Tennessee Valley Authority
Water Control Planning Department
Geologic Division

GEOLOGY OF THE NEW JOHNSONVILLE STEAM PLANT SITE

by
John M. Kellberg
Associate Geologist

Knoxville, Tennessee
January 14, 1948

GEOLOGY OF THE NEW JOHNSONVILLE STEAM PLANT SITE

CONTENTS

ILLUSTRATIONS

Plate 1	View of proposed plant site, looking north from south side of embayment.	18140-B and 18140-C
Plate 2	Terrace deposits 0.6 mile north of plant site, showing layers cemented by iron oxide directly below hammer.	18140-A
Plate 3	Ridgetop formation downfaulted into Chattanooga shale. Terrace deposits truncating both formations. Roadcuts along U. S. Highway 70, four miles east of Camden, looking north.	18142-D and 18142-F
Plate 4	Chattanooga shale thrust up on Ridgetop formation; new relocation of U. S. Highway 70, one mile east of Camden, looking northwest.	18141-A
Plate 5	Fishtail bits used in drilling holes at New Johnsonville site. Bit on right unused; bit on left drilled 55 feet of chert.	18141-D

Exhibits

1	Hole Location and Drilling Summary.	30 GE 1 822B977
2	Isometric Projection of Geologic Sections.	30 GE 1 822N967
3	Geologic Sections (Looking Northeast).	30 GE 1 822K968
4	Geologic Sections (Looking Southeast).	30 GE 1 822K969
5	Detailed Geologic Section Along South Bank of Embayment.	30 GE 1 822K971
6	Areal Geology, Contours on Top of Rock.	30 GE 1 820G62
7	Contour Map of Expected Foundation Grade.	30 GE 1 820G63
8	Isopach Map Between Surface and Foundation Grade.	30 GE 1 820G64
9	Isopach Map Between Surface and Top of Rock.	30 GE 1 820G65
10	Isopach Map Between Top of Rock and Foundation Grade.	30 GE 1 820G66

GEOLOGY OF THE NEW JOHNSONVILLE STEAM PLANT SITE

John M. Kellberg

INTRODUCTION

Location

The site investigated for the proposed New Johnsonville Steam Plant lies on the eastern shore of Kentucky Lake in Humphreys County, Tennessee. The site is 3000 feet north (downstream) of the Hickman-Lockhart Bridge on U. S. Highway 70 and the N. C. & St. L. railway bridge across Kentucky Reservoir (plate 1). An area extending 2000 feet east from the edge of the lake and 2000 feet along the lake was explored by 33 drill holes. The holes, spaced on 250-foot and 500-foot centers, varied in depth from 26.5 feet to 177 feet and totaled 2352 linear feet of drilling (exhibit 1). An additional area of approximately 500 acres extending from U. S. Highway 70 north to Alpha Landing was examined by surface reconnaissance.

Physiography

The area under consideration comprises a partially dissected river terrace. If restored to its former level, this terrace would be at an elevation of approximately 400 to 410 feet above sea level; however, as the Tennessee River cut down to its present level, a consequent drainage pattern developed on the terrace surface resulting in a series of small valleys and gullies transversing the whole area. Near the river these small valleys have cut down 50 to 60 feet, while near their heads they are gullies 10 to 15 feet deep. This dissection has resulted in a gently

Plate 1. View of proposed plant site, looking north from south side of embayment.

rolling terrain with the tops of the low hills at elevations around 410 feet and valley floors ranging from elevation 350 to 390.

GENERAL GEOLOGY

Stratigraphy

At the New Johnsonville site, five and possibly six geologic formations are present at or near the surface (exhibit 2). Recent deposits of river alluvium, older river terrace deposits, the Ridgetop formation, the Chattanooga shale, and the Camden chert are definitely known to be present and there is the possibility that residuum from the Fort Payne formation underlies the terrace deposits farther to the east, outside the area explored by the drilling. A brief stratigraphic description of these formations, from the youngest to the oldest, follows.

Alluvium--Exploratory drilling for the N. C. & St. L. railway bridge at New Johnsonville disclosed alluvial deposits ranging from 13 to 67 feet in depth over the flood plain of the Tennessee River. Although this material at present is covered by the waters of Kentucky Lake, it would be encountered in excavation for water intakes and in any contemplated channel deepening operations.

Near the surface the alluvium consists of silt and loam, grading in depth to sand and river gravel. It was deposited by the river and the gravel portion is made up predominantly of chert pebbles derived from the St. Louis and Warsaw limestones and the Fort Payne and Camden cherts outcropping farther upstream. A minor part is composed of quartzites and crystallines which have been transported from the mountainous areas along the eastern edge of the Tennessee River drainage basin.

Prior to the impounding of water behind Kentucky Dam, the Tennessee

River in this area had ceased cutting downward and had started filling its channel with alluvium. Drilling in 1941 disclosed an average depth of 35 feet of alluvial material in the channel. On the flood plains immediately adjacent to the river there was an average depth of 60 feet of alluvium.

Terrace Deposits--The recent drilling indicated a veneer of Tertiary terrace deposits from 3.0 to 31.9 feet in depth covering the entire area examined. This material consists of essentially the same components as the alluvium but it was deposited when the Tennessee River was flowing at an earlier base level. Since that time there has been a gentle uplift of the area and consequent renewed erosion resulting in the present base level, approximately 75 feet lower.

The terrace deposits consist of a clay, loam, and sand matrix containing up to 90 percent gravel. The gravel portion is similar to the gravel in the alluvium in that it is made up predominantly of chert pebbles with a minor admixture of quartzites and crystallines. Drilling through this material has indicated numerous hard layers from 0.1 foot to 0.2 foot in thickness at irregular intervals. These layers represent zones of gravel cemented by a ferruginous cement. Such zones are exposed in the wave-cut benches at Alpha Landing and in the gravel bank on the west side of the road to Old Johnsonville, 0.6 mile north of Alpha Landing (plate 2).

Fort Payne Chert--The Fort Payne cherty limestone of Mississippian age was not definitely identified at this site; however, it is believed that residuum from this formation underlies the terrace deposits near the eastern edge of the area.

The thickness of the Fort Payne varies from 100 to 200 feet and

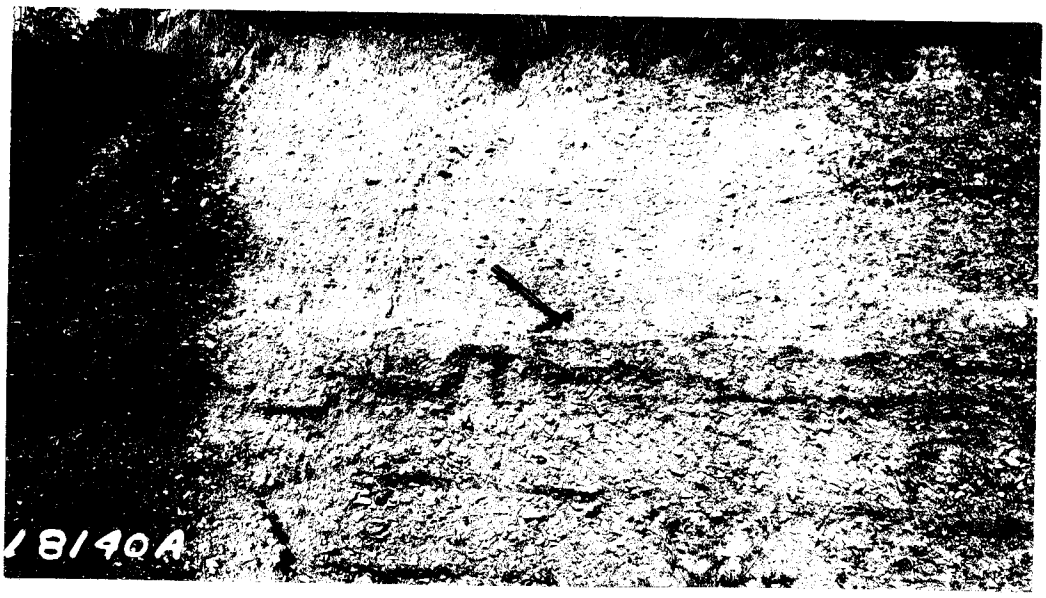


Plate 2. Terrace deposits 0.6 mile north of plant site, showing layers cemented by iron oxide directly below hammer.

it is composed of an exceedingly heterogeneous assemblage of siliceous and calcareous shale and sandy, cherty, earthy limestone. The upper part of the formation is very thick-bedded and consists of alternating bands of dense, dark-colored chert from one inch to a foot or more in thickness. The amount of chert decreases noticeably and the proportion of earthy limestone and calcareous shale increases from the top of the formation to the bottom.

This formation is deeply weathered throughout the upland areas and the weathering has generally produced a reddish or yellowish-buff soil that contains much dense chert in sub-angular fragments. In many places the tabular chert has not disintegrated, although the calcareous matter of the intervening limestone layers has been completely leached, so that the layers of chert are separated only by seams of yellowish clay a few inches thick.

Ridgetop Formation--The Fort Payne chert is underlain by approximately 100 feet of interbedded shale and thin cherty limestone known as the Ridgetop formation of Mississippian age. Weathered residuum from this formation was encountered in 11 drill holes where it generally consisted of thin beds of chert and weathered limestone separated by seams of buff to yellow clay. In hole NJ-14 and hole NJ-21 thirteen and twelve feet, respectively, of dark gray argillaceous limestone was encountered at the base of the formation overlying the Chattanooga shale.

When fresh, the Ridgetop formation in this area has the appearance of a thin-bedded, cherty, argillaceous limestone; however, on exposure, it will disintegrate rapidly into a cherty shale and clay. When unweathered, the Ridgetop contains an appreciable amount of bituminous material which, until oxidized, acts as a preservative and retards decomposition of the rock.

However, when this bituminous material is finally oxidized the rock disintegrates rapidly. An example of this can be seen along U. S. Highway 70, just east of Denver. When the highway was built in 1927 the rock in the cuts was fresh. It now shows conspicuous evidence of weathering and disintegration.

Chattanooga Shale--Underlying the Ridgetop formation is from 25 to 30 feet of black fissile carbonaceous shale containing thin seams of bituminous matter and disseminated small crystals of pyrite. This Chattanooga shale crops out intermittently for a distance of 1500 feet in the small bluff along the south bank of the embayment at the New Johnsonville site. In 25 of the 33 holes drilled the shale also was encountered in thicknesses ranging from 6.5 to 74.9 feet. The variation in thicknesses obtained in the drill holes is attributable to folding and repetition by faulting in the areas over 30 feet in thickness and to partial removal by erosion in the areas under 30 feet. On weathering this shale breaks down into thin plates and oxidation of the disseminated pyrite gives it a rusty brown color.

Camden Chert--Below the Chattanooga shale lies 100+ feet of hard, dense, brittle, white novaculite known as the Camden chert of Devonian age. The character of this formation is best shown in the numerous quarry faces on the western shore of the reservoir near the town of Camden where it is disposed in thin hard layers, usually from one to three inches thick, rarely as much as eight to ten inches. These layers are commonly separated by softer gritty clay along the bedding planes. Locally there are irregular and more or less vertical pockets of pure white powdered silica, apparently the result of leaching along ground water channels. The chert breaks with an irregular fracture into angular, sharp-edged fragments. It is always

extremely fractured so that under the influence of weathering even a fresh quarry face breaks down rapidly into a talus slope, while natural outcrops appear only as loose rubble or rough, angular pieces of chert, most of which are smaller than one's fist. So characteristic is this finely broken condition of the rock that the quarries where it is extensively worked for road metal are commonly called "gravel pits."

The brecciated condition of the formation is ascribed to the warping and compressive stress to which western Tennessee has been subjected in the geologic past while mountains were being formed to the east or the southwest. The softer limestones and shales of the valley have yielded to these compressive forces by mashing; but this deformation, being distributed throughout the formation, is so slight at any one point that it leaves almost no visible evidence of its effect. The extreme hardness and brittleness of the chert, however, caused it to yield only by crumpling and breaking. It is very noticeable that the bedding of the Camden chert is seldom quite horizontal for more than a few consecutive yards even where the adjacent shales and limestones show no disturbance. It is commonly thrown into low, open folds only a few yards wide, but with dips ranging from 45 to 90 degrees.

Decatur, Brownsport, and Dixon Limestones--Though not encountered in the present holes, as much as 160 feet of limestone was penetrated below the Camden chert in the wells drilled by the Construction and Maintenance Division for the N. C. & St. L. Railroad at the New Johnsonville station in 1943. In Well No. 2 there was 70 feet of red and green Decatur limestone, followed by 60 feet of light bluish-gray limestone and shale of the Brownsport formation, and the bottom 30 feet of the hole was in the reddish-brown and white limestone of the Dixon formation.

Structure

Folds--All rocks of this region are sedimentary strata which were deposited in flat and essentially horizontal layers. In general they maintain this attitude, but in detail the structure is much more complex. The axis of the Nashville structural dome forks to the southeast of this area and one branch of the axis striking to the northwest passes through this vicinity, accounting for the apparent divergence from the expected normal structural trends.

The regional dips are invariably slight and the folds broad and low in the older limestone and shale formations, but the hard brittle Camden chert and the relatively thin Chattanooga shale are extremely fractured and frequently crumpled by small sharp folds with dips at all angles up to vertical. It is characteristic of the chert that the bedding planes are seldom horizontal for more than a short distance, even though the underlying limestones and shales bear no appearance of disturbance. As the older limestones and shales could not have escaped the same stresses to which the chert has been subjected, the contrast in their structure must be attributed to their different physical characteristics. The heavy limestones were strong and tough enough to carry the stresses in broad open folds, while the shale was soft and weak enough to yield by mashing and to accommodate itself between the harder formations. The thin-bedded chert, on the contrary, being too hard to yield by mashing and too brittle to carry the strain into broad folds, has been thoroughly fractured and crumpled. Because the Chattanooga shale, which directly overlies the Camden chert, was not competent enough to carry the stresses without support from the underlying chert, it too is fractured and crumpled to conform to the structure in the chert.

Faults--Faults, though not as prominent nor of as great displacement as those of the Valley of East Tennessee, are quite numerous in the region. Because of the comparatively recent unconsolidated deposits which overlie the Paleozoic rocks in the area, the faults in the older sediments are hidden and are not obvious on the surface. Artificial exposures, such as road and railroad cuts or drill and well holes, afford the best means of determining the extent and offset of the faulting (plate 3). Evidently the major fault pattern has been controlled by the northwest-trending branch of the axis of the Nashville dome, while the minor faulting is directly related to the incompetency of the Camden chert to withstand regional stresses.

The major fault pattern comprises a series of northwest-striking southwest-dipping thrust faults. No definitely measurable displacement has been obtained for any of these larger faults, but the few exposures seen indicated displacements up to several hundred feet. The displacement of the minor faults, as indicated by the results of the drilling, apparently does not exceed 20 or 30 feet.

The age of these faults is uncertain. Apparently, however, only the formations older than the Cretaceous are involved so the age of the major disturbance may be placed between the Mississippian and the Cretaceous. As the Pennsylvanian also is faulted in Illinois, it seems probable that the deformation is of Permian time, when the Appalachian Mountains were elevated.

Joints--The most common directions of jointing in the area are N 55° W to N 65° W, and N 25° E to N 45° E, and the joints of the northwesterly set are generally more persistent and cut across those of the

Plate 3. Ridgetop formation downfaulted into Chattanooga shale. Terrace deposits truncating both formations. Roadcut along U. S. Highway 70, four miles east of Camden, looking north.

northeasterly set. These directions are approximately, but in most places not precisely, normal and parallel to the axis of the Nashville dome. The other joints, generally less persistent along their strike than those of the two dominant sets, commonly fall in the acute angle between N 65° E and S 70° E.

DETAILED GEOLOGY

The detailed geology of the site has been interpreted from the 33 drill holes and the few exposures of bedrock in the immediate vicinity (exhibits 3 and 4). As the drill holes were on 500-foot and 250-foot centers it was impossible to obtain sufficient information to work out the intricate relationship known to exist between the Camden chert and the Chattanooga shale. The only indication of this complex structure is found in the low bluff along the south side of the embayment at the site (exhibit 5). Sufficient data were obtained to determine the salient features of the structure and to prove the feasibility of the site; however, to obtain the detailed structure of any critical area it will be necessary to drill holes on centers as close as 10 feet.

Because of the blocky nature of the Camden chert and the comparative softness of the overlying Chattanooga shale, it was found that drilling with a diamond bit in an attempt to obtain good core recovery was slow and resulted in less than 50 percent core recovery. Also, several diamond bits were lost when hard chert cuttings remained between the core barrel and the casing of the hole and wore through the core barrel just above the bit, resulting in the loss of the bit in the hole. In most areas it was found that careful interpretation of the cuttings

obtained with a fishtail bit gave as good, if not better, geologic information than the partial core recovery obtained with a diamond bit. It was, therefore, decided to drill as many of the holes as possible with a fishtail bit, resorting to the use of a diamond bit only when the material was too hard to be drilled with a fishtail bit or in cases where core recovery was desirable in questionable areas for more accurate geologic interpretation.

Structure

From the results of the preliminary drilling, the site may be roughly divided into three major areas on the basis of the formation outcropping beneath the terrace cover (exhibit 6): (1) the area underlain by the Camden chert, (2) the area underlain by the Chattanooga shale, and (3) the area underlain by the Ridgetop formation. Each of these areas has different characteristics insofar as foundation conditions are concerned. The Camden chert is the foundation rock under the embayment, the north shore of the embayment, and most of the eastern shore of the main reservoir as far north as Alpha Landing. The Chattanooga shale underlies the south bank of the embayment and a larger belt crops out north of the embayment from the eastern shore of the reservoir inland for approximately 1000 feet. The Ridgetop formation underlies a small portion in the southeast corner of the area and all of the area east of the larger belt of the Chattanooga shale.

Four relatively small faults were encountered by the drill holes and a much larger fault is inferred from the correlation of the drill hole data. All faults appear to be thrusts striking northwest-southeast and dipping about 60 degrees to the southwest. The presence of the larger

fault is postulated on the differences in elevation of the top of the Camden chert found between holes NJ-22, NJ-23, NJ-7, and NJ-8 and holes NJ-11, NJ-17, NJ-18, and NJ-19. In the former series of holes the top of the Camden chert is at an average elevation of 347 while in the latter series the average elevation is 307, a difference of 40 feet. Although this fault was not encountered in any drill hole and no actual outcrop of it was seen beneath the terrace cover, similar faults were seen exposed in road cuts in the vicinity and are not uncommon (plate 4). It seems more probable that the anomalous relationship evidenced above is due to thrust faulting rather than to an increase in the angle of the dip of the formations.

The general dip of the formations north of the largest thrust fault averages about 2 degrees to the east, although because of minor folding and faulting the dip at any specific locality may be much greater. South of the largest fault the general dip is about 2 degrees to the southwest, changing to about 10 degrees to the southeast as the strike swings to the northeast near the eastern edge of the area. Here, again, the local dips may vary from horizontal to vertical because of the intricate relationship between the Camden chert and the Chattanooga shale.

Foundation Conditions

During the drilling program the foundation grade in each hole was arbitrarily set at the elevation at which the fishtail or diamond bit encountered material which afforded increased resistance (exhibits 7 and 8). From the beginning it was assumed that the structural load would be spread over a comparatively wide footing and not concentrated as would foundation loads for a gravity dam; therefore, the requirements for adequate foundation were not as rigid as they would be for a dam. At no

Plate 4. Chattanooga shale thrust up on Ridgetop formation; new relocation of U. S. Highway 70, one mile east of Camden, looking northwest.

place was suitable foundation found above top of bedrock (exhibit 9). The terrace deposits were not considered to have adequate bearing capacity for any of the major structures; however, the terrace deposits have ample strength to support the load imposed by the switchyard and transformer yard, receiving yard, coal storage, and railroad tracks.

In the area underlain by the Camden chert, foundation grade practically coincides with the top of rock (exhibit 10). In this area, however, adequate care must be taken in preparing the foundation or there will be excess excavation. As mentioned previously, the Camden chert is extensively jointed and fractured for its entire thickness and always presents the appearance of a mass of small, irregular blocks. There is slight weathering throughout, resulting in brown stains along the joint and fracture surfaces, although the weathering does not materially affect the strength of the individual blocks. Because of the fractured condition of the rock, excavation by power shovel can be carried on indefinitely far below the desired limits without obvious change in the character of the rock. Drilling and blasting will produce only a mass of rubble and will not give a straight vertical face. It is more probable that slopes will approach the vertical near the top with a talus slope on 1 to 1 slope near the bottom. Such faces are common in the quarries in the Camden chert on the western bank of the river. It is believed that if the foundation is covered soon after it is prepared, most of this slumping can be avoided. The fractured condition of the chert allows ground water to circulate freely between the joints, bedding planes, and fractures, and does not provide a watertight foundation. In this connection, the hardness and the toughness of the Camden chert cannot be over-emphasized. The individual blocks are very abrasive and cause excess wear on the equipment used to

handle them. Previous construction in the area by the Construction and Maintenance Division has shown that power shovel teeth and pan scraper blades have to be replaced every four to five operating hours. Plate 5 shows a fishtail bit tipped with stellite before and after drilling 55 feet of chert.

In the portion of the area underlain by the Chattanooga shale foundation grade varies from 5 to 30 feet below top of rock. This variation is due for the most part to the varying and irregular dips found in the shale. In places where the shale remains essentially horizontal it has formed a relatively impervious layer and has retarded weathering; however, in areas where it is faulted and contorted weathering has progressed to much greater depths. Because of the complicated interrelationship between the Chattanooga shale and the Camden chert it is difficult to predict with any accuracy where satisfactory foundation will be found in the shale and where it will be necessary to remove all of the shale and place the heavy structures on the underlying chert. The shale is very thin-bedded and platy and when weathered contains numerous seams of clay and in places where necessary its removal should be effected by the use of pan scrapers or bulldozers with the occasional aid of a rooter.

Only in two isolated instances in the extreme northeast portion of the area drilled was satisfactory foundation material found in the Ridgetop formation. As stated previously, the Ridgetop is a shaly to cherty limestone containing an appreciable amount of bituminous material. When this bituminous material is oxidized the rock soon disintegrates into loose rubble of shale, weathered limestone, and chert. This residual material is very similar to the overlying terrace deposits except that the fragments are more angular. The weathered Ridgetop can be removed with pan

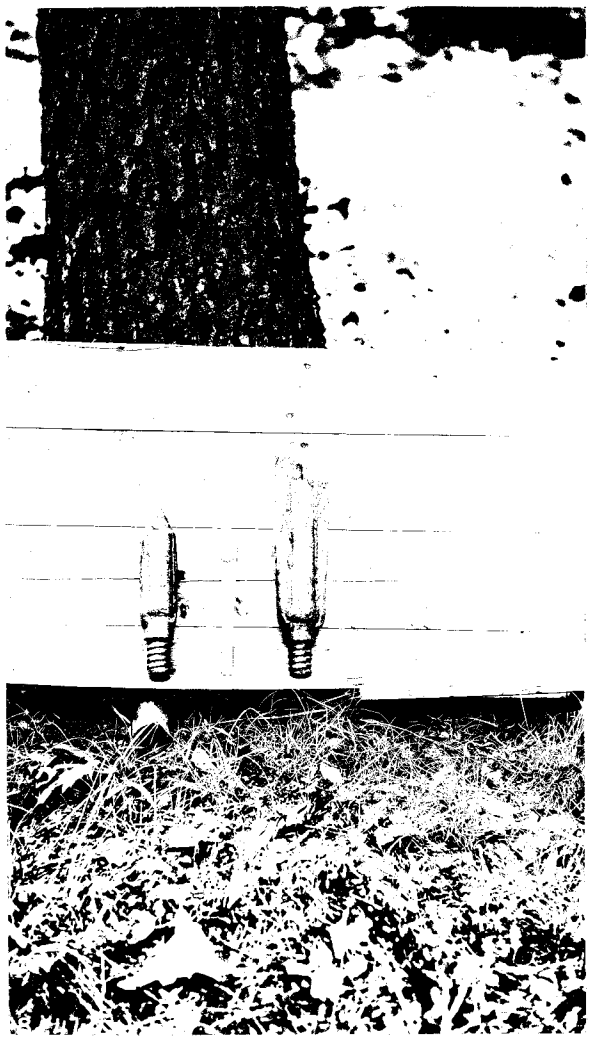


Plate 5. Fishtail bits used in drilling holes at New Johnsonville site. Bit on right unused; bit on left drilled 55 feet of chert.

DRILLING SUMMARY

Hole No.	Surface Elev.	Elev Top of Rock	Found Elev.	Bottom Elev.	Foundation Rock
NJ-1	362.9	323.9	[illegible]	[illegible]	Camden
NJ-2	[illegible]	373.6	344.6	[illegible]	Camden
NJ-3	367.2	363.2	335.2	[illegible]	Camden
NJ-4	358.5	342.0	333.0	259.5	Chattanooga
NJ-5	369.1	[illegible]	296.1	[illegible]	Chattanooga
NJ-6	358.6	[illegible]	[illegible]	[illegible]	Camden
NJ-7	360.5	345.5	345.5	334.0	Camden
NJ-8	358.4	345.4	342.0	326.3	Camden
NJ-9	385.1	366.9	275.1	247.3	Chattanooga
NJ-10	359.8	349.1	349.1	327.6	Camden
NJ-11	372.3	347.3	340.8	[illegible]	Camden
NJ-12	380.5	366.5	354.5	304.5	Chattanooga
NJ-13	391.2	370.4	340.4	239.2	Chattanooga
NJ-14	362.0	333.9	304.6	246.0	Ridgetop
NJ-15	383.1	394.1	344.4	329.5	Camden
NJ-16	387.8	371.6	349.2	333.9	Camden
NJ-17	376.0	350.8	333.0	326.3	Camden
NJ-18	383.4	368.7	377.4	303.2	Chattanooga
NJ-19	398.0	366.1	315.3	308.8	Camden
NJ-20	389.7	358.4	267.0	212.7	Chattanooga
NJ-21	370.5	361.0	314.6	239.2	Ridgetop
NJ-22	355.7	343.3	343.3	322.4	Camden
NJ-23	364.9	350.5	344.4	328.2	Camden
NJ-24	383.1	372.4	338.1	332.1	Camden
NJ-25	393.3	373.6	333.3	280.3	Chattanooga
NJ-26	394.7	369.7	349.5	323.8	Camden
NJ-27	401.5	371.1	336.3	297.3	Chattanooga
NJ-28	402.0	372.2	364.3	333.6	Chattanooga
NJ-29	404.3	374.0	310.8	280.5	Camden
NJ-31	394.2	371.0	347.7	336.8	Chattanooga
NJ-32	357.8	348.5	342.6	327.7	Camden
NJ-33	383.3	373.3	368.6	331.3	Chattanooga
NJ-34	397.9	370.8	355.5	344.2	Camden

SCALE

0 500FT

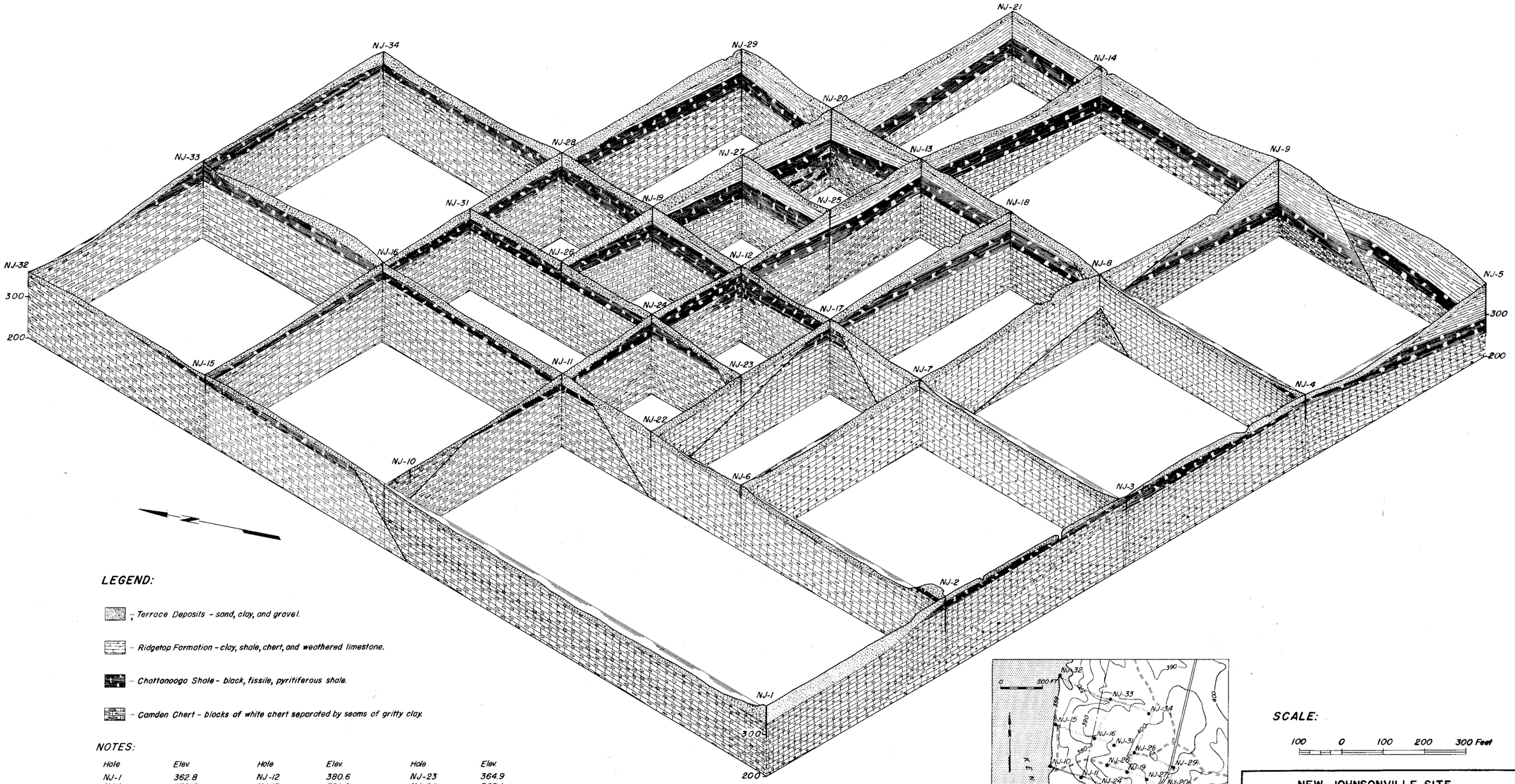
NEW JOHNSONVILLE SITE

HOLE LOCATION AND DRILLING SUMMARY

WESTERN AREA STEAM PLANT

TENNESSEE VALLEY AUTHORITY

KNOXVILLE

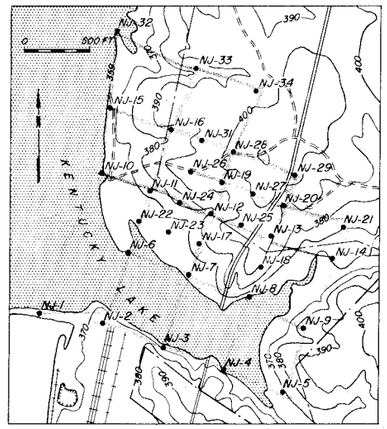


LEGEND:

- Terrace Deposits - sand, clay, and gravel.
- Ridgetop Formation - clay, shale, chert, and weathered limestone.
- Chattanooga Shale - black, fissile, pyritiferous shale.
- Camden Chert - blocks of white chert separated by seams of gritty clay.

NOTES:

Hole	Elev.	Hole	Elev.	Hole	Elev.
NJ-1	362.8	NJ-12	380.6	NJ-23	364.9
NJ-2	376.6	NJ-13	391.2	NJ-24	383.1
NJ-3	367.2	NJ-14	362.0	NJ-25	393.3
NJ-4	358.5	NJ-15	363.0	NJ-26	394.7
NJ-5	369.1	NJ-16	387.8	NJ-27	401.5
NJ-6	358.6	NJ-17	376.0	NJ-28	402.0
NJ-7	360.5	NJ-18	389.4	NJ-29	404.3
NJ-8	358.4	NJ-19	398.0	NJ-31	394.2
NJ-9	385.1	NJ-20	389.7	NJ-32	357.8
NJ-10	358.8	NJ-21	370.5	NJ-33	383.3
NJ-11	372.3	NJ-22	359.7	NJ-34	397.9



LOCATION PLAN

SCALE:

100 0 100 200 300 Feet

NEW JOHNSONVILLE SITE

ISOMETRIC PROJECTION OF GEOLOGIC SECTIONS

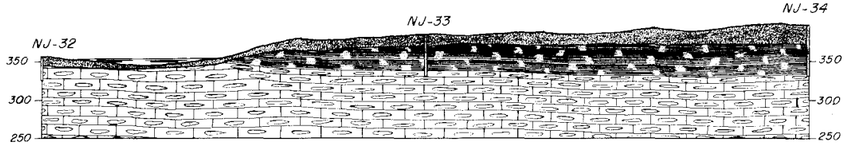
WESTERN AREA STEAM PLANT
TENNESSEE VALLEY AUTHORITY
WATER CONTROL PLANNING DEPARTMENT

SUBMITTED	RECOMMENDED	APPROVED
J. M. Kellberg		B. C. Moneymaker

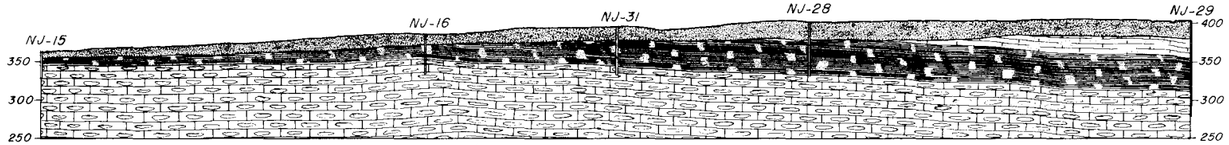
KNOXVILLE	9-29-47	30	GE	1	822N967

REV. NO.	DATE	MADE	CHKD	SUPV.	INSP.
DRWN.		COMPUTED			
TRCD		ENGINEER			
CHKD					

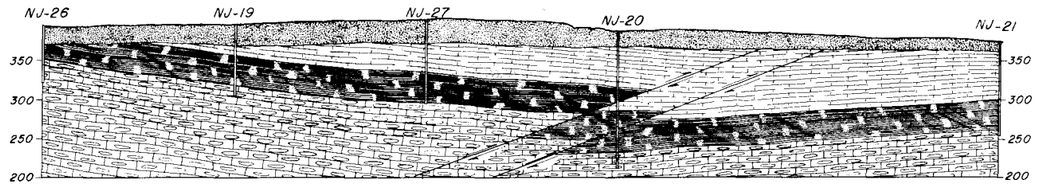
Exhibit 3



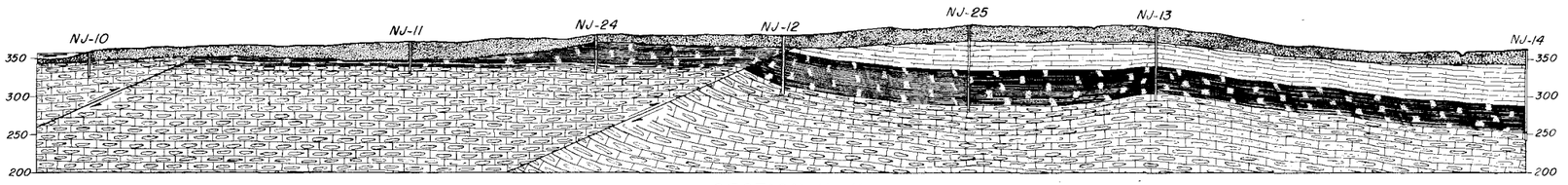
SECTION N-N



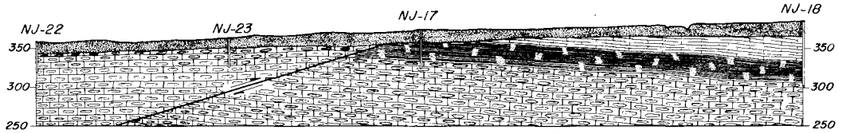
SECTION M-M



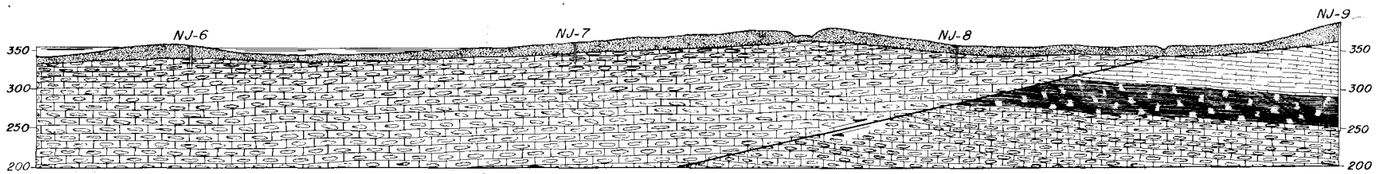
SECTION L-L



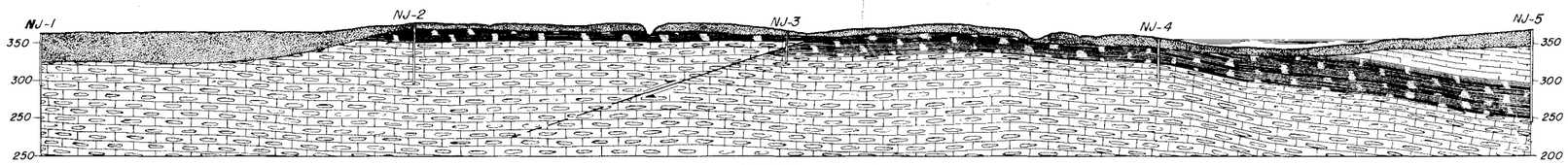
SECTION K-K



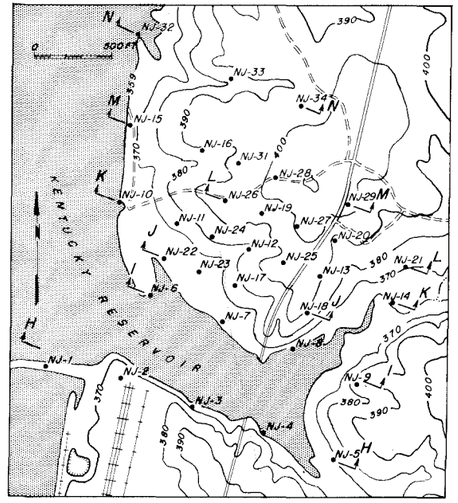
SECTION J-J



SECTION I-I



SECTION H-H



LOCATION PLAN

LEGEND:

- Terrace Deposits - Clay, sand, and gravel.
- Ridgetop Formation - Clay, shale, chert, and weathered limestone. Some shaly limestone near the base.
- Chattanooga Shale - Black, fissile, pyritiferous shale.
- Camden Chert - Blocks of hard, brittle, white novaculite separated by seams of gritty clay.

NOTE:

Companion drawings - 30 GE I 822 N 967
30 GE I 822 K 969

SCALE:

100 0 100 200 FEET

REV NO.	DATE	MADE	CHKD	SUPV	INSP
DRWN		COMPUTED			
TRCD		ENGINEER			
CHKD					

NEW JOHNSONVILLE SITE

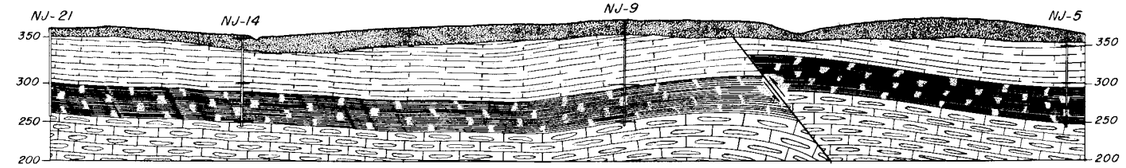
GEOLOGIC SECTIONS

(LOOKING NORTHEAST)

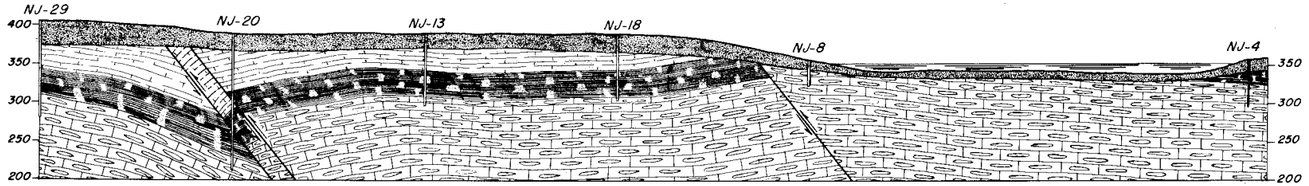
WESTERN AREA STEAM PLANT
TENNESSEE VALLEY AUTHORITY
WATER CONTROL PLANNING DEPARTMENT

SUBMITTED	RECOMMENDED	APPROVED
J. M. Kellberg		B. C. Moneymaker

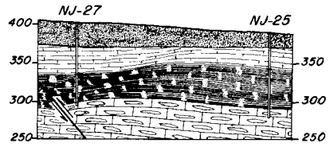
KNOXVILLE	10-6-47	30	GE	1	822 K968



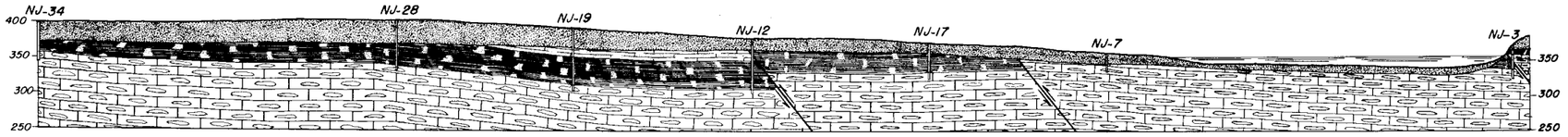
SECTION G-G



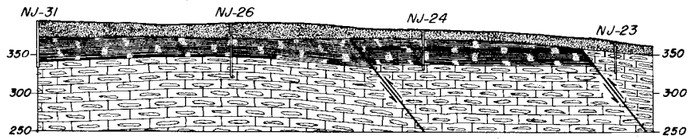
SECTION F-F



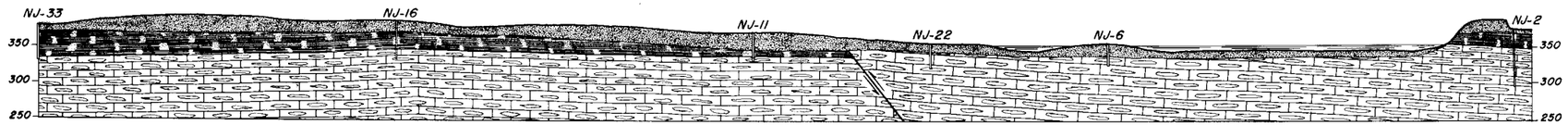
SECTION E-E



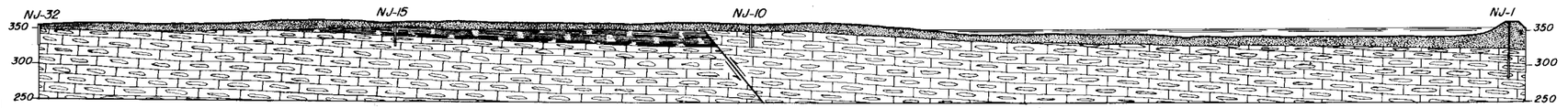
SECTION D-D



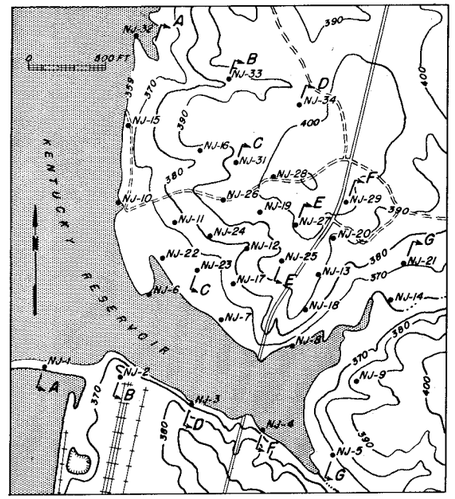
SECTION C-C



SECTION B-B



SECTION A-A



LOCATION PLAN

LEGEND:

- Terrace Deposits - Clay, sand, and gravel.
- Ridgetop Formation- Clay, shale, chert, and weathered limestone. Some shaly limestone near the base.
- Chattanooga Shale - Black, fissile, pyritiferous shale.
- Camden Chert - Blocks of hard, brittle, white novaculite separated by seams of gritty clay.

NOTE:
Companion drawings - 30 GE I 822 N 967
30 GE I 822 K 968

SCALE:

100 0 100 200 FEET

REV NO.	DATE	MADE	CHKD	SUPV	INSP
DRWN		COMPUTED			
TRCD		ENGINEER			
CHKD					

NEW JOHNSONVILLE SITE

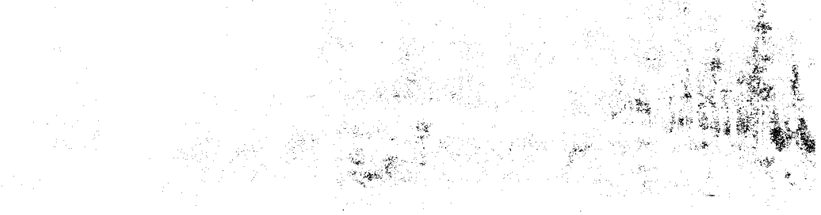
GEOLOGIC SECTIONS

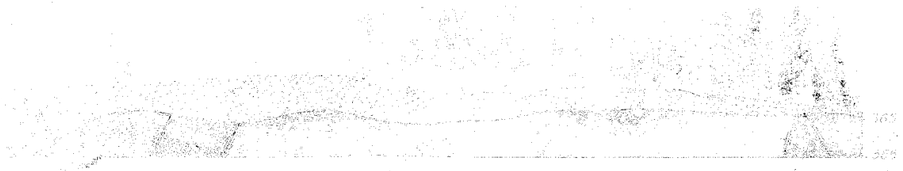
(LOOKING SOUTHEAST)

WESTERN AREA STEAM PLANT
TENNESSEE VALLEY AUTHORITY
WATER CONTROL PLANNING DEPARTMENT

SUBMITTED	RECOMMENDED	APPROVED
J.M Kellberg		B.C. Moneymaker

KNOXVILLE	10-17-47	30	GE	1	822 K 969





SCALE

NEW JOHNSONVILLE SITE

DETAILED GEOLOGIC SECTION ALONG SOUTH BANK OF EMBAYMENT

WESTERN AREA STEAM PLANT
TENNESSEE VALLEY AUTHORITY
OFFICE OF POWER, DIVISION OF

scrapers or bulldozers but the angularity and toughness of the chert fragments will cause wear on the excavating equipment similar to that caused by the Camden chert.

Physical Character of the Rocks

The rocks in the vicinity of the proposed plant, when unweathered, are strong enough to support any anticipated load. Although not as strong as the quartzites or the limestones and dolomites from the Valley of East Tennessee, they are sufficiently strong to support engineering structures if enough care is exercised in the preparation of the foundation.

Five representative samples of the drill cores--three samples of Chattanooga shale, and one each of the Camden chert and Ridgetop argillaceous limestone--were submitted to the Concrete Laboratory at Watauga Dam for compression tests. The following tabulation gives the results of the tests:

Sample	Size	Failure Load (pounds)	Corrected Load (pounds per square in.)	Manner of Failure
Chattanooga	2-1/8" x 2"	2593	2150	Shear.
Chattanooga	2-1/8" x 2"	3355	2800	Shear.
Chattanooga	2-1/8" x 2"	3890	3250	Shear.
Camden	2-1/8" x 2"	5356	4500	Vertical split along an incipient joint.
Ridgetop	1-5/8" x 2"	5257	5450	Shear, along a calcite vein.

Construction Materials

Concrete Aggregate--The most obvious source of aggregate for the steam plant is the alluvial gravels underlying the reservoir in the immediate vicinity of the site. There is already commercial production of this material at New Johnsonville; however, as the material produced consists practically entirely of residual chert from the Warsaw, St. Louis, Fort Payne, and Camden formations, it is not believed that it would meet the prescribed standards and specifications established by the Inspection and Testing Division.

The Warsaw and St. Louis limestones are the only formations in the area which will produce aggregate that will unquestionably meet the prescribed standards. These formations underlie the high ridges eight to ten miles back from the edge of the eastern bank of the river.

An underground quarry is operated by the Franklin Limestone Company of Nashville in the Warsaw and St. Louis formations 3 miles east of Waverly, 17 miles from the site. The plant is located on U. S. Highway 70 and the N. C. & St. L. Railroad and will produce aggregate of any desired size. This plant, however, is not equipped to produce riprap material.

Riprap Material--No material at the site is suitable for riprap. The most feasible site for obtaining this, from the standpoint of material alone, is one of the many bluffs along the river between Perryville and Gilbertsville; barging of the rock would, of course, be possible. In the vicinity of Perryville there are bluffs of moderate height along the river bank. The rocks in these bluffs are thinly bedded limestones, cherts, and

shales. The quarrying conditions are not ideal and the rock is not of the best quality, but it might be used if other factors make it desirable. Some high bluffs of Fort Payne cherty limestone occur in the Pine Bluff area of the Kentucky Reservoir (mile 54.4). The cherty limestone would make good riprap, but it might not be suitable for aggregate. Large quantities of rock of riprap quality are available at the Kentucky Dam Quarry and the near-by Diamond Quarry site. The rock here is light gray, oolitic, crystalline limestone of the Warsaw formation. All of these sites are situated so that transportation by barges would be possible.

SUMMARY AND CONCLUSIONS

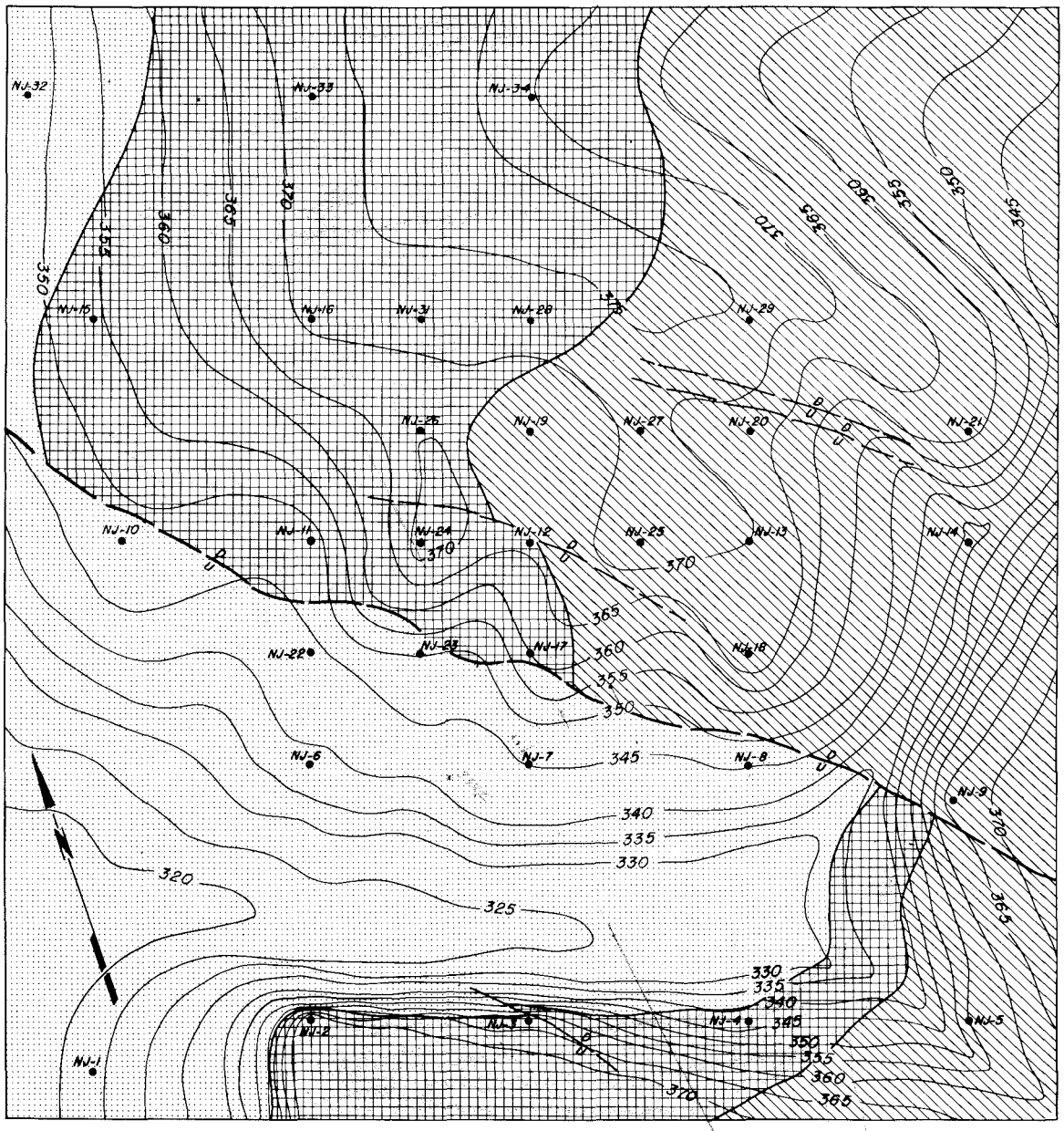
The preliminary drilling program has indicated that satisfactory foundation conditions for the loads intended are to be found at the required elevations at the site if proper care is exercised in the preparation of the foundation. It is recommended that future drilling in areas of critical loading be done on relatively close centers to determine the details of the geologic structure and the condition of the foundation. The preliminary investigation also has shown that suitable supplies of aggregate and riprap are not available at the site but will have to be obtained elsewhere and transported to the plant.

ACKNOWLEDGMENTS

All geologic work connected with the preliminary investigation of the New Johnsonville site was done by the writer under the direct supervision of Berlen C. Moneymaker, Chief Geologist, and the general supervision of James S. Bowman, Chief Water Control Planning Engineer.

EXHIBITS

Exhibit 6



LEGEND:

- Ridgetop Formation.
- Chattanooga Shale.
- Camden Chert.
- D/U — Thrust Fault — D - Downthrown Block; U - Upthrown Block

NOTE:

Contours interpreted from drill hole data. Entire area is blanketed by Tertiary terrace deposits consisting of sand, clay, and gravel.

SCALE:

200 0 200 400 FEET

REV NO.	DATE	MADE	CHKD	SUPV	INSP

DRWN ____ COMPUTED

TRCD ____ ENGINEER

CHKD ____

NEW JOHNSONVILLE SITE

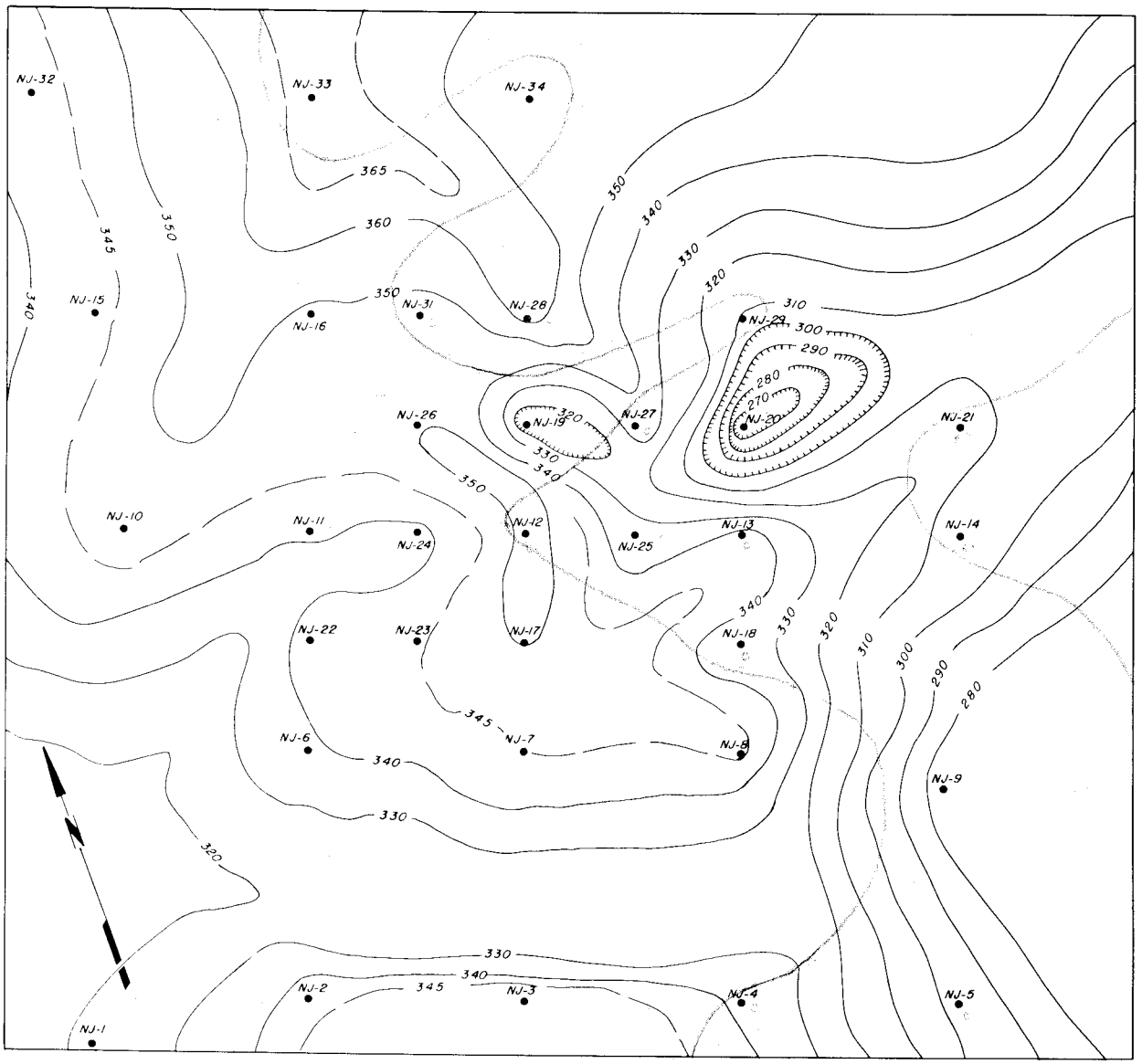
AREAL GEOLOGY

CONTOURS ON TOP OF ROCK

WESTERN AREA STEAM PLANT
TENNESSEE VALLEY AUTHORITY
WATER CONTROL PLANNING DEPARTMENT

SUBMITTED	RECOMMENDED	APPROVED
J. M. Kellberg		B. C. Moneymaker

KNOXVILLE	10-27-47	30	GE	1	820 G 62



NOTES

Contour interval ten feet

365 and 345 foot contours shown by dashed lines

Contours are based on data from drill holes spaced on relatively wide centers. Future drilling on closer centers will most certainly modify the present interpretation.

SCALE

200 0 200 400 FEET

REV NO.	DATE	MADE	CHKD	SUPV	INSP

DRWN COMPUTED

TRCD ENGINEER

CHKD

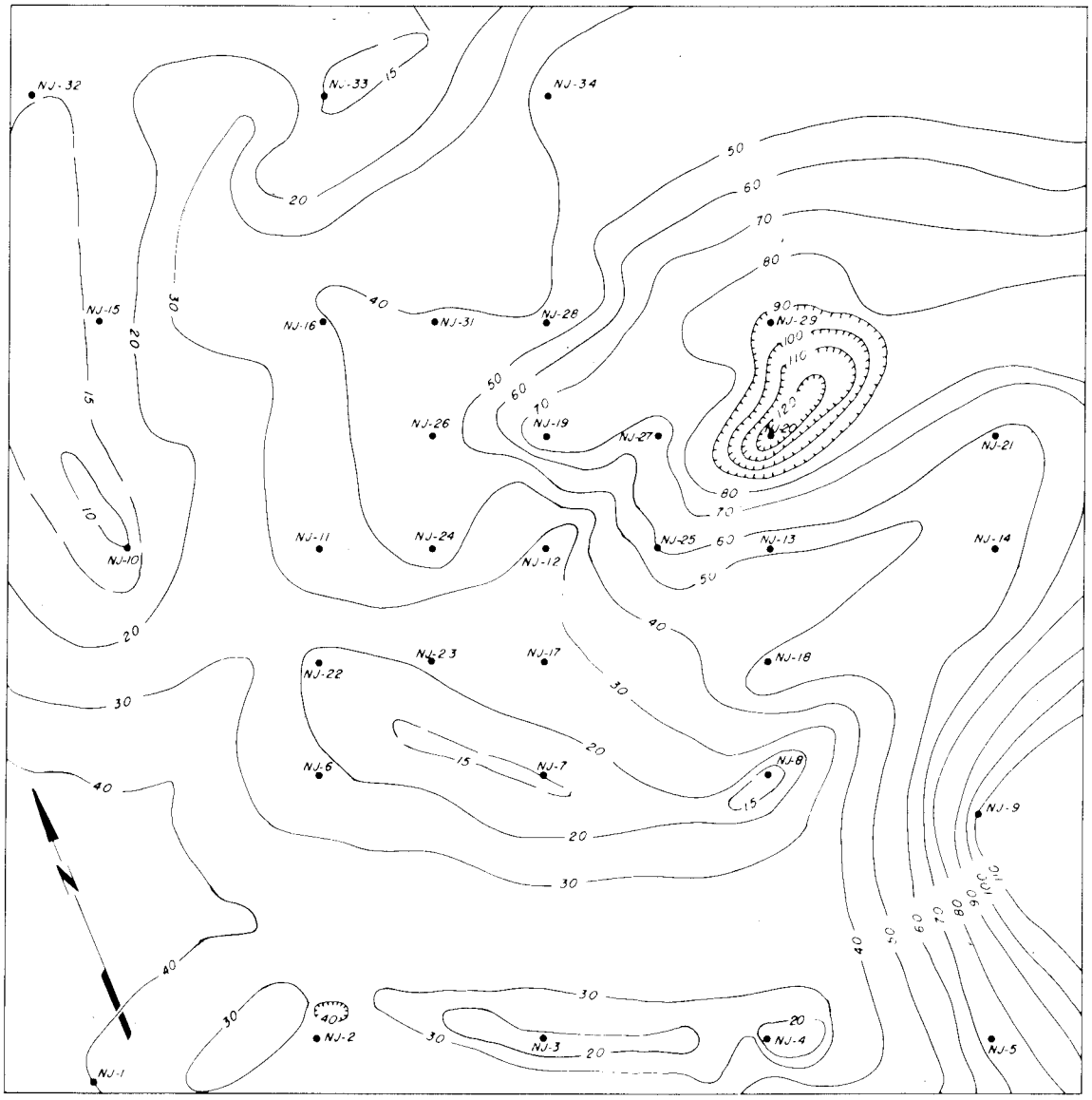
NEW JOHNSONVILLE SITE

CONTOUR MAP OF EXPECTED FOUNDATION GRADE

WESTERN AREA STEAM PLANT
TENNESSEE VALLEY AUTHORITY
WATER CONTROL PLANNING DEPARTMENT

SUBMITTED	RECOMMENDED	APPROVED
J.M. Kellberg		B.C. Moneymaker

KNOXVILLE	11-4-47	30	GE	1	820 G 63



NOTES

10 foot isopach interval

15 foot isopach shown by dashed line

Isopachs are contours connecting points of equal depth from the ground surface to estimated foundation grade These isopachs are interpreted from widely spaced drill holes Future drilling on closer centers will undoubtedly change the interpretation

SCALE

200 0 200 400 FEET

REV NO.	DATE	MADE	CHKD	SUPV	INSP

DRWN COMPUTED

TRCD ENGINEER

CHKD

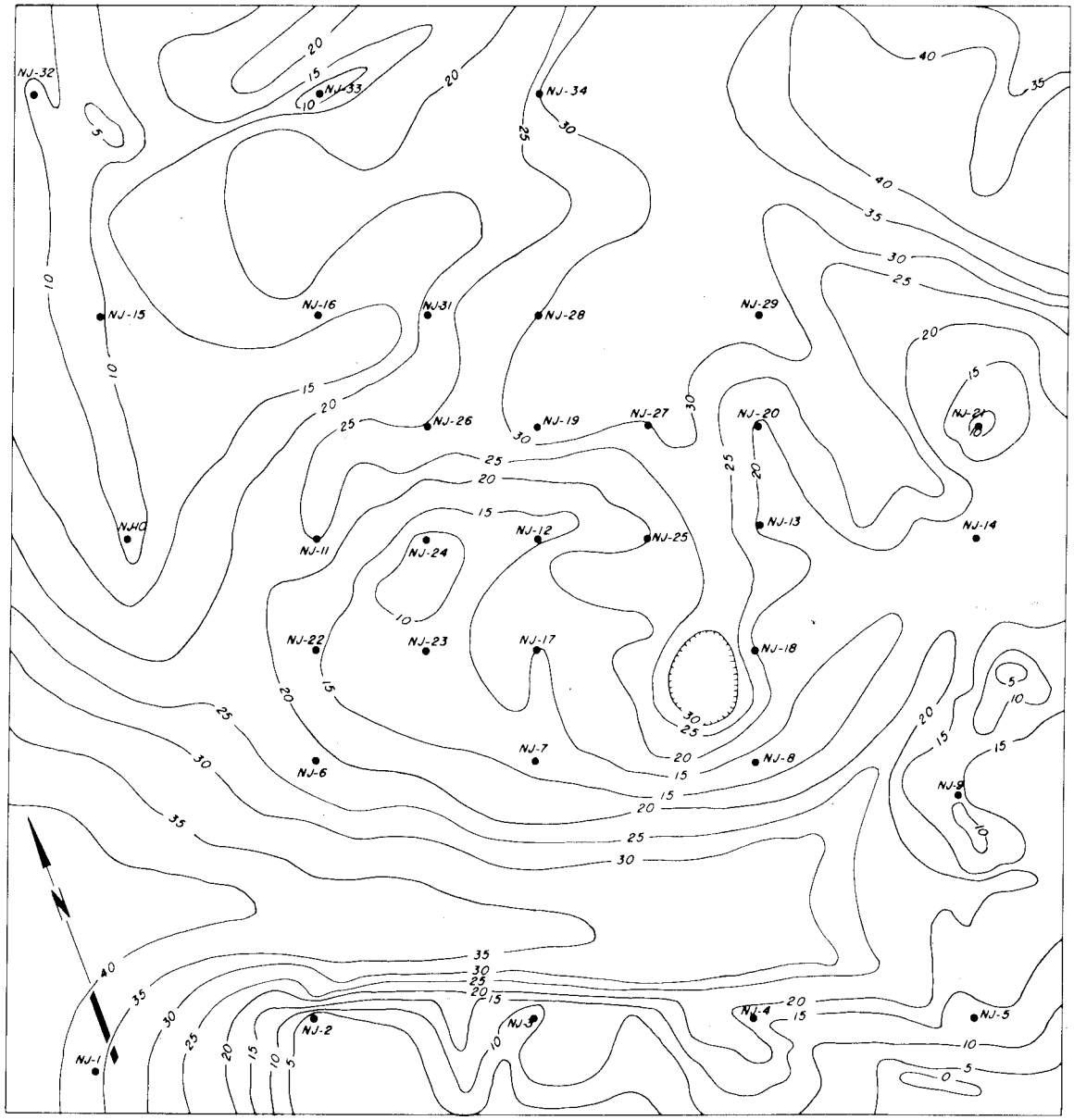
NEW JOHNSONVILLE SITE

ISOPACH MAP BETWEEN SURFACE AND FOUNDATION GRADE

WESTERN AREA STEAM PLANT
TENNESSEE VALLEY AUTHORITY
WATER CONTROL PLANNING DEPARTMENT

SUBMITTED	RECOMMENDED	APPROVED
J M Kellberg		B C Moneymaker

KNOXVILLE	11-5-47	30	GE	1	820 G 64



NOTES

5 foot isopach interval

Isopachs are contours connecting points of equal depth from the ground surface to estimated top of rock. These isopachs are interpreted from widely spaced drill holes. Future drilling on closer centers will undoubtedly change the interpretation.

SCALE:

200 0 200 400 FEET

REV NO.	DATE	MADE	CHKD	SUPV	INSP
DRWN		COMPUTED			
TRCD		ENGINEER			
CHKD					

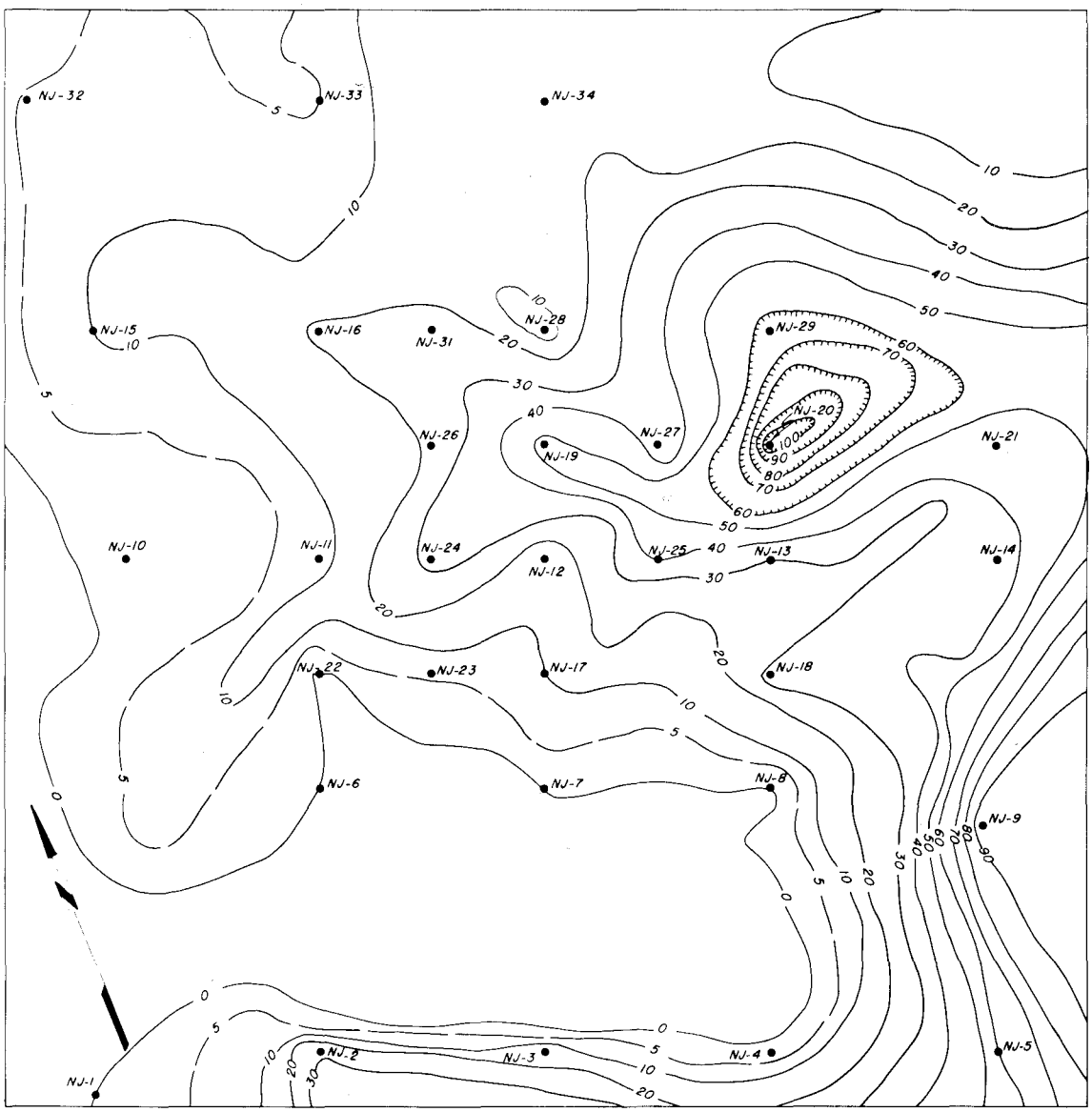
NEW JOHNSONVILLE SITE

ISOPACH MAP BETWEEN SURFACE AND TOP OF ROCK

WESTERN AREA STEAM PLANT
TENNESSEE VALLEY AUTHORITY
WATER CONTROL PLANNING DEPARTMENT

SUBMITTED	RECOMMENDED	APPROVED
J.M. Kellberg		B.C. Moneymaker

KNOXVILLE	11-7-47	30	GE	1	820 G 65



NOTES:

10 foot isopach interval.

5 foot isopach shown by dashed line.

Isopachs are contours connecting points of equal depth from the top of rock to estimated foundation grade. These isopachs are interpreted from widely spaced drill holes. Future drilling on closer centers will undoubtedly change the interpretation.

SCALE

200 0 200 400 FEET

REV NO.	DATE	MADE	CHKD	SUPV	INSP

DRWN. COMPUTED

TRCD. ENGINEER

CHKD

NEW JOHNSONVILLE SITE

ISOPACH MAP

BETWEEN TOP OF ROCK AND FOUNDATION GRADE

WESTERN AREA STEAM PLANT
TENNESSEE VALLEY AUTHORITY
WATER CONTROL PLANNING DEPARTMENT

SUBMITTED	RECOMMENDED	APPROVED
J. M. Kellberg		B. C. Moneymaker

KNOXVILLE	11-13-47	30	GE	1	820 G 66