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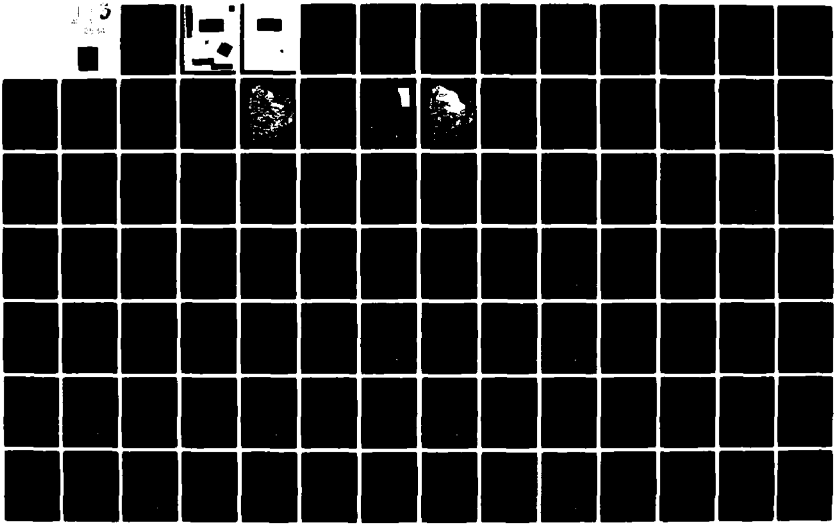

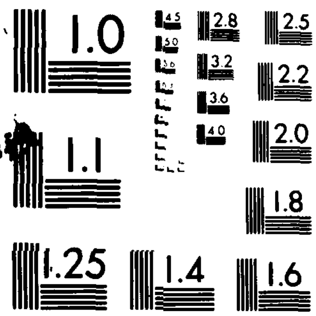

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MX SITING INVESTIGATION
GEOTECHNICAL EVALUATION

DETAILED AGGREGATE RESOURCES STUDY

WAH WAH VALLEY, UTAH

Prepared for:

U.S. Department of the Air Force
Ballistic Missile Office
Norton Air Force Base, California 92409

Prepared by:

Ertec Western, Inc.
3777 Long Beach Boulevard
Long Beach, California 90807

12 June 1981

Ertec

SECURITY CLASSIFICATION OF THIS PAGE (*When Data Entered*)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: E-TR-47-WA

2. GOVT ACCESSION NO.:

3. RECIPIENT'S CATALOG NUMBER:

4. TITLE (and Subtitle): Detailed Aggregate Resources Study Wah Wah Valley, Utah

5. TYPE OF REPORT & PERIOD COVERED: Final

6. PERFORMING ORG. REPORT NUMBER: E-TR-47-WA

7. AUTHOR(s): Ertec Western, Inc.

8. CONTRACT OR GRANT NUMBER(s): F04704-80-C-0006

9. PERFORMING ORGANIZATION NAME AND ADDRESS: Ertec Western Inc (formerly Fugro National) P.O. Box 7765 [illegible] Ca 9080[illegible]

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: 64312 F

11. CONTROLLING OFFICE NAME AND ADDRESS: [illegible] Air Force [illegible] Missile Systems [illegible] [illegible] (SA[illegible])

12. REPORT DATE: 12 Jun 81

13. NUMBER OF PAGES: 86

14. MONITORING AGENCY NAME & ADDRESS (*If different from Controlling Office*)

15. SECURITY CLASS. (*of this report*)

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (*of this Report*)

Distribution Unlimited

17. DISTRIBUTION STATEMENT (*of the abstract entered in Block 20, if different from Report*)

Distribution Unlimited

18. SUPPLEMENTARY NOTES

19. KEY WORDS (*Continue on reverse side if necessary and identify by block number*)

~~Road Base~~ Aggregate ~~, concrete aggregate~~ ~~Geologic setting~~, geology, grain size, petrography, caliche, soil, trench logs

20. ABSTRACT (*Continue on reverse side if necessary and identify by block number*)

Detailed aggregate resources study, Wah Wah Valley, Utah. Report contains analysis, evaluation and quantity of aggregate resources found in The Wah Wah Valley. classes RBIa, RBIb, RBII for Road-base and classes CA1, CA2, CB, CC1 and CC2 for concrete.

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FOREWORD

This report is one of a series prepared for the Department of the Air Force, Ballistic Missile Office (BMO), in compliance with Contract No. F04704-80-C-0006, CDRL Item No. 004A2. These reports present the results of Detailed Aggregate Resources Studies within and adjacent to selected areas in Nevada and Utah that are under consideration for siting the MX missile system.

This volume contains the results of the aggregate resources evaluation for Wah Wah Valley. Results of this report are presented as text, appendices, and three drawings. This report has been prepared and submitted on the assumption that the reader is familiar with previous aggregate resources reports.

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EXECUTIVE SUMMARY

This report contains the Detailed Aggregate Resources Study (DARS) evaluation for Wah Wah Valley, Utah. It is the sixth in a series of reports that contain detailed aggregate information on the location and quality of basin-fill and rock sources of road-base and concrete aggregates. Field reconnaissance, laboratory testing, and existing data from other Ertec Western, Inc. (formerly Fugro National, Inc.) investigations and the Utah State Department of Highways provide the basis for the findings presented in this report.

ROAD-BASE AGGREGATES

Potential road-base aggregate sources were classified as follows:

Class RBIa - Basin-fill or rock sources containing materials suitable for use as road-base aggregates; based on acceptable laboratory aggregate test results.

Class RBIb - Basin-fill sources containing materials suitable for use as road-base aggregates; based on correlation with Class RBIa source areas.

Class RBII - Potential basin-fill sources of materials suitable for use as road-base aggregates; based on photogeologic interpretations, field observations, and limited or inconclusive sieve analysis and/or abrasion data.

Assignment of an aggregate source to one of the above three classes was determined from laboratory test results (gradation, abrasion and, to a lesser extent, soundness) and geomorphological and compositional correlations.

Results of this evaluation are presented on a 1:62,500 scale aggregate resources map (Drawing 2) and are summarized as follows:

Class RBIa Sources: Twenty-two basin-fill sources consisting of good to high quality aggregates acceptable for use as road-base construction materials have been located in Wah Wah Valley. Fifteen of the Class RBIa sources are alluvial fan deposits (Aaf) and seven are older lacustrine deposits (Aol).

Six crushed-rock sources which yielded good to high quality aggregates acceptable for use as road-base construction materials have been delineated within the study area. Class RBIa rock types include quartzite (Qtz), limestone (Ls), undifferentiated carbonate rocks (Cau), granitic rock (Gr), and basalt (Vb).

Class RBIb Sources: Thirteen alluvial fan deposits and numerous older lacustrine deposits within the study area are defined as potential sources of good to high quality, road-base aggregates. Geomorphological and compositional similarities were used to correlate these units to tested RBIa deposits.

Class RBII Sources: Several potential basin-fill aggregate sources are located throughout the study area. All of these sources are alluvial fans that have been classified on the basis of limited field and laboratory data.

CONCRETE AGGREGATES

A classification system consisting of five classes was developed for the concrete aggregates evaluation to present potential basin-fill and crushed-rock sources. Although most rock sources will supply coarse concrete aggregates, their delineation was not an objective of this study. Assignment of an aggregate source to one of the five classes was determined from laboratory test results (trial concrete mixes and gradation, abrasion, and soundness of aggregates) and geomorphological and compositional correlations. The emphasis of this study was the evaluation of the concrete-making properties (especially 28-day compressive strengths) of potential aggregates when used in trial concrete mixes.

Class CA1	Basin-fill or rock sources containing aggregates that produced trial mix concrete with 28-day compressive strengths equal to or greater than 6500 psi.
Class CA2	Basin-fill or rock sources containing aggregates that produced trial mix concrete with 28-day compressive strengths less than 6500 psi.
Class CB	Basin-fill or rock sources containing aggregates potentially suitable for use in concrete; based on acceptable laboratory aggregate test results.
Class CC1	Basin-fill or rock sources containing aggregates potentially suitable for use in concrete; based on correlation with Class CA1 and CA2 source areas.
Class CC2	Basin-fill sources containing aggregates potentially suitable for use in concrete; based on correlation with Class CB source areas.

The following three trial mixes were used to obtain a range of compressive strength values; however, only Mix 3 results were used to classify sources. In all three trial mixes, fly ash, as a pozzolan, replaced 20 percent of the cement by weight.

- Mix 1 - 7.5 sacks of cement per cubic yard of concrete and 1.5-inches maximum aggregate size;
- Mix 2 - 8.5 sacks of cement per cubic yard of concrete and 1.5-inches maximum aggregate size; and
- Mix 3 - 8.5 sacks of cement per cubic yard of concrete, 0.75-inch maximum aggregate size, and a superplasticizer.

Results of this evaluation are presented on a 1:62,500 scale aggregate resources map (Drawing 3) and summarized as follows:

<u>Class CA1 and Class CA2 Sources</u>: Four basin-fill deposits in the area contained aggregates that, when used in Mix 3, produced 28-day compressive strengths greater than 6500 psi. Two of these sources are older lacustrine deposits (Aol) located on the east side of the valley, and two are alluvial fans (Aaf) located on the west side of the valley.

Crushed-rock aggregates from one rock source in the study area produced a 28-day compressive strength in excess of 6500 psi. This rock source is located on the east side of the valley and consists of quartzite (Qtz). A nearby fine aggregate source was used in conjunction with the crushed rock to produce trial concrete mixes.

Sufficient quantities of poor to fair quality fine aggregates are available in most basin-fill deposits. High quality, fine aggregate sources are lacking or of limited extent within the study area.

<u>Class CB Sources</u>: Ten alluvial fan (Aaf) and four small, older lacustrine (Aol) basin-fill deposits consisting of good to high quality aggregates, potentially acceptable for use as concrete construction materials, were delineated in the valley.

<u>Class CC1 Sources</u>: Four alluvial fans deposits (Aaf) and five small older lacustrine deposits (Aol) in the study area are classified as potential sources of concrete aggregates. They are correlated to Class CA1 sources based on geomorphological and compositional similarities.

<u>Class CC2 Sources</u>: Nine alluvial fan (Aaf) and numerous older lacustrine (Aol) basin-fill deposits have been classified as potential sources of concrete aggregates. They are correlated to Class CB units on the basis of geomorphological and compositional similarities.

CONCLUSIONS

Sufficient quantities of coarse and fine aggregates suitable for use as road-base and/or concrete construction material are available in Wah Wah Valley. Laboratory test results indicate that the quality of the coarse aggregates ranges from good to excellent, and the quality of the fine aggregates ranges from poor to satisfactory.

RECOMMENDATIONS

Additional aggregate field investigations and laboratory testing will be required to further refine the physical and chemical characteristics of road-base and concrete aggregate sources as borrow areas prior to the initiation of construction.

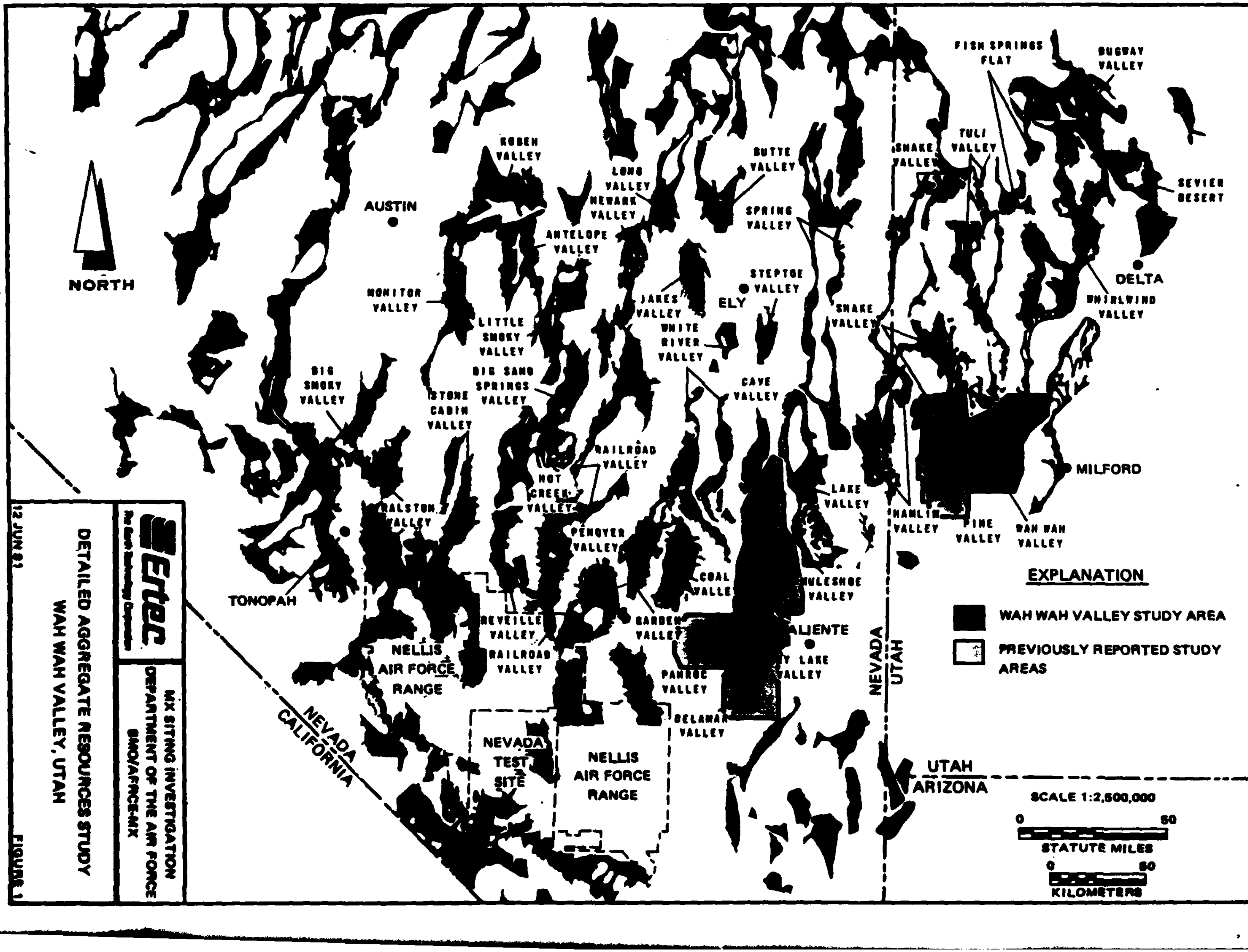
1.0 INTRODUCTION

1.1 STUDY AREA

This report presents the results of the Detailed Aggregate Resources Study (DARS) for Wah Wah Valley (Figure 1). Wah Wah Valley is located in portions of southwestern Millard County and northwestern Beaver County, Utah. It is bounded on the west by the Wah Wah Mountains and on the east by the San Francisco Mountains and isolated peaks (Squaw Peak and Antelope Peak). Sevier Lake and Tule Valley lie to the north of the study area, and the Escalante Desert lies to the south. Utah State Highway 21 provides paved-road access across the central portion of the study area. A network of graded, unpaved roads and four-wheel-drive trails provide access to most parts of the study area. Wah Wah Valley is mainly undeveloped desert rangeland administered by the Bureau of Land Management (BLM). Privately owned Wah Wah Ranch is located immediately north of Highway 21 in the center of the valley. The town of Milford, Utah, is located 25 miles (40 km) east of the study area.

1.2 BACKGROUND

Aggregate resources studies for the MX program were introduced in 1977 with the investigation of Department of Defense (DoD) and BLM lands in California, Nevada, Arizona, New Mexico, and Texas (FN-TR-20D). Refinement of the MX siting area added portions of Utah and Nevada that were not evaluated in this initial Aggregate Resources Evaluation Investigation (AREI). This additional area, defined as the Utah-Nevada aggregate resources study area, was examined in the fall of 1979 and a



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DETAILED AGGREGATE RESOURCES STUDY
WAH WAH VALLEY, UTAH

12 JUN 81

FIGURE 1

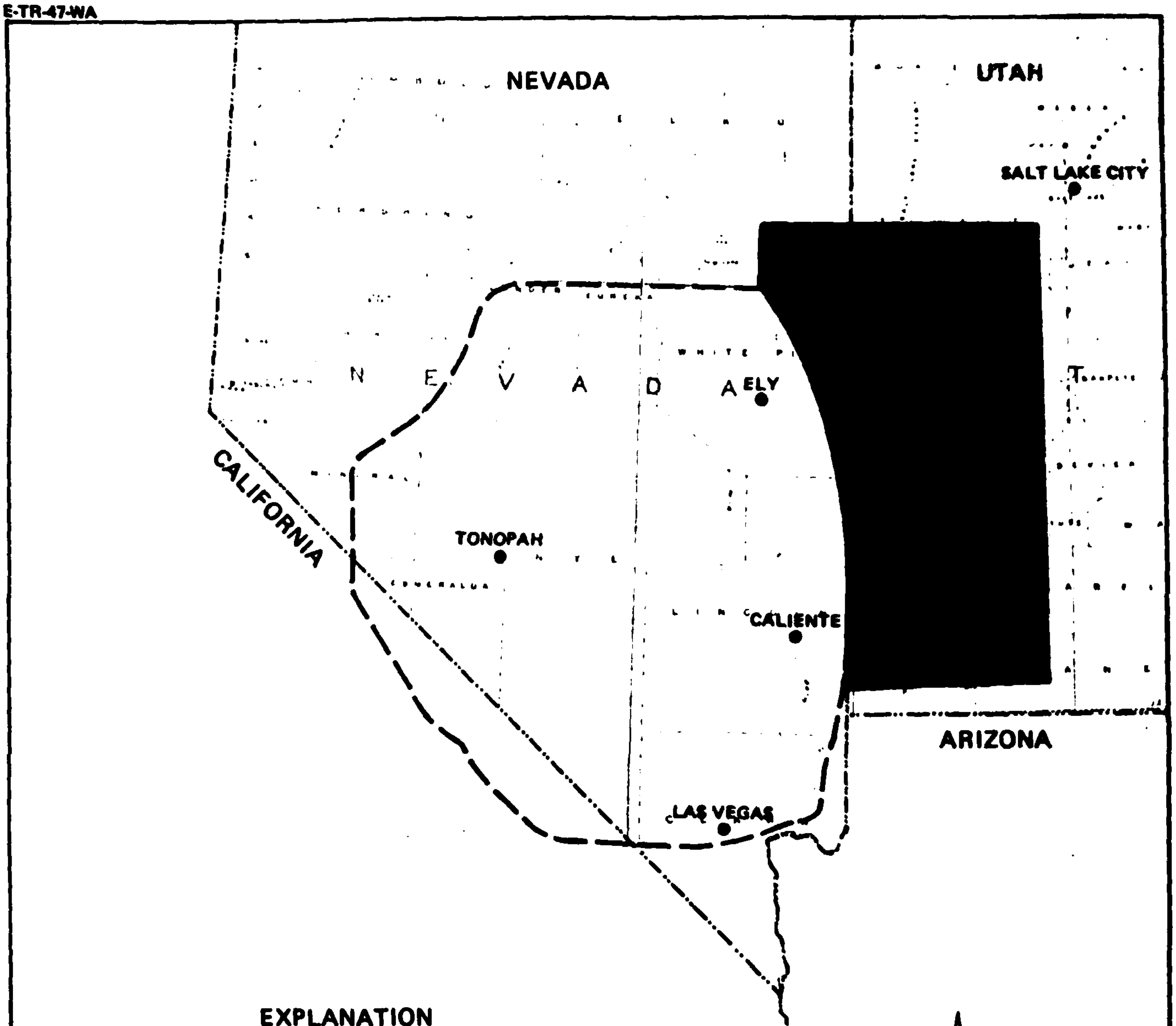
second regional aggregate resources report (FN-TR-34) was submitted on 3 March 1980 (Figure 2).

Both regional aggregate investigations consisted of the compilation and evaluation of existing data with limited field reconnaissance, sample collection, and laboratory aggregate testing. Only general information on the location, quality, and quantity of aggregates was provided.

Subsequent to the regional studies, Valley-Specific Aggregate Resources Studies (VSARS) were started in FY 79. The primary objective of these continuing studies is to provide additional information on potential aggregate sources in specified valleys and in the areas immediately surrounding them. Existing exposures of potential basin-fill and rock aggregate sources are sampled and subjected to a suite of laboratory tests. Results of these tests are used to classify coarse and fine basin-fill and crushed-rock aggregates for suitability as concrete and road-base construction materials.

The aggregate sources presented in the VSARS are to be used as a guide for preliminary construction planning and the selection of areas for more detailed-aggregate evaluations. To date, field investigations have been completed for 16 valley areas with final reports submitted for 11 valley areas (Figure 3). Field investigations for remaining valleys in the designated deployment area are planned in FY 81 and FY 82.

The DARS were initiated in FY 81 to further analyze and refine potential sources of coarse and fine basin-fill and crushed-rock



EXPLANATION

NEVADA–CALIFORNIA AGGREGATE RESOURCES STUDY AREA, FY 78 (FN-TR-20D)

UTAH AGGREGATE RESOURCES STUDY AREA, FY 79

NORTH

SCALE 1: 5,000,000

0 50 100 STATUTE MILES

0 50 100 KILOMETERS

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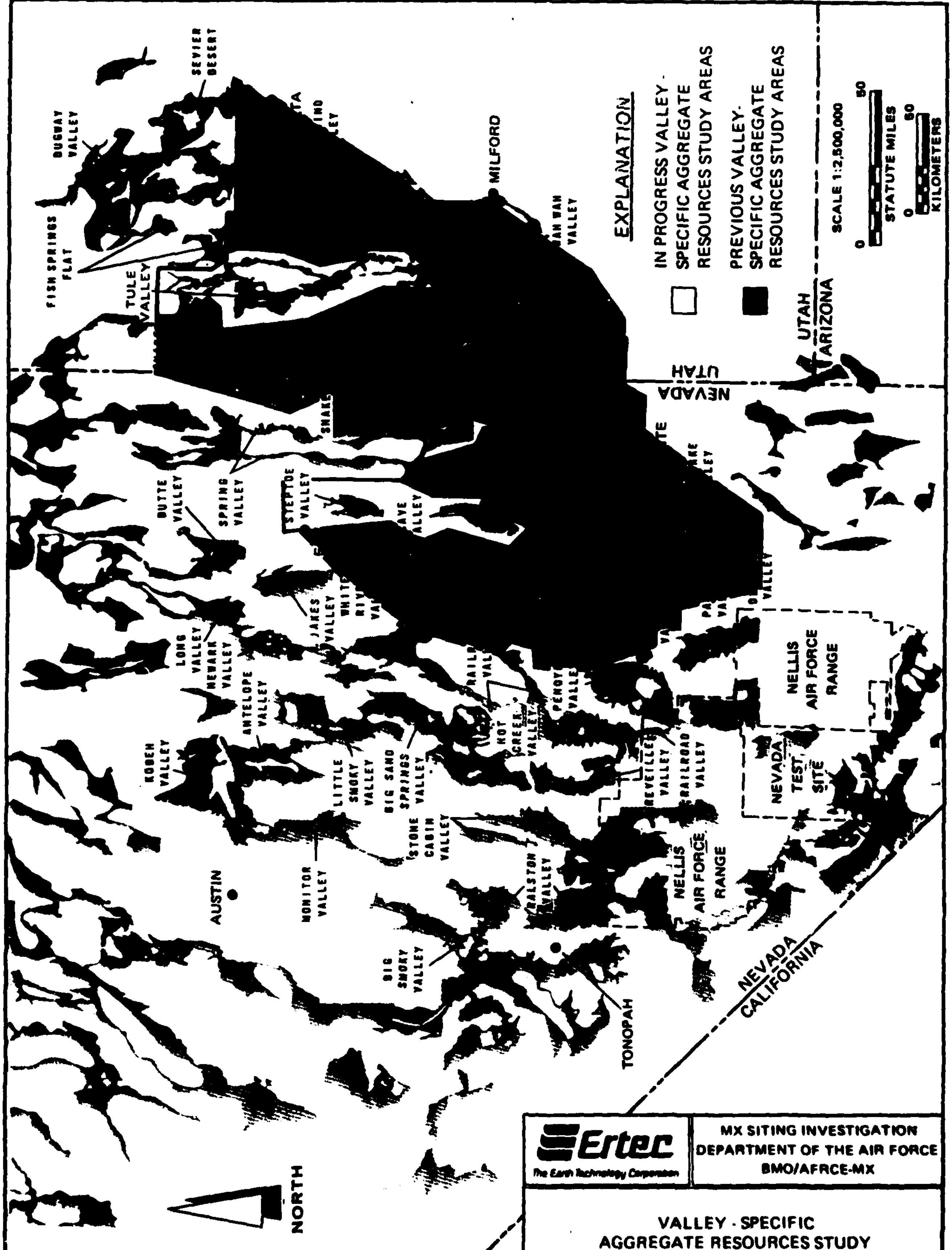
UTAH–NEVADA REGIONAL AGGREGATE STUDIES

12 JUN 81

FIGURE 2



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VALLEY - SPECIFIC
AGGREGATE RESOURCES STUDY
AREAS, NEVADA - UTAH

12 JUN 81

FIGURE 3

aggregates identified during the VSARS. These studies consist of both road-base (Section 3.0) and concrete (Section 4.0) aggregate evaluations. The major consideration was to further evaluate basin-fill deposits as potential sources of road-base and concrete aggregates. Limited new data were developed on crushed-rock sources.

1.3 OBJECTIVES

The objectives of the Detailed Aggregate Resources Study are as follows:

Road-Base Aggregates Evaluation

- o Refine potential basin-fill and rock sources (initially identified in VSARS) for road-base aggregates; and
- o Provide additional laboratory test data on the general quality of basin-fill aggregates for use as road-base material.

Concrete Aggregates Evaluation

- o Refine the areal extent of the most acceptable VSARS basin-fill and rock concrete aggregate sources; and
- o Provide additional laboratory testing information on the quality and the concrete-making properties of potential coarse and fine, basin-fill and crushed-rock aggregates.

1.4 SCOPE

The scope of the two evaluations required office and field studies and included the following:

a. Compilation and analysis of appropriate existing data on the quality and quantity of potential road-base and concrete aggregates. Major sources of data were other Ertec investigations for the siting of the MX system and the Utah State Department of Highways.

b. Initial and final basin-fill deposit differentiation based on geomorphology, grain size, lithology, and aerial-photograph and topographic-map interpretation. Initial and final rock-unit divisions based on evaluations of aerial photographs and published geologic maps.

c. Staking and permitting on selected BLM lands. Appropriate basin-fill trench locations for samples of road-base and concrete aggregates were determined from items a and b and a brief field reconnaissance.

d. Backhoe excavation of staked and permitted basin-fill locations, sampling when gravel percentage exceeded 30 percent, or when suitable fine aggregates for concrete mixes were present. Selection and sampling of acceptable crushed-rock sources of coarse aggregates for concrete mixes.

e. Valley-wide field reconnaissance utilizing aerial photographs and petrographic and grain-size analyses to determine lateral extent and acceptability of basin-fill deposits.

f. Laboratory tests to supplement available existing data for the determination of the suitability of specific basin-fill and rock units as sources of road-base or concrete aggregates. Trial (check) concrete mixes were made to evaluate the basic concrete-making properties of selected concrete aggregate sources as well as engineering properties of hardened concrete.

g. Development and application of road-base and concrete materials classification systems that textually and graphically depict the locations of the most suitable aggregate sources in the study area. The depiction and discussion of areas that are unsuitable or have a low probability for use were not done.

2.0 GEOLOGIC SETTING

2.1 PHYSIOGRAPHY

Wah Wah Valley lies within the Basin and Range Physiographic Province and exhibits the characteristic north-south trending, block-faulted mountain ranges and intervening alluvial basin. Elevations within the basin vary from about 5600 feet (1707 m) at the southern boundary to about 4640 feet (1414 m) on the playa in the north-central part of the valley. The lowest elevations within the study area are along the northeastern boundary of the study area on the Sevier Lake playa where elevations are as low as 4520 feet (1378 m) above sea level.

Mountain ranges, hills, and isolated peaks surround the alluvial basin on all sides. The basin is bounded on the southwest and west by the Wah Wah Mountains, on the northwest by the Gray Hills, on the north by the Black Hills, on the east by the San Francisco Mountains, and on the southeast by Squaw Peak, Antelope Peak, and numerous smaller hills. Topographic relief between mountain ridges and the basin varies from about 1300 to 4900 feet (396 to 1494 m).

Drainage in Wah Wah Valley is closed to the Wah Wah Valley Hardpan and open to the Sevier Lake playa.

2.2 LOCATION AND DESCRIPTION OF GEOLOGIC UNITS

Rocks of Precambrian, Paleozoic, and Cenozoic age are exposed within the study area. Various igneous, metamorphic, and sedimentary lithologies are represented. Unconsolidated Quaternary alluvial deposits unconformably overlie the older rock units.

Precambrian rocks are exposed in the San Francisco Mountains and consist of metaquartzite with interbedded phyllite and argillite. Paleozoic rocks crop out mainly in the Wah Wah Mountains, Gray Hills, Black Hills, and northern San Francisco Mountains and consist predominantly of Cambrian limestone and dolomite with appreciable thicknesses of orthoquartzite and minor interbeds of sandstone, siltstone, and shale. Cenozoic rocks consist of Tertiary igneous extrusive and intrusive rocks. Extrusive rocks crop out extensively in the southern Wah Wah Mountains and in the isolated hills and peaks to the south and southwest of Wah Wah Valley. These extrusive rocks are ash-flow and air-fall tuffs and lava flows ranging in composition from basaltic to rhyolitic. The Cenozoic intrusive rocks are exposed in the southern San Francisco Mountains and range in composition from dioritic to granitic.

Quaternary alluvial deposits unconformably overlie older rocks and consist of alluvial fan, older lacustrine, and stream-channel and terrace deposits.

Additional geologic information is presented in previous Ertec reports (FN-TR-27-WA-I and II; FN-TR-37-g).

Specific Paleozoic and Cenozoic geologic units have been grouped into five rock and two basin-fill categories for use in discussing potential aggregate sources. The grouping of the units was based on similarities in physical and chemical characteristics and map-scale limitations. The resulting categories simplify discussion and presentation without altering the conclusions of the study.

2.2.1 Rock Units

Geologic rock units that are potential sources of crushed-rock aggregates are grouped into the following five categories; quartzite (Qtz), limestone (Ls), carbonate rocks undifferentiated (Cau), granitic rocks (Gr), and basalt (Vb).

2.2.1.1 Quartzite - Qtz

Two quartzite units are present in the study area. They are an unnamed Precambrian quartzite and the Cambrian Prospect Mountain Quartzite.

The unnamed Precambrian quartzite is exposed in the San Francisco Mountains. This unit consists of medium- to thick-bedded, fine- to medium-grained, purple to red-brown metaquartzite with interbedded argillite and phyllite.

The Cambrian Prospect Mountain Quartzite overlies the unnamed Precambrian quartzite. There is only one small outcrop of Prospect Mountain Quartzite in the study area. This outcrop is located in the Wah Wah Mountains south of Highway 21 and consists of thin- to thick-bedded, fine- to medium-grained, pinkish-gray to reddish-brown orthoquartzite with interbedded sandstone, micaceous shale, and conglomerate.

2.2.1.2 Limestone - Ls

The only unit in the study area mapped as limestone is the Cambrian Orr Formation. This unit crops out in the Wah Wah Mountains and typically consists of thin- to thick-bedded, fine- to coarse-grained, light- to dark-gray limestone with interbedded dolomite, chert, sandstone, siltstone, and shale.

2.2.1.3 Carbonate Rocks Undifferentiated - Cau

The only unit mapped as undifferentiated carbonate rock is the Cambrian Notch Peak Formation. This unit crops out in the western Gray Hills and in the Wah Wah Mountains. The lithology of this unit varies somewhat but is typically medium- to thick-bedded, fine- to medium-grained, medium- to dark-gray dolomite and limestone with interbedded clastic rocks and chert.

2.2.1.4 Granitic Rocks - Gr

Granitic rocks of Tertiary age are exposed in the southern San Francisco Mountains and in the central Wah Wah Mountains. These units are typically medium-grained, moderately well-jointed, gray to brownish-gray rocks that are dioritic to granitic in composition.

2.2.1.5 Basalt - Vb

A basalt flow of Tertiary age forms a prominent knoll located immediately south of the Black Hills. The basalt is typically brown to black, very hard, fine-grained, thick- to very thick-bedded, moderately to poorly jointed, and vesicular.

2.2.2 Basin-fill Units

Basin-fill units within the study area that are sources of coarse and fine aggregates are alluvial fan deposits (Aaf) and older lacustrine deposits (Aol). other basin-fill units may locally supply aggregates but are not considered major sources and will not be discussed.

2.2.2.1 Older Lacustrine Deposits - Aol

Older lacustrine deposits in Wah Wah Valley were formed by Pleistocene Lake Bonneville. The highest strand elevation of Lake Bonneville was approximately 5200 feet (1585 m). Older lacustrine deposits are typically poorly graded and moderately to well-stratified. Deposits on the east side of the valley consist predominantly of boulders, cobbles, gravel, and sand derived from quartzitic source rocks. Deposits along the west side are generally gravel and sand with some cobbles, silt, and clay from predominantly carbonate source rocks.

2.2.2.2 Alluvial Fan Deposits - Aaf

Alluvial fan deposits are the most extensive sources of basin-fill aggregates in the study area. They are located in all parts of the valley adjacent to the mountain ranges. Alluvial fans generally consist of poorly to well-graded, poorly stratified sandy gravel and gravelly sand. Fans derived from volcanic source rocks are predominantly sand and fine gravel. Fans derived from quartzite and carbonate rocks are coarser grained and contain more coarse gravel, cobbles, and boulders. Most alluvial fan units have developed soil horizons consisting of silty, clayey sand a few inches to 1 foot (0.3 m) in thickness overlying a zone of carbonate accumulation (caliche). The caliche horizon generally ranges in thickness from 1 to 3 feet (0.3 to 1 m) and exhibits Stage II to III development (Appendix F-2).

3.0 ROAD-BASE AGGREGATES EVALUATION

3.1 STUDY APPROACH

The primary objective of the road-base aggregate study was to evaluate the suitability of basin-fill and rock aggregates for use as road base. Two important considerations were applied to basin-fill aggregate sources identified as potentially suitable in VSARS, refinement of source boundaries, and additional laboratory tests to further evaluate physical and chemical characteristics. Sources of crushed-rock aggregates were refined using only existing data, published geologic maps, and limited photogeologic interpretations. Information on potential rock sources for use as road-base aggregates was not specifically collected for this evaluation. Only existing VSARS data and data developed from the concrete aggregates evaluation (Section 4.1) were assessed.

The study approach for the road-base aggregates evaluation required a review of previous Ertec Verification (FN-TR-27-WA-I and II) and aggregate reports (FN-TR-34 and FN-TR-37-g) for Wah Wah Valley. This data base helped define the scope of the road-base materials investigation which included office and field photogeologic and topographic interpretations, field reconnaissance, and collection and laboratory testing of basin-fill samples.

3.1.1 Requirements for Road-Base Aggregates

For the purpose of this report, road-base aggregates are defined using the Nevada Department of Highways (1976) classification of

Type I Class A aggregate base. The requirements for aggregates suitable for such a base are as follows:

Gradation:

Sieve Size	Percent Passing by Weight
1.5 inches	100
1.0 inch	80-100
No. 4	30- 65
No. 16	15- 40
No. 200	2- 12

Fractured Faces .... 35 percent, minimum
Plasticity Index .... 3-15 percent
Liquid Limit .... 35 maximum
Resistance (R value) .... 70 minimum
Percent Wear (500 Rev.) .... 45 percent, maximum

During the road-base aggregate studies, gradation and percent wear were the two primary criteria used to evaluate potential source areas. Magnesium sulfate ($MgSO_4$) soundness tests were performed on selected coarse aggregate samples to gain additional information related to the effects of weathering on aggregates. Soundness losses exceeding 18 percent for coarse aggregates were considered potentially unacceptable (American Society of Testing and Materials, 1978). The remaining requirements were not evaluated during this study.

3.1.2 Data Acquisition and Analysis

Office studies for the road-base aggregates evaluation required preliminary basin-fill and rock-unit differentiation based on photogeologic interpretations and published topographic and geologic maps. All available data on basin-fill, grain-size gradations were compiled to estimate gravel content for the defined basin-fill units.

The field program involved backhoe excavation of 51 trenches selected during office studies and initial field reconnaissance. Trenches were excavated and sampled in groups of two or three, 0.1 to 0.2 mile (0.2 to 0.3 km) apart or in groups of five, 150 feet (46 m) apart, to characterize individual basin-fill units. Completion depths ranged from 12 to 15 feet (3.7 to 4.6 m) and, where collected, representative samples averaged 100 pounds (45 kg) per trench.

Due to gradation variability in basin-fill deposits, field limits of 30 percent or more gravel and 20 percent or less silt and clay were established as basic aggregate grain-size distribution requirements. Gravel is defined as coarse aggregates which pass the 3.0-inch (75-mm) sieve and are predominantly retained on a No. 4 (4.75-mm) sieve. Aggregates larger than 3.0 inches (cobbles and boulders) were generally present in the materials investigated but were not included in the laboratory samples because of sample-size limitations. Silt and clay particles are defined as material passing through a No. 200 sieve (0.0029-inch [0.075-mm]).

Field studies also included 41 petrographic and grain-size data field stops and valley-wide photogeologic field reconnaissance. These analyses were performed to supplement and confirm office studies and to provide a data base for lithologic and gradation correlations of basin-fill units.

Laboratory testing that included 25 sieve analyses, nine abrasion tests, and five $MgSO_4$ soundness tests was performed to broaden the existing data base during the road-base aggregates evaluation. Confirmation test data (gradation, abrasion, and soundness tests) from the concrete aggregates evaluation (Section 4.0) were also used to supplement test data for the road-base aggregates evaluation.

The scope of the study did not allow sample collection and laboratory testing of all potential road-base aggregate sources. Existing data and field petrographic and grain-size analyses were used to correlate lithologic and gradation properties to basin-fill units which were not sampled. An important element of this correlation procedure was the use of aerial photographs to help delineate the lateral extent of basin-fill deposits. Photogeologic and field observations ascertained geomorphological and topographical relationships of basin-fill units and the source rock lithology and distribution of predominantly gravelly materials.

3.1.3 Presentation of Results

Results of the road-base aggregates evaluation are presented in the form of text, figures, 1:62,500 scale drawings, and appendices. Drawing 1 shows the locations of all the data points used in the Detailed Aggregate Resources Study. The data points are grouped by study type and assigned categorized map numbers. VSARS data points are designated by map numbers 1 to 199 and correspond to map numbers in the appendix table of the Wah Wah area VSARS report (FN-TR-37-g). DARS data points are assigned map number groups 200 to 299 for trench locations and 300 to 399 for petrographic and grain-size data stop locations. Verification data points are assigned the map number group 400 to 599. For direct reference, appendix Table G-1 converts map number to the Wah Wah Valley Verification Report (E-TR-27-WA-I and II) activity type and number.

Drawing 2 presents the locations of all potential road-base aggregate sources, DARS trenches, DARS field petrographic and grain-size data stops, and select VSARS data stops in the study area. Geologic unit symbols used in Drawing 2 relate to standard geologic nomenclature whenever possible. A conversion table relating these symbols to the geologic unit nomenclature used in other Ertec reports is contained in Appendix Table F-3.

A solid contact line separates basin-fill and rock units in Drawing 2 to differentiate these two basic material types. All rock contacts are from published data or limited air-photo interpretation and are dashed. Basin-fill contacts are derived from photogeological mapping with limited field reconnaissance and are also dashed.

Classifications of potential sources of basin-fill and crushed-rock road-base aggregates are distinguished by different patterns. Patterns for basin-fill and rock sources of the same classification are similar, with the basin-fill pattern emphasized by a dark background tone.

The appendices contain tables that summarize the basic field data collected during the course of the study and the subsequent laboratory test procedures and results. Appendices A and B include DARS trench data and petrographic and grain-size analysis data, respectively. Appendix C contains representative trench logs. Appendix Table D-1 presents a laboratory testing flow diagram for the road-base aggregates evaluation. Appendix F includes three tables describing soil classification, caliche development, and geologic unit cross reference.

3.1.4 Classification of Road-Base Aggregates

A classification system was designed to present the most likely locations of potential sources of basin-fill and crushed-rock road-base aggregates. It was developed from an evaluation as well as from an extrapolation of all available data.

This classification system is primarily based on laboratory test results (gradation, abrasion and, to a lesser extent, soundness) and geomorphological and compositional correlations. The classification is presented in hierarchy form; classification of the highest potential source areas is described first, and classification of the lowest potential source areas is described last.

Class	Explanation
RBIa	Basin-fill or rock sources containing materials suitable for use as road-base aggregates; based on acceptable laboratory aggregate test results.

Class RBIa includes those source areas where the potential for suitable road-base aggregates is the highest. Each delineated area has been sampled and tested. In order to assign Class RBIa to a basin-fill deposit, the source must satisfy the overall requirements outlined in Section 3.1.1.

Class	Explanation
RBIb	Basin-fill sources containing materials suitable for use as road-base aggregates; based on correlation with Class RBIa source areas.

Class RBIb basin-fill deposits are correlated to tested RBIa deposits on the basis of limited laboratory sieve analysis data and field observations. Field observations included petrographic and grain-size analyses which provided data on the lithology of adjacent source rock and general amounts and lithologies of gravel present in the basin-fill units. Photogeologic interpretations were also used to correlate Class RBIb deposits to RBIa deposits. Specific geomorphological parameters included surface texture, drainage patterns, relative relief, and topographic profiles.

Class	Explanation
RBII	Potential basin-fill sources of materials suitable for use as road-base aggregates; based on photogeologic interpretations, field observations, and limited or inconclusive sieve analysis and/or abrasion data.

Class RBII includes poorly defined basin-fill aggregate sources. Field observations and inconclusive field and laboratory data indicate these deposits may be potentially acceptable for use as road-base aggregate sources.

All classifications are based on limited data. Additional field reconnaissance, testing, and case history stud[illegible] are needed to confirm adequacy, delimit exact areal boundaries, and refine chemical and physical characteristics.

3.2 SOURCES OF ROAD-BASE AGGREGATES

The potential basin-fill and rock units defined for use as road-base aggregates in the Wah Wah Valley study area include alluvial fan deposits (Aaf), older lucustrine deposits (Aal), and five rock units.

3.2.1 Basin-fill Sources

All three classes of road-base aggregates, RBIa, RBIb, and RBII, are present in the basin-fill units of Wah Wah Valley (Drawing 2).

3.2.1.1 Class RBIa

Class RBIa sources within the study area are located adjacent to the Wah Wah Mountains, Gray Hills, Black Hills, and San Francisco Mountains. There are 22 RBIa basin-fill deposits, 15 are alluvial fan units (Aaf), and seven are older lacustrine units (Aol).

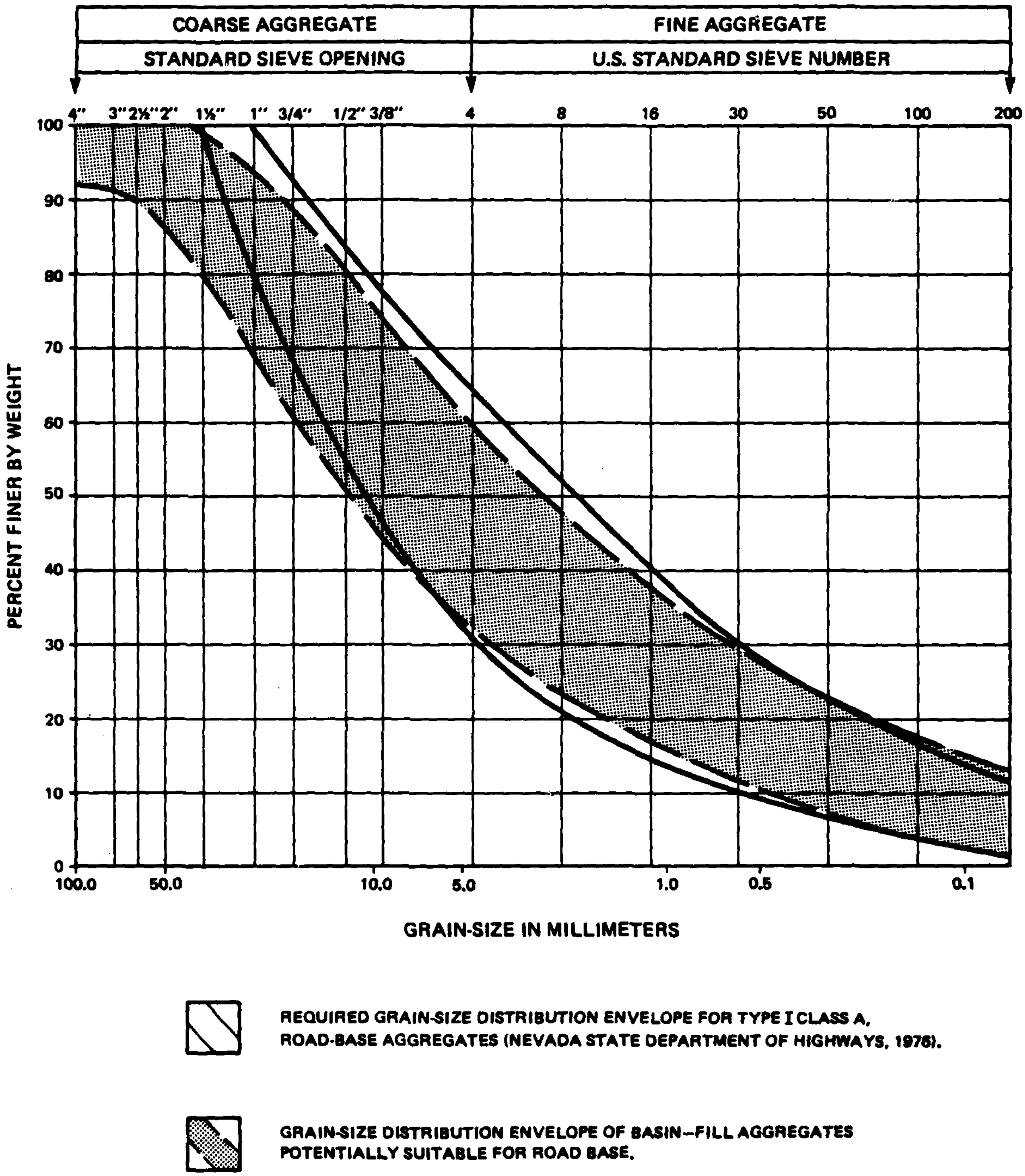
Class RBIa alluvial fan deposits (Aaf) typically consist of medium-dense to dense, poorly to well-graded, angular to subrounded sandy gravel and gravelly sand. The gravel content of alluvial fan deposits generally ranges from about 40 to 65 percent of the material less than 3 inches; the sand ranges from about 25 to 50 percent; and the silt and clay ranges from about three to 15 percent. Cobbles and boulders comprise from five to 20 percent of Aaf deposits.

Class RBIa older lacustrine deposits (Aol) typically consist of loose to medium-dense, poorly graded, subrounded to rounded sandy gravel. The ranges of gravel and sand within these deposits are similar to the alluvial deposits. Silt and clay, however, generally comprise only one to three percent (of the less than 3-inch material) of the deposits on the east side of the valley and three to eight percent of the deposits on the west side of the valley. Cobbles and boulders comprise up to 15 percent of the Aol deposits on the east side and up to 10 percent of the deposits on the west side of the valley.

The lithology of Class RBIa basin-fill deposits, both Aaf and Aol, is a function of geographic location. Deposits located on the east side of the valley, adjacent to the San Francisco Mountains and north of Highway 21, are composed either entirely or predominantly of quartzite material with minor amounts of carbonate, volcanic, and granitic material. Class RBIa deposits adjacent to the Gray Hills and Wah Wah Mountains north of Highway 21 on the west side of the valley are composed primarily of limestone and dolomite with minor amounts of sandstones, volcanics, and quartzite. All Class RBIa deposits south of Highway 21 are composed predominantly of volcanic material with lesser amounts of clastic and carbonate sedimentary material. One exception to these lithologic trends is the Class RBIa alluvial fan deposit located immediately north of Highway 21 on the east side of the valley. This deposit is composed mainly of granitic material with lesser amounts of quartzite, carbonate and volcanic clasts. The deposit located in the center of the valley basin immediately north of 38°30' N latitude is composed predominantly of carbonate material with a lesser amount of volcanic material.

Although Aol deposits are slightly coarser than Aaf deposits, all of the Class RBIa basin-fill deposits share the following general gradation characteristics (Figure 4); boulders, cobbles, and oversize gravel (3- to 1.5-inch) are present, coarse gravel passing the 1.5-inch sieve is less than required, and fine gravel and sand passing the 0.5-inch to No. 200 sieves are within gradation requirements. A few of the deposits are also deficient in gravels passing the 1-inch and 0.75-inch sieves. There is one exception to the gradation trend of the Class RBIa deposits. The Aol deposit on the east side of the valley and about 5 miles north of 38°30' N is significantly coarser than other Class RBIa deposits. The percentages of gravel and sand passing sieve sizes 1.5-inch to No. 16 fall well below gradation requirements. Gradation curves of samples collected from this deposit are not included in the gradation envelope for Class RBIa deposits (Figure 4). In general, minor processing will be necessary to bring the RBIa deposits within gradation requirements.

It has been observed that variations in grain-size gradations occur within a deposit depending on sample location. In general, gradations within a deposit are finer near the valley



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GRAIN-SIZE DISTRIBUTION ENVELOPES
ROAD-BASE AGGREGATES, CLASS RBIa
WAH WAH VALLEY, UTAH

12 JUN 81 — FIGURE 4

axis and coarser near the mountain fronts. Due to access restrictions, samples were often collected at distal and medial locations within each deposit.

Laboratory abrasion tests performed on 32 samples (both DARS and VSARS) from RBIa deposits yielded results ranging from 18.5 to 42.1 percent wear. Laboratory $MgSO_4$ soundness tests performed on samples from most RBIa deposits revealed a significant difference in soundness losses between Aol deposits and Aaf deposits. Soundness losses for Aol deposits ranged from 0.2 to 3.6 percent for coarse aggregates and from 4.0 to 13.2 percent for fine aggregates; whereas, soundness losses for Aaf deposits were considerably higher and ranged from 1.6 to 22.6 percent for coarse aggregates (most were less than 15 percent) and from 13.9 to 36.5 percent for fine aggregates. Generally, the highest soundness losses were in Aaf deposits composed predominantly of volcanic material.

The areal extent of Class RBIa alluvial-fan deposits range from approximately 50 acres (0.2 km^2) to 9.5 mi^2 (24.6 km^2). It is estimated that the thickness of the material in these deposits, as described above, is at least 25 feet (7.6 m) and that 70 to 90 percent of this material will be suitable for use as road-base aggregates.

The Class RBIa older lacustrine deposits range in areal extent from approximately 20 acres (0.1 km^2) to 0.7 mi^2 (1.8 km^2). The thickness of these deposits is highly variable, ranging from a few feet to about 100 feet (30.5 m). It is estimated that 80 to 90 percent of the material in these deposits will be suitable for use as road-base aggregates.

3.2.1.2 Class RBIb

Class RBIb basin-fill aggregate sources consist of alluvial units that have been correlated to Class RBIa deposits and, therefore, are considered to contain material acceptable for use as road-base aggregates. Class RBIb deposits are located in all parts of the valley and consist of 13 alluvial fan units (Aaf) and numerous small older lacustrine deposits (Aol).

Since Class RBIb deposits are correlated to Class RBIa deposits, they have the same general characteristics as the RBIa deposits. The alluvial fans consist of medium-dense to dense, poorly to well-graded, angular to subrounded sandy gravel and gravelly sand. Aol deposits consist of loose to medium-dense, poorly graded, subrounded to rounded sandy gravel. Class RBIb deposits in the southern part of the valley are composed predominantly of volcanic material, the deposits in the east and northeast are mostly quartzitic, and the deposits in the west and northwest are composed mainly of carbonate material.

Although variations in grain-size gradations will occur, depending on sample location within the deposit and the proximity of the deposit to its source area, Class RBIb deposits are interpreted to have gradation distributions similar to Class RBIa deposits.

Individual Class RBIb alluvial fan deposits range in areal extent from 0.3 to 2.8 mi^2 (0.8 to 7.3 km^2). It is estimated that the thickness of the material in these deposits, as described above, is at least 25 feet (7.6 m). From 70 to 90 percent of the material in Class RBIb alluvial fans will be suitable for use as road-base aggregates.

The Class RBIb older lacustrine deposits range in areal extent from a few acres for some of the smaller deposits to 0.3 mi^2 (0.8 km^2). The thickness of these deposits is highly variable, ranging from a few feet to greater than 25 feet (7.6 m). Generally, 80 to 90 percent of the material in the Aol deposits will be suitable for use as road-base aggregates.

3.2.1.3 Class RBII

Class RBII basin-fill aggregate sources are alluvial units that are potentially acceptable for use as road base. These deposits have been classified on the basis of limited field and laboratory data collected during this and other Ertec studies.

There are 10 Class RBII deposits located in all parts of the valley adjacent to the Black Hills, Wah Wah Mountains, San Francisco Mountains, and near Antelope Peak. All of the Class RBII deposits are alluvial fan units (Aaf).

Limited laboratory and field data used to define the Class RBII deposits in the study area indicate that they are compositionally similar to Class RBIa and RBIb deposits, consisting of sandy gravel and gravelly sand composed predominantly of quartzite clasts on the east side of the valley, carbonate clasts on the west side of the valley, and volcanics south of Highway 21. However, there may be considerable variations from this general description within individual deposits.

The areal extent of the individual Class RBII deposits range from approximately 0.5 to 5.0 mi^2 (1.3 to 13.0 km^2).

3.2.2 Rock Sources

The study approach used to evaluate road-base aggregates emphasized the analysis of basin-fill deposits and dictated that only previously tested, crushed-rock sources be discussed and classified. As a consequence, other rock units potentially suitable as sources of crushed-rock, road-base aggregates are not included or described in this study.

Sources of crushed rock for use as road-base aggregates consist of quartzite (Qtz), granitic rocks (Gr), undifferentiated carbonate rocks (Cau), limestone (Ls), and basalt (Vb), all classified as RBIa. There are two Class RBIa quartzite outcrops located in the San Francisco Mountains. The larger is located in the central part of the range, and the smaller is an outlier in the northwest part of the valley. The Class RBIa granitic rock source is also located in the San Francisco Mountains immediately south of latitude 38°30' N. A fairly extensive outcrop of Class RBIa undifferentiated carbonate rocks is located in the northwest corner of the study area in the Gray Hills. East of this, at the end of a ridge projecting into the valley, is a smaller exposure of Class RBIa limestone. A prominent knoll located just south of the Black Hills in the north-central part of the study area consists of Class RBIa basalt.

Results of laboratory abrasion tests performed on samples from the Class RBIa rock units range from 23.4 to 30.5 percent wear. Laboratory $MgSO_4$ soundness test results range from 0.2 to 6.7 percent loss. These test results are well below the maximum acceptable values for road-base aggregates.

4.0 CONCRETE AGGREGATES EVALUATION

4.1 STUDY APPROACH

The purpose of the concrete aggregates evaluation is to determine the suitability of aggregates within Wah Wah Valley for use in concrete. To accomplish this, two objectives have been established:

- o Evaluate the basic physical and chemical characteristics of the aggregates; and
- o Determine the concrete-making properties of the aggregates.

The study approach required to achieve these objectives included a review of previous Ertec Verification (FN-TR-27-WA-I and II) and aggregate reports (FN-TR-34 and FN-TR-37-g). This data base helped define the scope of the concrete aggregates investigation and included office and field photogeologic and topographic interpretations, field reconnaissance, and collection and laboratory testing of basin-fill and rock samples.

4.1.1 Requirements for Concrete Aggregates

The following requirements for aggregates and concrete (made using these aggregates) were established using criteria from the American Society of Testing and Materials (1979), the "Concrete Manual" prepared by the United States Department of the Interior (1975), and from Milos Polivka (1981, personal communication).

1. Aggregates

   - o Gradation - The aggregate gradation specifications used by the American Society of Testing and Materials (1979, C 33) were selected to evaluate the samples tested. These grading specifications follow.

Coarse Aggregates

Sieve Size	Percent Passing by Weight	Sieve Size	Percent Passing by Weight
2 inches	100	1 inch	100
1.5 inches	95-100	0.75 inch	90-100
1 inch	---	0.5 inch	---
0.75 inch	35-70	0.375 inch	20-55
0.50 inch	---	No.4	0-10
0.375 inch	10-30	No.8	0-5
No.4	0-5		

Fine Aggregates

Sieve Size	Percent Passing by Weight
0.375 inch	100
No.4	95-100
No.8	80-100
No.16	50-85
No.30	25-60
No.50	10-30
No.100	2-10
No.200	

- Abrasion - Los Angeles Machine abrasion losses for coarse aggregates are not to exceed 50 percent.

- Soundness - Five-cycle magnesium sulfate ($MgSO_4$) soundness losses are not to exceed 18 percent and 15 percent for coarse and fine aggregates, respectively. Although not a requirement for the evaluation, five-cycle sodium sulfate ($NaSO_4$) soundness tests are performed on samples that failed $MgSO_4$ testing. Resultant losses are not to exceed 12 percent and 10 percent for coarse and fine aggregates, respectively.

- Reactivity - Aggregates are to be nonreactive to alkali-silica and alkali-carbonate rock tests. Results are incomplete and will be submitted as an addendum to this report.

2. Concrete

- Compressive Strength - The primary concrete requirement is a 28-day compressive strength equal to or greater than 6500 psi.

- Static Modulus of Elasticity - Values of 3 to 6 millicn psi at 28 days required.
- Splitting Tensile Strength - Values of 10 percent or less of the compressive strength value at 28 days required.
- Ultimate Drying Shrinkage - Values of 0.03 to 0.10 percent (300 to 1000 millionths) required.

4.1.2 Data Acquisition and Analysis

4.1.2.1 Office Studies

Office studies for the concrete aggregates evaluation required preliminary basin-fill and rock unit differentiation based upon photogeologic interpretations and published topographic and geologic maps. All available data on basin-fill, grain-size gradations were compiled to estimate gravel content for the defined basin-fill units. All available test data on the aggregate properties of basin-fill and rock units were compiled to select sample locations in units previously tested and found preliminarily acceptable for use as concrete aggregate sources.

4.1.2.2 Field Studies

The field program involved backhoe excavation of 21 trenches selected during office studies and initial field reconnaissance; 20 trenches were excavated to obtain samples of coarse and fine aggregates (gravel and sand), and one was excavated to obtain a sample of fine aggregates (sand).

Due to gradation variability in basin-fill deposits, field limits of 30 percent or more gravel and 15 percent or less silt and clay were established as basic aggregate grain-size distribution requirements. Gravel is defined as coarse aggregates which pass the 3.0-inch (75-mm) sieve and are predominantly retained on a No. 4 (4.75-mm) sieve. Silt and clay particles are defined as material passing through a No. 200 sieve (0.0029-inch [0.075-mm]).

The 20 trenches excavated to collect basin-fill samples for concrete aggregate evaluations were grouped into four sets of five trenches 150 feet apart (46 m) to characterize individual basin-fill units. A single trench was excavated to investigate a fine aggregate source. Trenches were excavated to depths ranging from 12 to 15 feet (3.7 to 4.6 m). Representative bulk samples averaged 400 pounds (182 kg) per trench. The sample from the fine aggregate trench weighed approximately 800 pounds (364 kg). A bulk sample of surface rock, weighing about 1200 pounds (545 kg), was collected manually.

Field studies also included 41 petrographic and grain-size data field stops and valley-wide photogeologic field reconnaissance. These analyses were performed to supplement and confirm the office studies and to provide a broader data base for lithologic and gradation correlations of basin-fill units.

4.1.2.3 Laboratory Testing

The laboratory aggregate testing program was performed in two phases. The first phase consisted of standard tests for determining the basic properties of the aggregates and included the following:

- o Unit Weights and Voids in Aggregates;
- o Standard Specifications for Concrete Aggregates;

- o Soundness of Aggregates, Magnesium Sulfate ($MgSO_4$) and Sodium Sulfate ($NaSO_4$);
- o Sieve Analysis by Washing, less than No. 200 fraction;
- o Fineness Modulus;
- o Specific Gravity and Absorption, Coarse and Fine Aggregates;
- o Resistance to Abrasion, Los Angeles Machine;
- o Sieve Analysis, Coarse and Fine Aggregates; and
- o Petrographic Examination of Aggregates for Concrete.

Generally, these tests were performed on aggregates from different locations within sources previously tested and identified as the most promising in the VSARS program. This repetitive testing was done to confirm the suitability of aggregates for concrete (see Section 4.1.1, Requirements for Concrete Aggregates). Table 1 lists the number of tests completed in Wah Wah Valley.

The second phase of the testing consisted of an evaluation of the concrete-making properties of the aggregates when used in the following three trial (check) concrete mixes.

Mix 1 - 7.5 sacks (94 pounds per sack) of cement per cubic yard of concrete with 1.5-inches maximum aggregate size.

Mix 2 - 8.5 sacks (94 pounds per sack) of cement per cubic yard of concrete with 1.5-inches maximum aggregate size.

Mix 3 - 8.5 sacks (94 pounds per sack) of cement per cubic yard of concrete with 0.75-inch maximum aggregate size and a superplasticizer.

	ASTM STANDARD TEST	AGGREGATE AND CONCRETE TEST DESCRIPTIONS [1]	TOTAL NUMBER OF TESTS*			
			BASIN-FILL		ROCK	
			CA	FA	ROCK	FA
AGGREGATES	C29	UNIT WEIGHT AND VOIDS IN AGGREGATE	4		1	
	C33	STANDARD SPECIFICATIONS FOR CONCRETE AGGREGATE	4		1	
	C88	SOUNDNESS OF AGGREGATE; $MgSO_4/NaSO_4$	4/–	4/4	1/–	1/1
	C117	SIEVE ANALYSIS BY WASHING, < # 200 FRACTION	8		–	1
	C125	FINENESS MODULUS	–	4	–	1
	C127	SPECIFIC GRAVITY/ABSORPTION, COARSE AGGREGATE	24/8	–/–	6/2	–/–
	C128	SPECIFIC GRAVITY/ABSORPTION, FINE AGGREGATE	–/–	12/4	–/–	3/1
	C131	RESISTANCE TO ABRASION, LOS ANGELES MACHINE	4	–	1	–
	C136	SIEVE ANALYSIS, COARSE AND FINE AGGREGATE	27	23	2	2
	C295	PETROGRAPHIC EXAM. OF AGGREGATES FOR CONCRETE	4	4	1	1
CONCRETE	C39	COMPRESSIVE STRENGTH OF CYLINDRICAL CONCRETE SPECIMENS	96		24	
	C138	UNIT WEIGHT, YIELD, AIR CONTENT OF CONCRETE	12		3	
	C143	SLUMP OF PORTLAND CEMENT CONCRETE	16		4	
	C157	LENGTH CHANGE OF HARDENED CEMENT MORTAR AND CONCRETE	120		30	
	C173	AIR CONTENT OF CONCRETE, VOLUMETRIC METHOD	12		3	
	C192	MAKING AND CURING CONCRETE SPECIMENS	12		3	
	C227	POTENTIAL ALKALI-SILICA REACTIVITY, MORTAR-BAR METHOD	–	2 (IP)	–	1 (IP)
	C469	STATIC MODULUS OF ELASTICITY, POISSONS RATIO OF CONCRETE IN COMPRESSION	96		24	
	C496	SPLITTING TENSILE STRENGTH OF CYLINDRICAL CONCRETE SPECIMENS	24		6	
	C684	MAKING AND TESTING ACCELERATED CURE CONCRETE COMPRESSION TEST SPECIMENS	24		6	
	222-1-77 [2]	SELECTING PROPORTIONS FOR NORMAL AND HEAVY WEIGHT CONCRETE	12		3	
	PROP. [3]	POTENTIAL ALKALI-CARBONATE ROCK REACTIVITY, LENGTH CHANGE METHOD	1 (IP)		–	
	C39-65 [4]	COEFFICIENT OF LINEAR THERMAL EXPANSION OF CONCRETE	24 (IP)		6 (IP)	

1. AMERICAN SOCIETY FOR TESTING AND MATERIALS (1978)
2. AMERICAN CONCRETE INSTITUTE (1977)
3. MIELENZ (1980) PROPOSED ASTM STANDARD TEST
4. UNITED STATES ARMY CORPS OF ENGINEERS (1977)

(IP) - TEST IN PROGRESS

* BASIN-FILL SOURCES SUPPLIED BOTH COARSE AND FINE AGGREGATES FOR CONCRETE MIX. LEDGE-ROCK SOURCES SUPPLIED COARSE AGGREGATES; LOCAL SAND SOURCES (GENERALLY COLLECTED WITHIN A FEW MILES OF CORRESPONDING LEDGE-ROCK SOURCES) SUPPLIED FINE AGGREGATES FOR CONCRETE MIX.

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AGGREGATE AND TRIAL MIX TESTS
CONCRETE AGGREGATES EVALUATION
WAH WAH VALLEY, UTAH

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TABLE 1

In all three trial mixes, fly ash, as a pozzolan, replaced 20 percent of the cement by weight. All concrete trial mix design criteria are presented in Table 2. Samples were collected for a total of five trial mixes; four basin fill (coarse and fine aggregates) and one rock (coarse aggregates) and basin fill (fine aggregates). Material greater than 1.5 inches was crushed to conform to gradation requirements. If necessary, coarse and fine aggregates were processed to conform to gradation requirements.

The following tests were performed to evaluate fresh and hardened properties of concrete made from Wah Wah Valley aggregates:

Fresh Properties

- o Unit Weight, Yield and Air Content of Concrete;
- o Slump of Portland Cement Concrete;
- o Air Content of Concrete, Volumetric Method;
- o Making and Curing Concrete Specimens;
- o Making and Testing Accelerated Cure Concrete Compression Test Specimens; and
- o Selection Proportions for Normal and Heavyweight Concrete.

Hardened Properties

- o Compressive Strength of Cylindrical Concrete Specimens;
- o Length Change of Hardened Cement Mortar and Concrete;
- o Potential Alkali-Silica Reactivity, Mortar-Bar Method;
- o Static Modulus of Elasticity of Concrete in Compression;
- o Splitting Tensile Strength of Cylindrical Concrete Specimens;

CONCRETE CONSTITUENTS AND PROPERTIES	CONCRETE TRIAL MIX DESIGN CRITERIA					
	MIX 1 7.5/1.5 IN.[1]		MIX 2 8.5/1.5 IN.[1]		MIX 3 8.5/0.75 IN.; SUPER.[1]	
	VOLUME	WEIGHT	VOLUME	WEIGHT	VOLUME	WEIGHT
CEMENT, NEVADA TYPE II (LOW ALKALI; FT^3, LBS)	2.87	564	3.25	639	3.25	639
FLY ASH, WESTERN (REPLACES 20% OF CEMENT BY WEIGHT; FT^3, LBS)	0.99	141	1.12	160	1.12	160
SUPERPLASTICIZER (WRDA 19; OZ/CWT)[2]	—	—	—	—	15	—
WATER REDUCER (WRDA 79; OZ/CWT)	5	—	5	—	5	—
AIR ENTRAINMENT ADMIXTURE (DARAVAIR: OZ/CWT [FT^3])	1.63 - 1.88 [1.08]	—	1.63 - 1.88 [1.08]	—	1.5 - 1.75 [1.08]	—
SLUMP, MAXIMUM (INCHES)	3 - 4		3 - 4		0 - 1[3]	
AIR CONTENT, RANGE (PERCENT)	4 - 6		4 - 6		4 - 6	
WATER/CEMENT RATIO (BY WEIGHT)	0.36		0.32		0.33	
CEMENT FACTOR (SCY)[4]	7.5		8.5		8.5	

1. SACKS OF CEMENT PER CYD / MAXIMUM AGGREGATE SIZE
2. OZ/CWT = OUNCES/100 POUNDS OF CEMENT AND FLY ASH
3. SLUMP BEFORE ADDITION OF SUPERPLASTICIZER
4. SCY = SACKS OF CEMENT/CUBIC YARD OF CONCRETE

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CONCRETE TRIAL MIX DESIGN CRITERIA
WAH WAH VALLEY, UTAH

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TABLE 2

- o Potential Alkali-Carbonate Rock Reactivity, Length Change Method; and
- o Coefficient of Linear Thermal Expansion of Concrete.

The results of all tests summarized in Table 1 are important to the concrete aggregates evaluation, but hardened concrete properties are considered the most significant (see Section 4.1.1, Requirements for Concrete Aggregates). Although the primary requirement for concrete is a 28-day compressive strength of 6500 psi, one-day (accelerated), seven-day, and 90-day tests were done to determine the range of compressive strength values. In order to compare different aggregate sources, 28-day compressive strengths of Mix 3 were always used.

Occasionally, fresh concrete properties varied from design concrete specifications and may have affected hardened concrete test results. If known or significant, the causative factor and its effect on test results are mentioned in the discussions on sources of concrete aggregates (Sections 4.2.1 and 4.2.2).

The scope of the study did not allow sample collection and laboratory testing of all potential basin-fill and rock concrete aggregate sources. Existing data and field petrographic and grain-size analyses were used to correlate lithologic and gradation properties to basin-fill units which were not sampled. An important element of this correlation procedure was the use of aerial photography to help delineate the lateral extent of basin-fill deposits. Photogeologic field observations ascertained geomorphological and topographical relationships of basin-fill units and the source rock lithology and distribution of predominantly gravelly materials.

Limited laboratory and field data prevented most correlations of data from tested to untested rock units. Potential aggregate sources were confined to the limits of tested or correlated outcrops as determined from existing data, limited photogeological interpretation, and field reconnaissance.

4.1.3 Presentation of Results

Results of the concrete aggregates evaluation are presented in the form of text, tables, figures, 1:62,500 scale drawings, and appendices. Drawing 1 is a location map showing the position in the study area of all data points used in the DARS. All data points are grouped by study type and assigned categorized map numbers (see Section 3.1.3).

Drawing 3 presents the locations of the potential concrete aggregate sources, basin-fill sources of fine aggregates that were mixed with crushed rock, DARS trenches, DARS field petrographic and grain-size data stops, and VSARS tested sample locations in the study area. Geologic unit symbols used in Drawing 3 relate to standard geologic nomenclature whenever possible. A conversion table relating these symbols to the geologic unit nomenclature used in other Ertec reports is contained in Appendix Table F-3.

A solid contact line separates basin-fill and rock units in Drawing 3 to differentiate these two basic material types. All rock contacts are taken from published data or limited air-photo interpretation and are dashed. Basin-fill contacts are derived from photogeological mapping with limited field reconnaissance and are also dashed.

Classifications of potential basin-fill and rock concrete aggregate sources are distinguished by different patterns. Patterns for basin-fill and rock sources of the same classification are similar, with the basin-fill pattern emphasized by a dark background tone.

The appendices contain tables that summarize the basic field data collected during the course of the study and the subsequent laboratory test procedures and results. Appendices A and B contain DARS trench data and petrographic and grain-size data, respectively. Appendix C contains representative trench logs. Appendix Table D-2 presents a laboratory test flow diagram for the concrete aggregates evaluation. Appendix E presents the chemical analyses of cement, fly ash, and water used in making all concrete trial mixes. Appendix F includes three tables describing soil classification, caliche development, and geologic unit cross reference.

4.1.4 Classification of Concrete Aggregates

A classification system was designed to present the most likely basin-fill and crushed-rock concrete aggregate sources. It was developed from an evaluation, as well as from an extrapolation, of all available data. Data include laboratory test results (compressive strength of concrete and grain-size, abrasion, and soundness of aggregates) and geomorphological and compositional correlations.

The classification system groups potential aggregate sources into three categories:

1. Aggregate sources which were used in concrete mixes - Class CA1 and Class CA2;
2. Aggregate sources which were subjected to basic aggregate tests - Class CB; and
3. Untested aggregate sources which were correlated to Classes CA1, CA2, or CB - Class CC1 and Class CC2.

The classification is presented in hierarchy form; classification of the highest potential source areas is described first, and classification of the lowest potential source areas is described last.

Class	Explanation
CA1	Basin-fill or rock sources containing aggregates that produced trial mix concrete with 28-day compressive strengths equal to or greater than 6500 psi using Mix 3 (Section 4.1.2).
CA2	Basin-fill or rock sources containing aggregates that produced trial mix concrete with 28-day compressive strengths less than 6500 psi using Mix 3 (Section 4.1.2).

The Classes CA1 and CA2 describe those specific sources where basin-fill or crushed-rock aggregates have been collected and used in making trial mix batches of concrete. Following appropriate ASTM standards, concrete cylinders containing the collected aggregates were made, cured, and tested for various hardened concrete properties. The class is divided into two categories by 28-day compressive strength test results.

Generally, aggregates from each potential source area have been tested previously during the VSARS program. Confirmation testing that includes gradation, abrasion, and soundness tests was performed when applicable to ensure the continued acceptability of a sample for use in concrete. Abrasion and $MgSO_4$ soundness values for coarse aggregates do not exceed the requirements specified in Section 4.1.1. Tested samples of fine aggregate used in the concrete trial mixes consistently have $MgSO_4$ soundness losses exceeding the required 15 percent maximum; however, $NaSO_4$ soundness losses generally do not exceed the required 10 percent maximum.

Class	Explanation
CB	Basin-fill or rock sources containing aggregates potentially suitable for use in concrete; based on acceptable laboratory aggregate test results.

The Class CB describes those source areas that have been sampled and tested only for grain-size gradation, abrasion, and $MgSO_4$ sulfate soundness. Trial concrete mixes were not made. Gradation, abrasion, and soundness values specified in Section 4.1.1 were used to assign this classification to an aggregate source.

Class	Explanation
CC1	Basin-fill or rock sources containing aggregates potentially suitable for use in concrete; based on correlation with Class CA1 or CA2 areas.
CC2	Basin-fill sources of aggregates potentially suitable for use in concrete; based on correlation with Class CB areas.

Untested Class CC deposits are correlated to tested Class CA or CB deposits on the basis of field observations and limited field and laboratory test results. Class CC basin-fill deposits consist of units of the same apparent relative age as Class CA and CB deposits. Class CC1 rock deposits are nearby outcrops of the same geological rock units as Class CA deposits.

Field observations and petrographic and grain-size analyses provided correlative data on the lithology of adjacent source rock and the lithology and general amounts of gravel present in the basin-fill units. Photogeologic interpretations were also used to correlate Class CC basin-fill deposits to Class CA or CB basin-fill deposits. Specific geomorphological parameters correlated during the procedure included surface texture, drainage patterns, relative relief, and topographic profiles.

All classifications are based on limited data. Additional field reconnaissance, testing, and case history studies are needed to confirm adequacy, delimit exact areal boundaries, and refine chemical and physical properties.

4.2 SOURCES OF CONCRETE AGGREGATES

4.2.1 Basin-Fill Sources

Basin-fill sources of concrete aggregates within the study area are grouped into four classes. Deposits defined on the basis of laboratory test data are included in Class CA1 and Class CB. Untested basin-fill deposits correlated to deposits with test data are in Classes CC1 and CC2. Class CA2 sources were not identified in the study area.

4.2.1.1 Class CA1

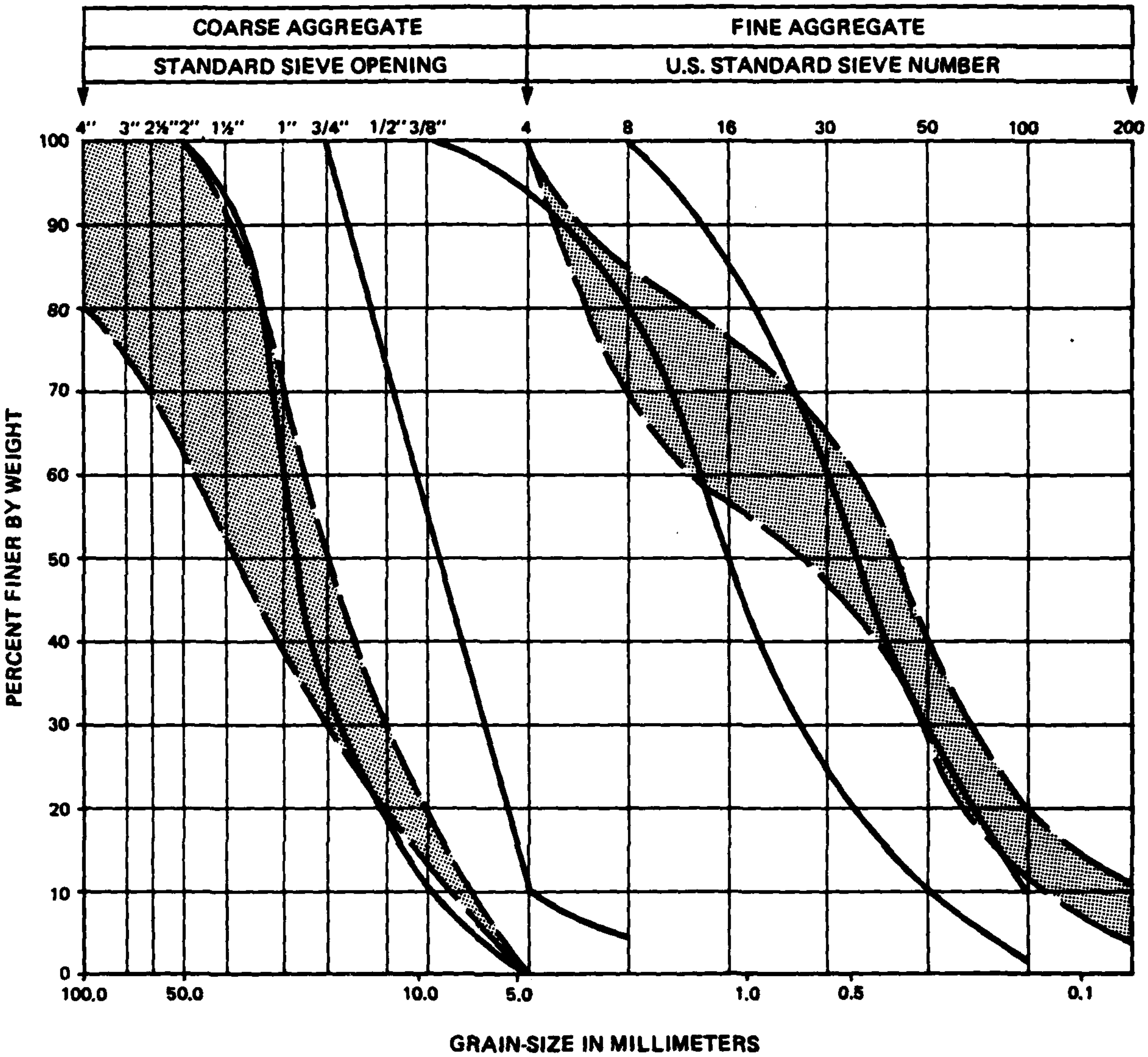
There are four Class CA1 basin-fill sources within the study area. These sources include two older lacustrine deposits (Aol) on the east side of the valley adjacent to the San Francisco Mountains and two alluvial fan deposits (Aaf) on the west side of the valley adjacent to the Wah Wah Mountains (Drawing 3).

1. The southernmost Class CA1 older lacustrine deposit is located adjacent to the San Francisco Mountains approximately 5 miles (8 km) north of latitude 38°30' N (Drawing 3). This deposit consists of poorly graded sandy gravel. The gravel ranges from 61 to 83 percent of the deposit (excluding cobbles and boulders), the sand ranges from 15 to 38 percent, and silt and clay ranges from one to three percent of the deposit. Cobbles and boulders comprise about 10 to 20 percent of the entire deposit.

The gravel clasts sampled from the southernmost Class CA1 older lacustrine deposit are typically subrounded to rounded and approximately thick-tabular in shape. Approximately 88 percent of the gravel clasts are of satisfactory physical quality; 11 percent are porous, moderately weathered, or weak and are of fair physical quality; and about one percent is highly porous coating material of poor physical quality. The gravel is composed of approximately 81 percent quartzite and quartzose sandstone, seven percent volcanic clasts, two percent carbonate clasts, and 10 percent phyllite, weathered sandstone, and minor constituents. About four percent of the gravel clasts are partially encrusted with calcareous coating material. The volcanic clasts within this deposit may be susceptible to a deleterious degree to the alkali-silica reaction. The gravel is not susceptible to the alkali-carbonate reaction.

The sand particles sampled from the southernmost Class CA1 older lacustrine deposit are typically subrounded to subangular. Approximately 76 percent of the sand particles are of satisfactory physical quality; 21 percent are weathered or weak and are of fair physical quality; and three percent are soft, porous particles of coating material of poor physical quality. The composition of the sand particles is similar to that of the gravel clasts. About 15 to 20 percent of the sand may be susceptible to a deleterious degree to the alkali-silica reaction, but the sand is not susceptible to the alkali-carbonate reaction.

The grain-size envelopes for the southernmost Class CA1 older lacustrine deposit are shown on Figure 5 with the required gradation envelopes for coarse and fine concrete aggregates. In addition to the presence within the deposit of a significant quantity of oversize material (greater than 2 inches), the percentages of coarse gravels passing the 2- to 1-inch sieves are less than required. The percentages of fine gravels passing the 0.75 to No. 4 sieves are generally within gradation requirements. Also, the percentage of coarse sand passing the No. 8 sieve is generally less than required, and the percentages of medium and fine sand passing the No. 30 to No. 100 sieves are generally greater than required. Processing will be necessary to bring this deposit within gradation requirements. Variations in grain-size gradations will occur in this deposit depending on proximity to the source area.



REQUIRED GRAIN-SIZE DISTRIBUTION ENVELOPES FOR COARSE AND FINE AGGREGATES USED IN CONCRETE (AMERICAN SOCIETY FOR TESTING AND MATERIALS, 1978, C 33; THE RECOMMENDED GRADATIONS FOR AGGREGATES WITH 1.5 AND 0.75 INCH MAXIMUM SIZE ARE COMBINED INTO ONE ENVELOPE).

GRAIN-SIZE DISTRIBUTION ENVELOPES OF BASIN–FILL COARSE AND FINE AGGREGATES POTENTIALLY SUITABLE FOR CONCRETE.

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GRAIN-SIZE DISTRIBUTION ENVELOPES
CONCRETE AGGREGATES, WA-A- (9-13)
WAH WAH VALLEY, UTAH

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FIGURE 5

Samples of coarse aggregate from the southernmost Class CA1 older lacustrine deposit were subjected to laboratory abrasion and $MgSO_4$ soundness tests. The results of these tests were 24.3 and 26.5 percent abrasion wear and 1.6 and 3.6 percent soundness losses. Samples of fine aggregates subjected to $MgSO_4$ soundness tests resulted in values of 6.4 and 11.2 percent loss. These results are well within acceptable ranges for coarse and fine concrete aggregates.

Concrete (Mix 3) made using the aggregates from the southernmost older lacustrine deposit had a 28-day compressive strength of 8165 psi and a 90-day compressive strength of 9835 psi (Table 3). Concrete trial Mixes 1 and 2 yielded 28-day compressive strengths of 4505 and 5250 psi, respectively. The air contents of Mixes 1 and 2 (6.5 and 6.1 percent, respectively) were slightly higher than the maximum air content as specified by the mix design (6.0 percent) and may have caused a lowering of the compressive strengths of these mixes. Fresh concrete properties and hardened concrete test results (chord modulus of elasticity, splitting tensile strength, drying shrinkage) are included in Table 3. Except for high splitting tensile strengths for Mixes 1 and 2, the test results for hardened concrete are within the requirements mentioned in Section 4.1.1.

The areal extent of the southernmost Class CA1 older lacustrine deposit is approximately 0.3 mi^2 (0.8 km^2). The thickness of this deposit ranges from a few feet around its periphery to nearly 100 feet (30 m) in its interior. It is estimated that,

AGGREGATE SOURCE[1]	FIELD STATION	CONCRETE MIX DESIGN CRITERIA[2] SACKS OF CEMENT/CYD / MAX. AGG. SIZE	FRESH CONCRETE PROPERTIES: SLUMP[3] (IN.)	AIR CONTENT (%)	UNIT WEIGHT (PCF)	WATER/CEMENT RATIO	CEMENT FACTOR (SCY)	ASTM STANDA
BASIN–FILL	WA-A-(9 - 13)	MIX 1 7.5/1.5 IN.	3.5	6.5	142.8	0.33	7.43	COMPRESSIVE STRE (PSI)
								CHORD MODULUS OF ELA (PSI x 10
								SPLITTING TENSILE STR (PSI)
								DRYING SHRINKAG (PERCE
	WA-A-(9 - 13)	MIX 2 8.5/1.5 IN.	3.0	6.1	143.1	0.31	8.38	COMPRESSIVE STRE (PSI)
								CHORD MODULUS OF ELA (PSI x 10
								SPLITTING TENSILE STR (PSI)
								DRYING SHRINKAG (PERCE
	WA-A-(9 - 13)	MIX 3 8.5/0.75 IN., SUPER-PLASTICIZER	0.0 BEF. 4.5 AFT.	5.4	144.2	0.27	8.57	COMPRESSIVE STRE (PSI)
								CHORD MODULUS OF ELA (PSI x 10
								SPLITTING TENSILE STR (PSI)
								DRYING SHRINKAG (PERCE

1. BASIN-FILL SOURCES SUPPLIED BOTH COARSE AND FINE AGGREGATES FOR CONCRETE MIX. LEDGE-ROCK SOURCES SUPPLIED COARSE AGGREGATES; LOCAL SAND SOURCES (GENERALLY COLLECTED WITHIN A FEW MILES OF CORRESPONDING LEDGE-ROCK SOURCES) SUPPLIED FINE AGGREGATES FOR CONCRETE MIX.
2. ASTM AND ACI SPECIFICATIONS AND PROCEDURES WERE FOLLOWED IN THE MIX DESIGN AND BATCHING OF THE CONCRETE TRIAL MIXES. THE CONCRETE MIXES CONSISTED OF COARSE AND FINE AGGREGATES, LOW ALKALI CEMENT, FLY ASH (20% BY WEIGHT REPLACEMENT OF CEMENT), SUPERPLASTICIZER, AIR-ENTRAINING ADMIXTURE, AND WATER REDUCER.
3. BEF. – SLUMP BEFORE ADDITION OF SUPERPLASTICIZER.
   AFT. – SLUMP AFTER ADDITION OF SUPERPLASTICIZER.
4. COMPRESSIVE AND TENSIL CYLINDERS. DRYING SHR MENS; TIMETABLE INCLUD

HARDENED CONCRETE TEST RESULTS

STM STANDARD TEST [4]	TIMETABLE			
	1 DAY (ACCELERATED)	7 DAYS	28 DAYS	90 DAYS
ESSIVE STRENGTH, ASTM C 39 (PSI)	1890	3120	4505	5660
ULUS OF ELASTICITY, ASTM C 469 (PSI x 10^6)	3.10	3.96	4.27	4.67
TENSILE STRENGTH, ASTM C 496 (PSI)	–	–	485	–

	7 DAYS	14 DAYS	21 DAYS	28 DAYS	35 DAYS
NG SHRINKAGE, ASTM C 157 (PERCENT)	0.00	0.017	0.033	0.038	0.046

	1 DAY (ACCELERATED)	7 DAYS	28 DAYS	90 DAYS
ESSIVE STRENGTH, ASTM C 39 (PSI)	2395	3970	5250	6375
ULUS OF ELASTICITY, ASTM C 469 (PSI x 10^6)	3.17	4.03	4.35	4.66
TENSILE STRENGTH, ASTM C 496 (PSI)	–	–	555	–

	7 DAYS	14 DAYS	21 DAYS	28 DAYS	35 DAYS
NG SHRINKAGE, ASTM C 157 (PERCENT)	0.00	0.020	0.030	0.036	0.043

	1 DAY (ACCELERATED)	7 DAYS	28 DAYS	90 DAYS
ESSIVE STRENGTH, ASTM C 39 (PSI)	3215	5825	8165	9835
ULUS OF ELASTICITY, ASTM C 469 (PSI x 10^6)	3.17	3.93	4.55	4.83
TENSILE STRENGTH, ASTM C 496 (PSI)	–	–	620	–

	7 DAYS	14 DAYS	21 DAYS	28 DAYS	35 DAYS
NG SHRINKAGE, ASTM C 157 (PERCENT)	0.00	0.025	0.036	0.041	0.050

E AND TENSILE STRENGTH VALUES ARE AVERAGES OBTAINED FROM TWO TESTED
DRYING SHRINKAGE VALUES ARE AVERAGES OBTAINED FROM TWO TESTED SPECI-
TABLE INCLUDES A SEVEN DAY MOIST CURE.

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CONCRETE TRIAL MIX TEST RESULTS
WA-A- (9 - 13)
WAH WAH VALLEY, UTAH

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TABLE 3

where sampled, this deposit has a yield of 75 to 90 percent after gradation deficiencies and handling, poor-quality constituents, and silt and clay losses.

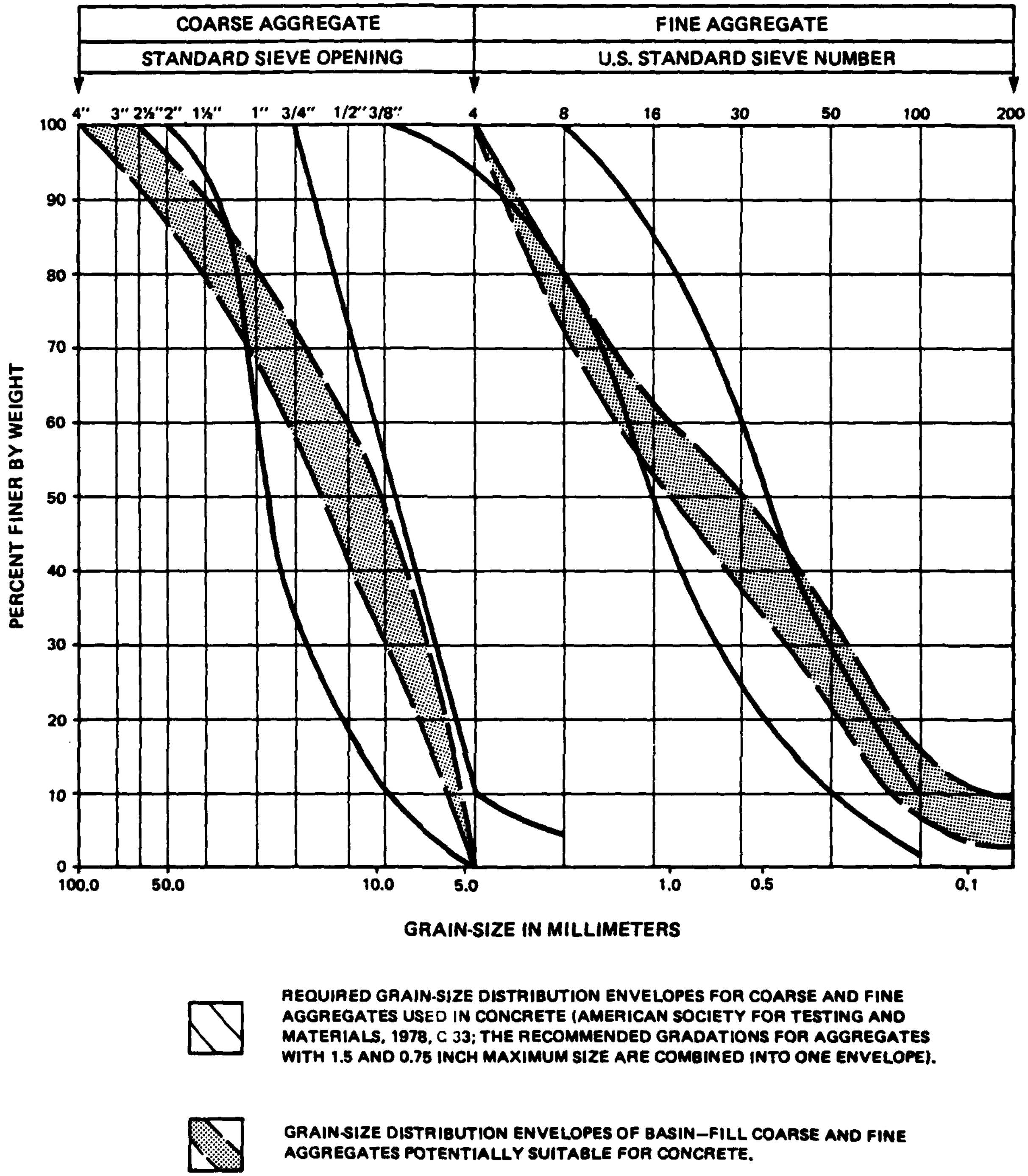
2. The northernmost Class CA1 older lacustrine deposit is located adjacent to the San Francisco Mountains approximately 7 miles (11.2 km) north of latitude 38°30' N (Drawing 3). This deposit consists of poorly graded sandy gravel. The gravel content ranges from 47 to 70 percent of the deposit (excluding cobbles and boulders), the sand content ranges from 25 to 50 percent, and the silt and clay content ranges from one to four percent of the deposit. Cobbles and boulders comprise about five percent of the total deposit.

The gravel clasts sampled from the northernmost Aol deposit are typically subrounded to rounded. Approximately 92 percent of the gravel clasts are of satisfactory physical quality, and about eight percent are moderately weathered, porous, or weak and are of fair physical quality. The gravel is composed of approximately 85 percent quartzite and quartzose sandstone, eight percent graywacke sandstone, three percent limestone and dolomite, and about four percent phyllite and granite. About 11 percent of the gravel clasts are partially encrusted with calcareous coating material. The graywacke sandstone and phyllite clasts within this deposit may be susceptible to a deleterious degree to the alkali-silica reaction. The gravel is not susceptible to the alkali-carbonate reaction.

The sand particles sampled from the northernmost Class CA1 older lacustrine deposit are typically subrounded to subangular. Approximately 85 percent of the sand particles are of satisfactory physical quality; 13 percent are moderately weathered, porous, or weak and are of fair physical quality; and about two percent are porous, weak particles of coating material of poor physical quality. The sand is similar in composition to the gravel within this deposit. About 15 percent of the sand may be susceptible to a deleterious degree to the alkali-silica reaction, but the sand is not considered susceptible to the alkali-carbonate reaction.

The grain-size envelopes for the northernmost Class CA1 older lacustrine deposit are shown in Figure 6 with the required gradation envelopes for coarse and fine concrete aggregates. In addition to the presence of some oversize material (greater than 2 inches), the percentages of coarse gravels passing the 2-inch and 1.5-inch sieves are less than required. The percentages of medium and fine gravels passing the 1.5-inch to No. 4 sieves are within gradation requirements. Except for a deficiency of coarse sand passing the No. 8 sieve, the fine aggregates within the deposit generally conform to the gradation requirements. However, processing will be necessary to bring this deposit within gradation specifications. Variations in grain size gradations will occur in this deposit depending on proximity to the source area.

Samples of coarse and fine aggregates from the northernmost Aol deposit were subjected to laboratory abrasion and $MgSO_4$ soundness tests. The results of these tests were 23.5 and 24.2 percent abrasion wear, 1.4 and 3.5 percent coarse aggregate soundness losses, and 8.6 and 10.8 percent fine aggregate soundness



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GRAIN-SIZE DISTRIBUTION ENVELOPES
CONCRETE AGGREGATES, WA-A- (38-42)
WAH WAH VALLEY, UTAH

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FIGURE 6

losses. These results are well within the acceptable ranges of abrasion wear and soundness loss for concrete aggregates.

Concrete (Mix 3) made using the aggregates from the northernmost Class CA1 older lacustrine deposit had a 28-day compressive strength of 6695 psi and a 90-day compressive strength of 8855 psi (Table 4). Concrete trial Mixes 1 and 2 yielded 28-day compressive strengths of 5030 and 5200 psi, respectively. The air content of all of the trial mixes were in excess of the 6.0 percent maximum as specified by the mix designs. These excessive air contents may have caused a lowering of the compressive strengths of the mixes. Fresh concrete properties and hardened concrete test results (chord modulus of elasticity, splitting tensile strength, and drying shrinkage) are included in Table 4. Except for high splitting tensile strengths for Mixes 1 and 2, the test results for hardened concrete are within the requirements mentioned in Section 4.1.1.

The areal extent of the northernmost Class CA1 older lacustrine deposit is approximately 0.7 mi^2 (1.8 km^2). The thickness of this deposit ranges from a few feet around its periphery to nearly 100 feet (30.5 m) in its interior. It is estimated that, where sampled, this deposit will have a yield of 80 to 90 percent after gradation deficiencies and handling, poor quality constituents, and silt and clay losses.

3. The southernmost Class CA1 alluvial fan deposit is located at latitude 38°30' N adjacent to the Wah Wah Mountains (Drawing 3). This deposit consists of poorly to well-graded sandy gravel and gravelly sand. The gravel content ranges

AGGREGATE SOURCE[1]	FIELD STATION	CONCRETE MIX DESIGN CRITERIA[2] SACKS OF CEMENT/CYD / MAX. AGG. SIZE	FRESH CONCRETE PROPERTIES SLUMP[3] (IN.)	AIR CONTENT (%)	UNIT WEIGHT (PCF)	WATER/ CEMENT RATIO	CEMENT FACTOR (SCY)	ASTM STAND
BASIN – FILL	WA-A- (38 - 42)	MIX 1 7.5/1.5 IN.	3.25	7.0	142.7	0.33	7.38	COMPRESSIVE STR (P CHORD MODULUS OF E (PSI x SPLITTING TENSILE ST (P DRYING SHRINKA (PERC
	WA-A- (38 - 42)	MIX 2 8.5/1.5 IN.	2.75	6.5	143.9	0.34	8.34	COMPRESSIVE STR (PS CHORD MODULUS OF EL (PSI x SPLITTING TENSILE ST (P DRYING SHRINKA (PERC
	WA-A- (38 - 42)	MIX 3 8.5/0.75 IN., SUPER-PLASTICIZER	0.0 BEF. 7.0 AFT.	7.0	144.5	0.29	8.50	COMPRESSIVE STR (P CHORD MODULUS OF EL (PSI x SPLITTING TENSILE ST (P DRYING SHRINKA (PERC

1. BASIN-FILL SOURCES SUPPLIED BOTH COARSE AND FINE AGGREGATES FOR CONCRETE MIX. LEDGE-ROCK SOURCES SUPPLIED COARSE AGGREGATES; LOCAL SAND SOURCES (GENERALLY COLLECTED WITHIN A FEW MILES OF CORRESPONDING LEDGE-ROCK SOURCES) SUPPLIED FINE AGGREGATES FOR CONCRETE MIX.
2. ASTM AND ACI SPECIFICATIONS AND PROCEDURES WERE FOLLOWED IN THE MIX DESIGN AND BATCHING OF THE CONCRETE TRIAL MIXES. THE CONCRETE MIXES CONSISTED OF COARSE AND FINE AGGREGATES, LOW ALKALI CEMENT, FLY ASH (20% BY WEIGHT REPLACEMENT OF CEMENT), SUPERPLASTICIZER, AIR-ENTRAINING ADMIXTURE, AND WATER REDUCER.
3. BEF. – SLUMP BEFORE ADDITION OF SUPERPLASTICIZER.
   AFT. – SLUMP AFTER ADDITION OF SUPERPLASTICIZER.
4. COMPRESSIVE AND TEN
   CYLINDERS. DRYING SH
   MENS; TIMETABLE INCL

HARDENED CONCRETE TEST RESULTS

ASTM STANDARD TEST [4]	TIMETABLE			
	1 DAY (ACCELERATED)	7 DAYS	28 DAYS	90 DAYS
PRESSIVE STRENGTH, ASTM C 39 (PSI)	2220	3796	5030	5890
ODULUS OF ELASTICITY, ASTM C 469 (PSI x 10^6)	2.54	3.93	5.03	5.12
NG TENSILE STRENGTH, ASTM C 496 (PSI)	–	–	555	·

YING SHRINKAGE, ASTM C 157 (PERCENT)	7 DAYS	14 DAYS	21 DAYS	28 DAYS	35 DAYS
	0.00	0.023	0.040	0.048	0.051

	1 DAY (ACCELERATED)	7 DAYS	28 DAYS	90 DAYS
PRESSIVE STRENGTH, ASTM C 39 (PSI)	2285	3950	5200	5975
ODULUS OF ELASTICITY, ASTM C 469 (PSI x 10^6)	3.01	3.97	4.14	4.64
NG TENSILE STRENGTH, ASTM C 496 (PSI)	–	–	590	–

YING SHRINKAGE, ASTM C 157 (PERCENT)	7 DAYS	14 DAYS	21 DAYS	28 DAYS	35 DAYS
	0.00	0.025	0.038	0.046	0.047

	1 DAY (ACCELERATED)	7 DAYS	28 DAYS	90 DAYS
PRESSIVE STRENGTH, ASTM C 39 (PSI)	3075	5555	6695	8855
ODULUS OF ELASTICITY, ASTM C 469 (PSI x 10^6)	3.20	3.96	4.43	4.90
NG TENSILE STRENGTH, ASTM C 496 (PSI)	–	–	610	–

YING SHRINKAGE, ASTM C 157 (PERCENT)	7 DAYS	14 DAYS	21 DAYS	28 DAYS	35 DAYS
	0.00	0.025	0.038	0.048	0.049

...SSIVE AND TENSILE STRENGTH VALUES ARE AVERAGES OBTAINED FROM TWO TESTED ...ERS. DRYING SHRINKAGE VALUES ARE AVERAGES OBTAINED FROM TWO TESTED SPECI- ...TIMETABLE INCLUDES A SEVEN DAY MOIST CURE.

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CONCRETE TRIAL MIX TEST RESULTS
WA-A- (38 - 42)
WAH WAH VALLEY, UTAH

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TABLE 4

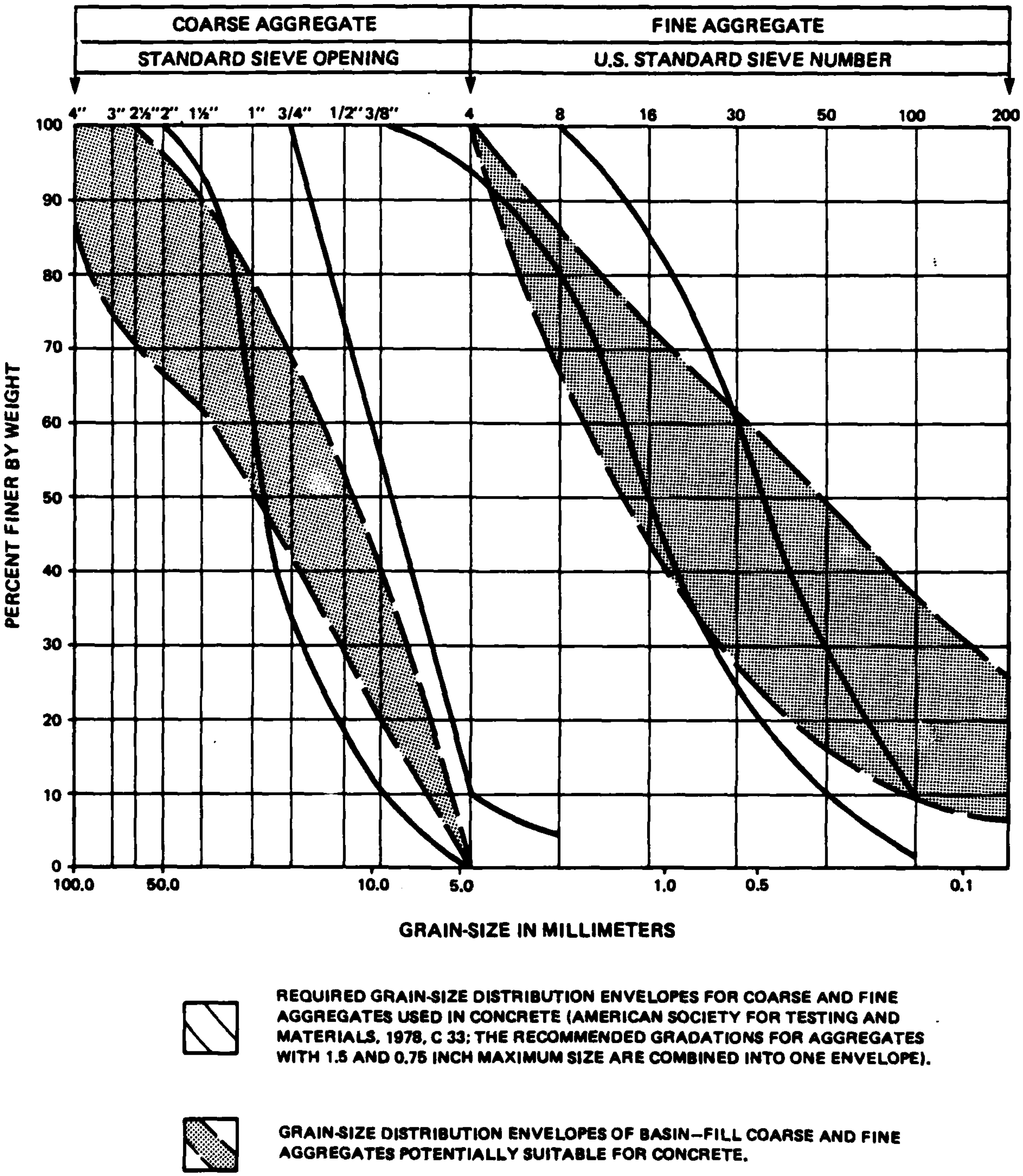
from 44 to 56 percent of the deposit (excluding cobbles and boulders), the sand content ranges from 35 to 47 percent, and the silt and clay ranges from three to 13 percent. Cobbles and boulders comprise from 10 to 20 percent of the total deposit.

The gravel clasts sampled from the southernmost Class CA1 alluvial fan deposit are typically subangular and approximately equidimensional to thick-tabular in shape. Approximately 55 percent of the gravel clasts are of satisfactory physical quality; 39 percent are porous or weathered and are of fair physical quality; and about six percent are highly porous, soft, or deeply weathered and are of poor physical quality. The gravel is composed of approximately 53 percent limestone and dolomitic limestone, 33 percent dolomite, 12 percent volcanics, and two percent granitic clasts and coating material. Approximately 66 percent of the gravel clasts are partially or completely encrusted with calcareous coating material. The volcanic clasts are potentially subject to the alkali-silica reaction. Dolomitic limestone and calcitic dolomite clasts are potentially subject to the alkali-carbonate reaction.

The sand particles within the southernmost Class CA1 alluvial fan deposit are typically subangular to angular and irregular in shape. The sand particles are similar in physical quality to the gravel clasts. The sand is composed of 59 percent limestone and dolomite particles; 28 percent volcanic particles; and 13 percent quartz, feldspar, and coating material particles. About 50 percent of the sand particles are partially or completely encrusted by calcareous coating material. The volcanic sand particles are potentially subject to the alkali-silica reaction, and the calcitic dolomite and dolomitic limestone particles are potentially subject to the alkali-carbonate reaction.

The grain-size envelopes for the southernmost Class CA1 alluvial fan deposit are shown in Figure 7 with the required gradation envelopes for coarse and fine concrete aggregates. In addition to the presence of a significant amount of oversize material (greater than 2-inches), the percentages of coarse gravels passing the 2-inch and 1.5-inch sieves are considerably less than required. The percentage of medium and fine gravels passing the 1-inch to No. 4 sieves are within gradation requirements. Also, the percentage of coarse sand passing the No. 8 sieve is generally less than required and the percentages of fine sand passing the No. 50 and No. 100 sieves are greater than is required. Processing will be necessary to bring this deposit within gradation requirements. Variations in grain-size gradations will occur within the deposit depending on proximity to the source area.

Samples of coarse and fine aggregates from the southernmost Class CA1 alluvial fan deposit were subjected to laboratory abrasion and $MgSO_4$ soundness tests. The coarse aggregates passed the tests with results of 32.4 and 42.1 percent abrasion wear and 9.5 and 6.3 percent soundness losses. Two samples of fine aggregates failed $MgSO_4$ soundness tests with losses of 24.9 and 33.6 percent, but one of these passed a $NaSO_4$ soundness test with a loss of 4.2 percent.



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GRAIN-SIZE DISTRIBUTION ENVELOPES
CONCRETE AGGREGATES, WA-A- (20-24)
WAH WAH VALLEY, UTAH

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FIGURE 7

Concrete (Mix 3) made using aggregates from the southernmost Class CA1 alluvial fan deposit yielded a 28-day compressive strength of 7650 psi and a 90-day compressive strength of 9700 psi (Table 5). Concrete trial Mixes 1 and 2 yielded 28-day compressive strengths of 5570 and 6035 psi, respectively. Fresh concrete properties and hardened concrete test results (chord modulus of elasticity, splitting tensile strength, and drying shrinkage) are included in Table 5. The test results for hardened concrete are within the requirements mentioned in Section 4.1.1.

The areal extent of the southernmost Class CA1 alluvial fan deposit is approximately 3.5 mi^2 (9.1 km^2). It is estimated that the thickness of the material described above is at least 25 feet (7.6 m). It is also estimated that, where sampled, this deposit will have a yield of 65 to 80 percent after gradation deficiencies and handling, poor quality constituents, and silt and clay losses.

4. The northernmost Class CA1 alluvial fan deposit is located adjacent to the Wah Wah Mountains and approximately 5.5 miles (8.8 km) north of latitude 38°30' N (Drawing 3) The deposit consists of poorly to well-graded sandy gravel. The gravel content ranges from 50 to 65 percent of the deposit (excluding cobbles and boulders), the sand content ranges from 28 to 40 percent, and silt and clay ranges from about six to 11 percent. Cobbles and boulders comprise about 10 percent of the entire deposit.

The gravel clasts sampled from the northernmost Class CA1 alluvial fan deposit are typically subrounded to subangular and approximately equidimensional to thick-tabular in shape.

AGGREGATE SOURCE[1]	FIELD STATION	CONCRETE MIX DESIGN CRITERIA[2] SACKS OF CEMENT/CYD / MAX. AGG. SIZE	FRESH CONCRETE PROPERTIES					
			SLUMP[3] (IN.)	AIR CONTENT (%)	UNIT WEIGHT (PCF)	WATER/ CEMENT RATIO	CEMENT FACTOR (SCY)	ASTM STAND
BASIN – FILL	WA-A- (20 - 24)	MIX 1 7.5/1.5 IN.	3.75	4.2	145.8	0.36	7.51	COMPRESSIVE STR (PS CHORD MODULUS OF EL (PSI x SPLITTING TENSILE ST (PS DRYING SHRINKA (PERC
	WA-A- (20 - 24)	MIX 2 8.5/1.5 IN.	4.25	4.1	146.2	0.34	8.48	COMPRESSIVE STR (PS CHORD MODULUS OF EL (PSI x SPLITTING TENSILE ST (PS DRYING SHRINKA (PERC
	WA-A- (20 - 24)	MIX 3 8.5/0.75 IN., SUPER-PLASTICIZER	0.0 BEF. 3.25 AFT.	1.9	149.0	0.29	8.79	COMPRESSIVE STR (PS CHORD MODULUS OF EL (PSI x SPLITTING TENSILE ST (PS DRYING SHRINKA (PERC

1. BASIN-FILL SOURCES SUPPLIED BOTH COARSE AND FINE AGGREGATES FOR CONCRETE MIX. LEDGE-ROCK SOURCES SUPPLIED COARSE AGGREGATES; LOCAL SAND SOURCES (GENERALLY COLLECTED WITHIN A FEW MILES OF CORRESPONDING LEDGE-ROCK SOURCES) SUPPLIED FINE AGGREGATES FOR CONCRETE MIX.
2. ASTM AND ACI SPECIFICATIONS AND PROCEDURES WERE FOLLOWED IN THE MIX DESIGN AND BATCHING OF THE CONCRETE TRIAL MIXES. THE CONCRETE MIXES CONSISTED OF COARSE AND FINE AGGREGATES, LOW ALKALI CEMENT, FLY ASH (20% BY WEIGHT REPLACEMENT OF CEMENT), SUPERPLASTICIZER, AIR-ENTRAINING ADMIXTURE, AND WATER REDUCER.
3. BEF. – SLUMP BEFORE ADDITION OF SUPERPLASTICIZER.
   AFT. – SLUMP AFTER ADDITION OF SUPERPLASTICIZER.
4. COMPRESSIVE AND TEN CYLINDERS. DRYING SH MENS; TIMETABLE INCL

HARDENED CONCRETE TEST RESULTS

ASTM STANDARD TEST [4]	TIMETABLE				
	1 DAY (ACCELERATED)	7 DAYS	28 DAYS	90 DAYS	
PRESSIVE STRENGTH, ASTM C 39 (PSI)	2410	4640	5570	7140	
ODULUS OF ELASTICITY, ASTM C 469 (PSI x 10^6)	2.69	3.81	4.48	4.89	
NG TENSILE STRENGTH, ASTM C 496 (PSI)	–	–	530	–	
YING SHRINKAGE, ASTM C 157 (PERCENT)	7 DAYS	14 DAYS	21 DAYS	28 DAYS	35 DAYS
	0.00	0.020	0.030	0.035	0.043
PRESSIVE STRENGTH, ASTM C 39 (PSI)	2515	4855	6035	6930	
ODULUS OF ELASTICITY, ASTM C 469 (PSI x 10^6)	2.89	3.74	4.30	4.70	
NG TENSILE STRENGTH, ASTM C 496 (PSI)	–	–	515	–	
YING SHRINKAGE, ASTM C 157 (PERCENT)	7 DAYS	14 DAYS	21 DAYS	28 DAYS	35 DAYS
	0.00	0.020	0.031	0.036	0.043
PRESSIVE STRENGTH, ASTM C 39 (PSI)	3165	5430	7650	9700	
ODULUS OF ELASTICITY, ASTM C 469 (PSI x 10^6)	3.15	4.01	4.50	4.96	
NG TENSILE STRENGTH, ASTM C 496 (PSI)	–	–	665	–	
YING SHRINKAGE, ASTM C 157 (PERCENT)	7 DAYS	14 DAYS	21 DAYS	28 DAYS	35 DAYS
	0.00	0.018	0.035	0.040	0.050

SIVE AND TENSILE STRENGTH VALUES ARE AVERAGES OBTAINED FROM TWO TESTED
RS. DRYING SHRINKAGE VALUES ARE AVERAGES OBTAINED FROM TWO TESTED SPECI-
METABLE INCLUDES A SEVEN DAY MOIST CURE.

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CONCRETE TRIAL MIX TEST RESULTS
WA-A- (20 - 24)
WAH WAH VALLEY, UTAH

12 JUN 81 TABLE 8

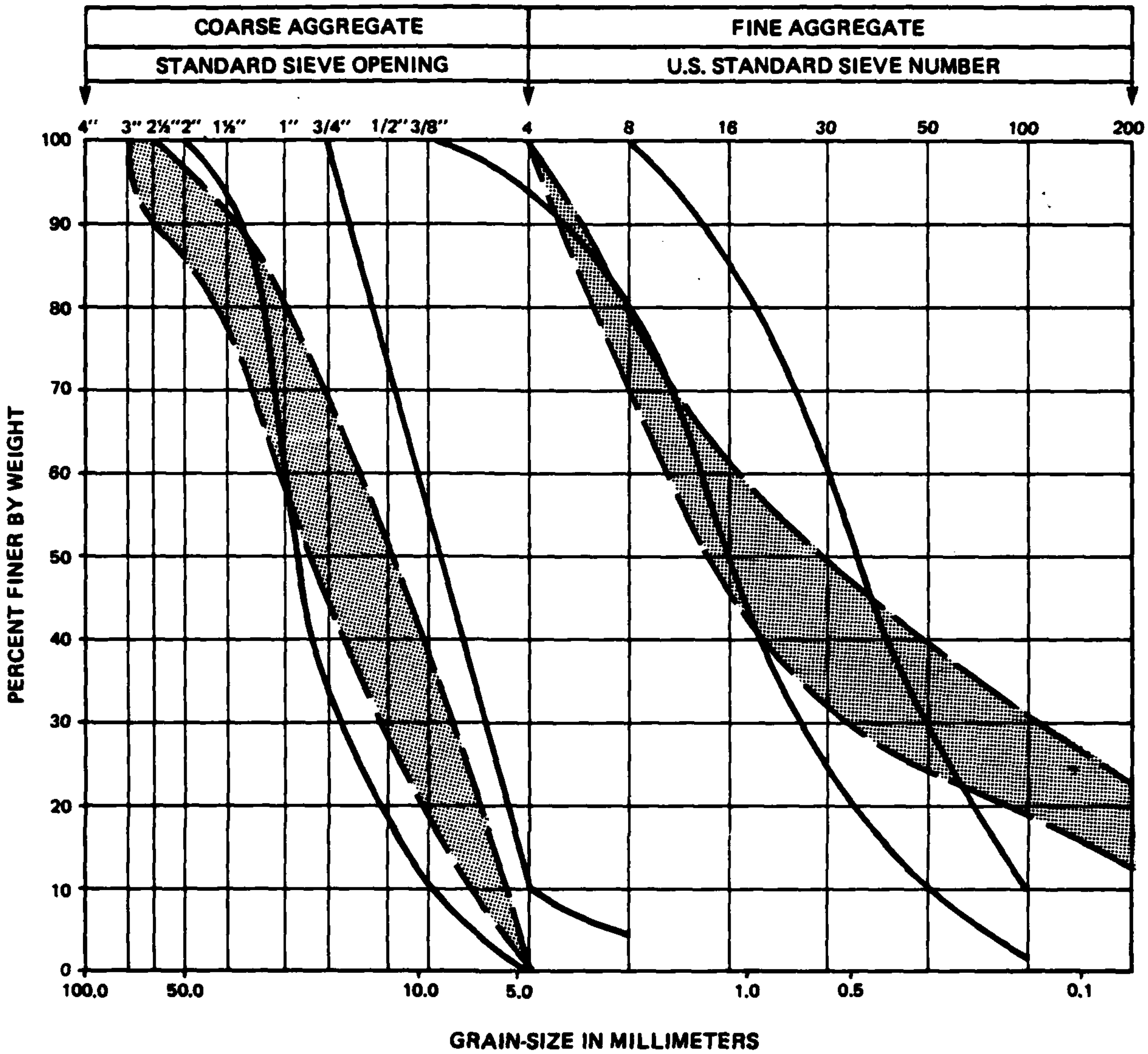
Approximately 64 percent of the gravel clasts are of satisfactory physical quality, about 35 percent are porous or moderately weathered and are of fair physical quality, and only one percent is deeply weathered or highly porous and of poor physical quality. The gravel is composed of approximately 44 percent dolomite, 35 percent limestone and dolomitic limestone, 18 percent volcanic rocks, and three percent chert and minor constituents. About 49 percent of these clasts are partially encrusted by calcareous coating material. The volcanic and chert clasts are potentially subject to the alkali-silica reaction, and the dolomitic limestone clasts are potentially subject to the alkali-carbonate reaction.

The sand particles within the northernmost Class CA1 alluvial fan deposit are typically subangular to angular and irregular in shape. Approximately 51 percent of the sand particles are of satisfactory physical quality; 42 percent are porous, weak, or moderately weathered and are of fair physical quality; and seven percent are very porous, deeply weathered particles of poor physical quality. The sand is composed of approximately 50 percent limestone and dolomite, 36 percent volcanic rocks, four percent quartz, and 10 percent coating material and minor constituents. The volcanic sand particles are potentially subject to the alkali-silica reaction and some of the carbonate sand particles are potentially subject to the alkali-carbonate reaction.

The grain-size envelopes for the northernmost Class CA1 alluvial fan deposit are shown in Figure 8 with the required gradation envelopes for coarse and fine concrete aggregates. In addition to the presence of 3- to 2-inch oversize material, the percentages of coarse gravels passing the 2-inch and 1.5-inch sieves are less than required. The percentages of gravels passing the 1-inch to No. 4 sieves are within gradation requirements. Also, the percentage of coarse sand passing the No. 8 sieve is less than required, and the percentages of fine sand passing the No. 50 and No. 100 sieves are greater than required. Processing will be necessary to bring this deposit within gradation requirements. Variations in grain-size gradations will occur within the deposit depending on proximity to the source area.

Samples of coarse and fine aggregates from the northernmost Class CA1 alluvial fan deposit were subjected to laboratory abrasion and soundness tests. The coarse aggregates passed all tests with results of 29.9 and 35.1 percent abrasion wear and 2.5 and 5.6 percent $MgSO_4$ soundness losses. Two samples of fine aggregates failed $MgSO_4$ soundness tests with losses of 15.5 and 21.7 percent. However, one of these passed a $NaSO_4$ soundness test with a 5.4 percent loss.

Concrete (Mix 3) made using the aggregates from the northernmost Class CA1 alluvial fan deposit yielded a 28-day compressive strength of 7130 psi and a 90-day compressive strength of 8660 psi (Table 6). Concrete trial Mixes 1 and 2 yielded 28-day compressive strengths of 5460 and 6070 psi, respectively. Fresh



REQUIRED GRAIN-SIZE DISTRIBUTION ENVELOPES FOR COARSE AND FINE AGGREGATES USED IN CONCRETE (AMERICAN SOCIETY FOR TESTING AND MATERIALS, 1978, C 33; THE RECOMMENDED GRADATIONS FOR AGGREGATES WITH 1.5 AND 0.75 INCH MAXIMUM SIZE ARE COMBINED INTO ONE ENVELOPE).

GRAIN-SIZE DISTRIBUTION ENVELOPES OF BASIN–FILL COARSE AND FINE AGGREGATES POTENTIALLY SUITABLE FOR CONCRETE.

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GRAIN-SIZE DISTRIBUTION ENVELOPES
CONCRETE AGGREGATES, WA-A- (46-50)
WAH WAH VALLEY, UTAH

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FIGURE 8

AGGREGATE SOURCE[1]	FIELD STATION	CONCRETE MIX DESIGN CRITERIA[2] SACKS OF CEMENT/CYD / MAX. AGG. SIZE	FRESH CONCRETE PROPERTIES: SLUMP[3] (IN.)	AIR CONTENT (%)	UNIT WEIGHT (PCF)	WATER/ CEMENT RATIO	CEMENT FACTOR (SCY)	ASTM STAND
BASIN – FILL	WA-A- (46 - 50)	MIX 1 7.5/1.5 IN.	3.0	2.5	148.1	0.37	7.58	COMPRESSIVE STR (PS CHORD MODULUS OF EL (PSI x SPLITTING TENSILE ST (PS DRYING SHRINKA (PERC
	WA-A- (46 - 50)	MIX 2 8.5/1.5 IN.	2.5	3.0	148.9	0.33	8.6	COMPRESSIVE STR (PS CHORD MODULUS OF EL (PSI x SPLITTING TENSILE ST (PS DRYING SHRINKA (PERC
	WA-A- (46 - 50)	MIX 3 8.5/0.75 IN., SUPER-PLASTICIZER	0.0 BEF. 7.0 AFT.	2.6	146.4	0.30	8.68	COMPRESSIVE STR (PS CHORD MODULUS OF EL (PSI x SPLITTING TENSILE ST (PS DRYING SHRINKA (PERC

1. BASIN-FILL SOURCES SUPPLIED BOTH COARSE AND FINE AGGREGATES FOR CONCRETE MIX. LEDGE-ROCK SOURCES SUPPLIED COARSE AGGREGATES; LOCAL SAND SOURCES (GENERALLY COLLECTED WITHIN A FEW MILES OF CORRESPONDING LEDGE-ROCK SOURCES) SUPPLIED FINE AGGREGATES FOR CONCRETE MIX.
2. ASTM AND ACI SPECIFICATIONS AND PROCEDURES WERE FOLLOWED IN THE MIX DESIGN AND BATCHING OF THE CONCRETE TRIAL MIXES. THE CONCRETE MIXES CONSISTED OF COARSE AND FINE AGGREGATES, LOW ALKALI CEMENT, FLY ASH (20% BY WEIGHT REPLACEMENT OF CEMENT), SUPERPLASTICIZER, AIR-ENTRAINING ADMIXTURE, AND WATER REDUCER.
3. BEF. – SLUMP BEFORE ADDITION OF SUPERPLASTICIZER.
   AFT. – SLUMP AFTER ADDITION OF SUPERPLASTICIZER.
4. COMPRESSIVE AND TENS CYLINDERS. DRYING SH MENS; TIMETABLE INCLU

HARDENED CONCRETE TEST RESULTS

ASTM STANDARD TEST [4]	TIMETABLE			
	1 DAY (ACCELERATED)	7 DAYS	28 DAYS	90 DAYS
RESSIVE STRENGTH, ASTM C 39 (PSI)	2645	4345	5460	6815
DULUS OF ELASTICITY, ASTM C 469 (PSI x 10^6)	3.12	4.13	4.20	4.87
G TENSILE STRENGTH, ASTM C 496 (PSI)	–	–	540	–

	7 DAYS	14 DAYS	21 DAYS	28 DAYS	35 DAYS
YING SHRINKAGE, ASTM C 157 (PERCENT)	0.00	0.027	0.043	0.046	0.051

	1 DAY (ACCELERATED)	7 DAYS	28 DAYS	90 DAYS
RESSIVE STRENGTH, ASTM C 39 (PSI)	2835	4490	6070	6895
DULUS OF ELASTICITY, ASTM C 469 (PSI x 10^6)	3.08	4.20	4.65	5.19
G TENSILE STRENGTH, ASTM C 496 (PSI)	–	–	530	–

	7 DAYS	14 DAYS	21 DAYS	28 DAYS	35 DAYS
YING SHRINKAGE, ASTM C 157 (PERCENT)	0.00	0.031	0.050	0.054	0.058

	1 DAY (ACCELERATED)	7 DAYS	28 DAYS	90 DAYS
RESSIVE STRENGTH, ASTM C 39 (PSI)	3090	5930	7130	8600
DULUS OF ELASTICITY, ASTM C 469 (PSI x 10^6)	2.91	3.89	4.53	4.87
G TENSILE STRENGTH, ASTM C 496 (PSI)	–	–	605	–

	7 DAYS	14 DAYS	21 DAYS	28 DAYS	35 DAYS
YING SHRINKAGE, ASTM C 157 (PERCENT)	0.00	0.029	0.052	0.058	0.062

IVE AND TENSILE STRENGTH VALUES ARE AVERAGES OBTAINED FROM TWO TESTED
S. DRYING SHRINKAGE VALUES ARE AVERAGES OBTAINED FROM TWO TESTED SPECI-
ETABLE INCLUDES A SEVEN DAY MOIST CURE

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CONCRETE TRIAL MIX TEST RESULTS
WA-A- (46 50)
WAH WAH VALLEY, UTAH

12 JUN 81 TABLE 8

concrete properties and hardened concrete test results (chord modulus of elasticity, splitting tensile strength, and drying shrinkage) are included in Table 6. The test results for hardened concrete are within the requirements mentioned in Section 4.1.1.

The areal extent of the northermost Class CA1 alluvial fan deposit is approximately 3.2 mi^2 (8.3 km^2). It is estimated that the thickness of the material described above is at least 25 feet (7.6 m). It is also estimated that, where sampled, the deposit will have a yield of 70 to 80 percent after gradation deficiencies and handling, poor quality constituents, and silt and clay losses.

4.2.1.2 Class CB

Class CB basin-fill sources are alluvial deposits that have been sampled and laboratory tested and, on the basis of the test results, are considered to be potential sources of concrete materials. Class CB aggregates have not been used in trial concrete mixes. Test results show that these deposits contain at least 30 percent gravel clasts of all sizes (3 inches to No. 4), have less than 50 percent abrasion wear, and, where applicable, have less than 18 percent loss when subjected to a $MgSO_4$ soundness test.

There are 14 Class CB sources in the study area, 10 are alluvial fan units (Aaf) and four are older lacustrine deposits (Aol). These deposits are located adjacent to the Wah Wah Mountains, Gray Hills, Black Hills, and San Francisco Mountains.

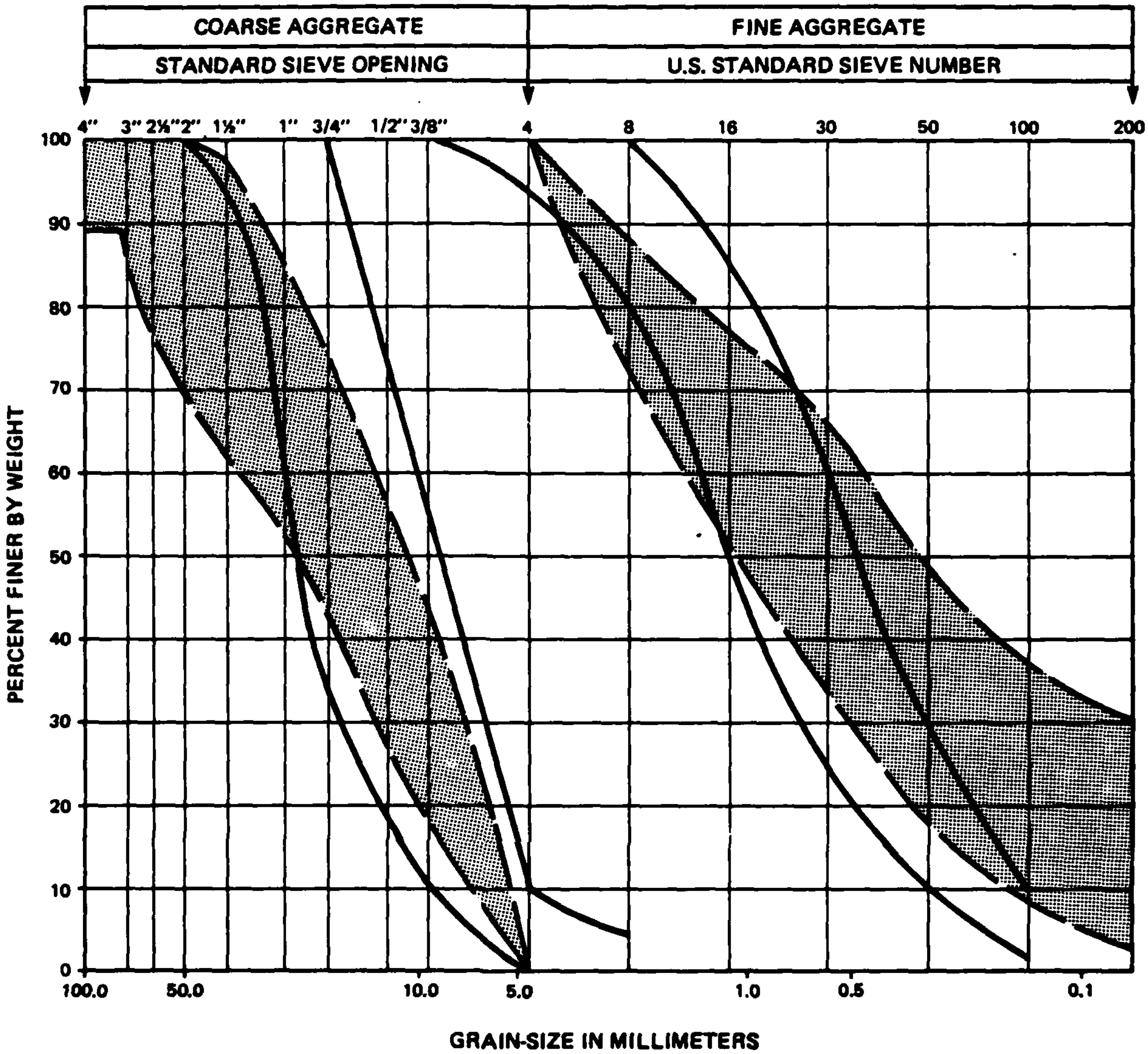
Class CB alluvial fan deposits typically consist of medium-dense to dense, poorly to well-graded, angular to subrounded sandy gravel and gravelly sand. Alluvial fan deposits generally contain approximately 40 to 65 percent gravel, 25 to 50 percent sand, and three to 13 percent silt and clay. Cobbles and boulders comprise from five to 20 percent of Aaf deposits.

Class CB older lacustrine deposits typically consist of loose to medium-dense, poorly graded, subrounded to rounded sandy gravel. Older lacustrine deposits generally contain about the same percentage of gravel and sand as the Aaf deposits. On the east side of the valley, Aol deposits generally contain about one to three percent silt and clay and up to 15 percent cobbles and boulders. Older lacustrine deposits on the west side of the valley generally contain less silt and clay, (three to eight percent of the less than 3-inch material) and fewer cobbles and boulders.

The lithology of Class CB deposits varies within the study area. Deposits located adjacent to the San Francisco Mountains and north of Highway 21 are composed either entirely or predominantly of quartzite material with minor amounts of carbonate, volcanic, and granitic material. Class CB deposits adjacent to the Gray Hills and Wah Wah Mountains north of Highway 21 are composed predominantly of limestone and dolomite with minor amounts of sandstones, volcanics, and quartz. The two Class CB deposits south of Highway 21 are composed predominantly of volcanic material with lesser amounts of clastic and carbonate sedimentary material. The Aol deposit located in the center of the valley is composed predominantly of carbonate material with secondary volcanics.

The grain-size gradation envelopes for Class CB are shown in Figure 9 with the required gradation envelopes for coarse and fine concrete aggregates. In the Class CB deposits, oversize material (greater than 2-inches) is generally present, the percentages of gravels passing the 2- to 1-inch sieves are generally less than required, and coarse and fine gravels passing the 1-inch to No. 4 sieves are within gradation requirements. A few of the Class CB deposits have fine aggregate gradations that approximate the required gradation range for fine aggregates. Most Class CB deposits, however, have greater than the required amount of fine sand passing the No. 50 and No. 100 sieves. Variations in grain-size gradations will occur within each deposit depending on proximity to the source area. In general, the deposits are relatively finer grained near the valley axis and coarser grained near the mountain fronts. In all cases, processing will be necessary to bring the Class CB deposits within gradation requirements for concrete aggregates.

Laboratory abrasion tests performed on samples from all Class CB deposits yielded results ranging from 18.5 to 30.3 percent wear. There is a significant difference in $MgSO_4$ soundness losses between Aol deposits and Aaf deposits. Soundness losses from samples collected from Aol deposits ranged from 1.1 to 4.5 percent



REQUIRED GRAIN-SIZE DISTRIBUTION ENVELOPES FOR COARSE AND FINE AGGREGATES USED IN CONCRETE (AMERICAN SOCIETY FOR TESTING AND MATERIALS, 1978, C 33; THE RECOMMENDED GRADATIONS FOR AGGREGATES WITH 1.5 AND 0.75 INCH MAXIMUM SIZE ARE COMBINED INTO ONE ENVELOPE).

GRAIN-SIZE DISTRIBUTION ENVELOPES OF BASIN—FILL COARSE AND FINE AGGREGATES POTENTIALLY SUITABLE FOR CONCRETE.

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GRAIN-SIZE DISTRIBUTION ENVELOPES
CONCRETE AGGREGATES, CLASS CB
WAH WAH VALLEY, UTAH

12 JUN 81

FIGURE 9

for coarse aggregates and 4.0 to 13.2 percent for fine aggregates. All of these results are within the acceptable range of soundness losses for concrete aggregates. Soundness losses from samples taken from Aaf deposits, however, were generally much higher than Aol soundness losses, ranging from 1.6 to 8.2 percent loss for coarse aggregates and from 13.9 to 28.4 percent loss for fine aggregates. The fine aggregates from Aaf deposits consistently failed the $MgSO_4$ soundness test.

The areal extent of the Class CB alluvial fan deposits ranges from approximately 50 acres (0.2 km^2) to 9.5 mi^2 (24.6 km^2). It is estimated that the thickness of the material in these deposits, as described above, is at least 25 feet (7.6 m) and will have a yield of 65 to 80 percent.

The areal extent of the Class CB older lacustrine deposits ranges from approximately 20 acres (0.1 km^2) to 0.7 mi^2 (1.8 km^2). The thickness of these deposits is highly variable, ranging from a few feet to about 25 feet (7.6 m). Class CB older lacustrine deposits have a yield of about 75 to 85 percent.

4.2.1.3 Class CC1

Class CC1 basin-fill aggregate sources are alluvial fan deposits that have been correlated to Class CA1 deposits on the basis of geomorphological and compositional similarities. There are four Class CC1 alluvial fan deposits (Aaf) located on the west side of the valley adjacent to the Wah Wah Mountains. These alluvial fans are correlated to adjacent Class CA1 fans and, therefore, are considered to be potential sources of concrete aggregates consisting of medium dense to dense, poorly to well graded, angular to subrounded sandy gravel and gravelly sand composed predominantly of limestone and dolomite with lesser amounts of volcanic rocks and quartzite. The areal extent of the individual Class CC1 alluvial fan deposits ranges from approximately 0.5 to 1.5 mi^2 (1.3 to 3.9 km^2).

There are five small Class CC1 older lacustrine deposits (Aol) located on the east side of the valley adjacent to the San Francisco Mountains. These Class CC1 deposits are correlated to nearby Class CA1 lacustrine deposits and are therefore considered to be potential sources of concrete aggregates consisting of loose to medium-dense, poorly graded, subrounded to rounded sandy gravel composed predominantly of quartzite with minor amounts of carbonate and volcanic clasts. The areal extent of the Class CC1 older lacustrine deposits ranges from approximately a few acres to 0.3 mi^2 (0.8 km^2).

4.2.1.4 Class CC2

Class CC2 basin-fill aggregate sources are alluvial units that have been correlated to Class CB concrete aggregate sources on the basis of geomorphological and compositional similarities. Class CC2 deposits are therefore assumed to contain material similar in size and composition to Class CB deposits. There are nine alluvial fan (Aaf) and numerous older lacustrine (Aol) deposits included in Class CC2. These deposits are located in all parts of the valley adjacent to the Wah Wah Mountains, Gray

Hills, and San Francisco Mountains. The areal extent of the Class CC2 deposits ranges from a few acres to approximately 3.0 mi^2 (7.8 km^2).

4.2.2 Rock Sources

Rock concrete aggregate sources are grouped into three classes. Rock defined on the basis of laboratory test data are included in Classes CA1 and CB. Class CC1 contains rocks correlated to Class CA1 rocks.

4.2.2.1 Class CA1

One Class CA1 crushed-rock aggregate source was delineated in the study area. This rock source is located in the San Francisco Mountains about 3 miles (4.8 km) north of 38°30' N. (Drawing 3). Class CA1 rocks belong to the quartzite (Qtz) geologic rock unit and were sampled during the present study. The fine aggregate used in conjunction with the Class CA1 rock is from a basin-fill unit located approximately 2.3 miles (3.7 km) southwest of the Class CA1 rock unit.

The Class CA1 rock sample used in the concrete trial mix consisted of pink, very hard, brittle, massive, fine-grained quartzite. Constituents other than quartz are very rare in the rock. When crushed, this rock produced fragments that were angular, ranging in shape from approximately cubic to thick-tabular and platey.

Approximately 93 percent of the crushed-rock fragments are satisfactory in physical quality and seven percent of the fragments are internally fractured and are of fair physical quality. No constituents susceptible to deleterious cement-aggregate reactions were found in the sample.

The sand sample used in conjunction with the Class CA1 rock is from an older lacustrine deposit (Aol) which consists of poorly graded, angular to rounded gravelly sand. Approximately 55 percent of the sand particles are of satisfactory physical quality; 40 percent are moderately weathered or internally fractured and are of fair physical quality; and five percent are deeply weathered, highly porous, or fragile and of poor physical quality. The sand is composed of approximately 43 percent rhyolite and andesite, 32 percent limestone and dolomite, eight percent quartz, and 17 percent feldspar and minor constituents. The rhyolite particles may be susceptible to a deleterious degree to the alkali-silica reaction. The dolomite particles are not considered susceptible to the alkali-carbonate reaction.

The crushed-rock aggregates from the Class CA1 deposit were subjected to a laboratory abrasion test which yielded a result of 23.5 percent wear. A $MgSO_4$ soundness test performed on the crushed rock resulted in a loss of 0.2 percent. The fine aggregates used in conjunction with the crushed rock were subjected to a $MgSO_4$ soundness test which resulted in a loss of 12.8 percent. All of these test results are well below the maximum allowable values for abrasion wear and soundness loss for concrete aggregates.

Concrete (Mix 3) made using aggregates from the Class CA1 crushed rock yielded a 28-day compressive strength of 8395 psi and a 90-day compressive strength of 9565 psi (Table 7). Concrete trial Mixes 1 and 2 yielded 28-day compressive strengths of 5965 and 6180 psi, respectively. Fresh concrete properties and hardened concrete test results (chord modulus of elasticity, splitting tensile strength, and drying shrinkage) are included in Table 7. The test results for hardened concrete are within the requirements mentioned in Section 4.1.1.

4.2.2.2 Class CB

Class CB crushed-rock sources are rock units that have been sampled and laboratory tested and, on the basis of the test results, are considered to be potential concrete aggregate sources. Class CB rocks have not been used in concrete trial mixes.

Class CB rock sources consist of quartzite (Qtz), granitic rocks (Gr), undifferentiated carbonate rocks (Cau), limestone (Ls), and basalt (Vb) (Drawing 3). The Class CB quartzite source is a small outlier of the San Francisco Mountains in the northwest part of the valley. A sample from this source consisted of slightly weathered, very hard, medium-grained, thick-bedded quartzite.

The Class CB granitic (Gr) rock source is located in the San Francisco Mountains immediately north of 38°30' N. A sample from this source consisted of slightly weathered, hard, medium-grained, blocky diorite.

AGGREGATE SOURCE[1]	FIELD STATION	CONCRETE MIX DESIGN CRITERIA[2] SACKS OF CEMENT/CYD / MAX. AGG. SIZE	FRESH CONCRETE PROPERTIES: SLUMP[3] (IN.)	AIR CONTENT (%)	UNIT WEIGHT (PCF)	WATER/ CEMENT RATIO	CEMENT FACTOR (SCY)	ASTM STAN
LEDGE ROCK AND SAND	WA-R-1 & WA-FA-1	MIX 1 7.5/1.5 IN.	3.0	4.0	143.9	0.37	7.44	COMPRESSIVE ST
								CHORD MODULUS OF (PSI
								SPLITTING TENSILE
								DRYING SHRIN (PE
	WA-R-1 & WA-FA-1	MIX 2 8.5/1.5 IN.	3.0	5.3	141.6	0.36	8.21	COMPRESSIVE ST
								CHORD MODULUS OF (PSI
								SPLITTING TENSILE
								DRYING SHRI (PE
	WA-R-1 & WA-FA-1	MIX 3 8.5/0.75 IN., SUPER-PLASTICIZER	0.0 BEF. 7.0 AFT.	4.0	143.9	0.31	8.49	COMPRESSIVE S
								CHORD MODULUS OF
								SPLITTING TENSIL
								DRYING SH

1. BASIN-FILL SOURCES SUPPLIED BOTH COARSE AND FINE AGGREGATES FOR CONCRETE MIX. LEDGE-ROCK SOURCES SUPPLIED COARSE AGGREGATES; LOCAL SAND SOURCES (GENERALLY COLLECTED WITHIN A FEW MILES OF CORRESPONDING LEDGE-ROCK SOURCES) SUPPLIED FINE AGGREGATES FOR CONCRETE MIX.
2. ASTM AND ACI SPECIFICATIONS AND PROCEDURES WERE FOLLOWED IN THE MIX DESIGN AND BATCHING OF THE CONCRETE TRIAL MIXES. THE CONCRETE MIXES CONSISTED OF COARSE AND FINE AGGREGATES, LOW ALKALI CEMENT, FLY ASH (20% BY WEIGHT REPLACEMENT OF CEMENT), SUPERPLASTICIZER, AIR-ENTRAINING ADMIXTURE, AND WATER REDUCER.
3. BEF. – SLUMP BEFORE ADDITION OF SUPERPLASTICIZER.
   AFT. – SLUMP AFTER ADDITION OF SUPERPLASTICIZER.
4. COMPRESSIVE AND CYLINDERS. DRY MENS: TIMETABLE

HARDENED CONCRETE TEST RESULTS

ASTM STANDARD TEST [4]	TIMETABLE			
	1 DAY (ACCELERATED)	7 DAYS	28 DAYS	90 DAYS
PRESSIVE STRENGTH, ASTM C 39 (PSI)	2345	4475	5965	7095
ODULUS OF ELASTICITY, ASTM C 469 (PSI x 10^6)	3.25	4.34	4.44	5.27
NG TENSILE STRENGTH, ASTM C 496 (PSI)	–	–	555	–

RYING SHRINKAGE, ASTM C 157 (PERCENT)	7 DAYS	14 DAYS	21 DAYS	28 DAYS	35 DAYS
	0.00	0.019	0.042	0.049	0.050

ASTM STANDARD TEST [4]	1 DAY (ACCELERATED)	7 DAYS	28 DAYS	90 DAYS
PRESSIVE STRENGTH, ASTM C 39 (PSI)	2430	4755	6180	7370
ODULUS OF ELASTICITY, ASTM C 469 (PSI x 10^6)	3.42	4.86	4.62	5.08
NG TENSILE STRENGTH, ASTM C 496 (PSI)	–	–	560	–

RYING SHRINKAGE, ASTM C 157 (PERCENT)	7 DAYS	14 DAYS	21 DAYS	28 DAYS	35 DAYS
	0.00	0.017	0.036	0.049	0.050

ASTM STANDARD TEST [4]	1 DAY (ACCELERATED)	7 DAYS	28 DAYS	90 DAYS
PRESSIVE STRENGTH, ASTM C 39 (PSI)	3275	6400	8395	9565
ODULUS OF ELASTICITY, ASTM C 469 (PSI x 10^6)	2.75	4.32	4.64	5.26
NG TENSILE STRENGTH, ASTM C 496 (PSI)	–	–	610	–

YING SHRINKAGE, ASTM C 157 (PERCENT)	7 DAYS	14 DAYS	21 DAYS	28 DAYS	35 DAYS
	0.00	0.018	0.039	0.048	0.049

SIVE AND TENSILE STRENGTH VALUES ARE AVERAGES OBTAINED FROM TWO TESTED
RS. DRYING SHRINKAGE VALUES ARE AVERAGES OBTAINED FROM TWO TESTED SPECI-
METABLE INCLUDES A SEVEN DAY MOIST CURE.

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CONCRETE TRIAL MIX TEST RESULTS
WA-R-1 AND WA-FA-1
WAH WAH VALLEY, UTAH

12 JUN 81 TABLE 7

The Class CB undifferentiated carbonate rock (Cau) source is located in the Gray Hills in the extreme northwestern corner of the study area. A sample from this source consisted of slightly weathered, hard, fine- to medium-grained, thin- to thick-bedded, blocky to slabby limestone.

The Class CB limestone (Ls) rock source is located in the northwestern part of the valley at the end of a ridge of rock projecting into the valley. A sample from this source consisted of slightly weathered, gray, hard to very hard, medium-gray, thick-bedded, massive to blocky dolomite. However, the geologic unit (Orr Formation) in which this dolomite exposure was collected generally consists predominantly of limestone.

The Class CB basalt (Vb) rock source comprises a prominent knoll or outlier just south of the Black Hills. A sample from this source consisted of fresh to slightly weathered, brown to black, very hard, fine-grained, thick- to very thick-bedded, moderately to poorly jointed vesicular basalt.

Laboratory abrasion and $MgSO_4$ soundness tests were performed on all samples of Class CB crushed rock. Results of these tests were 23.4 to 30.5 percent abrasion wear and 0.2 to 6.7 percent soundness loss. These test results are well below the maximum acceptable values for concrete aggregates.

4.2.2.3 Class CC1

Class CC1 potential concrete aggregate sources are untested rock outcrops of the quartzite geological unit (Qtz). Published geologic maps were used to delineate these extensive outcrops. These sources are part of the same geologic unit as the Class CA1 source and have essentially the same lithology.

5.0 CONCLUSIONS

Results of the Detailed Aggregate Resources Study indicate that there are sufficient quantities of aggregates available for the construction of the MX missile system in the Wah Wah Valley study area.

Good to high quality basin-fill and crushed-rock coarse aggregates are present in all areas of the valley. Sufficient quantities of fair quality, fine aggregates are present in basin-fill deposits in the valley. After shelter layouts are finalized, potential borrow areas can be delineated based on the results of this study.

Although most rock will supply acceptable coarse aggregates, limited sources are delineated in this study. Sufficient quantities of basin-fill aggregates within the valley will probably make processing of crushed-rock aggregates unnecessary.

As discussed in the report, field studies placed an arbitrary cut-off limit of a minimum of 30 percent gravel for the source to be considered for road-base or concrete aggregates. Nevertheless, basin-fill deposits with less than 30 percent gravel are also potentially suitable for use as aggregates. However, yield from such sources will be low and extensive processing and/or blending will be required to satisfy the gradation requirements.

5.1 ROAD-BASE AGGREGATES

5.1.1 Class RBIa Sources

Twenty-two basin-fill deposits consisting of good to high quality coarse aggregates acceptable for road base have been located within the study area. Fifteen of these deposits are alluvial fan units (Aaf) and seven are older lacustrine units (Aol). Their total areal extent is approximately 32.5 mi^2 (84.2 km^2).

Gradation results indicate that, where sampled, the deposits approximate ASTM standards and DARS requirements. Boulders, cobbles, and coarse gravels are generally excessive but the percentages of fine gravels and sand are within gradation requirements. Grain-size variations will occur depending on sample location within the deposit. Generally, finer grained material can be obtained nearer the valley axis and coarser grained material can be obtained near mountain front source areas.

Abrasion and soundness results on tested samples are also within ASTM standards and DARS requirements.

Six good to high quality coarse aggregate crushed-rock sources which are acceptable for use as road-base aggregates have been delineated within the study area. These sources include outcrops of quartzite (Qtz), limestone (Ls), undifferentiated carbonate rocks (Cau), granite (Gr), and basalt (Vb). Samples from these rock sources yielded test results for gradation, abrasion, and soundness well within acceptable ranges as specified by ASTM standards and DARS requirements.

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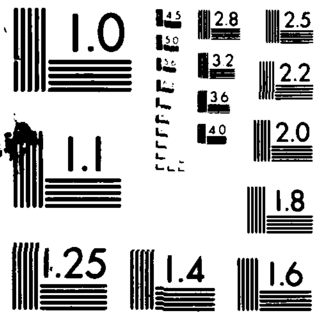

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963 A

5.1.2 Class RBIb Sources

Thirteen alluvial fan (Aaf) and numerous small older lacustrine (Aol) basin-fill deposits within the study area are defined as potential sources of good to high quality coarse aggregates for use as road-base construction material. Geomorphological and compositional similarities were used to correlate these units to tested RBIa deposits. Their total areal extent is approximately 18.5 mi^2 (47.9 km^2).

5.1.3 Class RBII Sources

Several potential sources of road-base aggregates defined by limited field and laboratory data are present throughout the study area. All deposits are alluvial fans, consist predominantly of sandy gravel or gravelly sand, and are compositionally similar to Class RBIa and RBIb deposits. These deposits have a total areal extent of approximately 16.3 mi^2 (42.2 km^2).

5.2 CONCRETE AGGREGATES

5.2.1 Class CA1 Sources

Four basin-fill deposits consisting of good to high quality aggregates that produced concrete with 28-day compressive strengths equal to or greater than 6500 psi have been delineated within the study area. Chord modulus of elasticity, splitting tensile strength, and drying shrinkage results generally conform to the standard concrete requirements.

Gradation results indicate that, where sampled, the deposits deviate somewhat from ASTM standards and DARS requirements. Typically, oversize material is present, coarse gravels passing the

2- to 1.5-inch sieves are deficient, coarse sand passing the No. 8 sieve is deficient, and fine sands passing the No. 50 and No. 100 sieves are excessive. Fine gravels and medium sand percentages are generally within gradation requirements. Processing of basin-fill deposits can be used to bring gradations within design requirements. In addition, variations in grain-size gradation will occur within the deposit depending on proximity to the source area. Aggregates are relatively finer grained near the valley axis and coarser grained near the mountain fronts.

Abrasion and soundness tests performed on coarse aggregates from Class CA1 deposits are also within specified ASTM and DARS requirements. The fine aggregates within these deposits are generally of lower quality (high $MgSO_4$ soundness losses) but results are inconclusive regarding their use as concrete construction material. Two of the Class CA1 basin-fill deposits are older lacustrine units (Aol) located on the east side of the valley, and two are alluvial fan units (Aaf) located on the west side of the valley. Their total areal extent is approximately 7.7 mi^2 (19.9 km^2).

One Class CA1 crushed-rock source (Qtz) was delineated on the east side of the study area. The crushed-rock coarse aggregates from this source have acceptable abrasion and soundness test results and the local sand (fine aggregates) used in the mix had an acceptable $MgSO_4$ soundness loss.

5.2.2 Class CB Sources

Fourteen basin-fill deposits consisting of good to high quality coarse aggregates potentially acceptable for use as concrete construction material were delineated within the study area. Ten of these deposits are alluvial fan units (Aaf) and four are older lacustrine units (Aol). Their total areal extent is approximately 21.8 mi^2 (56.5 km^2). Gradation results indicate that, where sampled, Class CB deposits approximate ASTM standards and DARS requirements. No concrete trial mixes were made, but abrasion and soundness test results on samples from these deposits were generally within acceptable ranges as specified by ASTM standards and DARS requirements.

5.2.3 Class CC1 Sources

Nine alluvial fan and older lacustrine basin-fill units in the study area are classified as potential sources of concrete aggregates. The units were correlated to Class CA1 sources based on geomorphological and compositional similarities. These deposits have a total areal extent of approximately 5.5 mi^2 (14.2 km^2).

5.2.4 Class CC2 Sources

Several alluvial fan and older lacustrine deposits within the study area are classified as potential sources of concrete aggregates. Units were correlated to Class CB sources on the basis of geomorphological and compositional similarities. They have a total areal extent of approximately 14.5 mi^2 (37.6 km^2).

6.0 RECOMMENDATIONS FOR FUTURE STUDIES

The conclusions of this Detailed Aggregate Resources Study of Wah Wah Valley, as enumerated in Section 5.0, are based on limited field and laboratory test results. However, the results presented in this report provide sufficient data for selecting potential borrow areas. After selection of the borrow areas, more extensive studies are required to further determine the characteristics of the aggregates.

6.1 SOURCES OF ROAD-BASE AGGREGATES

It is recommended that additional field exploration (backhoe or drilling) and detailed laboratory testing be performed. The laboratory tests should consist of sieve analysis, resistance to abrasion, CBR, and other appropriate tests as deemed necessary by the designers.

6.2 SOURCES OF CONCRETE AGGREGATES

It is recommended that additional field investigations (backhoe or drilling) and detailed laboratory testing be performed. The aggregate samples should be subjected to the following tests:

- Sieve Analysis;
- Resistance to Abrasion;
- Soundness;
- Specific Gravity and Absorption; and
- Petrographic Examination of Aggregates for Concrete.

In addition, the following detailed tests using concrete made from these aggregates should be performed:

- Compressive Strength;
- Splitting Tensile Strength;
- Flexural Strength;
- Shrinkage;

- o Thermal Expansion;
- o Modulus of Elasticity;
- o Potential Alkali-Silica Reactivity;
- o Potential Alkali-Carbonate Rock Reactivity; and
- o Resistance of Concrete to Rapid Freezing and Thawing.

It is also recommended that concrete trial mixes with different size aggregates and admixtures be made in order to assess the variation in compressive strength, durability, shrinkage, and thermal properties of concrete.

Verification studies (FN-TR-27-WA-I and II) performed in Wah Wah Valley indicate that the potential for sulfate attack of soils on concrete ranges from "negligible" to "severe." It is recommended that additional studies be made to further evaluate the potential for sulfate attack of soils on concrete and determine the type of cement to be used in concrete.

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PERSONAL COMMUNICATION

Polivka, Milos, 1981, Consulting Civil Engineer, Berkeley, California.

APPENDIX A

SUMMARY OF FIELD AND LABORATORY TEST DATA

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FIELD AND LABORATORY TEST DATA

Field observations and laboratory test data on samples collected at selected stations are presented in Table A-1. Field stations were established at various locations throughout the study area where detailed descriptions of potential basin-fill, fine aggregate, and crushed-rock sources were recorded. Detailed explanations for the column headings of Table A-1 are as follows:

COLUMN HEADING	EXPLANATION
MAP NUMBER	Map numbers are sequentially arranged identifiers of field stations occupied during the course of the aggregate study.
FIELD STATION	These designations are internal DARS identifiers of all field stations. Each one consists of a two-letter valley abbreviation followed by the letter A (aggregate trench), FA (fine aggregate trench), or R (ledge rock).
LOCATION	The location column lists the geographic portion of the valley in which the field station is located (e.g., NE-northeast).
GEOLOGIC UNIT	The geologic unit listed is a term used to differentiate basin-fill deposits based on geomorphology and rock units based on existing geologic maps. A geologic unit cross reference, outlining all units used, is included as Table F-3.
MATERIAL DESCRIPTION	Material descriptions are based on either field or laboratory USCS classifications using appropriate ASTM standards for basin-fill deposits and existing references and Travis (1955) for rock units. Coarse and fine aggregate gradations used in concrete trial mix designs are included at the end of each concrete aggregate trench group.
USCS SYMBOL	Appropriate field or laboratory ASTM standards are used to classify sampled

material. The Unified Soil Classification System is used in this study. Table F-1 contains detailed information on the USCS.

FIELD OBSERVATIONS

<u>Boulders and/or Cobbles</u>

The estimated occurrence of boulders and cobbles is based on an appraisal of the entire deposit. Cobbles have an intermediate diameter of 3 to 12 inches (8 to 30 cm); boulders have an intermediate diameter of 12 inches (30 cm) or more. Because of sample-size limitations, boulders were not generally sampled. Cobbles were representatively sampled for concrete aggregate evaluations but only generally sampled for road-base aggregate evaluations. Field observations of boulders and cobbles are important considerations for in-situ gradations only. Number percentages are equated to the following equivalent dry weight terms:

Rare - 1 - 4 percent
Few - 5 - 20 percent
Some - > 20 percent

<u>Gravel</u>

Coarse aggregate particles that pass a 3-inch (76-mm) sieve but are predominantly retained on a No. 4 (4.75 mm) sieve.

<u>Sand</u>

Fine aggregate particles that almost entirely pass a No. 4 sieve but are predominantly retained on a No. 200 (0.075 mm) sieve.

<u>Fines</u>

Soil particles that pass a No. 200 sieve (silt and clay).

<u>Overburden Thickness (Feet)</u>

Surficial soil overlying a usable aggregate deposit. Material generally consists of silt and sand with low concentrations of gravel. Numbers presented indicate thickness of deposit in feet.

<u>Total Trench Depth (Feet)</u>

Depth, in feet, of trench excavation used to collect aggregate samples. Depth followed by the letter R indicates that depth below which soil strength exceeded excavation capability. The common conditions for refusal (R) are calcium carbonate accumulation (caliche) and/or presence of oversized material.

Deleterious Materials (Material/Depth/ Stage)

Deleterious materials are substances that are potentially detrimental to concrete in service. Substances that may be present include: organic impurities, low density materials (ash, vesicles, pumice, cinders), amorphous silica (opal, chert, chalcedony), volcanic glass, caliche and clay coatings, mica, gypsum, pyrite, chlorite, friable materials, and aggregates that may react chemically or be affected chemically by other external influences. The most common deleterious material is calcium carbonate accumulation (caliche). When it is abundant, the interval(s) at which it occurs and the stage of development (Table F-2) are listed. Caliche can occur disseminated throughout a deposit, as lenses, and as discrete layers. The depth space is left blank when caliche is present throughout the deposit.

Plasticity (Index)

Plasticity index (PI) is the range of water content, expressed as a percentage of the weight of the oven-dried soil (less than No. 40 sieve material), through which a soil behaves plastically . It is defined as the liquid limit minus the plastic limit. Field terms used to approximate plasticity index range include the following.

Plasticity	PI	Wet Consistency
Slight	(4-15)	Slightly sticky; after pressure, soil adheres to both thumb and finger but comes off cleanly. Does not appreciably stretch.
Medium	(15-30)	Sticky; after pressure, soil adheres to both thumb and finger and tends to stretch somewhat before pulling apart from either digit.
High	(>30)	Very sticky; after pressure, soil adheres strongly to both digits and is markedly stretched when digits are separated.

Hardness

Hardness determination is a field test used to identify materials that are soft or poorly bonded by estimating their resistance to crushing by impact with a rock hammer. Classification terms used include:

Soft — Hammer point indents deeply with firm blow.

Moderately Hard — Hammer point indents only shallowly with firm blow.

Hard — Hammer breaks hand-held sample with one firm blow.

Very Hard — Hammer breaks intact sample with many blows.

Weathering — Weathering is defined as any changes in color, texture, strength, chemical composition, or other properties of rock due to the effects of various atmospheric conditions. Field terms used to classify degree of weathering include: fresh, slight(ly), moderate(ly), or very weathered.

LABORATORY TEST DATA

Sieve Analysis (ASTM C 136) — A sieve analysis is the determination of the proportions of particles existing within certain size ranges in granular material by separation on sieves of different size openings, expressed as a weight percent of the total sample. Numbers presented represent the percent of the sample passing through the stated sieve size. Sieve sizes include: 3-inch (75-mm), 2 1/2-inch (63-mm), 2-inch (50-mm), 1 1/2-inch (38.1-mm), 1-inch (25-mm), 3/4-inch (19-mm), 1/2-inch (12.5-mm), 3/8-inch (9.5-mm), No. 4 (4.75 mm), No. 8 (2.36 mm) No. 16 (1.18 mm) No. 30 (0.6 mm), No. 50 (0.3 mm), No. 100 (0.15 mm), No. 200 (0.075 mm).

Specific Gravity and Absorption (ASTM C 127 and 128) — In general, specific gravity is defined as the ratio of the weight in air of a unit volume of material to the weight in air of an equal volume of water. Absorption is the process by which a liquid is drawn into and tends to fill permeable pores in a porous solid body, also, the increase in weight of a porous solid body resulting from the penetration of a liquid into its permeable pores. Specific definitions of bulk, bulk saturate-surface-dry (SSD), and apparent specific gravity, as well as absorption are contained in ASTM-E 12-70 and C 125, respectively.

<u>Fineness Modulus</u>

Fineness modulus is an empirical factor obtained by adding the total percentages of a sample of aggregate, retained on each of a specified series of sieves, and dividing the sum by 100.

<u>Unit Weight</u>

Unit weight is the weight of a unit volume of dry, rodded aggregate, commonly expressed as pounds per cubic foot (pcf).

<u>Abrasion Test (ASTM C 131)</u>

The abrasion test is a method for testing resistance to wearing away by rubbing and friction, by placing a specified quantity of aggregates in a steel drum (the Los Angeles testing machine), rotating the drum 500 times, and determining the percent of material worn away.

<u>Soundness Test (ASTM C 88)</u>

Soundness tests are used to determine resistance to large or permanent volume changes of aggregates by placing samples in saturated solutions of magnesium or sodium sulfate. The test furnishes information useful in studying resistance to weathering action, particularly when adequate service records of the material tested are not available. For concrete aggregate tests, magnesium sulfate soundness tests are run first. If the material fails this test, sodium sulfate soundness tests are performed.

<u>Petrographic Examination (ASTM C 295)</u>

A petrographic examination is a procedure used to identify the physical and chemical properties of aggregates that have a bearing on the quality of the material in consideration of its intended use. Typical properties analyzed include: description and classification of constituents, relative amounts of constituents, particle coatings, rock type, particle condition and particle shape, texture and structure, color, mineral composition and heterogeneities, and presence of constituents known to cause deleterious chemical reactions in concrete.

Alkali Reactivity

Alkali-Silica ASTM C 227 — A potential alkali-silica reactivity test evaluates the susceptibility of cement-aggregate combinations to expansive reactions involving the alkalies sodium and potassium by measurement of the increase (or decrease) in length of mortar bars containing the combination during storage under prescribed conditions of test.

Alkali-Carbonate ASTM Proposed Standard — A potential alkali-carbonate reactivity test evaluates the susceptibility of cement-aggregate combinations to expansive reactions involving the carbonates of dolomite (in certain calcitic dolomites and dolomitic limestones) by measurement of the increase (or decrease) in length of concrete specimens (prisms) containing the combination during storage under prescribed conditions of test. This test is a proposed ASTM standard and has not been formally approved by the American Society of Testing and Materials.

AGGREGATE USE CLASSIFICATION

Road Base Aggregate

RBIa — Basin-fill or rock sources containing materials suitable for use as road-base aggregates; based on acceptable laboratory aggregate test results.

RBIb — Basin-fill sources containing materials suitable for use as road-base aggregates; based on correlation with Class RBIa areas.

RB II — Potential basin-fill sources of materials suitable for use as road-base aggregates; based on photogeologic interpretations, field observations, and limited or inconclusive sieve analysis and/or abrasion data.

<u>Concrete Aggregate</u>	CA1	Basin-fill or rock sources containing aggregates that produced trial mix concrete with 28-day compressive strengths equal to or greater than 6500 psi.
	CA2	Basin-fill or rock sources containing aggregates that produced trial mix concrete with 28-day compressive strengths less than 6500 psi.
	CB	Basin-fill or rock sources containing aggregates potentially suitable for use in concrete; based on acceptable laboratory aggregate test results.
	CC1	Basin-fill or rock sources containing aggregates potentially suitable for use in concrete; based on correlation with Class CA1 or CA2 source areas.
	CC2	Basin-fill sources containing aggregates potentially suitable for use in concrete; based on correlation with Class CB source areas.
	FA	Basin-fill sources containing fine aggregates used with crushed-rock samples for certain concrete trial mixes.

MAP NUMBER	FIELD STATION	LOCATION	GEOLOGIC UNIT	MATERIAL DESCRIPTION	USCS SYMBOL	BOULDERS AND/ OR COBBLES	GRAVEL	SAND
201	WA-A-1	Wah Wah Valley, SE	Aaf	Gravelly Sand	SW-SM	-/Few		
202	WA-A-2	Wah Wah Valley, E	Aaf	Gravelly Sand	SW-SM	Rare/ Some		
203	WA-A-3	Wah Wah Valley, E	Aaf	Gravelly Sand	SW-SM	Some/ Some		
204	WA-A-4	Wah Wah Valley, E	Aaf	Sandy Gravel	GW-GM	Some/ Some		
	WA-A (1, 2,3,4)			Gravelly Sand	SW-SM			
205	WA-A-5	Wah Wah Valley, C	Aol	Sandy Gravel	GP	/Rare		
206	WA-A-6	Wah Wah Valley, E	Aaf	Sandy Gravel	GP-GM	Rare/ Some		
207	WA-A-7	Wah Wah Valley, E	Aaf	Sandy Gravel	GW-SM	Rare/ Some		
208	WA-A-8	Wah Wah Valley, E	Aaf	Sandy Gravel	GP-GM	Rare/ Some		
	WA-A (6, 7,8)			Sandy Gravel	GP-GM			
209	WA-A-9	Wah Wah Valley, E	Aol	Sandy Gravel	GP	Rare/ Some		
210	WA-A-10	Wah Wah Valley, E	Aol	Sandy Gravel	GW	Rare/ Some		

FIELD OBSERVATIONS								SIEVE ANAL[illegible]					
[illegible]N OF [illegible]INER [illegible]LES [illegible]T) FINES	OVERBURDEN THICKNESS (FEET)	TOTAL TRENCH DEPTH (FEET; R= REFUSAL DEPTH)	DELETERIOUS MATERIALS (MATERIAL/DEPTHS/ STAGE)	PLASTICITY	HARDNESS	WEATHERING	3 IN.	2½ IN.	2 IN.	1½ IN.	1 IN.	[illegible]
	2.0	14.0	Caliche/1.0-2.0/II, III	Slight					100	99.2	98.9	[illegible]
	1.0	13.0	Caliche/1.0-2.0, 6.0-8.5/II,III	Slight			87.2	87.2	85.6	82.8	77.8	[illegible]
	1.0	13.5	Caliche/1.0-2.5/II	Slight			100	87.7	84.6	78.6	74.7	[illegible]
	1.0	14.0	Caliche/1.0-2.0/II	Slight			93.0	93.0	93.0	89.2	81.7	[illegible]
							95.6	93.8	89.0	81.2	76.2	[illegible]
	1.0	11.0							100	98.2	90.6	[illegible]
	1.0	13.0	Caliche/1.0-5.0/II, III	Slight			100	94.0	89.6	84.5	75.9	[illegible]
	1.0	13.0	Caliche/1.0-4.0/II	Slight			100	91.5	90.4	86.7	78.6	[illegible]
	1.0	12.0	Caliche/1.0-5.0/III	Slight			96.9	96.9	92.1	87.6	76.7	[illegible]
							93.9	86.8	82.7	78.5	70.1	[illegible]
	1.0	12.0	Caliche/ - /I				80.7	75.6	68.9	62.7	52.7	[illegible]
	1.0	13.0	Shale, Phyllite, Caliche/ - /I				88.5	81.8	77.7	74.3	66.3	[illegible]

2

LABORATORY TEST DATA

...LYSIS, ASTM C 136 (PERCENT PASSING)										SPECIFIC GRAVITY AND ABSORPTION, ASTM C 127 AND C 128							
										COARSE AGGREGATE				FINE AGGREGATE			
										SPECIFIC GRAVITY			ABSORP. (PERCENT)	SPECIFIC GRAVITY			ABSORP. (PERCENT)
¾ IN.	½ IN.	⅜ IN.	NO. 4	NO. 8	NO. 16	NO. 30	NO. 50	NO. 100	NO. 200	BULK	BULK SSD	APPAR-ENT		BULK	BULK SSD	APPAR-ENT	
98.1	95.3	91.6	70.4	50.1	30.3	18.1	10.9	7.8	6.4								
73.6	68.0	64.0	53.5	42.7	31.3	22.2	14.7	10.3	7.9								
70.2	66.7	63.3	59.4	46.6	33.0	22.5	14.7	10.5	7.9								
75.6	68.4	61.9	47.9	36.1	25.0	17.1	11.4	8.0	6.0								
73.1	67.7	63.9	53.8	42.8	30.6	21.2	13.9	9.7	7.2								
84.6	75.9	68.9	50.0	39.3	28.6	16.6	9.2	2.4	1.4								
69.8	60.8	54.8	41.4	34.4	28.8	24.3	18.2	13.1	9.5								
71.3	62.1	55.1	39.7	31.5	25.6	21.4	16.2	11.2	7.6								
68.5	56.7	48.9	37.5	32.4	28.1	24.6	19.7	14.8	11.0								
61.8	52.8	47.1	35.3	27.9	22.8	19.2	15.1	11.2	8.2								
44.4	37.4	32.7	22.6	15.7	12.6	10.8	6.8	2.6	1.0								
60.4	53.1	47.6	34.5	26.6	21.8	18.1	9.3	2.8	1.2								

FINENESS MODULUS (PERCENT)	UNIT WEIGHT (PCF)	ABRASION TEST ASTM C 131 (PERCENT WEAR)	SOUNDNESS TEST, ASTM C 88 (PERCENT LOSS)				PETROGRAPHIC EXAMINATION ASTM C 295	ALKALI REACTIVITY		AGGREGATE USE CLASSIFICATION
			COARSE AGGREGATE		FINE AGGREGATE			SILICA METHOD, ASTM C 227 (LENGTH CHANGE, PERCENT)	CARBONATE METHOD, PROP. ASTM (LENGTH CHANGE, PERCENT)	
			$MgSO_4$	$NaSO_4$	$MgSO_4$	$NaSO_4$				
										RBII,-
										RBIa,CB
										RBIa,CB
										RBIa,CB
		26.7								
		26.7	4.5		4.0					RBIa,CB
										RBIa,CB
										RBIa,CB
										RBIa,CB
		28.4	4.4		15.8					
										RBIa,CA1
										RBIa,CA1

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MX SITING INV
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SUMMARY OF FIELD AND LABOR
TEST DATA
WAH WAH VALLEY, UTAH

12 JUN 81 TABLE A-1

MAP NUMBER	FIELD STATION	LOCATION	GEOLOGIC UNIT	MATERIAL DESCRIPTION	USCS SYMBOL	BOULDERS AND/ OR COBBLES	...TION OF ... FINER ...BBLES ...ENT)		
							GRAVEL	SAND	FINES
211	WA-A-11	Wah Wah Valley, E	Aol	Sandy Gravel	GP	Rare/ Some			
212	WA-A-12	Wah Wah Valley, E	Aol	Sandy Gravel	GP	Rare/ Some			
213	WA-A-13	Wah Wah Valley, E	Aol	Sandy Gravel	GP	Rare/ Some			
	WA-A-(9,10, 11,12,13)			1.5in-0.75in					
	WA-A-(9,10, 11,12,13)			0.75in-No.4					
	WA-A-(9,10, 11,12,13)			Blend (1.5in-No.4)					
	WA-A-(9,10, 11,12,13)			No.4-No.200					
214	WA-A-14	Wah Wah Valley, W	Aaf	Sandy Gravel	GW-GM	-/Few			
215	WA-A-15	Wah Wah Valley, W	Aaf	Silty Sand	SM	Rare/ Some			
216	WA-A-16	Wah Wah Valley, W	Aaf	Sandy Gravel	GW-GM	Rare/ Some			
	WA-A-(14, 15,16)			Silty Sand	SM				
217	WA-A-17	Wah Wah Valley, W	Aol	Sandy Gravel	GP-GM	-/Few			
218	WA-A-18	Wah Wah Valley, W	Aol	Sandy Gravel	GW	-/Few			

FIELD OBSERVATIONS													
OVERBURDEN THICKNESS (FEET)	TOTAL TRENCH DEPTH (FEET; R= REFUSAL DEPTH)	DELETERIOUS MATERIALS (MATERIAL/DEPTHS/ STAGE)	PLASTICITY	HARDNESS	WEATHERING	SIEVE ANALYSIS,							
						3 IN.	2½ IN.	2 IN.	1½ IN.	1 IN.	¾ IN.	[illegible]
1.0	13.0	Shale, Caliche/ - /I				90.0	90.0	84.4	80.0	70.5	63.4	52
1.0	12.0	Shale, Caliche/ 1.0-12.0/I				93.7	93.7	92.5	83.1	67.6	54.2	42
1.0	12.0	Shale, Caliche/ 1.0-12.0/I						100	92.1	74.0	58.4	40
									100	56.1	4.0	[illegible]
											100	[illegible]
									100	78	52	[illegible]
1.0	14.0	Caliche/1.0-2.5/ III	Slight				100	98.6	93.8	87.3	81.5	[illegible]
1.0	14.0	Caliche/1.0-3.0/ III	Slight					100	98.0	89.8	82.6	[illegible]
1.0	13.0	Caliche/1.0-3.5/ III	Slight			95.7	94.4	86.8	82.0	76.9	69.6	[illegible]
						98.1	98.1	97.3	95.5	88.1	81.2	[illegible]
1.5	12.0	Caliche/1.5-12.0/ I,II	Slight					100	94.4	90.0	84.8	[illegible]
2.0	13.0	Caliche/2.0-13.0/I	Slight					100	98.8	94.2	85.8	[illegible]

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SIS, ASTM C 136 (PERCENT PASSING)									LABORATORY TEST DATA — SPECIFIC GRAVITY AND ABSORPTION, ASTM C 127 AND C 128								FINE[illegible] MODU[illegible] (PERC[illegible]
									COARSE AGGREGATE				FINE AGGREGATE				
									SPECIFIC GRAVITY			ABSORP. (PERCENT)	SPECIFIC GRAVITY			ABSORP. (PERCENT)	
½ IN.	⅜ IN.	NO. 4	NO. 8	NO. 16	NO. 30	NO. 50	NO. 100	NO. 200	BULK	BULK SSD	APPAR-ENT		BULK	BULK SSD	APPAR-ENT		
52.7	44.7	31.6	25.0	20.8	17.2	9.8	3.9	1.9									
42.6	35.4	22.9	19.5	17.1	14.8	9.5	4.3	2.5									
40.2	30.6	17.0	11.6	9.9	8.5	5.7	3.2	2.1									
1.0									2.62	2.64	2.67	0.6					
64.9	42.4	1.3							2.62	2.64	2.68	0.8					
33	21	1															
		100	75.4	61.3	50.2	26.8	8.9	3.5					2.58	2.60	2.64	1.0	2[illegible]
72.2	65.1	50.1	41.8	33.2	26.0	19.4	14.6	10.6									
75.4	70.2	60.1	51.5	42.6	34.9	26.9	19.7	13.2									
58.3	51.9	40.8	34.6	27.9	22.0	16.6	12.4	9.0									
73.1	67.8	56.5	48.5	40.1	32.7	25.3	18.9	13.5									
78.1	72.2	33.9	20.9	17.1	15.1	13.5	11.5	8.1									
75.6	68.0	45.7	26.8	12.9	8.8	7.0	3.7	2.0									

NENESS ODULUS RCENT)	UNIT WEIGHT (PCF)	ABRASION TEST ASTM C 131 (PERCENT WEAR)	SOUNDNESS TEST, ASTM C 88 (PERCENT LOSS)				PETROGRAPHIC EXAMINATION ASTM C 295	ALKALI REACTIVITY		AGGREGATE USE CLASSIFICATION
			COARSE AGGREGATE		FINE AGGREGATE			SILICA METHOD, ASTM C 227 (LENGTH CHANGE, PERCENT)	CARBONATE METHOD, PROP. ASTM (LENGTH CHANGE, PERCENT)	
			$MgSO_4$	$NaSO_4$	$MgSO_4$	$NaSO_4$				
										RBIa,CA1
										RBIa,CB
										RBIa,CB
							Performed			
	105.0						Performed			
	103.5	26.5	3.6							
2.77					11.2		Performed	In Progress		
										RBIa,CB
										RBIa,CB
										RBIa,CB
		27.8								
										RBIa,CB
										RBIa,CB

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SUMMARY OF FIELD AND LABORA
TEST DATA
WAH WAH VALLEY, UTAH

12 JUN 81 TABLE A-1 PA

4

MAP NUMBER	FIELD STATION	LOCATION	GEOLOGIC UNIT	MATERIAL DESCRIPTION	USCS SYMBOL	BOULDERS AND/ OR COBBLES	DISTRIBUTION OF MATERIAL FINER THAN COBBLES (PERCENT)		
							GRAVEL	SAND	FINES
219	WA-A-19	Wah Wah Valley, W	Aol	Sandy Gravel	GP-GM	-/Few			
	WA-A-(17, 18,19)			Sandy Gravel	GP-GM				
220	WA-A-20	Wah Wah Valley, W	Aaf	Sandy Gravel	GW	Few/ Few			
221	WA-A-21	Wah Wah Valley, W	Aaf	Sandy Gravel	GW	Few/ Few			
222	WA-A-22	Wah Wah Valley, W	Aaf	Sandy Gravel	GW	Few/ Few			
223	WA-A-23	Wah Wah Valley, W	Aaf		GP-GM	-/Few			
224	WA-A-24	Wah Wah Valley, W	Aaf		GP	Few/			
	WA-A-(20,21, 22,23,24)			1.5in-0.75in					
	WA-A-(20,21, 22,23,24)			0.75in-No.4					
	WA-A-(20,21, 22,23,24)			Blend (1.5in-No.4)					
	WA-A-(20,21, 22,23,24)			No.4-No.200					
225	WA-A-25	Wah Wah Valley, SW	Aaf	Gravelly Sand	GM	-/Few	40	45	15
226	WA-A-26	Wah Wah Valley, SW	Aaf	Gravelly Sand	GM	Rare/ Few	35	50	15

…OF …ER …ES / …FINES	OVERBURDEN THICKNESS (FEET)	TOTAL TRENCH DEPTH (FEET; R= REFUSAL DEPTH)	DELETERIOUS MATERIALS (MATERIAL/DEPTHS/ STAGE)	PLASTICITY	HARDNESS	WEATHERING	SIEVE ANALYSIS 3 IN.	2½ IN.	2 IN.	1½ IN.	1 IN.	¾ IN.
	2.5	13.0	Caliche/2.5-13.0/I	Slight				100	98.8	96.3	90.1	83.1
								100	98.5	95.8	90.0	84.1
	0.0	12.0	Caliche/0-13.0/I	Slight			92.2	89.5	86.9	84.9	76.9	71.8
	0.0	13.0	Caliche/0-13.0/II	Slight			92.4	91.2	86.4	84.0	79.6	74.2
	0.0	13.0	Caliche/0-13.0/I	Slight			100	97.5	96.3	94.5	87.0	78.9
	0.0	12.0	Caliche/0-12.0/I	Slight			86.7	84.4	83.1	80.6	74.8	69.4
	0.0	14.0	Caliche/7.0-9.0/II	Slight				100	97.9	94.5	89.9	84.7
										100	68.6	13.2
												100
										100	84	57
5	7.0	10.0(R)	Caliche/7.0-10.0/ III	Slight								
5	5.0	9.0(R)	Caliche/5.0-9.0/ III	Slight								

2

LABORATORY TEST DATA

	YSIS, ASTM C 136 (PERCENT PASSING)									SPECIFIC GRAVITY AND ABSORPTION, ASTM C 127 AND C 128								FIN MOD (PER
										COARSE AGGREGATE				FINE AGGREGATE				
										SPECIFIC GRAVITY			ABSORP. (PERCENT)	SPECIFIC GRAVITY			ABSORP. (PERCENT)	
	½ IN.	⅜ IN.	NO. 4	NO. 8	NO. 16	NO. 30	NO. 50	NO. 100	NO. 200	BULK	BULK SSD	APPAR-ENT		BULK	BULK SSD	APPAR-ENT		
.1	74.2	67.0	42.2	25.8	18.9	18.0	17.4	13.8	5.7									
.1	76.7	70.9	44.4	26.6	17.5	14.7	13.0	9.8	5.5									
.8	63.7	56.9	41.5	29.3	19.3	13.0	8.4	5.7	4.0									
.2	65.5	58.9	42.6	31.8	21.2	14.1	8.9	5.8	4.0									
.9	67.5	59.9	42.6	28.6	18.3	11.8	6.7	3.9	2.5									
.4	63.1	58.5	48.3	41.6	35.6	30.0	23.5	17.3	10.9									
.7	76.1	68.5	49.9	36.4	24.5	15.8	8.8	4.9	3.1									
.2	1.7	0.8	0.5							2.64	2.66	2.70	0.8					
	74.7	51.6	4.3							2.61	2.66	2.74	1.7					
	38	26	3															
			100	80.4	55.9	37.0	19.7	8.1	1.5					2.56	2.61	2.7	2.1	2

[..]NENESS [MO]DULUS [(PE]RCENT)	UNIT WEIGHT (PCF)	ABRASION TEST ASTM C 131 (PERCENT WEAR)	SOUNDNESS TEST, ASTM C 88 (PERCENT LOSS) COARSE AGGREGATE $MgSO_4$	COARSE AGGREGATE $NaSO_4$	FINE AGGREGATE $MgSO_4$	FINE AGGREGATE $NaSO_4$	PETROGRAPHIC EXAMINATION ASTM C 295	ALKALI REACTIVITY SILICA METHOD, ASTM C 227 (LENGTH CHANGE, PERCENT)	ALKALI REACTIVITY CARBONATE METHOD, PROP. ASTM (LENGTH CHANGE, PERCENT)	AGGREGATE USE CLASSIFICATION
										RBIa,CB
		25.5	3.3		13.2					
										RBIa,CA1
										RBIa,CA1
										RBIa,CA1
										RBIa,CA1
										RBIa,CA1
							Performed			
	103.2						Performed		In Progress	
	108.8	32.3	9.5							
99					24.9	4.2	Performed		In Progress	
										RBII,-
										RBII,-

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BMO/AFRCE-MX

SUMMARY OF FIELD AND LABORATO[RY]
TEST DATA
WAH WAH VALLEY, UTAH

12 JUN 81 TABLE A-1 PAG[E]

4

MAP NUMBER	FIELD STATION	LOCATION	GEOLOGIC UNIT	MATERIAL DESCRIPTION	USCS SYMBOL	BOULDERS AND/ OR COBBLES	DISTRIBUTION OF MATERIAL FINER THAN COBBLES (PERCENT)		
							GRAVEL	SAND	FINES
227	WA-A-27	Wah Wah Valley, SW	Aaf	Sandy Gravel	GW-GM	-/Few			
228	WA-A-28	Wah Wah Valley, SW	Aaf	Sandy Gravel	GW	-/Few			
229	WA-A-29	Wah Wah Valley, SW	Aaf	Gravelly Sand	SW-SM	-/Few			
	WA-A-(27, 28,29)			Gravelly Sand	SP-SM				
233	WA-A-33	Wah Wah Valley, NE	Aaf	Sandy Gravel	GP-GM	Rare/ Some			
234	WA-A-34	Wah Wah Valley, NE	Aaf	Gravelly Sand	SP	Rare/ Some			
235	WA-A-35	Wah Wah Valley, NE	Aaf	Sandy Gravel	GW-GM	Rare/ Some			
	WA-A-(33, 34,35)			Sandy Gravel	GP				
236	WA-A-36	Wah Wah Valley, NE	Aaf	Sandy Gravel	GM	Some/ Some	55	30	1[illegible]
237	WA-A-37	Wah Wah Valley, NE	Aaf	Sandy Gravel	GM	Some/ Some	55	30	1[illegible]
238	WA-A-38	Wah Wah Valley, NE	Aol	Sandy Gravel	GP-GM	-/Few			
239	WA-A-39	Wah Wah Valley, NE	Aol	Sandy Gravel	GP-GM	-/Few			
240	WA-A-40	Wah Wah Valley, NE	Aol	Sandy Gravel	GP-GM	-/Few			

FIELD OBSERVATIONS													
...N OF ...INER ...LES ...T)							SIEVE ANAL...						
FINES	OVERBURDEN THICKNESS (FEET)	TOTAL TRENCH DEPTH (FEET; R= REFUSAL DEPTH)	DELETERIOUS MATERIALS (MATERIAL/DEPTHS/ STAGE)	PLASTICITY	HARDNESS	WEATHERING	3 IN.	2½ IN.	2 IN.	1½ IN.	1 IN.	[illegible]
	3.0	12.0	Caliche/3.0-12.0/I	Slight			100	97.0	95.7	91.6	88.4	[illegible]
	4.5	12.0	Caliche/4.5-12.0/I	Slight			100	93.7	91.2	83.7	73.9	[illegible]
	2.5	13.0	Caliche/2.5-13.0/ I,II	Slight			96.9	96.9	94.6	93.5	91.8	[illegible]
							92.9	91.0	87.8	86.6	80.6	[illegible]
	1.0	13.0	Caliche/1.0-13.0/ II,III	Slight			100	96.4	87.2	83.3	77.5	[illegible]
	1.0	13.0	Caliche/1.0-13.0/ II,III	Slight			91.5	90.0	90.0	88.7	86.6	[illegible]
	1.0	13.0	Caliche/1.0-13.0/ I,III	Slight			97.2	97.2	94.4	90.1	78.6	[illegible]
							94.6	94.6	93.6	88.3	78.0	[illegible]
15	1.0	6.0(R)	Caliche/1.0-6.0/ III	Slight								
15	1.0	5.5(R)	Caliche/1.0-5.5/ III	Slight								
	1.0	14.0	Caliche/ - /I	Slight			100	97.9	96.6	95.0	90.8	[illegible]
	1.0	14.0	Caliche/ - /I	Slight			100	97.2	96.5	91.9	86.2	[illegible]
	0.5	14.0	Caliche/ - /I	Slight			100	97.1	96.2	92.7	86.9	[illegible]

7-

LABORATORY TEST DATA

NALYSIS, ASTM C 136 (PERCENT PASSING)										SPECIFIC GRAVITY AND ABSORPTION, ASTM C 127 AND C 128							
										COARSE AGGREGATE				FINE AGGREGATE			
										SPECIFIC GRAVITY			ABSORP. (PERCENT)	SPECIFIC GRAVITY			ABSORP. (PERCENT)
3/4 IN.	1/2 IN.	3/8 IN.	NO. 4	NO. 8	NO. 16	NO. 30	NO. 50	NO. 100	NO. 200	BULK	BULK SSD	APPARENT		BULK	BULK SSD	APPARENT	
80.2	69.9	60.5	40.4	31.1	22.9	15.4	10.2	7.4	5.5								
68.4	60.8	55.4	40.5	30.9	21.5	14.2	8.6	5.1	3.5								
90.0	86.6	83.4	72.4	61.6	44.5	28.1	17.9	13.1	10.4								
77.4	72.5	69.0	58.6	49.3	36.4	23.7	14.5	9.6	7.3								
72.7	65.9	61.1	50.6	43.3	35.4	27.2	17.4	10.5	6.8								
82.7	76.6	71.4	57.7	49.6	37.9	25.0	12.3	6.2	4.2								
67.7	54.1	46.8	33.9	27.2	21.4	16.3	11.0	7.5	5.5								
69.9	59.9	53.8	41.2	33.9	26.0	18.6	10.9	6.6	4.8								
87.2	81.0	74.8	52.7	38.3	27.7	20.2	12.0	4.3	2.0								
78.0	64.9	56.0	37.8	29.8	22.6	16.5	9.3	4.0	2.0								
82.8	75.0	67.5	48.6	39.4	29.8	22.5	12.5	4.1	1.7								

3

...ENESS ...DULUS ...RCENT)	UNIT WEIGHT (PCF)	ABRASION TEST ASTM C 131 (PERCENT WEAR)	SOUNDNESS TEST, ASTM C 88 (PERCENT LOSS)				PETROGRAPHIC EXAMINATION ASTM C 295	ALKALI REACTIVITY		AGGREGATE USE CLASSIFICATION
			COARSE AGGREGATE		FINE AGGREGATE			SILICA METHOD, ASTM C 227 (LENGTH CHANGE, PERCENT)	CARBONATE METHOD, PROP. ASTM (LENGTH CHANGE, PERCENT)	
			$MgSO_4$	$NaSO_4$	$MgSO_4$	$NaSO_4$				
										RBIa,CB
										RBIa,CB
										RBIa,CB
		29.0								
										RBIa,CB
										RBIa,CB
										RBIa,CB
		27.3	8.2		13.9					
										RBII,-
										RBII,-
										RBIa,CA1
										RBIa,CA1
										RBIa,CA1

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MX SITING INVEST...
DEPARTMENT OF THE...
BMO/AFRCE-...

SUMMARY OF FIELD AND LABORAT...
TEST DATA
WAH WAH VALLEY, UTAH

12 JUN 81 TABLE A-1

MAP NUMBER	FIELD STATION	LOCATION	GEOLOGIC UNIT	MATERIAL DESCRIPTION	USCS SYMBOL	BOULDERS AND/ OR COBBLES	DISTRIBUTIO MATERIAL F THAN COBB (PERCEN	
							GRAVEL	SAND
241	WA-A-41	Wah Wah Valley, NE	Aol	Sandy Gravel	GP-GM	-/Few		
242	WA-A-42	Wah Wah Valley, NE	Aol	Sandy Gravel	GP-GM	-/Few		
	WA-A-(38,39, 40,41,42)			1.5in-0.75in				
	WA-A-(38,39, 40,41,42)			0.75in-No.4				
	WA-A-(38,39, 40,41,42)			Blend (1.5in- No.4)				
	WA-A-(38,39, 40,41,42)			No.4-No.200				
243	WA-A-43	Wah Wah Valley, NE	Aaf	Sandy Gravel	GM	-/Few		
244	WA-A-44	Wah Wah Valley, NE	Aaf	Sandy Gravel	GP-GM	-/Few		
245	WA-A-45	Wah Wah Valley, NE	Aaf	Sandy Gravel	GW-GM	Rare/ Some		
	WA-A-(43, 44,45)			Sandy Gravel	GM			
246	WA-A-46	Wah Wah Valley, NW	Aaf	Sandy Gravel	GW-GM	-/Few		
247	WA-A-47	Wah Wah Valley, NW	Aaf	Sandy Gravel	GP-GM	Rare/ Some		
248	WA-A-48	Wah Wah Valley, NW	Aaf	Sandy Gravel		Some/		

FIELD OBSERVATIONS												
...N OF ...INER ...LES ...T)							SIEVE ANALY...					
FINES	OVERBURDEN THICKNESS (FEET)	TOTAL TRENCH DEPTH (FEET; R= REFUSAL DEPTH)	DELETERIOUS MATERIALS (MATERIAL/DEPTHS/ STAGE)	PLASTICITY	HARDNESS	WEATHERING	3 IN.	2½ IN.	2 IN.	1½ IN.	1 IN.	¾ IN.
	1.0	13.5	Caliche/ - /I	Slight			96.6	95.2	92.6	87.8	81.5	76.
	1.0	14.0	Caliche/ -/I	Slight				100	95.6	89.0	79.3	72.
									100	97.4	58.4	5.
											100	98.
									100	99	79	52
	1.5	14.0	Caliche/ - /II	Slight			93.5	90.4	87.2	84.0	77.1	71.
	1.5	14.0	Caliche/ - /II	Slight			100	96.9	96.1	92.6	84.7	76.
	1.5	13.0	Caliche/ - /II	Slight			100	98.1	91.0	84.3	74.7	66.
							95.1	87.8	85.8	82.6	74.0	69.
	5.0	13.0	Caliche/5.0-13.0/II	Slight			100	96.8	92.5	89.2	79.2	73
	1.0	13.0	Caliche/ - /II	Slight			100	95.8	92.3	88.8	81.5	74
	4.0	4.0 (R)	Caliche/0-4/II	Slight								

LABORATORY TEST DATA

YSIS, ASTM C 136 (PERCENT PASSING)										SPECIFIC GRAVITY AND ABSORPTION, ASTM C 127 AND C 128								FINE MOD (PER
										COARSE AGGREGATE				FINE AGGREGATE				
										SPECIFIC GRAVITY			ABSORP. (PERCENT)	SPECIFIC GRAVITY			ABSORP. (PERCENT)	
¾ IN.	½ IN.	⅜ IN.	NO. 4	NO. 8	NO. 16	NO. 30	NO. 50	NO. 100	NO. 200	BULK	BULK SSD	APPAR-ENT		BULK	BULK SSD	APPAR-ENT		
.8	68.1	60.1	40.6	30.2	23.0	18.5	10.5	2.9	1.0									
.1	60.7	51.3	31.6	24.8	19.6	16.1	10.7	5.2	3.0									
.7	1.6	1.1	0.8							2.63	2.64	2.66	0.4					
.3	66.9	43.9	1.5							2.63	2.65	2.68	0.8					
2	34	23	1															
			100	83.6	61.4	45.3	24.3	6.6	1.5					2.63	2.65	2.69	0.9	2
1.7	63.2	56.9	43.0	36.5	31.6	28.0	23.3	18.8	15.0									
6.5	65.3	57.1	39.5	30.7	24.8	21.1	17.0	12.8	9.9									
6.6	56.5	49.5	36.9	32.4	28.5	25.5	21.2	16.1	11.8									
9.5	61.5	56.3	43.8	35.0	29.3	25.5	20.8	15.9	12.2									
.3	66.1	60.9	47.4	33.3	22.1	15.5	11.6	8.8	6.2									
.9	68.8	63.1	48.0	37.3	29.0	23.5	18.9	15.0	10.8									

SS US NT)	UNIT WEIGHT (PCF)	ABRASION TEST ASTM C 131 (PERCENT WEAR)	SOUNDNESS TEST, ASTM C 88 (PERCENT LOSS)				PETROGRAPHIC EXAMINATION ASTM C 295	ALKALI REACTIVITY		AGGREGATE USE CLASSIFICATION
			COARSE AGGREGATE		FINE AGGREGATE			SILICA METHOD, ASTM C 227 (LENGTH CHANGE, PERCENT)	CARBONATE METHOD, PROP. ASTM (LENGTH CHANGE, PERCENT)	
			$MgSO_4$	$NaSO_4$	$MgSO_4$	$NaSO_4$				
										RBIa,CA1
										RBIa,CA1
							Performed			
	103.6						Performed			
	108.0	23.5	1.4							
79					8.5		Performed			
										RBIa,CB
										RBIa,CB
										RBIa,CB
		24.2								
										RBIa,CA1
										RBIa,CA1
										RBIa,CA1

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SUMMARY OF FIELD AND LABORATO
TEST DATA
WAH WAH VALLEY, UTAH

12 JUN 81 TABLE A-1 PAG

MAP NUMBER	FIELD STATION	LOCATION	GEOLOGIC UNIT	MATERIAL DESCRIPTION	USCS SYMBOL	BOULDERS AND/OR COBBLES	DISTRIBUTION OF MATERIAL FINER THAN COBBLES (PERCENT)		
							GRAVEL	SAND	FINES
249	WA-A-49	Wah Wah Valley, NW	Aaf	Sandy Gravel	GW-GM	Rare/Some			
250	WA-A-50	Wah Wah Valley, NW	Aaf	Sandy Gravel	GP-GM	Rare/Some			
	WA-A-(46,47,48,49,50)			1.5in-0.75in					
	WA-A-(46,47,48,49,50)			0.75in-No.4					
	WA-A-(46,47,48,49,50)			Blend (1.5in-No.4)					
	WA-A-(46,47,48,49,50)			No.4-No.200					
251	WA-A-51	Wah Wah Valley, NW	Aaf	Sandy Gravel	GP-GM	Few/Few			
252	WA-A-52	Wah Wah Valley, NW	Aaf	Sandy Gravel	GP-GM	-/Few			
253	WA-A-53	Wah Wah Valley, NW	Aaf	Sandy Gravel	GP-GM	Rare/Few			
	WA-A-(51,52,53)			Sandy Gravel	GW-GM				
254	WA-FA-1	Wah Wah Valley, C	Aol	Gravelly Sand	SP	-/Few			
	WA-FA-1								
255	WA-R-1	Wah Wah Valley, E	Qtz	Quartzite					

FIELD OBSERVATIONS														
...ION OF ... FINER ...BBLES ...ENT)		OVERBURDEN THICKNESS (FEET)	TOTAL TRENCH DEPTH (FEET; R= REFUSAL DEPTH)	DELETERIOUS MATERIALS (MATERIAL/DEPTHS/ STAGE)	PLASTICITY	HARDNESS	WEATHERING	SIEVE ANA...						
	FINES							3 IN.	2½ IN.	2 IN.	1½ IN.	1 IN.		
		1.5	14.0	Caliche/ - /II	Slight				100	98.5	96.0	89.1	8	
		1.0	12.0	Caliche/ - /II	Slight			100	93.4	90.5	84.1	72.1	6	
										100	98.6	57.2		
												100	9	
										100	99	79	5	
		1.0	13.0	Caliche/ - /II	Slight				100	95.7	92.8	85.8	7	
		1.0	14.0	Caliche/1.0-2.0, 7.0-8.0/II	Slight			100	96.6	94.2	91.2	84.0	7	
		1.0	13.0	Caliche/1.0-2.0, 11.0-12.0/II	Slight			97.3	95.4	93.1	92.3	85.6	7	
								100	95.0	92.8	87.9	82.2	7	
		3.0	13.0	None	Slight						100	99.2	9	
						Very Hard	Fresh							

LABORATORY TEST DATA

	ANALYSIS, ASTM C 136 (PERCENT PASSING)										SPECIFIC GRAVITY AND ABSORPTION, ASTM C 127 AND C 128							
											COARSE AGGREGATE				FINE AGGREGATE			
											SPECIFIC GRAVITY			ABSORP. (PERCENT)	SPECIFIC GRAVITY			ABSORP. (PERCENT)
	3/4 IN.	1/2 IN.	3/8 IN.	NO. 4	NO. 8	NO. 16	NO. 30	NO. 50	NO. 100	NO. 200	BULK	BULK SSD	APPAR-ENT		BULK	BULK SSD	APPAR-ENT	
1	83.4	75.0	67.7	49.7	38.2	26.2	18.9	13.9	10.2	7.1								
1	63.1	54.2	48.3	35.1	28.3	21.8	17.4	13.8	10.1	6.5								
2	7.5	1.0	0.4	0.1							2.75	2.76	2.79	0.5				
	98.5	69.3	46.9	2.9							2.58	2.64	2.73	2.18				
	53	35	24	2														
				100	81.9	55.1	35.8	20.5	11.0	3.8					2.51	2.58	2.71	2.94
8	78.3	66.7	58.6	42.7	32.9	24.9	19.1	14.6	11.1	8.1								
0	75.8	66.6	57.6	37.8	28.2	21.1	16.2	12.3	9.2	6.9								
6	79.8	69.8	61.5	40.5	28.4	20.9	16.2	12.6	10.2	7.8								
2	74.6	63.9	55.7	37.8	27.7	20.4	15.6	12.0	9.2	6.8								
3	99.2	98.7	97.2	88.1	74.6	55.3	41.1	32.3	8.2	2.7								
				100	82.3	54.8	36.0	23.0	6.2	1.2					2.54	2.59	2.66	1.8

…ENESS …DULUS …RCENT)	UNIT WEIGHT (PCF)	ABRASION TEST ASTM C 131 (PERCENT WEAR)	SOUNDNESS TEST, ASTM C 88 (PERCENT LOSS) COARSE AGGREGATE		FINE AGGREGATE		PETROGRAPHIC EXAMINATION ASTM C 295	ALKALI REACTIVITY		AGGREGATE USE CLASSIFICATION
			MgSO4	NaSO4	MgSO4	NaSO4		SILICA METHOD, ASTM C 227 (LENGTH CHANGE, PERCENT)	CARBONATE METHOD, PROP. ASTM (LENGTH CHANGE, PERCENT)	
										RBIa,CA1
										RBIa,CA1
							Performed			
	101.6						Performed			
	107.7	29.9	5.6							
2.96					15.5	5.4	Performed			
										RBIa,CB
										RBIa,CB
										RBIa,CB
		24.3	5.4	20.5						
										-,FA
.98					12.8		Performed	In Progress		RBIa,CA1

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SUMMARY OF FIELD AND LABORAT…
TEST DATA
WAH WAH VALLEY, UTAH

12 JUN 81 TABLE A-1 P…

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MAP NUMBER	FIELD STATION	LOCATION	GEOLOGIC UNIT	MATERIAL DESCRIPTION	USCS SYMBOL	BOULDERS AND/OR COBBLES	DISTRIBUTION OF MATERIAL FINER THAN COBBLES (PERCENT)		
							GRAVEL	SAND	FINES
	WA-R-1			1.5in-0.75in					
	WA-R-1			0.75in-No.4					
	WA-R-1			Blend (1.5in-No.4)					

FIELD OBSERVATIONS

OVERBURDEN THICKNESS (FEET)	TOTAL TRENCH DEPTH (FEET; R= REFUSAL DEPTH)	DELETERIOUS MATERIALS (MATERIAL/DEPTHS/ STAGE)	PLASTICITY	HARDNESS	WEATHERING	SIEVE ANALYSIS 3 IN.	2½ IN.	2 IN.	1½ IN.	1 IN.	¾ IN.
									100	58.3	2.9
										100	98.6
									100	79	51

2

LABORATORY TEST DATA

...IS, ASTM C 136 (PERCENT PASSING)

½ IN.	⅜ IN.	NO. 4	NO. 8	NO. 16	NO. 30	NO. 50	NO. 100	NO. 200	SPECIFIC GRAVITY AND ABSORPTION, ASTM C 127 AND C 128 — COARSE AGGREGATE — SPECIFIC GRAVITY: BULK	BULK SSD	APPAR-ENT	ABSORP. (PERCENT)	FINE AGGREGATE — SPECIFIC GRAVITY: BULK	BULK SSD	APPAR-ENT	ABSORP. (PERCENT)	FINEN... MODU... (PERCE...)
0.9									2.64	2.65	2.66	0.2					
43.3	24.7	2.2							2.64	2.65	2.66	0.3					
22	12	1															

UNIT WEIGHT (PCF)	ABRASION TEST ASTM C 131 (PERCENT WEAR)	SOUNDNESS TEST, ASTM C 88 (PERCENT LOSS)				PETROGRAPHIC EXAMINATION ASTM C 295	ALKALI REACTIVITY		AGGREGATE USE CLASSIFICATION
		COARSE AGGREGATE		FINE AGGREGATE			SILICA METHOD, ASTM C 227 (LENGTH CHANGE, PERCENT)	CARBONATE METHOD, PROP. ASTM (LENGTH CHANGE, PERCENT)	
		$MgSO_4$	$NaSO_4$	$MgSO_4$	$NaSO_4$				
						Performed			
89.1						Performed			
94.2	23.5	0.2							

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SUMMARY OF FIELD AND LABORATORY
TEST DATA
WAH WAH VALLEY, UTAH

12 JUN 81 TABLE A-1

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APPENDIX B

SUMMARY OF FIELD PETROGRAPHIC AND GRAIN-SIZE ANALYSES

FIELD PETROGRAPHIC AND GRAIN-SIZE ANALYSES

Field petrographic observations are presented in Table B-1. Field stations were established at various locations throughout the study area where detailed petrographic descriptions of potential basin-fill sources of aggregates were recorded. Detailed explanations for the column headings of Table B-1 are as follows:

COLUMN HEADING	EXPLANATION
MAP NUMBER	Map numbers are sequentially arranged identifiers of field petrographic stations occupied during the course of the aggregate study.
FIELD STATION	These designations are internal DARS identifiers of field petrographic designations.
LOCATION	The location column lists the geographic portion of the valley in which the field station is located (e.g., NE-northeast).
GEOLOGIC UNIT	The geologic unit listed is a term used to differentiate basin-fill deposits based on geomorphology. A geologic unit cross reference, outlining all units used, is included as Table F-3.
FIELD OBSERVATIONS	
Clast Count	Clast or petrographic counts are the main data collected during the field petrographic analysis. Data collected include lithology and percent present by size. Categorization by lithology is done to determine general percentages of nondeleterious and deleterious materials.
Other Deleterious Clasts Present	This column is reserved for recording additional types of materials present that are of poor quality for use as aggregate. Items mentioned include samples of rock types not sieved, counted, and described under clast count, such as: amorphous silica

(chert, opal, chalcedony), volcanic glass, mica, chlorite, friable materials, low density clasts (ash, vesicles, pumice, cinders), gypsum, pyrite, organic material, and coatings (clay and caliche).

Size Distribution	The estimated occurrence of boulders and cobbles is based on the appraisal of an entire deposit only if the materials are observed in the banks of prominent stream channels. Size distribution information for gravel was generally recorded only at trench locations. Any gravel values given are expressed as a percent of the total amount of less than 3.0-inch material present. The numeral zero is used to indicate a size fraction not observed, and the letter R is used to indicate the rare occurrence of a size fraction (one to four percent).
Gradation	Gradation information was recorded at trench locations only.
Maximum Particle Size	Maximum particle size is defined as the intermediate diameter length of the most frequently occurring clast present in a deposit (in centimeters). Erratic oversized materials (boulders, large cobbles) are generally not represented as the maximum particle size.
Particle Shape	Shape of clasts are classified into the following six categories.
Angular (ANG)	Particles have sharp edges and relatively plane sides with unpolished surfaces.
Sub-angular (SA)	Particles are similar to angular but have somewhat rounded edges.
Sub-rounded (SR)	Particles exhibit nearly plane sides but have well-rounded corners and edges.
Rounded (R)	Particles have smoothly curved sides and no edges.
Platey (P)	Particles are thin and flat with either rounded or nonrounded corners and edges.
Elongate (E)	Particles are several times longer than they are wide with rounded corners and edges.

Remarks

This column is used to describe the general site location of petrographic field stations; location terms used include: surface, shallow wash, stream channel bank or bottom, borrow pit, and road cut. Surface indicates analysis was performed on top of the stated geologic unit. Shallow wash indicates analysis was performed on top of the unit but at the bottom of a small swale. Stream channel bank or bottom indicates analysis was performed in an exposed section (incision) or within a minor stream channel deposit, respectively.

MAP NUMBER	FIELD STATION	LOCATION	GEOLOGIC UNIT	CLAST COUNT, > 1 IN. TO ≤ 3 IN. DIAMETER							
				NON-DELETERIOUS						DEL	
				Qtz	Ls	Do	Gr	Vu	Vb	CALI-CHE	CHERT
301	WA-1	Wah Wah Valley, SE	Aaf	36	14		6	40	4		
302	WA-2	Wah Wah Valley, SE	Aaf	12	38	12	10	22	4		
303	WA-3	Wah Wah Valley, SE	Aaf			8		72	20		
304	WA-4	Wah Wah Valley, SE	Aaf					94			
305	WA-5	Wah Wah Valley, SE	Aaf		2			74	16		
306	WA-6	Wah Wah Valley, S	Aaf		10			72	12		
307	WA-7	Wah Wah Valley, SW	Aaf	14	48			28	10		
308	WA-8	Wah Wah Valley,SW	Aaf	6	66	14		8	6		
309	WA-9	Wah Wah Valley, W	Aaf	8	52	18		22			
310	WA-10	Wah Wah Valley, SE	Aaf	26	12	8	10	38		2	
311	WA-11	Wah Wah Valley, SE	Aaf	18	12		66		4		
312	WA-12	Wah Wah Valley, E	Aaf		68		32				

FIELD OBSERVATIONS

R (PERCENT)				CLAST COUNT, > ½ IN. TO ≤ 1 IN. DIAMETER (PERCENT)											OTHER DELETERIOUS CLASTS PRESENT	SIZE D
ELETERIOUS				NON-DELETERIOUS						DELETERIOUS						PERC TO
RT	TUFF	GLASS	OTHER	Qtz	Ls	Do	Gr	Vu	Vb	CALICHE	CHERT	TUFF	GLASS	OTHER		BOUL-DERS
				22	24		2	50	2						Caliche	
	2			14			14	50	8		2	12			Caliche Chalcedony, Chert	
					2			74	24						Caliche	0
		6				2		90	8						Caliche	
	8		2		2			94	2					2	Caliche, Chalcedony	
	6			4				80	12					4	Chalcedony, Caliche	
				18	28	2		46	6						Caliche	
				12	34	22		20	12						Caliche	
					94	6									Caliche	
			4	54	10	6	18	12							Caliche, Opal	3
				38	14		38		10						Caliche	20
				2	68		30								Caliche	5

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ZE DISTRIBUTION			GRADATION	MAXIMUM PARTICLE SIZE (CM)	PARTICLE SHAPE	REMARKS
ERCENT OF TOTAL		< 3" %				
OUL-DERS	COB-BLES	GRA-VEL				
				2	SA,SR	Borrow Pit
				5		Stream Channel,Bank
0	5			4	SA,SR	Surface
				8	SA,SR	Surface
				6	SA,SR	Surface
				4	SA,SR	Stream Channel,Bank
				7	SA,SR	Surface
				4	SA	Stream Channel,Bank
				5	SA,SR	Shallow Wash
3	5	60		12	SA,SR	Shallow Wash
20	10	70		15	A,SA,SR	Stream Channel,Bottom
5	10	65		10	SA,SR	Road Cut

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SUMMARY OF FIELD PETROGRAPHIC
AND GRAIN-SIZE ANALYSES
WAH WAH VALLEY, UTAH

12 JUN 81 TABLE B-1

MAP NUMBER	FIELD STATION	LOCATION	GEOLOGIC UNIT	CLAST COUNT, > 1 IN. TO ≤ 3 IN. DIAMET							
				NON-DELETERIOUS						D	
				Qtz	Ls	Do	Gr	Vu	Vb	CALI-CHE	CHE
313	WA-13	Wah Wah Valley, E	Aaf	50	32		18				
314	WA-14	Wah Wah Valley, E	Aaf	4			96				
315	WA-15	Wah Wah Valley, E	Aaf	70	18		8			2	
316	WA-16	Wah Wah Valley, E	Aaf	62	20		18				
317	WA-17	Wah Wah Valley, E	Aaf	30	68	2					
318	WA-18	Wah Wah Valley, E	Aaf	76	16	8					
319	WA-19	Wah Wah Valley, E	Aol	100							
320	WA-20	Wah Wah Valley, E	Aaf	100							
321	WA-21	Wah Wah Valley, NE	Aaf	98							
322	WA-22	Wah Wah Valley, NE	Aaf	92							
323	WA-23	Wah Wah Valley, NE	Aaf	100							
324	WA-24	Wah Wah Valley, NE	Aol	96							
325	WA-25	Wah Wah Valley, NE	Aaf	100							

FIELD OBSERVATIONS

...AMETER (PERCENT)					CLAST COUNT, > ½ IN. TO ≤ 1 IN. DIAMETER (PERCENT)											OTHER DELETERIOUS CLASTS PRESENT
DELETERIOUS					NON-DELETERIOUS						DELETERIOUS					
	CHERT	TUFF	GLASS	OTHER	Qtz	Ls	Do	Gr	Vu	Vb	CALICHE	CHERT	TUFF	GLASS	OTHER	
					58	26	2	12							2	Caliche, Phylite
					16			84								Caliche
				2	60	8		10			14	6			2	Caliche, Phylite
					60	28		10			2					Caliche
					44	52	4									Caliche
					78	16	4								2	Caliche
					100											
					100											
				2	92										8	Caliche, Phylite
				8	96										4	Caliche, Arenite, Phylite
					96						2				2	Caliche, Phylite
				4	100											Caliche
					96										4	Caliche, Phylite

S IT	SIZE DISTRIBUTION			GRADATION	MAXIMUM PARTICLE SIZE (CM)	PARTICLE SHAPE	REMARKS
	PERCENT OF TOTAL		< 3" %				
	BOUL-DERS	COB-BLES	GRA-VEL				
te					15	A,SA,SR	Shallow Wash
	50	25	5				Shallow Wash
te	10	10	70		15	A,SA,SR	Road Cut
	R	10	65		10	A,SA,SR	Shallow Wash
					10	A,SA	Shallow Wash
					8	SA,SR	Stream Channel,Bank
					5	A,SA,SR	Surface
					12	A,SA	Surface
ite					7	SA,SR	Stream Channel,Bottom
ite,					10	SA,SR	Surface
ite					7	SA,SR	Stream Channel,Bank
					5	SA,SR	Lacustrine Deposit
ite					6	A,SR	Stream Channel,Bank

MAP NUMBER	FIELD STATION	LOCATION	GEOLOGIC UNIT	CLAST COUNT, > 1 IN. TO ≤ 3 IN, DIAN						
				NON-DELETERIOUS						
				Qtz	Ls	Do	Gr	Vu	Vb	CALI-CHE
326	WA-26	Wah Wah Valley, NE	Aaf	90	8					
327	WA-27	Wah Wah Valley, NE	Aol	88	8					
328	WA-28	Wah Wah Valley, NE	Aol	94	6					
329	WA-29	Wah Wah Valley, NE	Aol	98	2					
330	WA-30	Wah Wah Valley, NE	Aaf	84	4			12		
331	WA-31	Wah Wah Valley, NE	Aaf	92	2	4				2
332	WA-32	Wah Wah Valley, NE	Aaf	100						
333	WA-33	Wah Wah Valley, W	Aol	4	82	8		4	2	
334	WA-34	Wah Wah Valley, W	Aol	2	82	8		2	6	
335	WA-35	Wah Wah Valley, NW	Aaf	4	64	28			4	
336	WA-36	Wah Wah Valley, W	Aaf		68	20		8	4	
337	WA-37	Wah Wah Valley, W	Aaf		66	10		4	18	
338	WA-38	Wah Wah Valley, NW	Aaf		62	36				

FIELD OBSERVATIONS

DIAMETER (PERCENT)					CLAST COUNT, > ½ IN. TO ≤ 1 IN. DIAMETER (PERCENT)											OTHER DELETERIOUS CLASTS PRESEN
DELETERIOUS					NON-DELETERIOUS						DELETERIOUS					
ALI-CHE	CHERT	TUFF	GLASS	OTHER	Qtz	Ls	Do	Gr	Vu	Vb	CALI-CHE	CHERT	TUFF	GLASS	OTHER	
				2	94	2									4	Caliche, Phyli
				4	80	16			2						2	Caliche, Phyli
					98	2										Caliche
					96	4										
					82				18							Caliche
2					100											
					94										6	Phylite
						72	24					4				Caliche
						92	6			2						Caliche
						50	50									Caliche
						46	36		6	12						Caliche
		2				60	8		4	28						Caliche
	2					34	66									Caliche

·2

R IOUS ESENT	SIZE DISTRIBUTION PERCENT OF TOTAL		< 3" %	GRADATION	MAXIMUM PARTICLE SIZE (CM)	PARTICLE SHAPE	REMARKS
	BOUL-DERS	COB-BLES	GRA-VEL				
hylite					6	A,SA,SR	Surface
hylite					9	SA,SR,R	Lacustrine Deposit
					6	SR,R	Lacustrine Deposit
	0	10	90		15	SR,R	Lacustrine Deposit
					8	A,SA	Surface
					3	A,SA	Shallow Wash
					7	SA,SR	Shallow Wash
					6	SA,SR	Lacustrine Deposit
					8	SA,SR,R	Road Cut
					6	A,SA	Stream Channel,Bank
					8	A,SA	Stream Channel,Bank
					12	A,SA	Stream Channel,Bank
					7	A,SA	Stream Channel,Bank

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SUMMARY OF FIELD PETROGRAPHIC
AND GRAIN-SIZE ANALYSES
WAH WAH VALLEY, UTAH

12 JUN 81 TABLE B-1

MAP NUMBER	FIELD STATION	LOCATION	GEOLOGIC UNIT	CLAST COUNT, > 1 IN. TO ≤ [illegible] DIAMETER							
				NON-DELETERIOUS							DEL
				Qtz	Ls	Do	Gr	Vu	Vb	[illegible]	CHERT
339	WA-39	Wah Wah Valley, NW	Aol	10	74	8		4			2
340	WA-40	Wah Wah Valley, NW	Aaf	8	66	14		6		2	4
341	WA-41	Wah Wah Valley, NW	Aaf		80	14				6	

FIELD OBSERVATIONS

TER (PERCENT)				CLAST COUNT, > ½ IN. TO ≤ 1 IN. DIAMETER (PERCENT)											OTHER DELETERIOUS CLASTS PRESENT	SIZ
DELETERIOUS				NON-DELETERIOUS						DELETERIOUS						PE
HERT	TUFF	GLASS	OTHER	Qtz	Ls	Do	Gr	Vu	Vb	CALICHE	CHERT	TUFF	GLASS	OTHER		BO DE
2			2	12	72	12					4				Caliche, Phylite	
4				12	58	20		10							Caliche	
				86	8					6					Caliche	

2

S NT	SIZE DISTRIBUTION PERCENT OF TOTAL BOUL-DERS	COB-BLES	< 3" % GRA-VEL	GRADATION	MAXIMUM PARTICLE SIZE (CM)	PARTICLE SHAPE	REMARKS
ite					5	A,SA	Surface
					5	SA,SR	Stream Channel
					4	A,SA	Surface

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SUMMARY OF FIELD PETROGRAPHIC
AND GRAIN-SIZE ANALYSES
WAH WAH VALLEY, UTAH

APPENDIX C

TRENCH LOGS

EXPLANATION OF TRENCH LOGS

Trench logs were completed for excavated trenches. Each log presented in this appendix is chosen from a group of trench logs so that it represents the general aggregate conditions and properties of that entire group. Occasionally, the full compliment of trenches in a group was not excavated due to low gravel percentages and/or advanced caliche development found in the first one or two trenches of that group. Detailed explanations of the trench logs headings are as follows:

COLUMN HEADING		EXPLANATION
BULK SAMPLE		Representative samples were obtained by channel sampling a trench wall. Overburden and, in some trenches, dense caliche layers were avoided during the sampling procedure.
	II -	100 lb. sample (2 bags) for road-base aggregate testing.
	III -	400 lb. sample (55 gallon barrel) for concrete aggregate testing.
DEPTH		Depth corresponds to depth below ground surface in meters and feet.
LITHOLOGY		Graphic representation of soil types present in excavation.
USCS		Unified Soil Classification System symbols. For detailed information see Table F-1.
CONSISTENCY		The consistency of the in-situ deposit was estimated by visual observation of the soil in the trench walls, ease (or difficulty) of excavation of the trench, and trench-wall stability.
		Consistency descriptions of coarse-grained soils (GW, GP, GM, GC, SW, SP, SM, SC) are as follows:
		DESCRIPTION
Very Loose (VL)		Will not hold vertical cut (when dry).

<u>Loose (L)</u>	*Will hold vertical cut, but caves if disturbed.*
<u>Medium Dense (MD)</u>	Holds vertical cut, even when disturbed; easily excavated.
<u>Dense (D)</u>	Holds vertical cut, difficult to excavate.
<u>Very Dense (VD)</u>	Very difficult to impossible to excavate.

SOIL DESCRIPTION

Except in cases where samples were classified based on laboratory data, the descriptions are based on visual classification. The procedures outlined in ASTM D 2487-69, Classification of Soils for Engineering Purposes and D 2488-69, Description of Soils (Visual-Manual Procedure) were followed. Solid lines across the column indicate known changes in the strata at the depth shown.

Definitions of some of the terms and criteria used to describe soils and conditions encountered during the excavation follow:

<u>Descriptive Name</u> — Name of soil, as determined by USCS, preceded by an adjective indicating the size range of the most abundant secondary material present.

<u>Particle Size</u> — For coarse-grained soils (sands and gravels) the size range of the particles visible to the unaided eye was estimated as fine, medium, coarse, or a combined range (e.g., fine to medium). These terms approximately correspond to the following sieve sizes:

Gravel	Fine	No. 4 to 3/4-inch sieve
	Coarse	3/4-inch to 3-inch sieve
Sand	Fine	No. 200 to No. 40 sieve
	Medium	No. 40 to No. 10 sieve
	Coarse	No. 10 to No. 4 sieve

<u>Particle Shape</u> — See Appendix B explanation pages.

<u>Gradation</u> — Gradations listed are those determined from percent amounts of boulders, cobbles, and gravel present. Descriptive terms used include: poor and well.

Poor(ly)	Predominantly one size or a range of sizes, with some intermediate sizes missing.
Well	Wide range in grain sizes present, with substantial amounts of most intermediate sizes.
Secondary Material	Percentage present by dry weight. Trace 5-12 percent Little 13-20 percent Some > 20 percent (e.g., Some slightly plastic silt)
Plasticity of Fines	See Appendix A explanation pages
HCL Reaction	As an aid for identifying calcium carbonate coatings and cementation, soil samples were tested in the field for their reaction to dilute hydrochloric acid. The intensity of the HCL reaction was described as none, weak, or strong.
Caliche	Caliche is a term applied to calcareous material of secondary accumulation. In this study, the definition includes both the soluble calcium (and other) salts and the clastic material (gravel, sand, silt or clay) in which the salts exist. See Table F-2 for a description of the stages of caliche development.
Cobbles and Boulders	See Appendix A explanation pages.
Lithology	The various rock types found in an excavated deposit are listed in order of decreasing abundance.
Remarks	This column was provided for comments regarding difficulty of excavation, caliche development, and backhoe refusal. Refusal indicates the inability of a JCB 3DIII backhoe (Case 680 equivalent) with a 2-foot wide bucket to excavate a trench to completion.
SIEVE ANALYSIS	The numbers cited represent the percentage by dry weight of each of the following soil components.

GR	Coarse aggregate particles that pass a 3-inch (75 mm) sieve but are predominantly retained on a No. 4 (4.75 mm) sieve.
SA	Fine aggregate particles that almost entirely pass a No. 4 sieve but are predominantly retained on a No. 200 (0.075 mm) sieve.
FI	Soil particles that pass a No. 200 sieve (silt and clay).

All percentages shown on logs are the result of laboratory testing.

Depth (ft)	USCS	Consistency	Soil Description	Remarks	Sieve Analysis GR	SA	FI
0	SM	loose	SILTY SAND - OVERBURDEN				
	SM	medium dense	SILTY SAND, stage III caliche throughout.				
2 – 5	SM	medium dense	GRAVELLY SAND, fine to coarse, subrounded, poorly graded; some fine, subrounded gravel; little slightly plastic silt; weak HCl reaction; predominantly volcanics, minor limestone/dolomite.				
5 – 14	SW-SM	medium dense	GRAVELLY SAND, fine to coarse, subrounded, well graded; some mostly fine, subrounded gravel; trace slightly-plastic silt; weak HCl reaction; few cobbles; predominantly volcanics, minor limestone/dolomite.		30	64	6
14			TOTAL DEPTH 14.0 ft. (4.3m)				

Depth scale: Meters 0–6; Feet 0–20. Bulk sample taken from approx. 5 to 14 ft.

TRENCH DETAILS

SURFACE ELEVATION : 5375 ft. (1638m)
DATE EXCAVATED : 18 November 1980
SURFACE GEOLOGIC UNIT : Asf
TRENCH LENGTH : 15 ft. (4.6m)
TRENCH ORIENTATION : W - E

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TRENCH LOG OF WA-A-1
WAH WAH VALLEY, UTAH

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FIGURE C-1

BULK SAMPLE	DEPTH METERS	DEPTH FEET	LITHOLOGY	USCS	CONSISTENCY	SOIL DESCRIPTION	REMARKS	SIEVE ANALYSIS GR	SA	FI
	0	0		SM	loose	SILTY SAND - OVERBURDEN				
		2		SM	medium dense	GRAVELLY SAND, silty, stage II caliche throughout.				
	1, 2, 3, 4	4, 6, 8, 10, 12		SW-SM	medium dense	GRAVELLY SAND, fine to medium, sub-rounded, well graded; some fine to coarse, sub-rounded gravel; trace silt; strong HCl reaction; trace stage I caliche; some cobbles and boulders; quartzite, limestone/dolomite, minor volcanics.		41	51	8
	5, 6	14, 16, 18, 20				TOTAL DEPTH 13.5 ft. (4.1m)				

TRENCH DETAILS

SURFACE ELEVATION : 5340 ft. (1628m)
DATE EXCAVATED : 18 November 1980
SURFACE GEOLOGIC UNIT : Aaf
TRENCH LENGTH : 17 ft. (5.2m)
TRENCH ORIENTATION : W - E

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TRENCH LOG OF WA-A-3
WAH WAH VALLEY, UTAH

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FIGURE C-2

BULK SAMPLE	DEPTH METERS	DEPTH FEET	LITHOLOGY	USCS	CONSISTENCY	SOIL DESCRIPTION	REMARKS	SIEVE ANALYSIS GR	SA	FI
	0	0		SM	loose	SILTY SAND - OVERBURDEN				
	1, 2, 3	2, 4, 6, 8, 10		GP	loose	SANDY GRAVEL, fine to coarse, rounded, poorly graded; some fine to coarse, rounded sand; strong HCl reaction; rare cobble; limestone/dolomite, minor quartzite and volcanics.	excessive caving	50	49	1
	4, 5, 6	12, 14, 16, 18, 20				TOTAL DEPTH 11.0 ft. (3.3m)				

TRENCH DETAILS

SURFACE ELEVATION	: 4765 ft. (1452m)
DATE EXCAVATED	: 18 November 1980
SURFACE GEOLOGIC UNIT	: Aol
TRENCH LENGTH	: 15 ft. (4.6m)
TRENCH ORIENTATION	: S - N

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TRENCH LOG OF WA-A-5
WAH WAH VALLEY, UTAH

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FIGURE C-3

BULK SAMPLE	DEPTH METERS	DEPTH FEET	LITHOLOGY	USCS	CONSISTENCY	SOIL DESCRIPTION	REMARKS	SIEVE ANALYSIS GR	SA	FI
	0	0		SM	loose	SILTY SAND - OVERBURDEN				
				GP-GM	dense	SANDY GRAVEL, fine to coarse, subrounded, poorly graded; some fine to medium, subrounded sand; trace silt; strong HCl reaction; stage III caliche to 5'; some cobbles, rare boulder; quartzite, limestone/dolomite.	caliche	61	28	11
					medium dense					
		12				TOTAL DEPTH 12.0 ft. (3.7m)				

Depth scale: meters 0, 1, 2, 3, 4, 5, 6; feet 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20

TRENCH DETAILS

SURFACE ELEVATION : 5365 ft. (1635m)
DATE EXCAVATED : 19 November 1980
SURFACE GEOLOGIC UNIT : Aaf
TRENCH LENGTH : 15 ft. (4.6m)
TRENCH ORIENTATION : N - S

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TRENCH LOG OF WA-A-8
WAH WAH VALLEY, UTAH

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FIGURE C-4

BULK SAMPLE	DEPTH METERS	DEPTH FEET	LITHOLOGY	USCS	CONSISTENCY	SOIL DESCRIPTION	REMARKS	SIEVE ANALYSIS GR	SA	FI
	0	0		GM	medium dense	SILTY GRAVEL - OVERBURDEN				
				GP	medium dense	SANDY GRAVEL, fine to coarse, subrounded, poorly graded; some fine to coarse, subrounded sand; weak HCl reaction; trace stage I caliche; some cobbles and boulders; predominantly quartzite and quartz sandstone, minor volcanics and limestone.		73	26	1
		12				TOTAL DEPTH 12 ft. (3.7m)				

Depth scale: Meters 0, 1, 2, 3, 4, 5, 6; Feet 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20

TRENCH DETAILS

SURFACE ELEVATION : 5100 ft. (1554m)
DATE EXCAVATED : 19 November 1980
SURFACE GEOLOGIC UNIT : Aol
TRENCH LENGTH : 14 ft. (4.3m)
TRENCH ORIENTATION : NE - SW

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TRENCH LOG OF WA-A-9
WAH WAH VALLEY, UTAH

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FIGURE C-5

BULK SAMPLE	DEPTH METERS	DEPTH FEET	LITHOLOGY	USCS	CONSISTENCY	SOIL DESCRIPTION	REMARKS	SIEVE ANALYSIS GR	SA	FI
	0	0		SM	loose	SILTY SAND - OVERBURDEN				
		2		SM	dense	GRAVELLY SAND, silty, stage III caliche throughout.				
	1, 2, 3, 4	4, 6, 8, 10, 12		SM	medium dense	GRAVELLY SAND, fine to medium, subrounded, poorly graded; some fine to coarse, subrounded gravel; little silt; strong HCl reaction; some stage I to II caliche; some cobbles, rare boulders; limestone/dolomite, quartzite, trace volcanics and chert.		40	47	13
	5, 6	14, 16, 18, 20				TOTAL DEPTH 14.0 ft. (4.3m)				

TRENCH DETAILS

SURFACE ELEVATION : 5155 ft. (1571m)
DATE EXCAVATED : 20 November 1980
SURFACE GEOLOGIC UNIT : Aaf
TRENCH LENGTH : 15 ft. (4.6m)
TRENCH ORIENTATION : N - S

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TRENCH LOG OF WA-A-15
WAH WAH VALLEY, UTAH

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FIGURE C-6

BULK SAMPLE	DEPTH METERS	DEPTH FEET	LITHOLOGY	USCS	CONSISTENCY	SOIL DESCRIPTION	REMARKS	SIEVE ANALYSIS GR	SA	FI
	0	0–2		SM	loose	SILTY SAND - OVERBURDEN				
	1–3	4–12		GP-GM	medium dense	SANDY GRAVEL, fine to coarse, rounded, poorly graded; some fine to coarse, rounded sand; trace silt; strong HCl reaction; trace stage I caliche; few cobbles; limestone/dolomite, quartzite, trace volcanics.		58	36	6
	4–6	14–20				TOTAL DEPTH 13.0 ft. (4.0m)				

TRENCH DETAILS

SURFACE ELEVATION : 5000 ft. (1524m)
DATE EXCAVATED : 20 November 1980
SURFACE GEOLOGIC UNIT : Aol
TRENCH LENGTH : 15 ft. (4.6m)
TRENCH ORIENTATION : N - S

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TRENCH LOG OF WA-A-19
WAH WAH VALLEY, UTAH

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FIGURE C-7

BULK SAMPLE	DEPTH METERS	DEPTH FEET	LITHOLOGY	USCS	CONSISTENCY	SOIL DESCRIPTION	REMARKS	SIEVE ANALYSIS GR	SA	FI
	0	0		GW	medium dense	SANDY GRAVEL, fine to coarse, subrounded, well graded; some fine to coarse, subrounded sand; strong HCl reaction; some stage II caliche; few cobbles and boulders; predominantly limestone/dolomite, minor volcanics.		54	42	4
	4	13				TOTAL DEPTH 13 ft. (4.0m)				

TRENCH DETAILS

SURFACE ELEVATION : 5325 ft. (1623m)
DATE EXCAVATED : 20 November 1980
SURFACE GEOLOGIC UNIT : Asf
TRENCH LENGTH : 15 ft. (4.6m)
TRENCH ORIENTATION : N - S

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FIGURE C-8

BULK SAMPLE	DEPTH METERS	DEPTH FEET	LITHOLOGY	USCS	CONSISTENCY	SOIL DESCRIPTION	REMARKS	SIEVE ANALYSIS GR	SA	FI
	0	0		SM	loose	SILTY SAND, fine to medium, subrounded, poorly graded; some slightly plastic silt; trace fine, subrounded gravel; strong HCl reaction; some stage I caliche; predominantly volcanics, some limestone.				
	1, 2	2, 4, 6								
		8		SM	dense very dense	GRAVELLY SAND, fine to medium, subrounded, poorly graded; some fine to coarse, subrounded gravel; little slightly plastic silt; strong HCl reaction; stage III caliche throughout; few cobbles; limestone/dolomite, volcanics.	refusal			
	3	10				TOTAL DEPTH 10.0 ft. (3.0m)				
	4, 5, 6	12, 14, 16, 18, 20								

TRENCH DETAILS

SURFACE ELEVATION : 5445 ft. (1660m)
DATE EXCAVATED : 21 November 1980
SURFACE GEOLOGIC UNIT : Asf
TRENCH LENGTH : 14 ft. (4.3m)
TRENCH ORIENTATION : N - S

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FIGURE C-9

BULK SAMPLE	DEPTH METERS	DEPTH FEET	LITHOLOGY	USCS	CONSISTENCY	SOIL DESCRIPTION	REMARKS	SIEVE ANALYSIS GR	SA	FI
	0	0		SM	loose	SILTY SAND - OVERBURDEN				
		2		SM	medium dense	SILTY SAND, stage III caliche throughout - OVERBURDEN				
	1, 2, 3	4, 6, 8, 10, 12		SW-SM	medium dense	GRAVELLY SAND, fine to coarse, subrounded, well graded; some fine to coarse, subrounded gravel; trace silt; strong HCl reaction; some stage I caliche; few cobbles; predominantly volcanics, some limestone/dolomite, quartzite.		25	64	11
	4, 5, 6	14, 16, 18, 20				TOTAL DEPTH 13.0 ft. (4.0m)				

TRENCH DETAILS

SURFACE ELEVATION : 5540 ft. (1688m)
DATE EXCAVATED : 21 November 1980
SURFACE GEOLOGIC UNIT : Aaf
TRENCH LENGTH : 15 ft. (4.6m)
TRENCH ORIENTATION : NE - SW

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WAH WAH VALLEY, UTAH

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FIGURE C-10

BULK SAMPLE	DEPTH METERS	DEPTH FEET	LITHOLOGY	USCS	CONSISTENCY	SOIL DESCRIPTION	REMARKS	SIEVE ANALYSIS GR	SA	FI
	0	0		SM	loose	SILTY SAND - OVERBURDEN				
		2		GM	dense	SANDY GRAVEL, silty, stage II - III caliche throughout.				
	1	4		GW-GM	medium dense	SANDY GRAVEL, fine to coarse, subrounded, well graded; some fine to coarse, subrounded sand; trace silt; strong HCl reaction; trace stage I caliche; some cobbles, rare boulder; quartzite, limestone/dolomite, volcanics.		65	29	6
	2, 3	6, 8, 10, 12								
	4	14, 16, 18, 20				TOTAL DEPTH 13.0 ft. (4.0m)				
	5, 6									

TRENCH DETAILS

SURFACE ELEVATION	: 5280 ft. (1609m)
DATE EXCAVATED	: 4 December 1980
SURFACE GEOLOGIC UNIT	: Asf
TRENCH LENGTH	: 15 ft. (4.6m)
TRENCH ORIENTATION	: W - E

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TRENCH LOG OF WA-A-35
WAH WAH VALLEY, UTAH

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FIGURE C-11

E-TR-47-WA

BULK SAMPLE	DEPTH METERS	DEPTH FEET	LITHOLOGY	USCS	CONSISTENCY	SOIL DESCRIPTION	REMARKS	SIEVE ANALYSIS GR	SA	FI
	0	0		SM	loose	GRAVELLY SAND, silty - OVERBURDEN				
	1	2, 4		GM	very dense	SANDY GRAVEL, very dense stage III caliche; large percentage of soil is cobbles and boulders; predominantly quartzite, some limestone/dolomite.	refusal			
	2	6				TOTAL DEPTH 6.0 ft. (1.8m)				

TRENCH DETAILS

SURFACE ELEVATION : 4835 ft. (1474m)
DATE EXCAVATED : 4 December 1980
SURFACE GEOLOGIC UNIT : Asf
TRENCH LENGTH : 14 ft. (4.3m)
TRENCH ORIENTATION : N - S

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TRENCH LOG OF WA-A-36
WAH WAH VALLEY, UTAH

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FIGURE C-12

BULK SAMPLE	DEPTH METERS	DEPTH FEET	LITHOLOGY	USCS	CONSISTENCY	SOIL DESCRIPTION	REMARKS	SIEVE ANALYSIS GR	SIEVE ANALYSIS SA	SIEVE ANALYSIS FI
	0	0		SM	loose	GRAVELLY SAND, silty - OVERBURDEN				
	1, 2, 3, 4	2, 4, 6, 8, 10, 12		GP	medium dense	SANDY GRAVEL, fine to coarse, rounded, poorly graded; some fine to coarse, subrounded to rounded sand; strong HCl reaction; trace stage I caliche; few cobbles; predominantly quartzite, little limestone/dolomite.		58	41	1
	5, 6	14, 16, 18, 20				TOTAL DEPTH 13.5 ft. (4.1m)				

TRENCH DETAILS

SURFACE ELEVATION	: 5080 ft. (1548m)
DATE EXCAVATED	: 4 December 1980
SURFACE GEOLOGIC UNIT	: Aol
TRENCH LENGTH	: 15 ft. (4.6m)
TRENCH ORIENTATION	: NE - SW

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TRENCH LOG OF WA-A-41
WAH WAH VALLEY, UTAH

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FIGURE C-13

BULK SAMPLE	DEPTH METERS	DEPTH FEET	LITHOLOGY	USCS	CONSISTENCY	SOIL DESCRIPTION	REMARKS	SIEVE ANALYSIS GR	SA	FI
	0	0		SM	loose	SILTY SAND - OVERBURDEN				
	0–4	2–14		GM	medium dense	SANDY GRAVEL, fine to coarse, subrounded, poorly graded; some fine to coarse, subrounded sand; little slightly-plastic silt; strong HCl reaction; little stage II caliche from 7' to 8'; few cobbles; predominantly quartzite, trace limestone/dolomite.	caliche layer	54	30	16
		14				TOTAL DEPTH 14.0 ft. (4.3m)				

Depth scale: meters 0, 1, 2, 3, 4, 5, 6; feet 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20

TRENCH DETAILS

SURFACE ELEVATION	: 5015 ft. (1529m)
DATE EXCAVATED	: 5 December 1980
SURFACE GEOLOGIC UNIT	: Aaf
TRENCH LENGTH	: 15 ft. (4.6m)
TRENCH ORIENTATION	: N - S

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TRENCH LOG OF WA-A-43
WAH WAH VALLEY, UTAH

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FIGURE C-14

BULK SAMPLE	DEPTH (METERS)	DEPTH (FEET)	LITHOLOGY	USCS	CONSISTENCY	SOIL DESCRIPTION	REMARKS	SIEVE ANALYSIS GR	SIEVE ANALYSIS SA	SIEVE ANALYSIS FI
	0	0		SM	loose	SILTY SAND - OVERBURDEN				
	1, 2, 3, 4	2, 4, 6, 8, 10, 12, 14		GP-GM	medium dense	SANDY GRAVEL, fine to coarse, subrounded, poorly graded; some fine to coarse, subrounded sand; trace slightly plastic silt; strong HCl reaction; little stage II caliche; some cobbles, occasional boulders; limestone/dolomite, volcanics.		50	43	7
	5, 6	16, 18, 20				TOTAL DEPTH 14.0 ft. (4.3m)				

TRENCH DETAILS

SURFACE ELEVATION	: 5350 ft. (1631m)
DATE EXCAVATED	: 5 December 1980
SURFACE GEOLOGIC UNIT	: Asf
TRENCH LENGTH	: 15 ft. (4.6m)
TRENCH ORIENTATION	: N - S

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TRENCH LOG OF WA-A-49
WAH WAH VALLEY, UTAH

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FIGURE C-16

BULK SAMPLE	DEPTH METERS	DEPTH FEET	LITHOLOGY	USCS	CONSISTENCY	SOIL DESCRIPTION	REMARKS	SIEVE ANALYSIS GR	SA	FI
	0	0		SM	loose	SILTY SAND - OVERBURDEN				
	0–4	0–14		GP-GM	medium dense	SANDY GRAVEL, fine to coarse, subrounded, poorly graded; some fine to coarse, subrounded sand; trace slightly plastic silt; strong HCl reaction; stage II caliche from 1' to 2' and 7' to 8'; few cobbles; predominantly limestone/dolomite, trace volcanics and quartzite	caliche layer (1'–2'); caliche layer (7'–8')	62	31	7
		14				TOTAL DEPTH 14.0 ft. (4.3m)				

TRENCH DETAILS

SURFACE ELEVATION : 5385 ft. (1641m)

DATE EXCAVATED : 6 December 1980

SURFACE GEOLOGIC UNIT : Asf

TRENCH LENGTH : 15 ft. (4.6m)

TRENCH ORIENTATION : NW - SE

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TRENCH LOG OF WA-A-52
WAH WAH VALLEY, UTAH

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FIGURE C-16

BULK SAMPLE	DEPTH METERS	DEPTH FEET	LITHOLOGY	USCS	CONSISTENCY	SOIL DESCRIPTION	REMARKS	SIEVE ANALYSIS GR	SA	FI
	0–1	0–3		SM	loose	SILTY SAND, fine, subrounded, poorly graded; some slightly-plastic silt; strong HCl reaction.				
X	1–4	3–13		SP	loose	GRAVELLY SAND, fine to coarse, rounded, poorly graded; trace mostly fine, rounded gravel; strong HCl reaction; few cobbles; limestone/dolomite, quartzite, volcanics, trace chert.	excessive caving	12	85	3
	4	13				TOTAL DEPTH 13.0 ft. (4.0m)				

TRENCH DETAILS

SURFACE ELEVATION : 4760 ft. (1451m)
DATE EXCAVATED : 18 November 1980
SURFACE GEOLOGIC UNIT : Aol
TRENCH LENGTH : 16 ft. (4.9m)
TRENCH ORIENTATION : S - N

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TRENCH LOG OF WA-FA-1
WAH WAH VALLEY, UTAH

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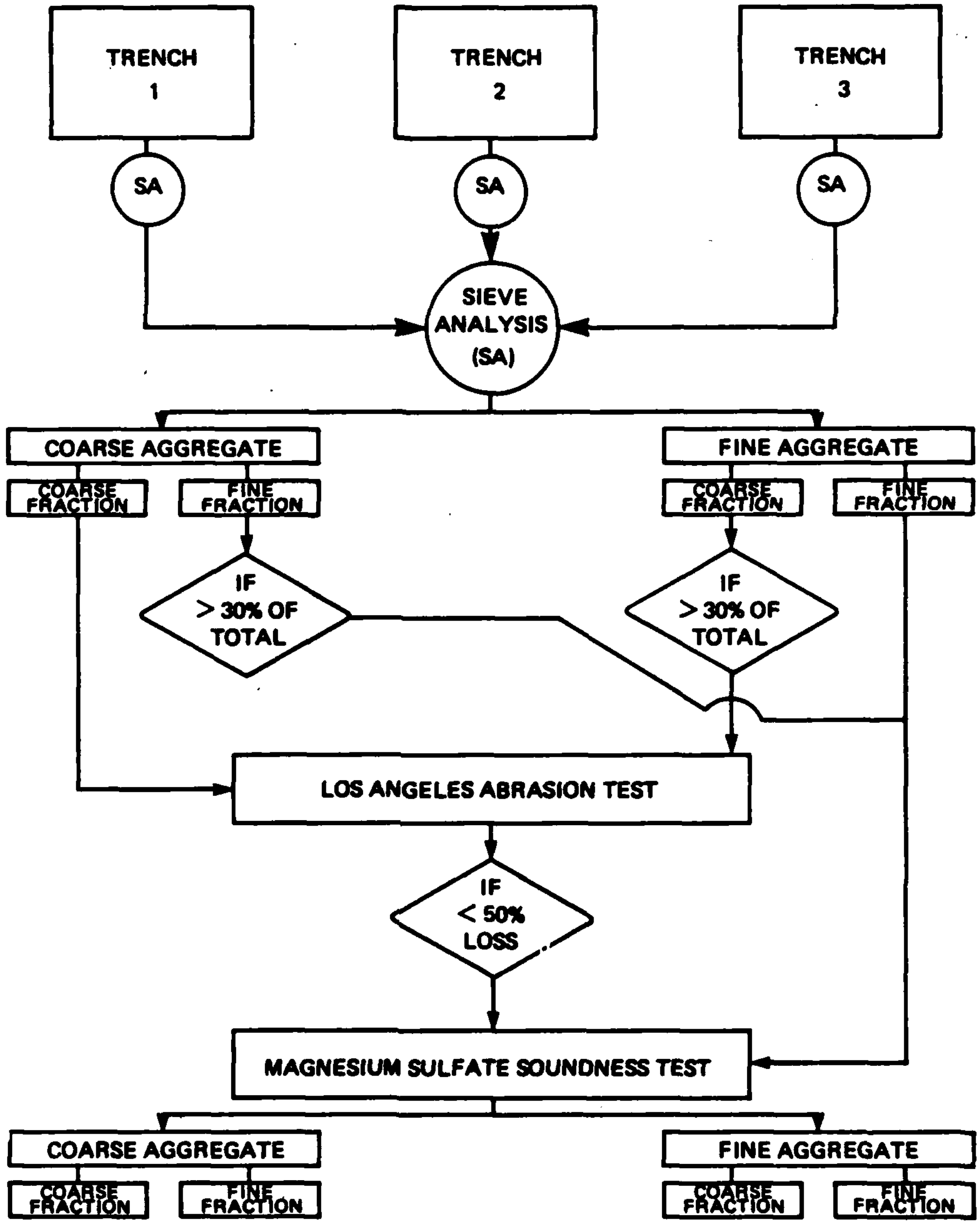
FIGURE C-17

APPENDIX D

FLOW DIAGRAM - ROAD-BASE AGGREGATES TESTING

FLOW DIAGRAM - CONCRETE TRIAL MIX DESIGN AND TESTING



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FLOW DIAGRAM — ROAD-BASE AGGREGATES TESTING

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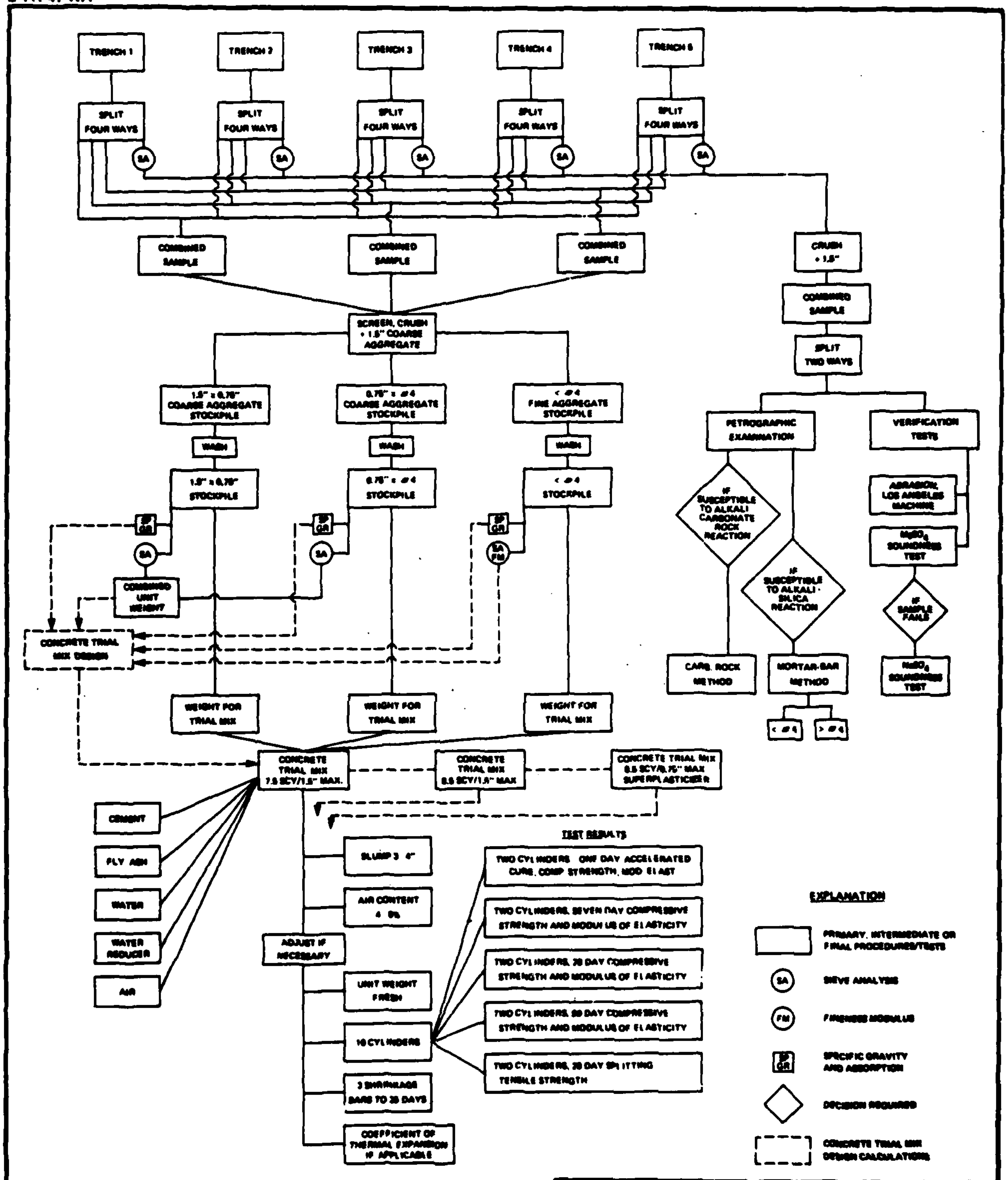
FIGURE D-1



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FLOW DIAGRAM – CONCRETE
TRIAL MIX DESIGN AND TESTING

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FIGURE D-2

APPENDIX E

CHEMICAL ANALYSES OF CEMENT,
FLY ASH, AND WATER USED IN
CONCRETE TRIAL MIXES

	PROPERTY ANALYZED	TOTAL PERCENTAGE OF SAMPLE	MINIMUM OR MAXIMUM REQUIREMENTS
CEMENT ASTM C 150, TYPE II	SiO_2	26.8	20.0 MIN.
	AL_2O_3	1.95	6.0 MAX.
	Fe_2O_3	2.71	6.0 MAX.
	MgO	1.57	6.0 MAX.
	ALKALIES (Na_2O + 0.658 K_2O)	0.53	0.60 MAX.
	LOSS ON IGNITION	0.56	3.0 MAX.
	SO_3	1.97	3.0 MAX.
	INSOLUBLE RESIDUE	0.61	0.75 MAX.
FLY ASH ASTM C 618, CLASS F	SiO_2	67.7	–
	AL_2O_2	17.2	–
	Fe_2O_3	8.34	–
	TOTAL	93.24	70.0 MIN.
	MgO	1.69	5.0 MAX.
	SO_3	0.14	5.0 MAX.
	Na_2O (OPTIONAL)	1.68	1.5 MAX.
	MOISTURE	0.08	3.0 MAX.
	LOSS ON IGNITION	0.63	12.0 MAX.
WATER CALIF. DEPT. TRANS. SEC. 90 - 2.03	pH	7.5	–
	COLOR	0 - 5	–
	SO_4	8 ppm	1300 ppm
	Cl	10.6 ppm	650 ppm
	OIL AND GREASE	NONE	NONE

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CHEMICAL ANALYSES OF CEMENT, FLY ASH, AND WATER USED IN CONCRETE TRIAL MIXES

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TABLE E-1

APPENDIX F

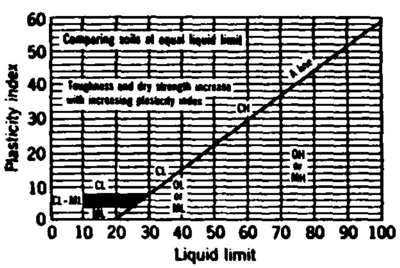
UNIFIED SOIL CLASSIFICATION SYSTEM

SUMMARY OF CALICHE DEVELOPMENT

ERTEC WESTERN GEOLOGIC UNIT CROSS REFERENCE

Field Identification Procedures (Excluding particles larger than 3 in. and basing fractions on estimated weights)			Group Symbols[a]	Typical Names	Information Required for Describing Soils	Laboratory Classification Criteria	
Coarse-grained soils: More than half of material is *larger* than No. 200 sieve size[b] (The No. 200 sieve size is about the smallest particle visible to naked eye). Gravels: More than half of coarse fraction is larger than No. 4 sieve size (For visual classification, the ¼ in. size may be used as equivalent to the No. 4 sieve size)	Clean gravels (little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes	*GW*	Well graded gravels, gravel-sand mixtures, little or no fines	Give typical name; indicate approximate percentages of sand and gravel; maximum size; angularity, surface condition, and hardness of the coarse grains; local or geologic name and other pertinent descriptive information; and symbols in parentheses	Use grain size curve in identifying the fractions as given under field identification. Determine percentages of gravel and sand from grain size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size) coarse grained soils are classified as follows: Less than 5% *GW, GP, SW, SP*; More than 12% *GM, GC, SM, SC*; 5% to 12% *Borderline* cases requiring use of dual symbols	$C_U = \frac{D_{60}}{D_{10}}$ Greater than 4; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3
	Clean gravels (little or no fines)	Predominantly one size or a range of sizes with some intermediate sizes missing	*GP*	Poorly graded gravels, gravel-sand mixtures, little or no fines			Not meeting all gradation requirements for *GW*
	Gravels with fines (appreciable amount of fines)	Nonplastic fines (for identification procedures see *ML* below)	*GM*	Silty gravels, poorly graded gravel-sand-silt mixtures			Atterberg limits below "A" line, or *PI* less than 4 / Above "A" line with *PI* between 4 and 7 are *borderline* cases requiring use of dual symbols
	Gravels with fines (appreciable amount of fines)	Plastic fines (for identification procedures, see *CL* below)	*GC*	Clayey gravels, poorly graded gravel-sand-clay mixtures			Atterberg limits above "A" line, with *PI* greater than 7
Sands: More than half of coarse fraction is smaller than No. 4 sieve size	Clean sands (little or no fines)	Wide range in grain sizes and substantial amounts of all intermediate particle sizes	*SW*	Well graded sands, gravelly sands, little or no fines	For undisturbed soils add information on stratification, degree of compactness, cementation, moisture conditions and drainage characteristics		$C_U = \frac{D_{60}}{D_{10}}$ Greater than 6; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3
	Clean sands (little or no fines)	Predominantly one size or a range of sizes with some intermediate sizes missing	*SP*	Poorly graded sands, gravelly sands, little or no fines	Example: *Silty sand*, gravelly; about 20% hard, angular gravel particles ½-in. maximum size; rounded and subangular sand grains coarse to fine, about 15% non-plastic fines with low dry strength; well compacted and moist in place; alluvial sand; (*SM*)		Not meeting all gradation requirements for *SW*
	Sands with fines (appreciable amount of fines)	Nonplastic fines (for identification procedures, see *ML* below)	*SM*	Silty sands, poorly graded sand-silt mixtures			Atterberg limits below "A" line or *PI* less than 5 / Above "A" line with *PI* between 4 and 7 are *borderline* cases requiring use of dual symbols
	Sands with fines (appreciable amount of fines)	Plastic fines (for identification procedures, see *CL* below)	*SC*	Clayey sands, poorly graded sand-clay mixtures			Atterberg limits below "A" line with *PI* greater than 7

Identification Procedures on Fraction Smaller than No. 40 Sieve Size	Dry Strength (crushing characteristics)	Dilatancy (reaction to shaking)	Toughness (consistency near plastic limit)	Group Symbols	Typical Names	Information Required for Describing Soils
Fine-grained soils: More than half of material is *smaller* than No. 200 sieve size. Silts and clays, liquid limit less than 50	None to slight	Quick to slow	None	*ML*	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity	Give typical name; indicate degree and character of plasticity, amount and maximum size of coarse grains; colour in wet condition, odour if any, local or geologic name, and other pertinent descriptive information, and symbol in parentheses
	Medium to high	None to very slow	Medium	*CL*	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	
	Slight to medium	Slow	Slight	*OL*	Organic silts and organic silt-clays of low plasticity	For undisturbed soils add information on structure, stratification, consistency in undisturbed and remoulded states, moisture and drainage conditions
Silts and clays, liquid limit greater than 50	Slight to medium	Slow to none	Slight to medium	*MH*	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts	
	High to very high	None	High	*CH*	Inorganic clays of high plasticity, fat clays	Example: *Clayey silt*, brown; slightly plastic; small percentage of fine sand; numerous vertical root holes; firm and dry in place; loess; (*ML*)
	Medium to high	None to very slow	Slight to medium	*OH*	Organic clays of medium to high plasticity	
Highly Organic Soils	Readily identified by colour, odour, spongy feel and frequently by fibrous texture			*Pt*	Peat and other highly organic soils	



Plasticity chart
for laboratory classification of fine grained soils

From Wagner, 1957.
[a] *Boundary classifications.* Soils possessing characteristics of two groups are designated by combinations of group symbols. For example *GW-GC*, well graded gravel-sand mixture with clay binder.
[b] All sieve sizes on this chart are U.S. standard.

Field Identification Procedure for Fine Grained Soils or Fractions

These procedures are to be performed on the minus No. 40 sieve size particles, approximately 1/64 in. For field classification purposes, screening is not intended, simply remove by hand the coarse particles that interfere with the tests.

Dilatancy (Reaction to shaking):
After removing particles larger than No. 40 sieve size, prepare a pat of moist soil with a volume of about one-half cubic inch. Add enough water if necessary to make the soil soft but not sticky.
Place the pat in the open palm of one hand and shake horizontally, striking vigorously against the other hand several times. A positive reaction consists of the appearance of water on the surface of the pat which changes to a livery consistency and becomes glossy. When the sample is squeezed between the fingers, the water and gloss disappear from the surface, the pat stiffens and finally it cracks or crumbles. The rapidity of appearance of water during shaking and of its disappearance during squeezing assist in identifying the character of the fines in a soil.
Very fine clean sands give the quickest and most distinct reaction whereas a plastic clay has no reaction. Inorganic silts, such as a typical rock flour, show a moderately quick reaction.

Dry Strength (Crushing characteristics):
After removing particles larger than No. 40 sieve size, mould a pat of soil to the consistency of putty, adding water if necessary. Allow the pat to dry completely by oven, sun or air drying, and then test its strength by breaking and crumbling between the fingers. This strength is a measure of the character and quantity of the colloidal fraction contained in the soil. The dry strength increases with increasing plasticity.
High dry strength is characteristic for clays of the CH group. A typical inorganic silt possesses only very slight dry strength. Silty fine sands and silts have about the same slight dry strength, but can be distinguished by the feel when powdering the dried specimen. Fine sand feels gritty whereas a typical silt has the smooth feel of flour.

Toughness (Consistency near plastic limit):
After removing particles larger than the No. 40 sieve size, a specimen of soil about one-half inch cube in size, is moulded to the consistency of putty. If too dry, water must be added and if sticky, the specimen should be spread out in a thin layer and allowed to lose some moisture by evaporation. Then the specimen is rolled out by hand on a smooth surface or between the palms into a thread about one-eight inch in diameter. The thread is then folded and re-rolled repeatedly. During this manipulation the moisture content is gradually reduced and the specimen stiffens, finally loses its plasticity, and crumbles when the plastic limit is reached.
After the thread crumbles, the pieces should be lumped together and a slight kneading action continued until the lump crumbles.
The tougher the thread near the plastic limit and the stiffer the lump when it finally crumbles, the more potent is the colloidal clay fraction in the soil. Weakness of the thread at the plastic limit and quick loss of coherence of the lump below the plastic limit indicate either inorganic clay of low plasticity, or materials such as kaolin-type clays and organic clays which occur below the A-line.
Highly organic clays have a very weak and spongy feel at the plastic limit.

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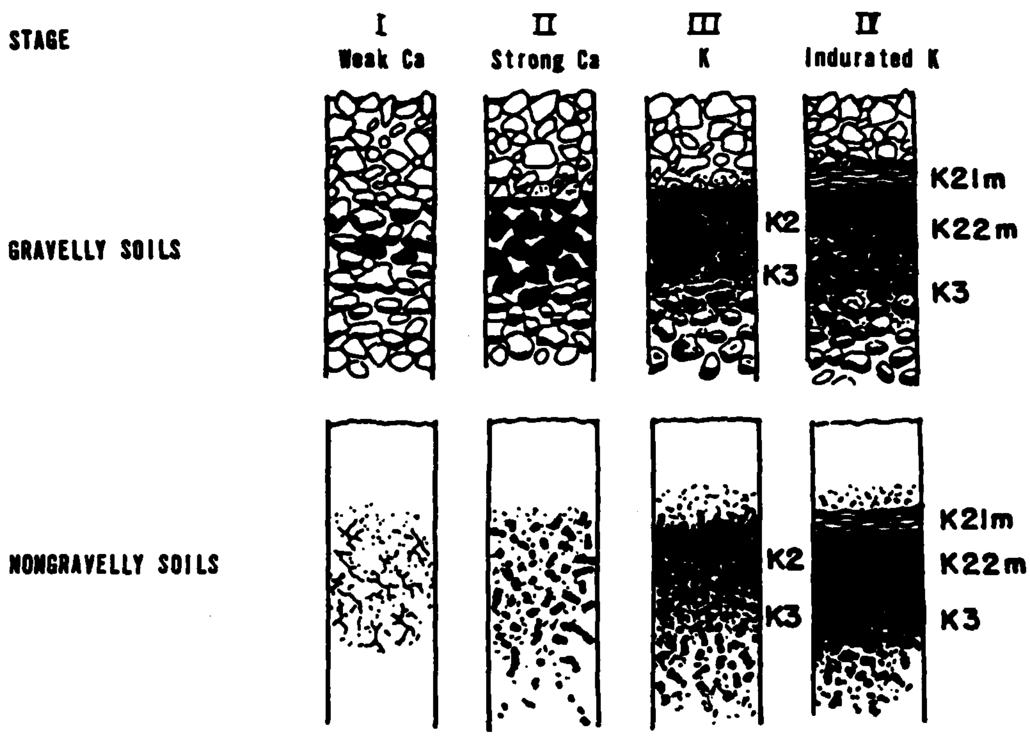
UNIFIED SOIL CLASSIFICATION SYSTEM

12 JUN 81

TABLE F-1

DIAGNOSTIC CARBONATE MORPHOLOGY

STAGE	GRAVELLY SOILS	NONGRAVELLY SOILS
I	Thin, discontinuous pebble coatings	Few filaments or faint coatings
II	Continuous pebble coatings, some interpebble fillings	Few to abundant nodules, flakes, filaments
III	Many interpebble fillings	Many nodules and internodular fillings
IV	Laminar horizon overlying plugged horizon	Laminar horizon overlying plugged horizon



Stages of development of a caliche profile with time. Stage I represents incipient carbonate accumulation, followed by continuous build-up of carbonate until, in Stage IV, the soil is completely plugged.

Reference: Gile, L.G. Peterson, F.F., and Grossman, R.B., 1965, The K horizon: A master horizon of carbonate accumulation: Soil Science, v. 99, p. 74-82.

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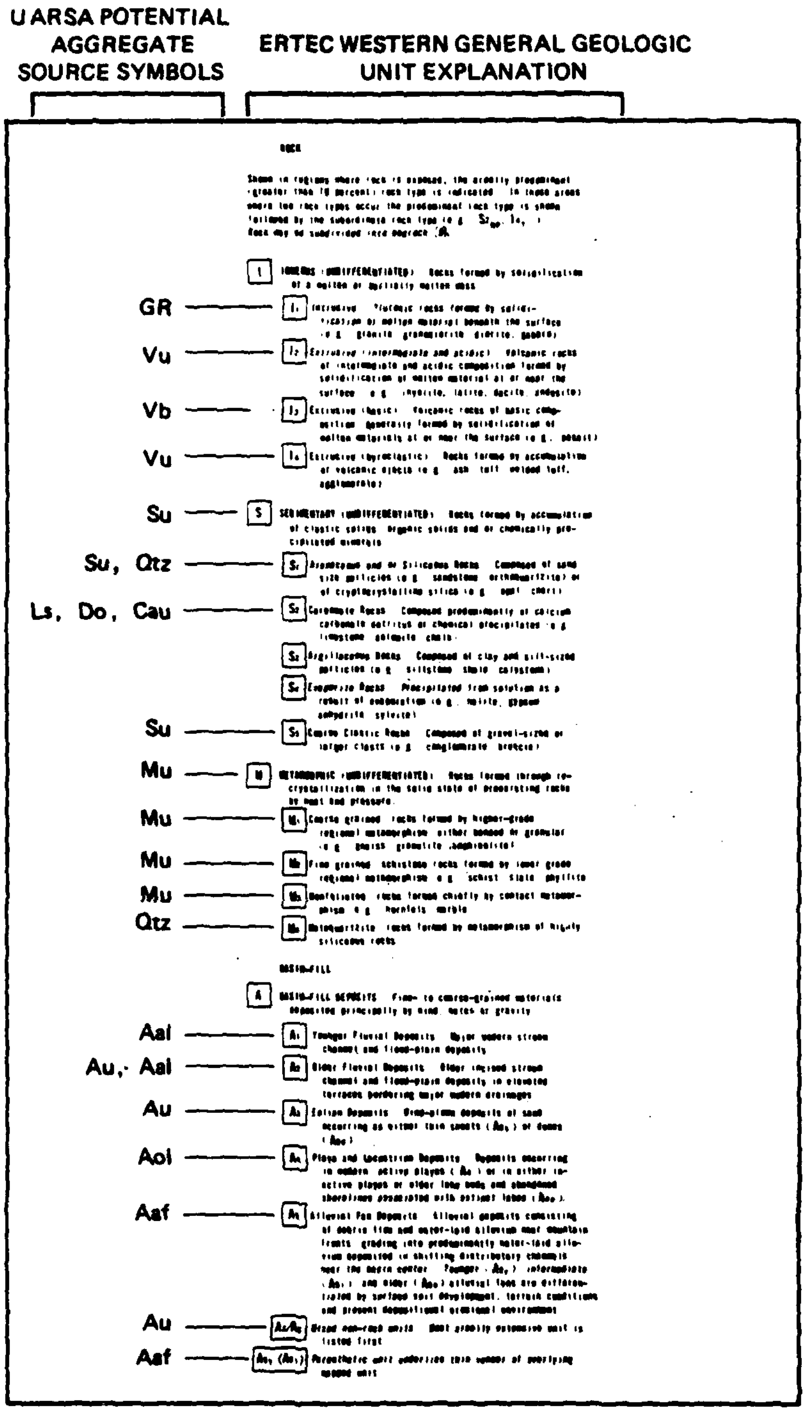
SUMMARY OF CALICHE DEVELOPMENT

12 JUN 81

FIGURE F-3



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ERTEC WESTERN GEOLOGIC UNIT CROSS REFERENCE

12 JUN 81

FIGURE F-3

APPENDIX G

CROSS REFERENCE FROM MAP
NUMBER TO VERIFICATION ACTIVITY

CROSS REFERENCE FROM MAP NUMBER TO VERIFICATION ACTIVITY

Included in this appendix is one table that is presented to allow cross reference to be made from this aggregate resources study to an appropriate verification study. Map numbers in the number series 400 to 599 on Drawing 1 are keyed to the Verification report of Wah Wah Valley, Utah (FN-TR-27-WA-I and II). If detailed information is required from a verification activity, the following search procedure can be used: determine the location of the activity required on Drawing 1, note the map number, refer to that map number in Table G-1, read from that table the verification activity type and number, refer to the appropriate verification report for the data required.

MAP NUMBER	ACTIVITY LOCATION	MAP NUMBER	ACTIVITY LOCATION
401	GS - 12	423	P - 19
402	B - 6	424	CS - 67
403	T - 1	425	CS - 71
404	GS - 7	426	GS - 21
405	GS - 9	427	P - 20
406	P - 1	428	CS - 69
407	GS - 6	429	T - 20
408	GS - 8	430	GS - 22
409	GS - 1	431	GS - 23
410	CS - 1	432	GS - 17
411	GS - 5	433	P - 13
412	P - 17	434	CS - 58
413	GS - 13	435	GS - 18
414	GS - 14	436	GS - 15
415	CS - 61	437	T - 17
416	T - 19	438	CS - 56
417	CS - 63	439	P - 12
418	GS - 10	440	GS - 16
419	P - 18	441	CS - 54
420	CS - 65	442	GS - 2
421	GS - 11	443	P - 14
422	GS - 58	444	CS - 52

T - TRENCH
B - BORING
P - TEST PIT
CS - SURFACE SAMPLE
GS - GEOLOGIC STATION

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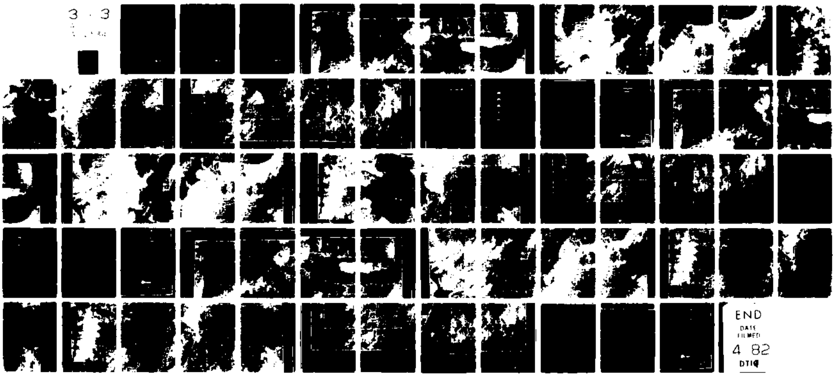
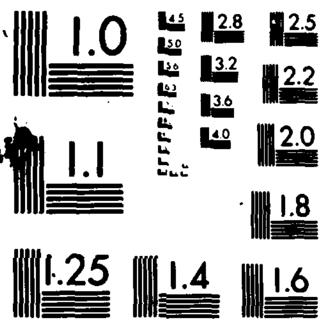
CROSS REFERENCE FROM MAP NUMBER
TO VERIFICATION ACTIVITY
WAH WAH VALLEY, UTAH

12 JUN 81 PAGE 1 OF 4 TABLE G-1

AD-A112 534 ERTEC WESTERN INC LONG BEACH CA F/G 8/7
MX SITING INVESTIGATION. GEOTECHNICAL EVALUATION. DETAILED AGGR--ETC(U)
JUN 81 F04704-80-C-0006
UNCLASSIFIED E-TR-47-WA NL





MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

MAP NUMBER	ACTIVITY LOCATION	MAP NUMBER	ACTIVITY LOCATION
445	T - 18	467	P - 11
446	GS - 3	468	GS - 59
447	P - 15	469	T - 14
448	CS - 49	470	CS - 30
449	GS - 4	471	T - 13
450	P - 16	472	CS - 32
451	GS - 19	473	GS - 51
452	GS - 68	474	GS - 25
453	GS - 67	475	P - 9
454	GS - 20	476	GS - 26
455	GS - 34	477	GS - 27
456	GS - 33	478	GS - 32
457	CS - 45	479	GS - 28
458	T - 16	480	GS - 29
459	GS - 57	481	GS - 50
460	GS - 56	482	CS - 34
461	GS - 55	483	T - 11
462	GS - 66	484	GS - 30
463	CS - 43	485	P - 8
464	P - 10	486	CS - 37
465	T - 15	487	T - 12
466	CS - 41	488	GS - 31

T - TRENCH
B - BORING
P - TEST PIT
CS - SURFACE SAMPLE
GS - GEOLOGIC STATION

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CROSS REFERENCE FROM MAP NUMBER
TO VERIFICATION ACTIVITY
WAH WAH VALLEY, UTAH

MAP NUMBER	ACTIVITY LOCATION	MAP NUMBER	ACTIVITY LOCATION
489	GS - 52	511	GS - 47
490	GS - 63	512	CS - 11
491	GS - 62	513	GS - 42
492	GS - 54	514	GS - 49
493	GS - 60	515	T - 4
494	P - 2	516	GS - 35
495	CS - 5	517	GS - 36
496	GS - 53	518	GS - 46
497	T - 2	519	GS - 69
498	P - 3	520	CS - 13
499	GS - 61	521	GS - 43
500	CS - 8	522	GS - 41
501	T - 3	523	GS - 37
502	CS - 10	524	P - 4
503	P - 7	525	CS - 15
504	CS - 28	526	GS - 44
505	GS - 65	527	CS - 20
506	P - 8	528	T - 8
507	CS - 26	529	GS - 40
508	GS - 64	530	GS - 72
509	T - 10	531	T - 5
510	GS - 48	532	GS - 70

T - TRENCH
B - BORING
P - TEST PIT
CS - SURFACE SAMPLE
GS - GEOLOGIC STATION

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CROSS REFERENCE FROM MAP NUMBER
TO VERIFICATION ACTIVITY
WAH WAH VALLEY, UTAH

MAP NUMBER	ACTIVITY LOCATION	MAP NUMBER	ACTIVITY LOCATION
533	T - 6		
534	P - 5		
535	CS - 23		
536	T - 9		
537	GS - 38		
538	GS - 15		
539	GS - 18		
540	T - 7		
541	GS - 39		
542	GS - 71		

T - TRENCH
B - BORING
P - TEST PIT
CS - SURFACE SAMPLE
GS - GEOLOGIC STATION

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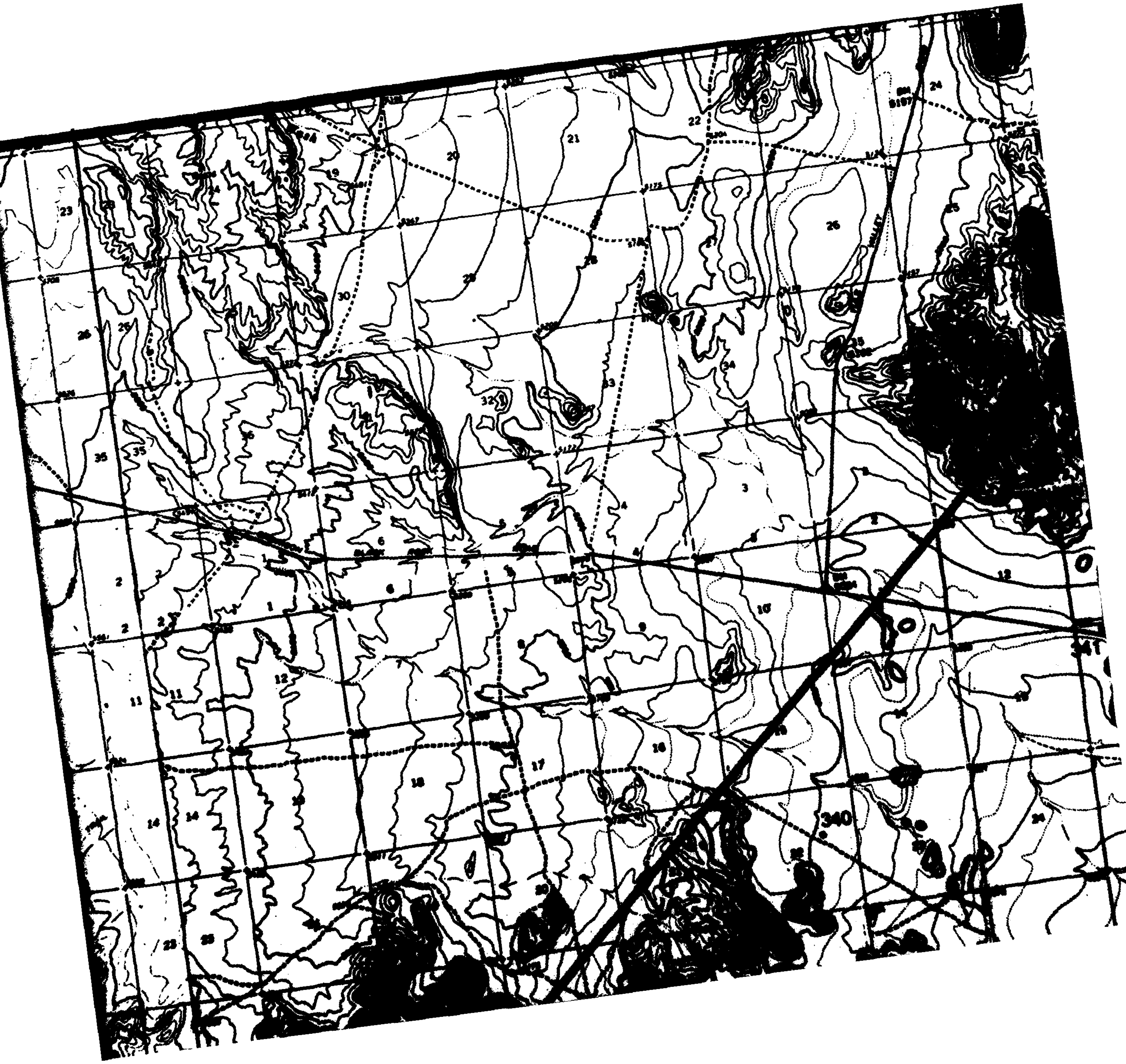
CROSS REFERENCE FROM MAP NUMBER
TO VERIFICATION ACTIVITY
WAH WAH VALLEY, UTAH


JEEP TRAIL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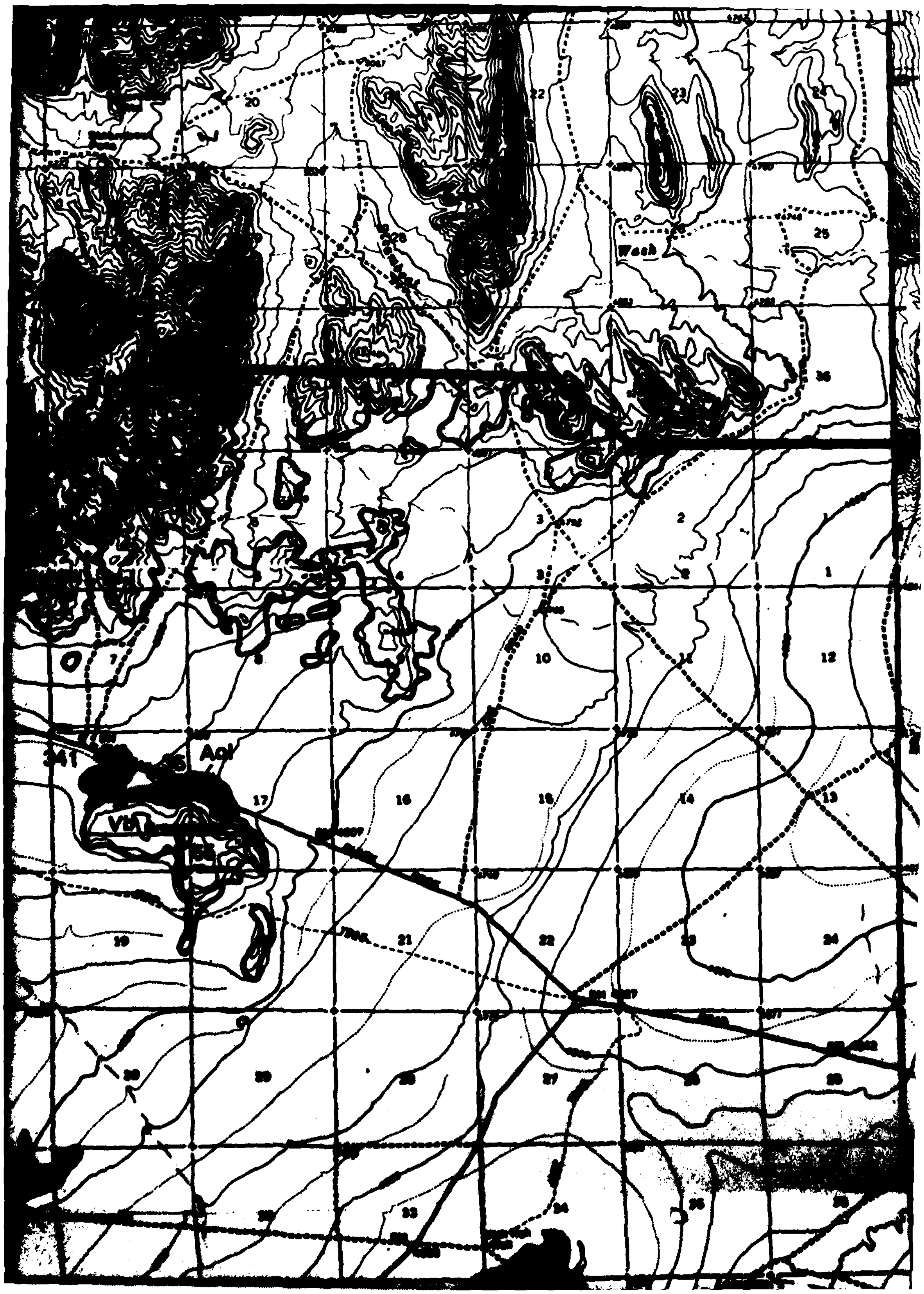
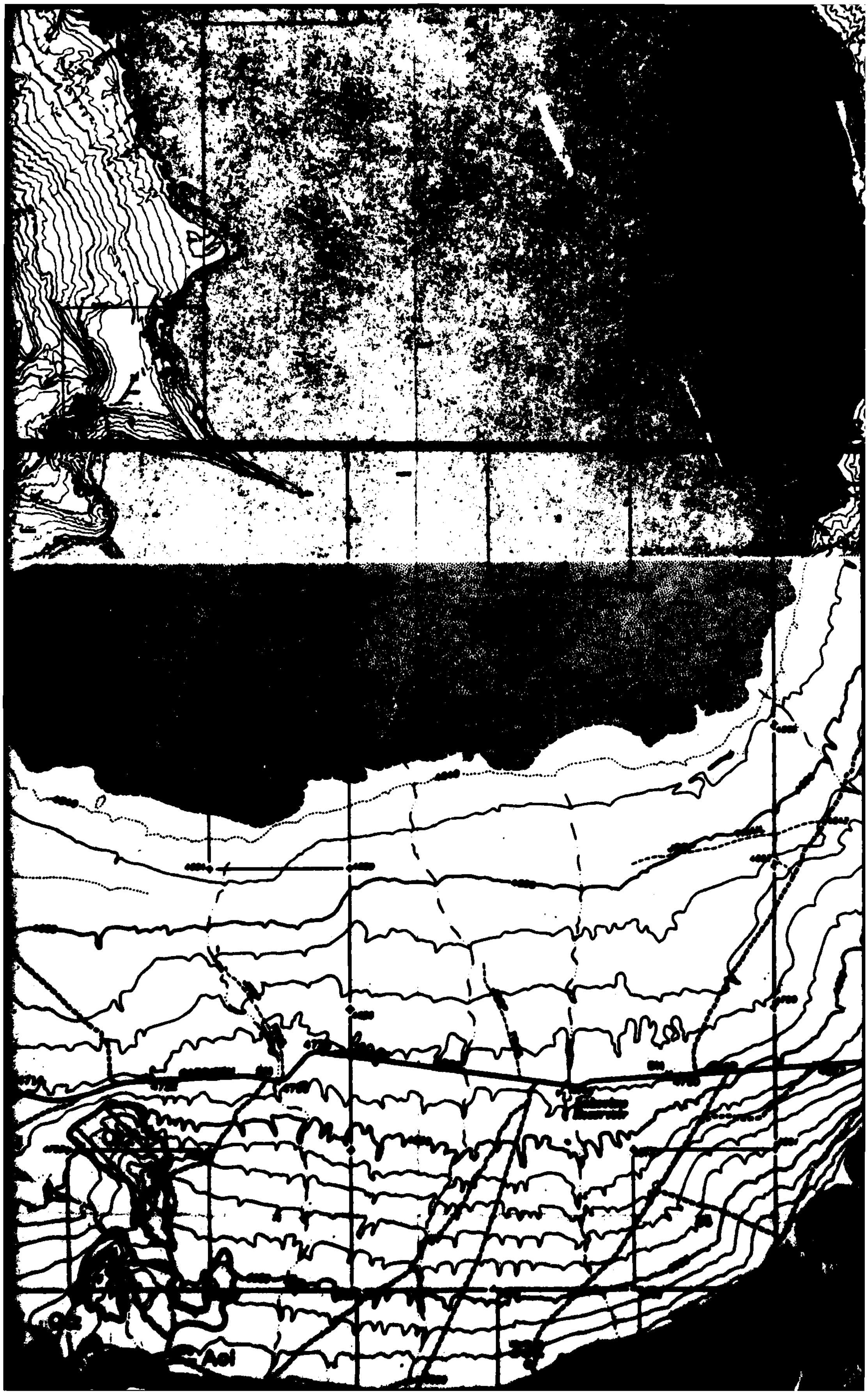
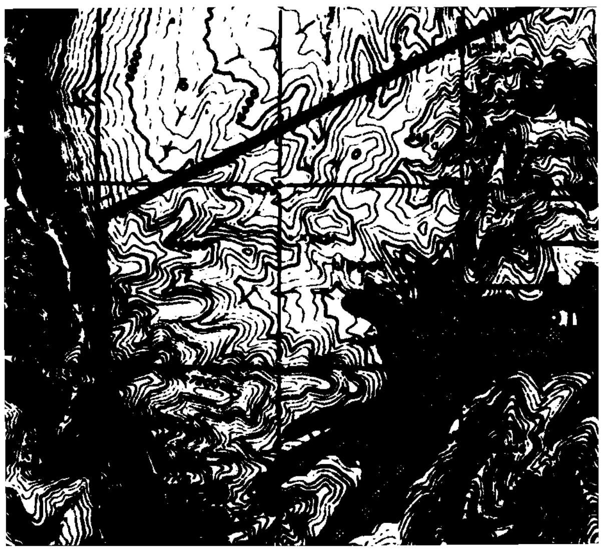
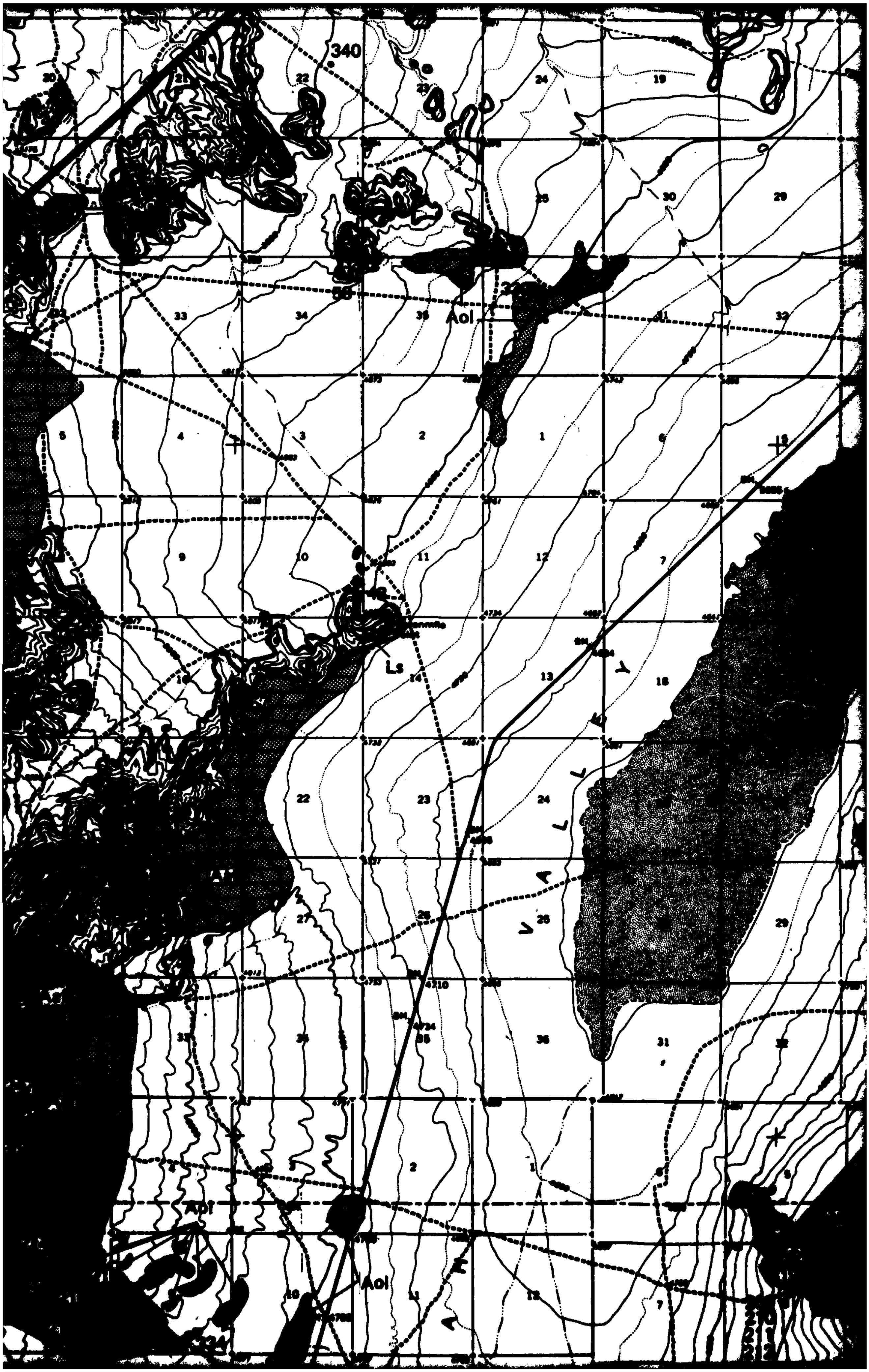
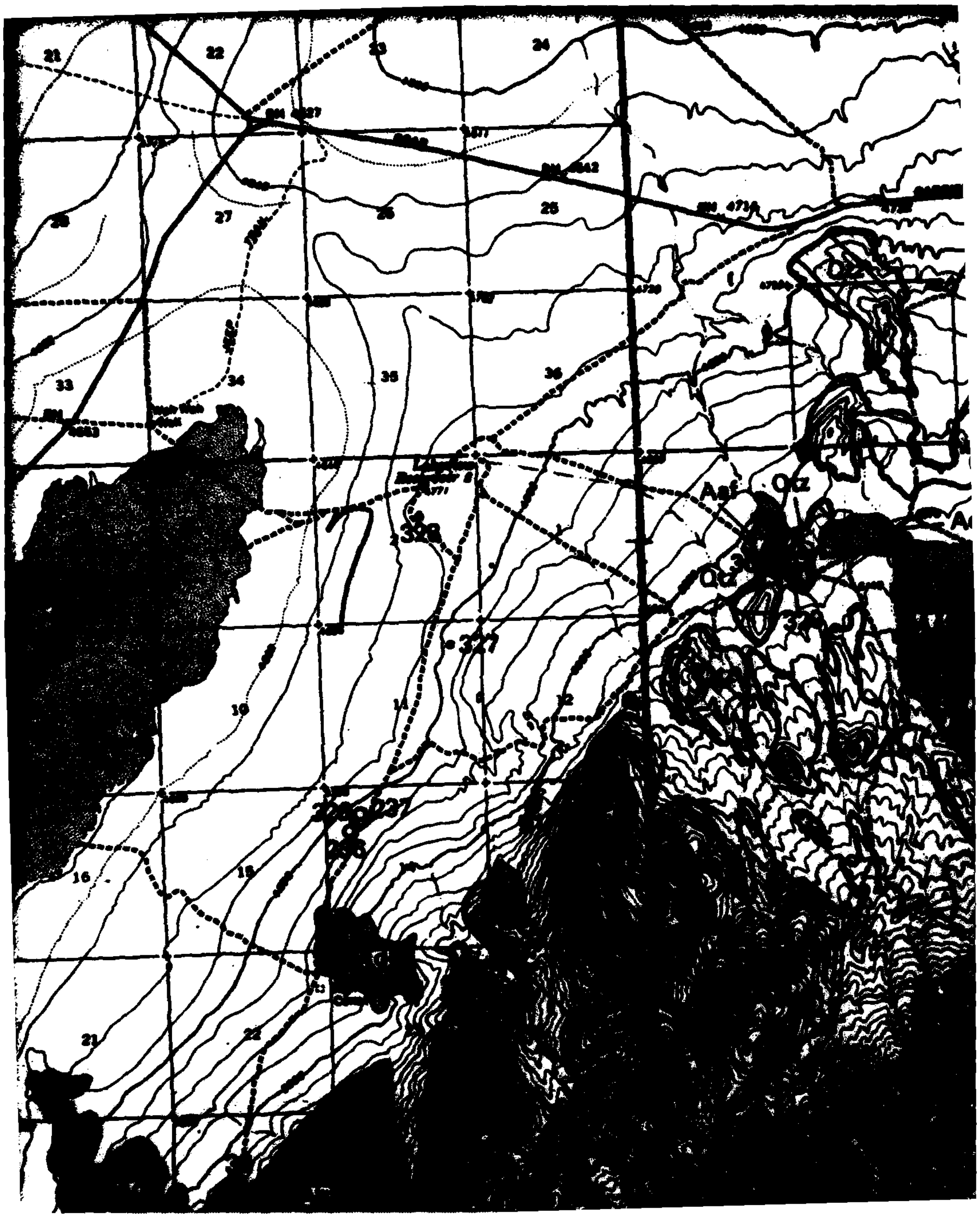

Wash
Aol






340
Aol
Ls
V A L L E Y
Aol
Aol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Aaf
Qtz
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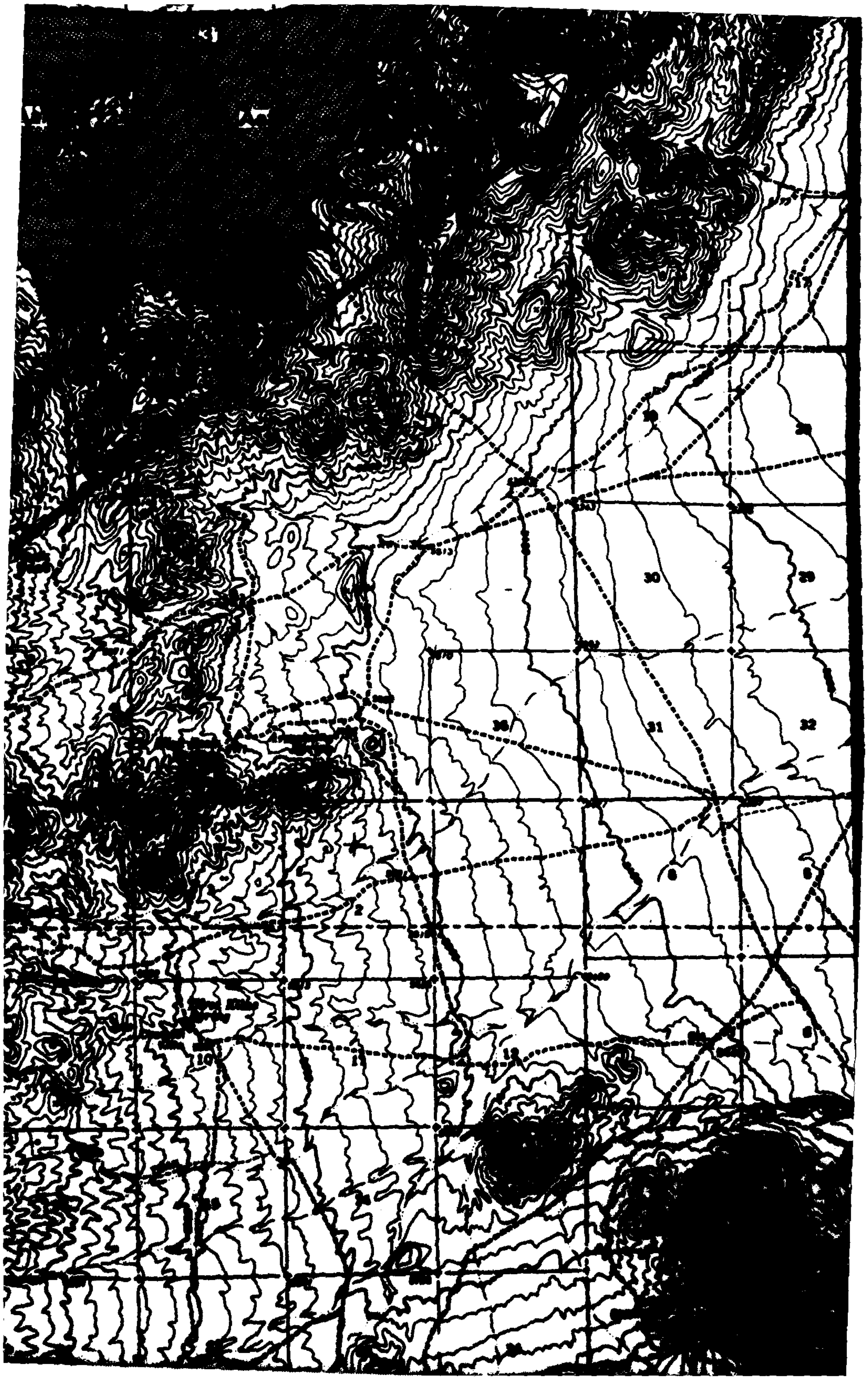
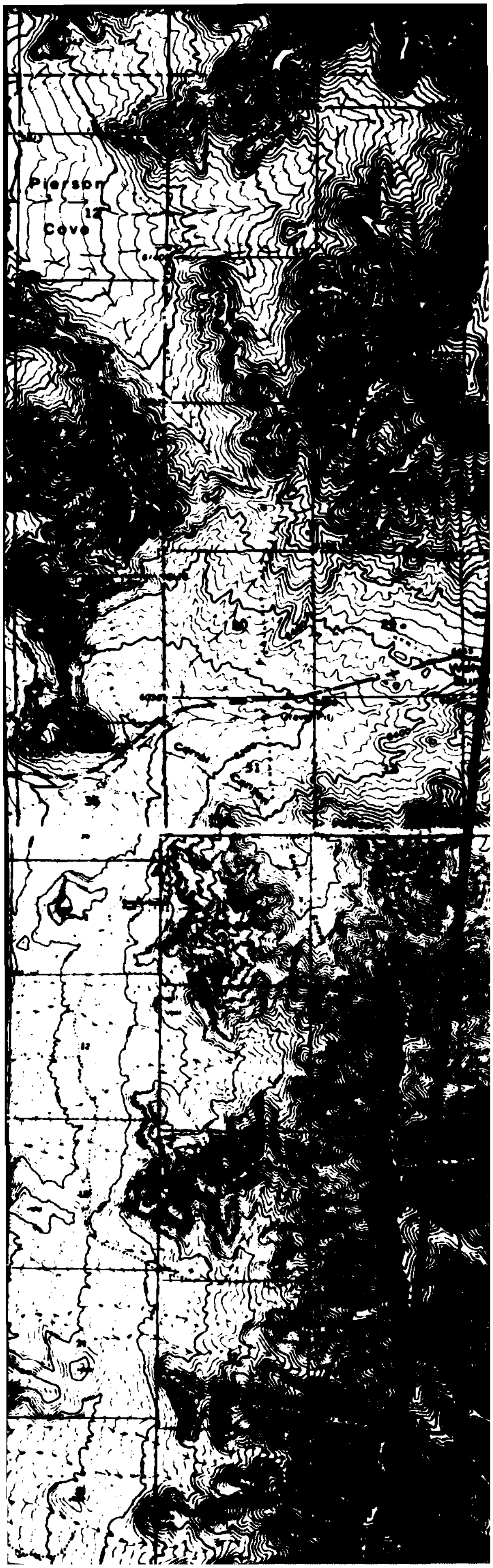
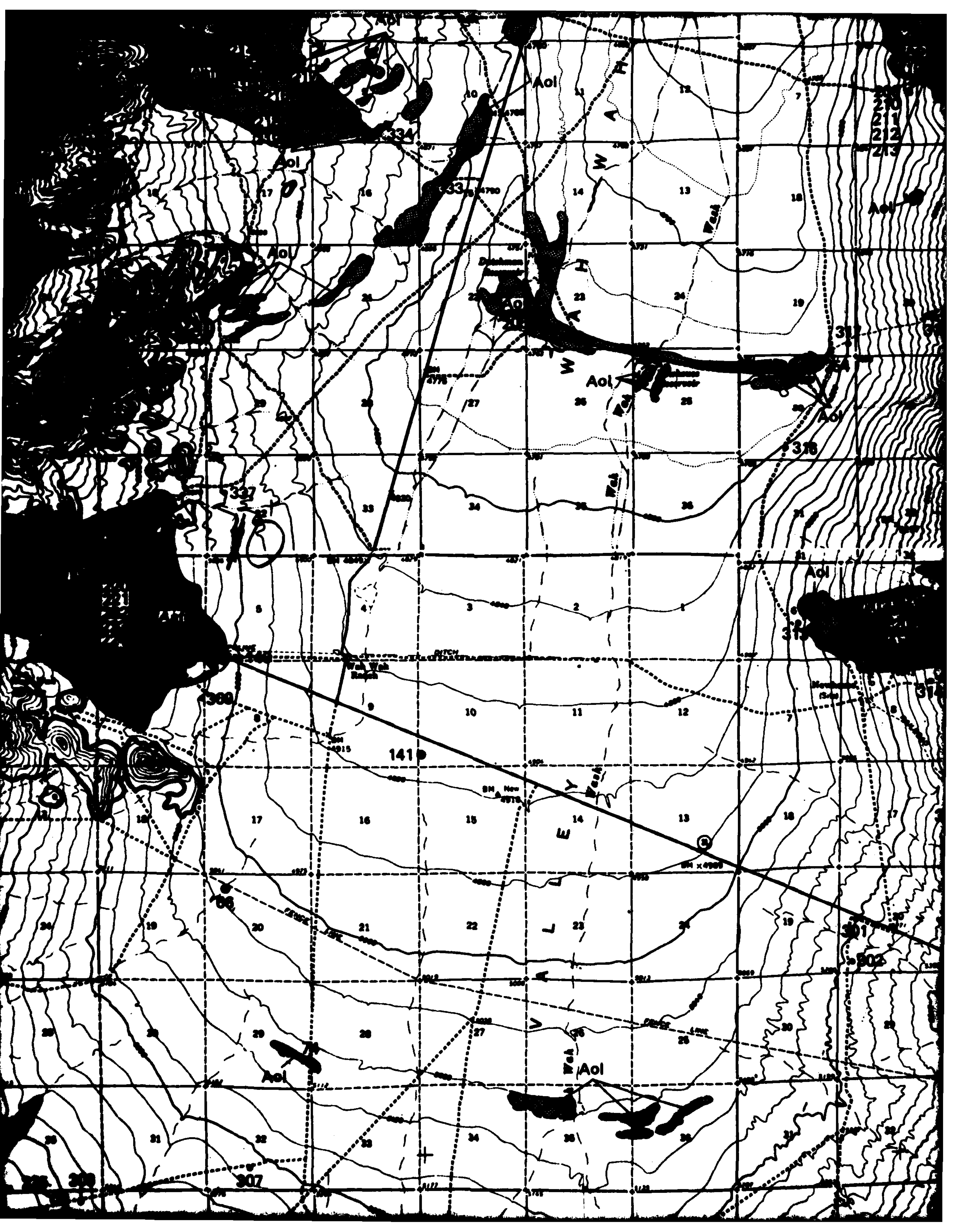
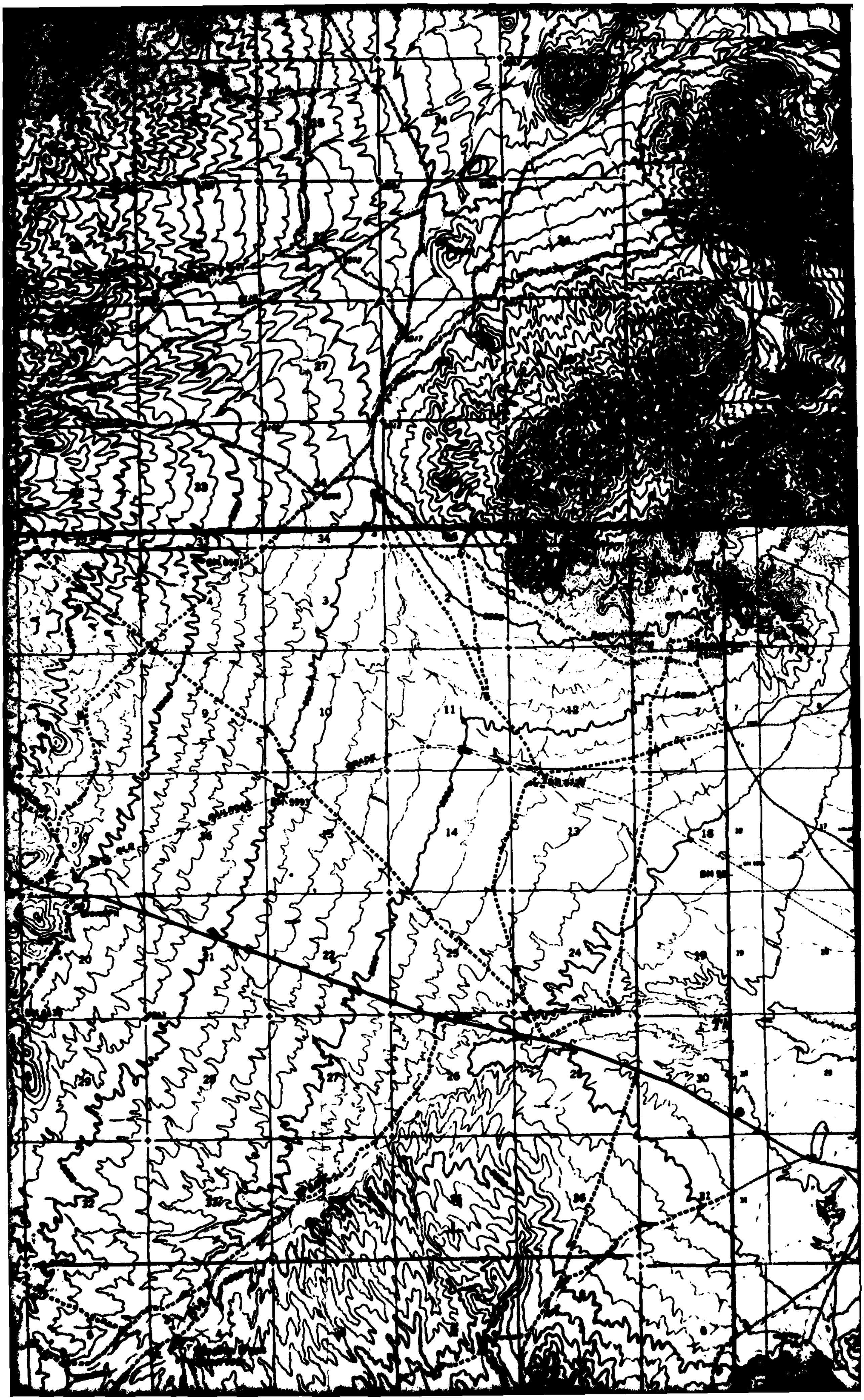
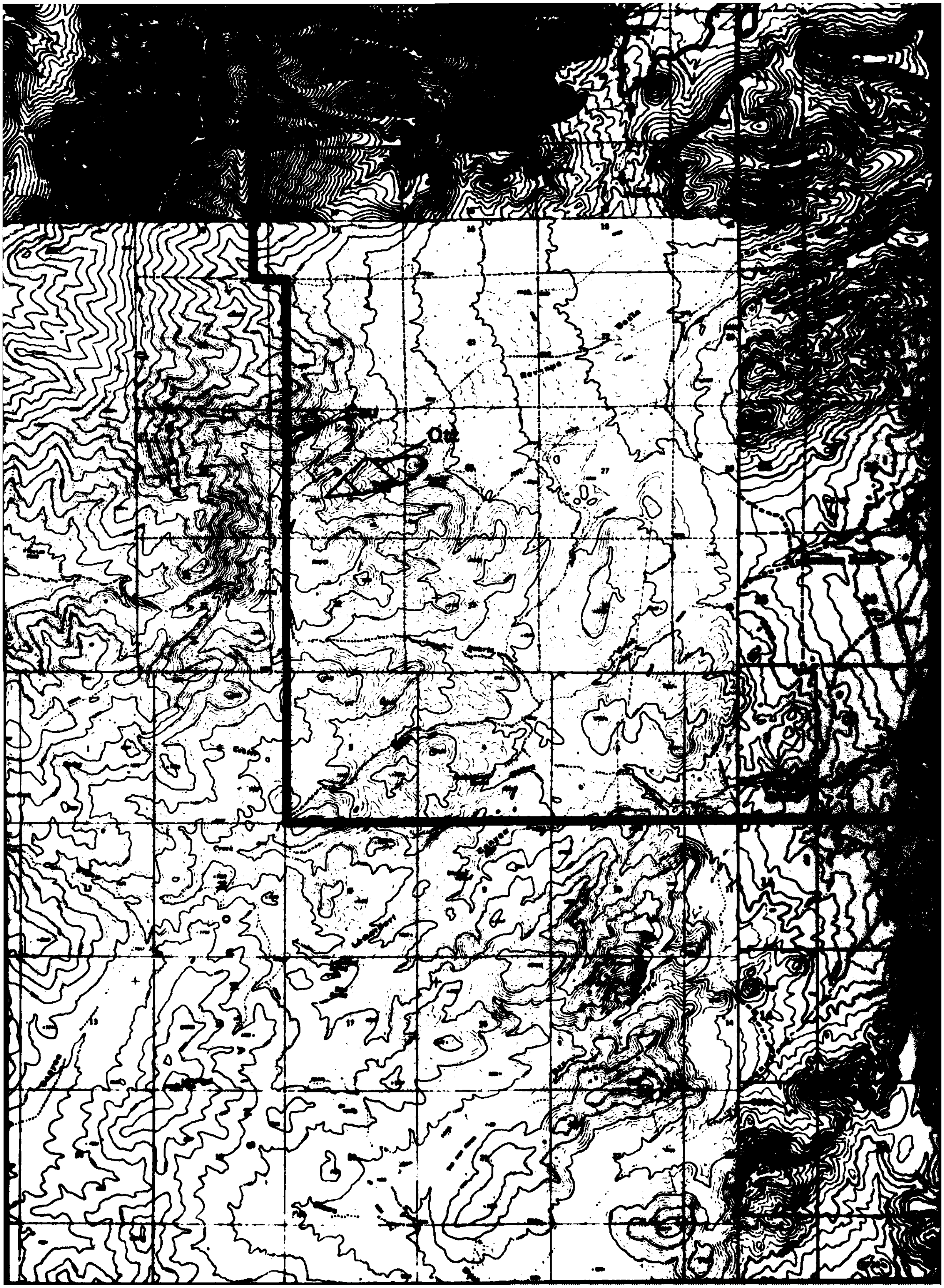
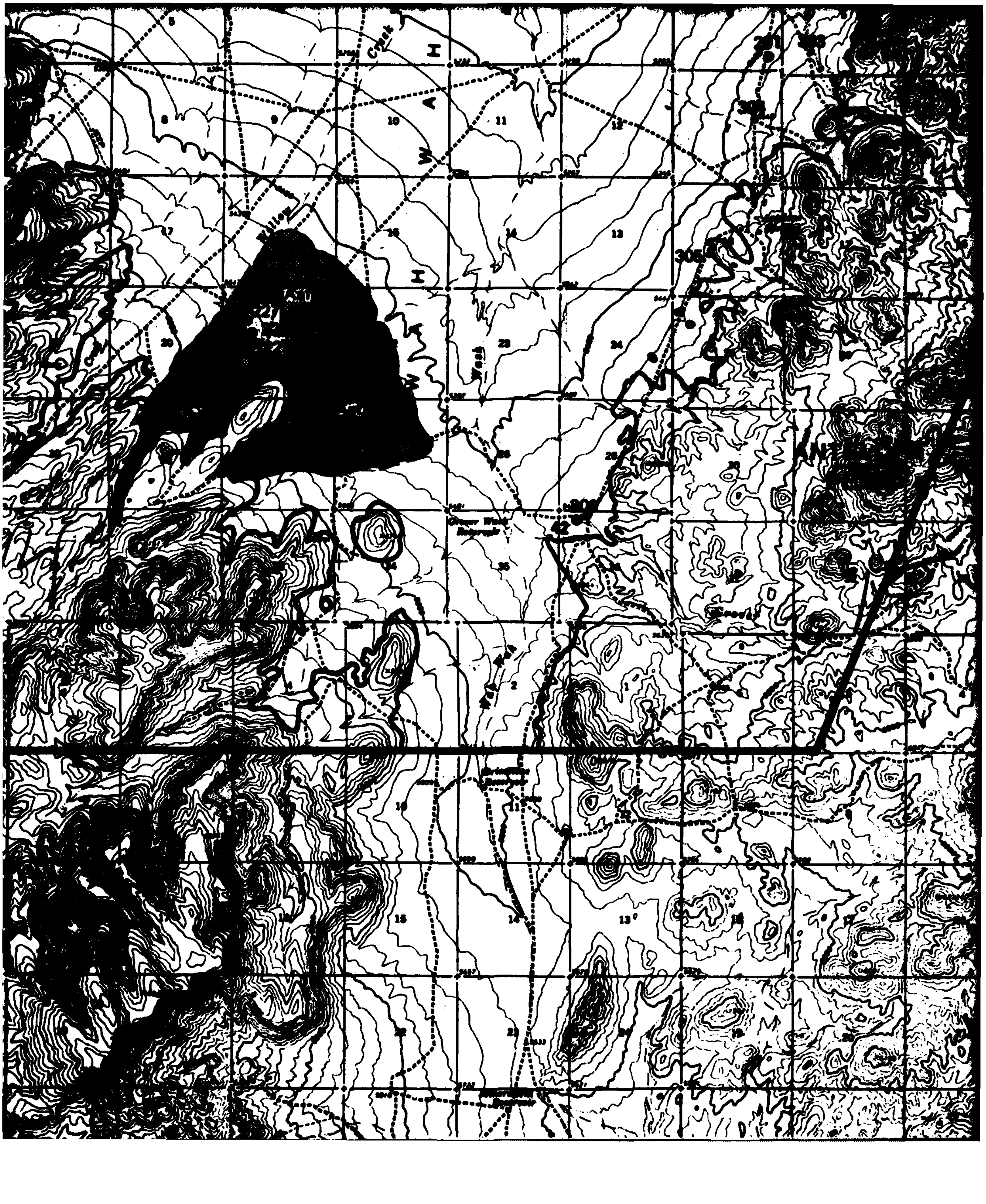


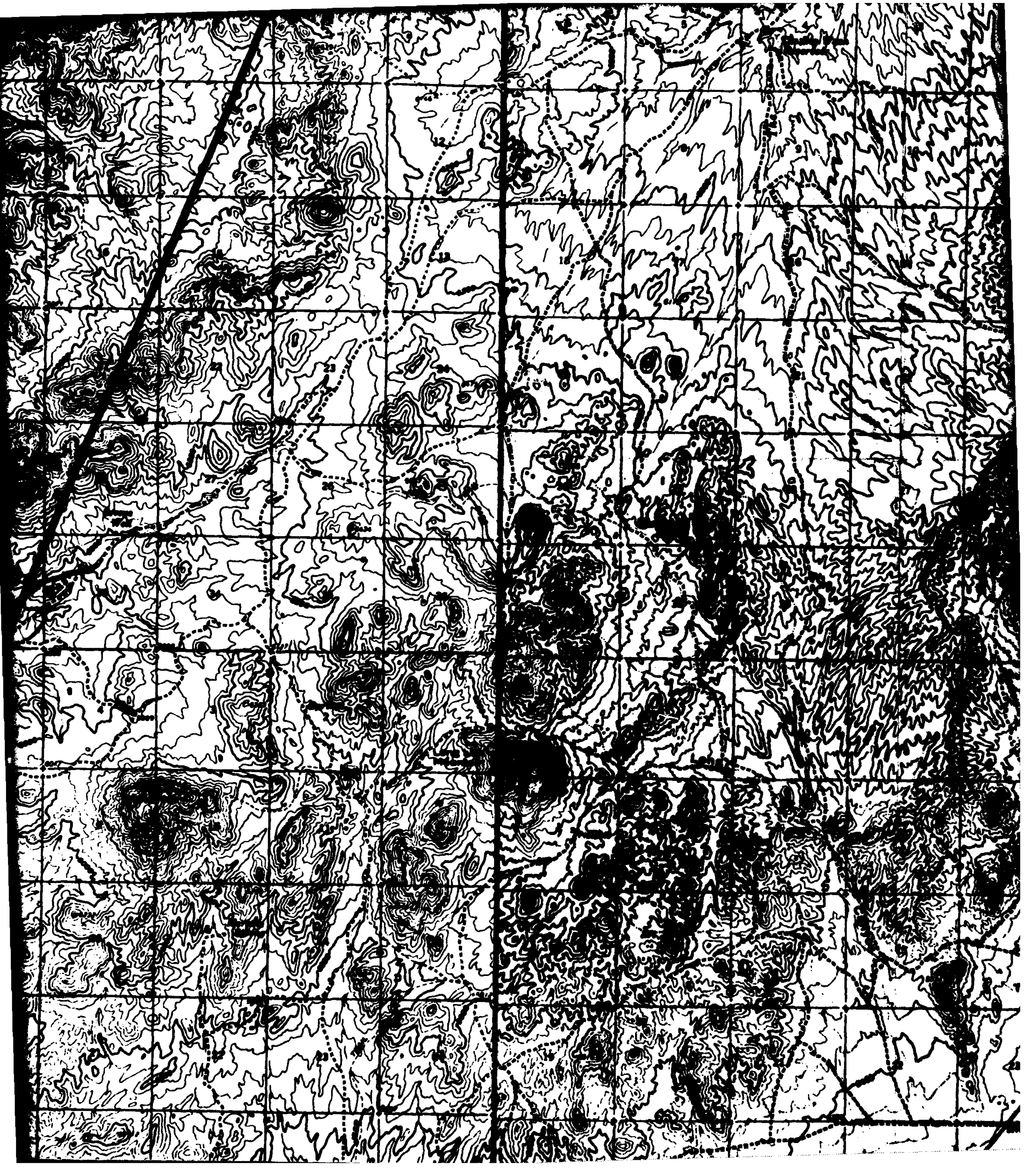

Pierson
12
Cove

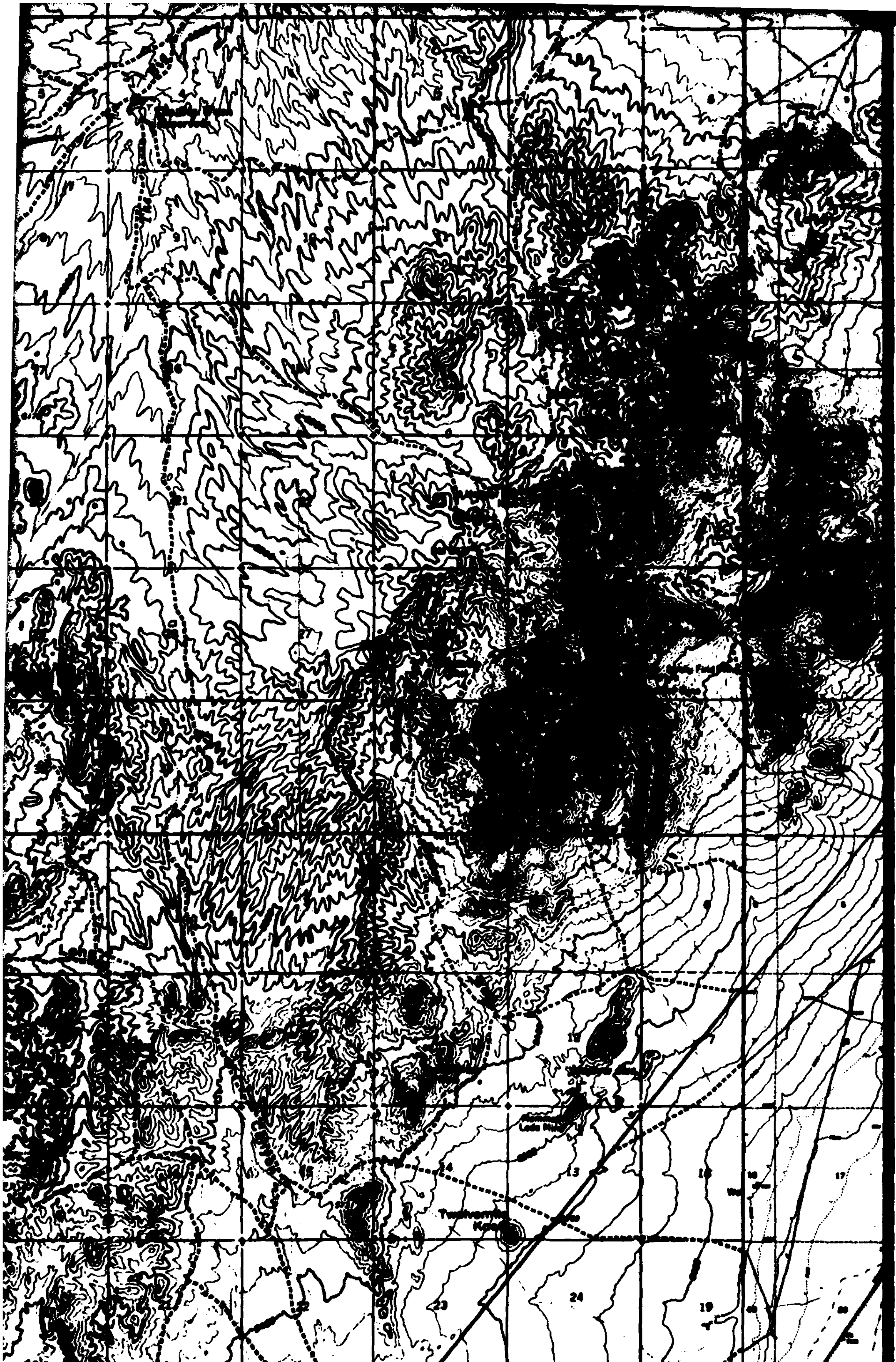

Aol
334
333
337
300
141
Wah Wah Ranch
DITCH
316
315
314
302
307
Wash






Creek
Wash





16

113°30'

17

ERTEC WESTERN AGGREGATE RESOURCES STUDY FIELD STATIONS

VALLEY–SPECIFIC AGGREGATE RESOURCES STUDY *
(MAP NUMBERS FROM 1 TO 199)

BASIN–FILL UNITS (COARSE AND/OR FINE AGGREGATES)

DATA STOP, SAMPLED AND TESTED

ROCK UNITS (CRUSHED–ROCK AGGREGATES)

▲ DATA STOP, SAMPLED AND TESTED

DETAILED AGGREGATE RESOURCES STUDY**
(MAP NUMBERS FROM 200 TO 299 FOR BASIN–FILL AND ROCK SAMPLE LOCATIONS; 300 TO 399 FOR FIELD PETROGRAPHIC STATIONS)

BASIN–FILL UNITS (COARSE AND/OR FINE AGGREGATES)

● DATA STOP, SAMPLED AND TESTED

○ DATA STOP

ROCK UNITS (CRUSHED–ROCK AGGREGATES)

▲ DATA STOP, SAMPLED AND TESTED

PETROGRAPHIC FIELD STATIONS

• DATA STOP

*SEE PINE VALLEY, WAH WAH VALLEY VSARS REPORT (FN-TR-37-d) FOR DETAILED INFORMATION.

**SEE CORRESPONDING MAP NUMBER IN APPENDICES A AND B FOR DETAILED INFORMATION.

30

EXPLANAT

ATIONS

AGGREGATE CLASSIFICATION SYSTEM

GREGATES)

BASIN–FILL AND ROCK SOURCES***

18

Class	Source	Description
CA1	BASIN FILL / ROCK	BASIN–FILL OR ROCK SOURCES CONTAINING AGGREGATES THAT PRODUCED TRIAL MIX CONCRETE WITH 28-DAY COMPRESSIVE STRENGTHS EQUAL TO OR GREATER THAN 6500 PSI.
CA2	BASIN FILL / ROCK	BASIN–FILL OR ROCK SOURCES CONTAINING AGGREGATES THAT PRODUCED TRIAL MIX CONCRETE WITH 28-DAY COMPRESSIVE STRENGTHS LESS THAN 6500 PSI.
CB	BASIN FILL / ROCK	BASIN–FILL OR ROCK SOURCES CONTAINING AGGREGATES POTENTIALLY SUITABLE FOR USE IN CONCRETE: BASED ON ACCEPTABLE LABORATORY AGGREGATE TEST RESULTS.
CC1	BASIN FILL / ROCK	BASIN–FILL OR ROCK SOURCES CONTAINING AGGREGATES POTENTIALLY SUITABLE FOR USE IN CONCRETE; BASED ON CORRELATION WITH CLASS CA1 OR CA2 SOURCE AREAS.
CC2	BASIN FILL	BASIN–FILL SOURCES CONTAINING AGGREGATES POTENTIALLY SUITABLE FOR USE IN CONCRETE; BASED ON CORRELATION WITH CLASS CB SOURCE AREAS.
		BASIN–FILL SOURCES CONTAINING FINE AGGREGAT[ES] USED WITH CRUSHED ROCK SAMPLES FOR CERTAIN CONCRETE TRIAL MIXES.
		UNSUITABLE SOURCES OF BASIN–FILL MATERIALS THAT MAY LOCALLY CONTAIN POTENTIALLY SUITABLE SOURCES OF AGGREGATES OF LIMITED EXTENT. UNTESTED SOURCES OF ROCK MATERIALS THAT MAY CONTAIN POTENTIALLY SUITABLE CRUSHED-ROCK AGGREGATES (SEE TEXT FOR ADDITIONAL INFORMATION).

FILL

BREGATES)

B

*** A COMPLETE CLASSIFICATION SYSTEM IS SHOWN, ALTHOUGH ALL BASIN–FILL OR ROCK SOURCES MAY NOT BE PRESENT WITHIN THE STUDY AREA.

113° 15'

TION

GEOLOGIC UNITS[†]

19

BASIN–FILL UNITS

Aaf	ALLUVIAL FAN DEPOSITS	(A5)
Aol	OLDER LACUSTRINE DEPOSITS	(A4o)

ROCK UNITS

Vb	BASALT (EXTRUSIVE; BASIC)	(I3)
Gr	GRANITIC ROCKS (INTRUSIVE; UNDIFFERENTIATED)	(I1)
Qtz	QUARTZITE	(M4 AND/OR S1)
Ls	LIMESTONE	(S2)
Cau	CARBONATE ROCKS UNDIFFERENTIATED	(S2)

[†] SEE APPENDIX TABLE F-3, FOR SYMBOL EXPLANATION AND COMPARISON.

ATES
IN

SYMBOLS[††]

STUDY AREA BOUNDARY

ROCK/BASIN–FILL CONTACT

GEOLOGIC ROCK CONTACT

BASIN–FILL CONTACT

LS
T-
ENT.
MAY
K
MA-

[††] GEOLOGIC ROCK AND BASIN–FILL CONTACTS ARE APPROXIMATELY LOCATED AND MAY VARY LOCALLY.

NORTH

SCALE 1:62,500

0 1 2

(A5)

(A4o)

(I3)

FERENTIATED) (I1)

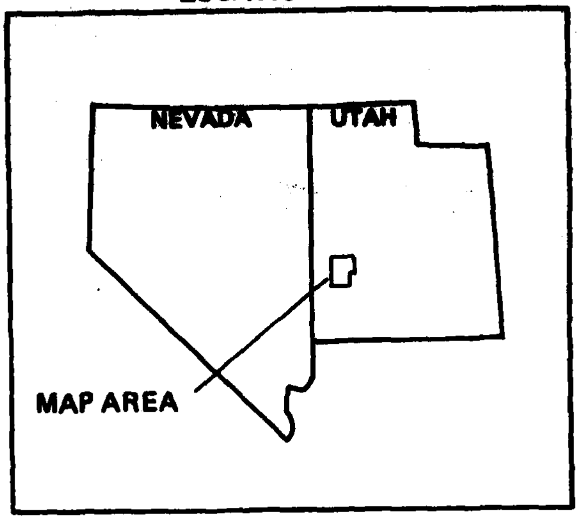
(M4 AND/OR S1)

(S2)

ATED (S2)

D COMPARISON.

LOCATION MAP



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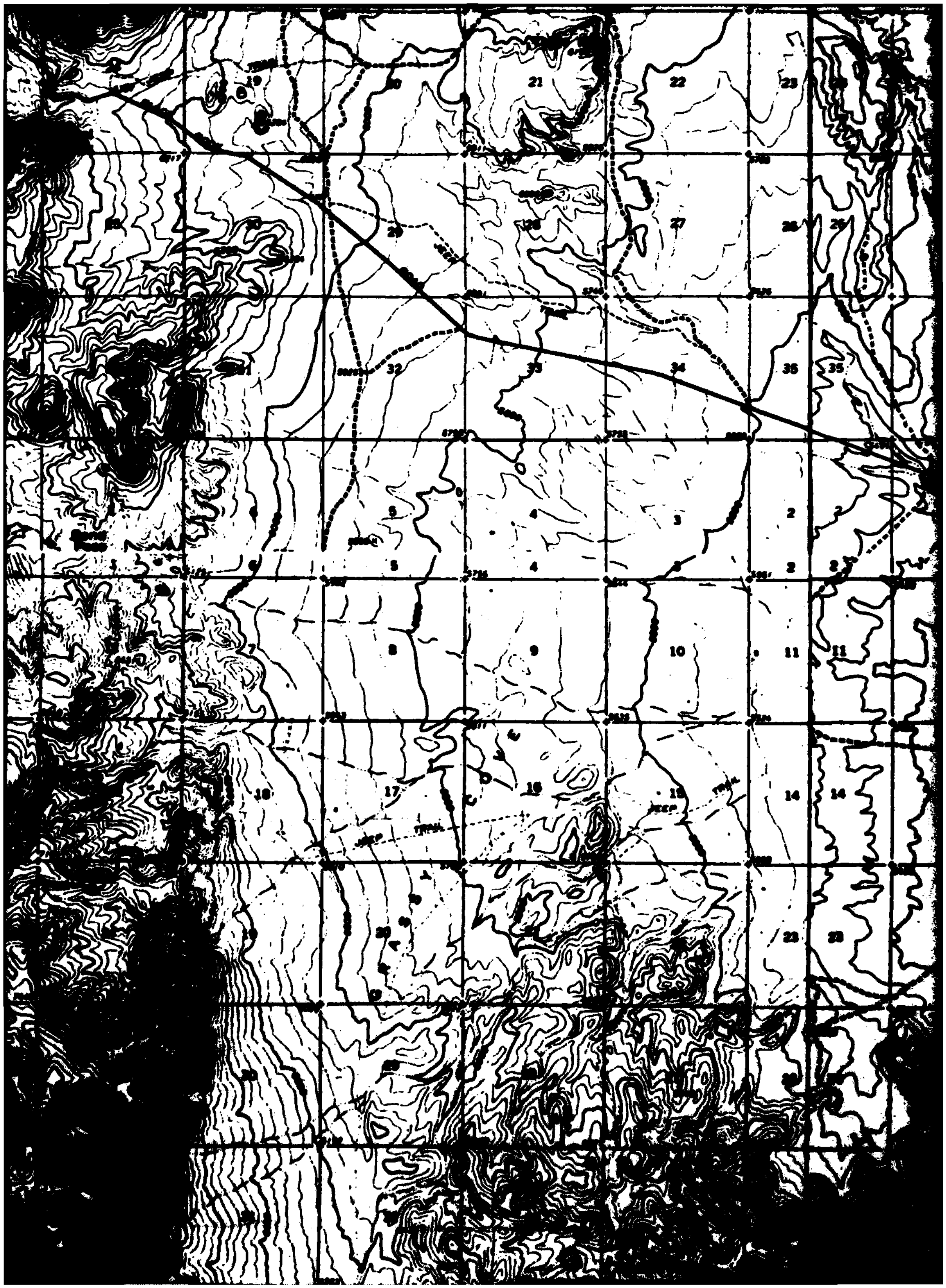
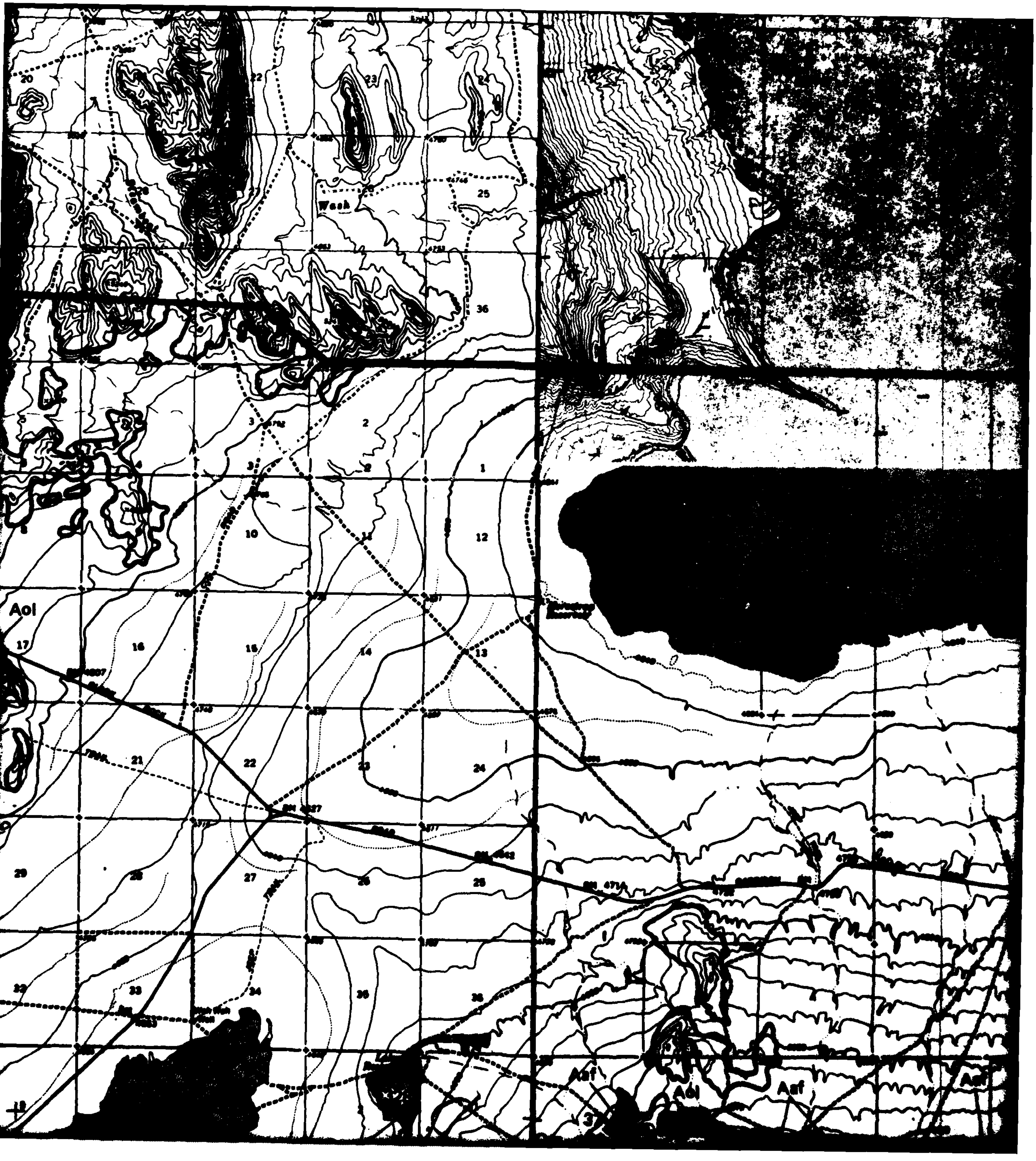
CONCRETE AGGREGATE RES
DETAILED AGGREGATE RES
WAH WAH VALLEY,

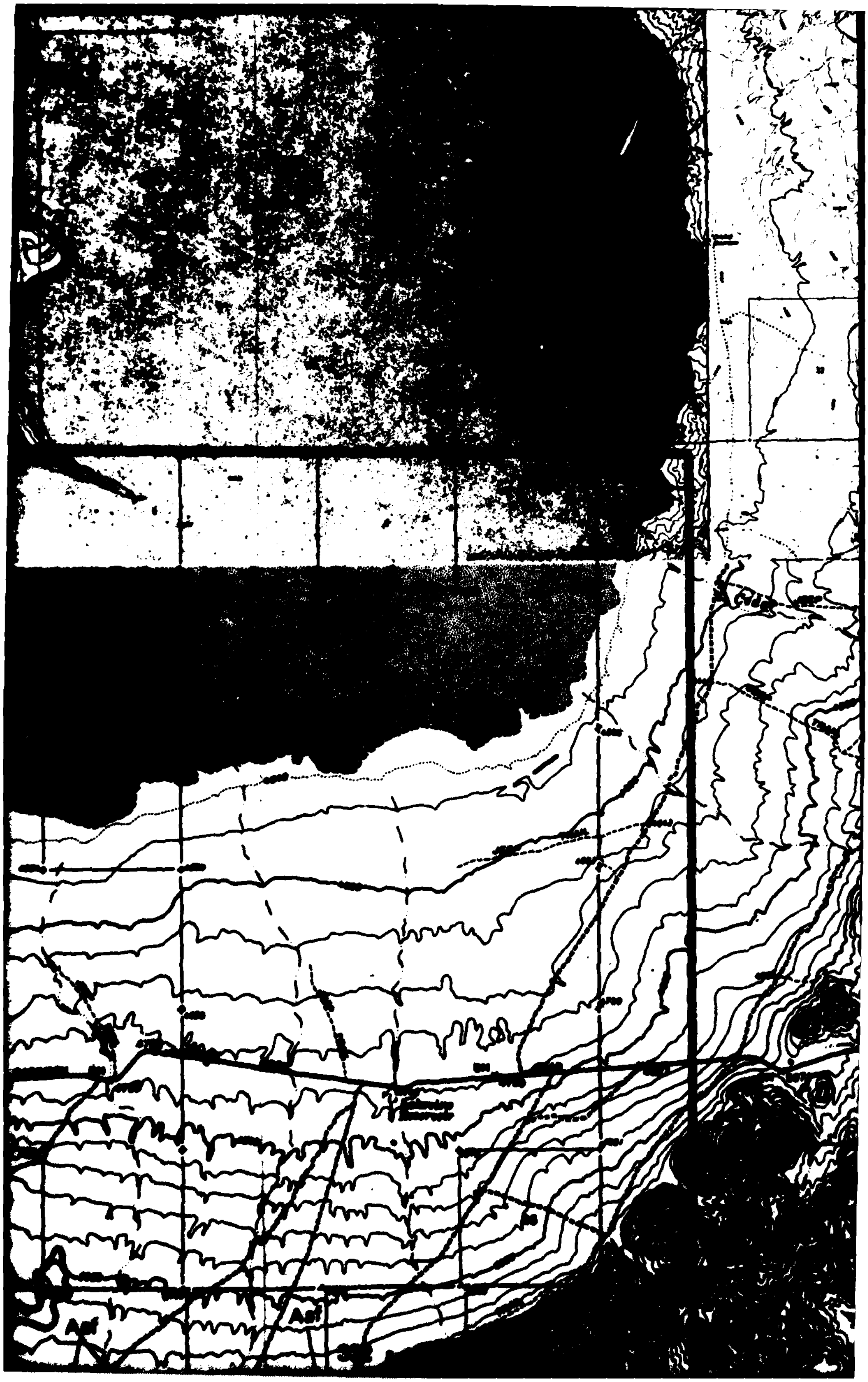
12 JUN 81


JEEP TRAIL


Aaf
Aol
341
340
Aol



Wash
Aol
Aaf

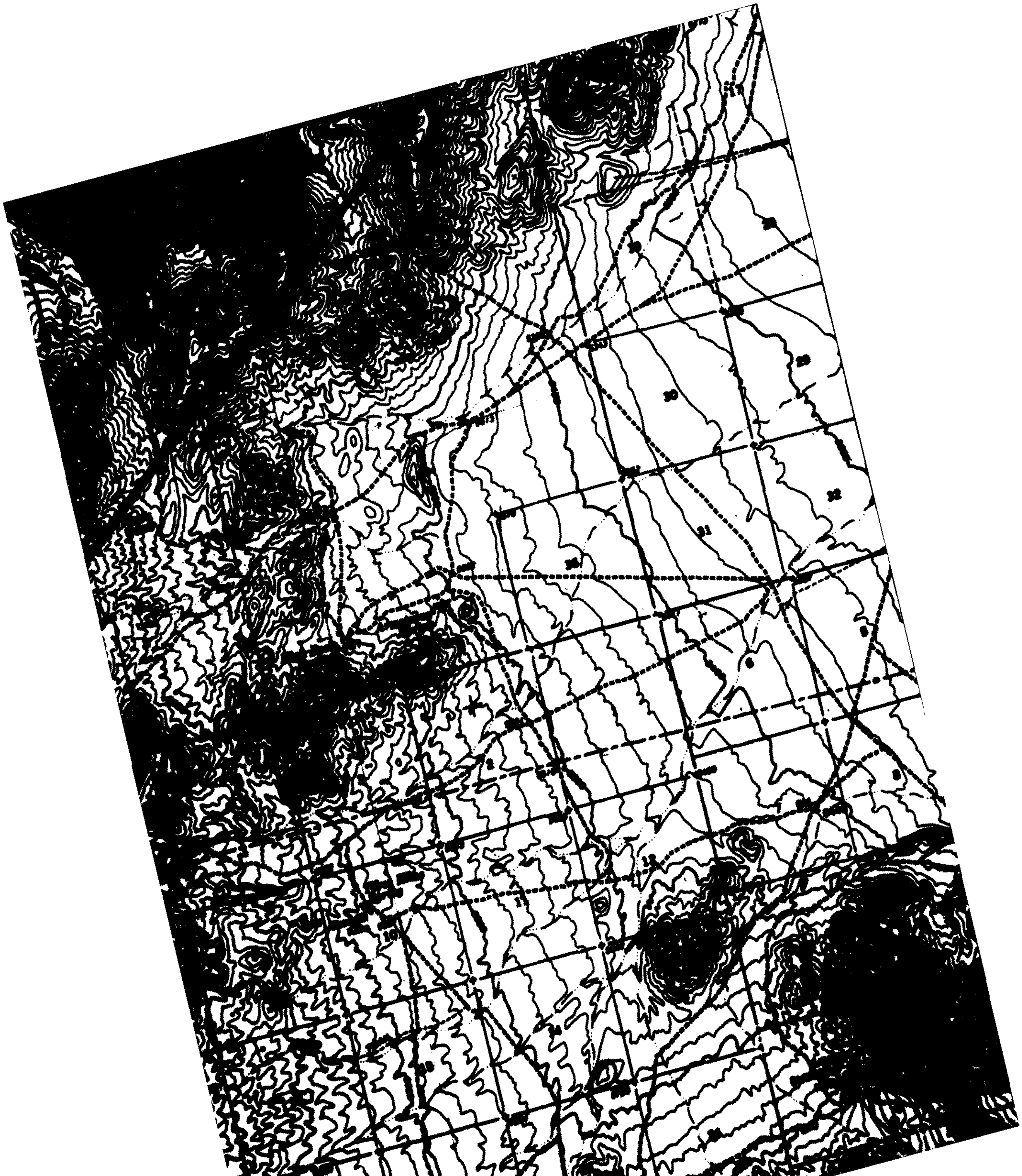


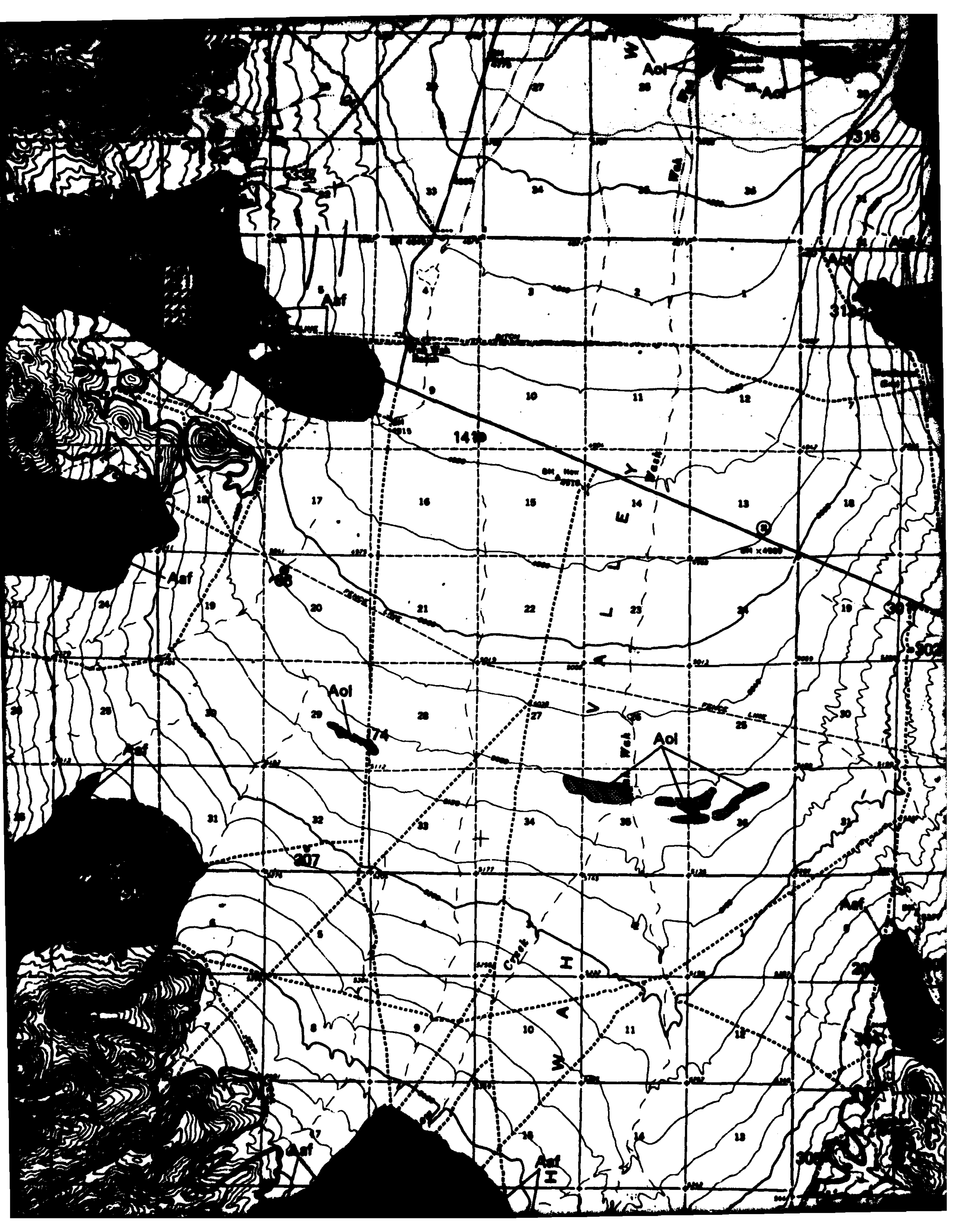
5

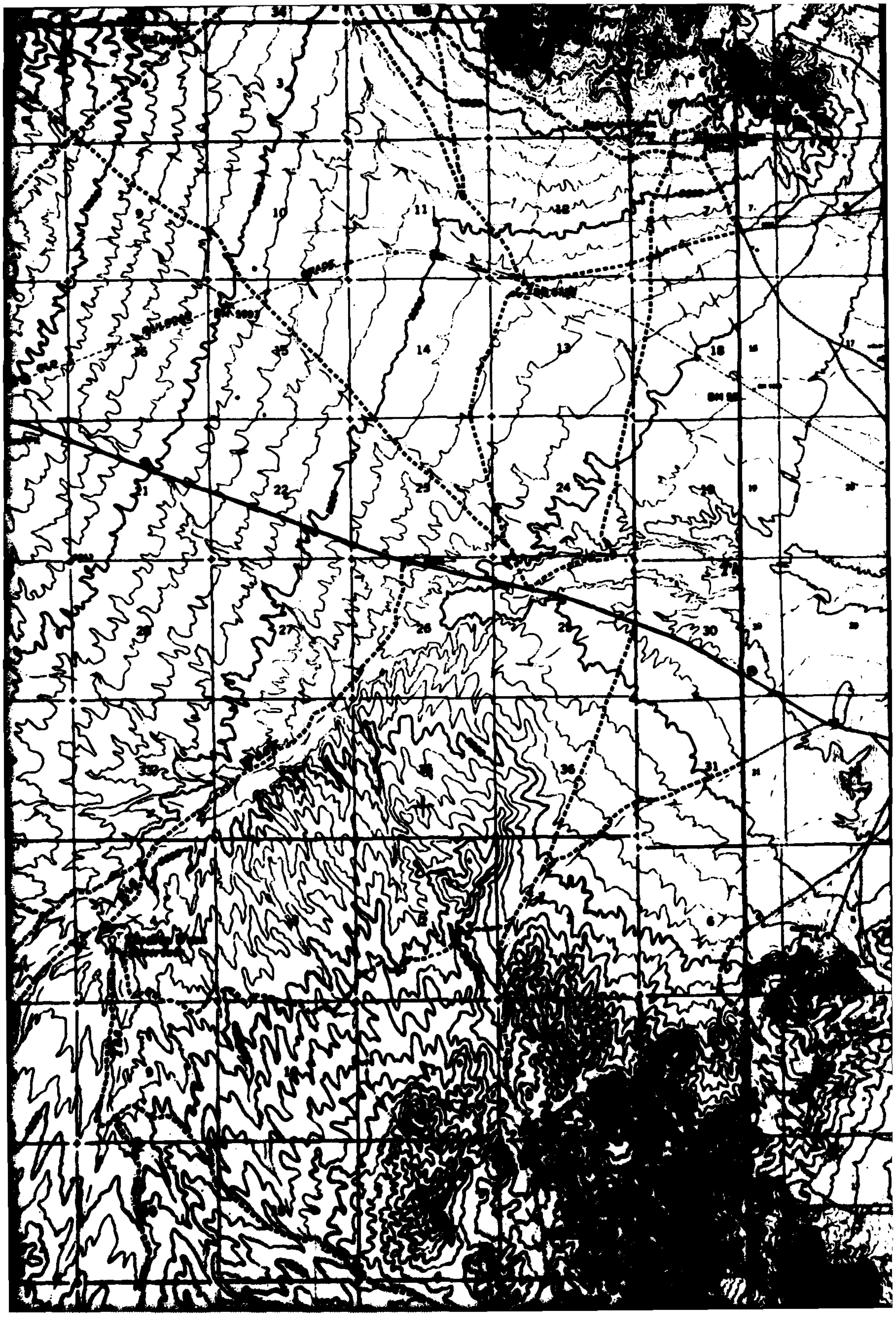
Aol
Aaf
Ls
VALLEY

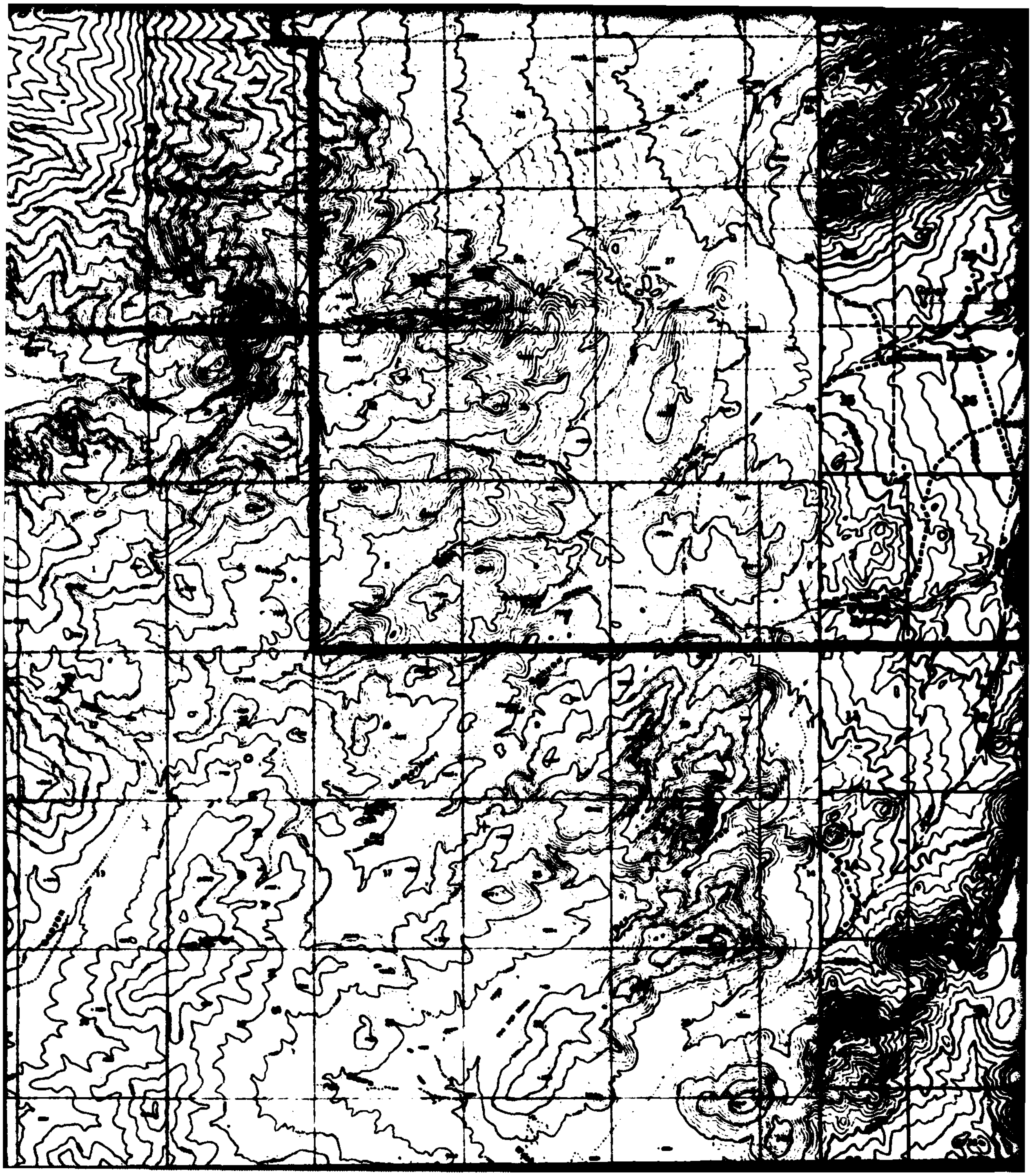
113° 30'

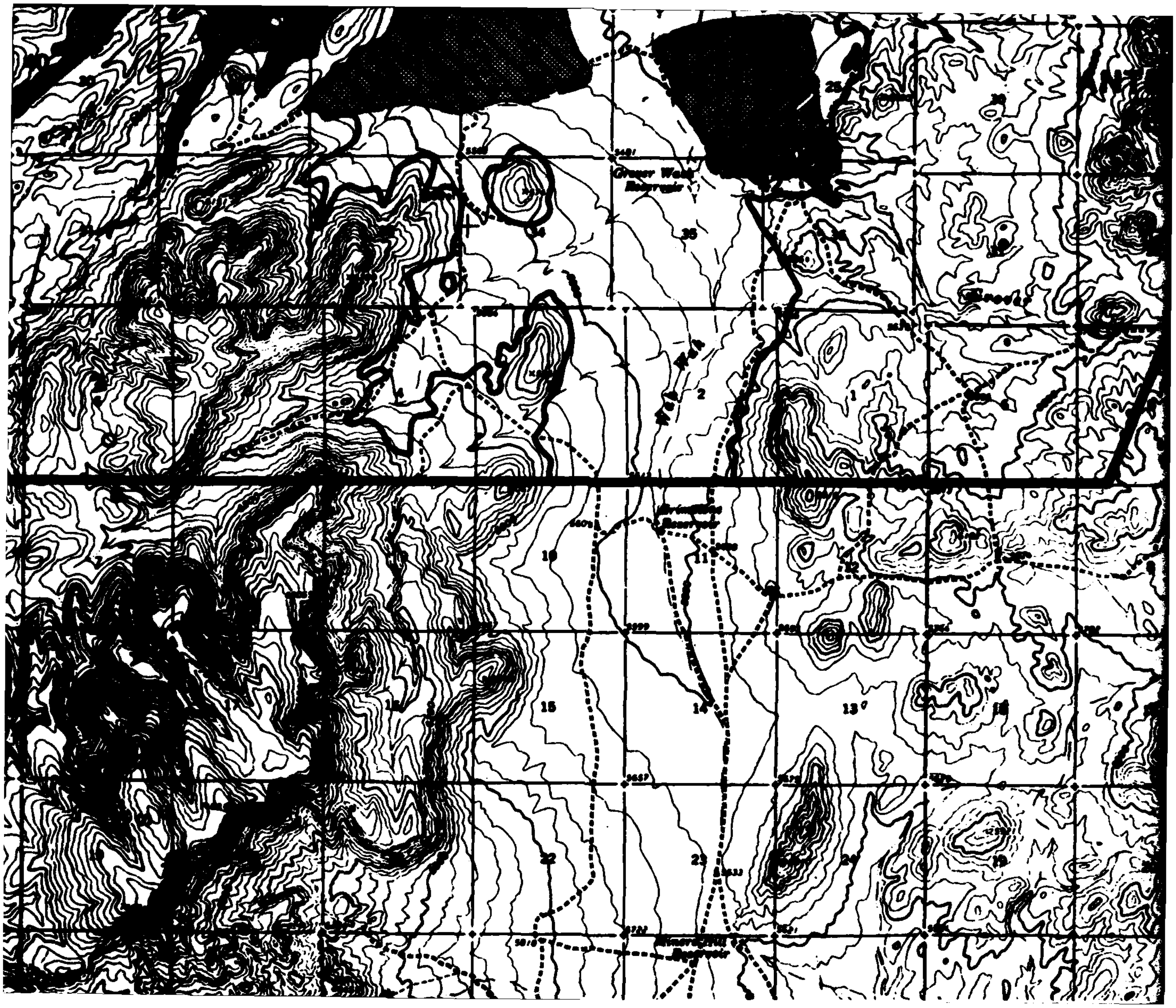
Aol
Aaf
Aol
Aaf
Aol
Aaf
Aaf
Aaf
Aaf
Aaf
Aol
Aaf
Qtz
37
86
32

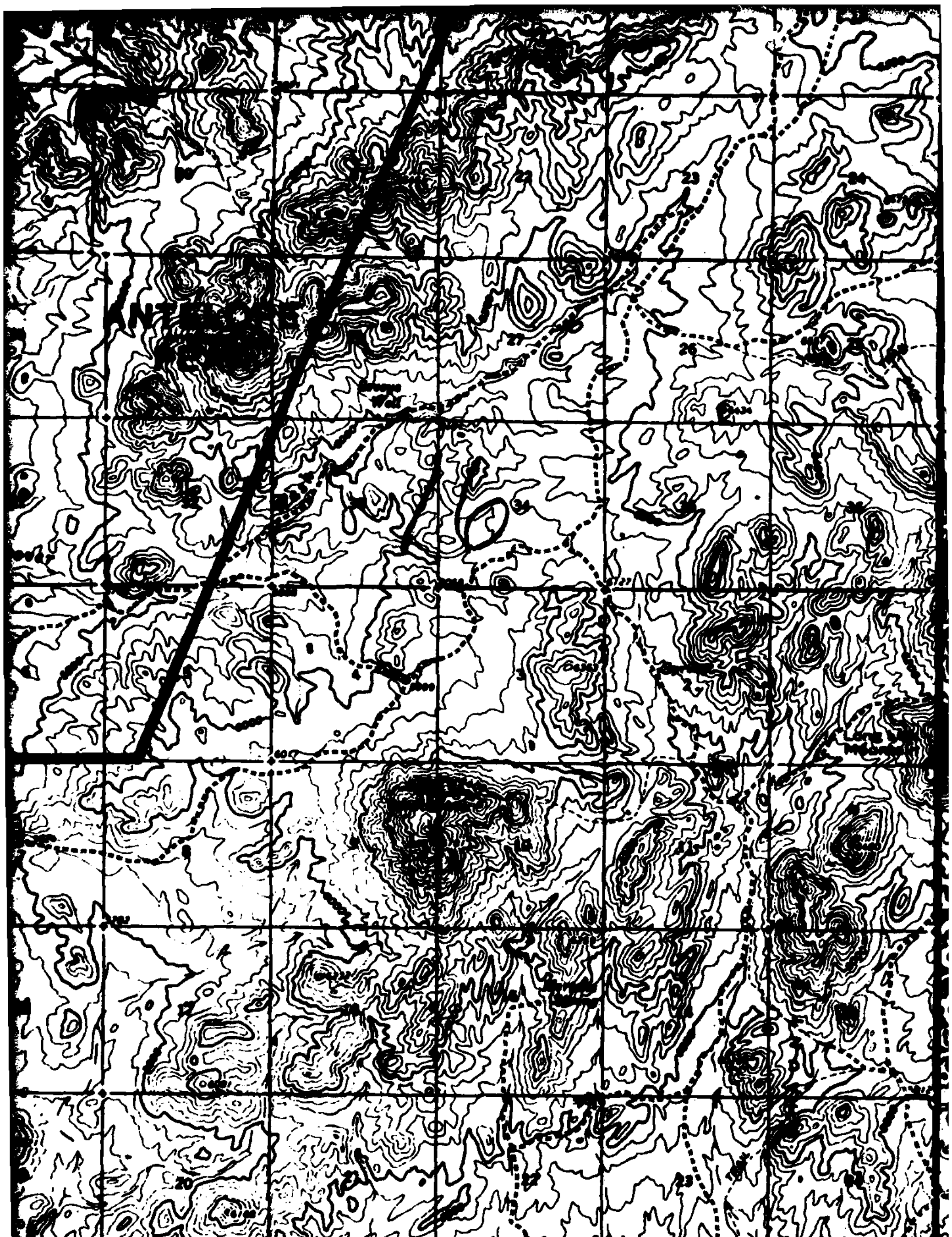


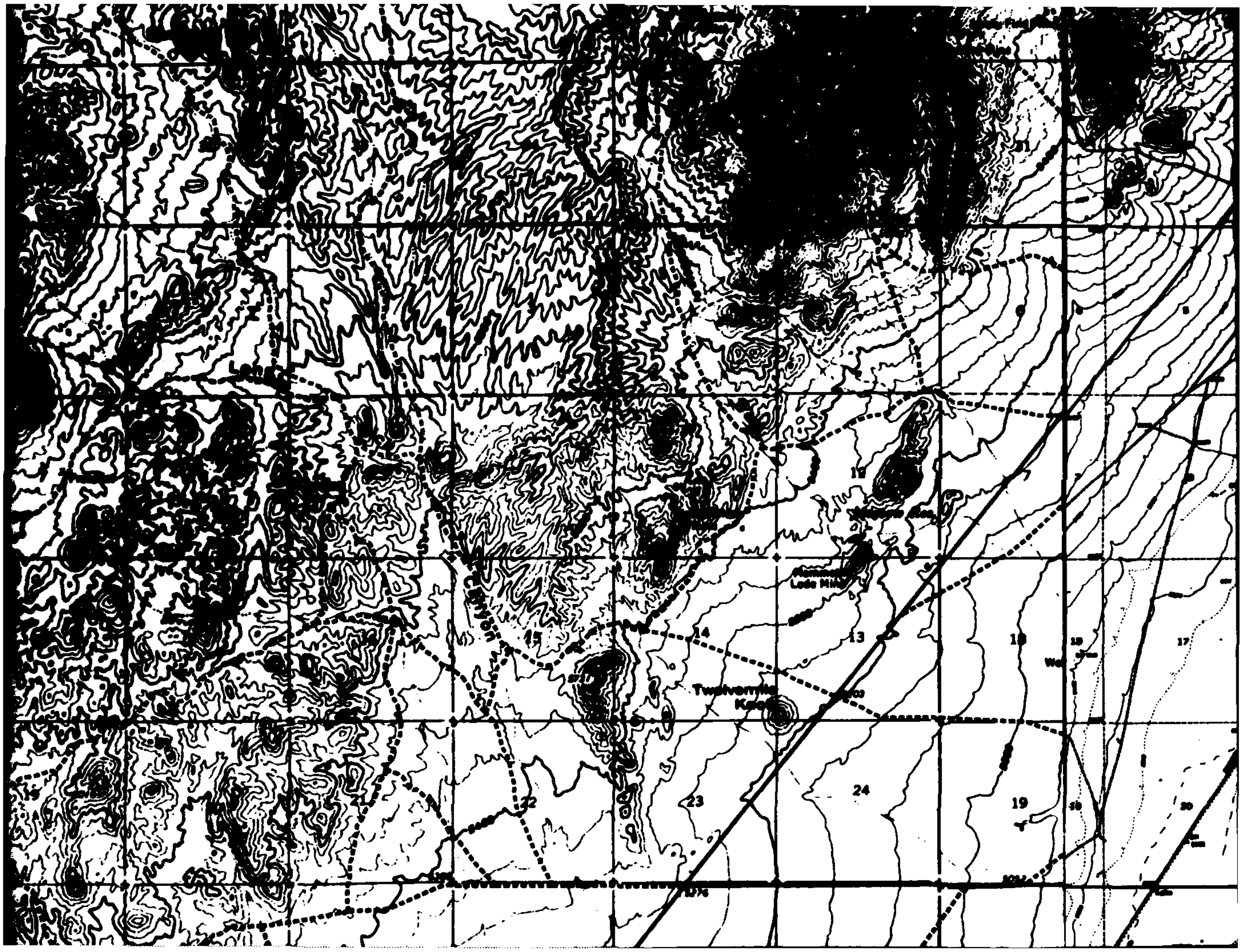

Aol
Aaf
174
307
Wash
Creek
VALLEY







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ERTEC WESTERN AGGREGATE RESOURCES STUDY FIELD STATIONS

VALLEY–SPECIFIC AGGREGATE RESOURCES STUDY*
(MAP NUMBERS FROM 1 TO 199)

BASIN–FILL UNITS (COARSE AND/OR FINE AGGREGATES)

● DATA STOP, SAMPLED AND TESTED

ROCK UNITS (CRUSHED–ROCK AGGREGATES)

▲ DATA STOP, SAMPLED AND TESTED

DETAILED AGGREGATE RESOURCES STUDY**
(MAP NUMBERS FROM 200 TO 299 FOR BASIN–FILL AND ROCK SAMPLE LOCATIONS; 300 TO 399 FOR FIELD PETROGRAPHIC STATIONS)

BASIN–FILL UNITS (COARSE AND/OR FINE AGGREGATES)

● DATA STOP, SAMPLED AND TESTED

○ DATA STOP

ROCK UNITS (CRUSHED–ROCK AGGREGATES)

▲ DATA STOP, SAMPLED AND TESTED

PETROGRAPHIC FIELD STATIONS

• DATA STOP

* SEE PINE VALLEY, WAH WAH VALLEY VSARS REPORT (FN-TR-37-g) FOR DETAILED INFORMATION.

** SEE CORRESPONDING MAP NUMBER IN APPENDICES A AND B FOR DETAILED INFORMATION.

AGGREGATE CLASSIFICATION SYSTEM

BASIN—FILL AND ROCK SOURCES

RBIa	BASIN FILL ROCK	BASIN—FILL OR ROCK SOURCES CONTAINING MATERIALS SUITABLE FOR USE AS ROAD-BASE AGGREGATES; BASED ON ACCEPTABLE LABORATORY AGGREGATE TEST RESULTS.
RBIb	BASIN FILL	BASIN—FILL SOURCES CONTAINING MATERIALS SUITABLE FOR USE AS ROAD-BASE AGGREGATES; BASED ON CORRELATIONS WITH CLASS RBIa SOURCE AREAS.
RBII	BASIN FILL	POTENTIAL BASIN—FILL SOURCES OF MATERIALS SUITABLE FOR USE AS ROAD-BASE AGGREGATES; BASED ON PHOTOGEOLOGIC INTERPRETATIONS, FIELD OBSERVATIONS, AND LIMITED OR INCONCLUSIVE SIEVE ANALYSIS AND/OR ABRASION DATA.
		UNSUITABLE SOURCES OF BASIN—FILL MATERIALS THAT MAY LOCALLY CONTAIN POTENTIALLY SUITABLE SOURCES OF AGGREGATES OF LIMITED EXTENT. UNTESTED SOURCES OF ROCK MATERIALS THAT MAY CONTAIN POTENTIALLY SUITABLE CRUSHED-ROCK AGGREGATES (SEE TEXT FOR ADDITIONAL INFORMATION).

NING
-BASE AGGRE-
TORY AGGRE-

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ERIALS
EGATES;
RBIs SOURCE

ATERIALS
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ATIONS, FIELD
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MATERIALS
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GEOLOGIC UNITS

BASIN–FILL UNITS†

Aaf	ALLUVIAL FAN DEPOSITS	(A5)
Aol	OLDER LACUSTRINE DEPOSITS	(A4o)

ROCK UNITS

Vb	BASALT (EXTRUSIVE; BASIC)	(I3)
Gr	GRANITIC ROCKS (INTRUSIVE; UNDIFFERENTIATED)	(I1)
Qtz	QUARTZITE	(M4 AND
Ls	LIMESTONE	(S2)
Cau	CARBONATE ROCKS UNDIFFERENTIATED	(S2)

† SEE APPENDIX TABLE F-3 FOR SYMBOL EXPLANATION AND COMPARISON.

SYMBOLS††

▬▬▬ (heavy line)	STUDY AREA BOUNDARY
——— (solid line)	ROCK/BASIN–FILL CONTACT
—— —— (long dash)	GEOLOGIC ROCK CONTACT
---- (short dash)	BASIN–FILL CONTACT

†† GEOLOGIC ROCK AND BASIN–FILL CONTACTS ARE APPROXIMATELY LOCATED AND MAY VARY LOCALLY.

NORTH

SCALE 1:62,500

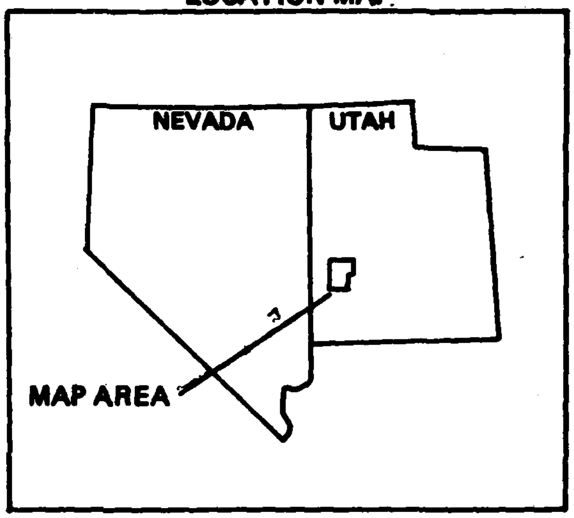
0 1 2
STATUTE MILES

0 1 2
KILOMETERS

(A5)

(A4o)

LOCATION MAP



(I3)

IFFERENTIATED) (I1)

(M4 AND/OR S1)

(S2)

IATED (S2)

AND COMPARISON.

LY.

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DEPARTMENT OF THE AIR FORCE
BMO/AFRCE-MX

ROAD-BASE AGGREGATE RESOURCES MAP
DETAILED AGGREGATE RESOURCES STUDY
WAH WAH VALLEY, UTAH

12 JUN 81

DRAWING


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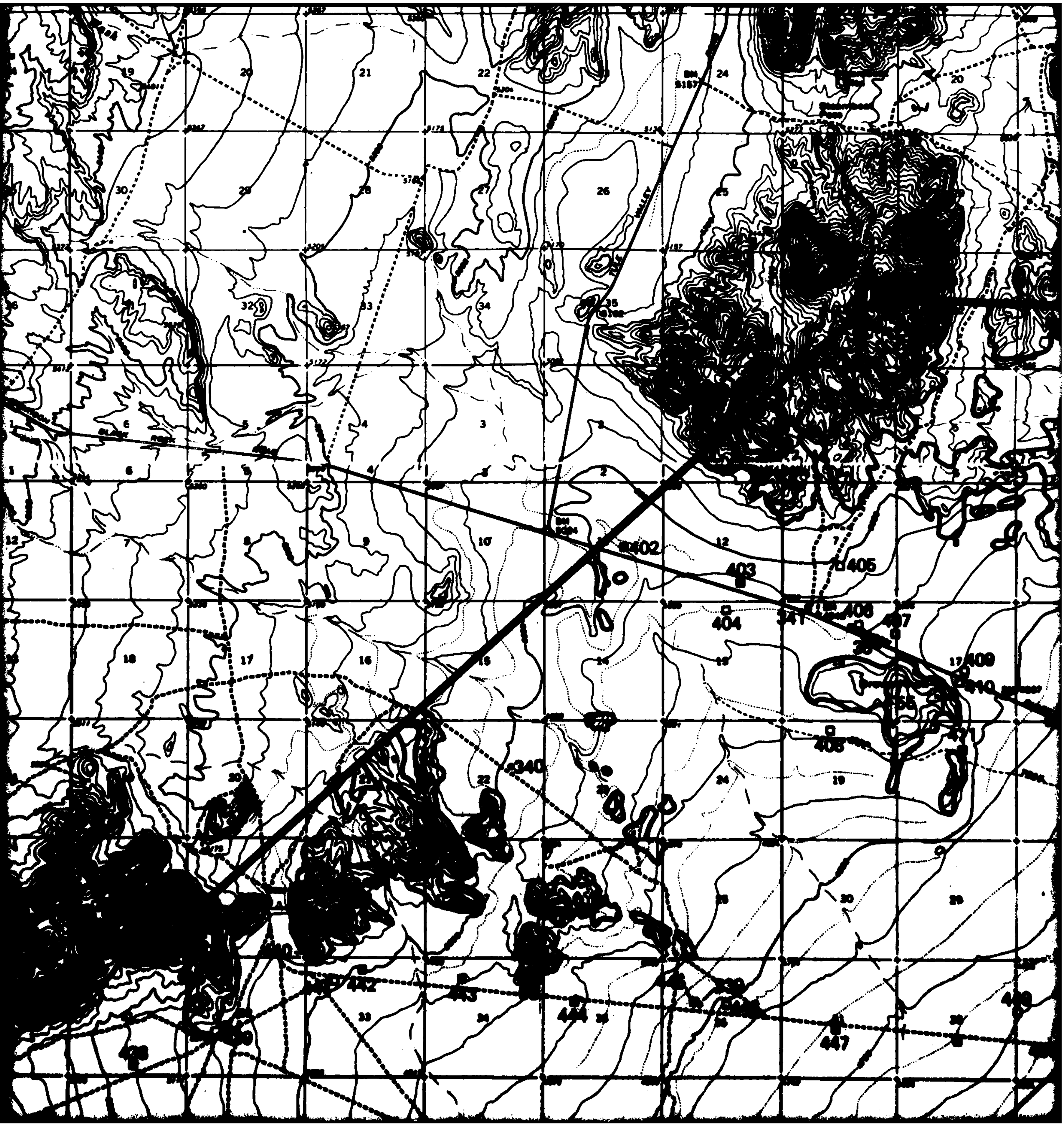
JEEP TRAIL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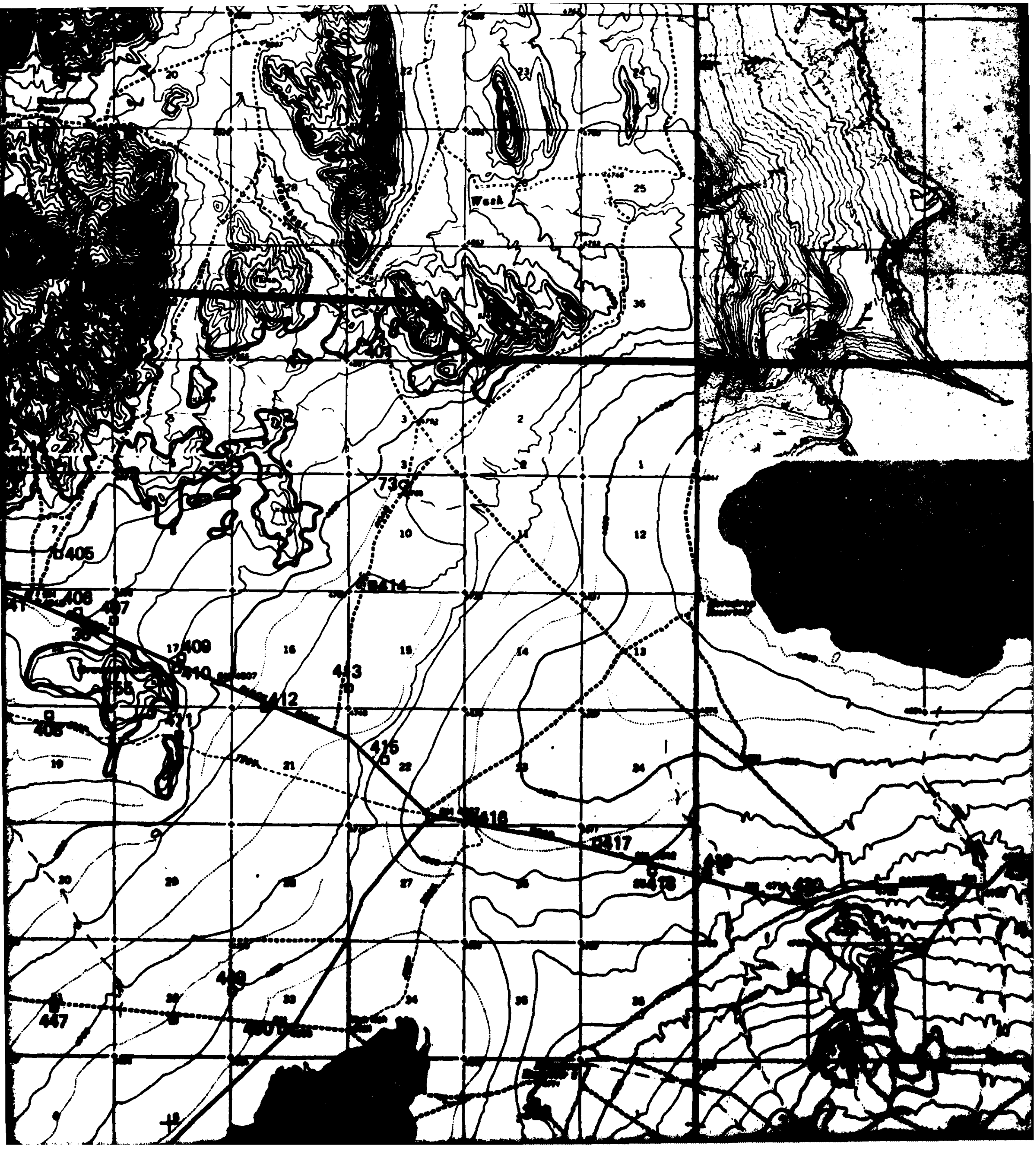
Wash
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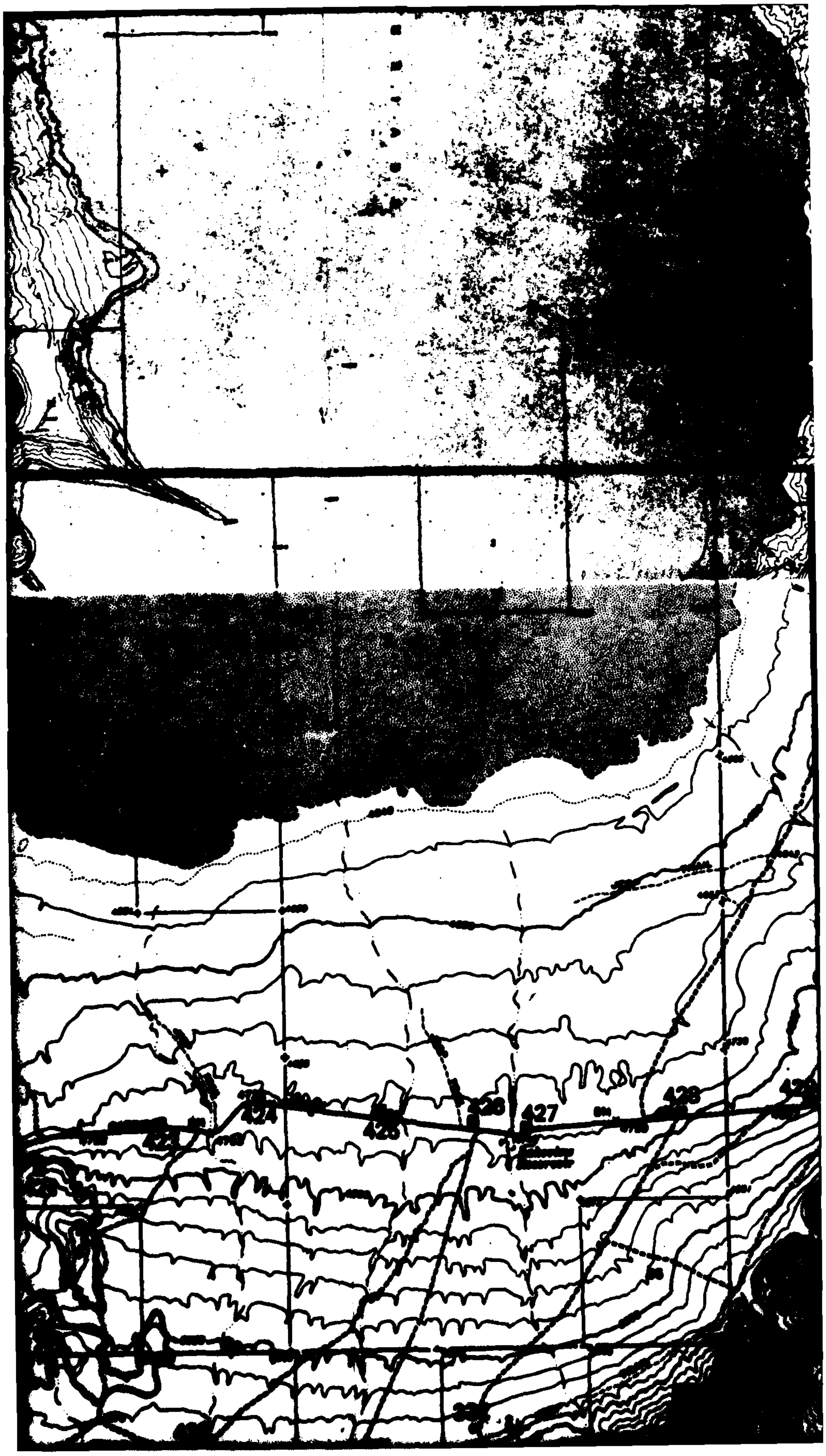

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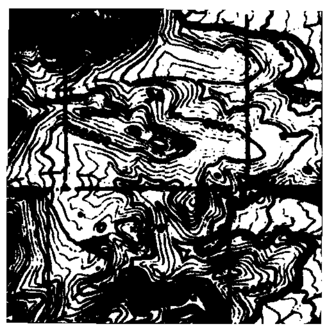

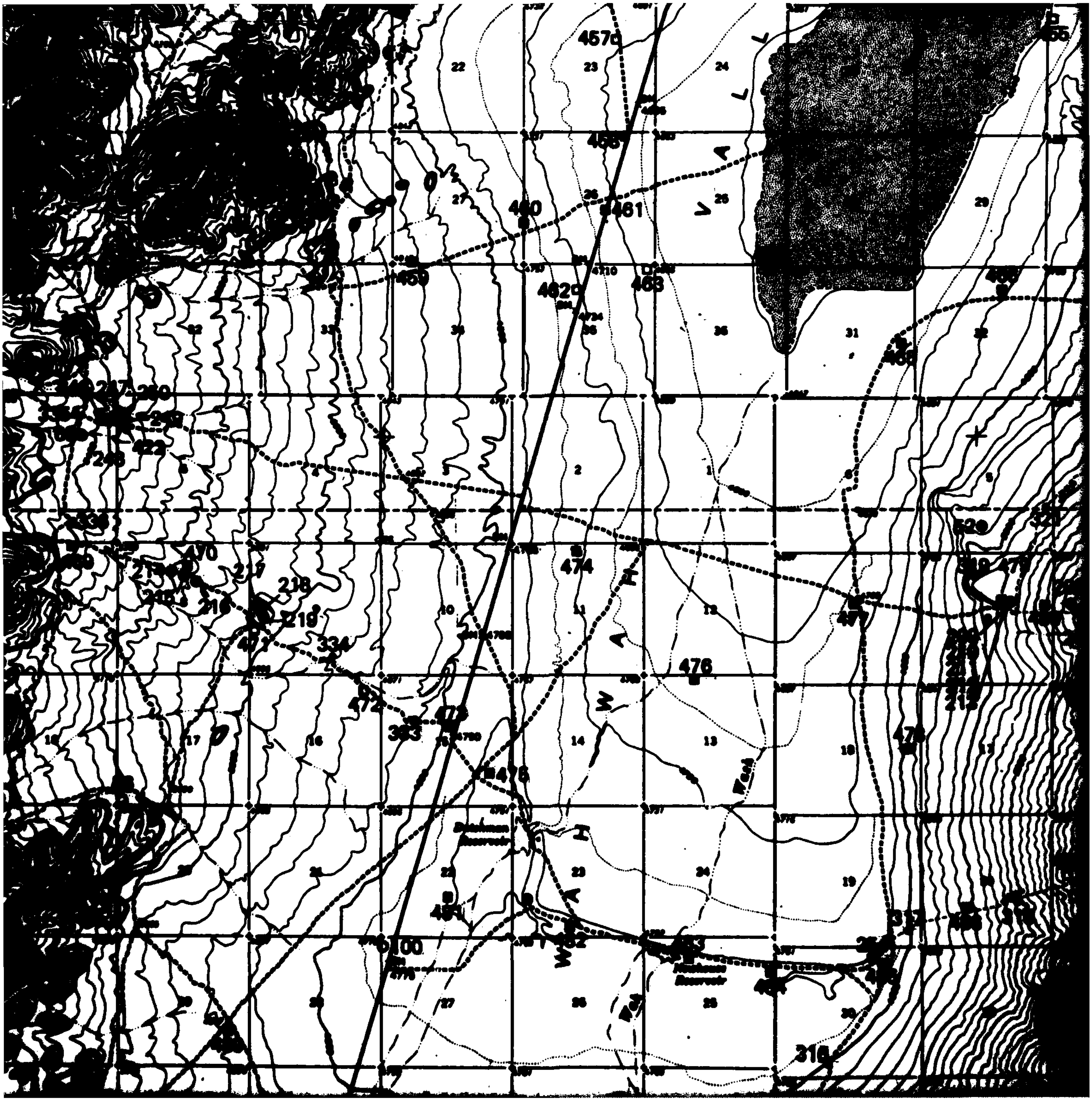

V A L L
W A H W A H
Wash
457
458
461
460
462
463
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474
476
472
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334
210
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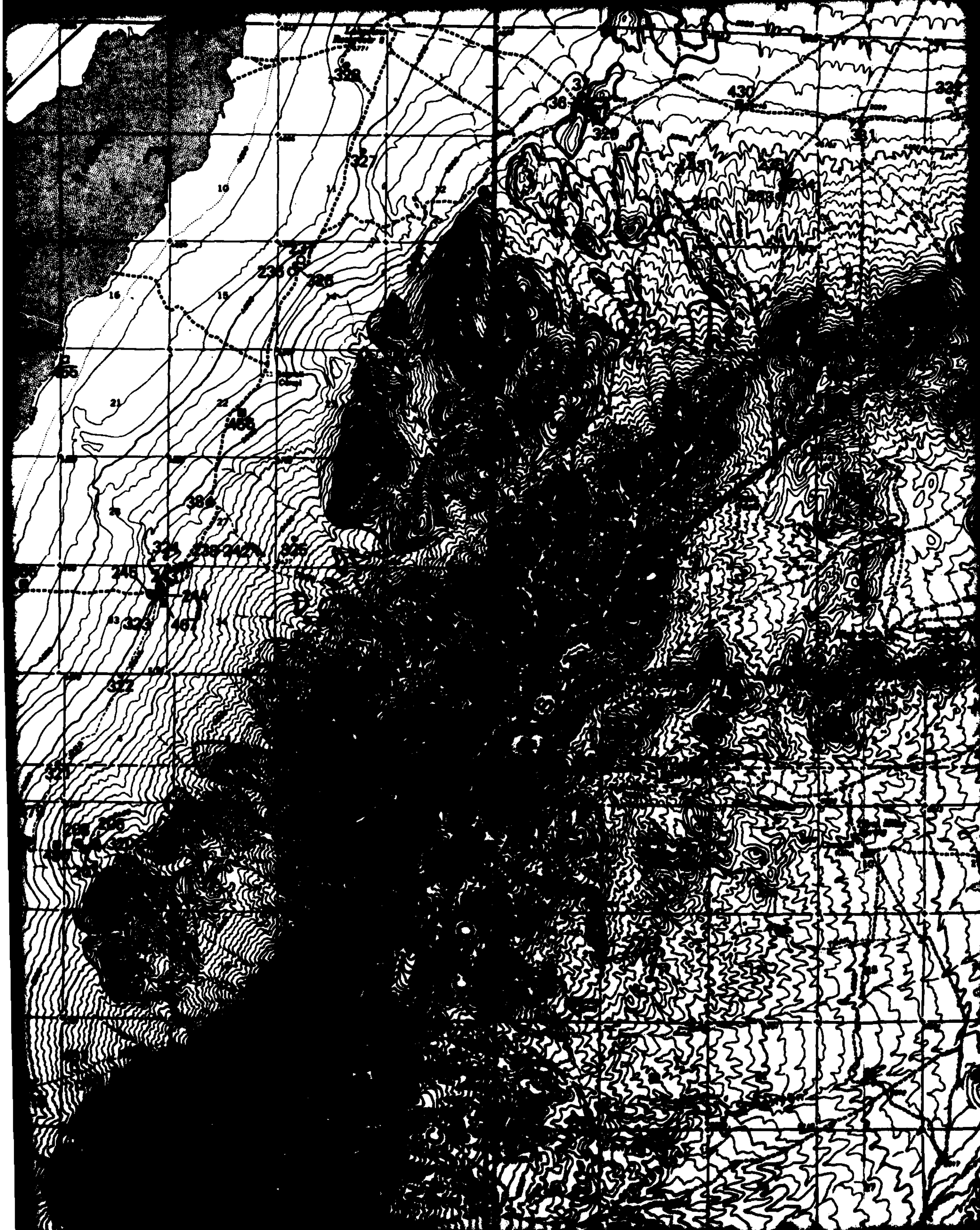
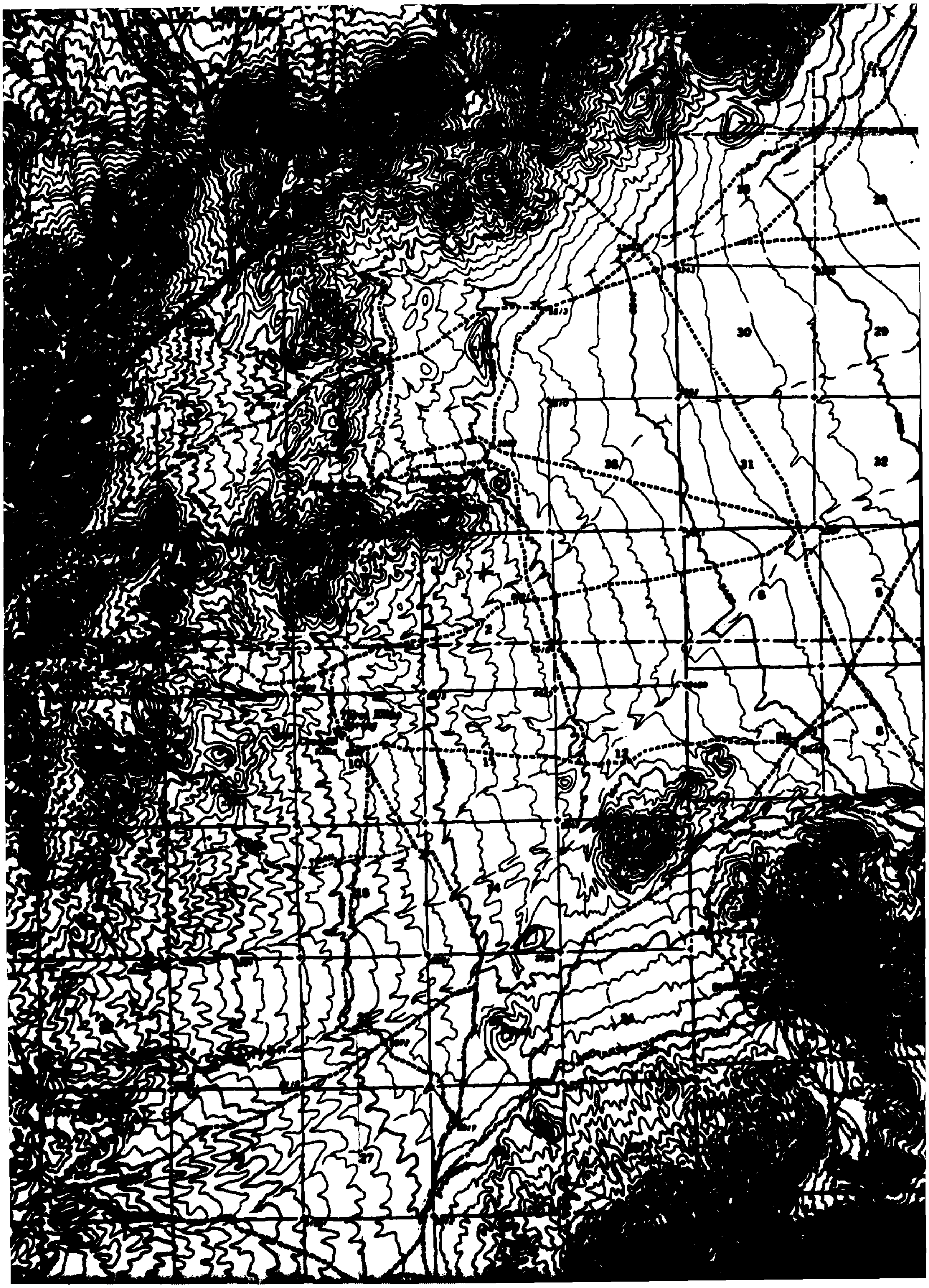
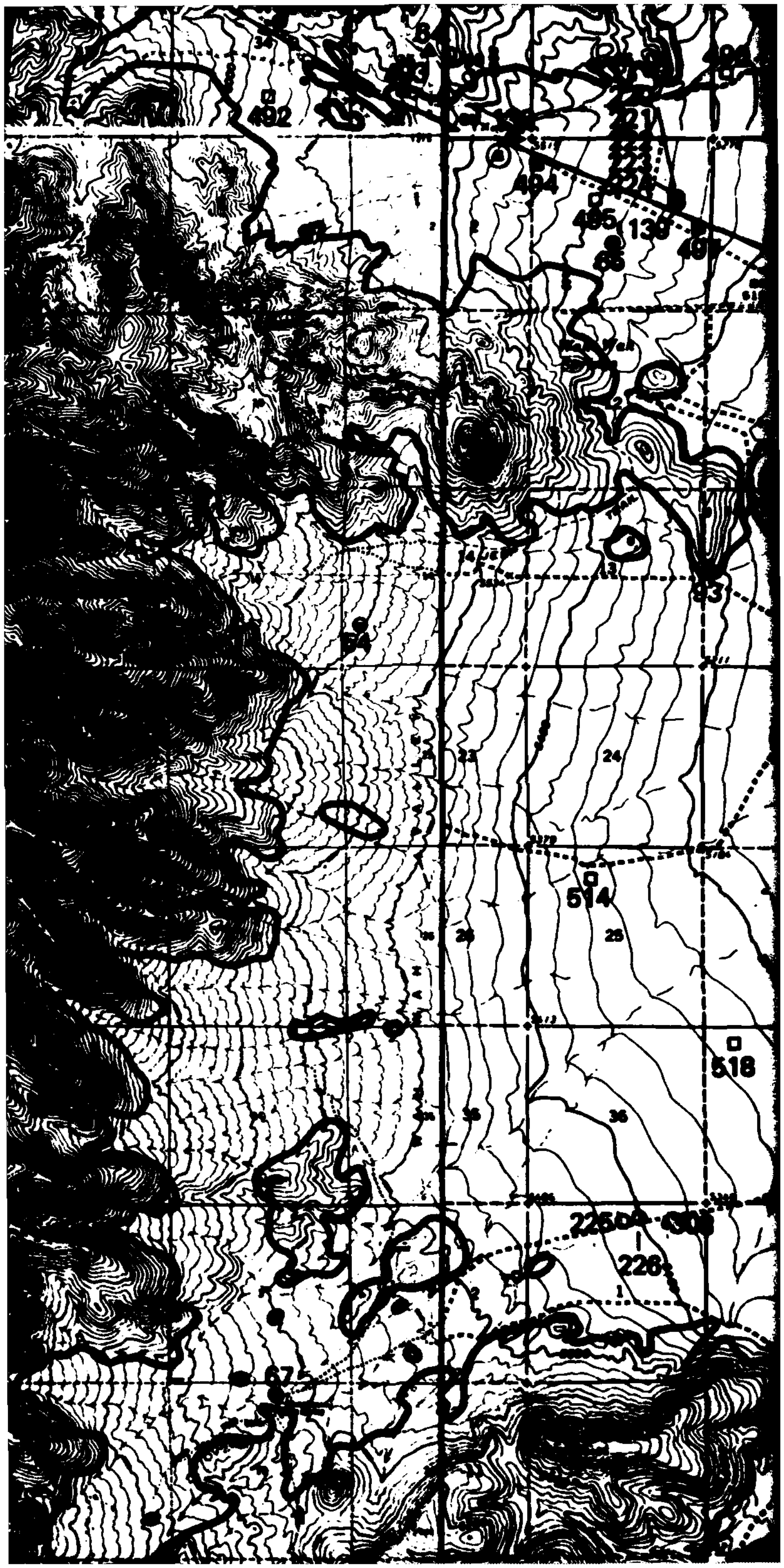
422

(MAP NUMBERS FROM 1 TO 199)

BASIN—FILL UNITS (COARSE AND/OR FINE AGGREGATES)



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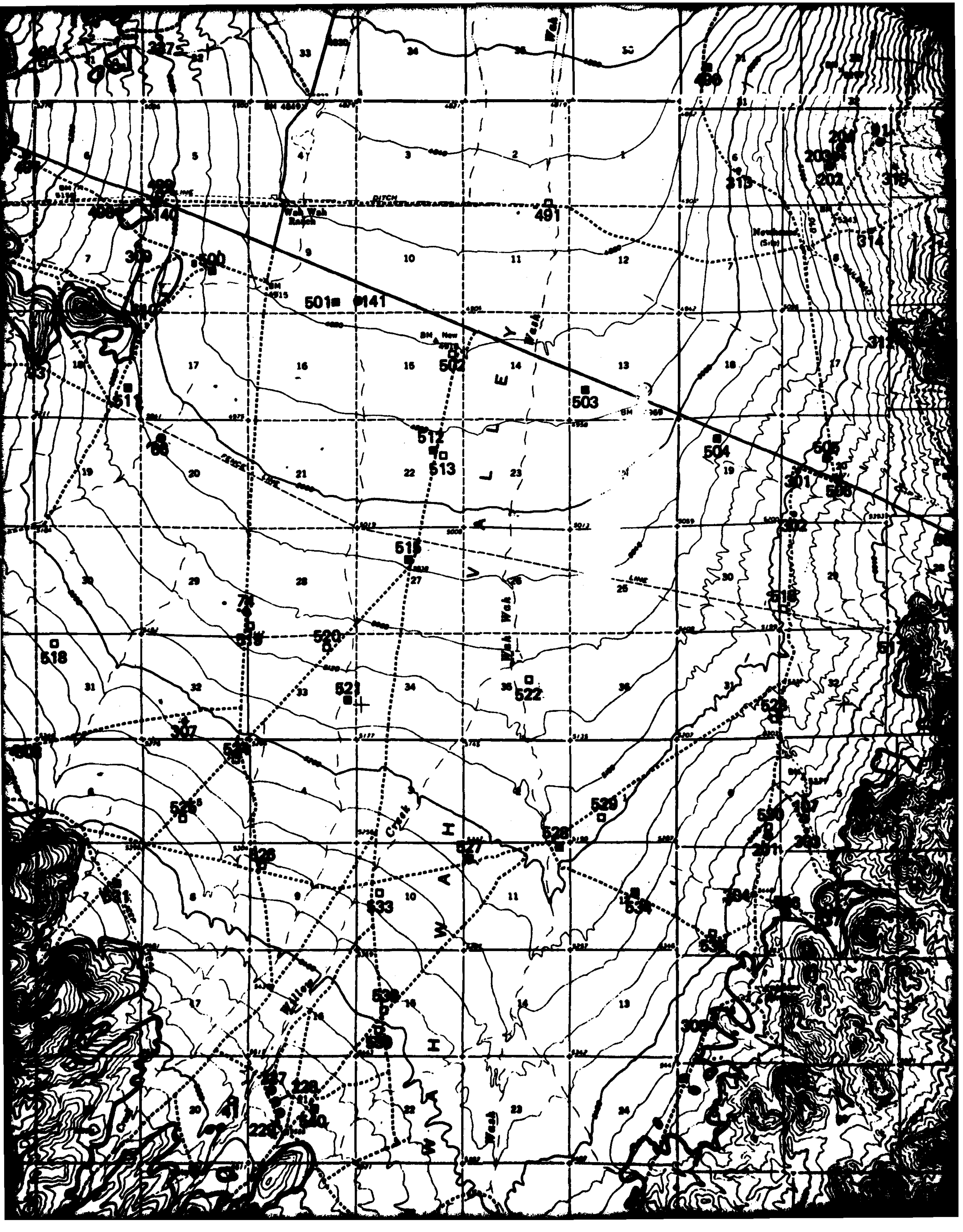
226



Wah Wah Ranch
DITCH
Newhouse (Site)
FENCE LINE
V A L L E Y
W A H W A H
Wah Wah Wash
Creek
491
500
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502
503
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515
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522
529
533
534
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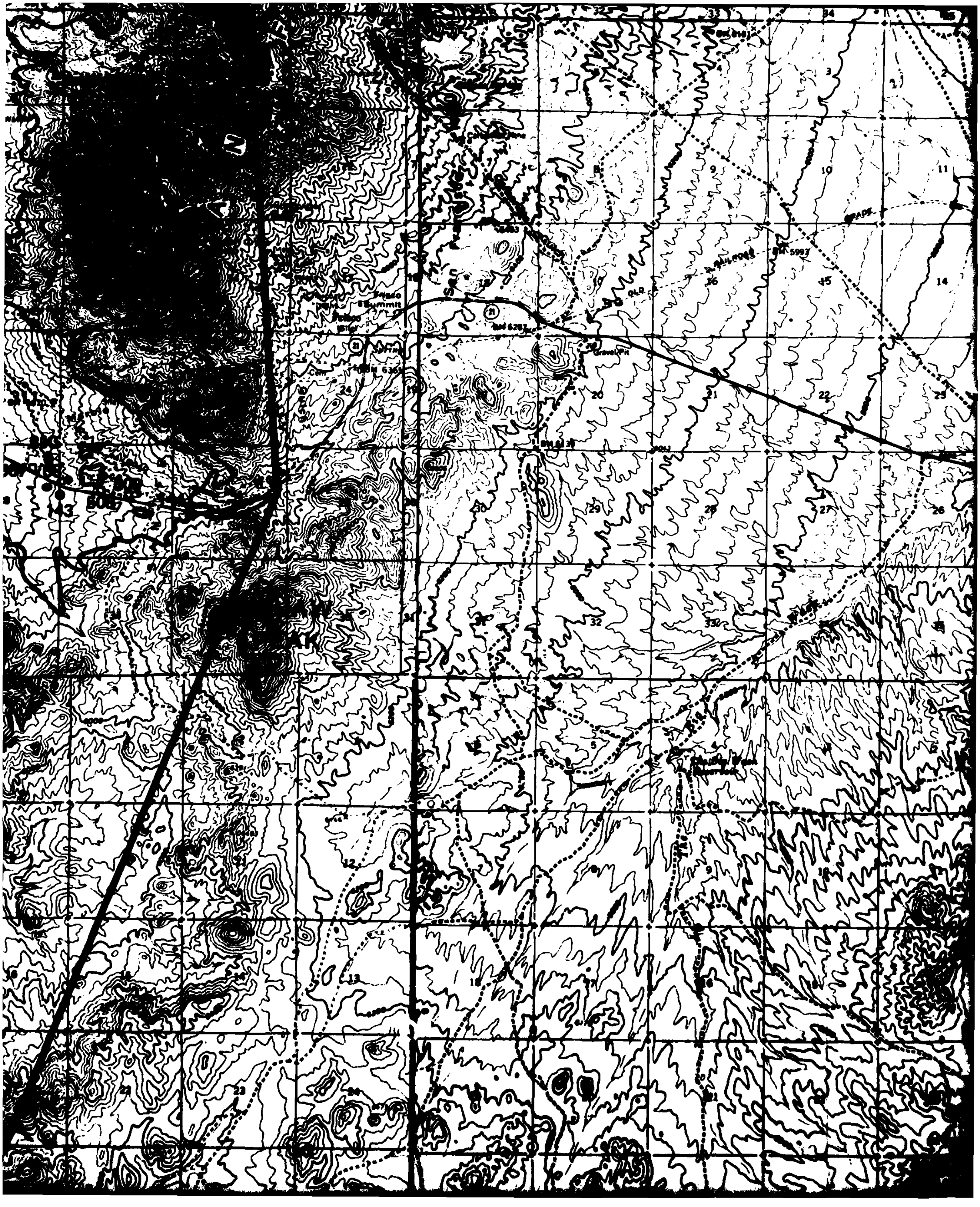
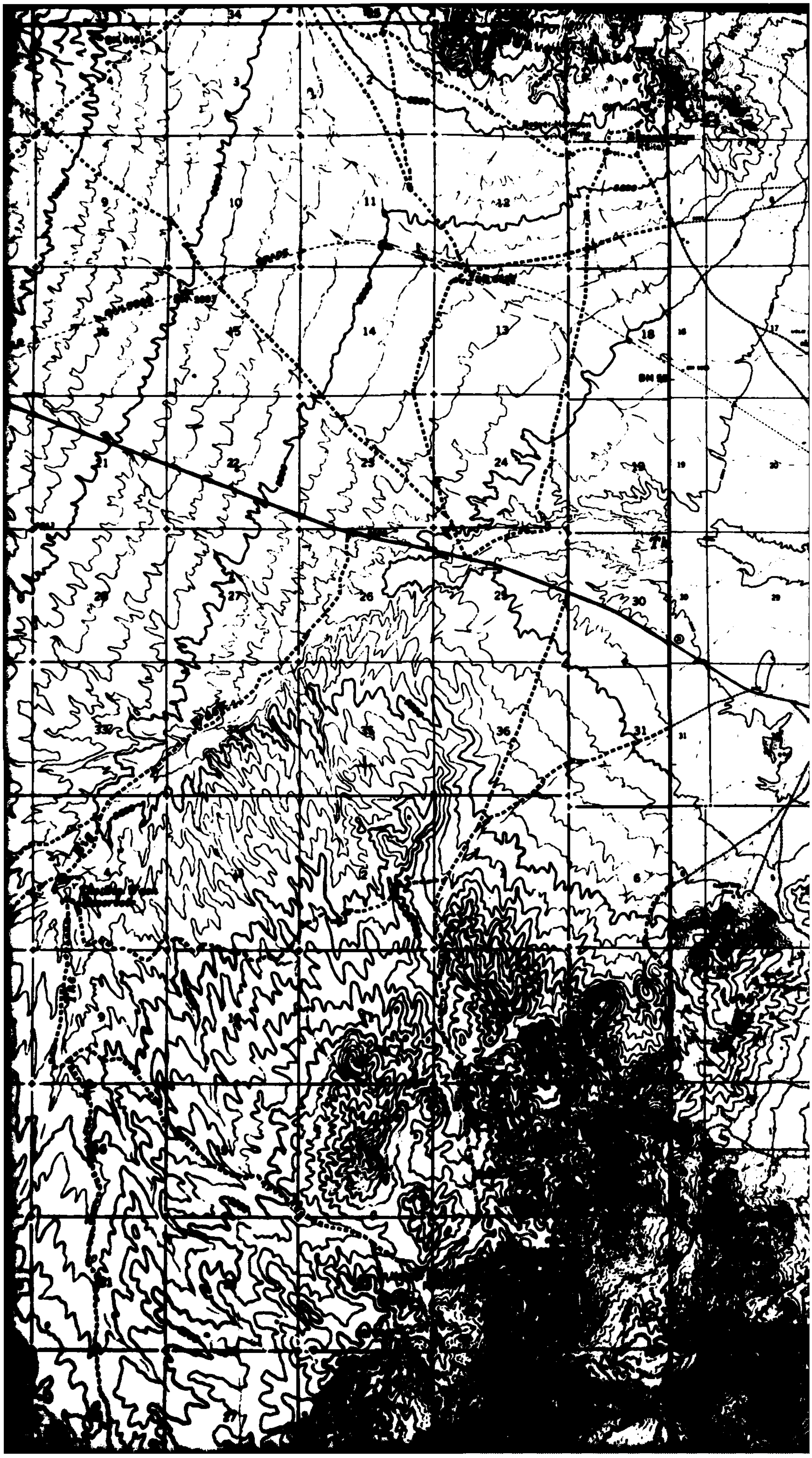
141
307



GRADE
RAILROAD
BM 5997
OLD
BM 6287
Gravel Pit
BM 6139



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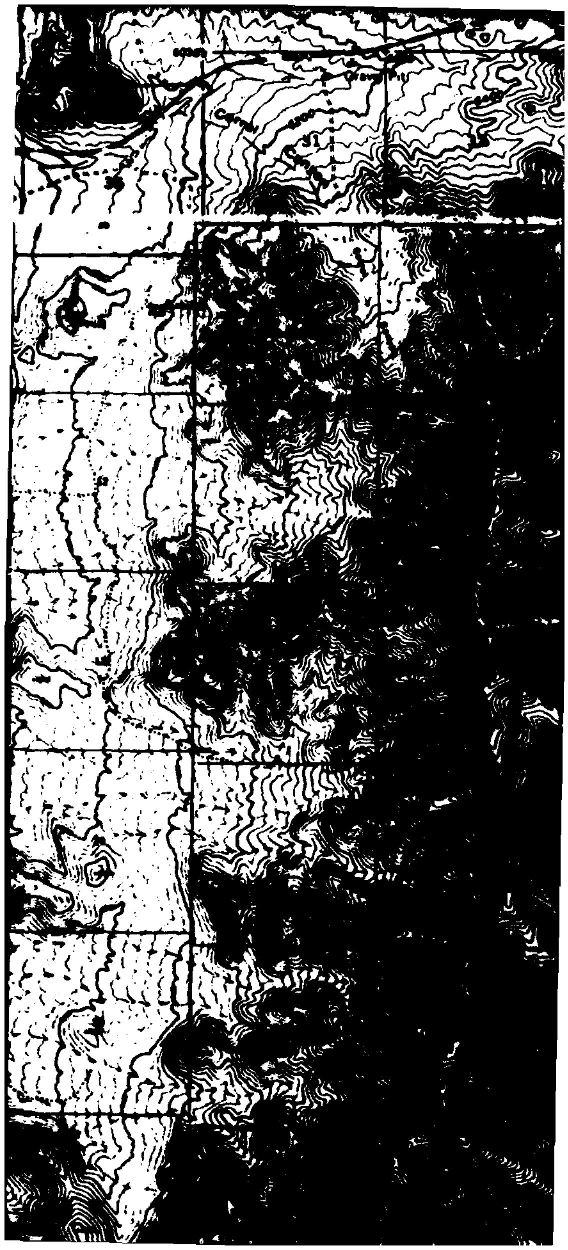

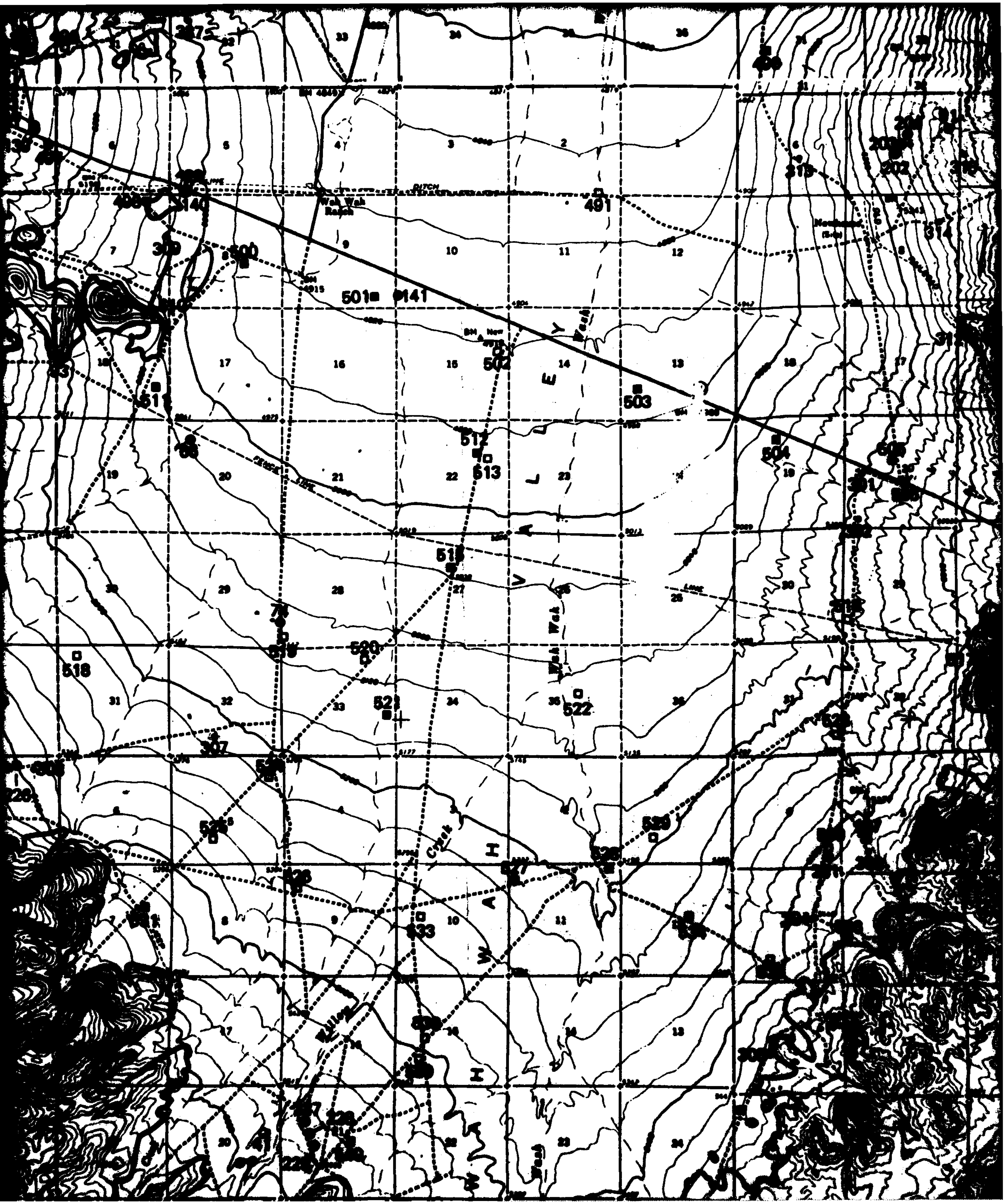

Wah Wah Ranch
DITCH
Newhouse
491
500
501
141
140
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503
504
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512
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515
518
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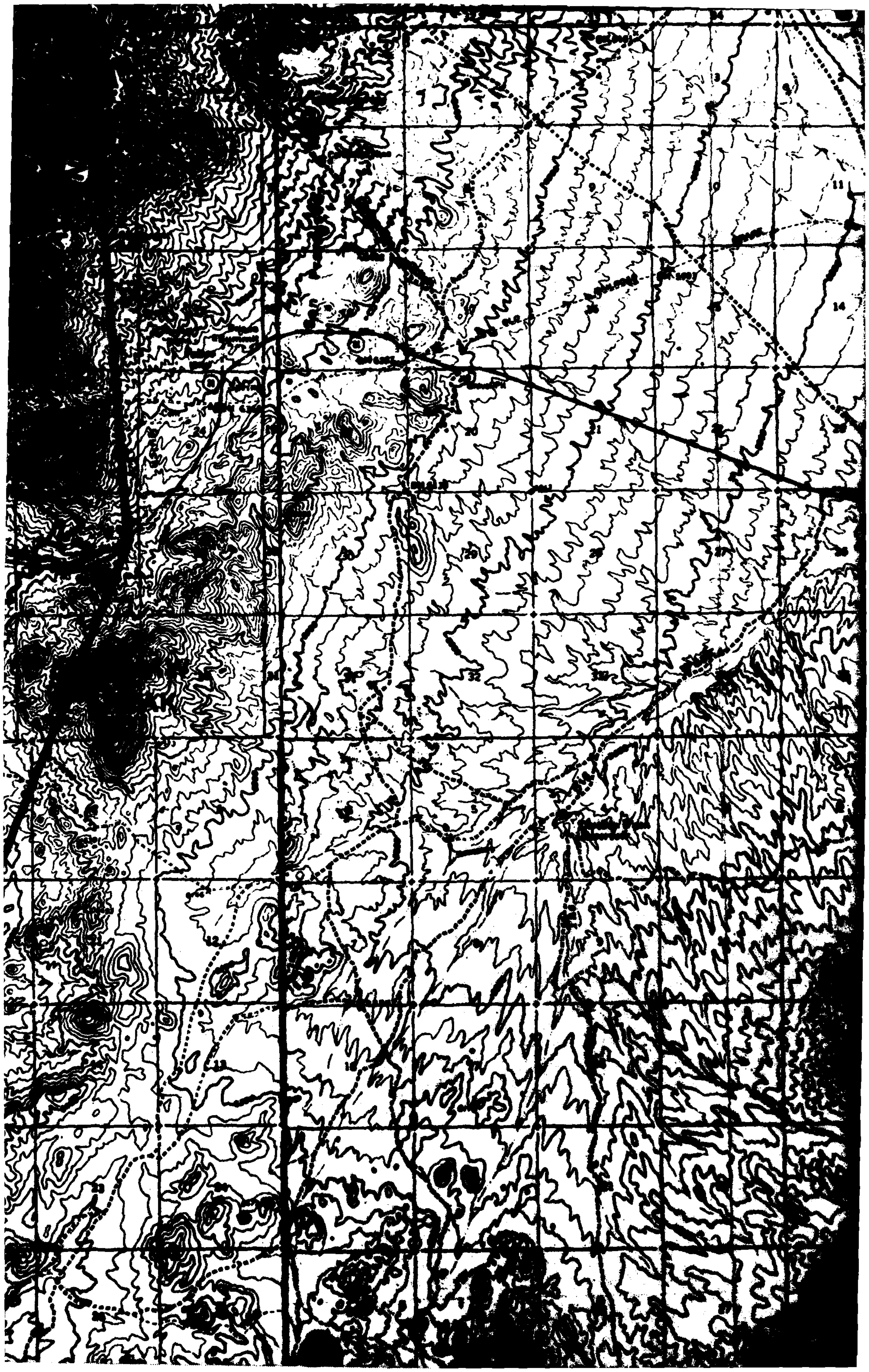
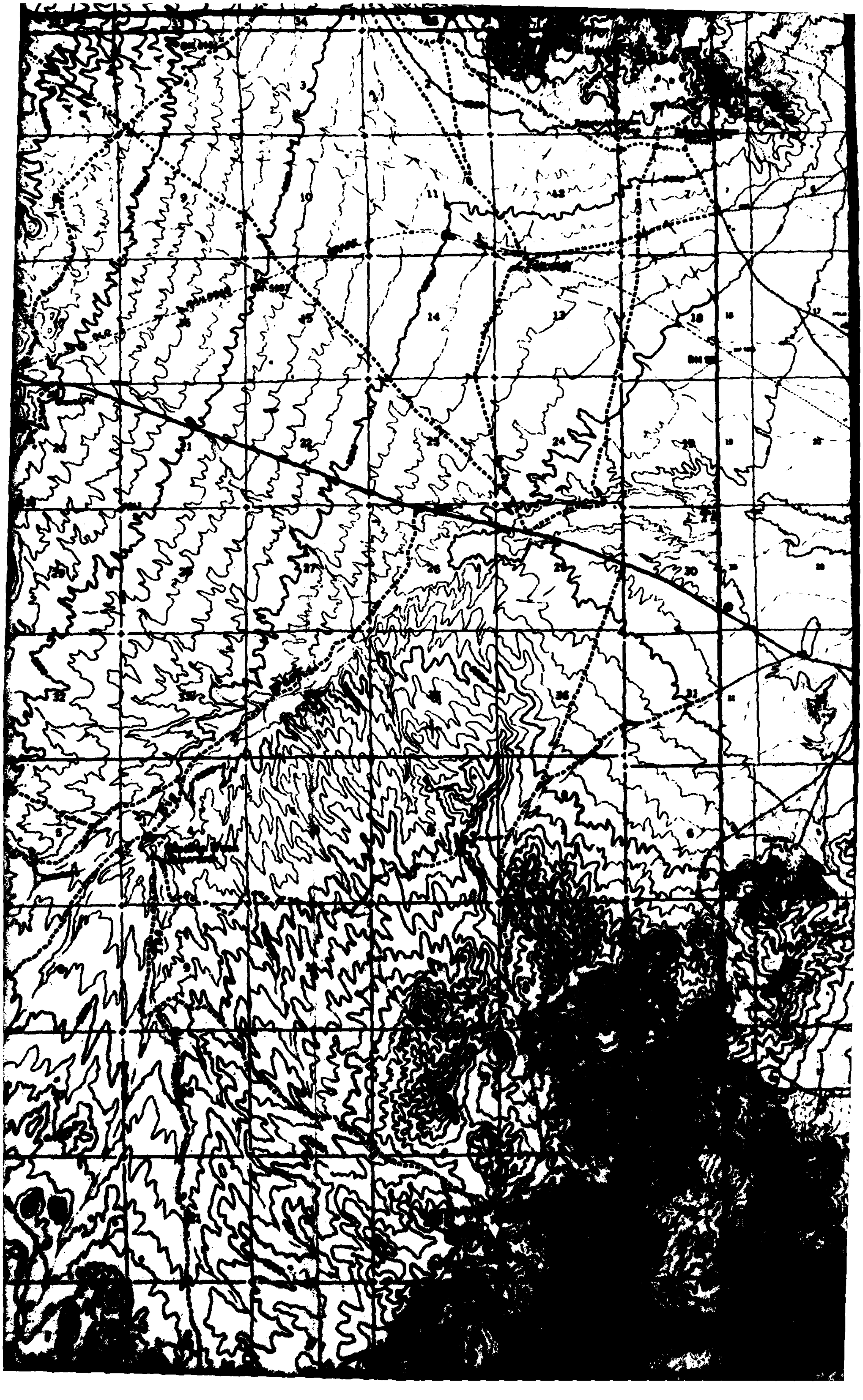
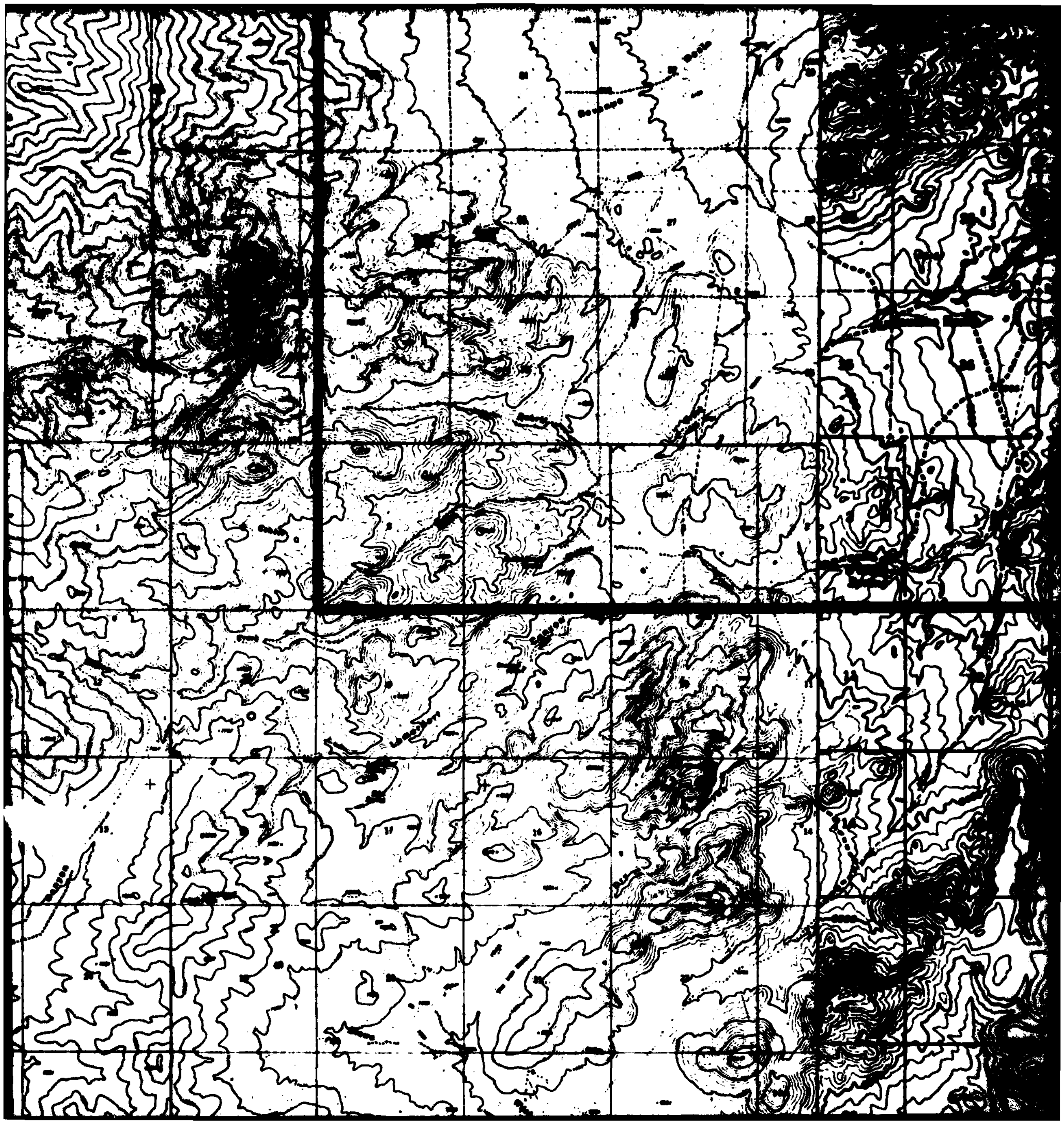
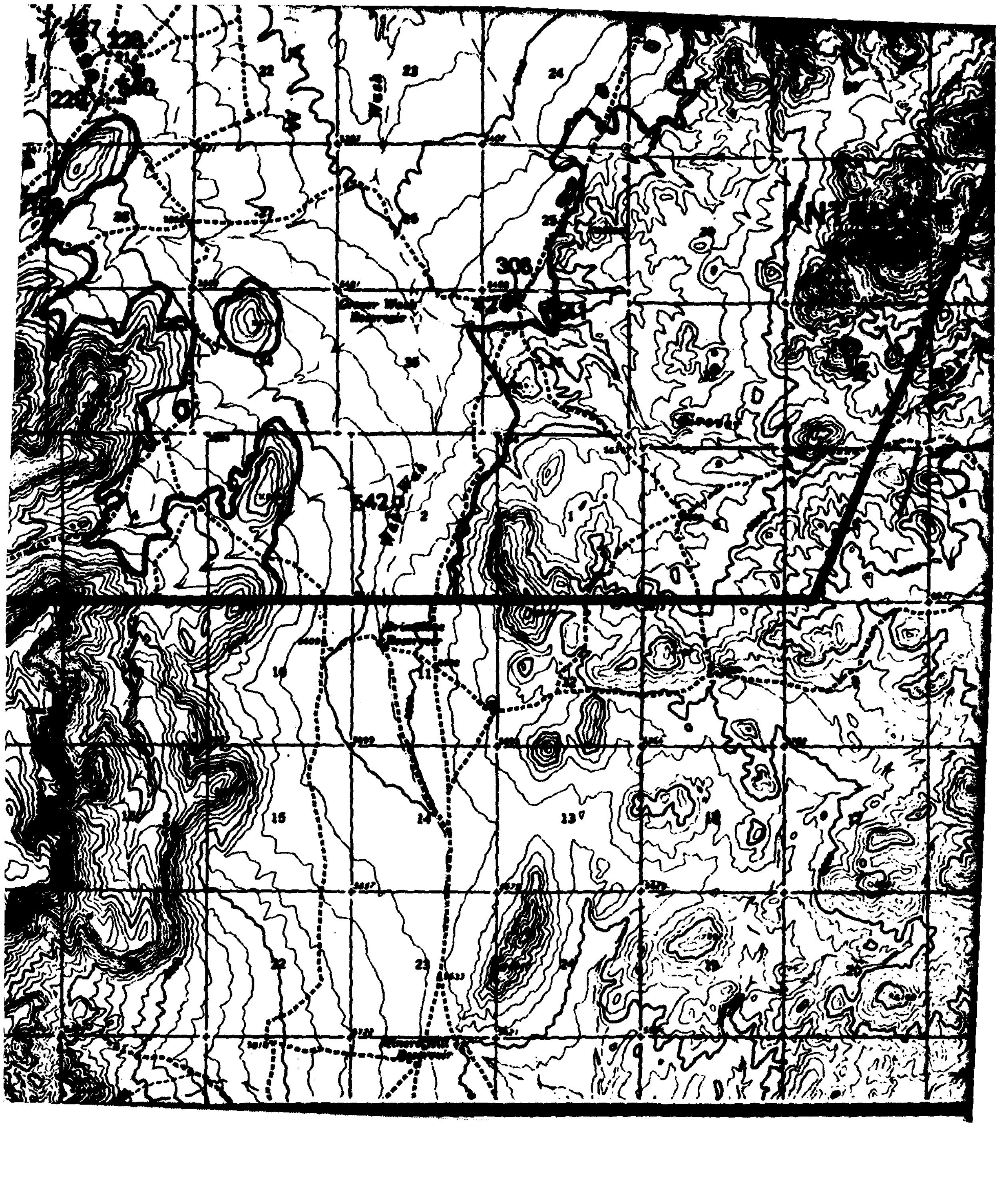
521
522
526
527
533
307
W
A
H
V
A
L
L
E
Y
Wah Wah
Wash
Creek





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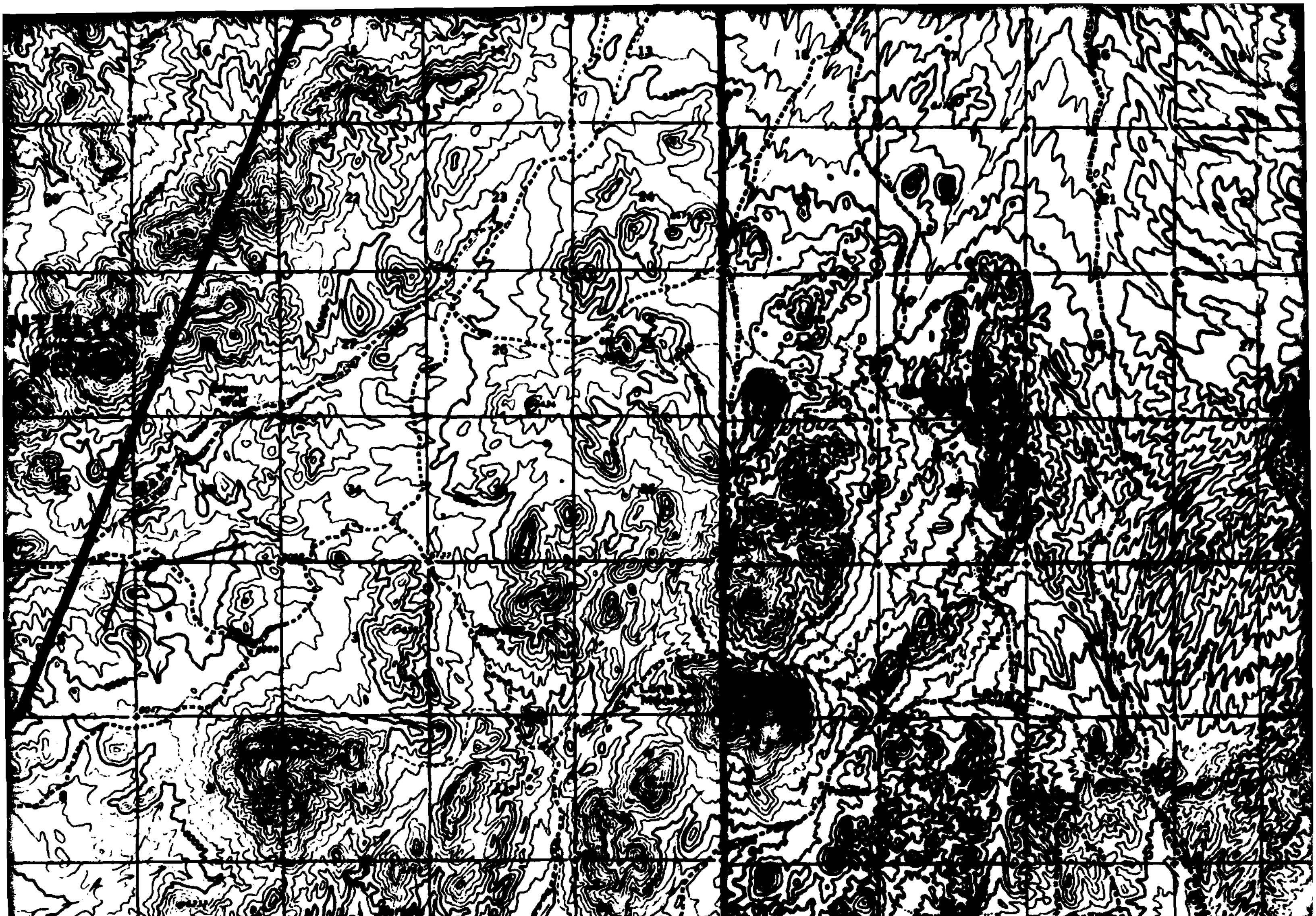

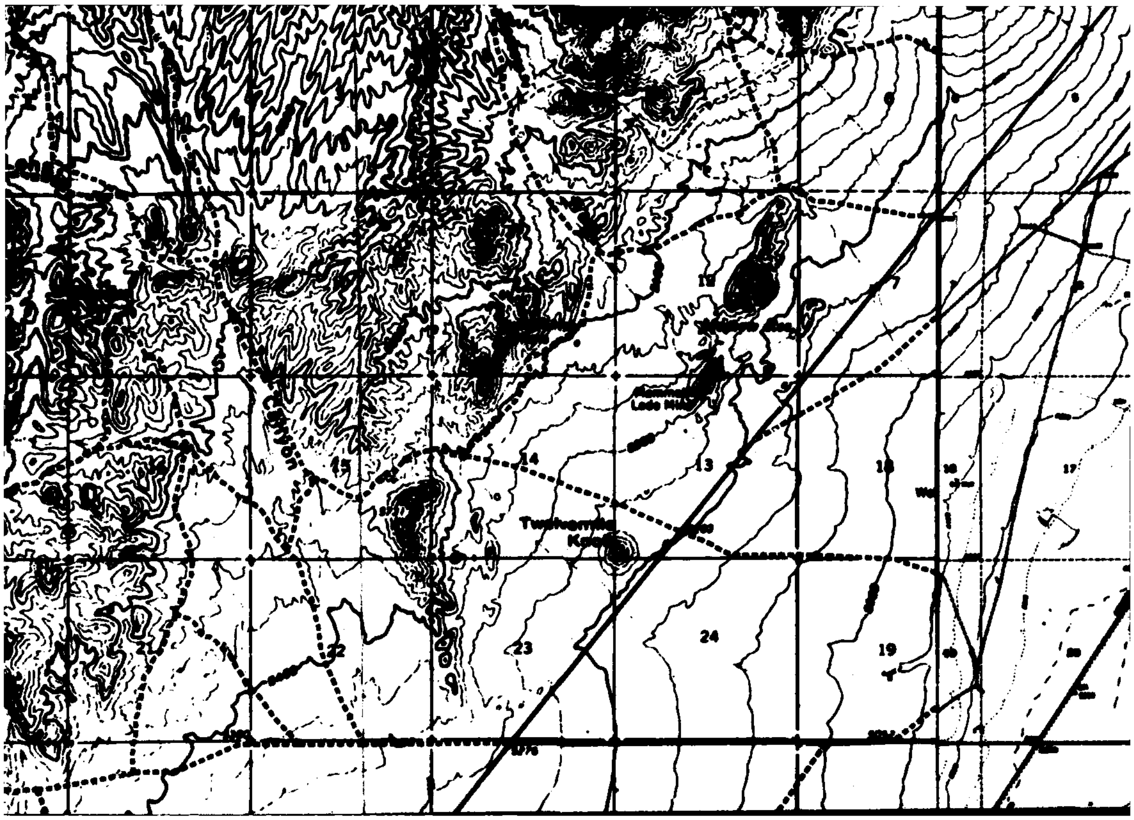
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113° 30'

EXP

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18

ERTEC WESTERN AGGREGATE RESOURCES STUDY FIELD STATIONS

VALLEY–SPECIFIC AGGREGATE RESOURCES STUDY*
(MAP NUMBERS FROM 1 TO 199)

BASIN–FILL UNITS (COARSE AND/OR FINE AGGREGATES)

● DATA STOP, SAMPLED AND TESTED

○ DATA STOP

ROCK UNITS (CRUSHED–ROCK AGGREGATES)

▲ DATA STOP, SAMPLED AND TESTED

△ DATA STOP

DETAILED AGGREGATE RESOURCES STUDY**
(MAP NUMBERS FROM 200 TO 299 FOR BASIN–FILL AND ROCK SAMPLE LOCATIONS; 300 TO 399 FOR FIELD PETROGRAPHIC STATIONS)

BASIN–FILL UNITS (COARSE AND/OR FINE AGGREGATES)

● DATA STOP, SAMPLED AND TESTED

○ DATA STOP

ROCK UNITS (CRUSHED–ROCK AGGREGATES)

▲ DATA STOP, SAMPLED AND TESTED

PETROGRAPHIC FIELD STATIONS

• DATA STOP

EXPLANATION

18

ONS

REGATES)

EXISTING ERTEC WESTERN TEST DATA LOCATIONS ***
(MAP NUMBERS FROM 400 TO 500)

■ DATA STOP, SAMPLED AND TESTED

□ DATA STOP

* SEE PINE VALLEY, WAH WAH VALLEY VSARS REPORT (FN-TR-37-g) FOR DETAILED INFORMATION.

** SEE CORRESPONDING MAP NUMBER IN APPENDICES A AND B FOR DETAILED INFORMATION.

*** SEE CORRESPONDING MAP NUMBER AND ACTIVITY TYPE IN APPENDIX G FOR REFERENCE TO WAH WAH VALLEY VERIFICATION REPORT (FN-TR-27-WA-I AND II).

LL
FIELD

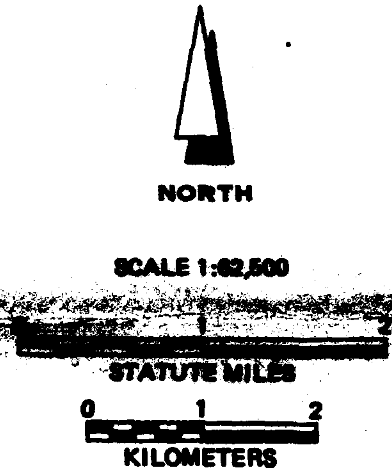
EGATES)

SYMBOLS

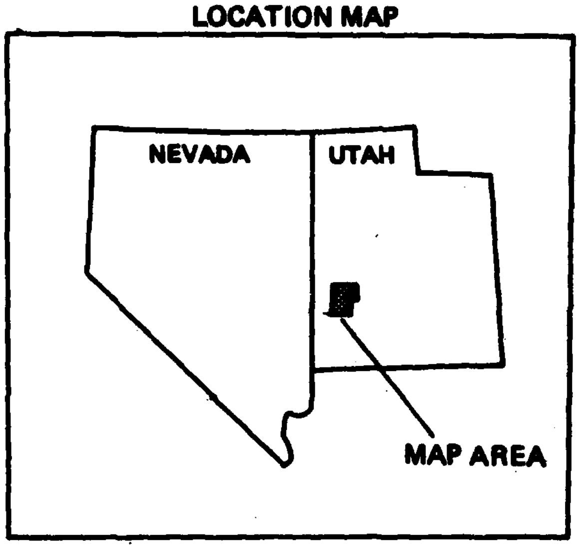
STUDY AREA BOUNDARY

ROCK/BASIN--FILL CONTACT

19



LOCATION MAP



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DEPARTMENT OF THE AIR FORCE
BMO/AFRCE-MX

FIELD STATION AND SELECTED EXISTING DATA SITE LOCATIONS DETAILED AGGREGATE RESOURCES STUDY WAH WAH VALLEY, UTAH

12 JUN 81