" 15	Core Loss 0.[illegible] 1 Box 8
22	505.0	501.1	496.5	486.5	14.6	4.6 "	"	" 9 "	" 9 "	Core Loss 0.0 Box No 4

*See Spec. G-3c-5 821/5

Hole No	ELEVATIONS W.S	ELEVATIONS Ground	ELEVATIONS Bed Rock	ELEVATIONS Bottom	Tot Depth	Over Burden	Core	Date Set In	Date Out	REMARKS
23	505.0	499.4	496.9	486.9	[illegible]	2.5 Clay Sand	L.stone	Nov [illegible]	Nov 10-32	[illegible]
24	"	500.3	495.5	465.5	[illegible]	4.8 Mud Sand	"	" 10 "	" 11 "	Core Loss 0.0 Box 5
25	505.1	500.3	494.5	484.5	15.8	5.8 Clay Sand	"	" 12 "	" 12 "	Core Loss 0.0 Box 7
26	505.0	500.1	495.4	485.4	14.7	4.7 Silt Sand	"	" 14 "	" 14 "	Core Loss 0.5 Box 7
27	504.9	499.9	496.1	486.1	13.8	3.8	"	" 15 "	" 15 "	Core Loss 0.0 Box 7
28	504.9	500.5	494.4	484.4	16.1	6.1	"	" 15 "	" 15 "	Core Loss 0.0 Box [illegible]
29	504.9	500.7	495.0	485.0	15.7	6.7	"	" 15 "	" 15 "	Core Loss [illegible]

TENNESSEE RIVER
DAM No 3 GEN. JOE WHEELER DAM
MILE 274.9

PROGRESS CHART

CORE BORINGS

FOR PERIOD Nov 2 to Nov 19th 1932

In 1 Sheet Sheet No 1 Scale As Shown

U.S. Engineer Office Florence Ala. Nov. 4 1932

Submitted Wm. A. [illegible] Principal Draftsman

Approved [illegible] Captain Corps of Engineers

Drawn by [illegible]

E 6530

Transmitted [illegible]

Date [illegible]

TENNESSEE VALLEY AUTHORITY

Office of Chief Engineer

APPENDIX D

FOUNDATION EXPLORATION FOR NEW WHEELER MAIN LOCK

Knoxville, Tennessee

November 1961

Reed A. Elliot, Chief Water Control Planning Engineer, 603 UB

Berlen C. Moneymaker, Chief, Geologic Branch, 615 UB

November 28, 1961

WHEELER LOCK--MUD SEAMS

In response to your request for a written statement describing the effort made to locate clay seams, or mud seams, at Wheeler lock, the following statement is submitted.

During the exploration program carried on in 1960, every core was logged carefully, in the presence of the drillers who supplied information not available from the cores recovered. The geologist who logged the cores was alert and included all available information in the logs. Even very slight weathering was noted and the lowest elevations of both serious weathering and slight weathering were reported in the logs prepared and issued. No filled or open cavities were found; no mud--or clay--seams were found. On basis of both the cores and subsequent excavation, the rock in the new Wheeler lock foundation was found to be exceptionally free from such weathering effects as rock decay and solution cavities. Kellberg's report of March 1960 states that the bedding planes "show no development of weak, soft material, or clay along them." (Bottom of page 8).

The "clay seams" and "mud seams" encountered in nearly all limestone terrains are thin solution cavities filled with clay. When thicker than 0.1' or 0.2', such features are more frequently referred to as "filled cavities." The origin of such seams is quite simple. The rock is dissolved out along some structure, usually a bedding plane or a joint. Subsequently, the resulting cavity becomes silted-up by moving ground water. Even to this day, no such mud seams have been found in either of the Wheeler lock sites, although they were found in both the dam site and the powerhouse site in the construction period.

The mud seam on which sliding resulted in the failure of the land wall of Wheeler lock is an entirely different geologic feature. It represents the hydration and partial decay of pulverized shale along a tectonic surface. At some stage of rock deformation, presumably the last, uplift and folding resulted in a break within the shale layer known as the

Reed A. Elliot

Berlen C. Moneymaker

November 28, 1961

WHEELER LOCK--MUD SEAMS

"A-zone." This break is parallel to bedding planes, a short interval above the lower contact of the shale within which it was developed. The break, developed in the relief of stress, was accompanied by movement along its surfaces. This movement, perhaps very slight in terms of feet and inches, was sufficient to pulverize a small amount of shale on its surfaces, and to provide a thin opening for the ingress of water. In the presence of water over a long period of time, the pulverized shale has become hydrated and the small amount of soluble material has been removed. In addition to the hydration and leaching of the pulverized material, some of the subjacent and superjacent shale has also become similarly weathered. That the weathering is partial and limited to hydration and leaching is attested by the lack of oxidation of the iron content of the material, and by the research completed to date.

The mud seam involved in the failure of the lock wall is much too thin to have been found in NX holes. In the three large-diameter holes logged by Allen and Hellberg and examined also by Harrell and Parker, the seam could not be detected visually. It has the same color as the contiguous shale, and both the shale and the seam were recessed by the grinding action of the chilled steel shot used as the cutting medium, which always happens in the drilling of a hole through dissimilar rocks which vary widely in their resistance to abrasion.

Although evidence of bedding plane slippages in folded sedimentary rocks are quite common, the mud seam at Wheeler lock is, so far as I know, unique in the Tennessee Valley. It is not on a contact, but within a fairly thin shale bed. It is only partially weathered and is, chemically, a very atypical or abnormal clay. It is because of its high water content and fineness of grain, a very effective lubricant.

Berlen C. Moneymaker

BCM:AEF

Tennessee Valley Authority
Division of Water Control Planning
Geologic Branch

FOUNDATION EXPLORATION FOR

NEW WHEELER LOCK

John M. Kellberg

Knoxville, Tennessee
March, 1960

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EXHIBITS

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2	Graphic Logs of Drill Holes New Lock	3 GE 1 822N1291

FOUNDATION EXPLORATION FOR NEW WHEELER LOCK

John M. Kellberg

INTRODUCTION

The new lock at the Wheeler project will be located adjacent to the right (north) bank of the Tennessee River at river mile 274.9. It will have a chamber 600 feet long by 110 feet wide and will be built between the existing lock and the right abutment.

During February and March, 1960, twenty-four exploratory holes totaling 1440.1 linear feet were drilled along the proposed alignment of the river and land walls and in the discharge area. These holes were spaced on 100-foot centers along the lock walls, while in the discharge area varied spacing was used in order to stay clear of the existing navigation channel (Exhibits 1 and 2).

GENERAL GEOLOGY

Physiography

The area surrounding Wheeler Dam lies near the southern margin of the Highland Rim section of the Interior Low Plateaus as defined by Fenneman.[1] This physiographic subdivision is characterized by a young to mature plateau of moderate relief. Between Wheeler Dam and Wilson Dam the outcrop belt of

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1. Fenneman, N. M., Physiography of the Eastern United States, pp. 415-427.

the cherty middle member of the Fort Payne formation is crossed by the Tennessee River forming the Muscle Shoals area. Because of this resistant horizon the local relief is somewhat more steep and gorge-like than the surrounding area.

Stratigraphy

The Fort Payne formation of Mississippian age is the only geologic unit that will be involved in the construction of the project. The total thickness of this formation in Lauderdale County, Alabama, is in the neighborhood of 200 feet. The Tuscumbia limestone, also of Mississippian age, overlies the Fort Payne. This formation probably is present in the upper part of the hill forming the right abutment well above pool level of Wheeler Lake - elevation 556. No outcrops of coarse-crystalline, slightly asphaltic, fossiliferous limestone typical of the Tuscumbia have been seen, but the red residual clay containing characteristic porous, iron-stained chert which is present in the road cuts just north of the dam is indicative of the presence of this formation at higher elevations in this vicinity. One exploration hole (5+55 DS - 60' R) was drilled through the Chattanooga shale which underlies the Fort Payne. The shale was found to be 18 feet thick, but, as it is more than 20 feet below the deepest excavation that will be required for the discharge tunnel, it will not be involved in the construction activities.

Structure

The regional geologic structure is controlled by the Nashville dome. The area around the Wheeler project lies on the southern flank of this dome and the regional dip is a degree or less to the south. This regional trend is often obscured by the slight variations caused by minor local folding. This is the case at Wheeler. Here the general structure is that of a broad, extremely low anticline, the crest of which is in the middle of the river, with the axis more or less parallel to the course of the river. As a result of this minor fold the rock strata in the area of the new lock strike N 38° E and dip $1\frac{1}{2}$° to the northwest.

DETAILED GEOLOGY

Stratigraphy

Various units of the Fort Payne formation are the bedrock at the site. Overlying bedrock are thicknesses of detrital and alluvial material varying from nothing to 19 feet. A brief description of the unconsolidated deposits and the subdivisions of the Fort Payne formation follows.

Overburden -- The unconsolidated materials overlying bedrock can be divided into three catagories: (1) alluvial clays and silts, (2) talus deposits, and (3) fill material. In 12 holes drilled from a barge in Wilson Lake an average of 1.6 feet of silt and clay was encountered overlying bedrock. This material represents sedimentation in relatively slack water areas which have been protected from scouring current action by the existing lock walls. In the holes drilled on the river-side of the existing lock current action has kept the bedrock bottom swept clean and little bottom sediments were encountered. Relatively minor amounts of talus materials are present at the bottom of the rock bluff north of the land wall of the proposed lock. This material has accumulated mainly from surface runoff washing debris down from higher on the hill. The majority of the overburden that is present is the result of prior construction activity in the area. Before the existing lock and dam were built a canal was in use along the right bank of the river. Material excavated to make this canal and other debris from the construction of the lock and dam were piled in the area in which the land wall of the new lock will be built. This fill is made up of limestone slabs ranging up to a cubic yard in size embedded in a matrix of smaller rocks, clay and silt. The maximum thickness of fill that was encountered in the drilling was 18.6 feet; the minimum was 11.7 feet; and the average was 14.4 feet.

Fort Payne Formation -- A maximum of 88 feet of the lower portion of the Fort Payne formation was encountered in drilling hole 5+55 DS - 60'R (Exhibit 2). From examination of the cores it was possible to subdivide the Fort Payne into five distinct units of varying thicknesses. The highest unit is composed of light-gray, coarse-crystalline, fossiliferous limestone in beds up to two feet thick. The total thickness of this unit is not known but a maximum of 6.5 feet was recovered from hole 7+40-60'R. A thin, but persistent, bed of medium-gray, fine-crystalline, argillaceous limestone underlies the upper coarse-crystalline unit. This unit averaged 1.5 feet thick in the 14 holes that penetrated it. Only the holes drilled in the fill area along the land wall of the proposed lock encountered bed rock sufficiently high to penetrate these first two units. In all the holes drilled from the barge in the lake, rock either had been excavated or eroded below these two units. The next lower unit is similar to the uppermost unit being an average of 5.9 feet of light-gray, coarse-crystalline, fossiliferous limestone. The fourth unit comprises the majority of the Fort Payne formation at the site and will, in all probability, be the unit on which the lock will be founded and through which the discharge tunnel will be driven. This unit consists of medium-gray, fine-crystalline to dense, slightly argillaceous limestone. The individual beds are a foot or less in thickness and thin shaly partings usually occur along the bedding planes. In most respects this unit is very similar to the rock which afforded the foundation for the lock recently completed at the Wilson project. From examination of the cores there appears to be one marked difference, however, in that there does not appear to be nearly as much chert in the rock at Wheeler as there was at Wilson. Two key horizons were noted in cores from all the holes drilled. Key bed "A" occurs approximately 6.4 feet below the top of the unit and consists of 0.5 foot of dark gray to black shale. Key bed "B" occurs 7 feet below "A" and consists of 0.1 foot of limestone containing small green specks of mineral glauconite. These key horizons are shown on Exhibits 1 and 2 and were used to determine the geologic structure in the lock area. The lowest unit of the Fort Payne was encountered in the one deep hole drilled and consisted of four feet of medium-gray, dense, cherty limestone. This unit will be well below any intended excavation and will not be involved in the construction of the lock.

Structure

Although the rock strata underlying the lock site are essentially horizontal, matching of key beds between drill holes indicates a dip of approximately $1\frac{1}{2}°$ to the northwest. The strike of the bedding N 38° E - makes an angle of 42° with the centerline of the lock - N 80° E - with the result that there is an apparent dip downstream of 1.5' per 100' and an apparent dip to the north or into the right abutment of 1' per 100'.

Vertical or near vertical joints are undoubtedly present in the foundation area, but only two were encountered in the drilling. Both of these were above foundation grade. During the construction of Wheeler Dam a few joints in the river bed were found to have been enlarged by solution near the surface, but these cavities narrowed to extinction a few feet down into rock.

Physical Character of the Rock

The lock will be founded entirely on the Fort Payne formation. Although often somewhat shaly, this formation is hard and resistant and has ample strength to support the weight of the lock. No recent tests have been made from rocks in the lock area for shear and compressive strengths, but tests of samples from the dam foundation made during the construction period give the following results. Nine specimens tested in compression showed an average compressive strength of 23,660 pounds per square inch and twelve specimens tested in shear were found to have an average shear strength of 2,112 pounds per square inch. These values are in excess of any loading that will be imposed by the structures.

In the portion of the Fort Payne formation at foundation grade the rock is relatively thin-bedded. The bedding planes vary in spacing from three to four inches up to a maximum of slightly over one foot. Although these well-defined bedding planes are usually marked by a thin shaly parting, they are tight where undisturbed and show no development of weak, soft material, or clay along them.

Foundation Conditions

In contrast to most sites with limestone foundations that have been explored in the Tennessee Valley area, no evidence of serious foundation defects was disclosed by the drilling. No cavities were encountered in any of the holes drilled and no weathering was seen along any of the bedding planes. This marked lack of weathering effects is probably attributable to two things. In the first place, the Fort Payne formation is relatively insoluble in this area as it contains a high percentage of siliceous and argillaceous material; in the second place, during the construction of the existing lock and dam, and prior to that when the canal was excavated, the slightly weathered rock that was near the surface in the present lock area was removed and no weathering of any consequence has occurred since that time.

The zone which produced gas when encountered in drilling relief holes along the north wall at Wilson lock is present in the Wheeler lock area as well, but it is apparently sufficiently deep that it will not be encountered in the construction activity. One exploratory hole (5+55 DS-60' R) was drilled through the Chattanooga shale and encountered a show of gas at elevation 391.0 about half a foot above the base of the shale (Exhibit 2). At this location this seam is some 90 feet below the expected excavation grade. The nearest this seam would come to the surface would be in the vicinity of the discharge outlet where it would be some 45 feet below invert grade.

Construction Problems

Possible geologic problems during the construction period can be divided into three categories. These are problems encountered during

(1) excavation, (2) grouting, and (3) tunneling. Each of these will be discussed briefly.

Excavation -- The foundation rock at Wheeler is very similar to that at Wilson. It is a flat-lying, thin-bedded, relatively brittle, siliceous to argillaceous limestone. If due care is not taken in spacing of blast holes and loading of the charges into these blast holes shifting along the near-horizontal bedding planes will take place as it did at Wilson, thereby necessitating the removal of otherwise sound and perfectly suitable rock. The experience gained at Wilson should prove valuable here and procedures developed during the later stages of the Wilson construction program should be followed here for optimum results.

During the construction of Wheeler Dam the final cleanup of the foundation blocks was deferred until just prior to pouring concrete. It was found that over most of the foundation if final cleanup was done too soon the exposed rock surfaces would slake and crack from alternate expansion and contraction. The only strata which is expected to disintegrate markedly upon exposure to air is key bed "A" (Exhibits 1 and 2). This thin - 0.5' average thickness - horizon was the only one to show any signs of disintegration in the cores. The other cores recovered from the exploratory holes have shown no tendency to break down after several weeks exposure to alternate wetting and drying and, from this evidence, it does not appear that cracking and slaking will be a major problem in the lock area. However, the early excavations should be watched closely to determine if this problem will arise.

Grouting -- Very little grouting should be required in the foundation area for the lock. The exploratory drilling has shown the rock to be tight and sound and no cavities were encountered. If the final foundation grade is set above the thin shale horizon of key bed "A" this undisturbed bed should serve as an adequate cutoff with no grouting required below it. The possibility is present that there may be a few vertical joints which pinch out below the key bed "A" horizon. If, upon exposing the foundation, this proves to be the case, these special areas can be treated individually as required.

Tunneling -- The major problem envisioned in driving the proposed discharge tunnel is the possible occurrence of a solution channel that would permit a heavy flow of water to enter the excavation. This possibility can not be ruled out, but the soundness and tightness of the rock make it appear to be a remote probability. It is believed that if proper drilling, loading, and shooting procedures are followed the tunnel can be safely driven. Loading should be light enough so that any incipient vertical joints will not be appreciably widened and a drilling pattern should be used that will place the least strain on the roof. After a round is drilled and before it is loaded observations should be made to determine if excessive leakage is indicated from any of the holes. If such leakage ahead of the face is encountered grouting may be necessary before the tunnel heading is advanced.

Construction Materials

No specific investigations have been made to locate an adequate supply of suitable aggregate. The quarries furnishing aggregate to the Wilson and Colbert projects would be capable of supplying sufficient material of suitable quality. If these sources are too distant from the project to be economically feasible, it is probable that a suitable quarry could be developed in the vicinity of Town Creek some 10 miles south of the river.

CONCLUSIONS

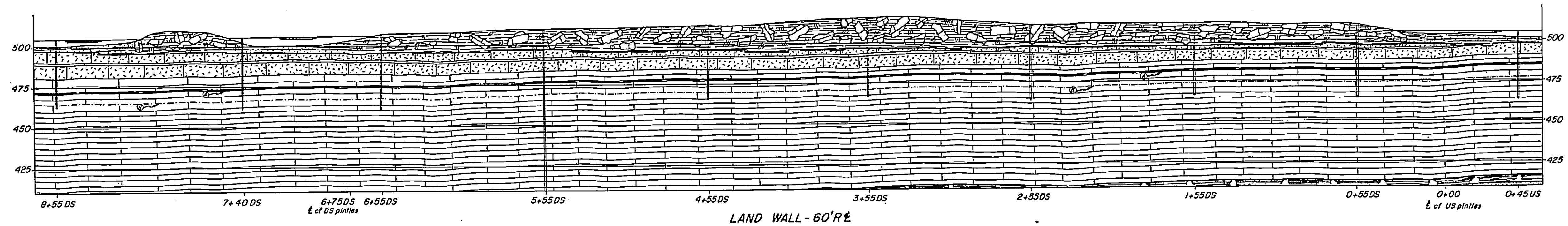
Exploratory drilling in the area proposed for the new lock at the Wheeler project has shown that no serious foundation problems should be encountered in the construction of the lock. Cores showed the rock to be sound and unweathered throughout. Inasmuch as the foundation rock is essentially flat-lying, thin-bedded, and relatively brittle proper care should be taken during excavation to prevent shifting of sound rock along bedding planes due to overloading of blast holes. In driving the discharge tunnel observations should be made of all drill holes in a round prior to loading to make sure that excessive flows of water will not be encountered when the round is shot. If excessive flows are noted, the area ahead of the face should be grouted before the tunnel heading is advanced.

ACKNOWLEDGEMENTS

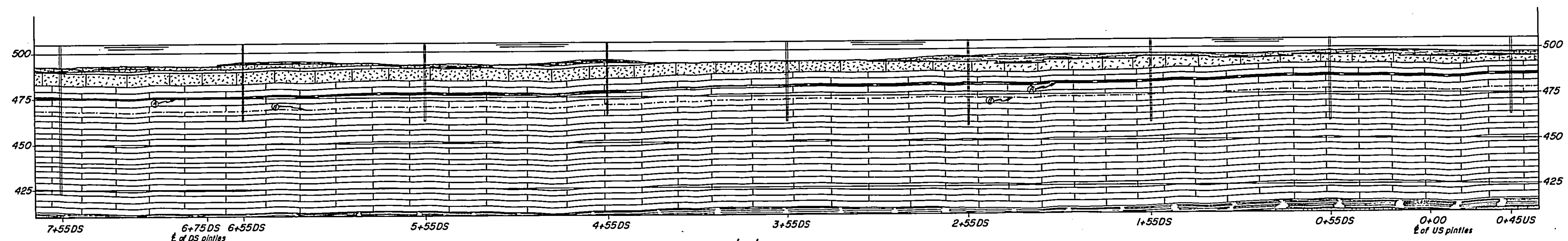
All the geologic work connected with the preliminary foundation investigations at this site was done by the writer under the direct supervision of Berlen C. Moneymaker, Chief Geologist, and the general supervision of Reed A. Elliot, Chief Water Control Planning Engineer.

EXHIBITS

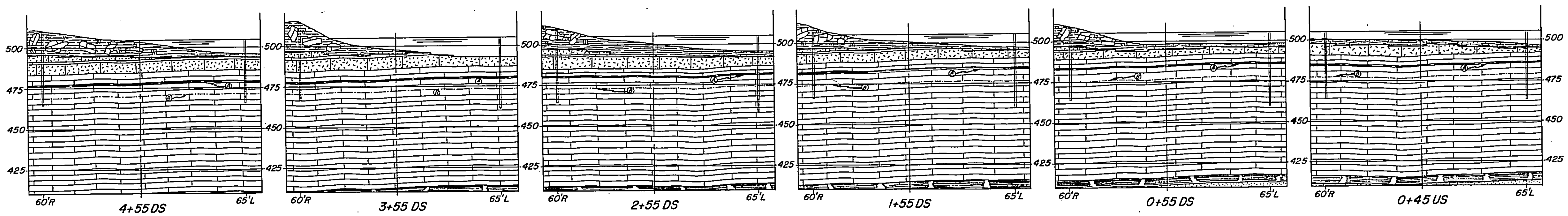
EXHIBIT I

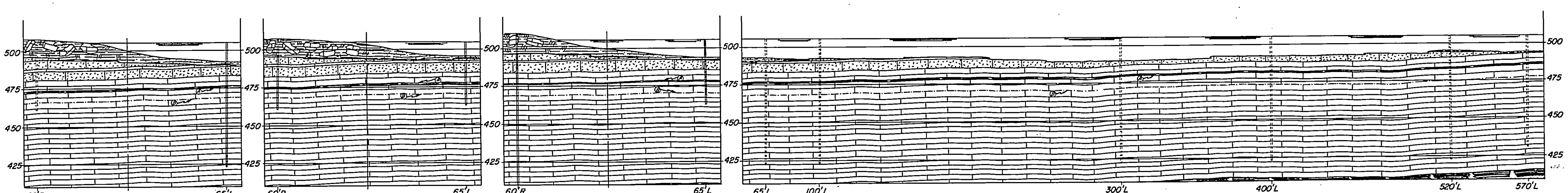


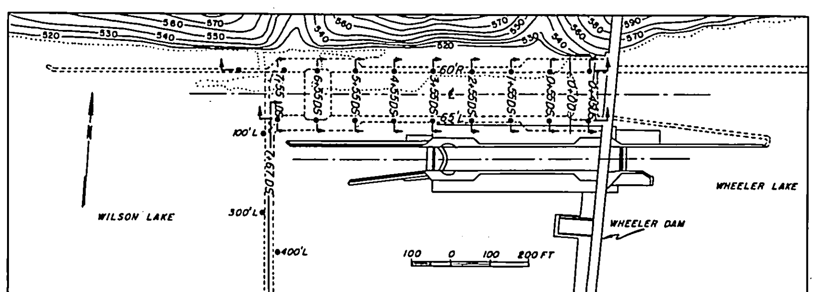
LAND WALL - 60'R ℄



RIVER WALL - 65'L ℄







LOCATION PLAN

LEGEND:

OVERBURDEN

- Fill - Boulders, silt, and clay.
- Silt and clay

FORT PAYNE

- Light gray, coarse crystalline, fossiliferous limestone.
- Medium gray, fine crystalline, slightly argillaceous limestone.
- 0.5' dark gray to black shale. - (A)
- 0.1' glauconitic zone. - (B)

CHATTANOOGA

- Black and gray banded shale, sandstone zone 5' from top.

NOTES:

For graphic logs of drill holes see drawing 3 GE 1 822 N 1291.

SCALE:

30 0 30 60 Feet

FOUNDATION INVESTIGATIONS

GEOLOGIC SECTIONS
NEW LOCK

WHEELER PROJECT
TENNESSEE VALLEY AUTHORITY
WATER CONTROL PLANNING DEPARTMENT

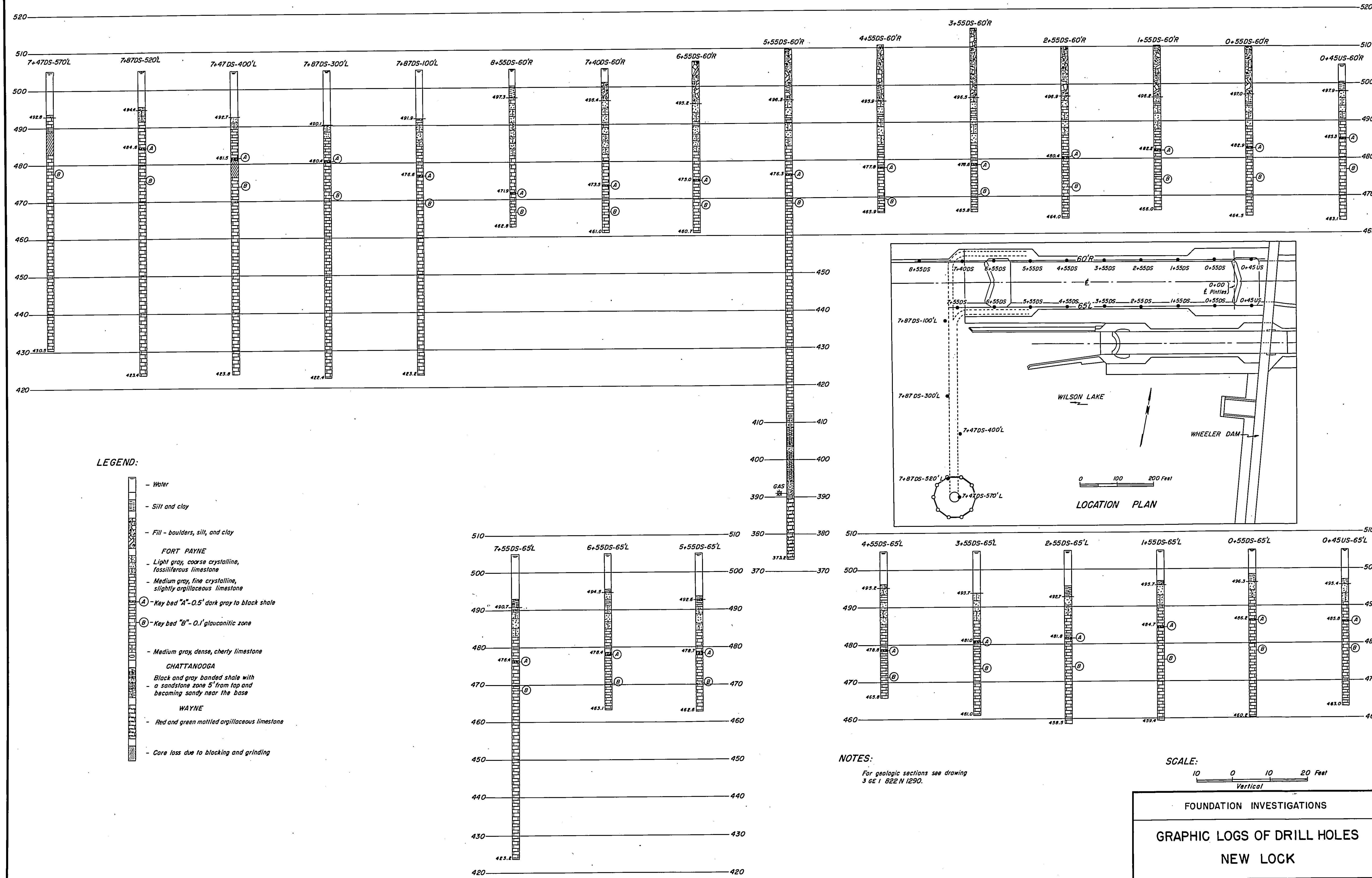
SUBMITTED	RECOMMENDED	APPROVED
John M. Kelley		[signature]

KNOXVILLE	3-23-60	3	GE	1	822N1290

REV NO.	DATE	MADE	CHKD	SUPV	INSP

DRWN .... COMPUTED
TRCD .... ENGINEER
CHKD ....

EXHIBIT 2



NOTES:

For geologic sections see drawing 3 GE 1 822 N 1290.

SCALE:

10 0 10 20 Feet

Vertical

REV NO	DATE	MADE	CHKD	SUPV	INSP

DRWN............ COMPUTED

TRCD............ ENGINEER

CHKD............

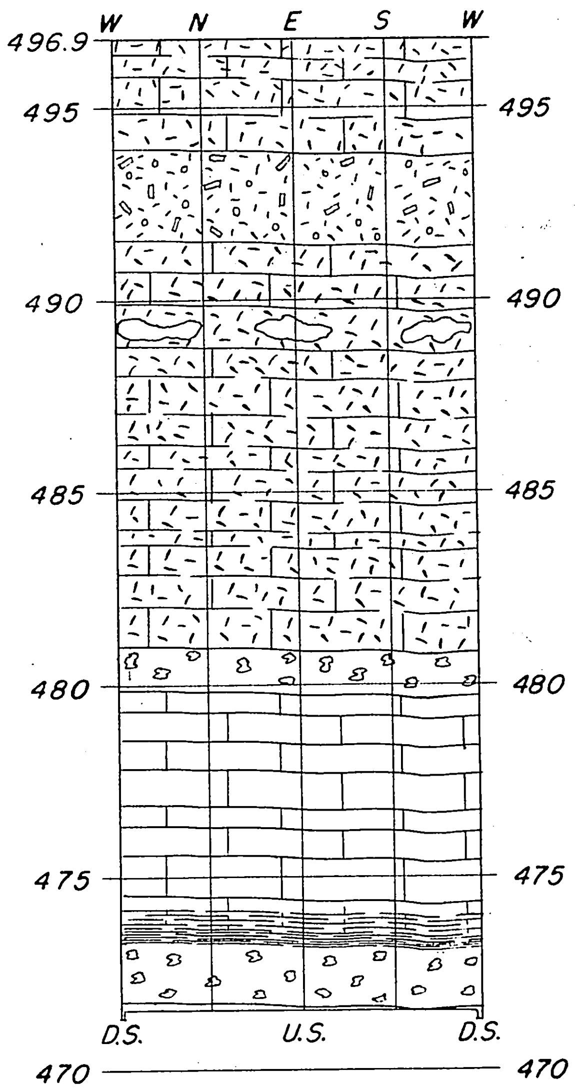
FOUNDATION INVESTIGATIONS

GRAPHIC LOGS OF DRILL HOLES
NEW LOCK

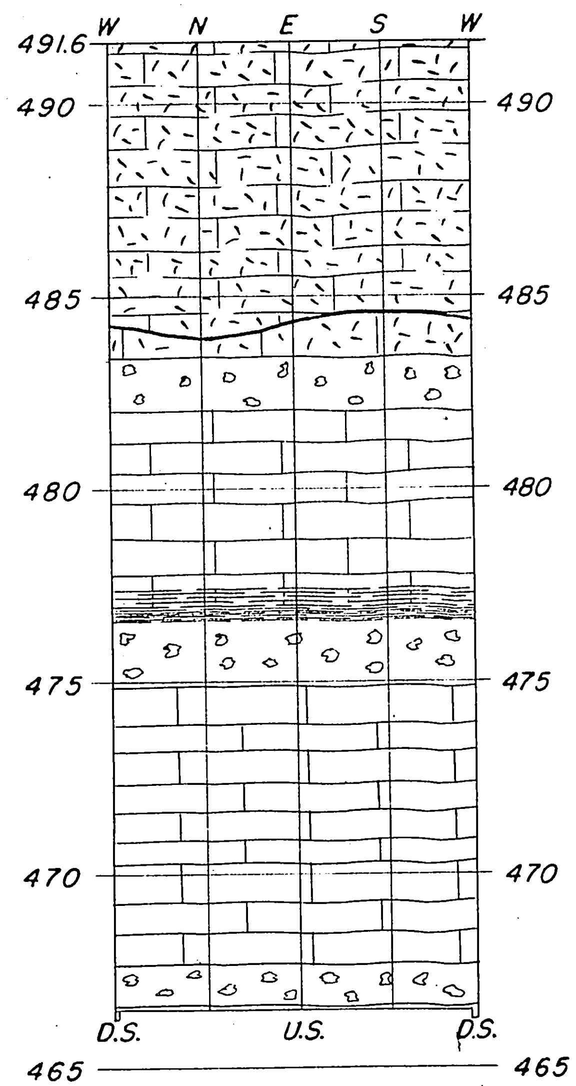
WHEELER PROJECT
TENNESSEE VALLEY AUTHORITY
WATER CONTROL PLANNING DEPARTMENT

SUBMITTED	RECOMMENDED	APPROVED
[signature]		[signature]

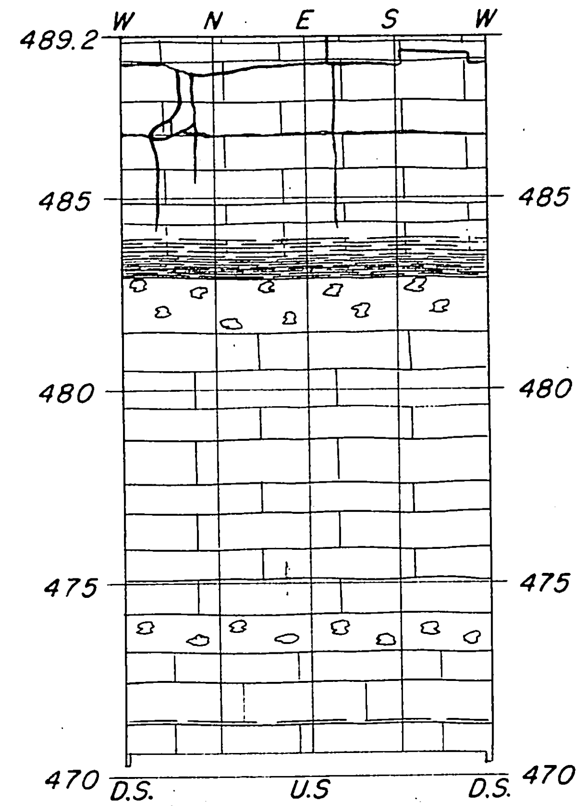
KNOXVILLE	3-23-60	3	GE	1	822 N 1291



Station 7+02.0 D
92.5' North

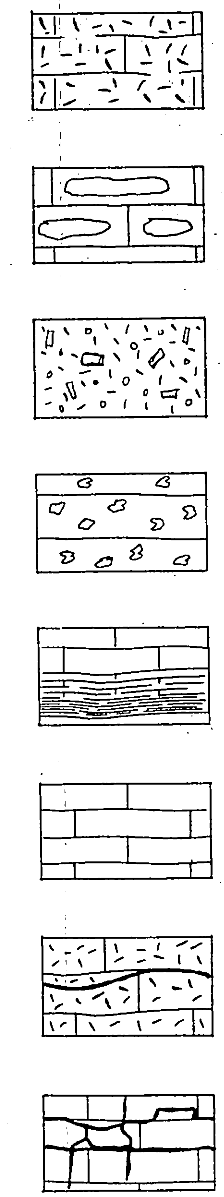


Station 7+36.0 D
85.5' South



Station 2+00.0 D
46.0' South

LEGEND:



Crystalline, fossiliferous limestone with shaly partings.

Crystalline limestone with large chert nodules.

Coarse crystalline, crinoidal limestone.

Limestone with quartz-calcite nodules.

Argillaceous limestone grading into 0.2' shale of zone "A".

Fine-grained limestone

0.1' shaly parting – probable shear.

Joints and open fractures.

SCALE:

NOTE:

For more detail concerning lithology see typed Geologic Record of Drill Hole.

REV NO.	DATE	MADE	CHKD	SUPV	INSP

DRWN........ COMPUTED
TRCD........ ENGINEER
CHKD........

FOUNDATION INVESTIGATIONS
NEW LOCK

GRAPHIC LOGS
OF
CALYX HOLES

WHEELER PROJECT
TENNESSEE VALLEY AUTHORITY
DIVISION OF WATER CONTROL PLANNING

SUBMITTED	RECOMMENDED	APPROVED
R.W. Cible		Berlen C. Moneymaker

KNOXVILLE	5-8-61	3	GE	1	822B1309

TVA 4215 (WCP-2-57)

GEOLOGIC RECORD OF DRILL HOLE

PROJECT NEW WHEELER LOCK

HOLE NUMBER 2+00 D. S.	LOCATION 46' Left	GEOLOGIC FORMATION Fort Payne	
ELEVATION OF SURFACE 489.2	ELEVATION OF RIVER BED -	ELEVATION OF WATER TABLE -	
ELEVATION TOP OF BEDROCK 489.2	THICKNESS OF OVERBURDEN -	ELEVATION OF WATER LOSS -	
ELEVATION BOTTOM OF HOLE 470.6	SIZE OF CORE 36" Calyx	ELEVATION OF WATER GAINED 486.5	
BOTTOM OF SERIOUS WEATHERING 489.2	BOTTOM OF ALL WEATHERING 483.8	DATE STARTED April 1961	DATE COMPLETED May 2, 1961

MATERIAL	ELEVATION OF STRATUM	DEPTH FROM SURFACE	THICKNESS OF STRATUM	LENGTH OF CORE RECOVERED	DIP	DESCRIPTION
			ROCK DRILLING			
Limestone	489.2	0.0	5.9	5.9		Medium-gray, medium to fine-grained, crystalline to slightly argillaceous. Rock fractured to 488.0. Slightly weathered vertical joint striking NW-SE pinching out at 483.8. Water on shaly parting at 486.5.
Limestone	483.3	5.9	0.2	0.2		Dark-gray, fine-grained, grades into shale.
Shale	483.1	6.1	0.2	0.2		Dark-gray-green--Key shale "A".
Limestone	482.9	6.3	7.7	7.7		Medium-gray, fine-grained with quartz/calcite geodes.
Limestone	475.2	14.0	4.6	4.6		As above with shaly partings. Quartz/calcite nodules 474.2 to 473.2
BOTTOM OF HOLE	470.6	18.6				

REMARKS: Surface rock fractured to el. 488.0. Narrow slightly weathered vertical joint pinches out at el. 483.8. Some water but no apparent weathering on slightly opened shaly parting at el. 486.6. All rock below el. 483.8 is very good.

Robert W. Allen, Geologist

GEOLOGIC RECORD OF DRILL HOLE

PROJECT NEW WHEELER LOCK

HOLE NUMBER	LOCATION	GEOLOGIC FORMATION	
7+02 D. S.	92.5' Right	Fort Payne	
ELEVATION OF SURFACE 496.9	ELEVATION OF RIVER BED -	ELEVATION OF WATER TABLE -	
ELEVATION TOP OF BEDROCK 496.9	THICKNESS OF OVERBURDEN -	ELEVATION OF WATER LOSS -	
ELEVATION BOTTOM OF HOLE 471.6	SIZE OF CORE 36" Calyx	ELEVATION OF WATER GAINED -	
BOTTOM OF SERIOUS WEATHERING 496.9	BOTTOM OF ALL WEATHERING 496.9	DATE STARTED March 1961	DATE COMPLETED April 1961

MATERIAL	ELEVATION OF STRATUM	DEPTH FROM SURFACE	THICKNESS OF STRATUM	LENGTH OF CORE RECOVERED	DIP	DESCRIPTION
			ROCK DRILLING			
Limestone	496.9	0.0	6.9	6.9		Medium-light gray, coarse crystalline, fossiliferous with shaly partings.
Limestone	490.0	6.9	1.3	1.3		Coarse crystalline with chert nodules.
Limestone	488.7	8.2	7.0	7.0		Coarse crystalline with shaly partings.
Limestone	481.0	15.9	1.0	1.0		Fine crystalline with calcite geodes.
Limestone	480.0	16.9	6.3	6.3		Fine crystalline, medium to thin bedded.
Limestone	473.7	23.2	0.2	0.2		Dark gray, fine grained grades into shale below.
Shale	473.5	23.4	0.2	0.2		Dark gray-green. Key shale "A".
Limestone	473.3	23.6	1.7	1.7		Medium gray, fine crystalline with calcite geodes.
BOTTOM OF HOLE	471.6	25.3				

REMARKS: No weathering. Rock excellent.
From graphic by J.M.K.

Robert W. Allen, Geologist

TVA 4215 (WCP-2-57)

GEOLOGIC RECORD OF DRILL HOLE

PROJECT NEW WHEELER LOCK

HOLE NUMBER	LOCATION	GEOLOGIC FORMATION	
7+36 D. S.	85.5' Left	Fort Payne	
ELEVATION OF SURFACE 491.6	ELEVATION OF RIVER BED -	ELEVATION OF WATER TABLE -	
ELEVATION TOP OF BEDROCK 491.6	THICKNESS OF OVERBURDEN -	ELEVATION OF WATER LOSS -	
ELEVATION BOTTOM OF HOLE 466.5	SIZE OF CORE 36" Calyx	ELEVATION OF WATER GAINED -	
BOTTOM OF SERIOUS WEATHERING 491.6	BOTTOM OF ALL WEATHERING 491.6	DATE STARTED April 1961	DATE COMPLETED April 1961

MATERIAL	ELEVATION OF STRATUM	DEPTH FROM SURFACE	THICKNESS OF STRATUM	LENGTH OF CORE RECOVERED	DIP	DESCRIPTION
			ROCK DRILLING			
Limestone	491.6	0.0	7.6	7.6		Medium-light gray, crystalline, fossiliferous, shaly partings, 0.1 ft. shaly parting at 484.5 - probable shear zone.
Limestone	484.0	7.6	1.3	1.3		Crystalline with calcite geodes.
Limestone	482.7	8.9	5.7	5.7		Medium-fine grained, medium-thin bedded.
Limestone	477.0	14.6	0.2	0.4		Dark gray, fine grained, grades into shale below.
Shale	476.8	14.8	0.2	0.2		Dark gray-green. Key shale "A".
Limestone	476.6	15.0	1.6	1.6		Crystalline with calcite geodes.
Limestone	475.0	16.6	8.5	8.5		Medium-fine grained.
BOTTOM OF HOLE	466.5	25.1				

REMARKS: No weathering. Rock excellent. Thin shale zone at 484.5 will probably create overbreak during blasting--could be source of slight amount of water.

Robert W. Allen, Geologist

TENNESSEE VALLEY AUTHORITY

Office of Chief Engineer

APPENDIX E

RESULTS OF TESTS OF FOUNDATION CORE AND CHEMICAL ANALYSIS OF SHALE WHEELER LOCK

Knoxville, Tennessee

November 1961

Results of Tests of Foundation Core
Wheeler Lock and Dam
Tennessee Valley Authority

1. References:
   a. Telephone conversations between the Chief, Concrete Division, U. S. Army Engineer Waterways Experiment Station and the Engineer-in-Charge, U. S. Army Engineer Division Laboratory, Southwestern on 19 and 20 July 1961.
   b. Letter from the Director, U. S. Army Engineer Waterways Experiment Station, dated 24 July 1961.

2. The following NX Cores from the vicinity of the foundation of Wheeler Lock, TVA, were received 21 July 1961:

SWD Sample No.	Description
F-1817	15 sections of NX core identified as "A"
F-1818	9 sections of NX core identified as "B"
F-1819	3 sections of NX core identified as "compression"

3. Twelve specimens of core marked "A" were tested for torsional shear. One half of the specimens were tested in the moisture condition as received and one-half were tested after vacuum saturation. It is noted that all but one of the specimens failed helically and sliding resistance after shear could not be obtained. Sliding resistance was determined at 100, 200, and 300 psi for the one specimen (A-7) that failed on a horizontal plane. Results of these tests are shown in Table 1 and on Plate 1. Three specimens marked "Compression" were tested for unconfined compression. Results of these tests are shown on Table 2.

4. All specimens were transported to the laboratory inundated in a tank of water. Results of moisture content determinations of the "as received" specimens and the "vacuum saturated" specimens indicated that the samples were saturated when received. This was also indicated by the fact that free water was extruded from the specimens during testing in compression.

Results of Torsional Shear Tests

NX Core Identified as "A"

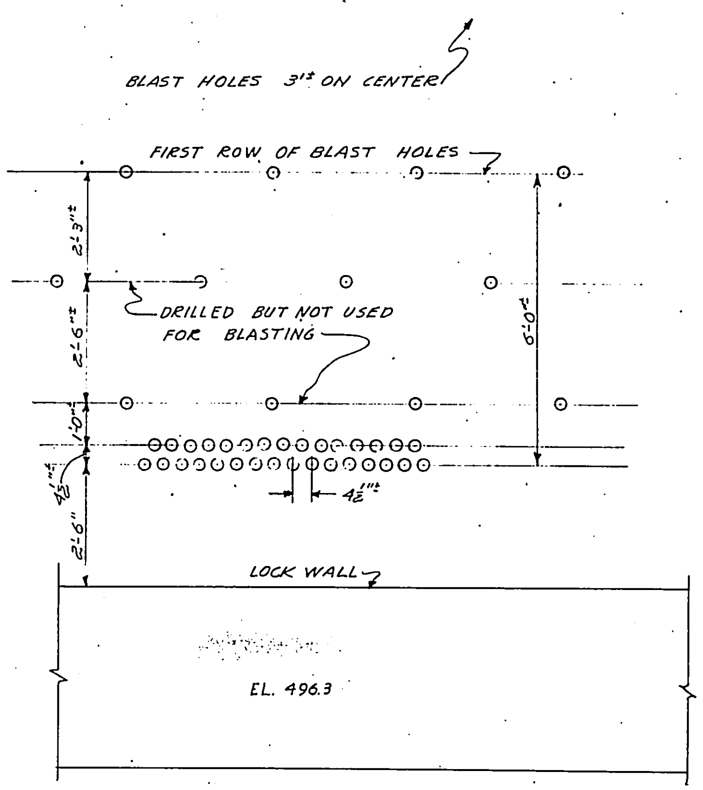
SWD Sample No.	Specimen No.	Specimen Length, Inches	Moisture Content, %	Unit Dry Weight, Lbs/cu.ft.	Normal Load, psi	Modulus of Rupture in Torsion, psi	Sliding Resistance after Shear, psi	Remarks
					Moisture Condition: As Received			
F-1718	A-1	2.0	-	-	10	287	-	Helical failure.
	A-2	3.2	3.2	159.2	100	345	-	Helical failure.
	A-3	3.1	-	-	10	162	-	Helical failure.
	A-4	4.8	3.0	159.4	100	409	-	Helical failure.
	A-5	2.6	2.1	160.0	10	441	-	Helical failure.
	A-6	4.2	-	-	100	410	-	Helical failure.
					Moisture Condition: Vacuum Saturated			
	A-7	7.7	-	-	10	184	-	Failed along a horizontal bedding plane; values for sliding resistance with normal loads of 100, 200 and 300 psi were all obtained from the same failure plane.
					100	-	59	
					200	-	94	
					300	-	127	
	A-8	8.6	2.5	161.6	100	854	-	Helical failure.
	A-9	5.1	-	-	10	375	-	Helical failure.
	A-10	7.1	2.5	160.6	100	468	-	Helical failure.
	A-11	6.7	-	-	10	382	-	Helical failure.
	A-12	4.7	2.7	159.7	100	565	-	Helical failure.

TABLE NO. 2

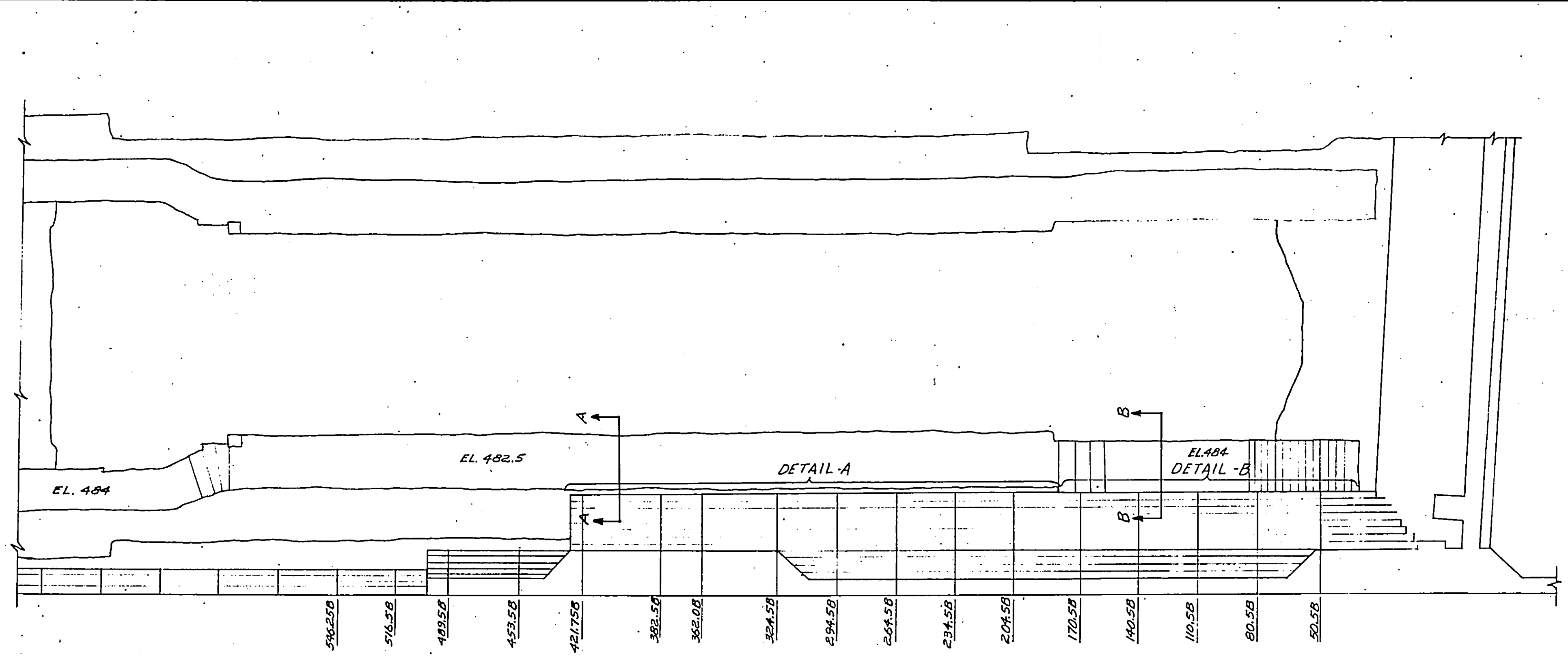
Results of Unconfined Compression Tests

NX Cores Identified as "Compression"

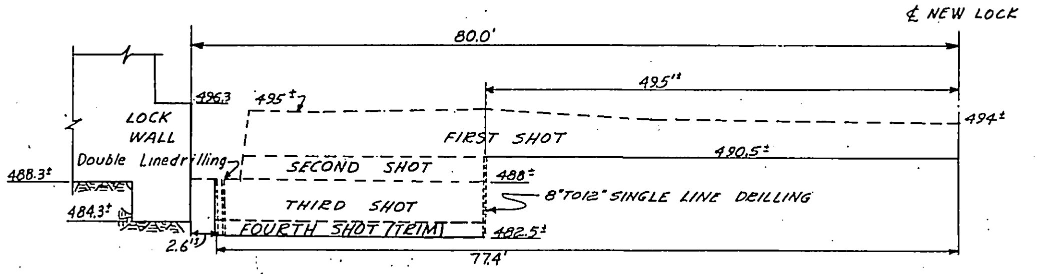
SWD Sample No.	Specimen No.	Specimen Diameter, Inches	Specimen Height, Inches	Compressive Strength, psi	Remarks
F-1719	C-1	2.15	6.15	3,085	Failed by splitting and crumbling in the lower 1-inch.
	C-2	2.15	6.0	9,650	Shattered.
	C-3	2.15	4.3	9,025	Shattered.



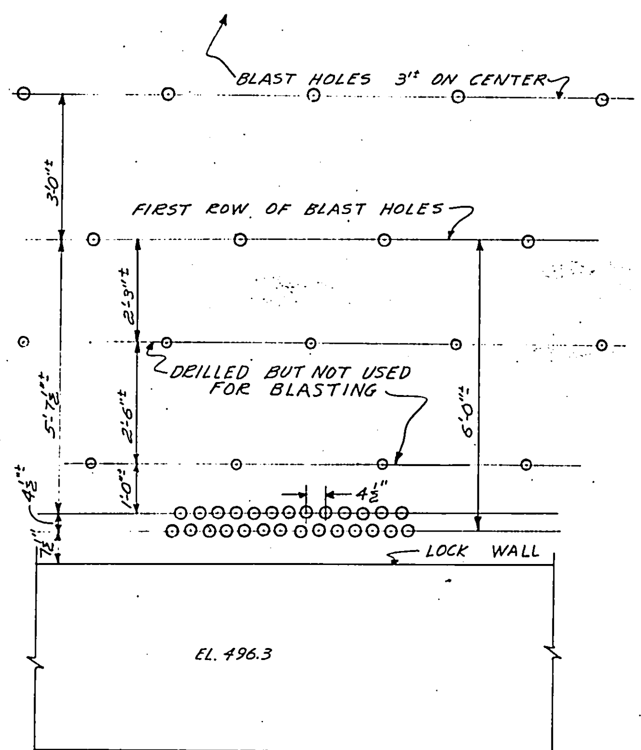
DETAIL A
Scale ½" = 1'-0"



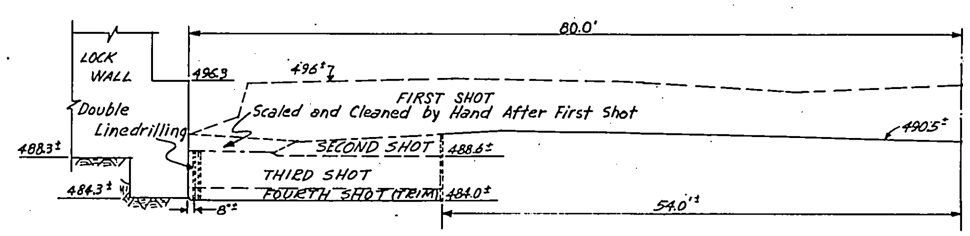
PLAN
Scale 1" = 40'



SECTION A-A
TYPICAL FOR DETAIL A
Scale: 1" = 10'



DETAIL B
Scale ½" = 1'-0"



SECTION B-B
TYPICAL FOR DETAIL B
Scale: 1" = 20'
(Sta 0+55D)

BLASTING DATA

PERIOD	ROCK CU YD	DYNAMITE LB.	PRIMACORD FT.	HOLES
3-8-61 TO 3-22-61	3691	7255 1.966	44,500 12.056	4215 1.142
3-23-61 TO 4-21-61	32,136	19,175 0.597	86,500 2.692	7755 0.241
4-24-61 TO 5-24-61	11,010	11,325 1.029	69,300 6.294	6928 0.629
TOTAL	46,837	37,755 0.806	200,300 4.277	18,898 0.403

REV NO.	DATE	MADE	CHKD	SUPV	INSP	SUBM	RECM
1	7-29-61	GVH					

Section B-B Added, Rev. Sec. A-A

DSGN. — SUPV.
DRWN. G.V.M. — INSP.
CHKD.
TRCD. — ENGINEER
COMP.

Scale as noted

AUXILIARY LOCK

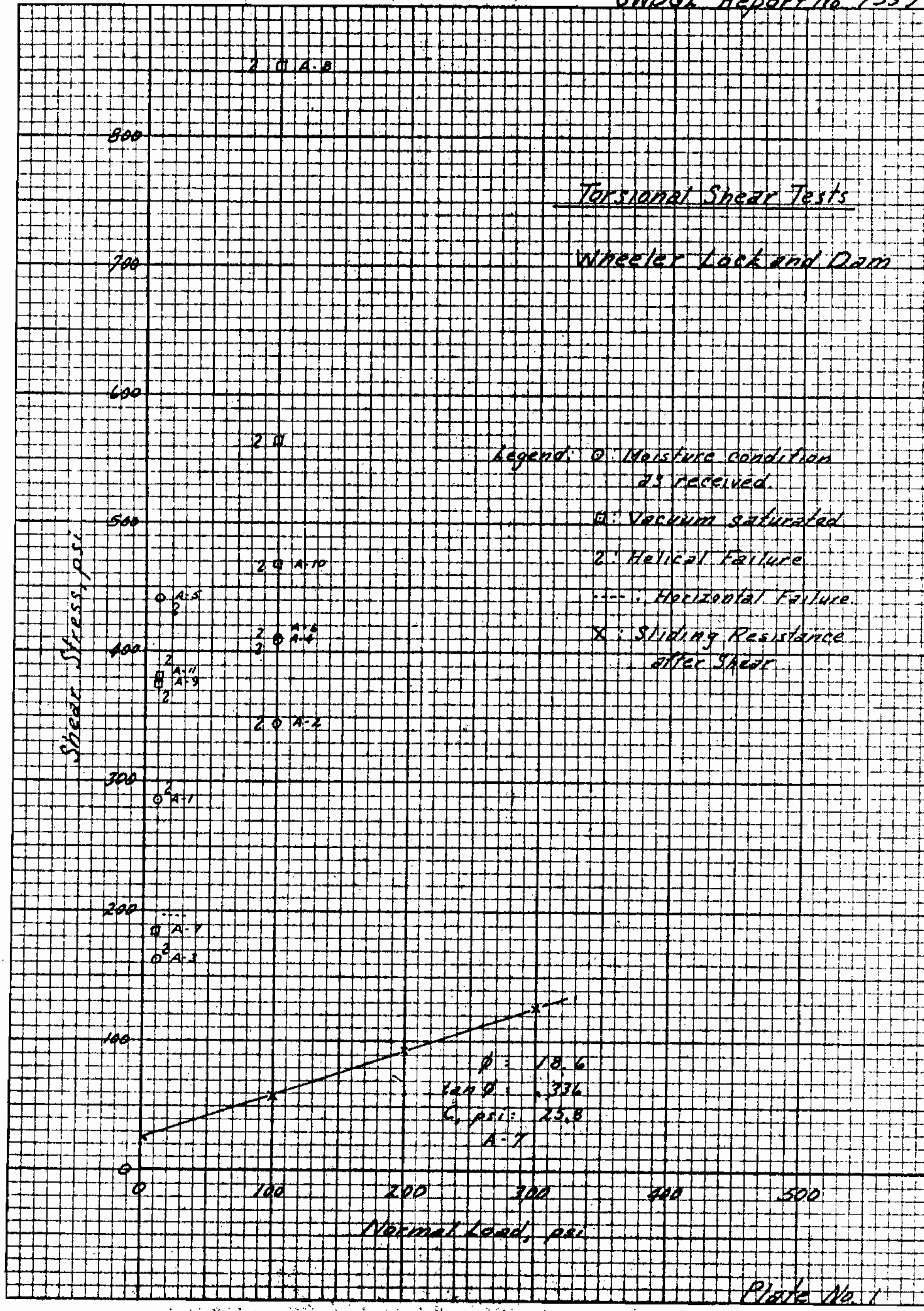
BLASTING DETAILS

WHEELER PROJECT
TENNESSEE VALLEY AUTHORITY
DIVISION OF CONSTRUCTION

SUBMITTED	RECOMMENDED	APPROVED
W.T. Webb		

FIELD OFFICE | 6-13-61 | 3' | PC | 4 | 61K11047 R1

RECORD DRAWING AS CONSTRUCTED


Torsional Shear Tests
Wheeler Lock and Dam
Legend: O: Moisture condition as received.
□: Vacuum saturated
Z: Helical Failure
----: Horizontal Failure
X: Sliding Resistance after Shear
ϕ: 18.6
tan ϕ: .336
C, psi: 25.8
A-7
Shear Stress, psi
Normal Load, psi
0
100
200
300
400
500
600
700
800
A-1
A-2
A-3
A-4
A-5
A-6
A-7
A-8
A-9
A-10
A-11

Form 37—10.—7-61

CORRECTED REPORT

REPORT
FROM
SOUTHERN TESTING LABORATORIES, INC.
BIRMINGHAM, ALABAMA

Cont. 61X58-56629 DATE November 3, 1961

SAMPLE OF AS SHOWN

LAB NOS. 164,322

MARKED

RECEIVED FROM Tennessee Valley Authority, Knoxville, Tennessee

REPORTED TO Tennessee Valley Authority, Knoxville, Tennessee
Mr. Berlen C. Moneymaker, Chief Geologist

DATE RECEIVED AT LABORATORY 10/9/61

Marked:	WLF-1	WLF-2	WLF-3
Silica (SiO_2)	58.08%	54.28%	55.16%
Aluminum oxide (Al_2O_3)	15.47%	20.78%	19.32%
Iron oxide (Fe_2O_3)	4.17%	4.30%	4.30%
Calcium oxide (CaO)	4.10%	2.18%	3.14%
Magnesium oxide (MgO)	4.38%	4.38%	4.48%
Manganese Oxide (MnO)	.012%	.014%	.024%
Titanium dioxide (TiO_2)	.38%	.84%	.46%
Sodium oxide (Na_2O)	3.66%	2.72%	2.95%
Potassium oxide (K_2O)	1.97%	1.88%	2.11%
Loss on ignition	7.78%	8.29%	7.72%

WLF-1 Typical shale of "A seam", above mud seam, as recovered in cores.

WLF-2 Shale of "A seam" immediately above mud seam taken from wall of 36" hole.

WLF-3 Mud from mud seam near base of "A seam".

SOUTHERN TESTING LABORATORIES, INC.

BY [signature]
President

TENNESSEE VALLEY AUTHORITY

Office of Chief Engineer

APPENDIX F

ROCK EXCAVATION

NEW WHEELER MAIN LOCK

Knoxville, Tennessee

November 1961

ROCK EXCAVATION

The general level of excavation for the new lock chamber was to elevation 490.5. Excavation of trenches for the filling and emptying culverts followed the chamber excavation and extended 6 to 8 feet lower. The north line of the south culvert cut was line-drilled to grade along its full length. From station 3 + 54 to station 5 + 92 the south line of this same culvert was drilled from approximately elevation 488.5 (bottom of original trench) to elevation 486.5 and shallow blast holes were used to create the first step of the excavation. After removal of broken rock in the cut, line drilling for the second step was done and the area blasted to grade at elevation 482.5. Farther downstream (station 5 + 92 to station 7 + 35) close line drilling to grade along the south line was done. In this area 6-foot-deep blast holes were used to make the full cut. Blasting in this area was done in May.

Along the old lock wall (station 0 + 10U to station 3 + 54D) a trench of approximately 2-foot depth remained after the general area cut was made to elevation 490.5. This trench was widened by using shallow blast to facilitate double-line drilling (adapted as an alternate to a plan for broaching decided upon earlier). Following this and starting in early May, double-line drilling was done between station 1 + 00D and station 3 + 54D. This drilling was 2-1/2 feet from the north toe of the old lock wall. From station 1 + 00D to station 0 + 10U, double-line drilling to grade was spaced 8 inches off the wall. Blast holes were not drilled to grade as was evident from the amount of trim blasting which followed. Blast holes for this excavation were usually spaced on 3-foot centers with holes as far from line drilling as possible to prevent breakage across the line drilling. Each blast consisted of a series of blasts separated with 17 milliseconds delay connectors. Dynamite use rate for culvert excavation was slightly in excess of 0.8 pounds per cubic yard of rock. Blasting along the lock wall for the final cut in the south culvert was done between May 12 and June 2. For drilling and blasting details, see attached print of drawing 61K11047.

TENNESSEE VALLEY AUTHORITY

Office of Chief Engineer

APPENDIX G

SEISMOGRAPH STATIONS REPORT -

SAINT LOUIS UNIVERSITY

WHEELER LOCK FAILURE

Knoxville, Tennessee

November 1961

TENNESSEE VALLEY AUTHORITY

Office of Chief Engineer

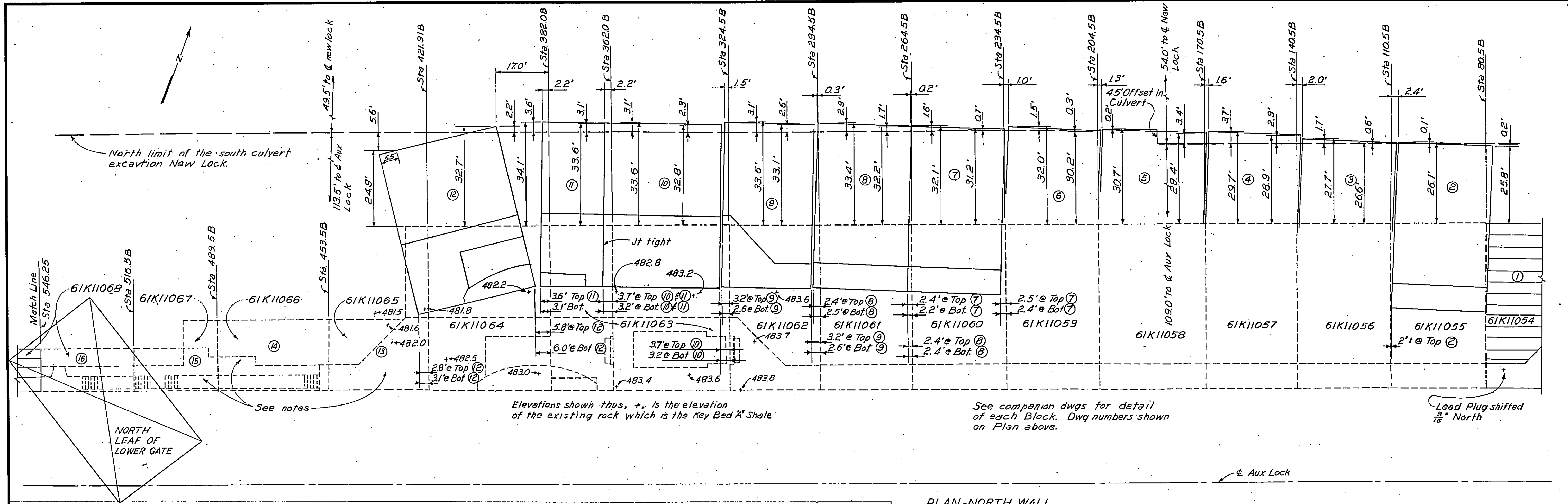
EXHIBITS

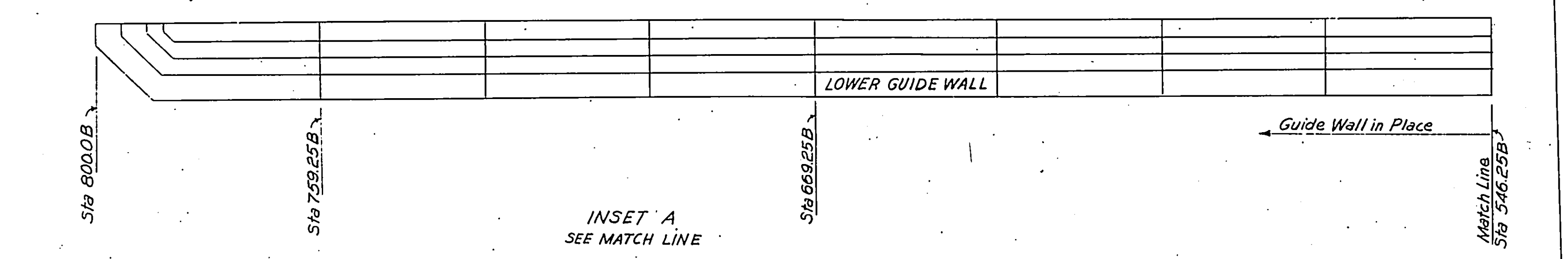
Datum: All elevations given in the consultants' report, appendix A, on TVA drawings in the appendixes, and in the exhibits have been adjusted to that of the U.S.C. & G.S. 1929 adjustment. Elevations given on all Corps drawings, etc., in this report are 0.3 foot lower based on the 1912 datum.

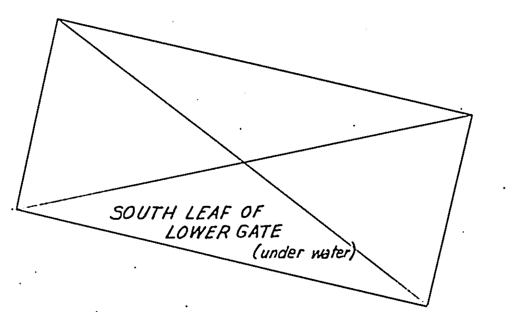
Knoxville, Tennessee

November 1961

EXHIBIT 1







PLAN-NORTH WALL
--- ORIGINAL POSITION
—— EXISTING POSITION

AS CONSTRUCTED ELEVATIONS SOUTH KEY DESIGN EL. 484.3		
BLOCK	END OF BLOCK	ELEVATION
8	D.S.	484.2
9	U.S.	484.2
9	D.S.	483.7
10	U.S.	483.7
10	D.S.	483.4
11	U.S.	483.4
11	DS	483.1
12	US	483.0
12	DS	483.5

AS CONSTRUCTED ELEVATIONS NORTH KEY DESIGN EL. 484.3		
BLOCK	END OF BLOCK	ELEVATION
2	US	484.2
4	D.S.	484.0
6	D.S.	483.9
7	U.S.	484.0
11	D.S.	483.9
12	U.S.	483.8
12	D.S.	483.3
13	DS	483.0

COMPANION DRAWINGS:

61K11054 THRU 61K11068 INCL. Block Dwgs.

61K11053, Scour Marks, Blocks 9 and 10

61K11069, Profile of Culvert Excavation.

ELEVATION OF THE 496.3 STEP AFTER MOVEMENT		
BLOCK	U.S. END.	D.S. END
2	496.1	495.5
3	496.0	496.3
4	497.2	496.9
5	496.9	496.5
6	496.0	495.7
7	495.5	495.4
8	495.6	495.5
9	495.9	495.6
10	495.9	495.6
11	495.6	495.5
12	495.4	495.5

Notes:

Blocks 3, 5, and 6, fell at time of movement, 6-2-61, and Block 4 fell 6:00pm, 6-4-61

The vertical joints, in detail on comp. dwgs., are not scarified for bond.

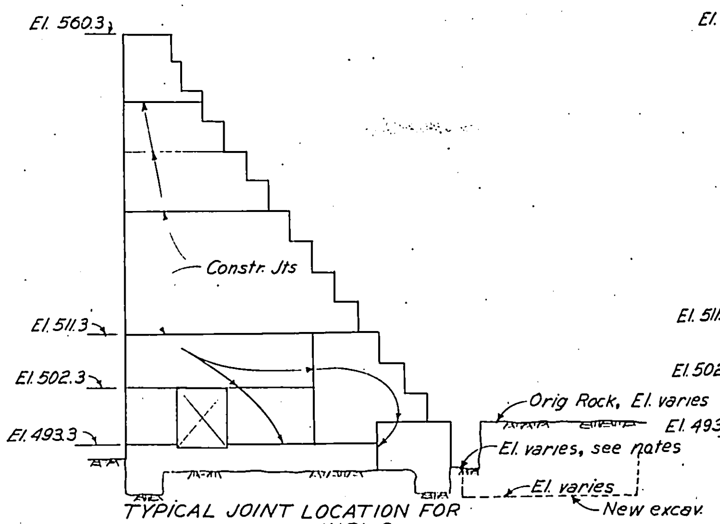
The Constr jts. in Blocks 9 and 10 are not complete since end elevations are only partially exposed.

See Dwg 61K11054 for typical Dimensions and Design Elevations of Blocks.

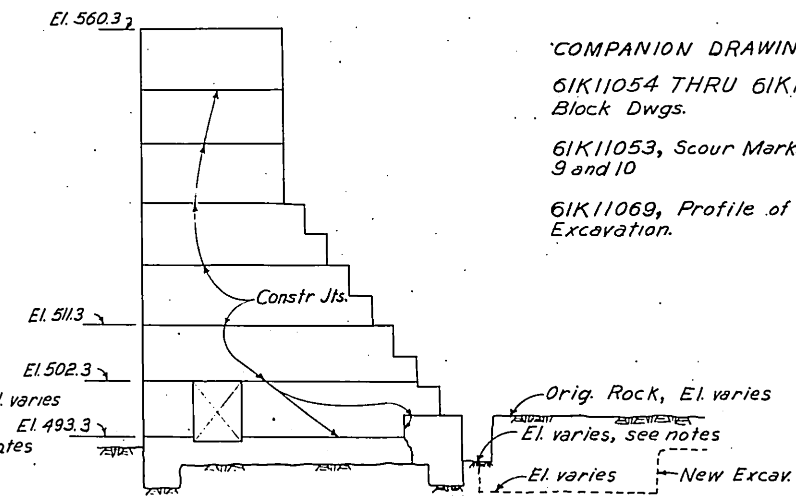
Blocks 13, 14, and 15, broken up. See Block Dwgs.

The elevation of the bottom of the old excav. trench, adjacent to the toe of the North Wall and as shown on the companion Dwgs, were obtained from "Orig. Rock Cross Sections." At the time these sections were taken the trench was full of muck, therefore these elevations are approx., but suitable for the original purpose for which they were intended, which was computing volumns. Removal of the muck and loose rock prior to blasting and after the Cross Sections were taken, reduced the elevation of the ditch to 488 or lower in a major portion of its entirety.

Scale: 1/16" = 1'-0"



TYPICAL JOINT LOCATION FOR BLOCKS 1 THRU 8
ELEVATION OF JOINTS VARIES ABOVE 511.3
SEE NOTES FOR BLOCKS 9 AND 10



TYPICAL JOINT LOCATION FOR BLOCKS 11 AND 12
ELEVATIONS OF JOINTS VARIES ABOVE 511.3

4	9-29	JNS					
Dim. Movement of Blocks							
3	7-28	JNS					
Add Dim., Notes, New Excav. details							
2	7-16-61	JNS					
Major Revision							
1	6-21	JNS					
Dim. of Block Movement							
REV NO.	DATE	MADE	CHKD	SUPV	INSP	SUBM	RECM

DSGN. ...... SUPV. ......
DRWN. GVM ...... INSP. ......
CHKD. ......
TRCD. ...... ENGINEER
COMP. ...... Jordan W. T. Dowell

AUXILIARY LOCK

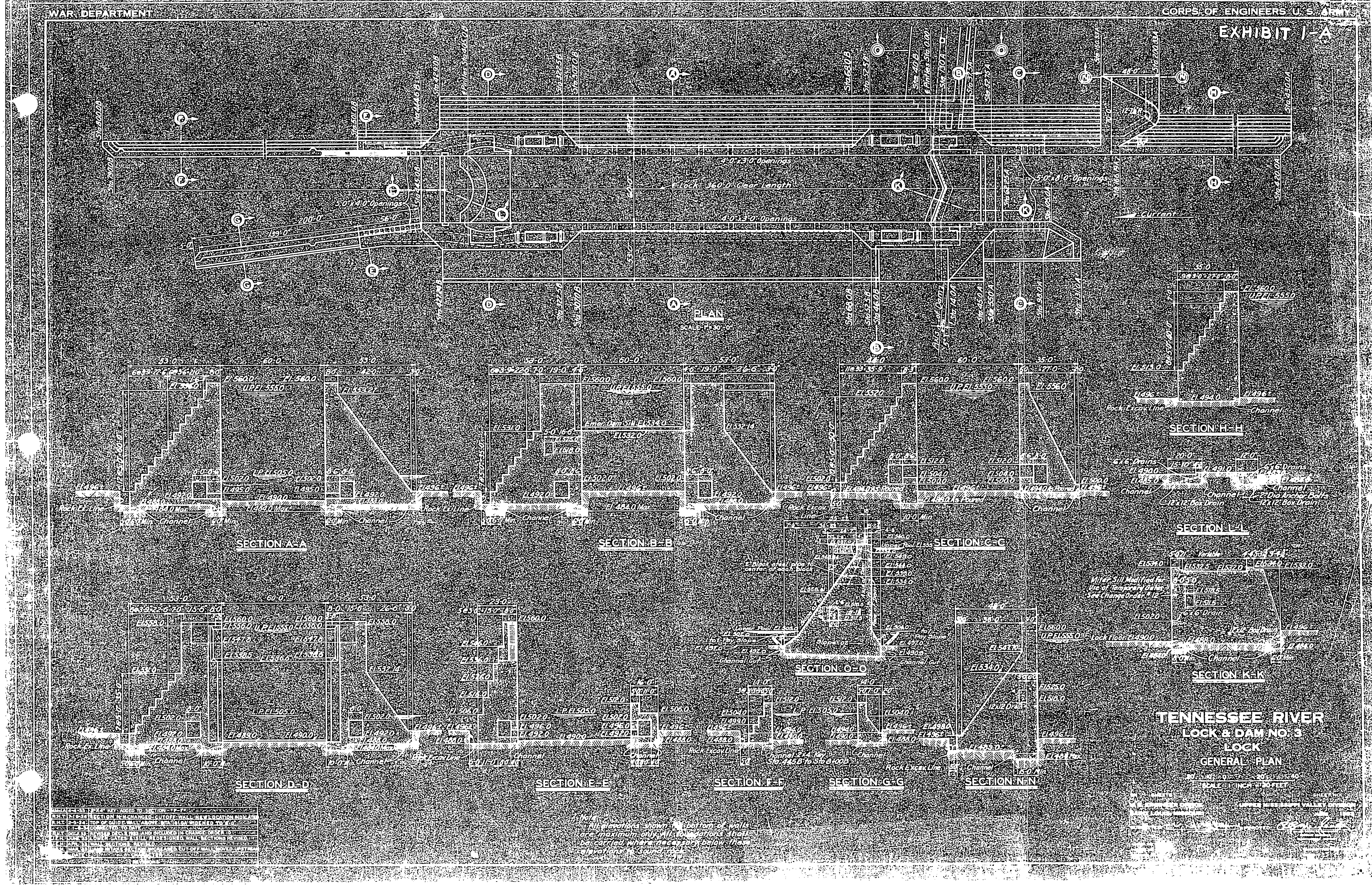
EXISTING CONDITION
NORTH WALL

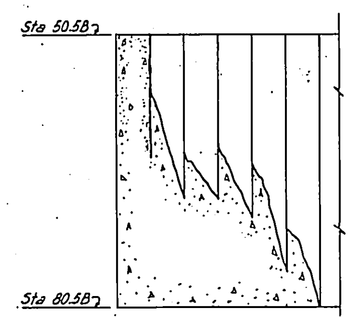
WHEELER PROJECT
TENNESSEE VALLEY AUTHORITY
DIVISION OF CONSTRUCTION

SUBMITTED	RECOMMENDED	APPROVED
W. T. Webb	H. L. Broadfoot	[illegible]

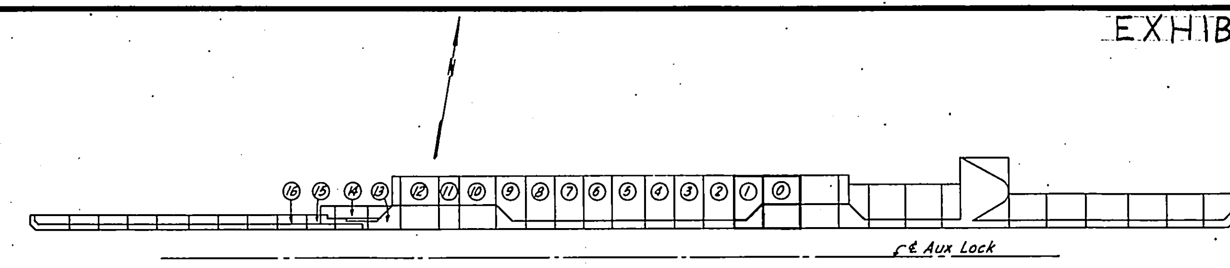
FIELD OFFICE	6-8-61	5	PC	4	61K11044 R4

RECORD DRAWING AS CONSTRUCTED

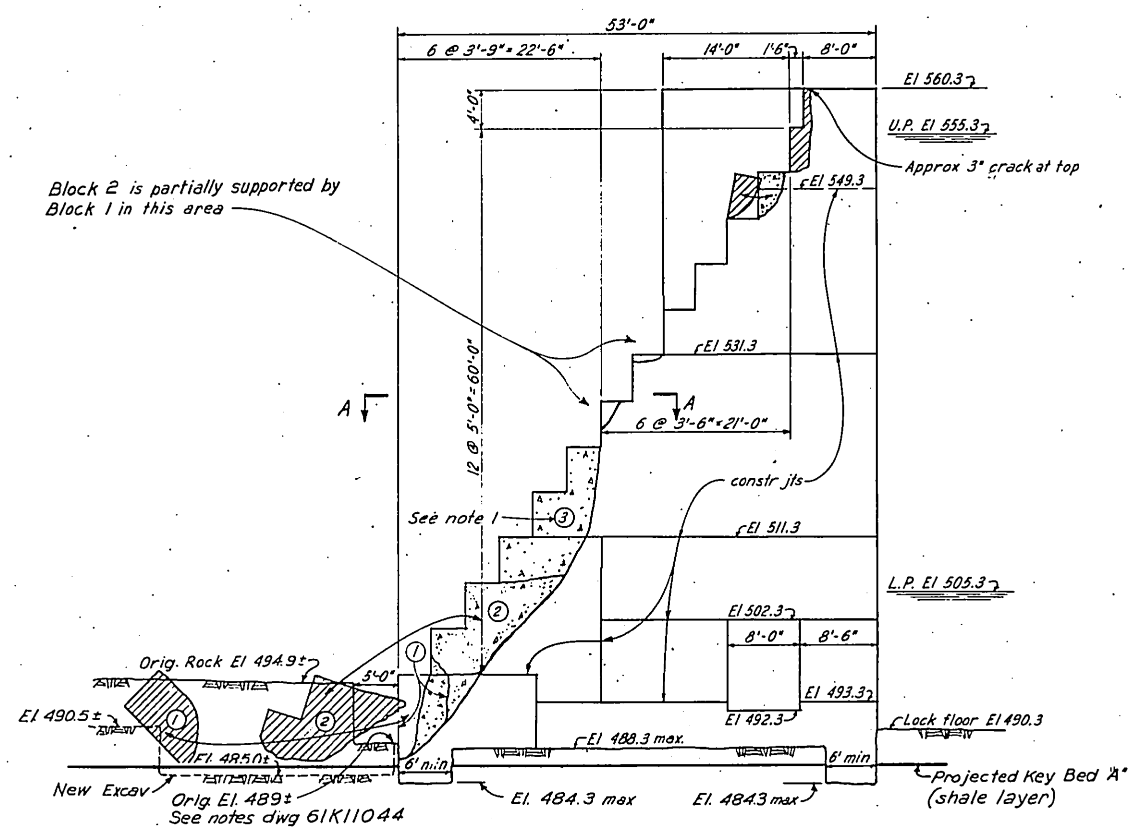

WAR DEPARTMENT
CORPS OF ENGINEERS U. S. ARMY
EXHIBIT 1-A
PLAN
Lock 360.0 Clear Length
Current
SECTION A-A
SECTION B-B
SECTION C-C
SECTION H-H
SECTION L-L
SECTION O-O
SECTION K-K
SECTION D-D
SECTION E-E
SECTION F-F
SECTION G-G
SECTION N-N
TENNESSEE RIVER
LOCK & DAM NO. 3
LOCK
GENERAL PLAN
SCALE: 1 INCH = 20 FEET



VIEW A-A
SHOWING BREAK IN STEPS

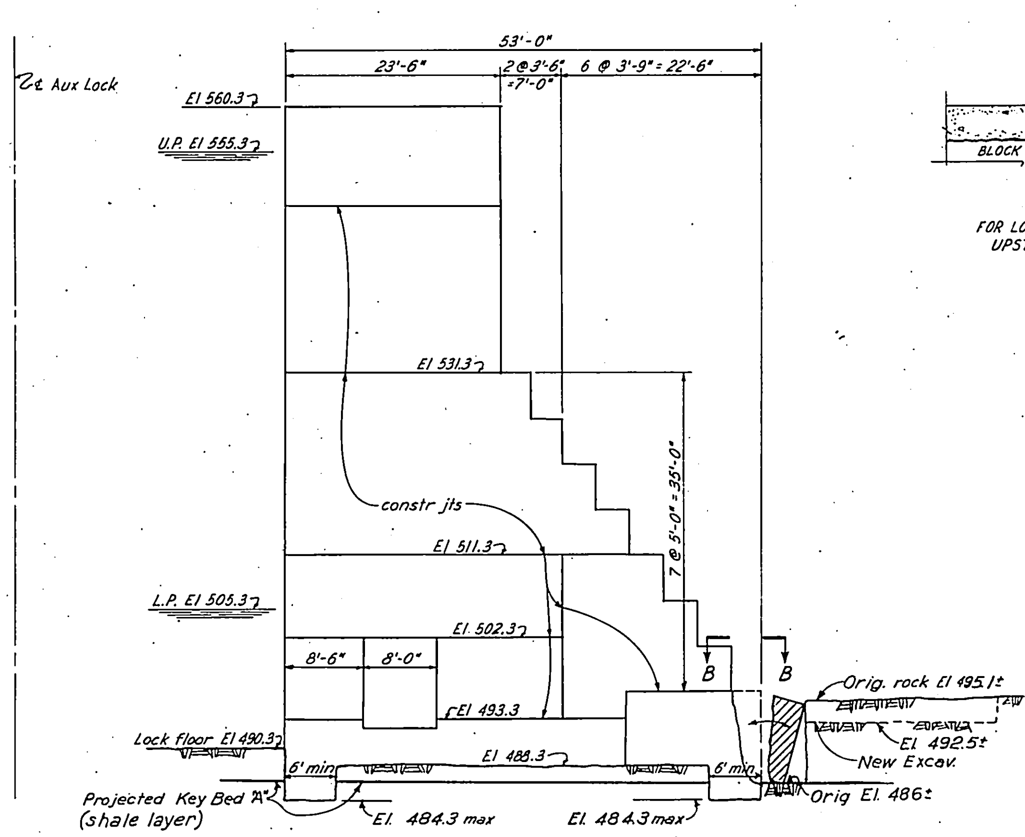


KEY PLAN-NORTH WALL
Scale: 1"=100'

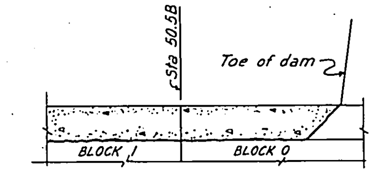


DOWNSTREAM END-BLOCK I

NOTE 1:
Piece ③ shattered.



UPSTREAM END-BLOCK I
DOWNSTREAM END BLOCK 0-OPP HAND



VIEW B-B
FOR LOCATION OF PIECE SEE
UPSTREAM END-BLOCK I.

Notes:
Hatched areas show location of concrete broken from the block.
A control point on block 1 moved $\frac{3}{16}$" North.
No movement occured in block 0.
Dimensions and Design El. shown are typical for blocks 0 thru 12.
All elevations shown are Design elevations except those pertaining to "New Excav" or indicated as "Orig."

Ref. Dwg. 61K11044

Scale: $\frac{3}{32}$" = 1'-0"
except as noted

AUXILIARY LOCK

EXISTING CONDITIONS
NORTH WALL
BLOCKS 0 AND 1

WHEELER PROJECT
TENNESSEE VALLEY AUTHORITY
DIVISION OF CONSTRUCTION

SUBMITTED	RECOMMENDED	APPROVED
W. T. Webb	H. B. Bradford	[illegible]

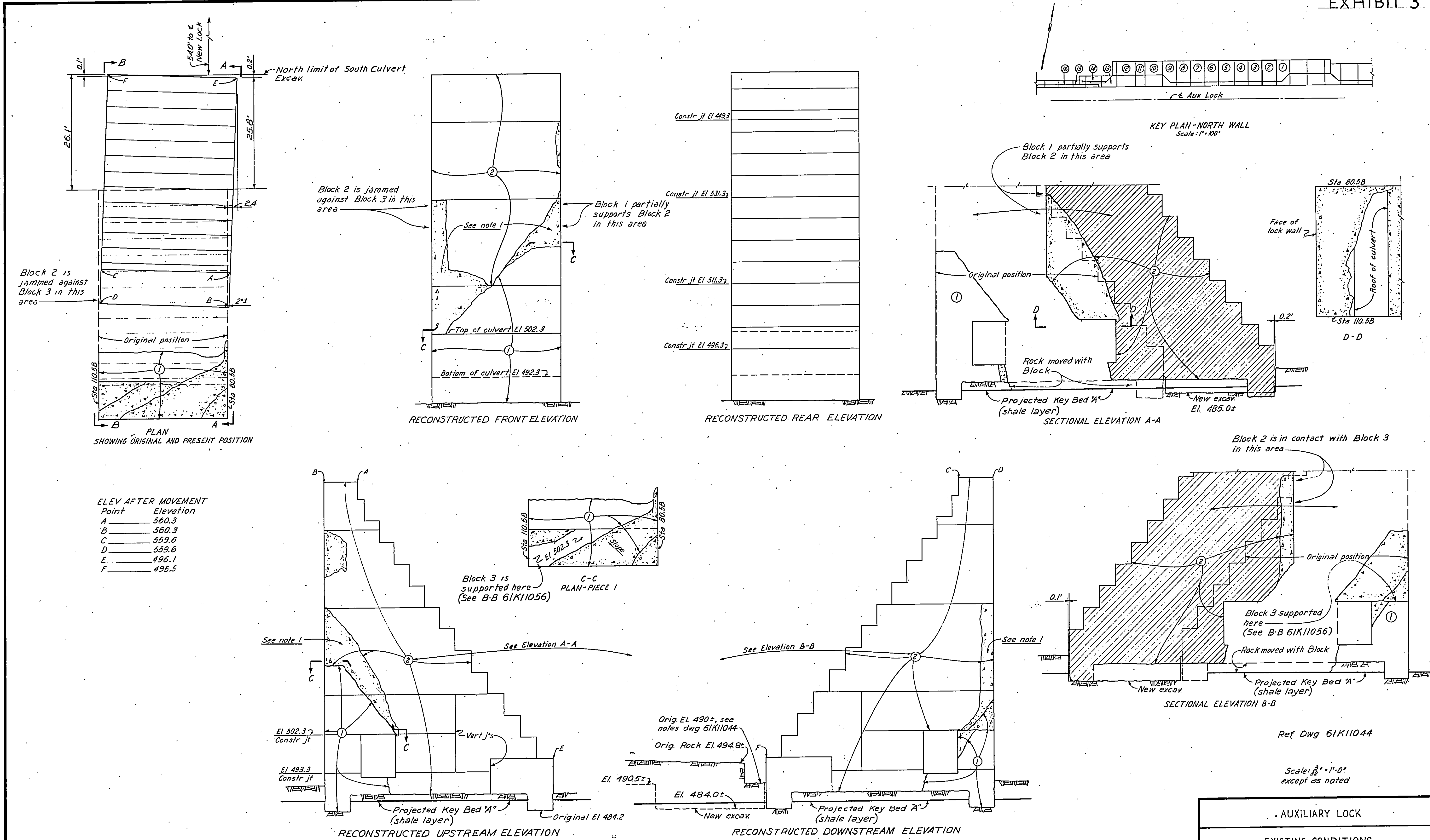
FIELD OFFICE	7-12-61	3	PC	4	61K11054 R2

RECORD DRAWING AS CONSTRUCTED

REV NO.	DATE	MADE	CHKD	SUPV	INSP	SUBM	RECM
2	9-29-61	JNS					
Add info							
1	7-28-61	JNS					
Add Rock elev and Notes							

DSGN.
DRWN. OPG
CHKD.
TRCD.
COMP.
SUPV.
INSP.
ENGINEER J. N. Stallins

EXHIBIT 3



ELEV AFTER MOVEMENT

Point	Elevation
A	560.3
B	560.3
C	559.6
D	559.6
E	496.1
F	495.5

Ref Dwg 61K11044

Scale: $\frac{3}{32}$" = 1'-0" except as noted

NOTES:
Note 1: Concrete in these areas were broken and shattered in small pieces.
GENERAL:
Piece (1) remained in original position.
Hatched areas show the location of piece (2) after movement.
All El. shown are Design El. except those indicated as Orig or those pertaining to Excav. for Main Lock.

REV NO.	DATE	MADE	CHKD	SUPV	INSP	SUBM	RECM
2	9-29-61	JNS					
Add Info							
1	7-29-61	JNS					
Add info							

DSGN .... SUPV ....
DRWN OPG .... INSP ....
CHKD ....
TRCD .... ENGINEER
COMP .... J. N. Stallings

AUXILIARY LOCK

EXISTING CONDITIONS
NORTH WALL
BLOCK 2

WHEELER PROJECT
TENNESSEE VALLEY AUTHORITY
DIVISION OF CONSTRUCTION

SUBMITTED	RECOMMENDED	APPROVED
W. T. Webb	H. [illegible]	[illegible]
FIELD OFFICE	7-12-61	13 PC 4 61K11055 RE

RECORD DRAWING AS CONSTRUCTED

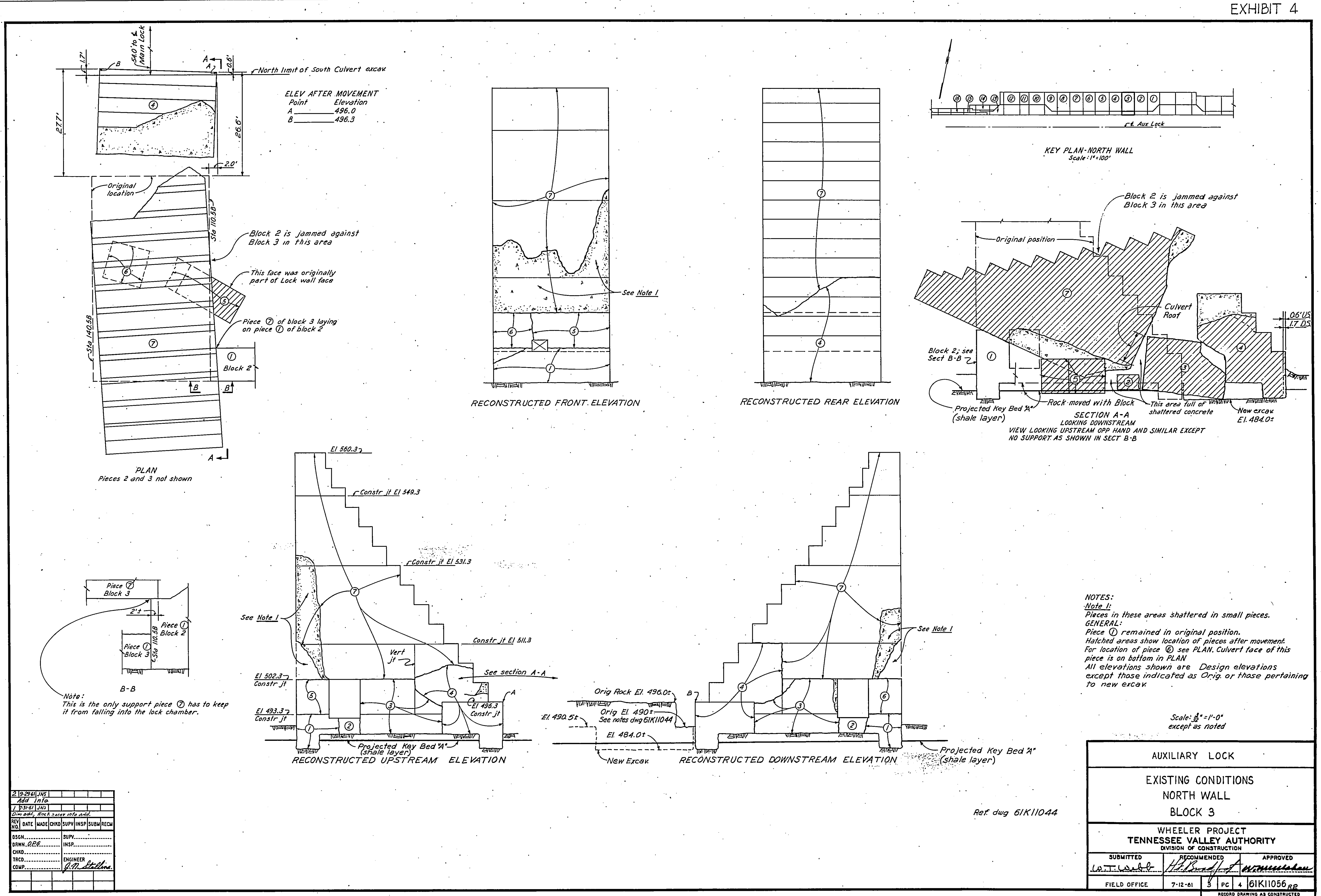
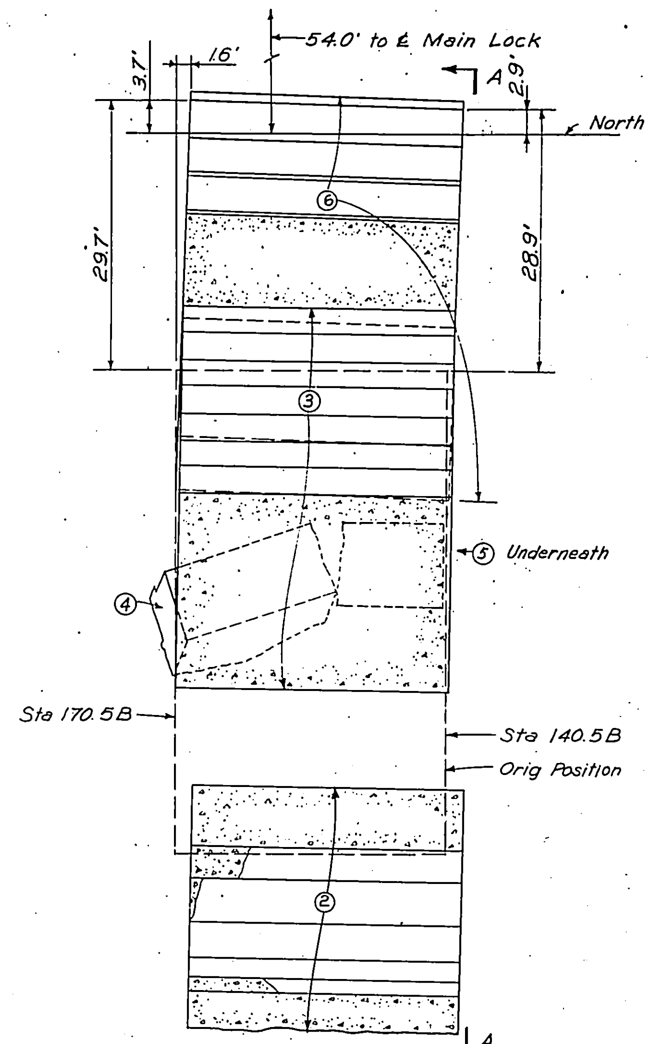
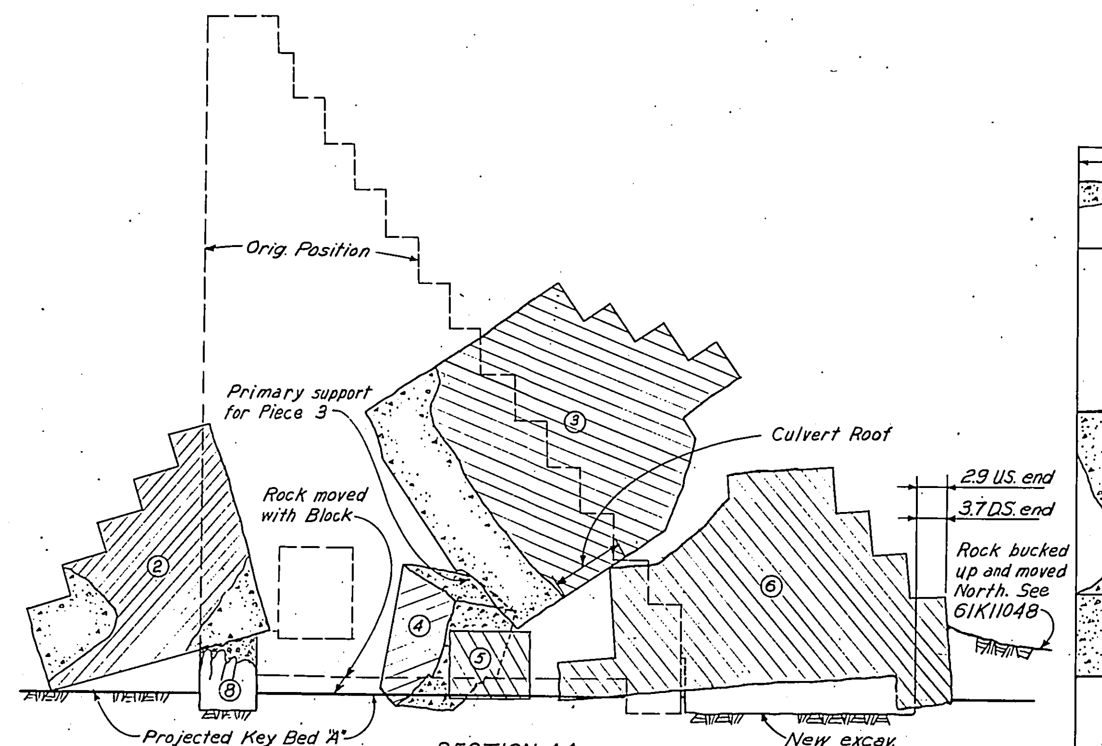


EXHIBIT 4
54.0' to ℄ Main Lock
1.7'
0.6'
North limit of South Culvert excav.
ELEV AFTER MOVEMENT
Point Elevation
A 496.0
B 496.3
27.7'
26.6'
2.0'
Original location
Sta 110.58
Block 2 is jammed against Block 3 in this area
This face was originally part of Lock wall face
Piece 7 of block 3 laying on piece 1 of block 2
Sta 140.58
Block 2
PLAN
Pieces 2 and 3 not shown
RECONSTRUCTED FRONT ELEVATION
See Note 1
RECONSTRUCTED REAR ELEVATION
KEY PLAN-NORTH WALL
Scale: 1"=100'
℄ Aux Lock
Block 2 is jammed against Block 3 in this area
Original position
Culvert Roof
0.6' US
1.7' DS
Block 2; see Sect B-B
Projected Key Bed "A" (shale layer)
Rock moved with Block
This area full of shattered concrete
New excav. El. 484.0±
SECTION A-A
LOOKING DOWNSTREAM
VIEW LOOKING UPSTREAM OPP HAND AND SIMILAR EXCEPT NO SUPPORT AS SHOWN IN SECT B-B
Piece 7 Block 3
2'±
Piece 1 Block 2
Piece 1 Block 3
Sta 110.58
B-B
Note:
This is the only support piece 7 has to keep it from falling into the lock chamber.
El 560.3
Constr jt El 549.3
Constr jt El 531.3
Constr jt El 511.3
Vert jt
See section A-A
See Note 1
El 502.3 Constr jt
El 493.3 Constr jt
El 496.3 Constr jt
Projected Key Bed "A" (shale layer)
RECONSTRUCTED UPSTREAM ELEVATION
Orig Rock El. 496.0±
Orig El. 490±
See notes dwg 61K11044
El. 490.5±
El. 484.0±
New Excav.
RECONSTRUCTED DOWNSTREAM ELEVATION
See Note 1
Projected Key Bed "A" (shale layer)
NOTES:
Note 1:
Pieces in these areas shattered in small pieces.
GENERAL:
Piece 1 remained in original position.
Hatched areas show location of pieces after movement.
For location of piece 6 see PLAN. Culvert face of this piece is on bottom in PLAN
All elevations shown are Design elevations except those indicated as Orig. or those pertaining to new excav.
Scale: 3/32"=1'-0" except as noted
Ref. dwg 61K11044
2 9-29-61 JNS Add Info
1 7-31-61 JNS Dim add, Rock excav info add.
REV NO. DATE MADE CHKD SUPV INSP SUBM RECM
DSGN. SUPV.
DRWN. OPG INSP.
CHKD.
TRCD. ENGINEER
COMP. J.M. Stallins
AUXILIARY LOCK
EXISTING CONDITIONS
NORTH WALL
BLOCK 3
WHEELER PROJECT
TENNESSEE VALLEY AUTHORITY
DIVISION OF CONSTRUCTION
SUBMITTED RECOMMENDED APPROVED
FIELD OFFICE 7-12-61 3 PC 4 61K11056 RB
RECORD DRAWING AS CONSTRUCTED

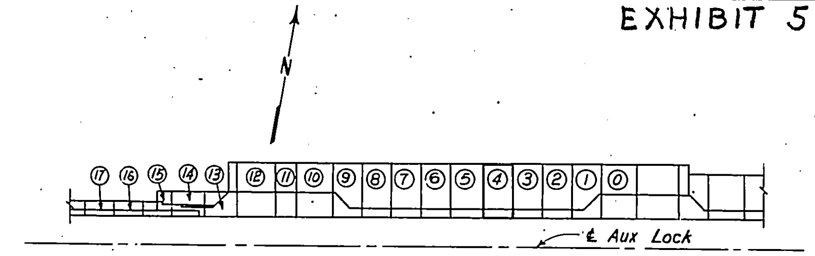
EXHIBIT 5



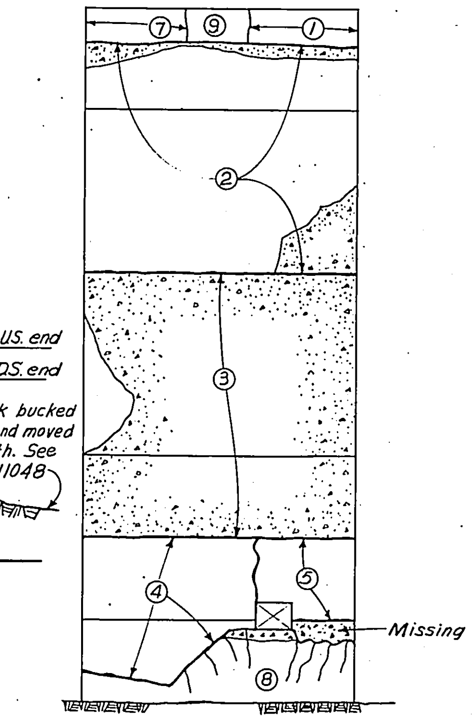
PLAN



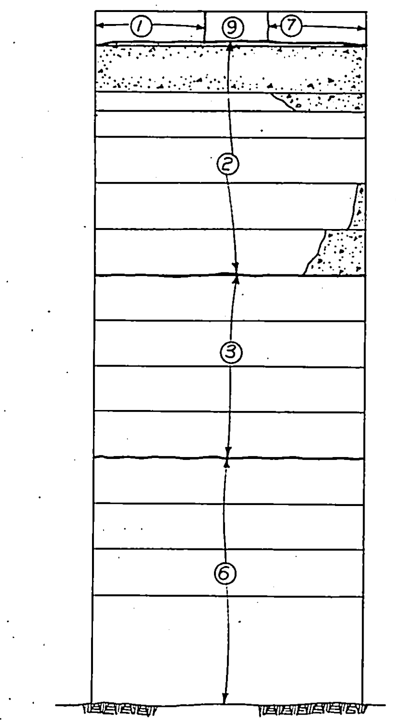
SECTION A-A
EXISTING UPSTREAM ELEVATION · DOWNSTREAM ELEVATION OPP. HAND AND SIMILAR



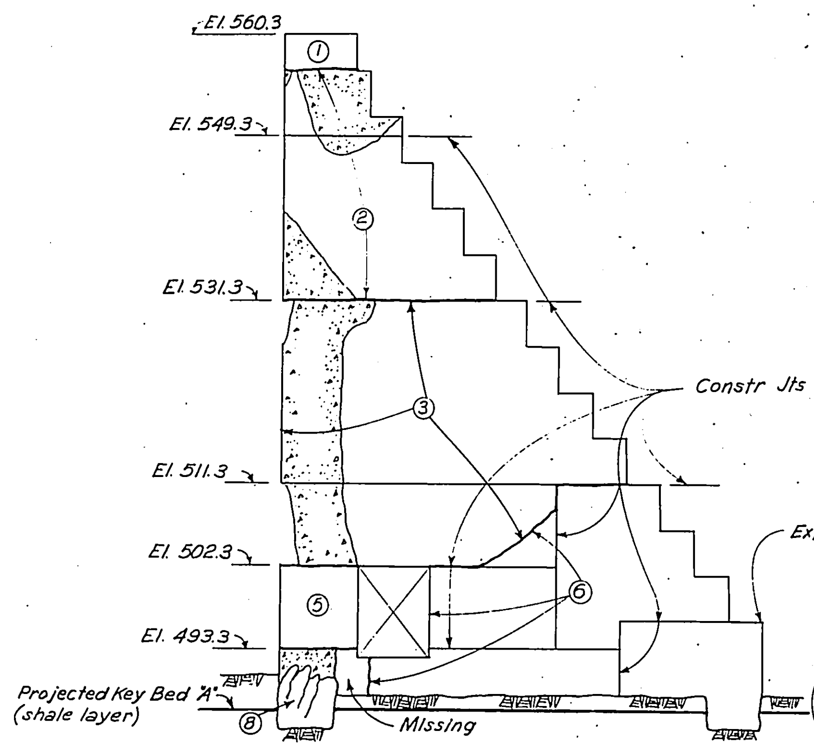
KEY PLAN - NORTH WALL
Scale: 1" = 100'



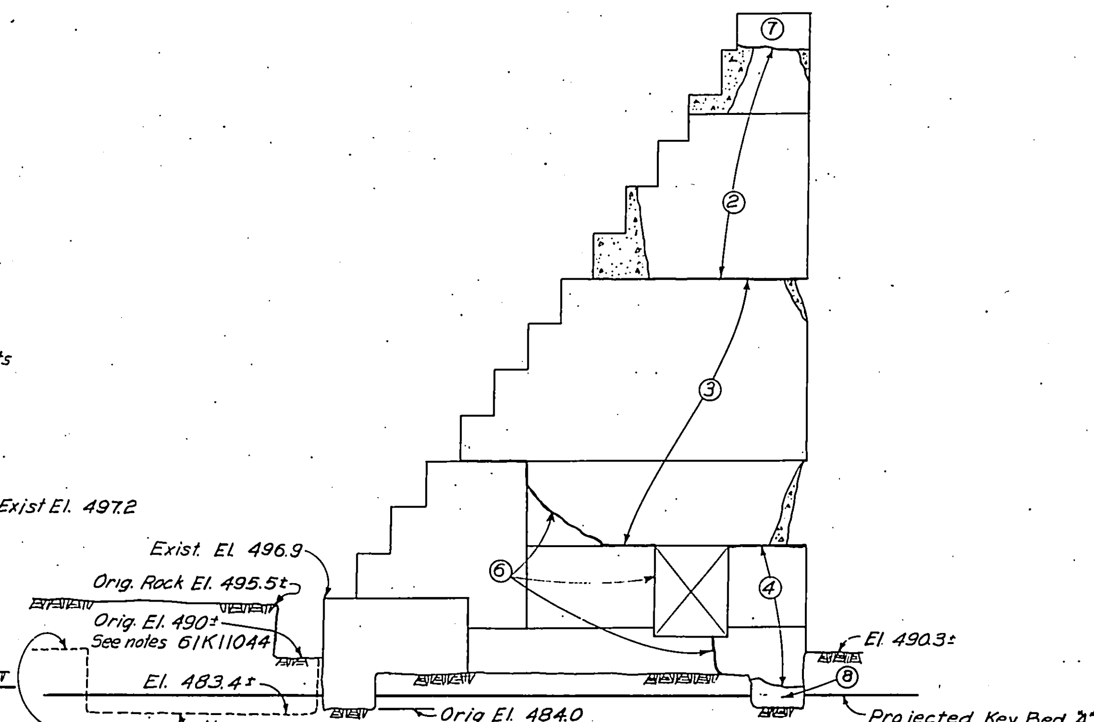
RECONSTRUCTED FRONT ELEVATION



RECONSTRUCTED REAR ELEVATION



RECONSTRUCTED UPSTREAM ELEVATION



RECONSTRUCTED DOWNSTREAM ELEVATION

Notes:

The entire Block moved except a portion of the front Key.

A majority of the spalled pieces are laying underneath the Block.

All Elevations shown are Design Elevations except those indicated as "Orig.", "Exist," or pertaining to new excav.

① ⑦ and ⑨ are laying toward the South Wall of Aux. Lock and D.S. 15' to 30' from ℄ of Block.

⑧ In original position, and severely cracked.

The lower limits of piece ④ and ⑧ are approximate only, and could vary from those limits shown.

This Block fell into the Lock Chamber 45 hours after initial movement

Ref. Dwg. 61K11044

Scale: 3/32" = 1'-0"
except as noted

REV NO.	DATE	MADE	CHKD	SUPV	INSP	SUBM	RECM
2	9-29-61	JNS					
	Add Info						
1	7-31-61	JNS					
	Add Dim. and Excav Info						

DSGN. .... SUPV. ....
DRWN. JNS .... INSP. ....
CHKD. ....
TRCD. .... ENGINEER
COMP. .... J. N. Stallins

AUXILIARY LOCK

EXISTING CONDITION
BLOCK 4
NORTH WALL

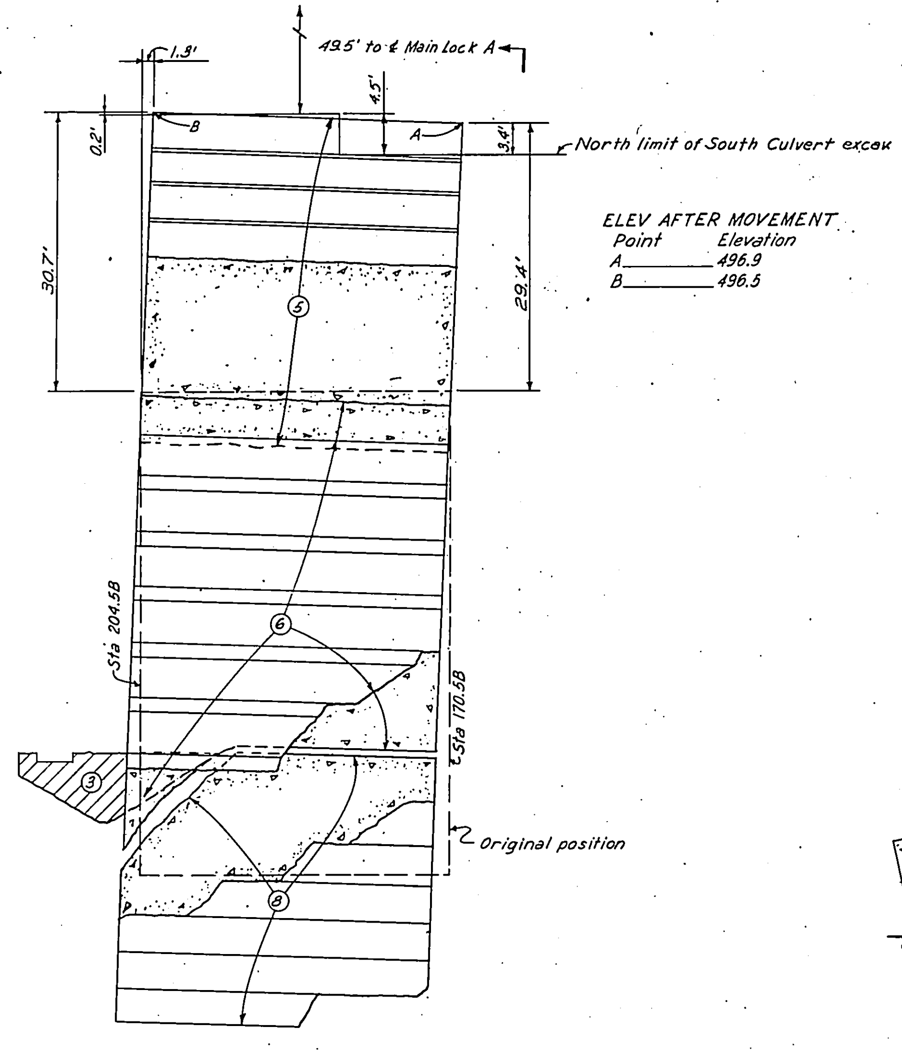
WHEELER PROJECT
TENNESSEE VALLEY AUTHORITY
DIVISION OF CONSTRUCTION

SUBMITTED	RECOMMENDED	APPROVED
W. T. Webb	H. L. Bradford	[illegible]

FIELD OFFICE	7-14-61	3	PC	4	61K11057 R2

RECORD DRAWING AS CONSTRUCTED

EXHIBIT 8

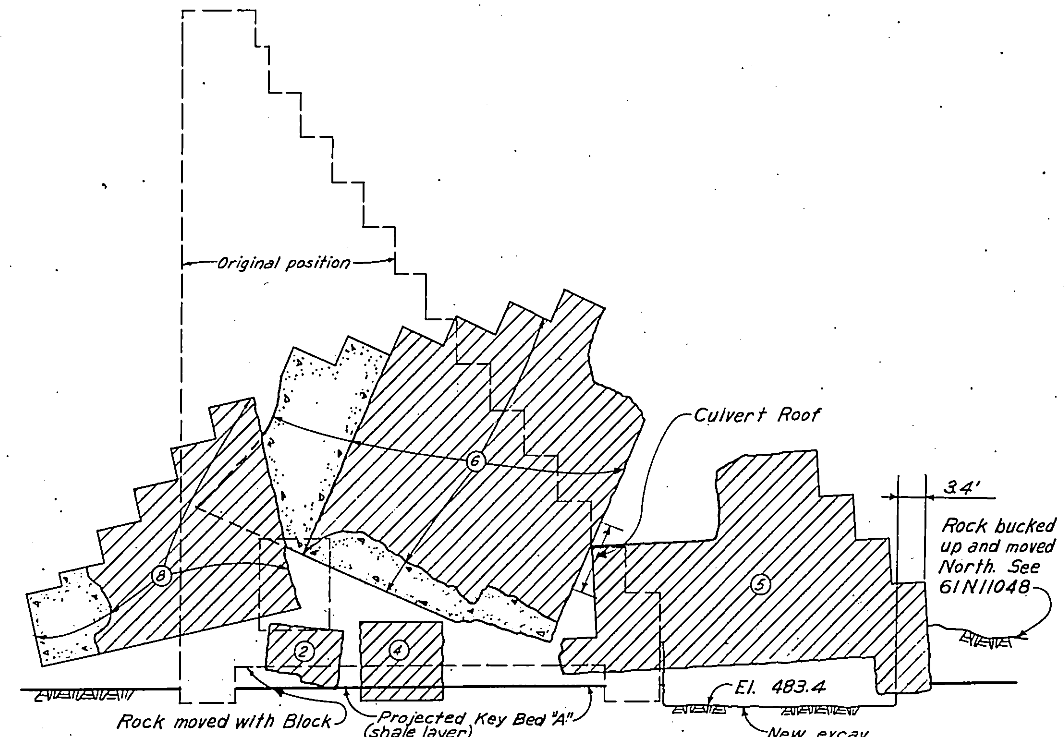


PLAN

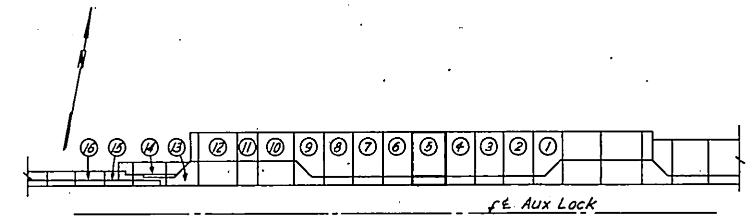
A

ELEV AFTER MOVEMENT

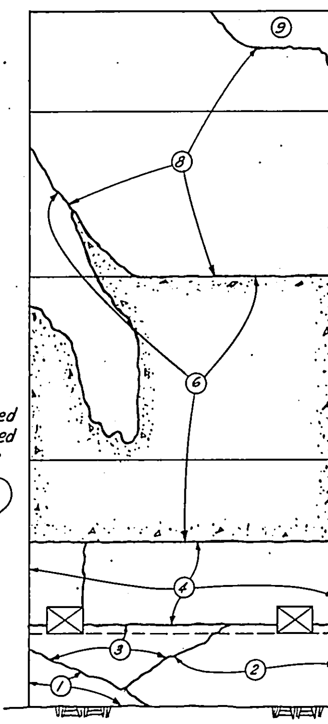
Point	Elevation
A	496.9
B	496.5

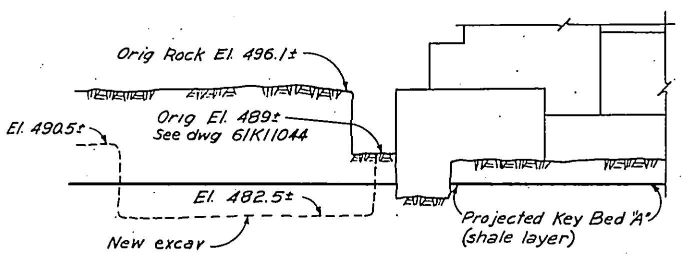


SECTION A-A

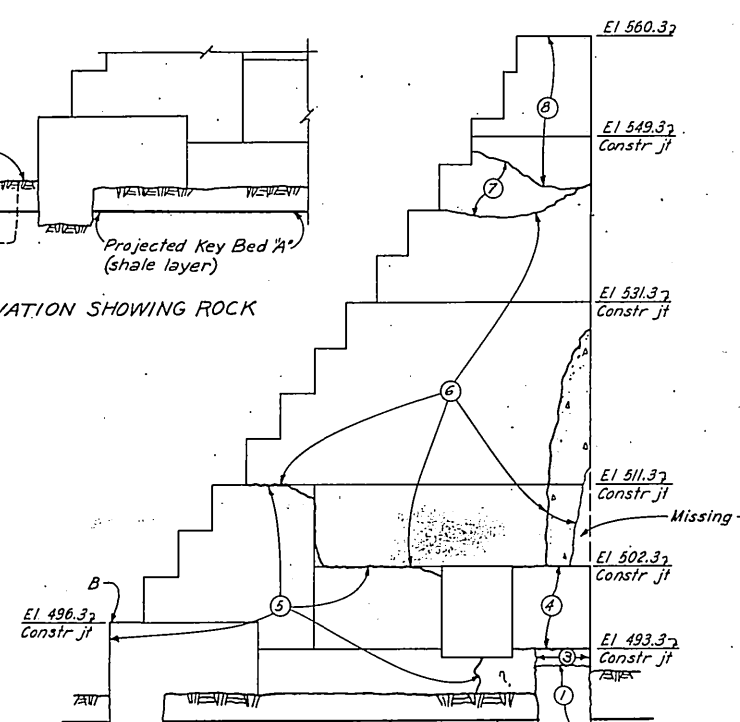


KEY PLAN-NORTH WALL
Scale: 1" = 100'

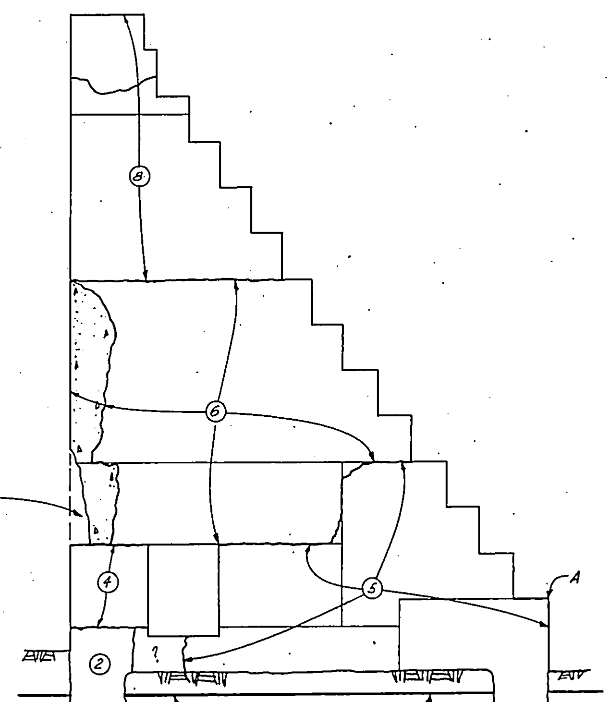

RECONSTRUCTED FRONT ELEVATION



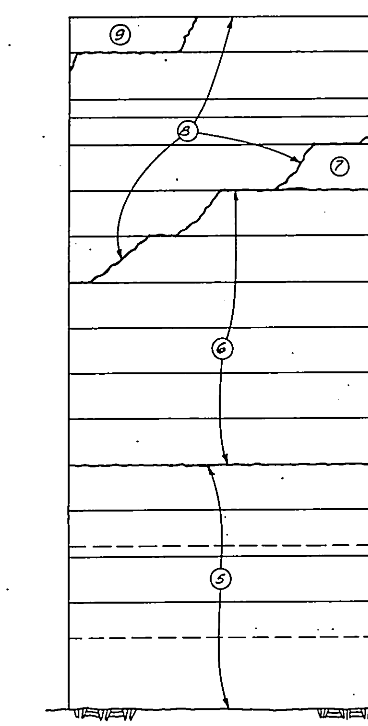
DOWNSTREAM ELEVATION SHOWING ROCK



RECONSTRUCTED DOWNSTREAM ELEVATION



RECONSTRUCTED UPSTREAM ELEVATION


RECONSTRUCTED REAR ELEVATION

NOTES:
Piece 1 remained in its original position.
Hatched areas in Sect A-A and plan show the present position of pieces 2,3,4,5,6 and 8.
Pieces 7 and 9 could not be located.
Piece marked ? is either shattered and gone or under the block and covered by a mass of small pieces.
All elevations shown are Design elevations except those indicated as "Orig" or pertaining to new excav.

Ref. Dwg 61K11044

Scale: 3/32" = 1'-0"
except as noted

REV NO.	DATE	MADE	CHKD	SUPV	INSP	SUBM	RECM
2	9-29-61	JNS					
	Add info						
1	7-31-61	JNS					
	Add dim and Rock info						

DSGN. SUPV.
DRWN. OPG INSP.
CHKD.
TRCD. ENGINEER
COMP. J.M. Stallins

AUXILIARY LOCK

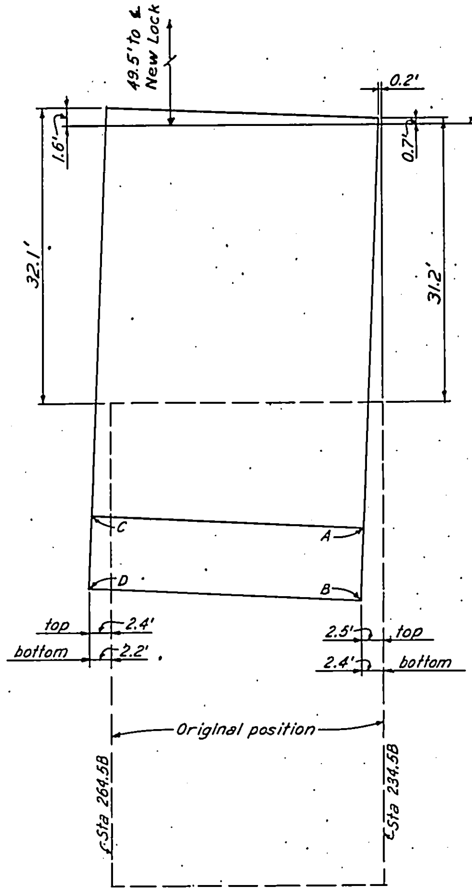
EXISTING CONDITIONS
NORTH WALL
BLOCK 5

WHEELER PROJECT
TENNESSEE VALLEY AUTHORITY
DIVISION OF CONSTRUCTION

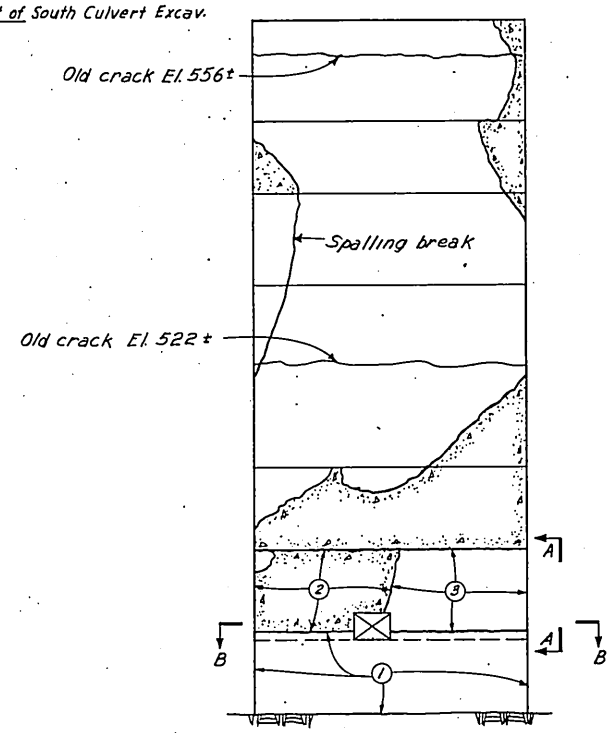
SUBMITTED	RECOMMENDED	APPROVED
W.T. Webb	H.L. Bradford	[illegible]

FIELD OFFICE | 7-13-61 | 3 | PC | 4 | 61K11058 R2
RECORD DRAWING AS CONSTRUCTED

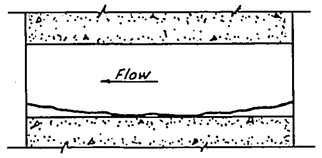
EXHIBIT 8



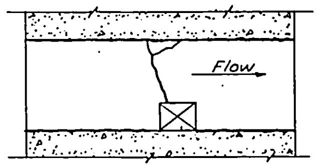
PLAN



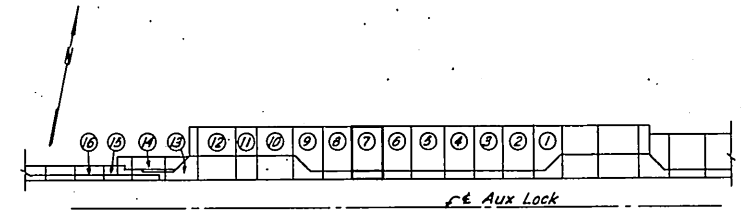
FRONT ELEVATION
BLOCK SHOWN IN ORIGINAL POSITION
SEE A-A FOR EXISTING LOCATION PIECES 3 & 4



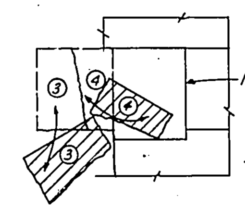
B-B
FLOOR OF CULVERT



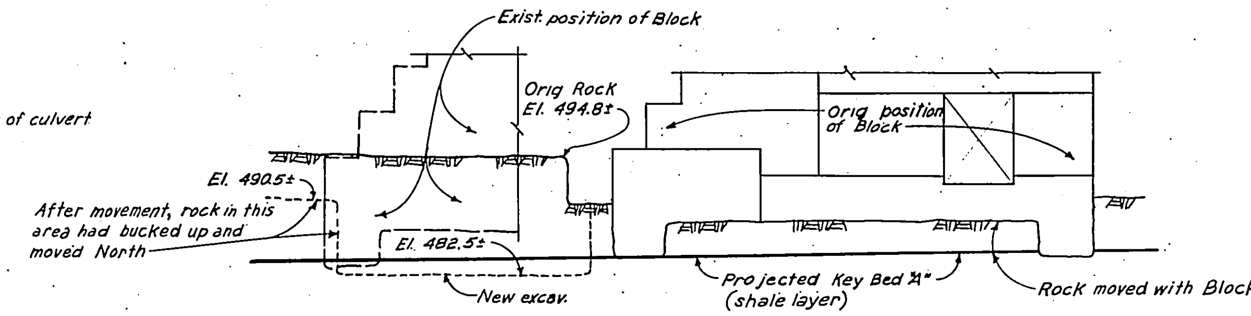
C-C
S. FACE OF CULVERT



KEY PLAN-NORTH WALL
Scale: 1" = 100'



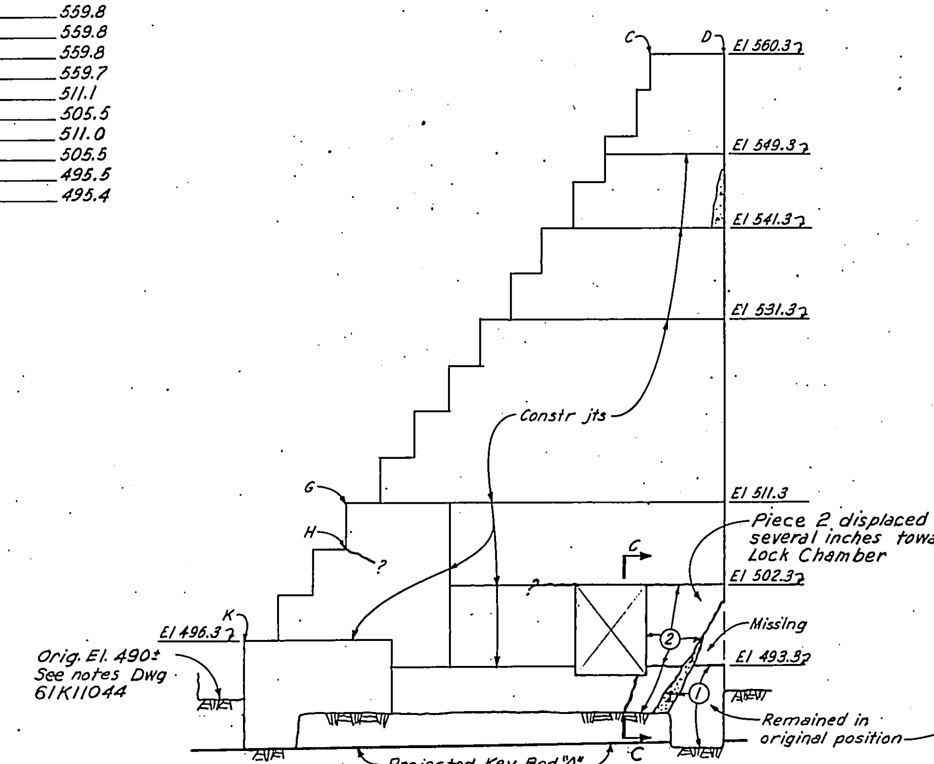
SECTION A-A
EXISTING POSITION OF PIECES 3 & 4



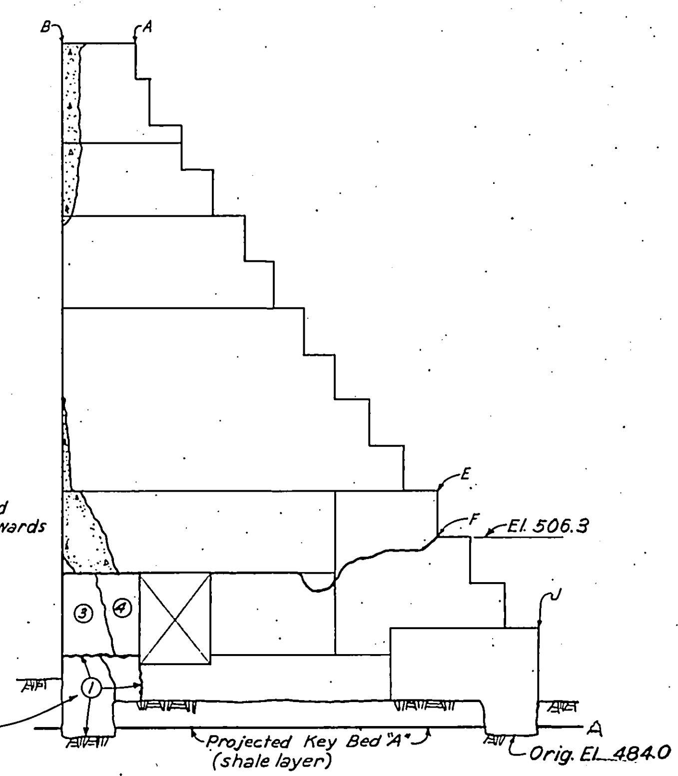
DOWNSTREAM ELEVATION - EXISTING AND ORIGINAL POSITIONS
SEE PLAN FOR DIMENSIONS

ELEV AFTER MOVEMENT

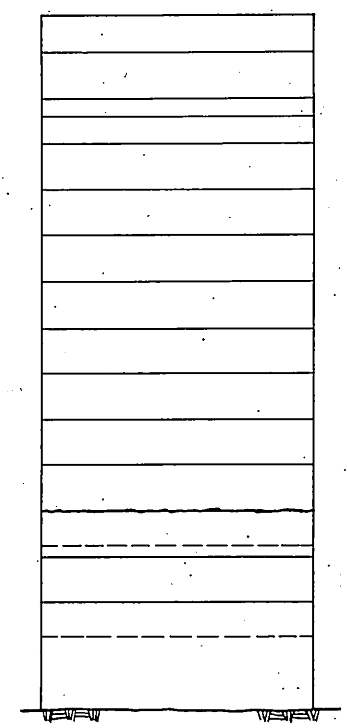
Point	Elevation
A	559.8
B	559.8
C	559.8
D	559.7
E	511.1
F	505.5
G	511.0
H	505.5
J	495.5
K	495.4



DOWNSTREAM ELEVATION
BLOCK SHOWN IN ORIGINAL POSITION



UPSTREAM ELEVATION
BLOCK SHOWN IN ORIGINAL POSITION
SEE A-A FOR EXISTING LOCATION PIECES 3 & 4



REAR ELEVATION

NOTES:
The location of the block after movement is shown in the plan view.
Piece ① remained in its original position.
Hatched areas, Sect. A-A, show the position of pieces ③ and ④ relative to the block after movement.
Piece ② moved with the block and is shown in its present position, relative to the block after movement, in the downstream elevation.
Breaks shown thus, ~~~?, could not be seen further to determine their course.
All elevations shown are Design elevations except those indicated as "Orig." or pertaining to new excavation.

REF. DWG 61K11044

Scale: 1/8" = 1'-0" except as noted

REV NO.	DATE	MADE	CHKD	SUPV	INSP	SUBM	RECM
2	9-29-61	JNS					
	Add Info						
1	7-31-61	JNS					
	Add Dim. and Rock info						

DSGN. .... SUPV. ....
DRWN. O.P.G. .... INSP. ....
CHKD. ....
TRCD. .... ENGINEER
COMP. .... J. N. Stallins

AUXILIARY LOCK

EXISTING CONDITIONS
NORTH WALL
BLOCK 7

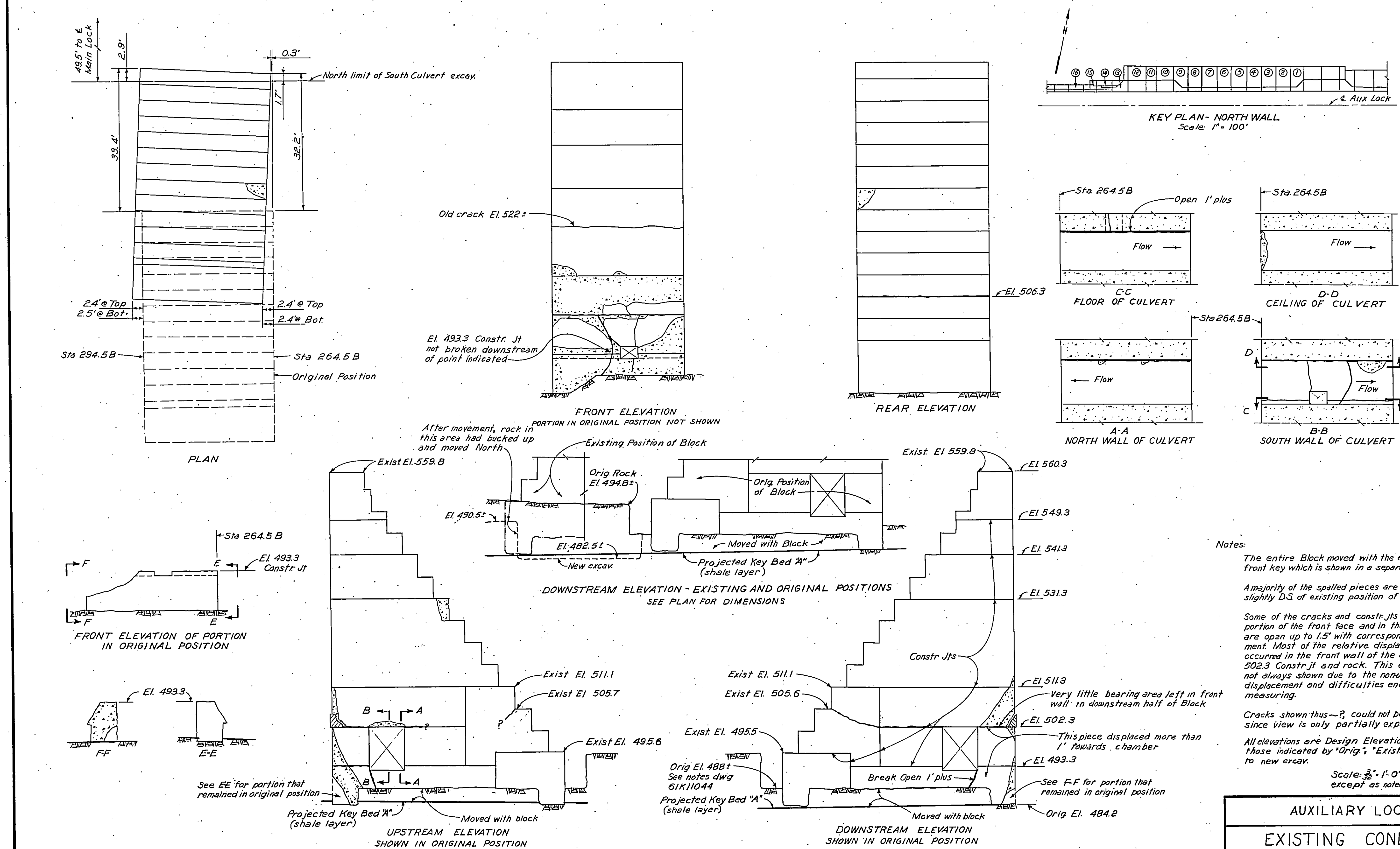
WHEELER PROJECT
TENNESSEE VALLEY AUTHORITY
DIVISION OF CONSTRUCTION

SUBMITTED	RECOMMENDED	APPROVED
W. T. Webb	[signature]	[signature]

FIELD OFFICE	7-12-61	3	PC	4	61K11060 R2

RECORD DRAWING AS CONSTRUCTED

EXHIBIT 9



Notes:

The entire Block moved with the exception of the front key which is shown in a separate view.

A majority of the spalled pieces are laying south and slightly D.S. of existing position of block.

Some of the cracks and constr. jts in the lower portion of the front face and in the culvert area are open up to 1.5' with corresponding displacement. Most of the relative displacement has occurred in the front wall of the culvert between 502.3 Constr. jt and rock. This displacement is not always shown due to the nonuniformity of displacement and difficulties encountered in measuring.

Cracks shown thus ~?, could not be seen further since view is only partially exposed.

All elevations are Design Elevations except those indicated by "Orig.", "Exist.", or pertaining to new excav.

Scale: 3/32" = 1'-0"
except as noted

Ref Dwg 61K11044

AUXILIARY LOCK

EXISTING CONDITION
BLOCK 8
NORTH WALL

WHEELER PROJECT
TENNESSEE VALLEY AUTHORITY
DIVISION OF CONSTRUCTION

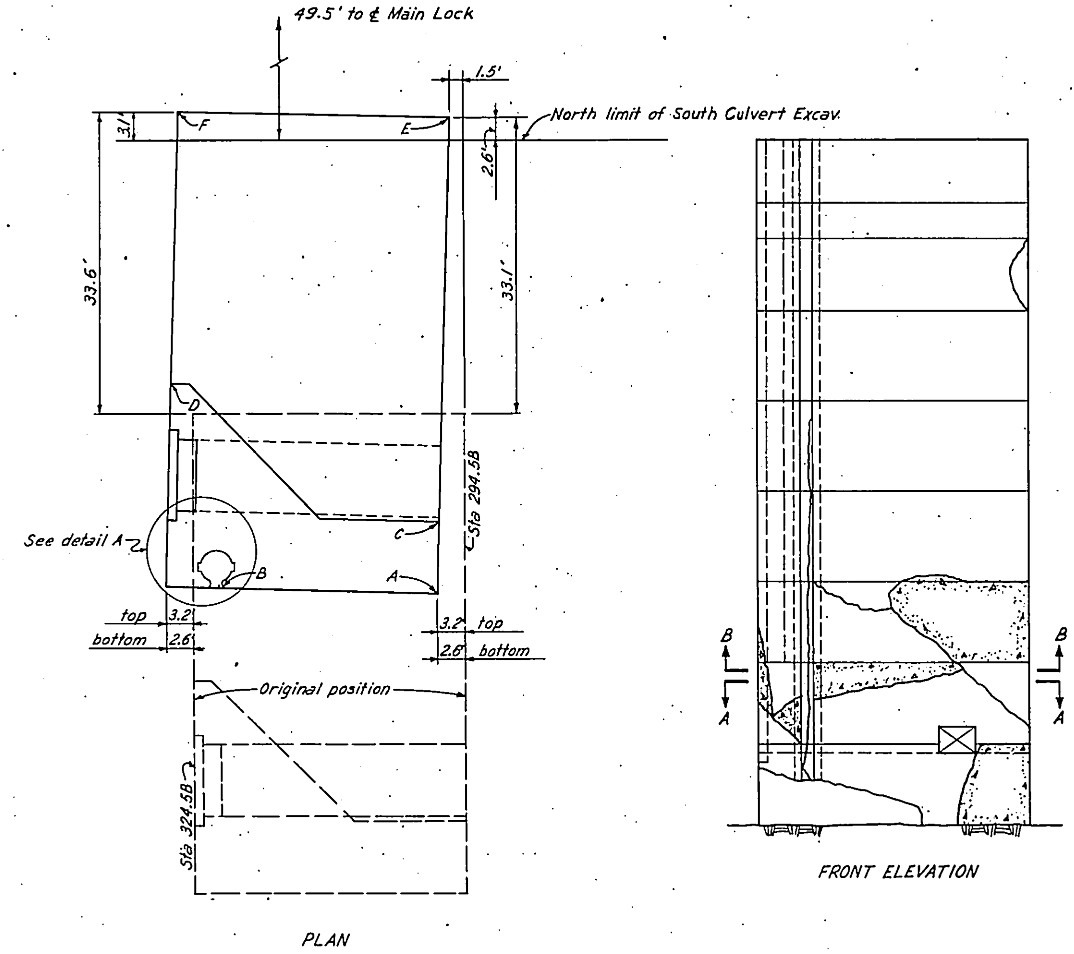
SUBMITTED	RECOMMENDED	APPROVED
W. T. Webb	[signature]	[signature]

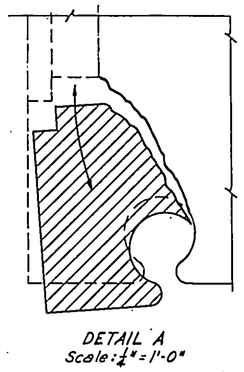
FIELD OFFICE	7-12-61	3	PC	4	61K11061 R2

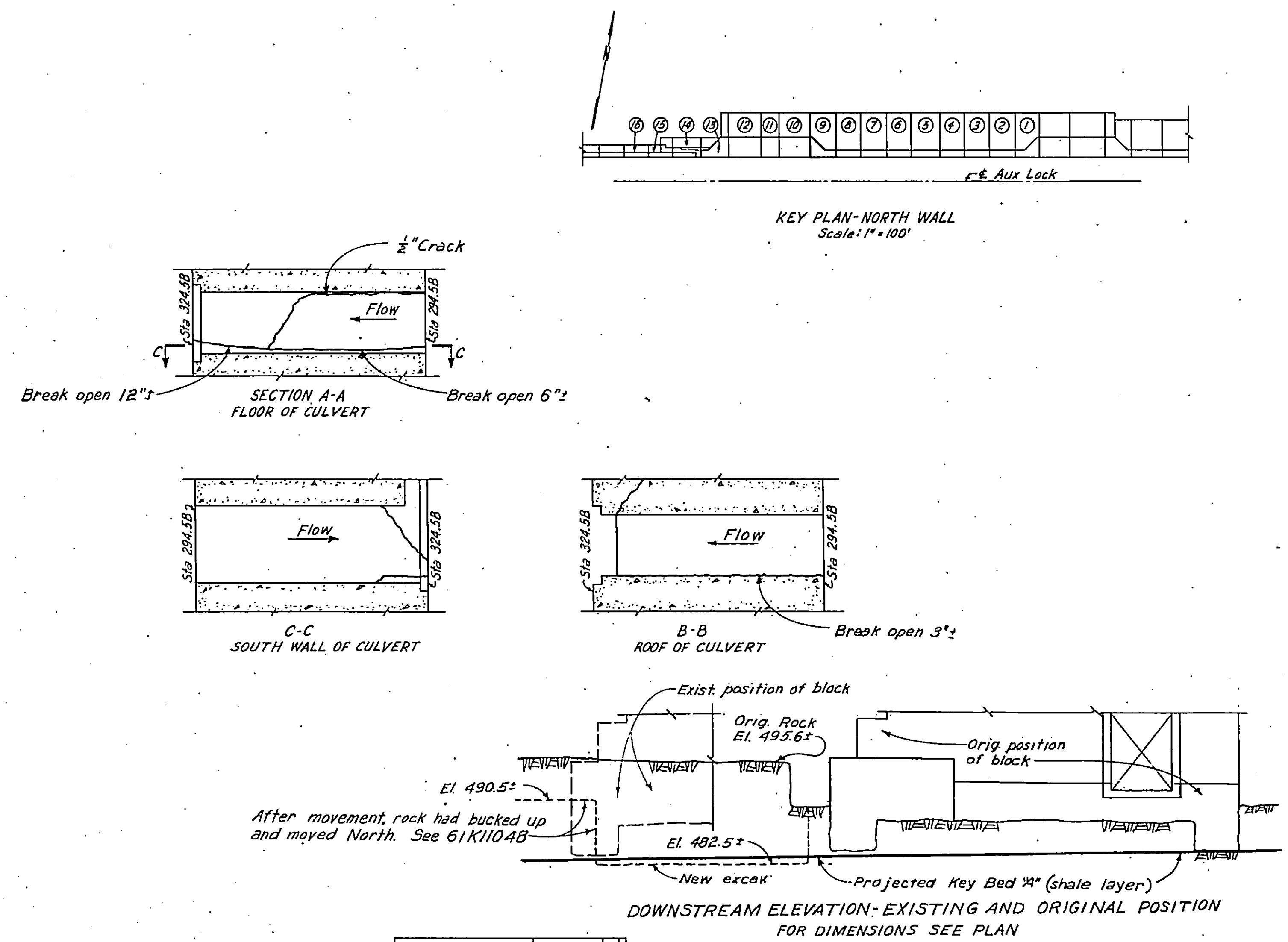
RECORD DRAWING AS CONSTRUCTED

REV NO.	DATE	MADE	CHKD	SUPV	INSP	SUBM	RECM
2	9-29-61	JNS					
	Add info						
1	7-31-61	JNS					
	Add Dim. and Rock info						

DSGN.......... SUPV..........
DRWN. JNS .... INSP..........
CHKD..........
TRCD.......... ENGINEER
COMP.......... J. N. Stallins

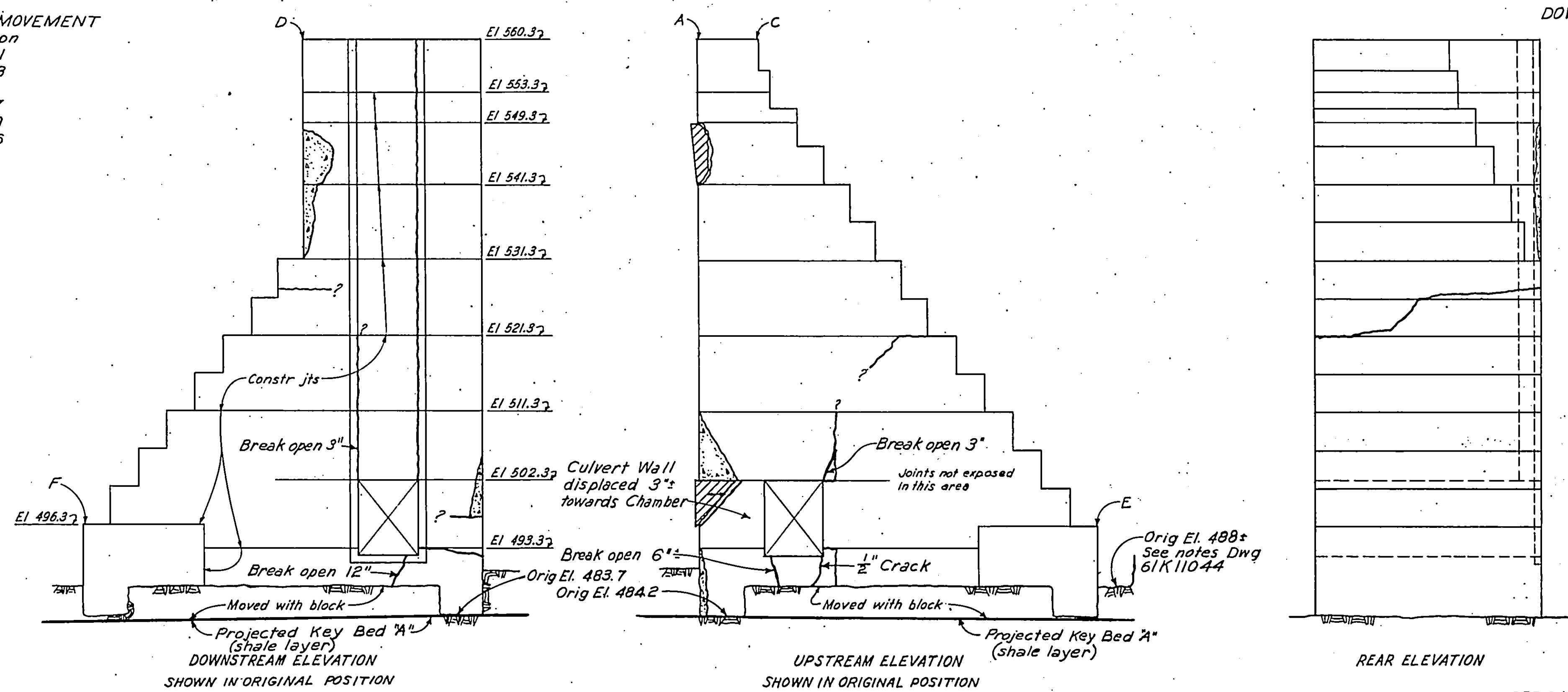






ELEVATIONS AFTER MOVEMENT

Point	Elevation
A	560.1
B	559.8
C	560.1
D	559.7
E	495.9
F	495.6



NOTES:
The plan view shows the location of the block after movement.
Hatched areas show position of pieces, relative to the main body of the block, after movement.
The rock shown in the upstream and downstream elevations moved with the Block.
Cracks in the culvert floor, roof and south wall, and shown in Sects A-A, B-B and C-C, vary in size from 6" to 12".
Breaks shown thus, ——?, could not be seen further to determine their course.
All elevations shown are Design elevations except those indicated as "Orig." or pertaining to new excav.

Scale: ⅛" = 1'-0"
except as noted

REF DWG. 61K11044

REV NO.	DATE	MADE	CHKD	SUPV	INSP	SUBM	RECM
2	9-29-61	JNS					
Add Info							
1	7-31-61	JNS					
Add Dim. and Rock info							

DSGN. ____ SUPV. ____
DRWN. OPG INSP. ____
CHKD. ____
TRCD. ____ ENGINEER
COMP. ____ J. N. Stallins

AUXILIARY LOCK

EXISTING CONDITIONS
NORTH WALL
BLOCK 9

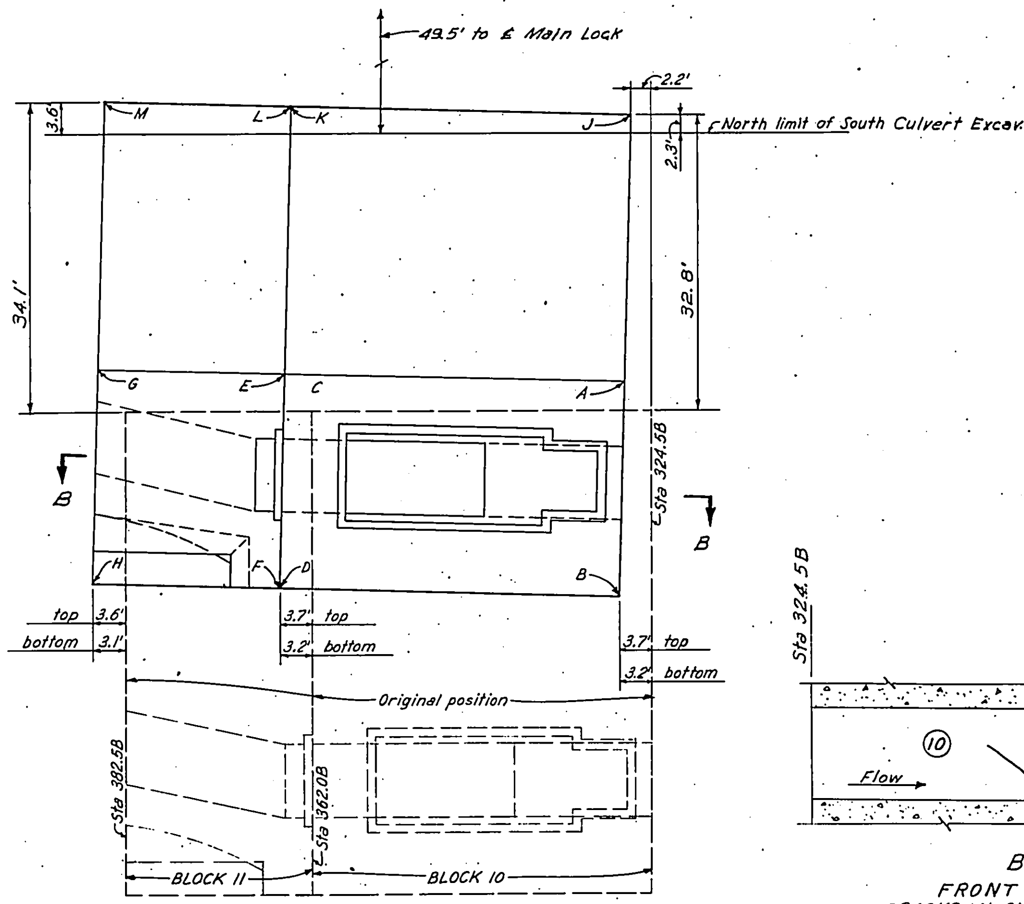
WHEELER PROJECT
TENNESSEE VALLEY AUTHORITY
DIVISION OF CONSTRUCTION

SUBMITTED	RECOMMENDED	APPROVED
W. T. Webb	H. L. Burkhart	[illegible]

FIELD OFFICE	7-12-61	3	PC	4	61K11062 R2

RECORD DRAWING AS CONSTRUCTED

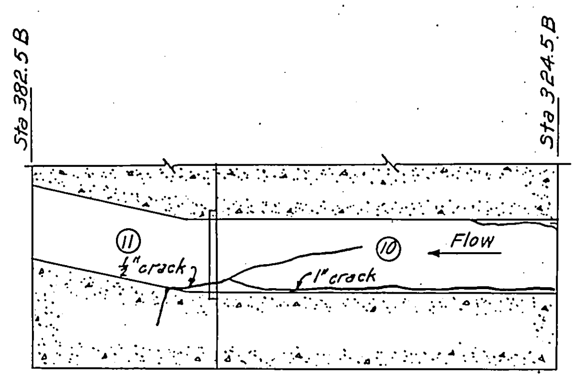
EXHIBIT II



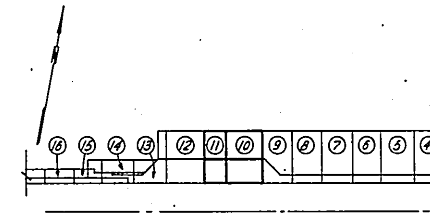
PLAN

ELEV AFTER MOVEMENT

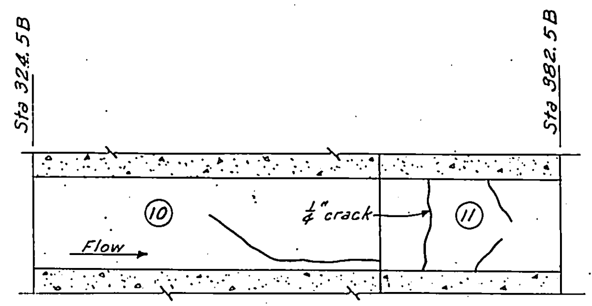
Point	Elevation
A	559.8
B	559.8
C	559.5
D	559.5
E	559.6
F	559.5
G	559.4
H	559.3
J	495.9
K	495.6
L	495.6
M	495.5



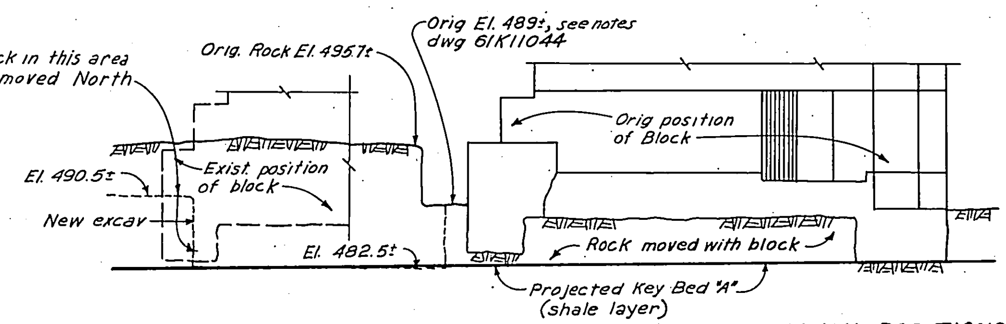
A-A
FLOOR OF CULVERT
CRACKS IN CULVERT INCOMPLETE
AREA PARTIALLY INACCESSIBLE



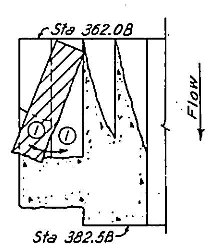
KEY PLAN-NORTH WALL
Scale: 1" = 100'



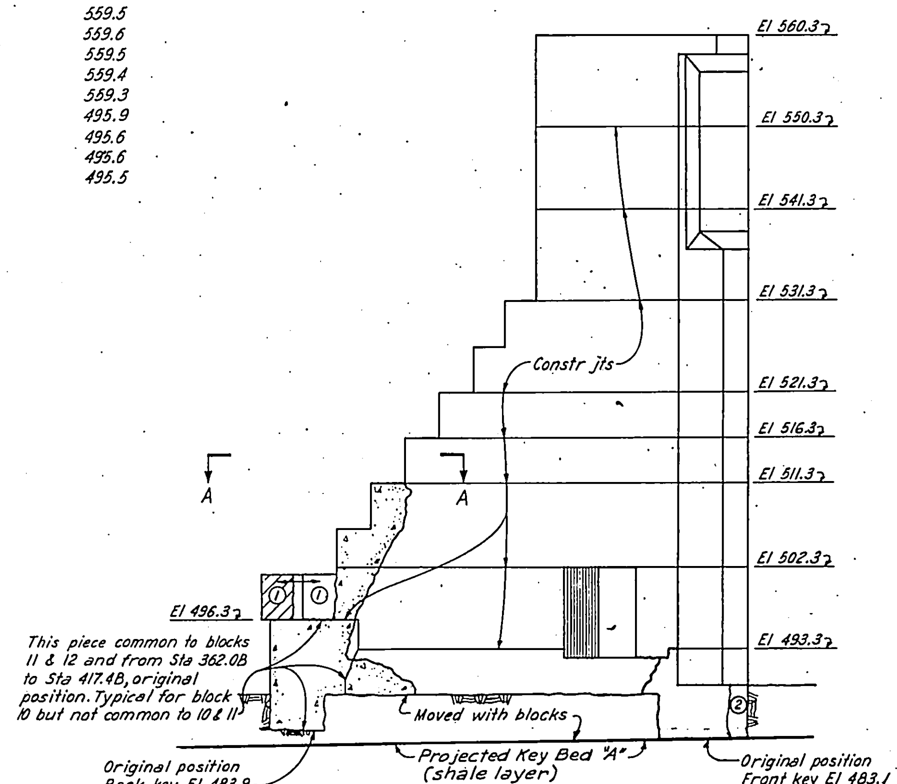
B-B
FRONT FACE OF CULVERT
CRACKS IN CULVERT INCOMPLETE-AREA
PARTIALLY INACCESSIBLE



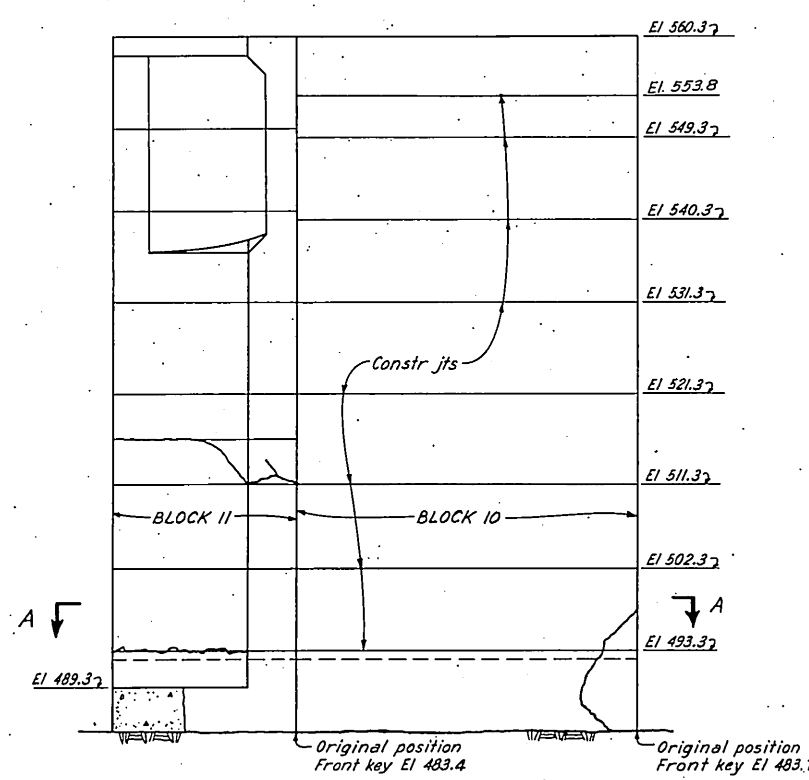
DOWNSTREAM ELEVATION - EXISTING AND ORIGINAL POSITIONS
SEE PLAN FOR DIMENSIONS



SECTION A-A
SHOWING BLOCK 11 ONLY



DOWNSTREAM ELEVATION
BLOCK 11
SHOWN IN ORIGINAL POSITION



FRONT ELEVATION
BLOCKS 10 & 11

NOTES:
All elevations shown are Design elevations except those indicated as "Orig." or pertaining to new excav.
The location of the blocks after movement is shown in the plan view. The joint between the blocks remained tight.
Hatched area shows the location of piece ①, block 11, after movement. Piece ② could not be located.
The rock shown in the downstream elevation of block 11 moved with the block. and is typical for blocks 10 & 11.
On the back face of block 10 there is evidence of a slight movement at constr jt El 511.3. The part of the block above El 511.3 moved downstream relative to the part below El 511.3.

Scale: 3/32" = 1'-0" except as noted

REF. DWG. 61K11044

REV NO.	DATE	MADE	CHKD	SUPV	INSP	SUBM	RECM
2	9-29-61	JHS					
	Add Info						
1	9-26-61	JHS					
	Add Dim. and Rock info						

DSGN. .... SUPV. ....
DRWN. OPG .... INSP. ....
CHKD. ....
TRCD. .... ENGINEER
COMP. .... J.N. Stallins

AUXILIARY LOCK

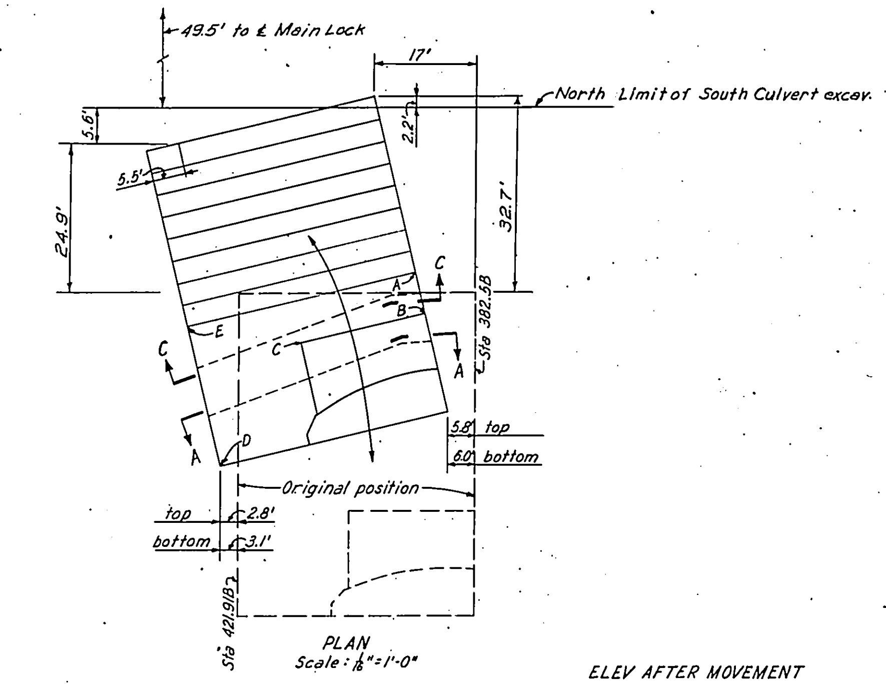
EXISTING CONDITIONS
NORTH WALL
BLOCKS 10 & 11

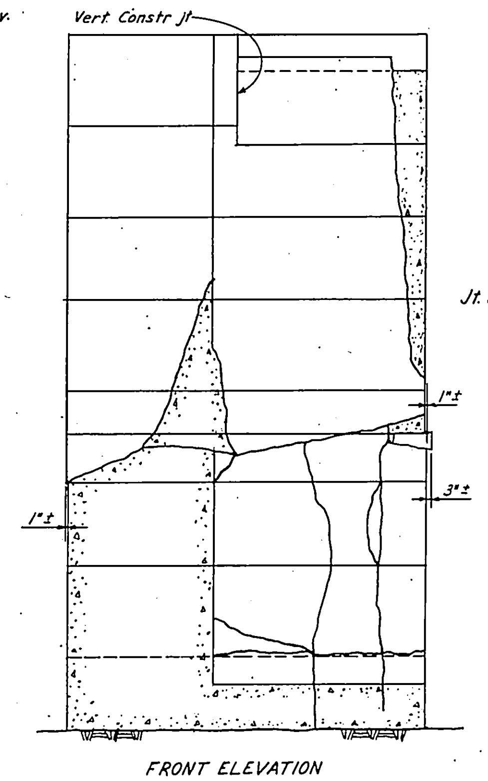
WHEELER PROJECT
TENNESSEE VALLEY AUTHORITY
DIVISION OF CONSTRUCTION

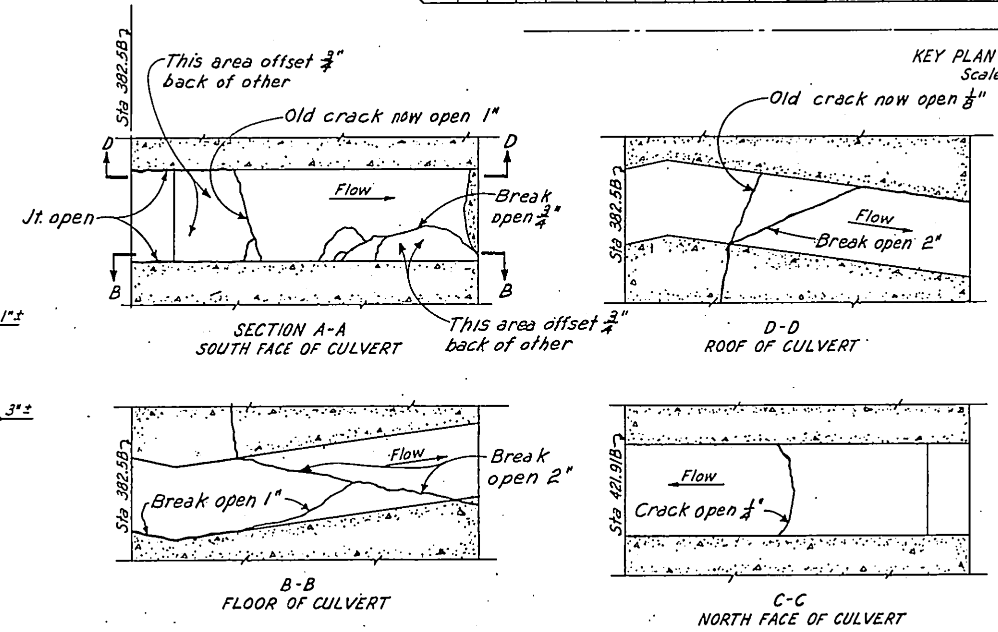
SUBMITTED	RECOMMENDED	APPROVED
W.T. Webb	H.J. Bradford	[signature]

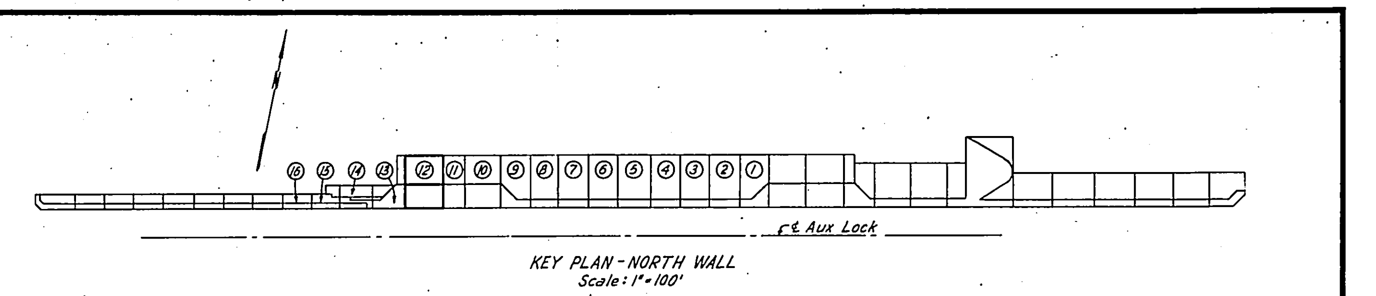
FIELD OFFICE	7-12-61	3	PC	4	61K11063 R2

RECORD DRAWING AS CONSTRUCTED



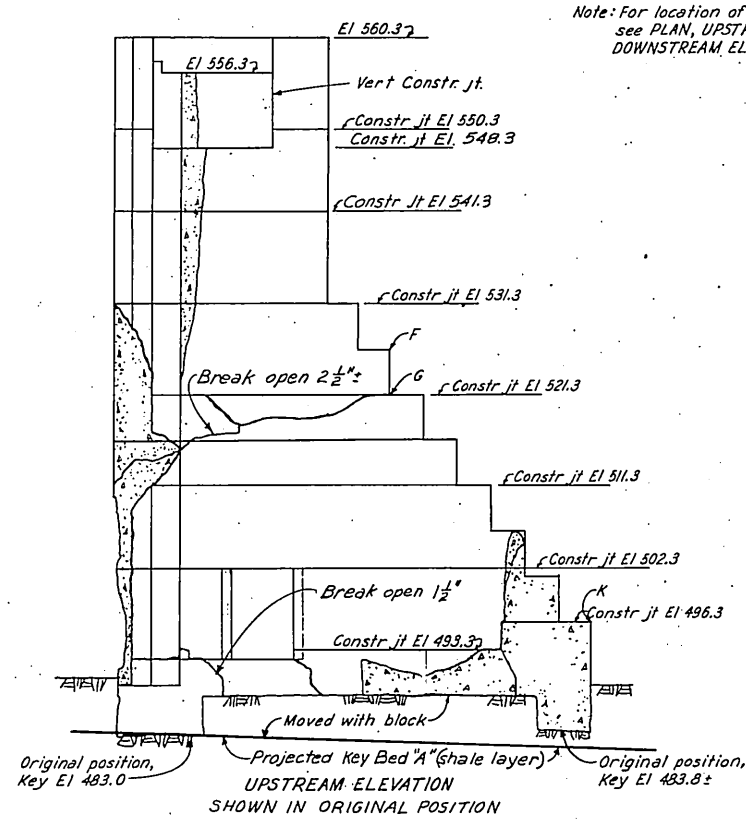


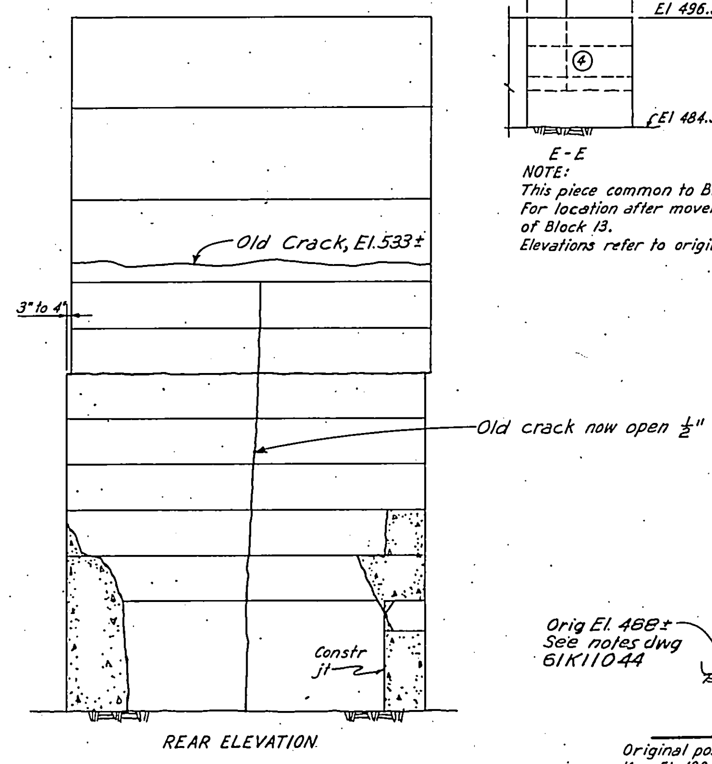


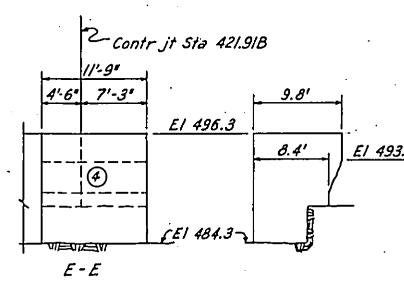


ELEV AFTER MOVEMENT	
Point	Elevations
A	559.5
B	559.4
C	559.3
D	559.3
E	559.6
F	525.5
G	520.3
H	525.6
J	520.6
K	495.4
L	495.5

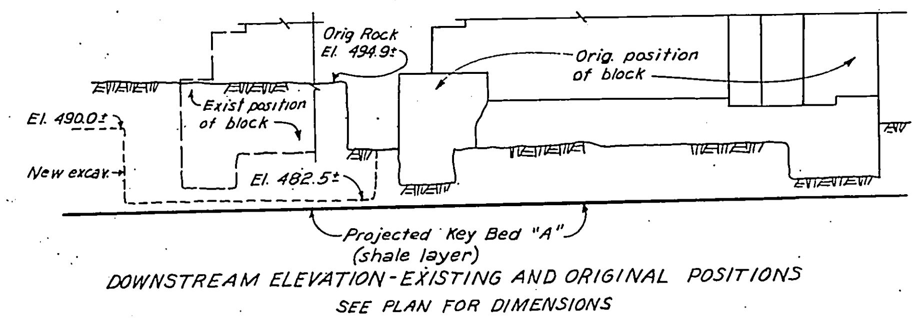
Note: For location of points, see PLAN, UPSTREAM & DOWNSTREAM ELEVS.

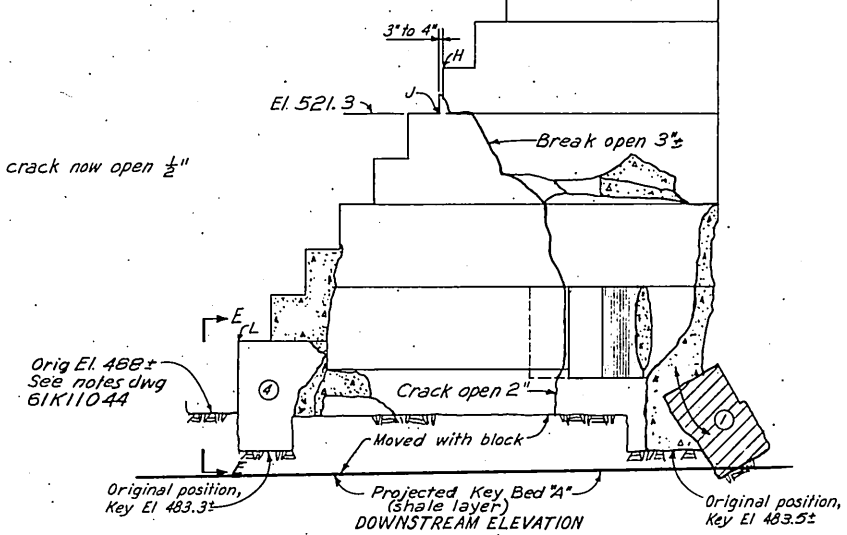






NOTE:
This piece common to Blocks 12 & 13. For location after movement see dwg of Block 13. Elevations refer to original position.





The location of piece 1 is shown relative to the Block after movement

NOTES:
This block is shown in its present position in the plan view. The breaks in the block and the position of the various pieces are shown in the elevations except Piece ④.
Hatched area shows the location of Piece ① after movement.
Piece ④, common to Blocks 12 & 13, is so numbered to coincide with the piece number in Block 13 and may be located in its present position on the dwg for Block 13. See E-E also.
All other concrete shown spalled from the block was shattered in small pieces.
All elevations are Design elevations except those indicated as "Orig." or pertaining to new excav.

Scale: 3/8" = 1'-0" except as noted

REF. DWG. 61K11044

REV NO.	DATE	MADE	CHKD	SUPV	INSP	SUBM	RECM
2	9-29-61	JNS					
	Add info						
1	7-31-61	JNS					
	Add Dim, contr jts, and Rock info						

DSGN. | SUPV.
DRWN. OPG | INSP.
CHKD.
TRCD. | ENGINEER
COMP. | J. M. Stallard

AUXILIARY LOCK

EXISTING CONDITIONS
NORTH WALL
BLOCK 12

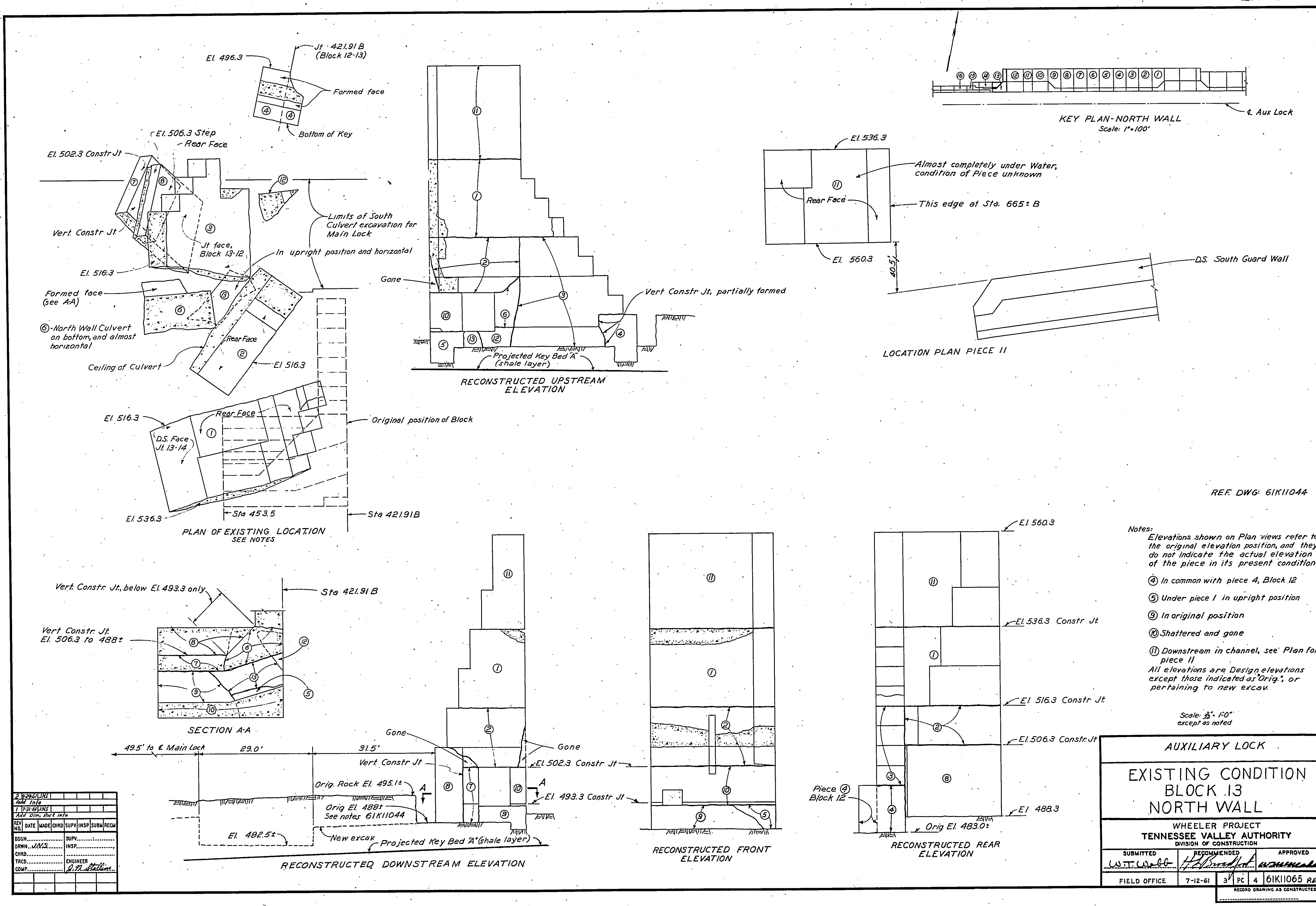
WHEELER PROJECT
TENNESSEE VALLEY AUTHORITY
DIVISION OF CONSTRUCTION

SUBMITTED	RECOMMENDED	APPROVED
W. T. Webb	H. L. Bradford	[illegible]

FIELD OFFICE	7-12-61	3	PC	4	61K11064 R2

RECORD DRAWING AS CONSTRUCTED

EXHIBIT 13



El. 496.3
Jt. 421.91 B (Block 12-13)
Formed face
Bottom of Key
El. 506.3 Step
Rear Face
El. 502.3 Constr Jt
Vert. Constr Jt.
Jt face, Block 13-12
Limits of South Culvert excavation for Main Lock
In upright position and horizontal
El. 516.3
Formed face (see A-A)
⑥-North Wall Culvert on bottom, and almost horizontal
Ceiling of Culvert
Rear Face
El 516.3
El. 516.3
Rear Face
D.S. Face Jt. 13-14
Original position of Block
El. 536.3
Sta 453.5
Sta 421.91B
PLAN OF EXISTING LOCATION
SEE NOTES
Gone
Vert Constr Jt, partially formed
Projected Key Bed "A" (shale layer)
RECONSTRUCTED UPSTREAM ELEVATION
KEY PLAN-NORTH WALL
Scale: 1"=100'
℄ Aux Lock
El. 536.3
Almost completely under Water, condition of Piece unknown
Rear Face
This edge at Sta. 665± B
El. 560.3
40.5'
D.S. South Guard Wall
LOCATION PLAN PIECE 11
REF. DWG: 61K11044
Vert. Constr. Jt., below El. 493.3 only
Sta 421.91 B
Vert Constr. Jt. El. 506.3 to 488±
SECTION A-A
49.5' to ℄ Main Lock
29.0'
31.5'
Gone
Vert. Constr Jt
Gone
El. 502.3 Constr Jt
El. 493.3 Constr Jt
Orig. Rock El. 495.1±
Orig El. 488± See notes 61K11044
El. 482.5±
New excav.
Projected Key Bed "A" (shale layer)
RECONSTRUCTED DOWNSTREAM ELEVATION
RECONSTRUCTED FRONT ELEVATION
El. 560.3
El. 536.3 Constr Jt
El. 516.3 Constr Jt
El. 506.3 Constr Jt
El. 488.3
Piece ④ Block 12
Orig El. 483.0±
RECONSTRUCTED REAR ELEVATION
Notes:
Elevations shown on Plan views refer to the original elevation position, and they do not indicate the actual elevation of the piece in its present condition.
④ In common with piece 4, Block 12
⑤ Under piece 1 in upright position
⑨ In original position
⑩ Shattered and gone
⑪ Downstream in channel, see Plan for piece 11
All elevations are Design elevations except those indicated as "Orig.", or pertaining to new excav.
Scale: 3/32"=1'-0" except as noted
AUXILIARY LOCK
EXISTING CONDITION
BLOCK 13
NORTH WALL
WHEELER PROJECT
TENNESSEE VALLEY AUTHORITY
DIVISION OF CONSTRUCTION
SUBMITTED
RECOMMENDED
APPROVED
FIELD OFFICE
7-12-61
61K11065 R2
RECORD DRAWING AS CONSTRUCTED
REV NO.
DATE
MADE
CHKD
SUPV
INSP
SUBM
RECM
Add Info
Add Dim, Rock info
DSGN.
DRWN. JNS
CHKD.
TRCD.
COMP.
SUPV.
INSP.
ENGINEER

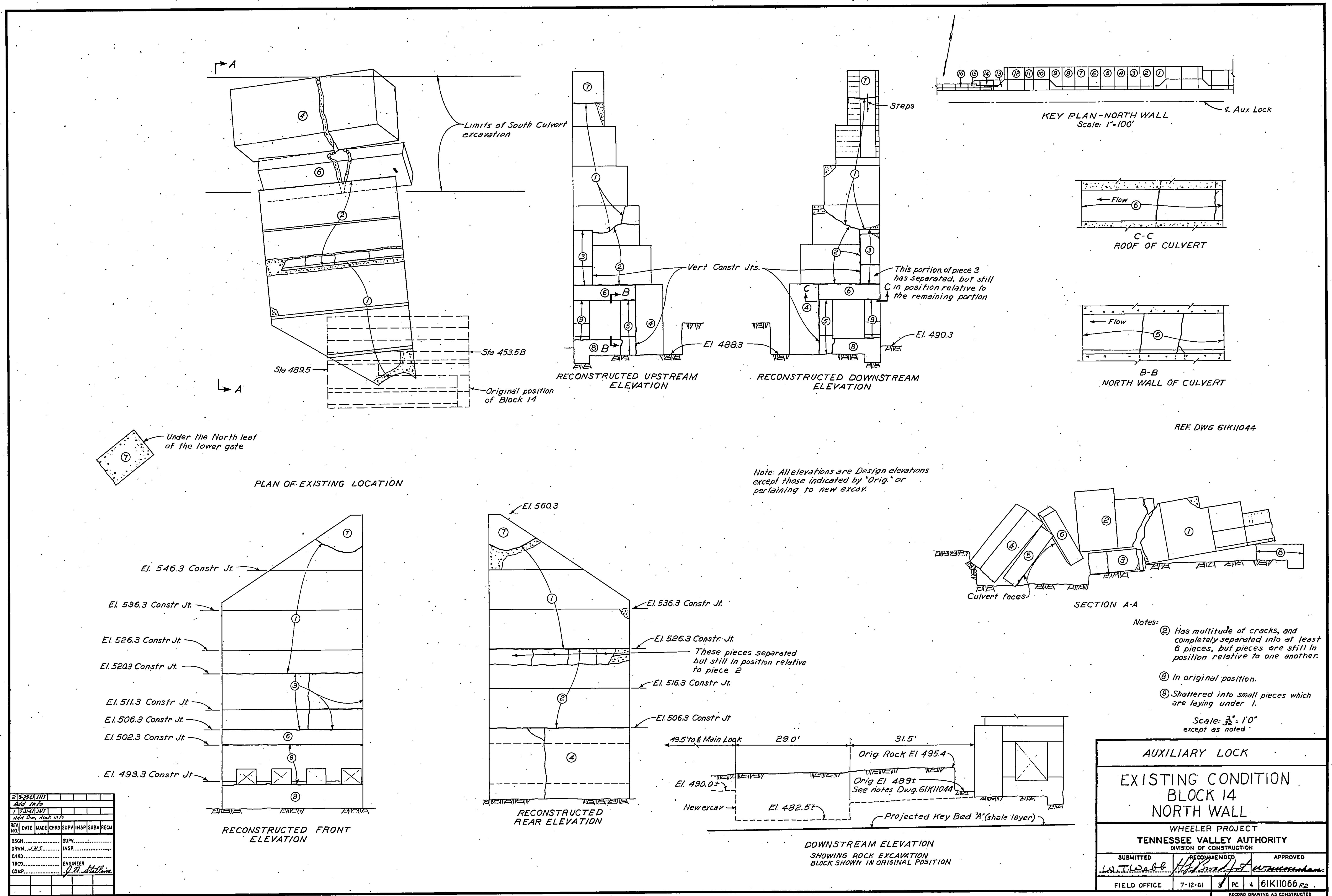


EXHIBIT 14
KEY PLAN-NORTH WALL
Scale: 1"=100'
℄ Aux Lock
Limits of South Culvert excavation
Sta 453.5B
Sta 489.5
Original position of Block 14
Under the North leaf of the lower gate
PLAN OF EXISTING LOCATION
Steps
Vert Constr Jts.
El. 488.3
El. 490.3
This portion of piece 3 has separated, but still in position relative to the remaining portion
RECONSTRUCTED UPSTREAM ELEVATION
RECONSTRUCTED DOWNSTREAM ELEVATION
Flow
C-C
ROOF OF CULVERT
B-B
NORTH WALL OF CULVERT
REF. DWG 61K11044
Note: All elevations are Design elevations except those indicated by "Orig." or pertaining to new excav.
Culvert faces
SECTION A-A
Notes:
② Has multitude of cracks, and completely separated into at least 6 pieces, but pieces are still in position relative to one another.
⑧ In original position.
⑨ Shattered into small pieces which are laying under 1.
Scale: 3/32" = 1'0" except as noted
El. 546.3 Constr Jt.
El. 536.3 Constr Jt.
El. 526.3 Constr Jt.
El. 520.3 Constr Jt.
El. 511.3 Constr Jt.
El. 506.3 Constr Jt.
El. 502.3 Constr Jt.
El. 493.3 Constr Jt.
RECONSTRUCTED FRONT ELEVATION
El. 560.3
El. 536.3 Constr Jt.
El. 526.3 Constr. Jt.
These pieces separated but still in position relative to piece 2
El. 516.3 Constr Jt.
El. 506.3 Constr Jt
RECONSTRUCTED REAR ELEVATION
49.5' to ℄ Main Lock
29.0'
31.5'
Orig. Rock El 495.4
Orig. El. 489±
See notes Dwg. 61K11044
El. 490.0±
New excav
El. 482.5±
Projected Key Bed "A" (shale layer)
DOWNSTREAM ELEVATION
SHOWING ROCK EXCAVATION
BLOCK SHOWN IN ORIGINAL POSITION
2 9-29-61 JNI Add Info
1 7-31-61 JNI Add Dim, Rock info
REV NO. DATE MADE CHKD SUPV INSP SUBM RECM
DSGN.
DRWN. JNS
CHKD.
TRCD.
COMP.
SUPV.
INSP.
ENGINEER J.N. Stallins
AUXILIARY LOCK
EXISTING CONDITION
BLOCK 14
NORTH WALL
WHEELER PROJECT
TENNESSEE VALLEY AUTHORITY
DIVISION OF CONSTRUCTION
SUBMITTED W.T. Webb
RECOMMENDED
APPROVED
FIELD OFFICE
7-12-61
3 PC 4 61K11066 R2
RECORD DRAWING AS CONSTRUCTED

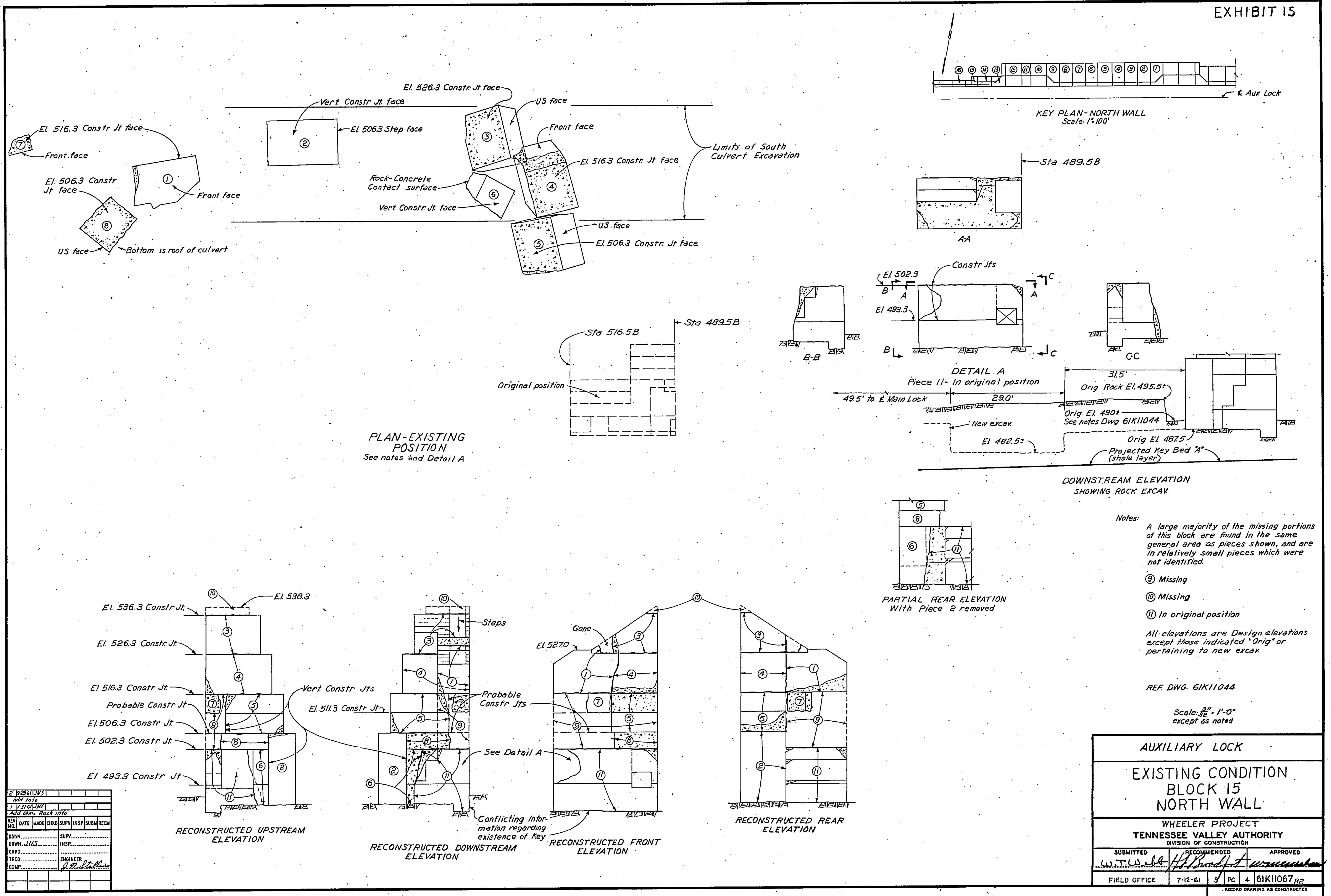
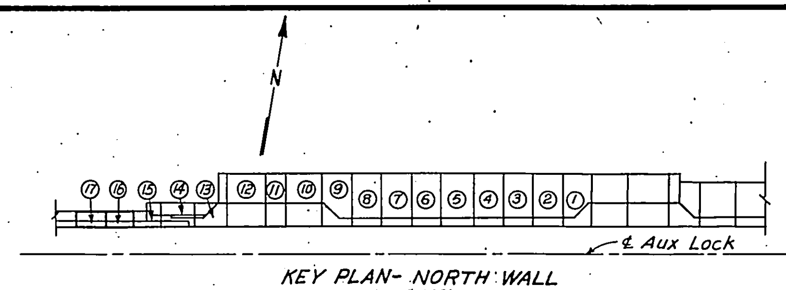
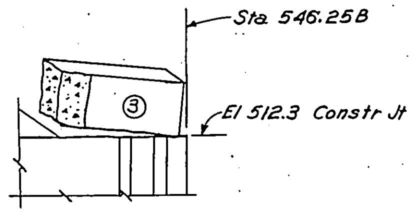


EXHIBIT 15
KEY PLAN-NORTH WALL
Scale: 1"=100'
℄ Aux Lock
El. 516.3 Constr Jt face
Front face
El. 506.3 Constr Jt face
Front face
US face
Bottom is roof of culvert
Vert. Constr Jt. face
El. 526.3 Constr. Jt face
El. 506.3 Step face
US face
Front face
El. 516.3 Constr. Jt face
Rock-Concrete Contact surface
Vert. Constr. Jt. face
US face
El. 506.3 Constr. Jt face
Limits of South Culvert Excavation
PLAN-EXISTING POSITION
See notes and Detail A
Sta 516.5B
Sta 489.5B
Original position
Sta 489.5B
A-A
El. 502.3
El. 493.3
Constr Jts
B-B
C-C
DETAIL A
Piece 11- In original position
49.5' to ℄ Main Lock
29.0'
31.5'
Orig Rock El. 495.5±
Orig. El. 490±
See notes Dwg 61K11044
New excav.
El 482.5±
Orig El. 487.5
Projected Key Bed "A" (shale layer)
DOWNSTREAM ELEVATION
SHOWING ROCK EXCAV.
PARTIAL REAR ELEVATION
With Piece 2 removed
Notes:
A large majority of the missing portions of this block are found in the same general area as pieces shown, and are in relatively small pieces which were not identified.
9 Missing
10 Missing
11 In original position
All elevations are Design elevations except those indicated "Orig" or pertaining to new excav.
REF. DWG. 61K11044
Scale: 3/32" = 1'-0"
except as noted
El. 538.3
El. 536.3 Constr Jt.
El. 526.3 Constr. Jt.
El 516.3 Constr Jt.
Probable Constr Jt
El. 506.3 Constr Jt.
El. 502.3 Constr Jt.
El 493.3 Constr Jt
Vert. Constr Jts
El. 511.3 Constr Jt
Steps
Probable Constr Jts
See Detail A
Conflicting information regarding existence of Key
Gone
El. 527.0
RECONSTRUCTED UPSTREAM ELEVATION
RECONSTRUCTED DOWNSTREAM ELEVATION
RECONSTRUCTED FRONT ELEVATION
RECONSTRUCTED REAR ELEVATION
2 9-29-61 JHS Add Info
1 7-31-61 JHI Add Dim, Rock info
REV NO. DATE MADE CHKD SUPV INSP SUBM RECM
DSGN. SUPV.
DRWN. JHS INSP.
CHKD.
TRCD. ENGINEER
COMP.
AUXILIARY LOCK
EXISTING CONDITION
BLOCK 15
NORTH WALL
WHEELER PROJECT
TENNESSEE VALLEY AUTHORITY
DIVISION OF CONSTRUCTION
SUBMITTED RECOMMENDED APPROVED
FIELD OFFICE 7-12-61 3 PC 4 61K11067 R2
RECORD DRAWING AS CONSTRUCTED

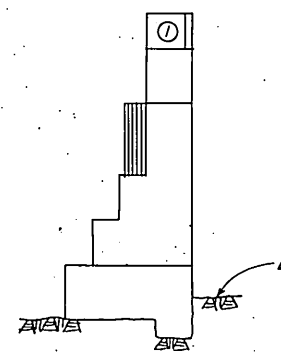
EXHIBIT 16



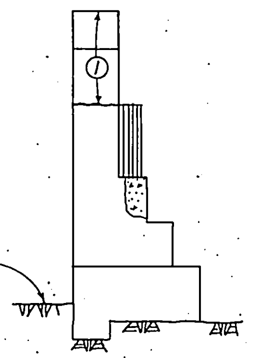
KEY PLAN- NORTH WALL
Scale: 1"=100'



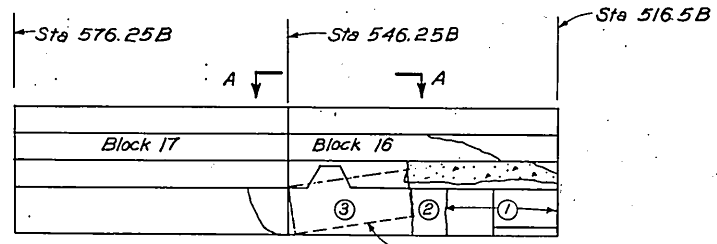
SECTION A-A



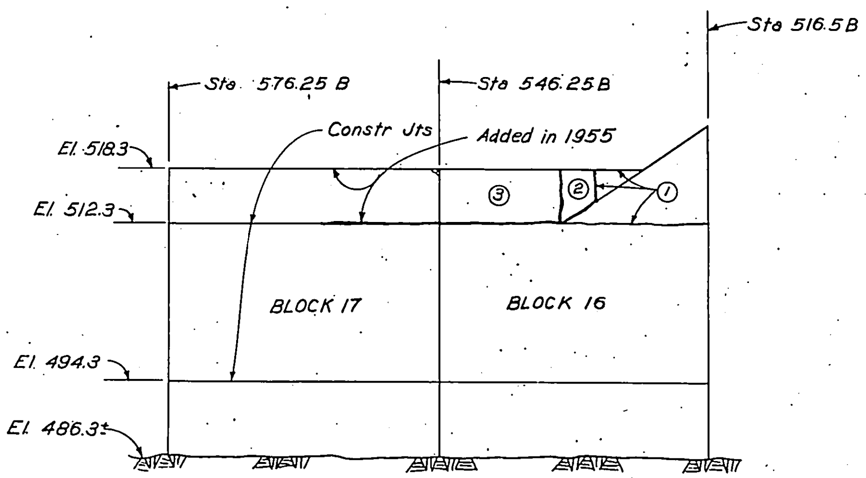
DOWNSTREAM ELEVATION



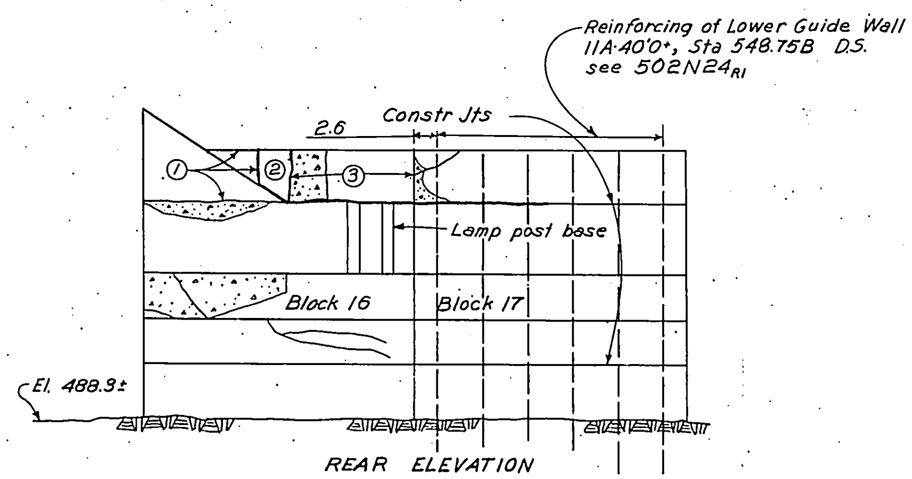
UPSTREAM ELEVATION



PLAN



FRONT ELEVATION



REAR ELEVATION

Notes:

The North leaf of the lower gate is presently laying upon Blocks 16 and 17, and it is probable that the damage to these Blocks is a result of the gate hitting them.

Block 17 is in its original condition with the exception of the cracks as shown.

Block 16 is in its original condition with the exception of the cracks as shown and as follows:

① Evidently broken into small pieces, as a few small fragments were found.
② Existing location approx Sta. 693B
③ Existing location as shown in Plan view and Section AA

Scale: $\frac{3}{32}$" = 1'-0"
except as noted

7	8-29-61	JNS					
Probable Constr Jt Add.							
REV NO.	DATE	MADE	CHKD	SUPV	INSP	SUBM	RECM

DSGN
DRWN JNS
CHKD
TRCD
COMP
SUPV
INSP
ENGINEER J.M. Stallcup

AUXILIARY LOCK

EXISTING CONDITION
BLOCKS 16 & 17
NORTH WALL

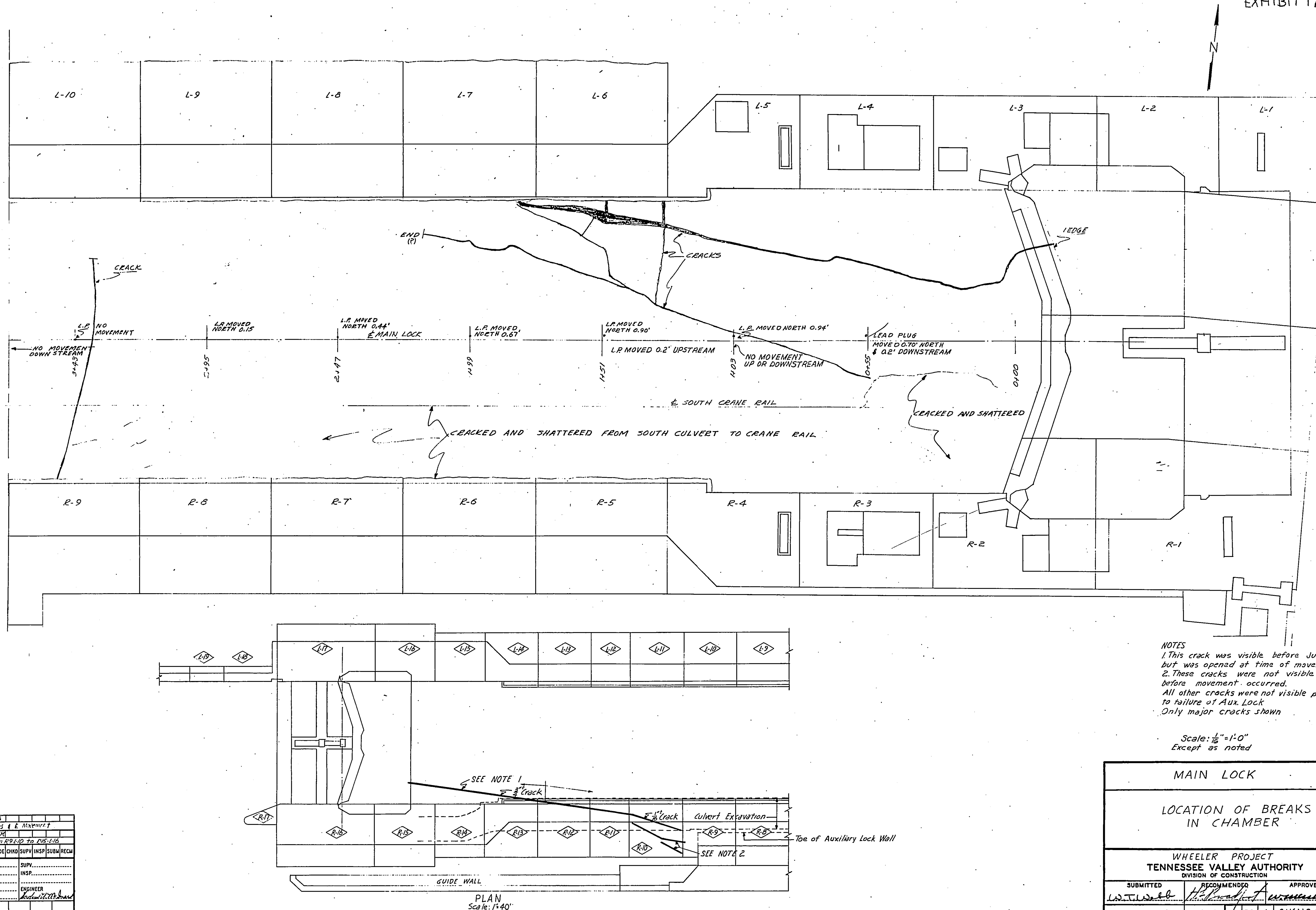
WHEELER PROJECT
TENNESSEE VALLEY AUTHORITY
DIVISION OF CONSTRUCTION

SUBMITTED	RECOMMENDED	APPROVED
W.T. Webb	H.E. Bradford	[signature]

FIELD OFFICE	7-12-61	3	PC	4	61K11068 R1

RECORD DRAWING AS CONSTRUCTED

EXHIBIT 17



NOTES
1. This crack was visible before June 2 but was opened at time of movement.
2. These cracks were not visible before movement occurred.
All other cracks were not visible prior to failure of Aux. Lock
Only major cracks shown

Scale: 1/16" = 1'-0"
Except as noted

2	8-3-61	JHS					
Add Notes & E Movement							
1	7-31-61	GVM					
Cracks from R9 L-10 to R15-L16							
REV NO.	DATE	MADE	CHKD	SUPV	INSP	SUBM	RECM

DSGN. ...... SUPV. ......
DRWN. GVM ...... INSP. ......
CHKD. ......
TRCD. ...... ENGINEER
COMP. ......

MAIN LOCK

LOCATION OF BREAKS IN CHAMBER

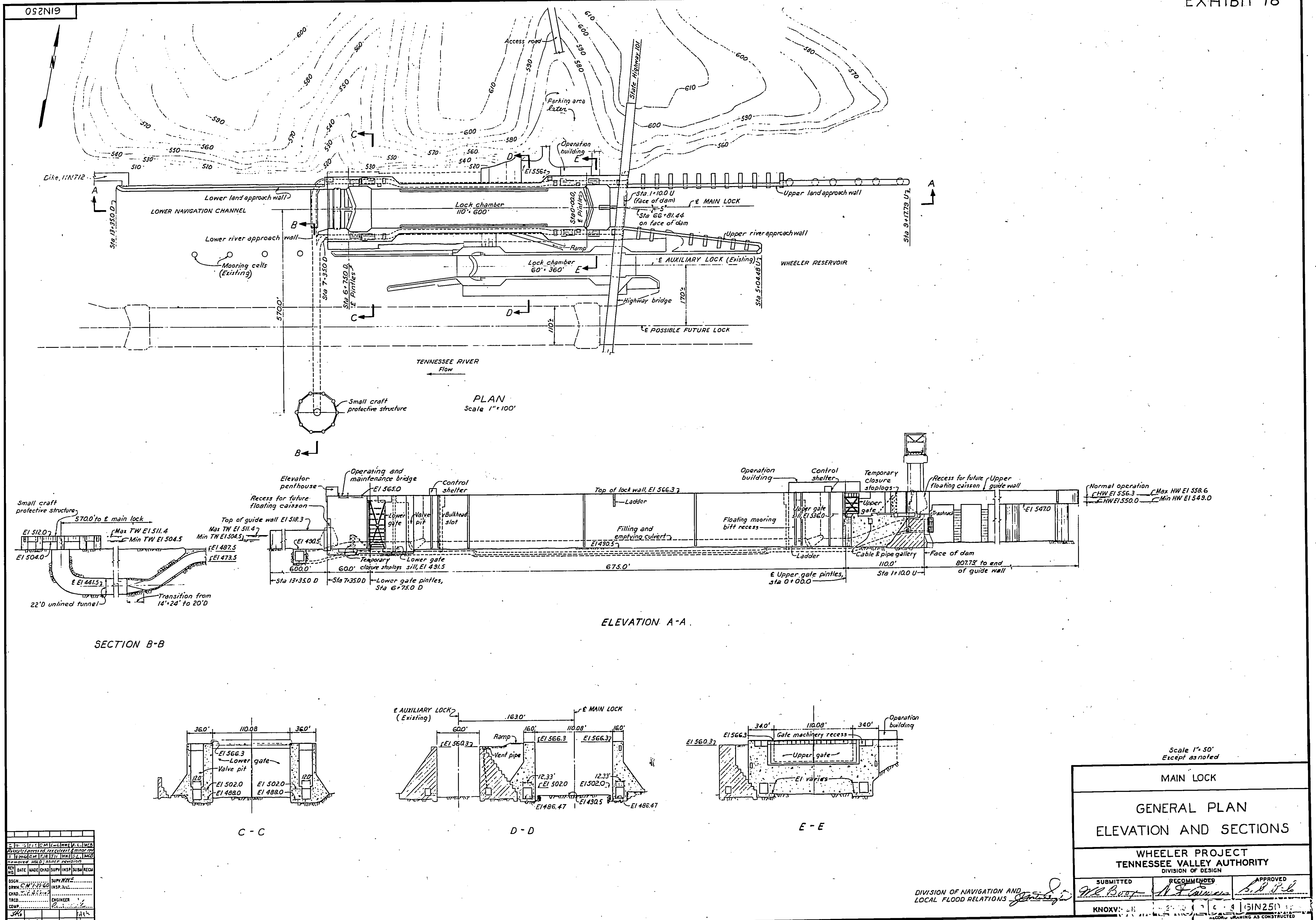
WHEELER PROJECT
TENNESSEE VALLEY AUTHORITY
DIVISION OF CONSTRUCTION

SUBMITTED	RECOMMENDED	APPROVED
W.T. Webb		

FIELD OFFICE	6-15-61	B	PC	4	61K11048 R2

RECORD DRAWING AS CONSTRUCTED

EXHIBIT 18



MAIN LOCK

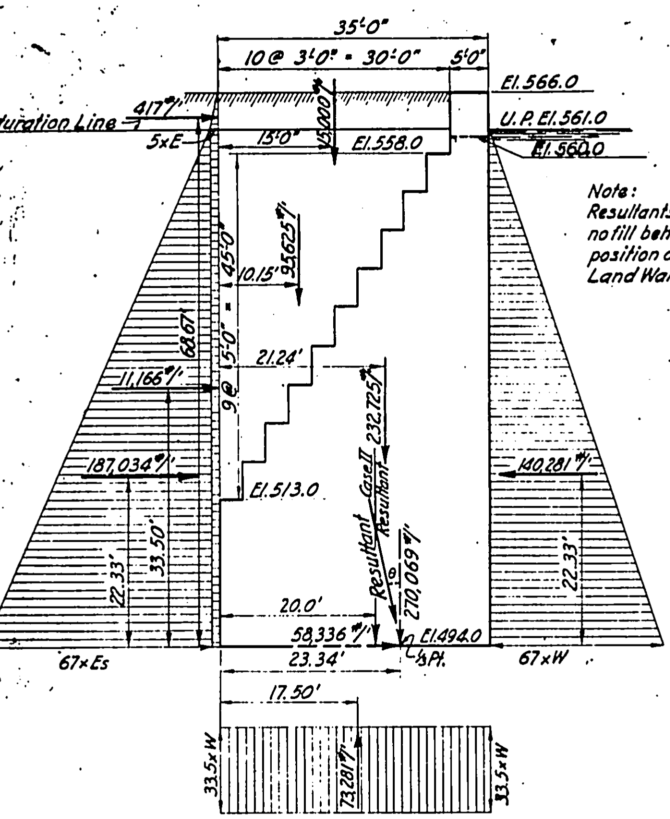
GENERAL PLAN
ELEVATION AND SECTIONS

WHEELER PROJECT
TENNESSEE VALLEY AUTHORITY
DIVISION OF DESIGN

SUBMITTED | RECOMMENDED | APPROVED

KNOXVILLE | 6IN250

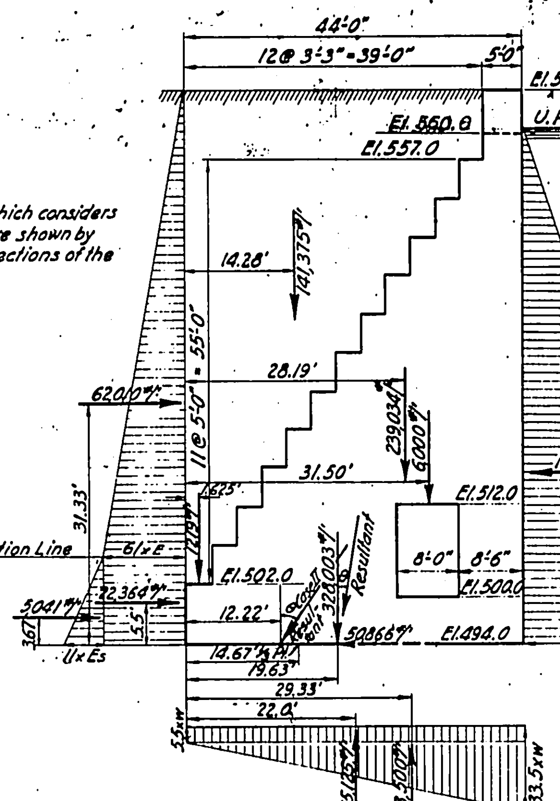
DIVISION OF NAVIGATION AND LOCAL FLOOD RELATIONS



UPPER GUIDE WALL

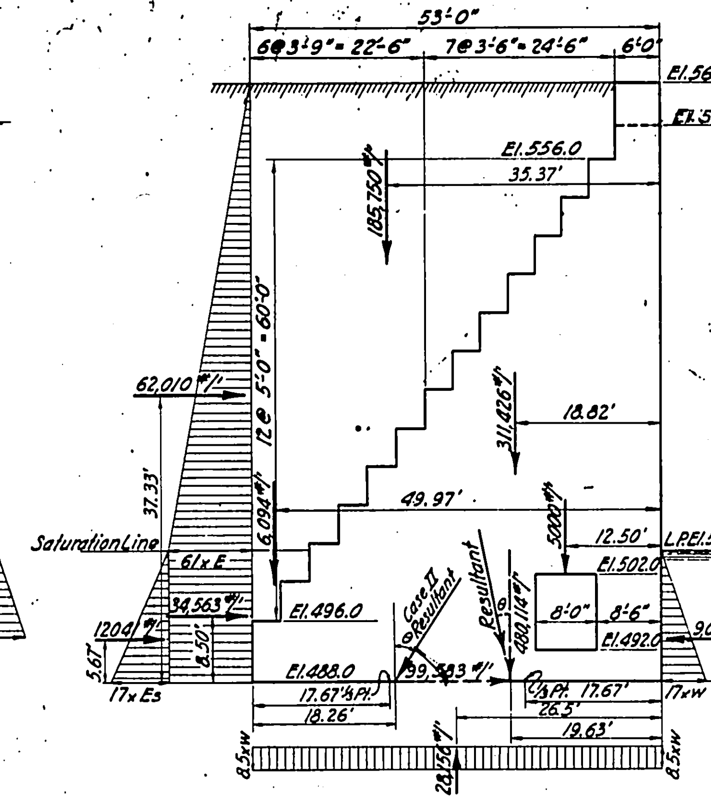
Loading Condition:
Water to El. 561.0 - Saturated Earth to El. 561.0
Dry Earth to Top of Wall
Resultant: Tan. θ = 0.216

Note: Resultants for Case II, which considers no fill behind walls, are shown by position only for all Sections of the Land Wall.



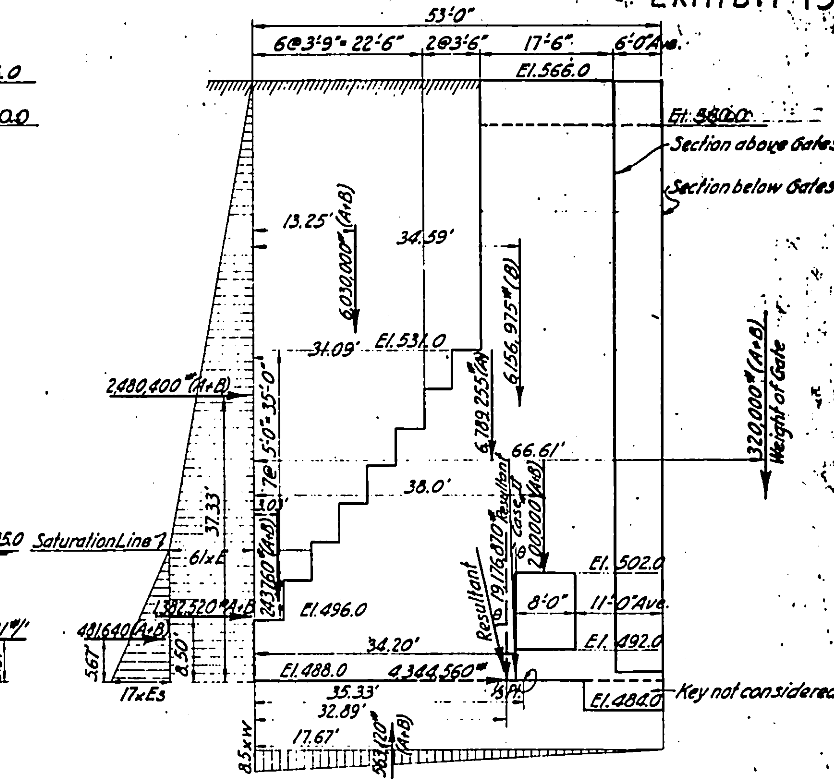
INTAKE SECTION - LAND WALL

Loading Condition:
Water to El. 561.0 - Saturated Earth to El. 505.0
Dry Earth to Top of Wall
Resultant: Tan. θ = 0.155



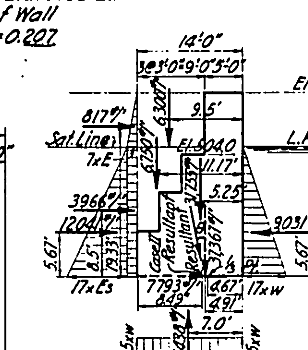
LAND WALL - BETWEEN BAYS

Loading Condition:
Water to El. 505.0 - Saturated Earth to El. 505.0
Dry Earth to Top of Wall
Resultant: Tan. θ = 0.207



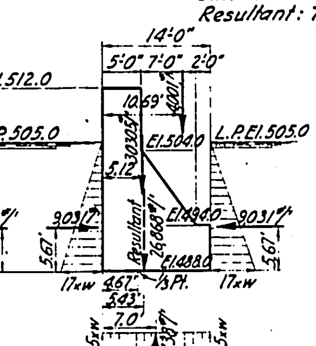
LOWER BAY - LAND WALL

Loading Condition: (See also Note "A") Saturated Earth to El. 505.0 - Dry Earth to Top of Wall - Lock Chamber pumped out. - Lock Gate in mitered Position. Culvert filled with Water.
Resultant: Tan. θ = 0.227



LOWER GUIDE WALL

Loading Condition:
Water to El. 505.0 - Sat. Earth to El. 505.0 - Dry Earth to Top of Wall
Resultant: Tan. θ = 0.209

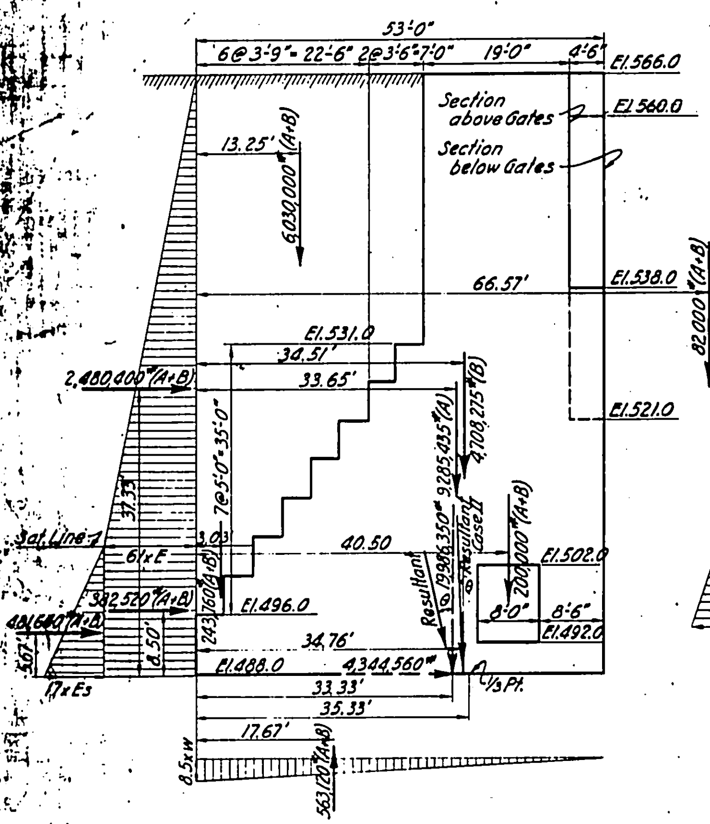


LOWER GUARD WALL

Loading Condition:
Water at El. 505.0 both sides
Resultant: Tan. θ = 0.00

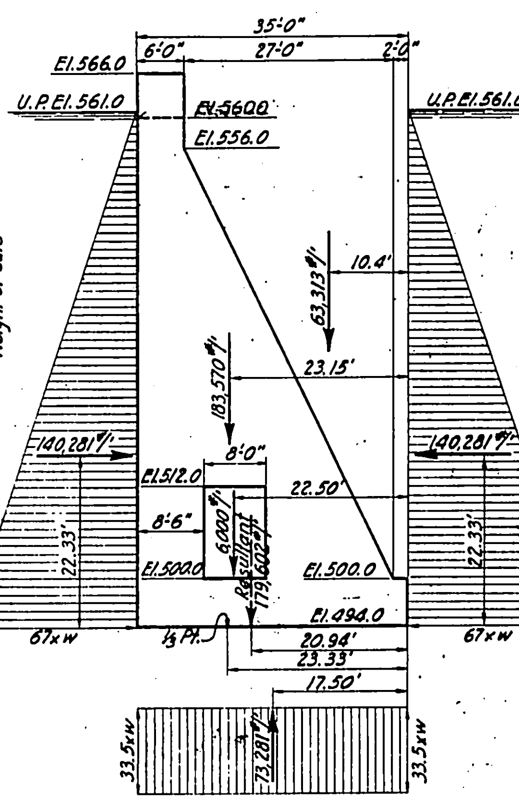
ASSUMPTIONS FOR DESIGN

Upper Pool Elevation 561.0
Lower Pool Elevation 505.0
Earth Fill behind Walls saturated to Ground Water Levels shown.
Full Upward Hydrostatic Water Pressure effective over 50% of area of the base (for simplicity shown as 50% head over entire base).
Elevation of Rock assumed same as bottom elevation of Walls in all cases.
Where Keys were used, they were neglected in calculations.
Unit Weight of Water 62.5 lbs. per cu. ft.
Unit Weight of Concrete 145 lbs. per cu. ft.
Unit Weight of Dry Earth 100 lbs. per cu. ft.
Unit Weight of Saturated Earth 125 lbs. per cu. ft.
Unit Pressure of Dry Earth on Vertical Plane 33.33 lbs. per sq. ft.
Unit Pressure of Saturated Earth on Vertical Plane 83.33 lbs. per sq. ft.
Forces apply to One Linear Foot of Wall, except as noted.
Horizontal and Vertical Components of Resultants are shown dotted.
Shaded Areas represent Hydrostatic Pressures on Bases and Sides of Walls to Scale (1/32" = 1 foot head of Water). Values of Unit Pressures are given in terms of the Heads, and the Unit Pressures are:
Water "W" 62.5 lbs. per sq. ft.
Dry Earth "E" 33.33 lbs. per sq. ft.
Saturated Earth "Es" 83.33 lbs. per sq. ft.
Sections to be constructed under present Contract to Elevation shown by dotted Lines for Upper Pool El. 544.0



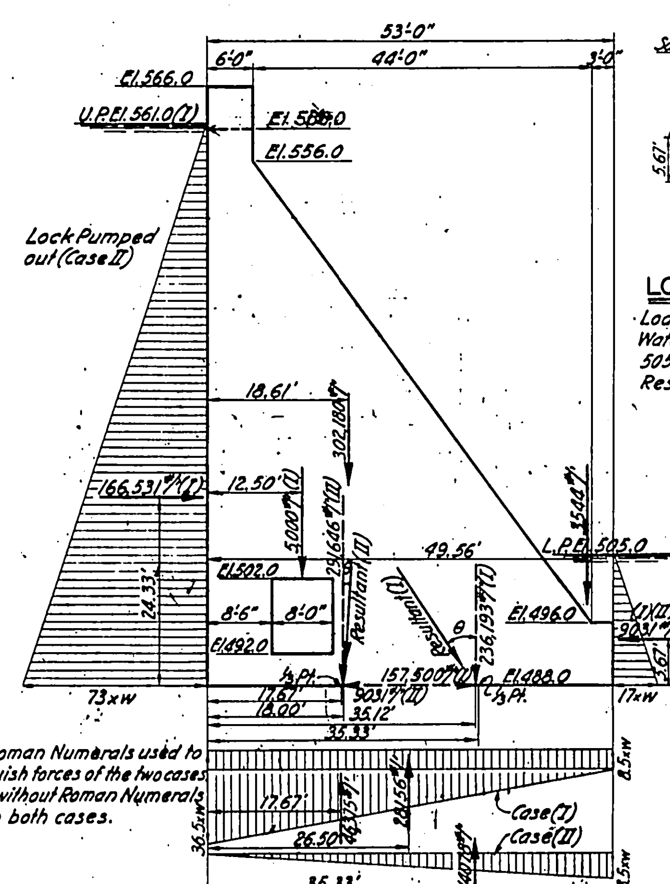
UPPER BAY - LAND WALL

Loading Condition: (See also Note "A")
Saturated Earth to El. 505.0 - Dry Earth to Top of Wall
Lock Chamber pumped out. - Lock Gate in mitered position
Resultant: Tan. θ = 0.217



INTAKE SECTION - RIVER WALL

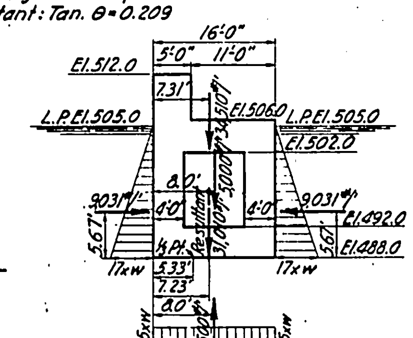
Loading Condition:
Upper Pool on both sides of Wall El. 561.0
Resultant: Tan. θ = 0.0



Note: Roman Numerals used to distinguish forces of the two cases. Forces without Roman Numerals apply in both cases.

RIVER WALL - BETWEEN BAYS

Loading Condition:
Case I - Water at El. 561.0 in Lock Chamber, at El. 505.0 outside
Case II - Lock pumped out - L.P. outside Lock Wall at El. 505.0
Resultant: Case I - Tan. θ = 0.667 - Case II - Tan. θ = 0.031



DISCHARGE SECTION - RIVER WALL

Loading Condition: Water at El. 505.0 both sides
Resultant: Tan. θ = 0.0

Note "A"
For Upper and Lower Bays, Land Wall, Forces and Resultants shown are totals for 40' Monoliths, divided as follows:
Upper Bay - 27' above pintles, 13' below
Lower Bay - 23' above pintles, 17' below
Forces marked "A" act on Section above pintles
Forces marked "B" act on Section below pintles
Forces marked "A & B" act on total 40' Section

TENNESSEE RIVER
LOCK & DAM NO. 3
LOCK
DESIGN DATA FOR TYPICAL SECTIONS

SCALE: 1/8 INCH = 1 FOOT

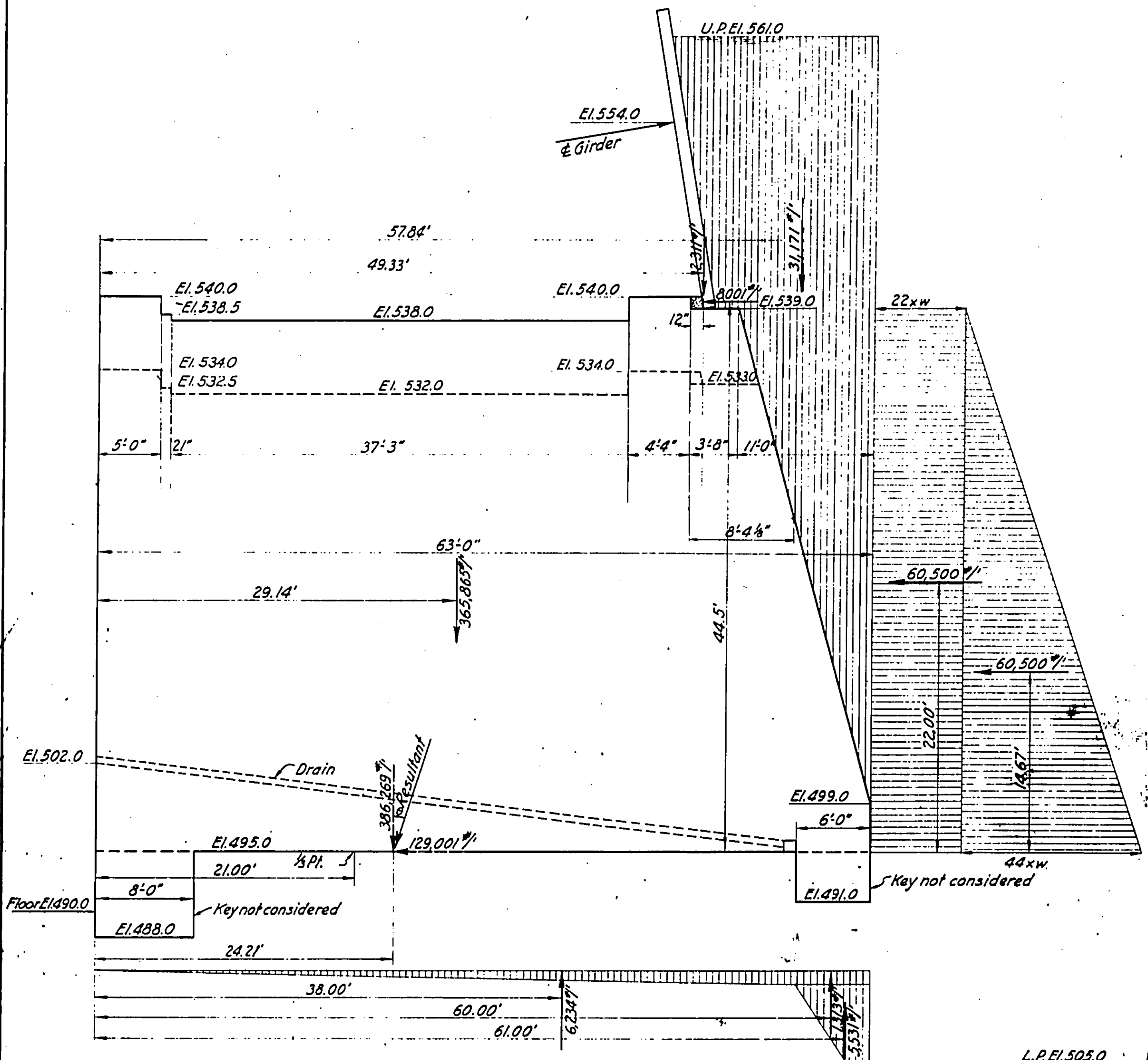
U. S. ENGINEER OFFICE
SAINT LOUIS, MISSOURI

UPPER MISSISSIPPI VALLEY DIVISION

SUBMITTED: [illegible] APPROVED:

DRAWN BY A.M.M.

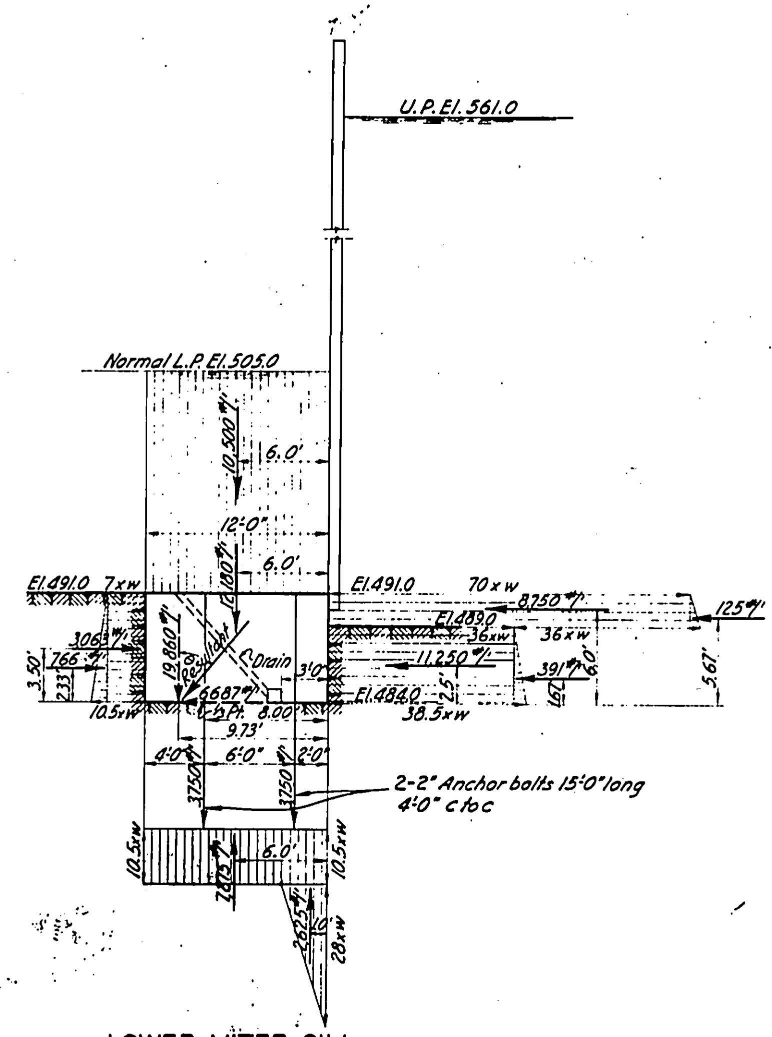
EXHIBIT 20



UPPER MITER AND EMERGENCY DAM SILL

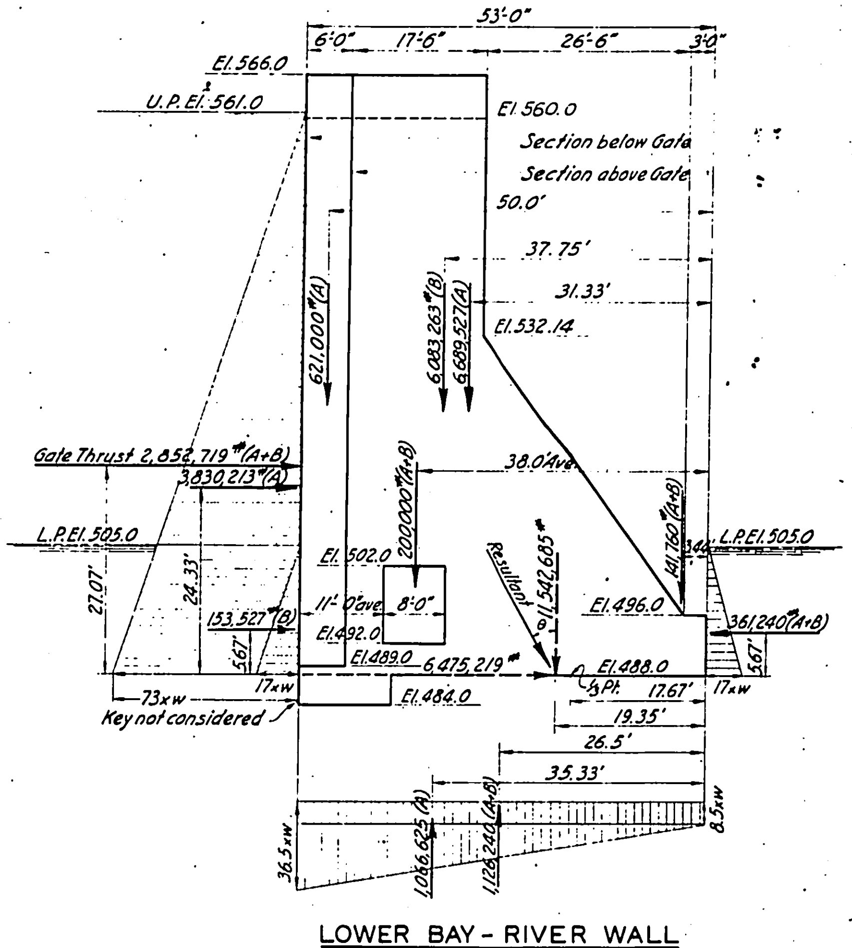
Emergency Dam in place
Conditions: U.P. El. 561.0
Lock pumped out.
Resultant: Tan. θ = 0.334

Note:
Elevation of Rock taken same as bottom of Sill - El. 495.0
Extreme Loading Condition shown. For normal condition of Gates mitered U.P. El. 561.0 & L.P. El. 505.0 Resultant falls 4.26' inside middle ⅓ Point.



LOWER MITER SILL

Gates Mitered
Conditions: U.P. El. 561.0
L.P. El. 505.0
Resultant: Tan. θ = 0.840
Note: Sill keyed into Rock as shown.



LOWER BAY - RIVER WALL

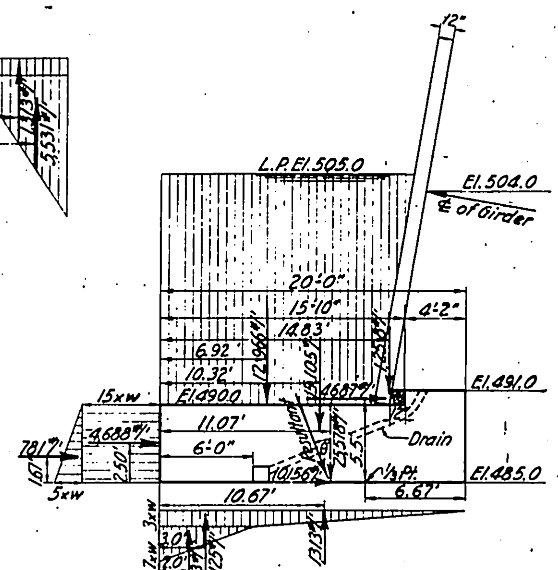
SCALE: 1/32" = 1'-0"

Loading Conditions: Gates Mitered
Water to El. 561.0 in Lock Chamber. Lower Pool outside of Lock Wall and below Gate El. 505.0
Resultant: Tan. θ = 0.561

Note: Forces & Resultant shown are totals for a 40' Monolith extending 23 ft. above Pintles and 17 ft. below.
Forces marked "A" act on Section above Pintle
Forces marked "B" act on Section below Pintle
Forces marked "A" & "B" act on total 40' Section
Hydrostatic Pressures on Base and Sides to scale 1/32" = 1 ft. Head water.
For assumptions of Design, see Sheet 20/0.1

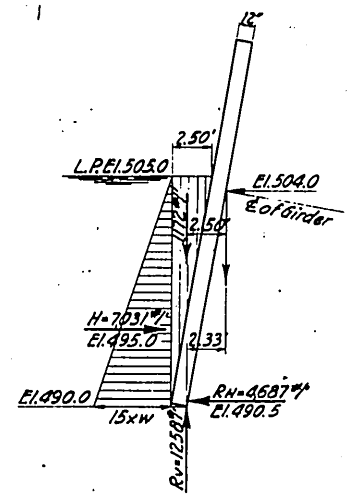
ASSUMPTIONS FOR DESIGN OF SILLS

Upper Pool El. 561.0 - Lower Pool El. 505.0
Full Upward Hydrostatic Water Pressure effective over 50% of Area of the Base. (For simplicity, shown as 50% Head over the entire Base)
Gates Horizontally framed - No pressure from Gate on Sill
Where Keys were used, they were neglected in Calculations
Unit Weight of Water = 62.5 lbs. per cu. ft.
Unit Weight of Concrete = 145 lbs. per cu. ft.
Forces apply to one linear ft. of Sill
Horizontal and Vertical Components of Resultants are shown dotted in the diagrams for Horizontal and Upward Water Pressure.
Values of Unit Pressure are given in terms of the Head and are to Scale 1/16" = 1 foot Head of Water.
Sections to be constructed under present Contract to Elevations shown by dotted lines for Upper Pool El. 544.0

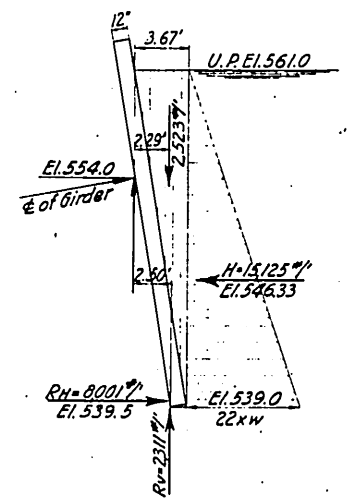


LOWER EMERGENCY DAM SILL

Emergency Dam in place
Conditions: L.P. El. 505.0
Lock pumped out
Resultant: Tan. θ = 0.397



LOWER EMERGENCY DAM SILL FORCES ON NEEDLES



UPPER EMERGENCY DAM SILL FORCES ON NEEDLES

TENNESSEE RIVER
LOCK & DAM NO. 3
LOCK
DESIGN DATA FOR TYPICAL SECTIONS

SCALE: 3/16 INCH = 1 FOOT

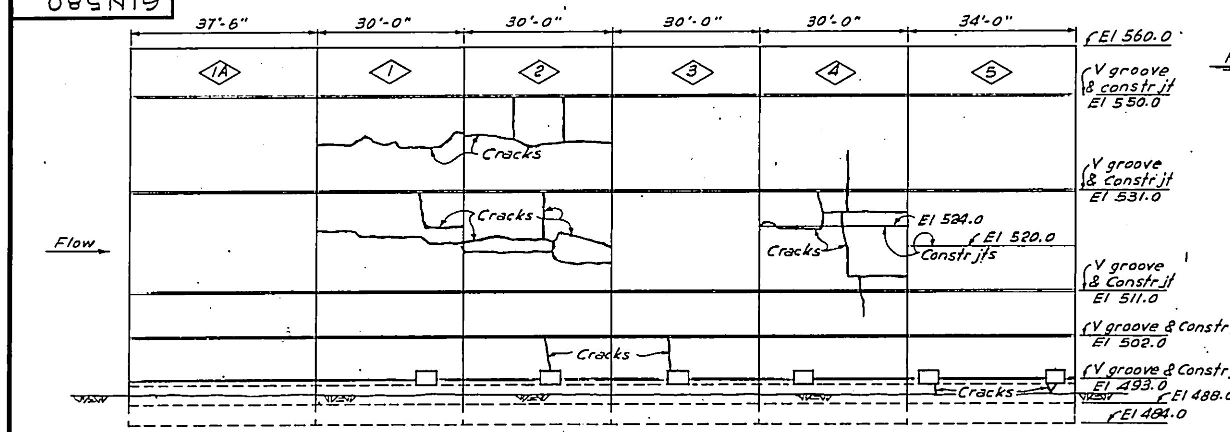
IN SHEETS — SHEET NO.

U. S. ENGINEER OFFICE, SAINT LOUIS, MISSOURI — UPPER MISSISSIPPI VALLEY DIVISION — JUNE 1933

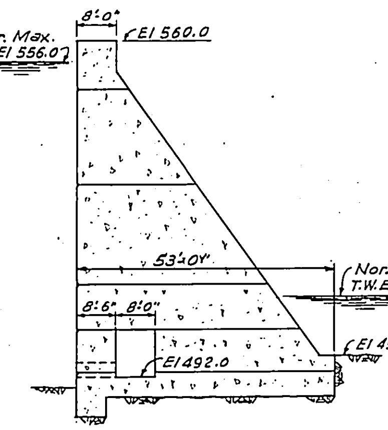
SUBMITTED: — APPROVED:

DRAWN BY: A.M.H.
TRACED BY: O.H.
CHECKED BY: J.E.H.

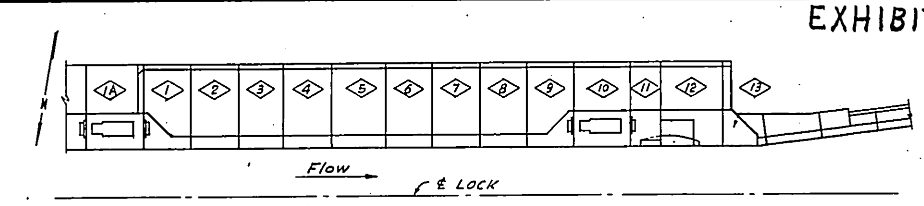
EXHIBIT 21



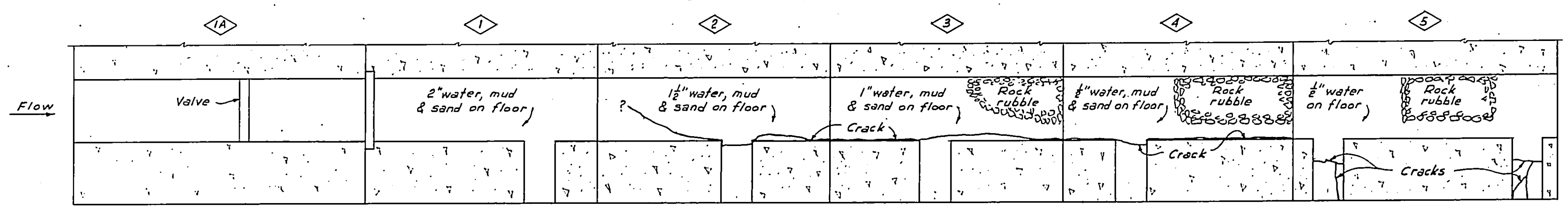
FRONT ELEVATION
(CHAMBER FACE)
Scale $\frac{1}{16}$" = 1'-0"



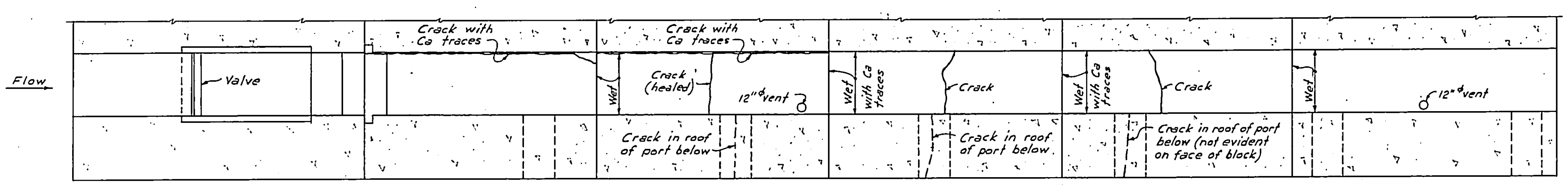
TYPICAL SECTION
Scale $\frac{1}{16}$" = 1'-0"



KEY PLAN
Scale 1" = 50'

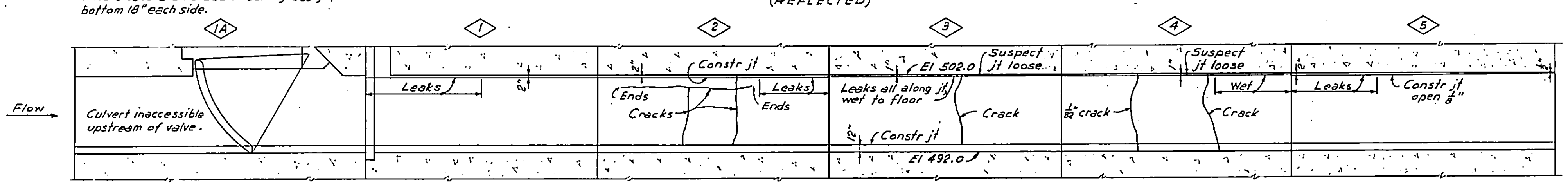


FLOOR PLAN

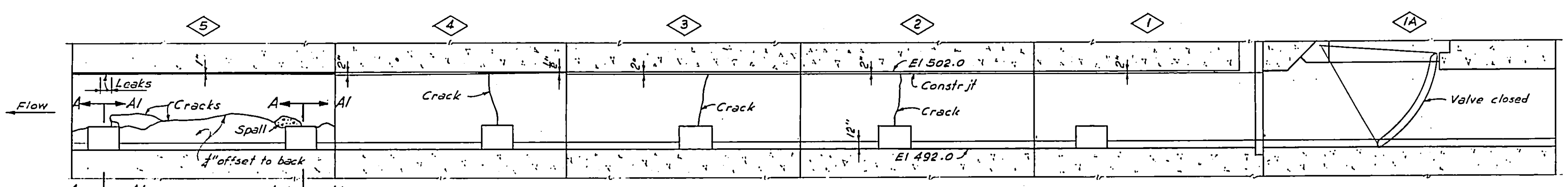


Note: No cracks in block 1A downstream of valve. Valve closed & side seals leaking badly for bottom 18" each side.

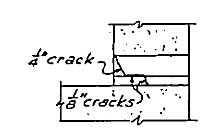
ROOF PLAN
(REFLECTED)



BACK WALL ELEV.



FRONT WALL ELEV.



A-A & A1-A1
A1-A1 OPP HAND

CULVERT

NOTES:
1. Cracks shown on Front Elevation are only the major cracks which cross the block or travel some distance vertically and are evident from a distance of 50 feet. There are many finer and shorter cracks, many of which show calcium stains indicating leakage. See photographs.
2. The sloping back of the wall has a multitude of cracks indicating leakage. See photographs.
3. All cracks shown in the culvert are old. Those without dimension are fine cracks less than $\frac{1}{32}$" wide, except those in the floor. The floor cracks are typically chipped and worn, with surface opening greater than crack itself. Water, mud and sand covers and fills the cracks. Floor cracks not dimensioned probably approach $\frac{1}{8}$" in width.
4. In several blocks the construction joint at the culvert roof is suspected to be loose. There is no evidence of movement, but the joint is not tight at the face of wall and the edges are irregular and somewhat worn.
5. The only cracks which show evidence of recent movement are noted in block 9. There is no displacement at the cracks, but along the whole length there are bright concrete specks visible behind the face of the wall.
6. The notation "Leaks" indicates visible water at and below the joint or crack. The notation "Wet" indicates only moisture stain at and around the joint or crack. Calcium traces noted are thin and of small surface area.
7. The culvert was inspected only between the valves, which were both closed. The downstream cofferdam between the approach walls was downstream of the outlet ports, but an earth berm inside the cofferdam covered the ports, preventing entrance to that portion of culvert.

Elevations shown are those used on original construction drawings by U.S. Engineer Office, Nashville, Tenn. Add 0.3 feet to correct elevations from 1912 Adjustment to that of the U.S.C. & G.S. 1929 General Adjustment.

Scale $\frac{1}{8}$" = 1'-0"
Except as noted

COMPANION DRAWING: 61N581

REV NO.	DATE	MADE	CHKD	SUPV	INSP	SUBM	RECM

DSGN. | SUPV. OHR
DRWN. JOA 7-17-61 | INSP.
CHKD. OHR |
TRCD. | ENGINEER
COMP. |

AUXILIARY LOCK RECONSTRUCTION

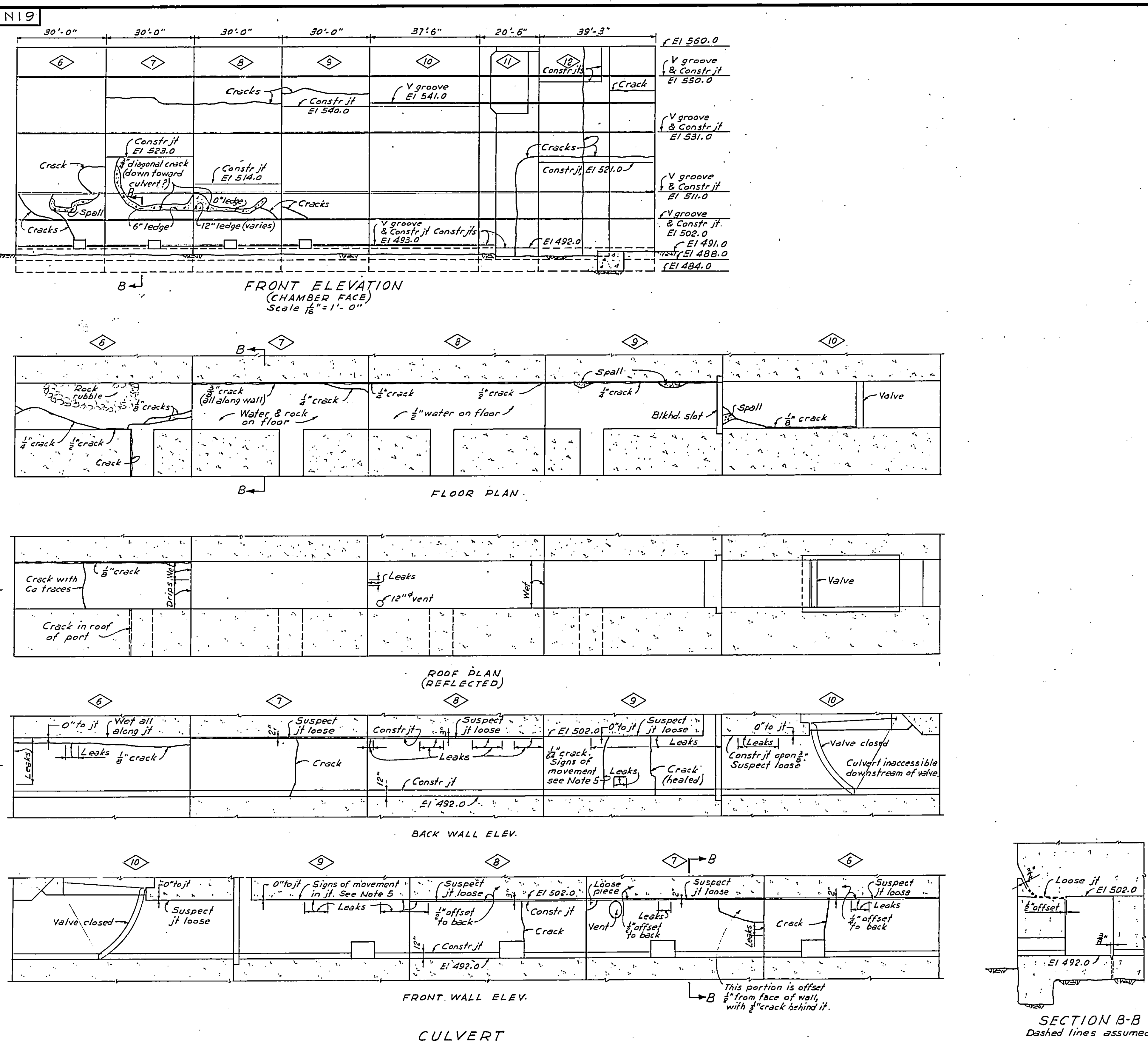
CONCRETE
EXISTING RIVER WALL
CRACK SURVEY - JULY 1961 - SHEET 1

WHEELER PROJECT
TENNESSEE VALLEY AUTHORITY
DIVISION OF DESIGN

SUBMITTED	RECOMMENDED	APPROVED
W. W. Engle		

KNOXVILLE	10-9-61	3	C	4	61N580	R0

RECORD DRAWING AS CONSTRUCTED



NOTE:
For key plan & notes see 61N580.

Scale 1/8" = 1'-0"
Except as noted

COMPANION DRAWING: 61N580

AUXILIARY LOCK RECONSTRUCTION

CONCRETE
EXISTING RIVER WALL
CRACK SURVEY-JULY 1961-SHEET 2

WHEELER PROJECT
TENNESSEE VALLEY AUTHORITY
DIVISION OF DESIGN

SUBMITTED	RECOMMENDED	APPROVED
W. W. Engle		

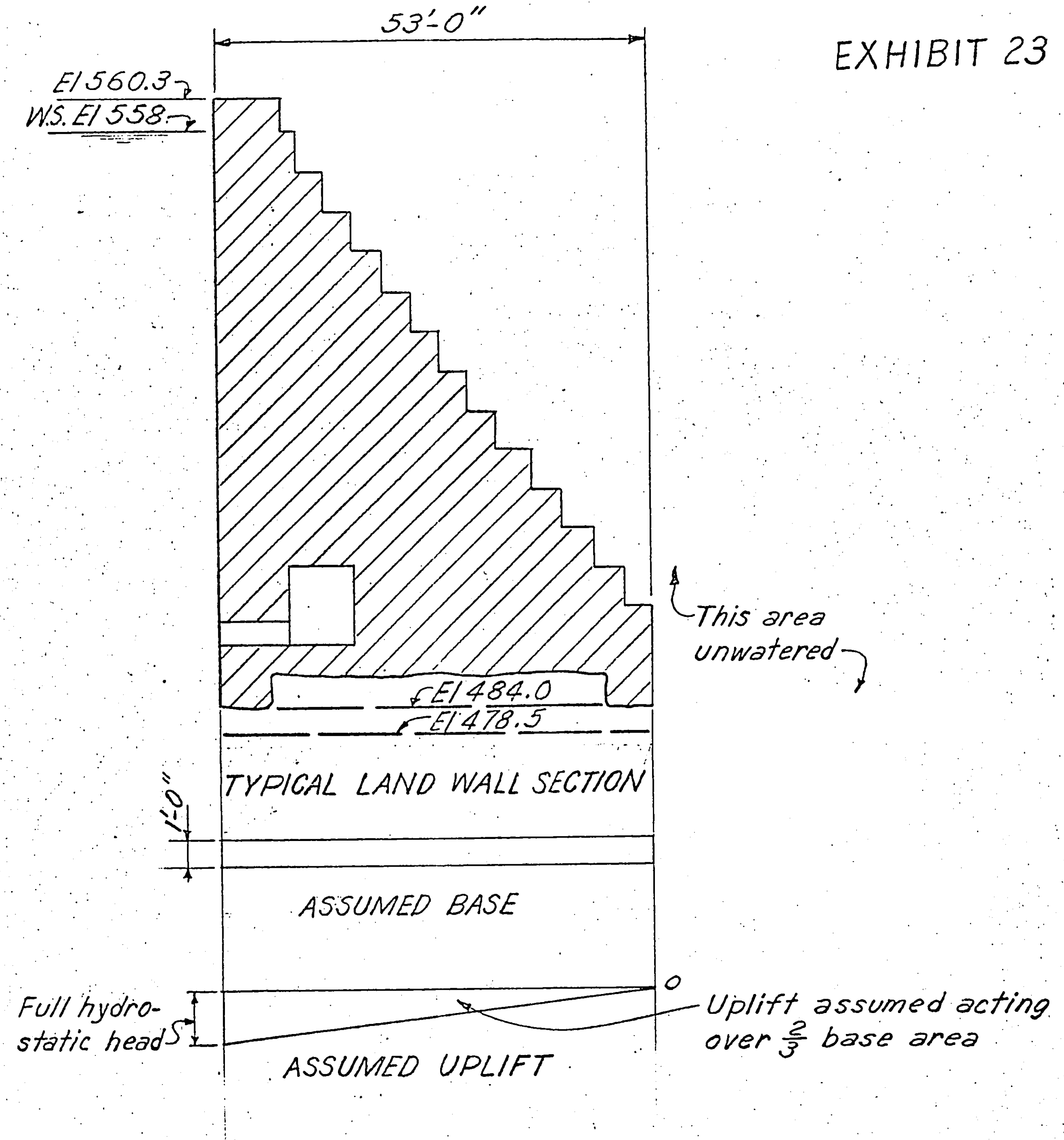
KNOXVILLE	10-9-61	3	C	4	61N581	R0

RECORD DRAWING AS CONSTRUCTED

REV NO	DATE	MADE	CHKD	SUPV	INSP	SUBM	RECM

DSGN. ... SUPV. OHR
DRWN. JDA 7-1161 INSP. ...
CHKD. OHR ...
TRCD. ... ENGINEER
COMP. ...

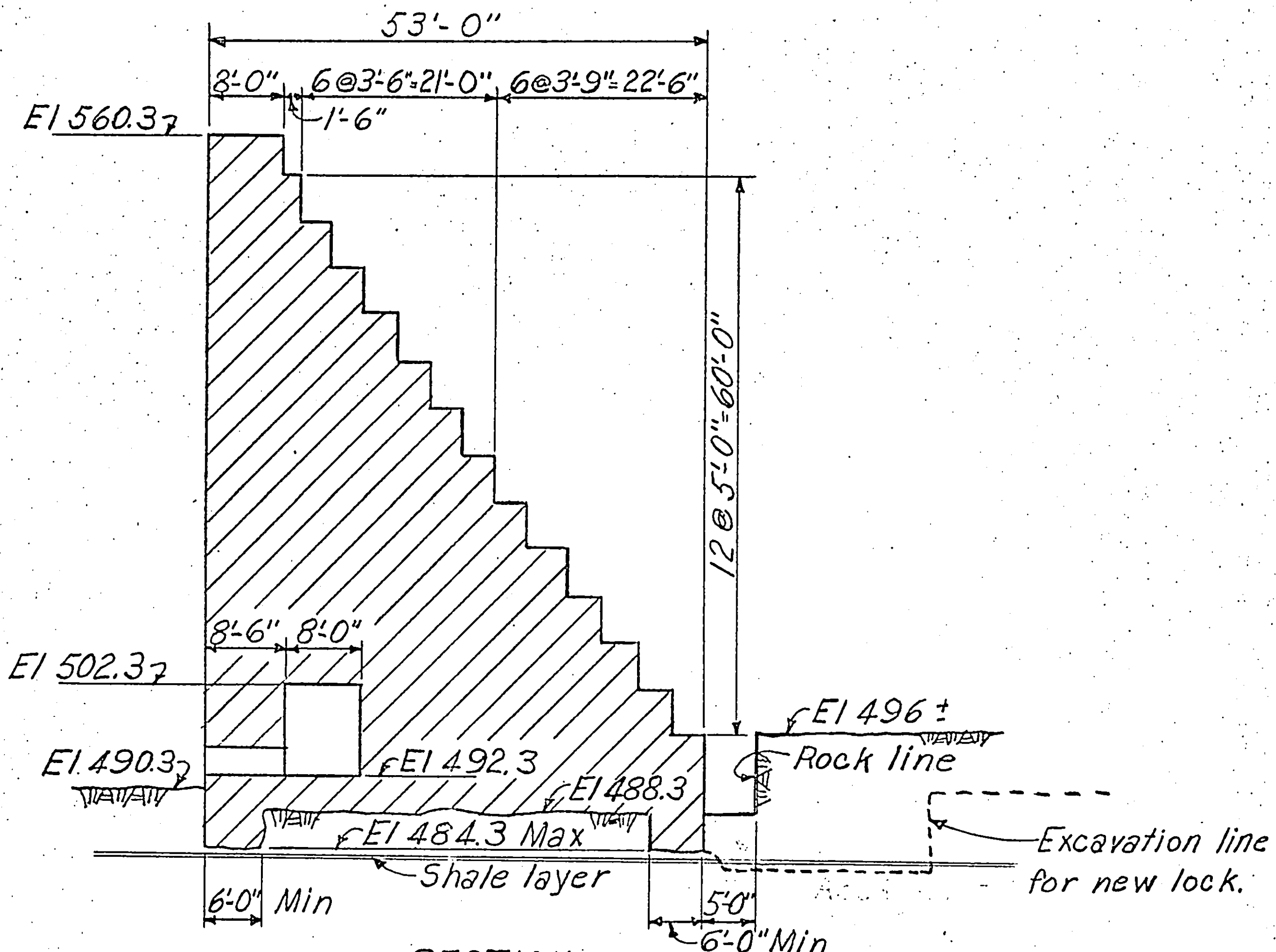
EXHIBIT 23



BASE	ΣH-KIPS	ΣV-KIPS	$\frac{\Sigma H}{\Sigma V}$	STRESS-LB/SQ IN	
				HEEL	TOE
El 478.5	197	302	.65	-11	90
El 484.0	171.5	274.6	.62	-3	75

TVA
WHEELER LOCK
STABILITY ANALYSIS

From computation of 3-31-59



SECTION
LAND WALL THAT FAILED

FIGURE 2

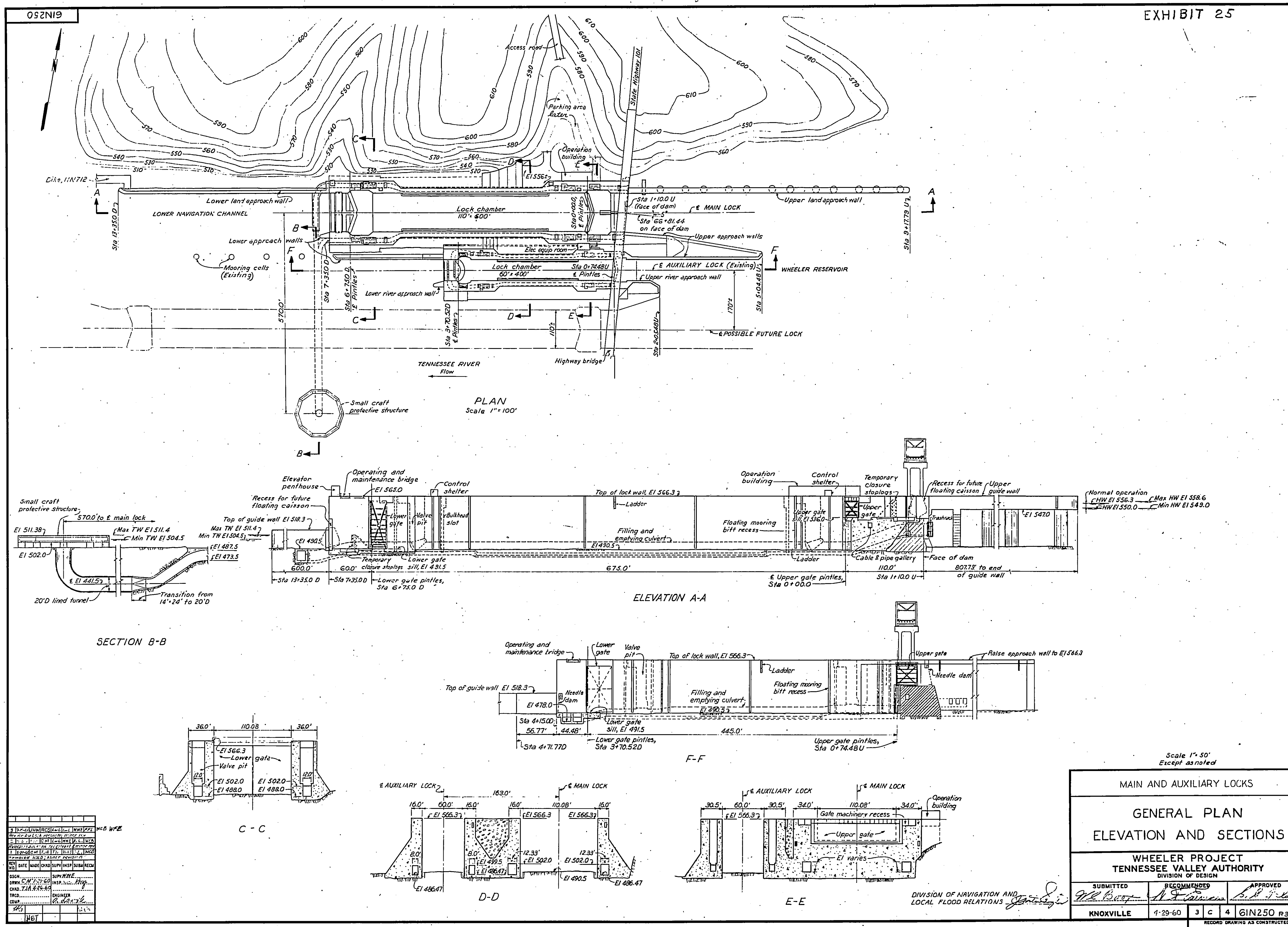


EXHIBIT 25
6IN250
Access road
State Highway 101
Parking area (later)
Operation building
Dike, 11N712
Lower land approach wall
LOWER NAVIGATION CHANNEL
Lock chamber 110' x 600'
Sta 0+00.0 ℄ Pintles
Sta 1+10.0 U (face of dam)
℄ MAIN LOCK
Sta 66+81.44 on face of dam
Upper land approach wall
Upper approach walls
Lower approach walls
Elec equip room
Mooring cells (Existing)
Lock chamber 60' x 400'
Sta 0+74.48U ℄ Pintles
℄ AUXILIARY LOCK (Existing)
Upper river approach wall
WHEELER RESERVOIR
Lower river approach wall
℄ POSSIBLE FUTURE LOCK
Highway bridge
TENNESSEE RIVER Flow
Small craft protective structure
PLAN
Scale 1" = 100'
Small craft protective structure
570.0' to ℄ main lock
El 511.38
Max TW El 511.4
Min TW El 504.5
El 502.0
El 487.5
El 473.5
℄ El 441.5
20'D lined tunnel
Transition from 14' x 24' to 20'D
SECTION B-B
Elevator penthouse
Operating and maintenance bridge
El 565.0
Control shelter
Recess for future floating caisson
Top of guide wall El 518.3
Lower gate
Valve pit
Bulkhead slot
Top of lock wall, El 566.3
Ladder
Filling and emptying culvert
El 490.5
Floating mooring bitt recess
Operation building
Control shelter
Temporary closure stoplogs
Upper gate sill, El 536.0
Upper gate
Recess for future floating caisson
Upper guide wall
Trashrack
El 547.0
Normal operation HW El 556.3
HW El 550.0
Max HW El 558.6
Min HW El 549.0
Temporary closure stoplogs
Lower gate sill, El 491.5
Cable & pipe gallery
Face of dam
600.0'
60.0'
675.0'
110.0'
807.73' to end of guide wall
Sta 13+35.0 D
Sta 7+35.0 D
Lower gate pintles, Sta 6+75.0 D
℄ Upper gate pintles, Sta 0+00.0
Sta 1+10.0 U
ELEVATION A-A
Operating and maintenance bridge
Lower gate
Valve pit
Top of lock wall, El 566.3
Ladder
Upper gate
Raise approach wall to El 566.3
Needle dam
Top of guide wall El 518.3
El 478.0
Filling and emptying culvert
Floating mooring bitt recess
El 490.5
Lower gate sill, El 491.5
Sta 4+15.00
56.77'
44.48'
445.0'
Sta 4+71.77D
Lower gate pintles, Sta 3+70.52D
Upper gate pintles, Sta 0+74.48U
F-F
36.0'
110.08'
36.0'
El 566.3
Lower gate
Valve pit
El 502.0
El 488.0
C - C
℄ AUXILIARY LOCK
℄ MAIN LOCK
163.0'
16.0'
60.0'
16.0'
110.08'
16.0'
El 566.3
El 502.0
El 490.5
El 486.47
D-D
℄ AUXILIARY LOCK
℄ MAIN LOCK
30.5'
60.0'
30.5'
34.0'
110.08'
34.0'
Operation building
Gate machinery recess
Upper gate
El varies
E-E
DIVISION OF NAVIGATION AND LOCAL FLOOD RELATIONS
Scale 1" = 50' Except as noted
MAIN AND AUXILIARY LOCKS
GENERAL PLAN
ELEVATION AND SECTIONS
WHEELER PROJECT
TENNESSEE VALLEY AUTHORITY
DIVISION OF DESIGN
SUBMITTED
RECOMMENDED
APPROVED
KNOXVILLE
4-29-60
3 C 4 6IN250 R3
RECORD DRAWING AS CONSTRUCTED