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Geology of the 241-B Tank Farm

April 1976

W. H. Price

K. R. Fecht

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Environmental Engineering Section
Research Department
Research and Engineering Division

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and Development Administration
Under Contract E(45-1)-2130

Atlantic Richfield Hanford Company
Richland, Washington 99352

ARH-LD-129

GEOLOGY OF THE 241-B TANK FARM

by

W. H. Price
K. R. Fecht

Environmental Engineering Section
Research Department
Research and Engineering Division

April 1976

ATLANTIC RICHFIELD HANFORD COMPANY
RICHLAND, WASHINGTON 99352

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INTRODUCTION

A series of maps have been compiled to document the structure and stratigraphy of the sediments underlying the high-level radioactive waste storage tank farms located within the Energy Research and Development Administration Hanford Reservation. The primary purpose of these maps is to provide basic geologic information to be utilized to evaluate the impact of suspected and confirmed tank leaks. For convenience of usage map sets for each tank farm have been published in separate document packets (see Table I). The contents of this packet (see Table II) contain maps compiled only for the 241-B Tank Farm.

TABLE I

TANK FARM GEOLOGY DOCUMENTS AVAILABLE
AS OF APRIL, 1976*

Title	Document Number
Geology of the 241-A Tank Farm	ARH-LD-127
Geology of the 241-AX Tank Farm	ARH-LD-128
Geology of the 241-B Tank Farm	ARH-LD-129
Geology of the 241-BX Tank Farm	ARH-LD-130
Geology of the 241-BY Tank Farm	ARH-LD-131
Geology of the 241-C Tank Farm	ARH-LD-132
Geology of the 241-S Tank Farm	ARH-LD-133
Geology of the 241-SX Tank Farm	ARH-LD-134
Geology of the 241-T Tank Farm	ARH-LD-135
Geology of the 241-TX Tank Farm	ARH-LD-136
Geology of the 241-TY Tank Farm	ARH-LD-137
Geology of the 241-U Tank Farm	ARH-LD-138
Generalized Geology of the 241-SY Tank Farm	ARH-LD-139

*Additional documents will be completed as new tank farms are built and well monitoring networks installed.

TABLE II

241-B TANK FARM GEOLOGY MAPS

Title	Drawing Number
241-B Tank Farm Geologic Map Legend and Plot Plan	H-2-38980
241-B Tank Farm Geologic Characterization Cross Section A-A'	H-2-70476
241-B Tank Farm Geologic Characterization Cross Section B-B'	H-2-70477
241-B Tank Farm Geologic Characterization Cross Section C-C'	H-2-70478
241-B Tank Farm Geologic Characterization Cross Section D-D'	H-2-70479
241-B Tank Farm Geologic Characterization Cross Section E-E'	H-2-70480
241-B Tank Farm Geologic Characterization Cross Section F-F'	H-2-70481
241-B Tank Farm Geologic Characterization Cross Section G-G'	H-2-70482
241-B Tank Farm Geologic Characterization Cross Section H-H'	H-2-70483
241-B Tank Farm Geologic Characterization Cross Section I-I'	H-2-70484
241-B Tank Farm Geologic Characterization Cross Section J-J'	H-2-70475

PROCEDURES

During the drilling of 27 dry wells and 3 water wells in and around the 241-B Tank Farm, sediment samples were collected from one to 5-foot depth intervals. Information utilized to prepare this series of maps was obtained by the analysis of these samples, numbering approximately 650.

Each sediment sample was quantitatively analyzed according to grain size and $CaCO_3$ content. Size analysis was carried out utilizing a nest of 9 sieves selected for coincidence with the Wentworth (1922) grain size nomenclature (see H-2-38980). The $CaCO_3$ content of each sample was determined utilizing a semiquantitative CO_2 displacement method (Horwitz, 1970). Size and $CaCO_3$ data was input into the Rocksan Computer Program (Parr, 1974) which categorized each sediment sample into 1 of 19 classes (classification scheme modified after Folk, 1968; see H-2-38980. After analysis, each sample was visually examined to aid in further characterization. Each sample was subsequently stored in the Hanford Well Library for future reference.

For convenience of usage, the geologic maps were prepared at the same scale (1" = 16') as drawing H-2-36938 (Wells in 241-B Farm As-built). Steps outlining the preparation of the maps are listed in Figure 1.

GENERALIZED GEOLOGY

Included within this section is a brief discussion of the geology underlying the 241-B Tank Farm. The stratigraphic descriptions included, along with the Glossary (see page 10), are designed only to provide sufficient information to permit a general understanding of the Tank Farm maps presented. For a more detailed discussion of the regional geologic setting of the 241-T Tank Farm, the reader is referred to articles listed in the Selected References (see page 12).

The 241-B Tank Farm is underlain by four major stratigraphic units (see Figure 2); (1) basalt of the Columbia River Group which forms the bedrock beneath the area; (2) semiconsolidated sediments of the Ringold Formation which directly overlie the bedrock; (3) unconsolidated eolian silt; and (4) unconsolidated sand, silt, and gravel, collectively termed glaciofluvial sediments, which directly overlie the eolian silt. A more detailed description of the character of these units underlying the Tank Farm follows.

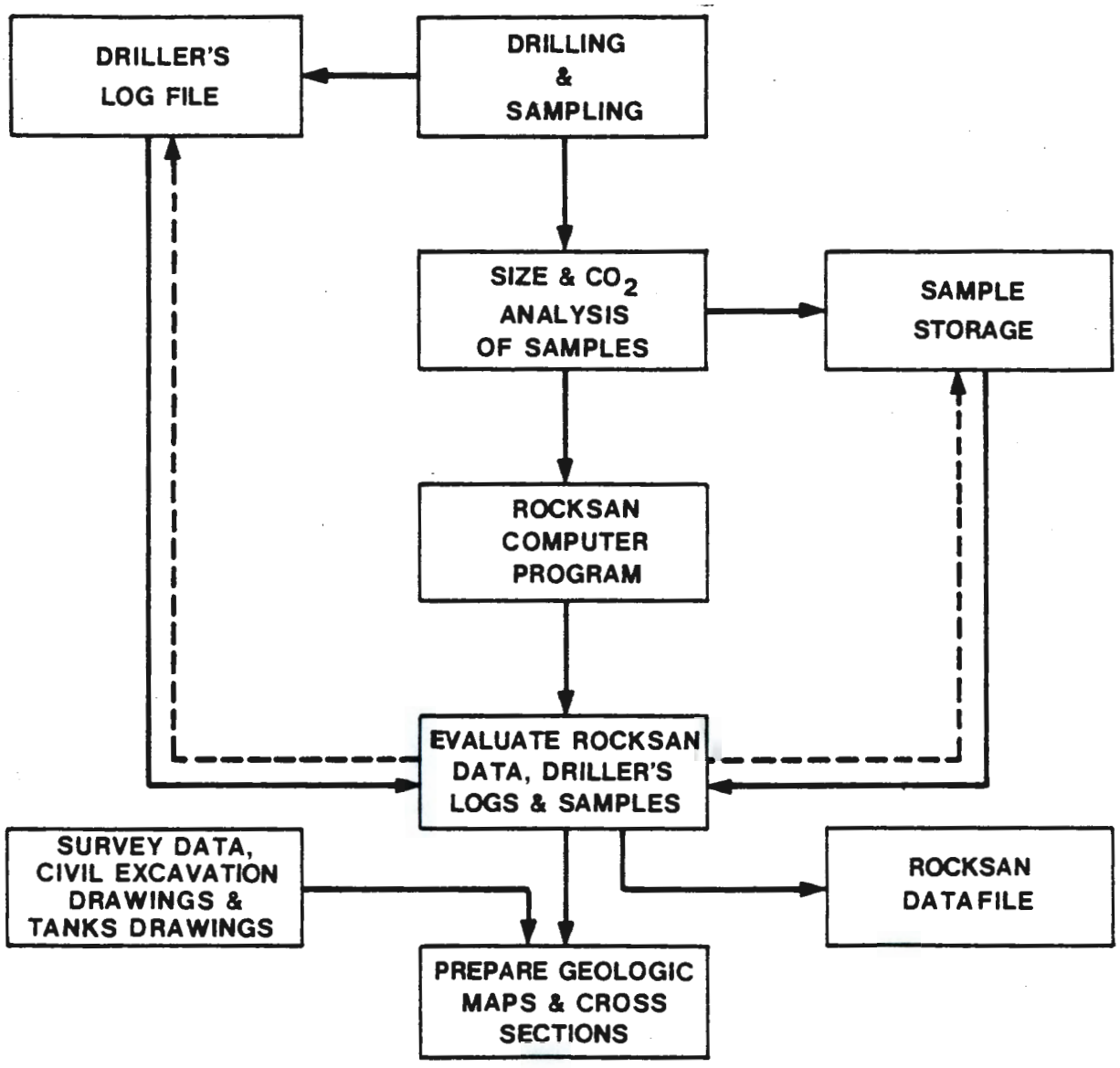

FIGURE 1

STEPS OUTLINING THE PREPARATION OF TANK FARM GEOLOGY MAPS

ERA	PERIOD	EPOCH	YEARS B. P.	STRATIGRAPHIC NAME AND/OR UNIT		LITHOLOGY DESCRIPTION
CENOZOIC	QUATERNARY	MODERN	30	BACKFILL		VERY POORLY SORTED GRAVEL, SAND & SILT
		PLEISTOCENE		GLACIOFLUVIAL SEDIMENTS		FAIRLY WELL SORTED FLUVIAL SAND & SILT WITH SOME GRAVEL
				EOLIAN SILT		FINE SAND & SILT DERIVED FROM THE UPPER RINGOLD
	TERTIARY	PLIOCENE	1,000,000	RINGOLD FORMATION	UPPER RINGOLD	WELL SORTED FLUVIAL OR LACUSTRINE SILT & SAND WITH SOME CALCAREOUS LAYERS
					MIDDLE RINGOLD	FLUVIAL GRAVEL & SAND VARIABLY CEMENTED WITH CALCIUM CARBONATE & SILICA
		MIOCENE	11,000,000	COLUMBIA RIVER BASALT GROUP	ELEPHANT MOUNTAIN MEMBER	DENSE BLACK EXTRUSIVE IGNEOUS ROCK, MICRO VESICULAR, BRICK BAT ENTABULATURE & NO COLUMNADE
					RATTLESNAKE RIDGE MEMBER	TUFFACEOUS SANDSTONE
					POMONA MEMBER	DENSE BLACK EXTRUSIVE IGNEOUS ROCK, SCATTERED OLIVINE PHENOCRYSTS, UPPER & SOMETIMES BASAL ENTABLATURE WELL DEVELOPED, FAN JOINTING IN COLUMNADE

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FIGURE 2

GENERALIZED STRATIGRAPHIC COLUMN FOR
THE 200 AREA TANK FARMS

COLUMBIA RIVER BASALT GROUP

About 20 million years ago a series of fissures opened around the periphery of the subsiding Pasco Basin and large volumes of basaltic lava poured out over the land surface. The highly fluid lava was extruded intermittently from these fissures until approximately 8 million years ago. At the cessation of Columbia River Basalt volcanism, the basin had been filled with more than 12,000 feet of basalt.

The surface of the Columbia River Basalt lies beneath 241-B Tank Farm at an elevation of 366 feet (all elevations based on feet above mean sea level measured at approximate center of Tank Farm).

RINGOLD FORMATION

Following the cessation of Columbia River Basalt volcanism the ancestral Columbia River transported sediments from the surrounding highlands into the Pasco Basin where they accumulated to form the Ringold Formation. Beneath the Hanford Reservation, this formation is up to 1200 feet thick and can generally be divided into three units on the basis of lithology; the clays and silts of the lower Ringold unit; the pebbles and cobbles of the middle Ringold unit; and the silts and fine sands of the upper Ringold unit.

Within the region beneath 241-B Tank Farm, the lower and upper Ringold units are missing. The total thickness of the middle Ringold unit present is approximately 26 feet.

Middle Ringold

Beneath the 241-B Tank Farm, middle Ringold unit lies unconformably on the Columbia River Basalt and dips about one degree to the southeast. The unit consists predominantly of well-rounded pebbles and cobbles with the interstitial spaces filled with very coarse to coarse sand. Table III summarizes the grain size and $CaCO_3$ values of the middle Ringold sediments.

TABLE III

TYPICAL SIEVE AND CALCIUM CARBONATE VALUES FOR MIDDLE RINGOLD LITHOLOGY BENEATH 241-B TANK FARM

Lithology	%Pebbles & Cobbles	% Sand					%Silt & Clay	%$CaCO_3$
		Very Coarse	Coarse	Medium	Fine	Very Fine		
Silty Sandy Coarse to Very Fine Pebble to Pebbly Silty Very Coarse to Coarse Sand	32	23	17	10	6	4	8	0.6

EOLIAN SILT DEPOSIT

After deposition of the Ringold Formation, the surface of the land was subjected to subaerial erosion. Wind action winnowed, reworked, and redeposited the fine grained sands and silts of the nearby upper Ringold unit. These wind-deposited sediments, termed Early Palouse soil or eolian silt, occur beneath the 241-B Tank Farm between elevations 392 and 432 feet. Table IV summarizes the grain size and $CaCO_3$ content of the eolian silt.

TABLE IV

TYPICAL SIEVE AND CALCIUM CARBONATE VALUES FOR EOLIAN SILT LITHOLOGY BENEATH 241-B TANK FARM

Lithology	%Pebbles & Cobbles	% Sand					%Silt & Clay	%$CaCO_3$
		Very Coarse	Coarse	Medium	Fine	Very Fine		
Silty Very Fine Sand to Sandy Silt	0	2	3	3	4	40	48	20

GLACIOFLUVIAL DEPOSITS

During the close of the Ice Age, approximately 20,000 years ago, a continental ice sheet covered much of northern Washington. As the ice sheet retreated northward, the breakup of ice dams resulted in catastrophic floods in which large volumes of glacial meltwater were released. During one of these floods, over 500 cubic miles of water is estimated to have poured into the Pasco Basin at a rate of more than 9 cubic miles of water

per hour. Sediments deposited within the basin by such flooding now comprise the glaciofluvial unit. The characteristic variability of sediment size and degree of sorting within this unit can be attributed to changes in water velocity and water level which occurred during the flooding process.

Glaciofluvial deposits are found beneath the 241-B Tank Farm between elevations 432 and 614 feet. The 182-foot thick section of these deposits consists predominently of very coarse to medium sand with some silt and pebbles. Table V summarizes the grain size and $CaCO_3$ values of the glaciofluvial sediments.

TABLE V

TYPICAL SIEVE AND CALCIUM CARBONATE VALUES FOR MAJOR GLACIOFLUVIAL LITHOLOGIES BENEATH 241-B TANK FARM

		% Sand						
Lithology	%Pebbles & Cobbles	Very Coarse	Coarse	Medium	Fine	Very Fine	%Silt & Clay	%$CaCO_3$
Slightly Pebbly Very Coarse to Coarse Sand to Very Coarse to Coarse Sand	6	35	31	10	4	3	4	1.3
Slightly Silty Very Coarse to Coarse Sand to Slightly Pebbly Slightly Silty Very Coarse to Coarse Sand	5	31	22	16	11	5	10	1.4

CLASTIC DIKES

Throughout the Pasco Basin, clastic dikes are found cross-cutting the Ringold Formation and glaciofluvial sediments. These dikes, which range from a few inches to several feet in width, are known to exist to depths of more than 100 feet below the ground surface. Generally, the dikes are composed of fine silts to coarse sands. The origin of the clastic dikes is still in refute and will not be discussed here (see Selected References).

Identification of clastic dikes by drilling is difficult and although some dikes were detected in the 241-B Tank Farm, they could not be mapped.

BACKFILL MATERIAL

In preparation for tank construction, glaciofluvial material was excavated at the 241-B Tank Farm site. This material, consisting predominantly of cobbles, pebbles, and very coarse to medium sands with some silt, was subsequently used as backfill from the base of the completed tanks (614 feet) to the ground surface (653 feet). An inherent characteristic of the backfill is its poor sorting. Grain size and $CaCO_3$ values for the backfill are found in Table VI.

TABLE VI

TYPICAL SIEVE AND CALCIUM CARBONATE VALUES FOR BACKFILL LITHOLOGY BENEATH 241-B TANK FARM

		% Sand						
Lithology	%Pebbles & Cobbles	Very Coarse	Coarse	Medium	Fine	Very Fine	%Silt & Clay	$\%CaCO_3$
Silty Sandy Gravel to Sandy Gravel	49	16	12	9	4	3	7	1.3

WATER TABLE

The water table beneath the 241-B Tank Farm is located within the middle Ringold unit at an elevation of 403 feet, 211 feet below the base of the tanks. For further information concerning contours on the water table beneath 200 East Area the reader is referred to drawings H-2-38398 (200 East Area Water Table Map) and H-2-38399 (200 East Area Depth to Water Map).

GLOSSARY

Basalt. Fine-grained, dark-colored, extrusive igneous rock.

Calcareous. Containing calcium carbonate.

Caliche. Gravel, sand, or silt cemented by calcium carbonate.

Cement. Chemically precipitated material occurring in the interstices between particles of gravel, sand, or silt.

Clastic. A textural term applied to rocks composed of fragmental material derived from pre-existing rocks.

Clastic dike. A tabular body of clastic material transecting the bedding of a sedimentary formation, representing extraneous material that has invaded the containing formation along a crack.

Dip. The angle at which a stratum or any planar feature is inclined from the horizontal.

Eolian. A formation formed by, or deposited from, the wind or currents of air.

Fluvial. Produced by the action of a river or stream.

Formation. The ordinary unit of geologic mapping consisting of a large and persistent stratum of some one kind of rock.

Glaciofluvial. Pertaining to streams flowing from glaciers or to the deposits made by such streams.

Grain. The particles or discrete crystals which comprise a rock or sediment.

Group. A local or provincial subdivision of a series, based on lithologic features and contains two or more formations.

Lacustrine. A formation deposited in a lake environment.

Lava. Fluid rock such as that which issues from a volcano or a fissure in the earth's surface and the same material solidified by cooling.

Lithology. The description of rocks or sediments on the basis of such characteristics as color, minerologic composition and grain size.

Sediment. Descriptive term for gravel, sand, and silt transported from their sources and deposited by air, water, or ice.

Sieve. A utensil having many small perforated openings, used to separate fine particles from coarser ones.

Siliceous. Containing silica.

Silt. Fine grained material between sand and clay in size.

Sorting. The grain size range of the sediments.

Stratigraphy. The part of descriptive geology of an area that pertains to the discrimination, character, thickness, sequence, age and correlation of the sediments and rocks of the area.

Subaerial. Formed, existing, or taking place on the land surface.

Unconformity. A surface of erosion or nondeposition that separates younger strata from older strata.

Water table. The upper surface of a zone of saturation except where that surface is formed by an impermeable body.

Winnowing. Separation of fine particles from coarser ones by wind action.

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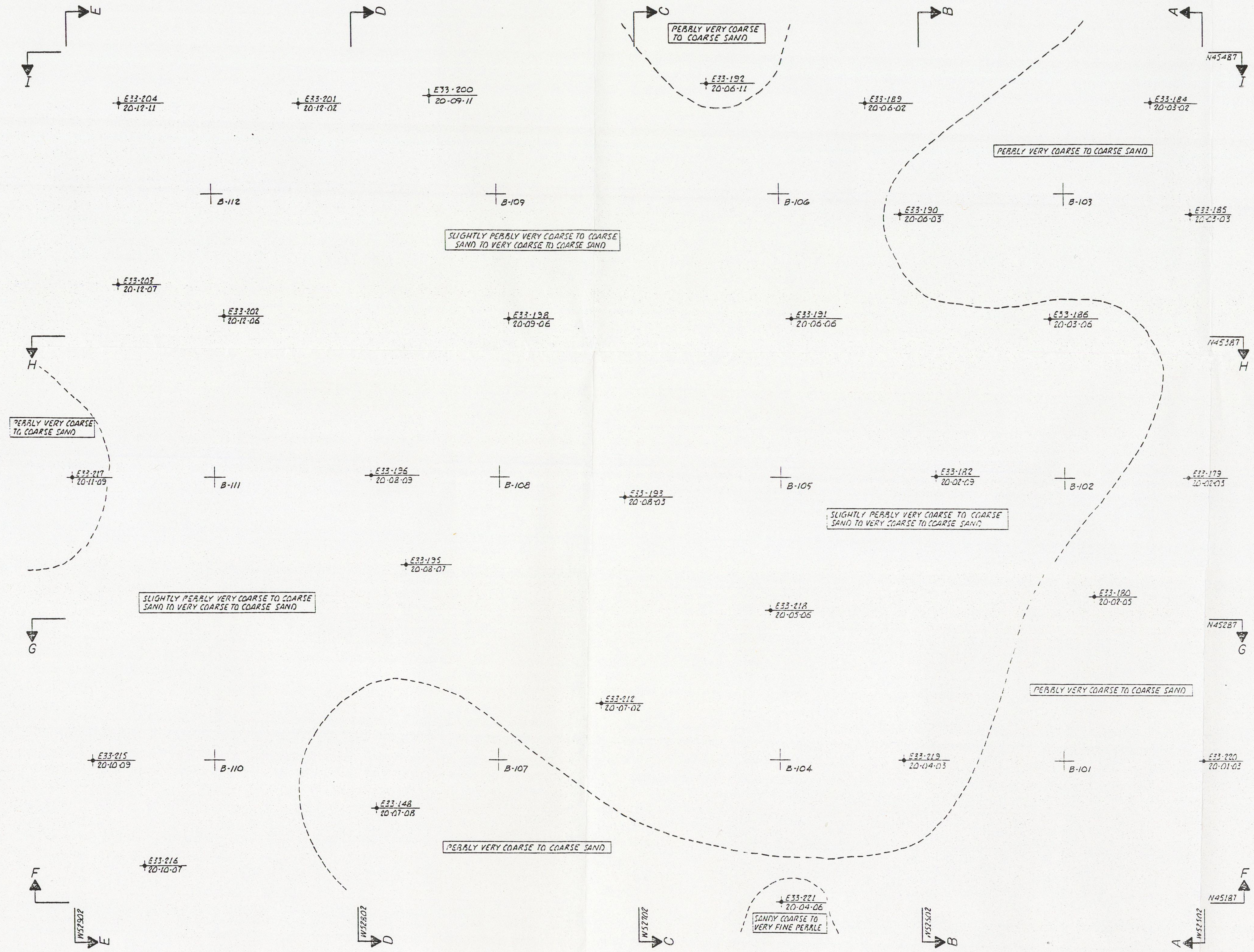

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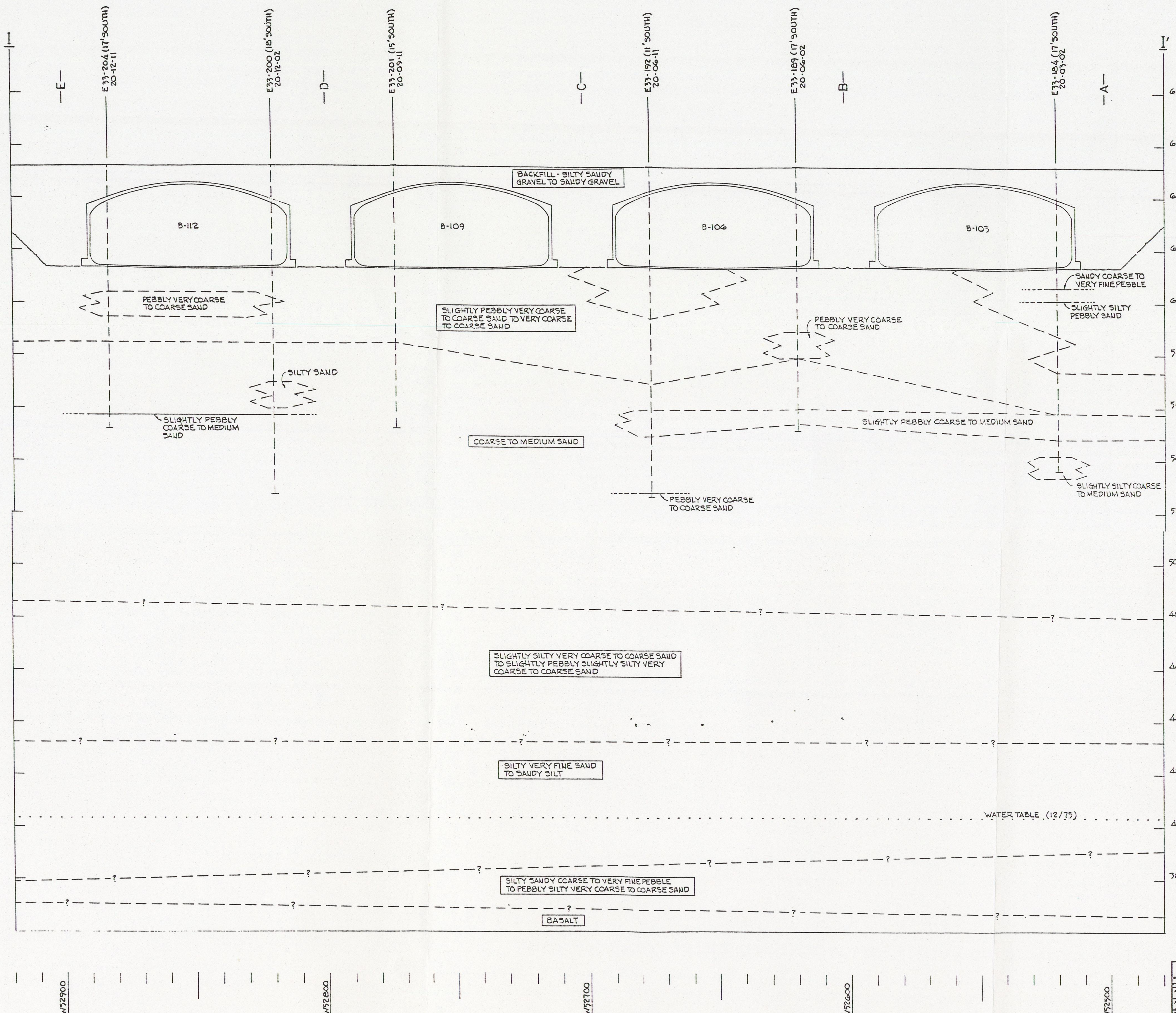

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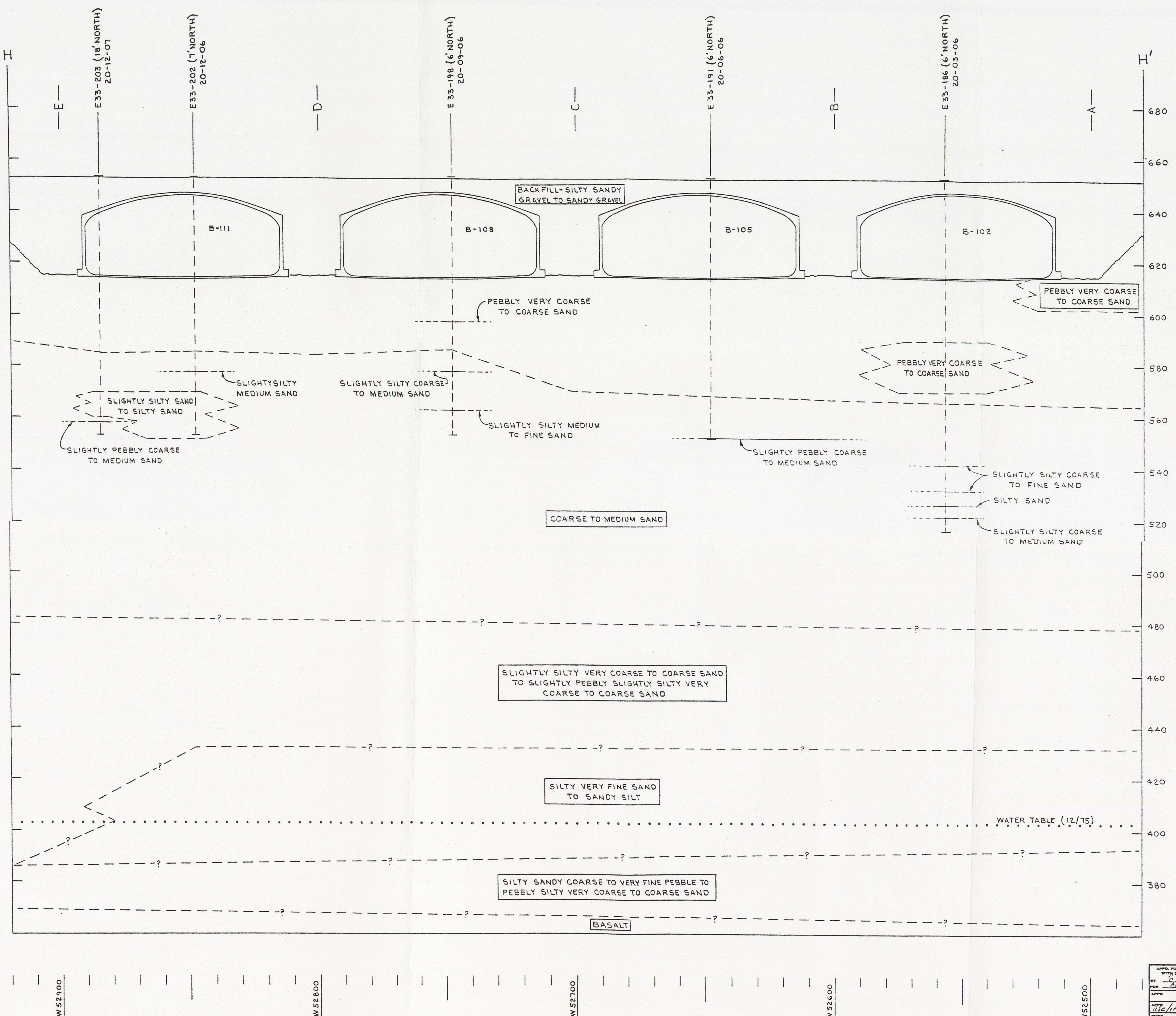

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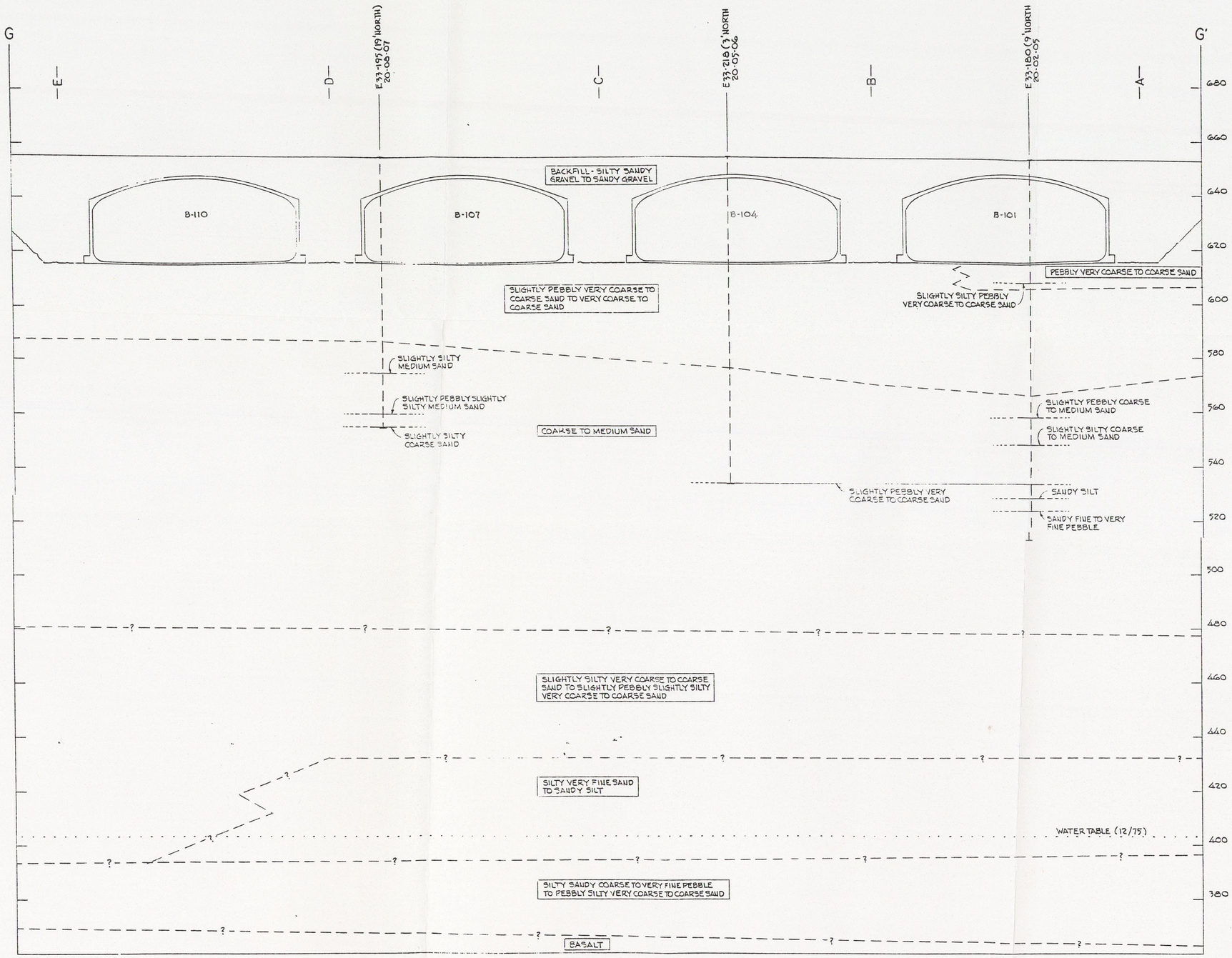

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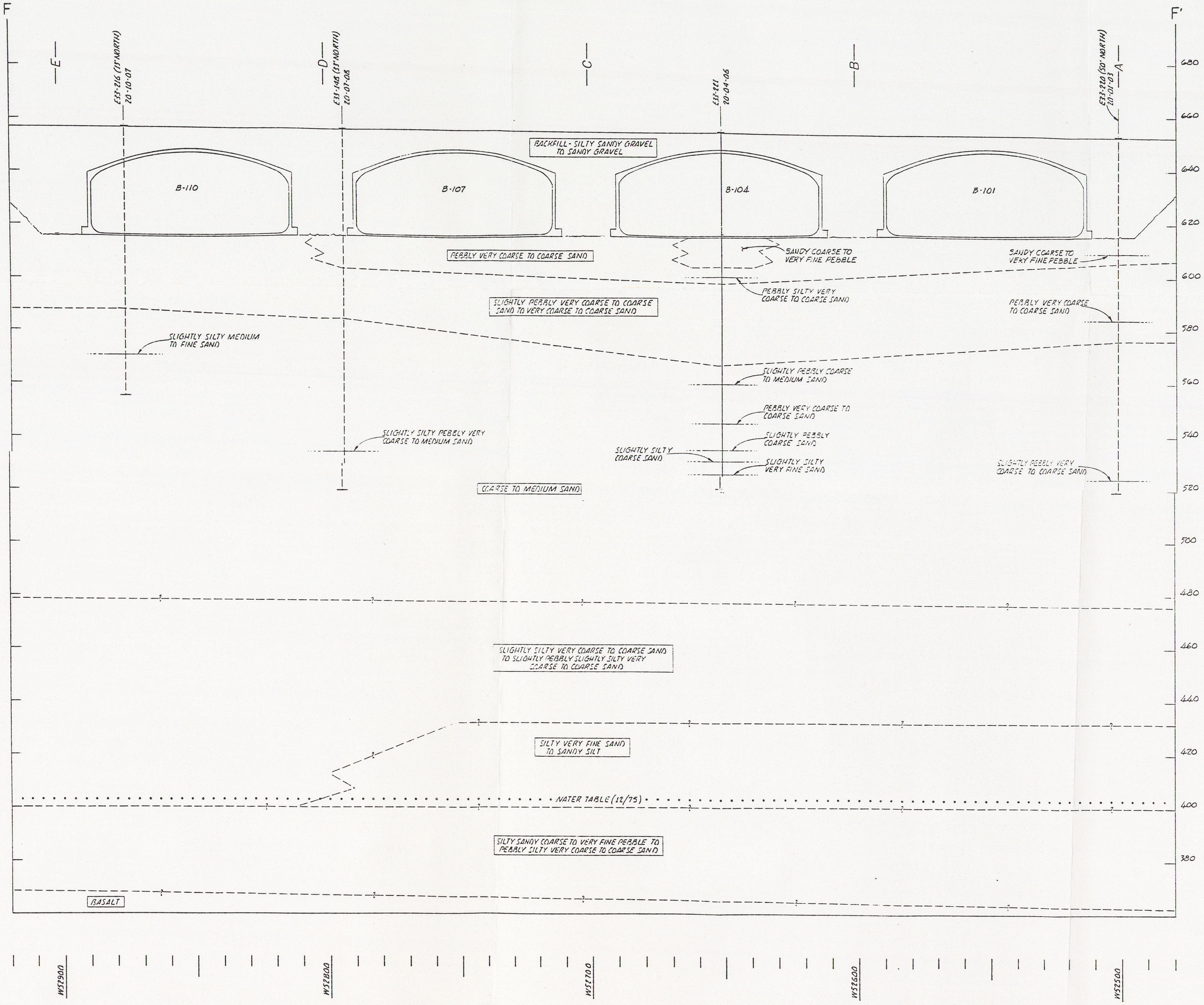

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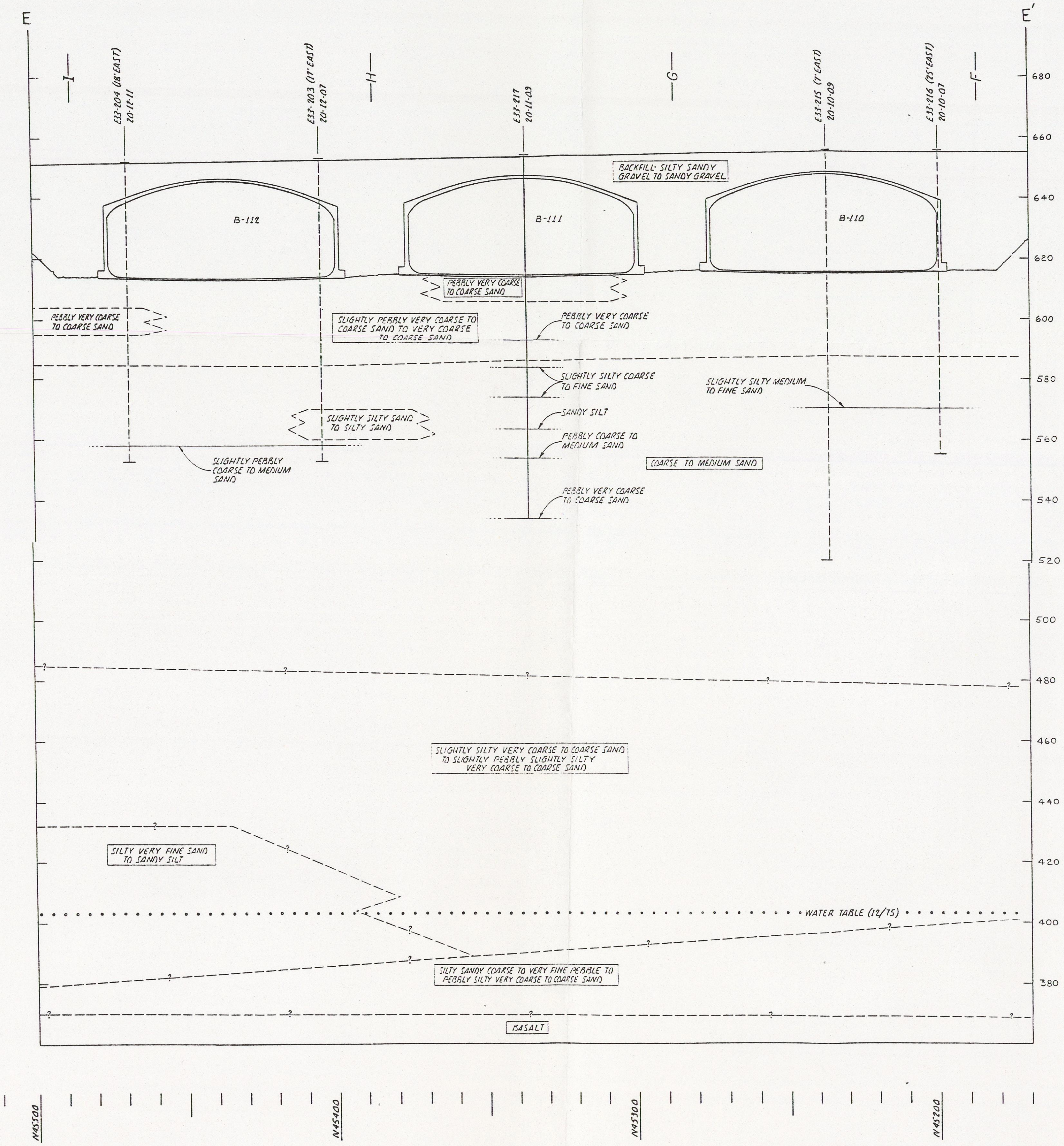

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RICHLAND OPERATIONS OFFICE

VITRO ENGINEERING • architects • engineers
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241-B TANK FARM
GEOLOGIC CHARACTERIZATION
CROSS SECTION E-E'

APPD. FOR CONFORMANCE WITH DESIGN CRITERIA BY / FOR ARHCO	DATE 4/2/76
APPD	
APPD	4/8/76
ENGR D. LIEN	4/2/76
APPD QA	4/2/76
CHECKED	
DRAWN R.C. SWAN	2/11/76
SCALE 1" = 16'-0"	
CLASSIFIED BY NOT REQ'D	DATE
CLASSIFICATION NONE	

PROJ No: WO No: CK-0065
PROJECT TITLE: TANK FARM GEOLOGIC CHARACTERIZATION
BLDG. NO. 241-B
INDEX NO. 0402, 0501
DWG NO. H-2-70480
LAST REV. 0
SHEET NO. — No. of Shts —

REFERENCE DRAWINGS: DWG. NO. | REV NO. | DRAWING TITLE OR INDEX NO.
NEXT USED ON
REVISIONS: MICRO FM'D | BY-DATE | FOR | BY-DATE | FOR | REV BY DATE | DESCRIPTION | REV NO.
APPD FOR CONFORM WITH DESIGN CRIT | APPD
DRAWING STATUS: COMMENT PRT ISSUE NO. | DATE | CHECK PRT ISSUE NO. | DATE