

RHO-BWI-LD-8

Informal Report

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Preliminary Geologic Map of the Late Cenozoic Sediments of the Western Half of the Pasco Basin

J. T. Lillie
A. M. Tallman
J. A. Caggiano

September 1978

Prepared for the United States
Department of Energy
Under Contract EY-77-C-06-1030

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PRELIMINARY REPORT

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Informal Report

PRELIMINARY GEOLOGIC MAP
OF THE LATE CENOZOIC SEDIMENTS
OF THE WESTERN HALF OF THE PASCO BASIN

J. T. Lillie

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Earth Sciences Group
Research Department

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for
Basalt Waste Isolation Program

September 1978

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ABSTRACT

The U. S. Department of Energy, through the Basalt Waste Isolation Program within the Rockwell Hanford Operations, is investigating the feasibility of terminal storage of radioactive waste in deep caverns constructed in Columbia River Basalt. This report represents a portion of the geological work conducted during fiscal year 1978 to assess the geological conditions in the Pasco Basin.

The surficial geology of the western half of the Pasco Basin was studied and mapped in a reconnaissance fashion at a scale of 1:62,500. The map was produced through a compilation of existing geologic mapping publications and additional field data collected during the spring of 1978. The map was produced primarily to: (1) complement other mapping work currently being conducted in the Pasco Basin and in the region by Rockwell Hanford Operations and its subcontractors; and, (2) to provide a framework for more detailed late Cenozoic studies within the Pasco Basin. A description of procedures used to produce the surficial geologic map and geologic map units is summarized in this report.

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INTRODUCTION

The U. S. Department of Energy, through the Basalt Waste Isolation Program within Rockwell Hanford Operations, is investigating the feasibility of terminal storage of radioactive waste in deep caverns constructed in Columbia River Basalt. This report represents a portion of the geological work conducted during fiscal year 1978 to assess the geological conditions in the Pasco Basin.

The surficial geology of the western half of the Pasco Basin (Figure 1) was studied and mapped in a reconnaissance fashion at a scale of 1:62,500. The map was produced through a compilation of existing geologic mapping publications and additional field data collected during the spring of 1978. The preliminary map was produced primarily to: (1) compliment other mapping work currently being conducted in the Pasco Basin and in the region by Rockwell Hanford Operations and its subcontractors; and, (2) to provide a framework for more detailed late Cenozoic studies within the Pasco Basin. A description of procedures used to produce the surficial geologic map and geologic map units is summarized in this report.

PROCEDURES

The existing surficial maps of the Pasco Basin and adjacent areas (Hajek, 1966; Newcomb, et al., 1972; and Grolier and Bingham 1971) were reviewed to determine the extent of mapping and to determine their utility to the current study. The geohydrologic map of Newcomb, et al., (1972) was found to be most applicable. Only minor changes, which include contact modification and the addition of more detail, were made on this map during field checking. Stereo air photographs at scales of 1:62,500, 1:24,000, and 1:6,000 were used to aid in field location and to map areas of geomorphic features, such as patterned ground, giant ripple marks, sand dunes (active and stable), and landslides. Due to the lack of adequate base map coverage at a scale of 1:24,000, the map was compiled at a scale of 1:62,500.

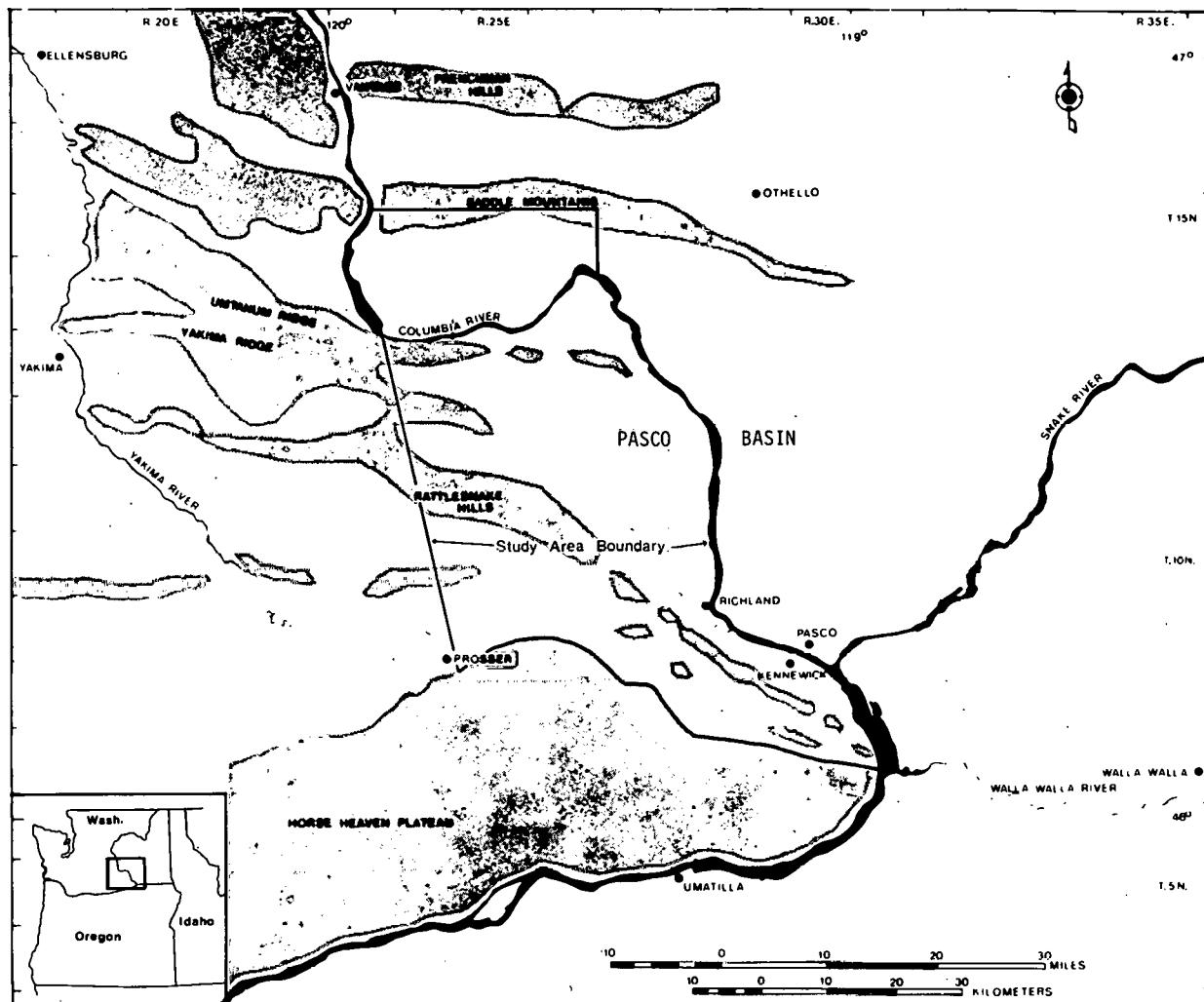


FIGURE 1
LOCATION MAP OF THE PASCO BASIN

Upon completion of photograph interpretation/mapping, stratigraphic units of known geology were studied for identifiable field criteria. Once field criteria were identified, the units were mapped. The map units are only preliminary due to the reconnaissance nature of the study. Additional work is required to integrate the Pasco Basin study with surficial geologic mapping currently being carried out in the surrounding region.

REGIONAL GEOLOGIC SETTING

The Pasco Basin is a structural and topographic low in south-central Washington underlain by at least three major stratigraphic units. These stratigraphic units in ascending order are: (1) the Columbia River Basalt Group; (2) the Ringold Formation; and, (3) the Hanford Formation. Outcrops of all three are found within the Pasco Basin. During the Tertiary, the basalts flowed intermittently into the basin. Between eruptions of the younger flows, streams from surrounding highlands flowed into the ancestral Pasco Basin depositing sediments which were covered by later basalt flows. The youngest basalt flow in the Pasco Basin is about 8 million years old and is overlain by fluvial detrital sediments.

Continued deformation of the basalt flows produced isolated, small topographic basins, such as the Pasco Basin, in which Pliocene and Quaternary sediments were deposited. Ancestral rivers which flowed into the Pasco Basin deposited a sequence of terrigenous sediments during Pliocene time known as the Ringold Formation.

The Ringold Formation consists of a number of textural facies and has been divided into the lower, middle, and upper Ringold. Lower Ringold, recognized from well data, is largely bluish-green clayey silt and contains some sand and gravel. The middle Ringold facies are composed predominantly of well-rounded pebbles and cobbles with interstitial sand and silt. Upper Ringold sediments are composed of nearly horizontal beds of sand and silt with some relatively minor fine gravel lenses.

Mammalian fauna from the upper Ringold have been identified as Blancan (late Pliocene) by Gustafson (1978). The age of the oldest Ringold sediments is not known.

After deposition of the Ringold sediments, the surface was subjected to subaerial erosion. An elolian silt overlying the Ringold Formation in the central part of the basin has been identified from wells (Brown 1960).

The Pasco and Touchet members of the Hanford Formation were deposited by Pleistocene flood waters when ice dams broke and glacial lakes were discharged catastrophically across the Columbia Plateau.

The Pend Oreille Lobe (Figure 2) of the Cordilleran ice sheet blocked the Clark Fork Valley in northwestern Montana forming glacial Lake Missoula (Bretz, 1969). Failure of this ice dam resulted in the catastrophic discharge of up to 21.3 million cubic meters per second (20 cubic miles per hour) across the Columbia Plateau (Baker, 1973) eroding the coulees of the channeled scablands and depositing clastic sediments. Sand and gravel of the Pasco Member were deposited in main flood channels and as bars on the lee of bedrock obstructions and channel restrictions (Baker, 1973).

Flood waters were hydraulically impounded in the Pasco Basin behind the narrow outlet at Wallula Gap. Low-energy environments resulting from this impoundment were the site of deposition of silt and fine sand of the Touchet Member. The last major flood in the Pasco Basin occurred about 13,000 years before present (Mullineaux, et al., 1977). The number of floods in the Pasco Basin is not known.

Giant ripple marks, large fluvial bars, flood channels, and bergmounds are geomorphic expressions of catastrophic flooding found in the Pasco Basin.

Late Quaternary and Holocene dune sand, loess, alluvium, and colluvium overlie the basalt, the Ringold Formation, and Hanford Formation in parts of the Pasco Basin.

Clastic dikes are also present in the Hanford and Ringold formations and produce surficial polygonally patterned ground in some areas.

SURFICIAL GEOLOGY OF THE WESTERN PASCO BASIN

DESCRIPTION OF MAP UNITS

The following description of map units is based on the late Cenozoic geologic map of the western portion of the Pasco Basin (Plates 1 through 13). This interpretation is preliminary and is only a progress report of

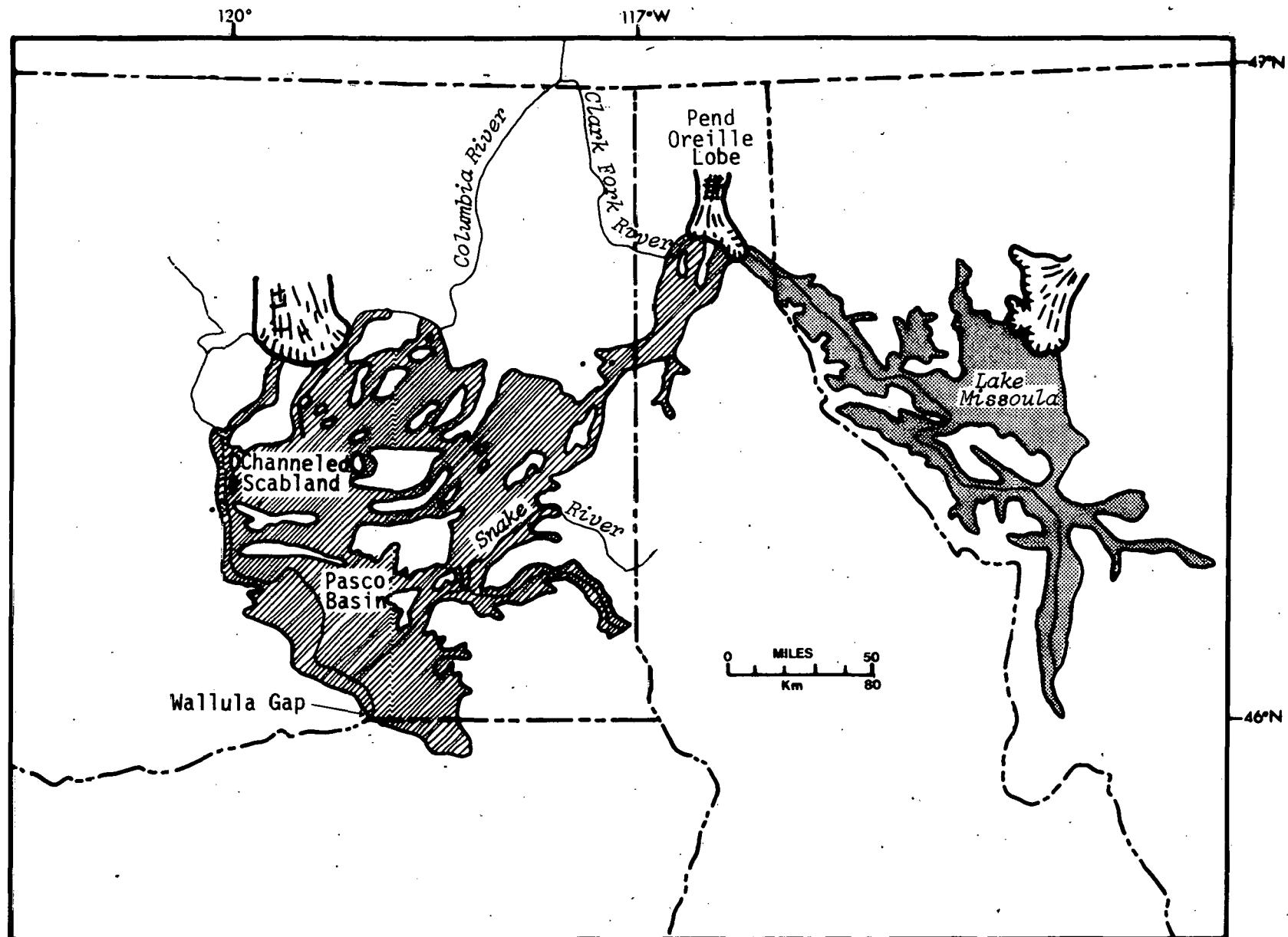


FIGURE 2
THE PEND OREILLE LOBE LOCATION MAP

ongoing investigations. Further work must be completed before any final interpretations can be made. All locations discussed in this section may be located on Plates 1 through 13.

Ringold Formation (TQrc) (TQr1)

Two outcrops of the Ringold Formation were found in the mapped area. One outcrop occurs at Coyote Rapids on the Columbia River and is the conglomeratic facies. The other outcrop occurs along the northern extension of the White Bluffs onto Wahluke Slope and is the fine-grained facies of the Upper Ringold.

Colluvium (Qco)

The mapping unit Qco may be a misnomer for this unit; these units may be tangularites of pre-flood(s) age. Preliminary mapping uncovered deposits of what appeared to be talus and slope wash of indeterminate age on the flanks of some ridges. These deposits are composed entirely of angular basalt clasts and are capped by an approximately 0.3-meter (1-foot) thick petrocalcic horizon.

HANFORD FORMATION

Touchet Member (Qht)

The second-most widespread sediment in the Pasco Basin and surrounding areas is the sand and silt facies known as the Touchet Member of the Hanford Formation. The major occurrences of this unit that have been mapped are in Cold Creek, Dry Creek, and the Yakima River valleys. They occur on the basin margins discontinuously to an altitude of at least 345 meters (1,150 feet) above mean sea level. The primary criterion for field identification, where stratification is not apparent, is the occurrence of ice-rafted glacial erratics. The Touchet is very easily reworked by eolian processes, which causes stripping of this deposit from higher elevations. For this reason, and the random occurrences of erratics, it is difficult to accurately map the upper limit of these sediments. Thus, the upper map limit has been tentatively dashed in on the map. Further field mapping will be required to

accurately map this contact, which is of significance as the upper limit of the Touchet in the basin is believed to closely correspond to the upper limit for the ponding of flood waters in the basin.

Pasco Member (Qhp)

The major surficial sediment unit within the Pasco Basin is the sand and gravel facies of the catastrophic flood deposits of the Pasco Member of the Hanford Formation. At least 777 square kilometers (300 square miles) are covered by these deposits. In places, these gravels exceed 200 meters (600 feet) in thickness, and unconformably overlie the Ringold Formation or basalt. They are overlain in places by active and stabilized dune fields, loess, and Touchet sediments. In areas near channel bottom irregularities (i.e., ridges which were under water during flooding), the tops of the bars are covered with giant current ripples (see Plate 5). The sand and gravel facies of the Pasco Member grade both laterally and vertically into the sand and silt facies of the Touchet Member.

Talus (Qt)

The only areas of active talus formation today are in areas of high relief where the basalt crops out as cliffs. These areas are the north face of the Saddle Mountains (out of mapping area), the north-northeast faces of Umtanum Ridge (out of mapping area), and minor amounts on the Rattlesnake and the Horse Heaven hills.

Loess (Q1) (Q1/Tb)

Loess is present over much of the Pasco Basin and on the ridges bounding the basin. Where present, it is variable in thickness ranging from a very thin veneer on windward ridge slopes to several meters on the leeward sides of valleys. The mapping unit Q1/Tb is used to indicate a thin loessal cover over the Columbia River Basalt. Portions of the Saddle Mountains and the Rattlesnake Hills are covered by loess, which, at this time, have not been differentiated as to age on the map (see Plates 1, 2, 3, 4, 7, 8, 10, and 11). The majority of the loess deposits within the basin are post-last flood. The source material for these

Loess deposits most likely is the fine sand and silt facies of the Touchet Member of the Hanford Formation which has been reworked by prevailing west-to-southwest winds. Loess can generally be differentiated from Touchet and the sand and silt facies of the Ringold by its massive, unstructured appearance in outcrop. Loess chronology, if it can be determined in this area, may be a useful tool for determination of the late Cenozoic stratigraphy and should be investigated further.

Landslides (Qld)

There are two areas of massive landslides in the western part of the mapping area. A landslide complex covering over 52 square kilometers (20 square miles) occurs in the area where the main structural trend of the Rattlesnake Hills changes from northwest to west-to-east. This slide complex is a series of very large slide blocks. Recent field evidence indicates that not only is this an area of complex sliding, but there are also intact structural blocks in a complex arrangement.

The second area of massive landsliding is along the northwest face of the Horse Heaven Hills from Chandler to Prosser. The area covered by the multiple slide blocks exceeds 65 square kilometers (25 square miles) in a strip 1.6 kilometers (1 mile) wide and 32 kilometers (20 miles) long. Individual slide blocks have not been mapped due to limited time, but should be. There are also several areas of local landslides on the northeast face of the Rattlesnake Hills. In places, these landslide complexes appear to have a thin veneer of flood deposits overlying them.

Alluvium and Alluvial Fans (Qa) (QaF)

Aside from the alluvial deposits of the Columbia and Yakima rivers, there is relatively little Holocene alluvium in the area mapped. Some minor run-off occurs on the flanks of the ridges in the spring and fall producing a small amount of very angular basalt cobble alluvium in the run-off gullies. Two of the larger alluvial fans in the basin are associated with the Snively Basin slide complex on the Rattlesnake Hills. There are small areas of alluvium not shown on the map, which will be picked up with additional detailed mapping.

EOLIAN DEPOSITS

Sand Dunes (Qda, Qds)

Several areas are covered by active sand dune fields (Qda). The largest of these fields occurs between Townships 12 and 11 North, Range 27 East and the Columbia River south of the town site of Hanford. This field is composed primarily of barchan dunes and covers an area of about 33.7 square kilometers (13 square miles). The other areas of active dunes are relatively small (no greater than 2.5 square kilometers [1 square mile]) and consist of longitudinally modified barchan dune fields. The probable source of sand for these dunes is the Touchet Member of the Hanford Formation.

The area of the basin from Township 13 North, south to the City of Richland, and between Cold Creek Valley-Yakima River Valley and the Columbia River is mantled by stabilized longitudinal dunes (Qds). These dunes generally trend from west to east and are covered with sagebrush and cheatgrass. The intervening blowouts associated with these dunes are covered with a gravel lag. These dunes are probably eolian reworked sand and silt of the Pasco gravels and sands. These dunes have been suggested to be giant ripple marks modified by eolian processes (Bretz, et al, 1956).

PATTERNEED GROUND

Several areas of Cold Creek Valley display a polygonal pattern in which narrow planar zones cut the Touchet sediments and are reminiscent of giant mud cracks. This patterned ground is the surface expression of clastic dikes which cut the Touchet sediments. On the map, these areas are represented by a mud crack-like pattern. This pattern is to show the location of these areas only and does not reflect the spatial distribution of the clastic dikes or the patterned ground.

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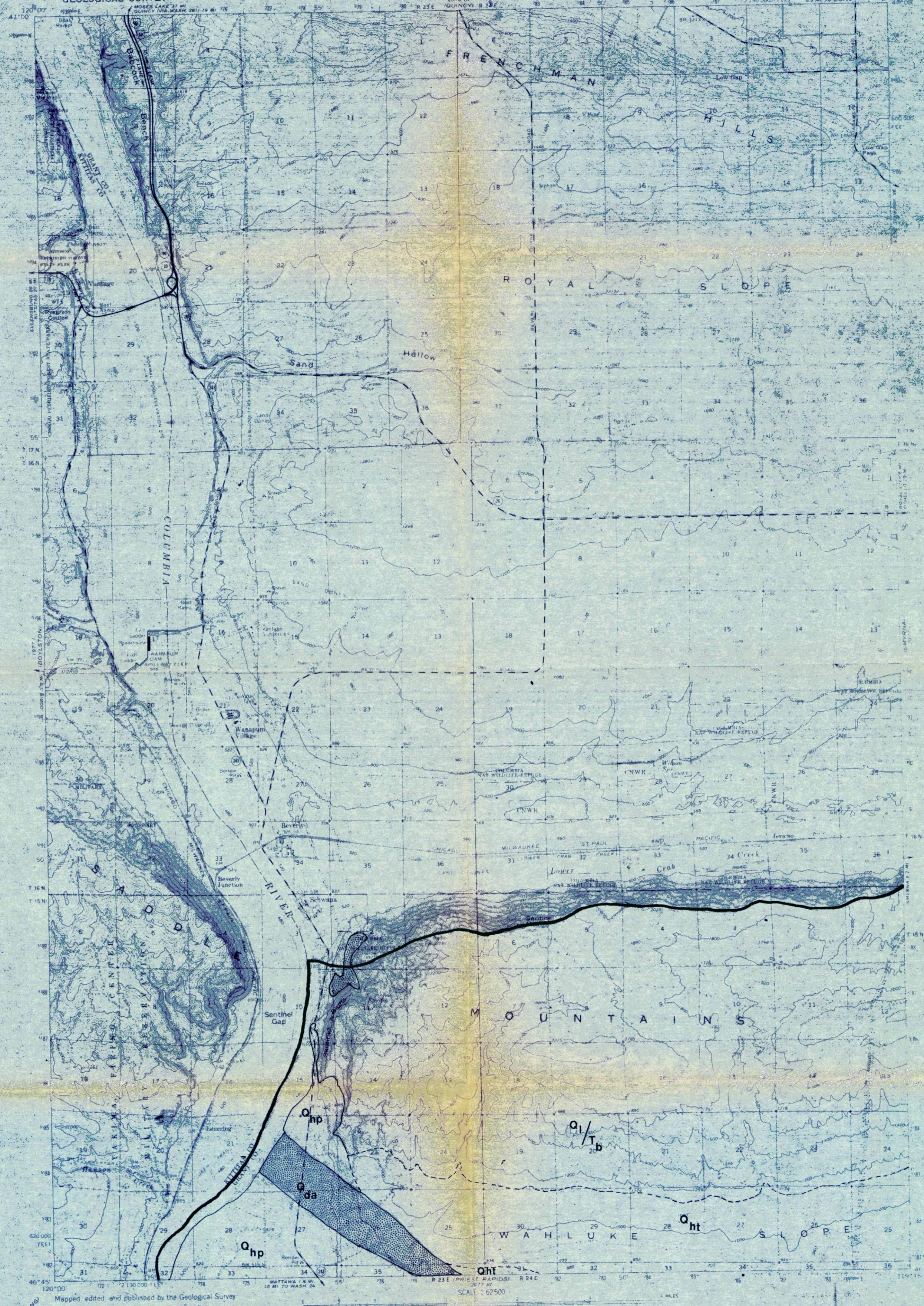
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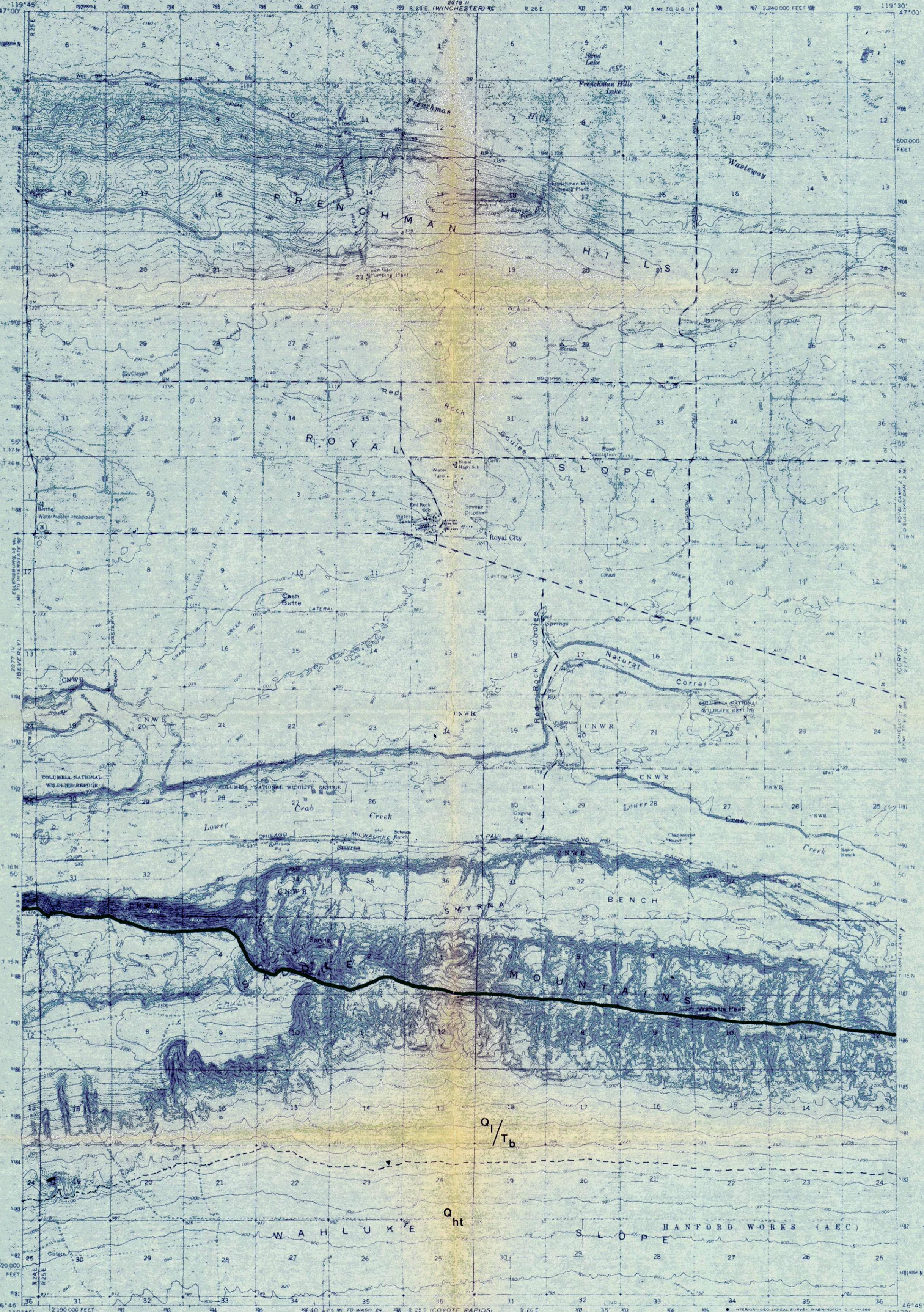
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Polyconic projection. 1927 North American datum

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south zone

1000-meter Universal Transverse Mercator grid ticks

zone 11, shown in blue

GN
21°
1150 MILES
378 MILES
34 MILES

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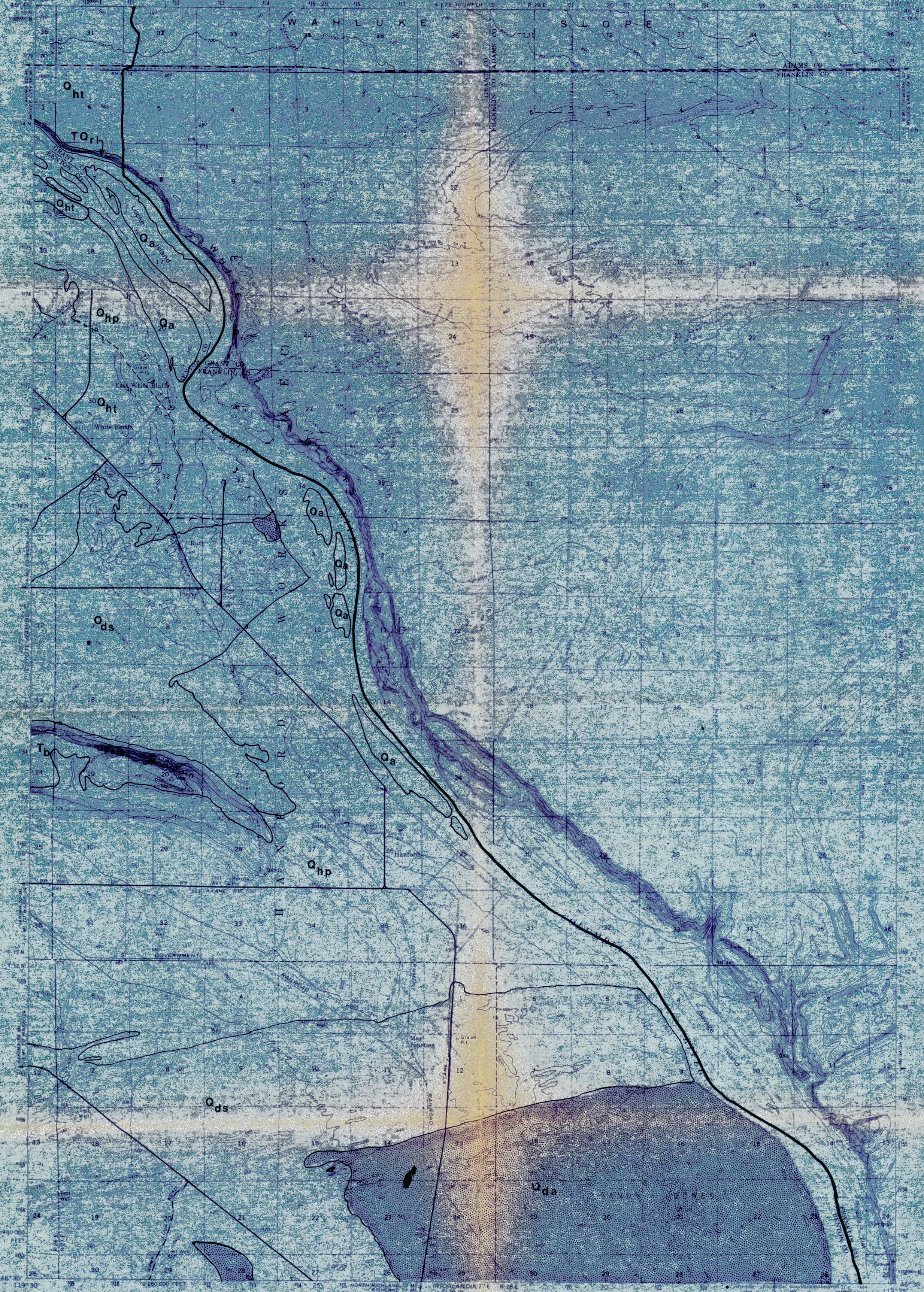
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OF THE WESTERN HALF OF THE PASCO BASIN

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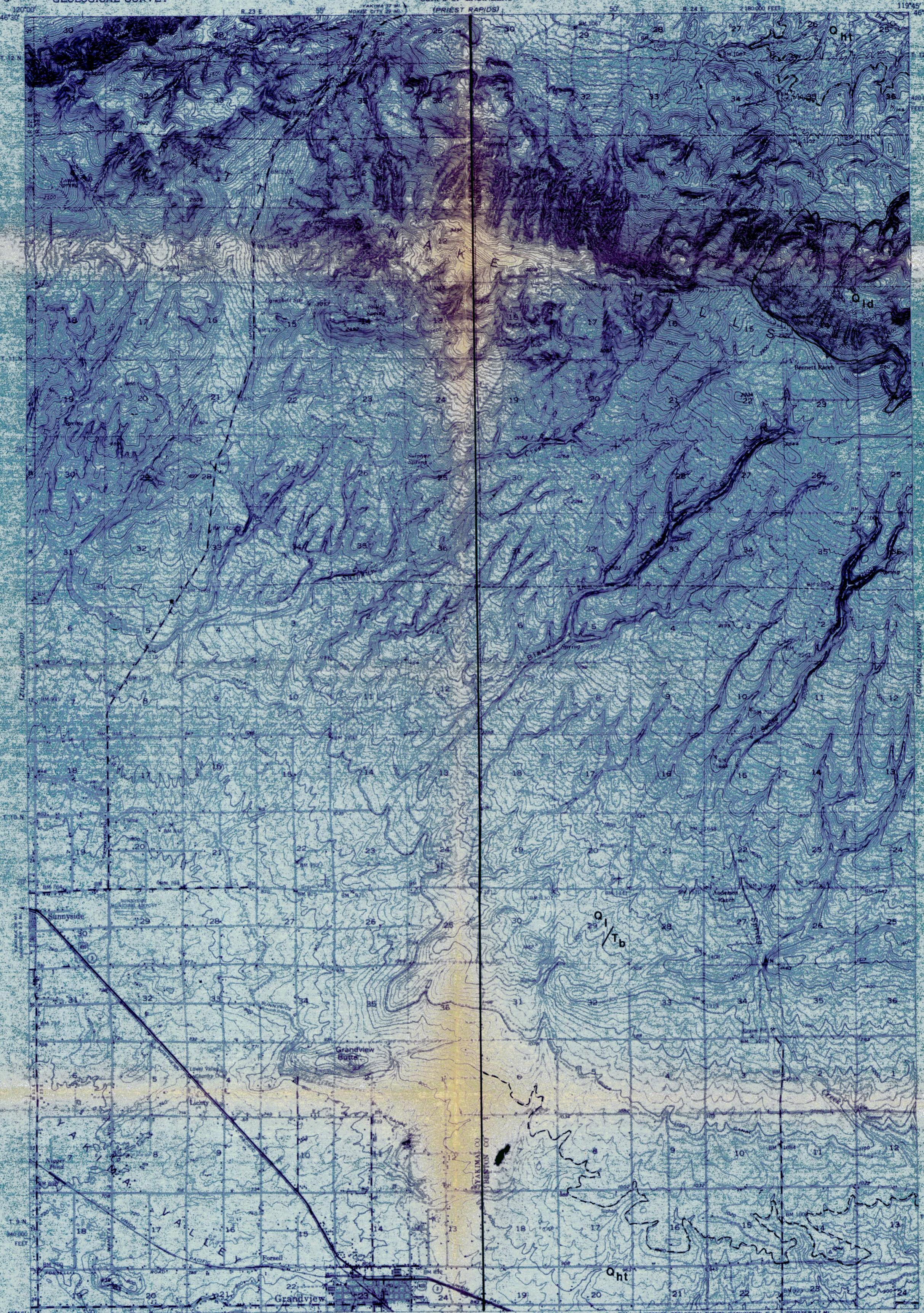
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Basalt Waste Isolation Program

Appd. Program Dir.	Date	Quality Assurance	Date
J. A. Currin (ARMY)	9/29/78	Appd. Project Mngr.	1/16/79
Drafting Appd.	9/29/78	Responsible Engr.	C. W. Myers 9/29/78
Drawn	John F. Hillie 9/29/78	Review	
Scale	Drawing No. H-06-4602-7		

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEYUNITED STATES
DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
(PRIEST RAPIDS)GRANDVIEW QUADRANGLE
WASHINGTON
15 MINUTE SERIES (TOPOGRAPHIC)

Mapped by the Geological Survey and Bureau of Reclamation.
Edited and published by the Geological Survey.

Control by USGS and USGGS.

Topography from plane table surveys by USBR 1935-1941
and by USGS from aerial photographs by multiplex methods.
Aerial photographs taken 1948. Field check 1950.

Polyconic projection. 1927 North American datum
10,000-foot grid based on Washington coordinate system,
south zone.

Red line indicates area in which only
landmark buildings are shown.

Dashed line indicates approximate location.

Dotted line were established by USBR.

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U.S. GEOLOGICAL SURVEY, FEDERAL CENTER, DENVER, COLORADO OR WASHINGTON 25, D.C.
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

GRANDVIEW, WASH.
N4615-W11945/15

EDITION OF 1951

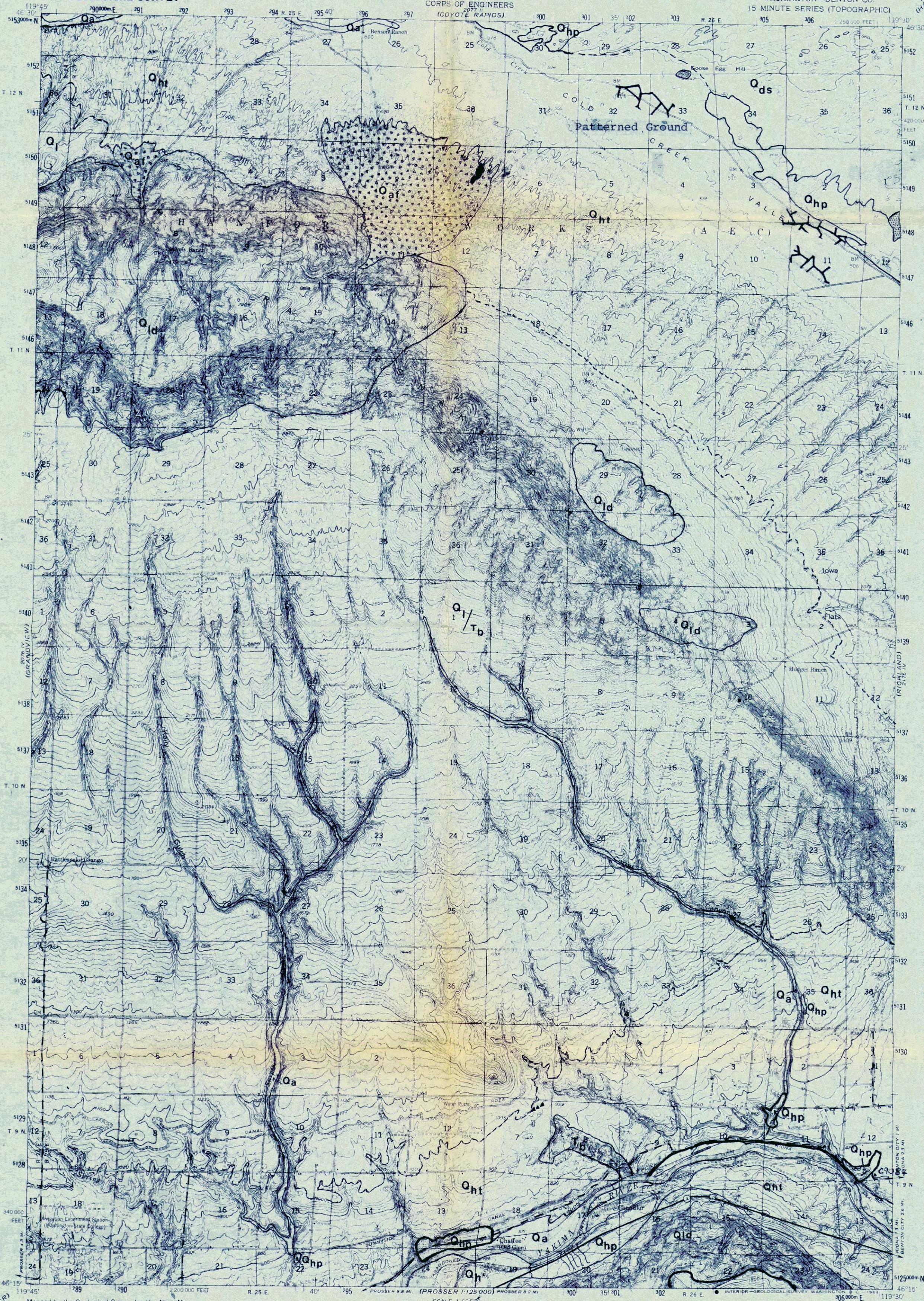
POCKET PART 7 OF 13 RHO-BWI-LD-8
PLATE 7 - PRELIMINARY GEOLOGIC MAP OF THE LATE CENOZOIC SEDIMENTS OF
THE WESTERN HALF OF THE PASCO BASIN

Rockwell Hanford Operations			Basalt Waste Isolation Program		
PRELIMINARY GEOLOGIC MAP OF THE LATE CENOZOIC SEDIMENTS OF THE WESTERN HALF OF THE PASCO BASIN			Appd. Program Dir. T.A. Curran (CWM) 9/29/78	Date 10/11/78	Quality Assurance
			Appd. Unit Mgr. T.A. Curran (CWM) 9/29/78	Appd. Project Mgr. 11/6/78	
			Drafting Appd. 9/29/78	Responsible Engr. E.W. Myers 9/29/78	
			Drawn by J. P. Hillier 9/29/78	Review	
			Scale 1:62500	Drawing No. H-06-4602-8	

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

UNITED STATES
DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
(COYOTE RAPIDS)

CORRAL CANYON QUADRANGLE
WASHINGTON-BENTON CO.
15 MINUTE SERIES (TOPOGRAPHIC)



Mapped by the Geological Survey for the Army Map Service

Edited and published by the Geological Survey

Control by USGS and USGS

Topography from aerial photographs by multiplex methods

and by plane-table surveys

Aerial photographs taken 1948. Field check 1951

Polyconic projection 1927 North American datum
10,000-foot grid based on Washington coordinate system,
south zone

1000-meter Universal Transverse Mercator grid ticks
zone 14, shown in blue

UTM GRID AND 1951 MAGNETIC NORTH
DECLINATION AT CENTER OF SHEET

37.3 MILS

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U.S. GEOLOGICAL SURVEY, DENVER 25, COLORADO OR WASHINGTON 25, D.C.
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

1000 2000 3000 4000 5000 6000 7000 8000 9000 10000 11000 12000 13000 14000 15000 16000 17000 18000 19000 20000 FEET
1 2 3 4 KILOMETERS

CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL

WASHINGTON

QUADRANGLE LOCATION

ROAD CLASSIFICATION
Heavy-duty 4 LANE, 6 LANE Light-duty 4 LANE, 6 LANE Unimproved dirt

U.S. Route State Route

CORRAL CANYON, WASH.
N4615-W11930/15

1051

AMS 2076 I-SERIES V79

POCKET PART 8 OF 13 RHO-BWI-LD-8
PLATE 8 - PRELIMINARY GEOLOGIC MAP OF THE LATE CENOZOIC SEDIMENTS OF
THE WESTERN HALF OF THE PASCO BASIN

Rockwell Hanford Operations

PRELIMINARY GEOLOGIC MAP OF THE LATE
CENOZOIC SEDIMENTS OF THE WESTERN
HALF OF THE PASCO BASIN

Basalt	Waste	Isolation	Program
Appd. Program Dir.	Date	Quality Assurance	Date
T.A. Curran (ewm)	9/29/78	Appd. Project Mngr.	9/29/78
Drafting Appd.	R.W. Cox	Responsible Engr.	C.W. Myers 9/29/78
Drawn:	Spencer A. Riddle 9/29/78	Review	

UNITED STATES

Drawing No. H-06-4602-9

RICHLAND QUADRANGLE

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Map by the Geological Survey for the Army Map Service

Edited and published by the Geological Survey

Controlled by USGS and USCGS

Topography from aerial photographs by multiple methods

and by triangulation surveys

Aerial photographs taken 1948-52, field check 1957

Polyconic projection, 1927 North American datum

10,000-foot grid based on Washington coordinate system
south zone

Red line indicates areas in which only

Incomparable buildings are shown

1000-meter Universal Transverse Mercator grid ticks

Zone 11 shown in blue

1000-meter Universal Transverse Mercator grid ticks

Zone 11 shown in blue

UTM GRID AND TRUE MAGNETIC NORTH
DECLINATION ALIGNED TO SHEETCONTOUR INTERVAL 30 FEET
DATUM IS MEAN SEA LEVEL

LAURENCE LOCATION

RICHLAND, WASH.

N46°15' W117°11'

1951

AMS 2175 D. SERIES V761

POCKET PART 9 OF 13 RHO-BWI-LD-8

PLATE 9 - PRELIMINARY GEOLOGIC MAP OF THE LATE CENOZOIC SEDIMENTS OF
THE WESTERN HALF OF THE UNITED STATESFOR SALE BY U. S. GEOLOGICAL SURVEY, DENVER, COLORADO 80225 OR WASHINGTON, D. C. 20240
A FIELD-DESCRIPTIONS, TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

Rockwell Hanford Operations

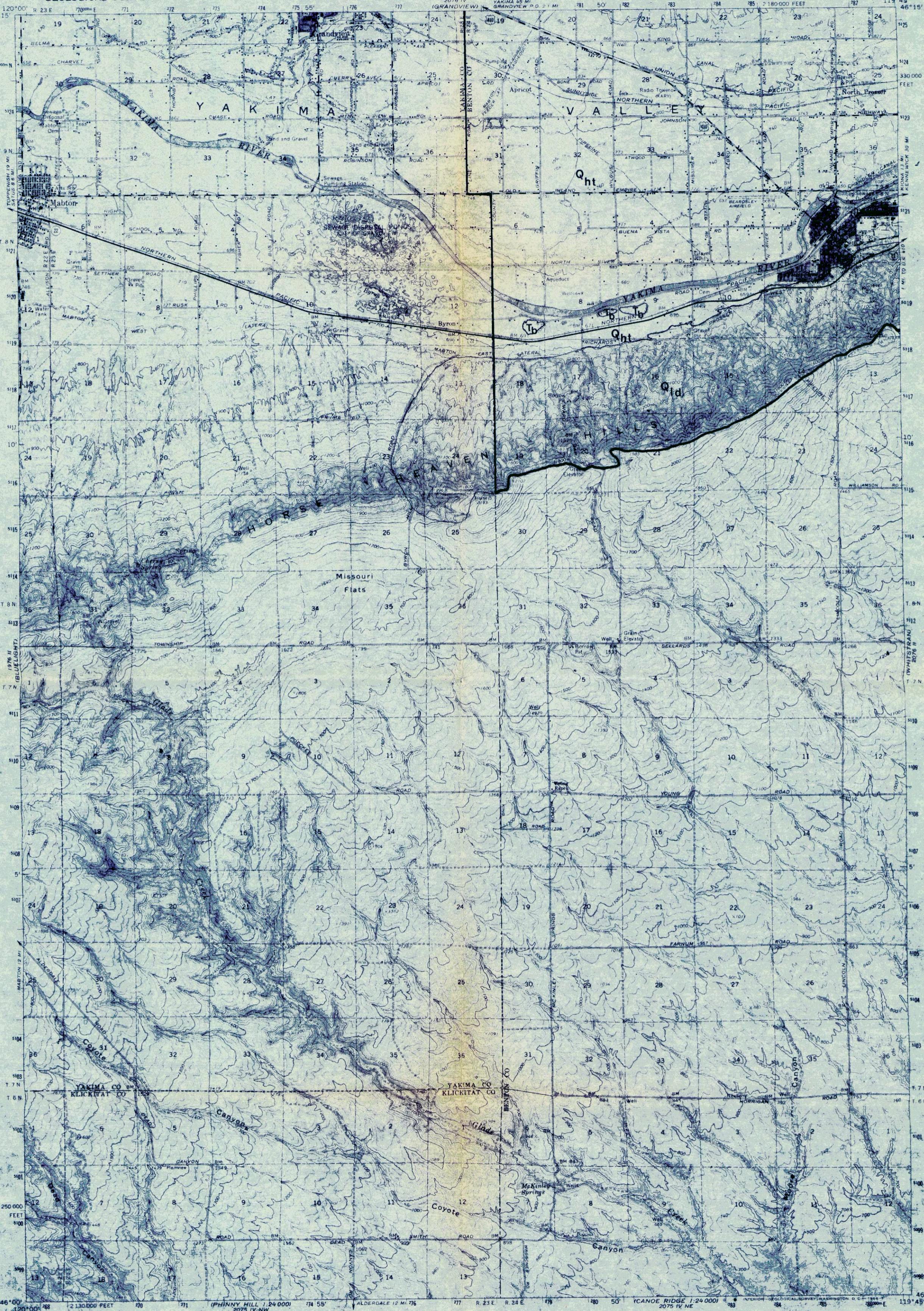
Basalt Waste Isolation Program

PRELIMINARY GEOLOGIC MAP OF THE LATE
CENOZOIC SEDIMENTS OF THE WESTERN
HALF OF THE PASCO BASIN

Appd. Program Dir.	Date	Quality Assurance	Date
Appd. Unit Mngt			
F.A. Curran (C.W. M)	9/29/78	Appd. Project Mngt	
Drafting Appd		Responsible Engr.	
R.M. Lass	9/29/78	C.W. Mayers	9/29/78
Drawn		Review	
G. Fillie	9/29/78		
Scale		Drawing No.	H-06-4602-10

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEYPROSSER QUADRANGLE
WASHINGTON

15 MINUTE SERIES (TOPOGRAPHIC)



Mapped, edited, and published by the Geological Survey

Control by USGS and USGS

Topography by photogrammetric methods from aerial photographs taken 1963. Field checked 1965

Polyconic projection. 1927 North American datum. 10,000-foot grid based on Washington coordinate system, south zone

1000-meter Universal Transverse Mercator grid ticks, zone 11, shown in blue

Red tint indicates areas in which only landmark buildings are shown

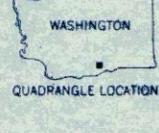
Certain land lines are omitted because of insufficient data

UTM GRID AND 1960 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

37° MILS

21° MILS

373 MILS

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U.S. GEOLOGICAL SURVEY, DENVER, COLORADO 80225, OR WASHINGTON, D.C. 20242
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUESTCONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

QUADRANGLE LOCATION

ROAD CLASSIFICATION

Heavy duty

Light duty

Medium-duty

Unimproved dirt

U.S. Route

State Route

PROSSER, WASH.
N4600-W11945/15

1965

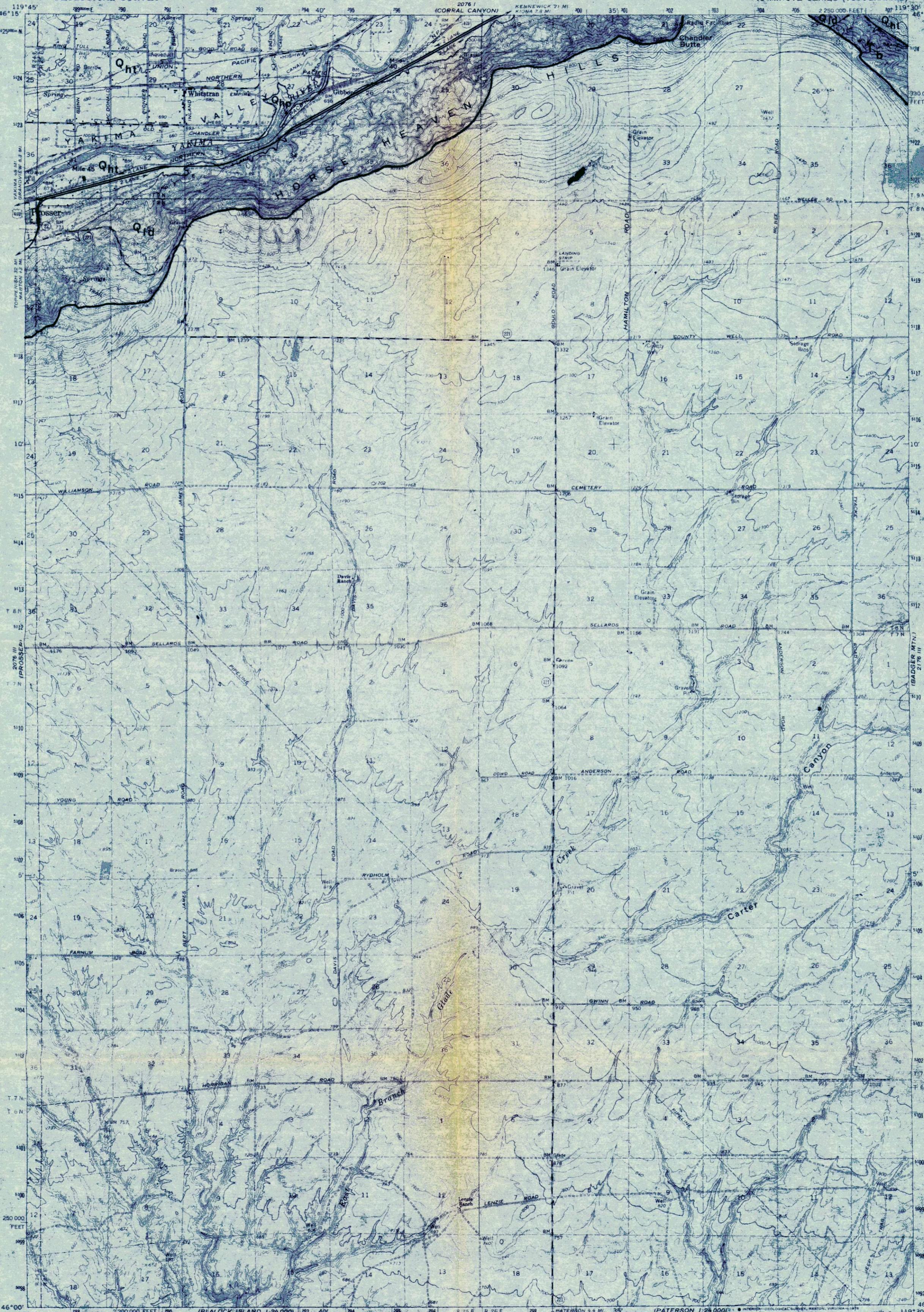
AMS 2076 III SERIES V79

POCKET PART 10 OF 13 RHO-BWI-LD-8

PLATE 10 - PRELIMINARY GEOLOGIC MAP OF THE LATE CENOZOIC SEDIMENTS OF
THE WESTERN HALF OF THE PASCO BASIN

Rockwell Hanford Operations		Basalt Waste Isolation Program	
Preliminary Geologic Map of the Late Cenozoic Sediments of the Western Half of the Pasco Basin		Appd. Program Dir. Date	Quality Assurance Date
		Appd. Unit Mngr. 9/29/78	Appd. Project Mngr. 9/29/78
		Drafting Appd. 9/29/78	Responsible Engr. C.W. Myers 9/29/78
		Drawn John P. Bell 9/29/78	Review
		Scale	Drawing No. H-06-4602-11

WHITSTRAN QUADRANGLE
WASHINGTON-BENTON CO.
15-MINUTE SERIES (TOPOGRAPHIC)



2075 NE
(CANCELLATION
1-2-000)

Mapped, edited, and published by the Geological Survey

Control by USGS and USC&GS

Topography by photogrammetric methods from aerial photographs taken 1965

Polycoric projection 1927 North American datum

10,000-foot grid based on Washington coordinate system, south zone

1000-metre Universal Transverse Mercator grid ticks, zone 11, shown in blue

Red tint indicates area in which only landmark buildings are shown.

UTM GRID AND 1965 MAGNETIC NORTH
DECIMATION AT CENTER OF SHEET

3375 MILS
21° 34 MILS

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
NATIONAL GEODETIC VERTICAL DATUM OF 1929

SCALE 1:62500

0 3000 6000 9000 12000 15000 18000 21000 FEET

0 5 10 15 20 25 KILOMETERS

ROAD CLASSIFICATION

Highway

Medium-duty

Unimproved road

State Route



WHITSTRAN, WASH.
N4600-W11930/15

1965

AMS 2075 II-SERIES V25

POCKET PART 11 OF 13 RHO-BW10D-8

Plate 11 PRELIMINARY GEOLOGIC MAP OF THE LATE CENOZOIC SEDIMENTS OF
THE WESTERN HALF OF THE PASCO BASIN

Rockwell Hanford Operations

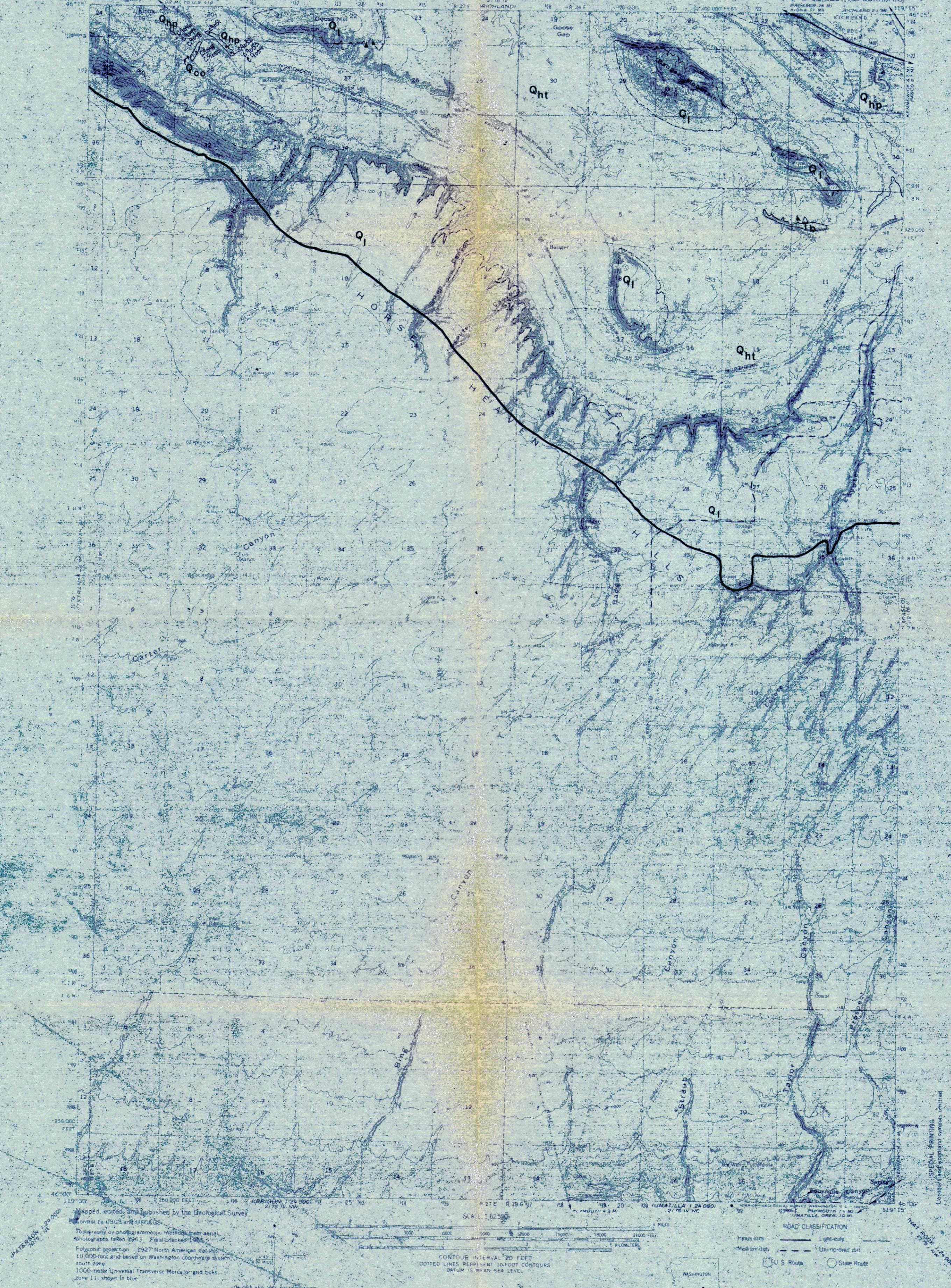
PRELIMINARY GEOLOGIC MAP OF THE LATE CENOZOIC SEDIMENTS OF THE WESTERN HALF OF THE PASCO BASIN

Basalt Waste Isolation Program

Appd. Program Dir.	Date	Quality Assurance	Date
J. A. Cutshaw (arm)	9/29/78	Appd. Project Mgr.	
Drafting Appd.		Responsible Engr.	1/29/78
Drawn by John J. Pelle 9/29/78		Review	
Scale		Drawing No.	H-06-4602-12

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

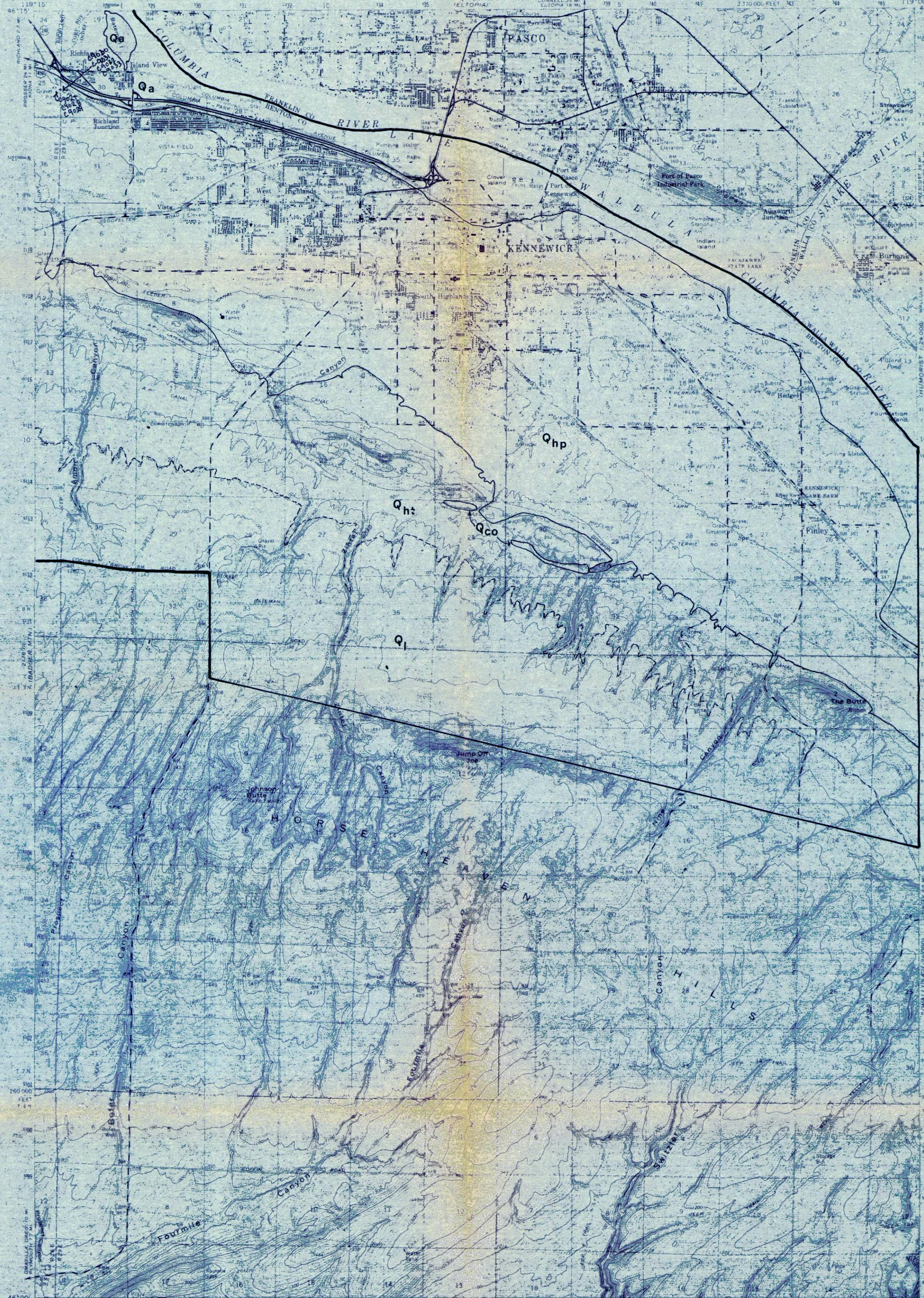
BADGER MTN. QUADRANGLE
WASHINGTON-BENTON CO.
15 MINUTE SERIES (TOPOGRAPHIC)



Rockwell Hanford Operations	Basalt Waste Isolation Program
PRELIMINARY GEOLOGIC MAP OF THE LATE CENOZOIC SEDIMENTS OF THE WESTERN HALF OF THE PASCO BASIN	Appd. Program Dir. Date Quality Assurance Date
	Appd. Unit Mngr. Appd. Project Mngr.
	Drafting Appd. Responsible Engr.
	Drawn by John Helle 9/29/78 C.W. Meyer 9/29/78 Review
Scale	Drawing No. H-06-4602-13

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

PASCO QUADRANGLE
WASHINGTON
15 MINUTE SERIES (TOPOGRAPHIC)



Mapped, edited, and published by the Geological Survey

Control by USGS and USC&GS

Topography by photogrammetric methods from aerial photographs taken 1959. Field checked 1964.

Underwater contours by USGS

Selected hydrographic data compiled from

USC&GS Charts 6164 (1960) and 682 SC (1963)

This information is not intended for navigational purposes

Polyconic projection. 1927 North American datum

10,000-foot grid based on Washington coordinate system, south zone

1000-meter Universal Transverse Mercator grid ticks, zone 11, shown in blue

Red tint indicates areas in which only landmark buildings are shown

POCKET PART 13 OF 13 RHO-BWI-LD-8

PLATE 13 - PRELIMINARY GEOLOGIC MAP OF THE LATE CENOZOIC SEDIMENTS OF THE WESTERN HALF OF THE PASCO BASIN

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U.S. GEOLOGICAL SURVEY, DENVER, COLORADO 80225, OR WASHINGTON, D.C. 20242
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

DEPTH CURVES AND ISOBINDS IN FEET - DATUM IS NORMAL POOL ELEVATION 340 FEET

UTM GRID AND 1960 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

112° 22' 27 MILS
373 MILS

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

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0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

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0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 6