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MX SITING INVESTIGATION. AGGREGATE RESOURCES STUDY; TULE VALLEY--ETC(U)
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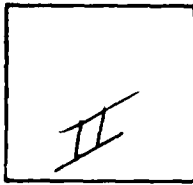
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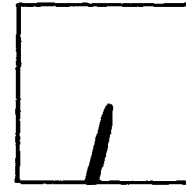
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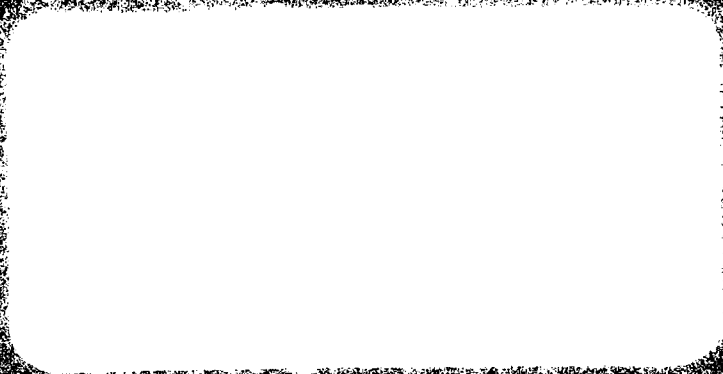
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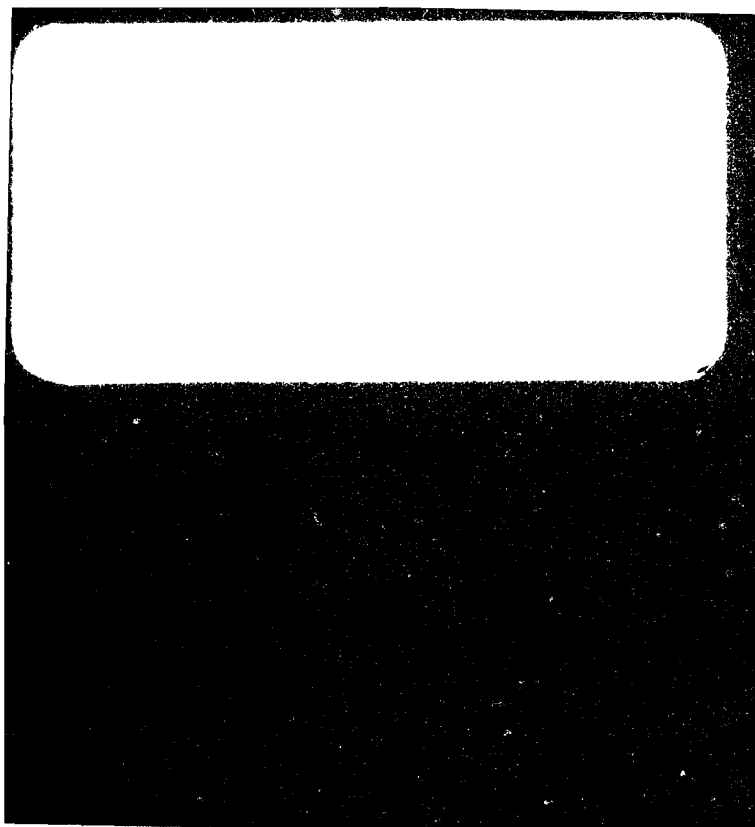
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AGGREGATE RESOURCES STUDY

TULE VALLEY

UTAH

Prepared for:

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

Prepared by:

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FOREWORD

This report was 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. It presents the results of Valley-Specific Aggregate Resources Studies within and adjacent to selected areas in Nevada that are under consideration for siting the MX system.

This volume contains the results of the aggregate resources study in Tule Valley. It is the eighth of several Valley-Specific Aggregate Resources investigations which will be prepared as separate volumes. Results of this report are presented as text, appendices, and two drawings.

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EXECUTIVE SUMMARY

This report presents results of the Valley-Specific Aggregate Resources Study (VSARS) for Tule Valley and surrounding areas in Utah. It is the eighth in a series of reports that contain aggregate information on the location and suitability of basin-fill and rock sources for concrete and road-base construction materials on a valley-specific basis. The findings presented are based on field reconnaissance and limited laboratory testing, existing data from the Utah State Department of Highways, and a previous regional aggregate investigation and Verification studies conducted by Ertec Western, Inc. (formerly Fugro National, Inc.).

A classification system based on aggregate type and potential use was developed to rank the suitability of all basin-fill and rock aggregate sources. Four aggregate types have been designated: coarse, fine, coarse and fine (multiple) aggregates derived from basin-fill sources, and crushed rock aggregates derived from rock sources. Each aggregate type was then classified using the following definitions:

- Class I Potentially suitable concrete aggregate or road-base material source;
- Class II Possibly unsuitable concrete aggregate/potentially suitable road-base material source; and
- Class III Unsuitable concrete aggregate or road-base material source.

Decisions on assigning a particular aggregate source to one of the three classes were determined from existing and Ertec

laboratory aggregate tests performed as part of this study (abrasion resistance, soundness, and alkali reactivity), and, to a lesser degree, from field visual observations.

Emphasis in this study is placed on the identification and delineation of Class I basin-fill coarse aggregate. These deposits are considered to be the primary sources of concrete and road-base construction materials. Results of the study are presented on a 1:125,000-scale aggregate resources map (Drawing 2) and are summarized as follows:

1. Coarse Aggregate - Major Class I coarse aggregate deposits are located in the Tule Valley study area in:
 - a. Alluvial fan (Aafg, Aafs) deposits west of the House Range and Fish Springs Range in eastern Tule Valley;
 - b. Alluvial fan (Aafg) deposits bordering the Confusion Range in western Tule Valley; and
 - c. Older lacustrine shoreline (Aolg, Aols) deposits throughout the valley.

Potentially suitable Class II coarse aggregate sources are widespread in the study area. They are typically located within alluvial fan (Aafs, Aafg) and older lacustrine (Aolg, Aols) deposits flanking Class I and/or Class II rock sources.

2. Fine Aggregates - Class I fine aggregate (multiple-type) sources were delineated in:
 - a. Alluvial fan (Aafg) deposits east of the southern Confusion Range in southwestern Tule Valley; and
 - b. Older lacustrine (Aolg, Aols) deposits located throughout the valley basin.

Potential Class II fine aggregate sources typically occurring basinward of most Class I and Class II rock exposures are extensively distributed throughout the study area.

Many coarse aggregate basin-fill sources are also potential multiple sources (coarse and fine) that will supply varying quantities of fine aggregate either from the natural deposit or during processing.

3. Crushed Rocks - Abundant Class I crushed rock sources are present throughout the study area in:

- a. Notch Peak and Guilmette formations (Cau) in the Confusion, Wah Wah, House, and Fish Springs ranges;
- b. Fish Haven, Laketown, Sevy, and Simonson dolomites (Do) in the Confusion and Fish Springs ranges;
- c. Prospect Mountain Quartzite (Qtz) in the northern House Range;
- d. Marjum Limestone (Ls) in the northern House and southern Fish Springs ranges; and
- e. Basalt (Vb) within northern Tule Valley.

The usability of any of these rock units as sources of crushed rock aggregate depends on their accessibility and minability within the study area.

Additional aggregate testing and field investigations will be required to further refine the lateral and vertical extents of classification boundaries and define exact physical and chemical characteristics of a particular deposit or rock source within the study area.

1.0 INTRODUCTION

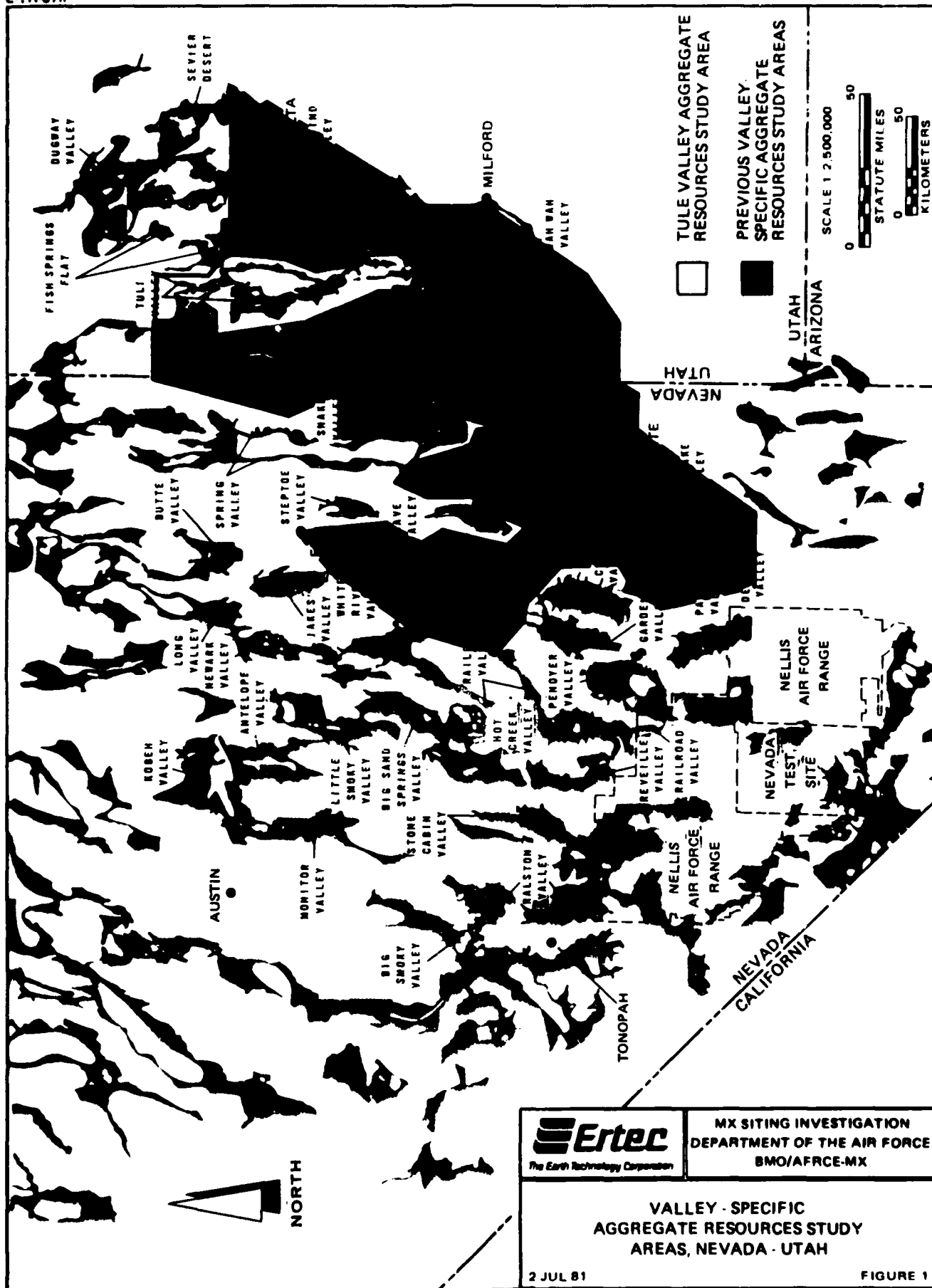
1.1 STUDY AREA

This report presents the results of the Valley-Specific Aggregate Resources Study (VSARS) completed for Tule Valley (Figure 1). Located in western Juab and Millard counties, Utah, the area contains a north-south trending alluvial basin flanked chiefly by sedimentary rock mountain ranges. Snake Valley and the Confusion and Wah Wah ranges border the site on the west, and the Fish Springs and House ranges mark the eastern boundary.

U.S. Highway 6 and 50 provide access to the central part of the study region. A network of unpaved roads and four-wheel-drive trails crisscross the study area (Drawing 1). The valley area is mainly comprised of undeveloped desert rangeland administered by the Bureau of Land Management (BLM).

1.2 BACKGROUND

The MX aggregate program began 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 studied in the initial Aggregate Resources Evaluation Investigation (AREI). This additional area (Figure 2), defined as the Utah Aggregate Resources Study Area (UARSA), was evaluated in the fall of 1979, and a second general aggregate resources report (FN-TR-34) was submitted on 3 March 1980. Both general aggregate investigations were designed to provide regional information of the general location, quality, and quantity of



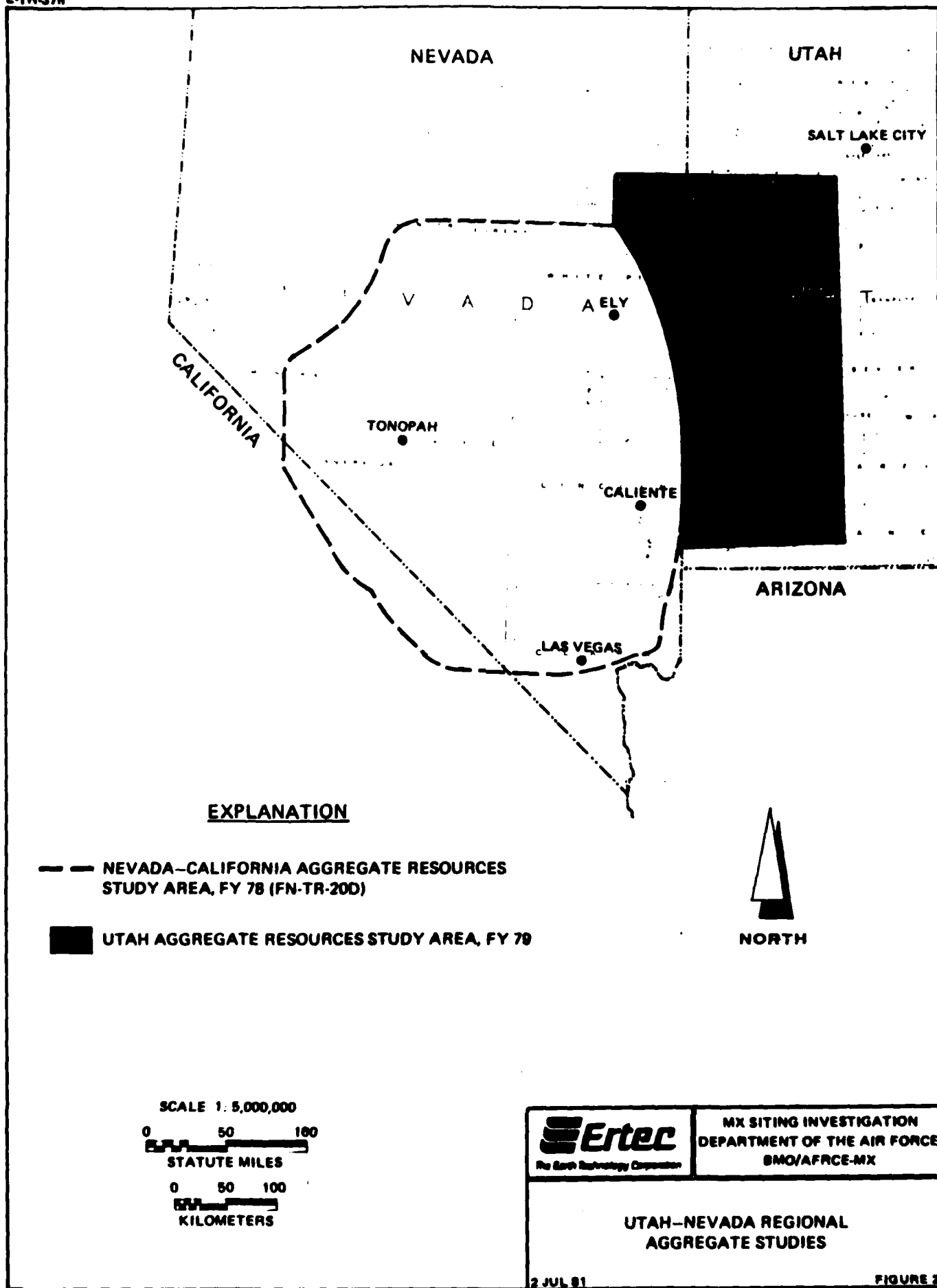
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VALLEY - SPECIFIC
AGGREGATE RESOURCES STUDY
AREAS, NEVADA - UTAH

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FIGURE 1



aggregates that could be used in the construction of the MX system.

Subsequent to the general studies, VSARS were developed in FY 79 and continued in FY 80 to provide more-detailed information on potential aggregate sources in specified valley areas (Figure 1).

1.3 OBJECTIVES

The primary objective of the VSARS program is to classify, on a valley basis, basin-fill and rock deposits for suitability as concrete and road-base construction materials. The VSARS format is designed to select and present the locations of the most acceptable aggregate sources for preliminary construction planning and follow-on, detailed aggregate investigations.

1.4 SCOPE

The scope of this investigation required office and field investigations and included the following:

1. Collection and analysis of available existing data on the quality and quantity of potential concrete aggregate and road-base material sources. American Society of Testing and Materials (ASTM) standards and Standard Specifications for Public Works Construction (SSPWC) were used to evaluate quality.
2. Aerial and ground reconnaissance of all identified potential aggregate sources in the valley area, with more-detailed investigation and sample collection of likely basin-fill (coarse and fine aggregates) and rock- (crushed-rock aggregates) construction material sources.
3. Laboratory testing to supplement available existing data and to provide detailed information to assist in determining the suitability of specific basin-fill or rock deposits as construction material sources within the valley area.

4. Development and application of an aggregate classification system (Section 2.5) that emphasizes aggregate type (coarse, fine, or crushed rock) and potential construction use (concrete and/or road base).

2.0 STUDY APPROACH

2.1 EXISTING DATA

Collection of existing test data from available sources was an important factor in the VSARS program. The principal source of existing data directly pertaining to aggregate construction materials was the Utah State Department of Highways (Appendix A). The majority of this information is related to the use of aggregate material for asphaltic concrete, base course in road construction, or ballast material; however, many of the suitability tests for these types of construction materials are similar to those for concrete and were applicable to this investigation (Appendix A).

2.2 SUPPLEMENTAL ERTEC WESTERN DATA

Supplemental Ertec data were obtained from: 1) field data and supplementary test data compiled during the general aggregate resources study (FN-TR-34), 2) Tule Valley Verification study (in progress), and 3) the current (Appendix A) and previous (FN-TR-37) Valley-Specific Aggregate Resources Studies.

The primary objective of the initial general aggregate study was a regional evaluation and ranking of all potential aggregate sources. Twenty-eight data points from the general aggregate study were located within the VSARS area (Drawing 1). These data stops supplied specific aggregate information which included two 150-pound samples collected for limited laboratory testing (Appendix A).

Verification geologic maps were an initial source of information on the type and extent of basin-fill units within specific valley areas. In addition, Verification study data included information from 22 trench locations distributed throughout the study area (Drawing 1). Depths of the selected trenches ranged from 8.5 to 14 feet (2.6 to 4.3 m). While the Verification studies are not specifically designed to generate aggregate data, the sampling techniques and testing procedures (Appendix A) are applicable to the aggregate evaluation.

The VSARS program required aerial and ground reconnaissance of the study area to collect additional information to verify conditions determined during the data review. Included in the 67 field station data stops was the collection of 26 samples for laboratory testing. Potential coarse and fine aggregate basin-fill samples were collected by channel sampling stream cuts or man-made exposures. Potential crushed-rock aggregate samples were obtained from exposures of fresh or slightly weathered material whenever possible. The weight of all laboratory samples collected ranged between 100 and 150 pounds. Rock hand samples, which generally did not exceed 5 pounds in weight, were collected for office analyses.

Identification of basin-fill materials in all field studies followed ASTM D 2488-69, Description of Soils (Visual-Manual Procedure), and the Unified Soil Classification System (Appendix C). Rock identifications followed procedures described in the Quarterly of the Colorado School of Mines (Travis, 1955)

and Standard Investigative Nomenclature of Constituents of Natural Mineral Aggregates (ASTM C 294-69).

2.3 DATA ANALYSIS

Geologic and engineering criteria were used in the evaluation of potential aggregate sources within the study area. This was supplemented by laboratory analysis of selected samples during the valley-specific aggregate testing program (Table 1). Coarse aggregate is defined as predominantly plus 0.185 inch (4.75 mm) fine gravel- to boulder-basin-fill material. Fine aggregate is defined as less than 0.375 inch (9.5 mm) and predominantly less than 0.185 inch (4.75 mm) and plus 0.0029 inch (0.074 mm) coarse to fine sand-basin-fill material. While all laboratory tests supplied definitive information, the abrasion, soundness, and alkali reactivity results were considered the most critical in determining the use and acceptability of a potential aggregate source.

2.4 PRESENTATION OF RESULTS

Study results are presented in text, tables, appendices, and two 1:125,000 scale maps. Drawing 1 presents the location of the 123 existing test data and supplemental Ertec data sites within the study area. Drawing 2 presents the location of all Ertec Western laboratory sample sites and all potential basin-fill and rock aggregate sources within the valley area. In addition, these potential aggregate sources are classified according to proposed aggregate use and type (Section 2.5).

ASTM TEST	SAMPLE TYPE AND NUMBER OF TESTS		
	COARSE	FINE	ROCK
ASTM C-88; SOUNDNESS BY USE OF MAGNESIUM SULFATE	16	17	8
ASTM C-131; RESISTANCE TO ABRASION BY USE OF THE LOS ANGELES MACHINE	14	NA	7
ASTM C-136; SIEVE ANALYSIS	18	17	NA
ASTM C-289; POTENTIAL REACTIVITY OF AGGREGATE (CHEMICAL METHOD)	4	5	4
ASTM C-127 AND C-128; SPECIFIC GRAVITY AND ABSORPTION	4	4	4



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AGGREGATE RESOURCES STUDY
AGGREGATE TESTS
TULE VALLEY, UTAH

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TABLE 1

Geologic unit symbols utilized in Drawing 2 relate to standard geological nomenclature whenever possible. Undifferentiated basin-fill and rock units were established primarily to accommodate accuracy of data and map scale and may contain deposits which could supply significant quantities of high-quality materials. A conversion table to relate these geologic symbols to the geologic unit nomenclature used in the Ertec Western Verification studies is contained in Appendix E.

All contacts which represent distinct boundaries between geologic units are shown as solid lines in Drawing 2. The contacts are dashed where the data were extrapolated beyond the limits of the source data or where accuracy of the data may be questionable. Local small deposits of one geologic unit may be found in close association with a larger deposit of a different geologic unit. Due to the reconnaissance level of the field investigation or scale limitations, these smaller deposits could not be depicted on the aggregate resources map and have been combined with the more prevalent material. Similarly, potential aggregate source classifications are preliminary and may contain lesser amounts of material of another use or type. Therefore, all classification lines are dashed and delimit the best aggregate evaluations possible at this level of investigation. In cases of highly variable rock or basin-fill units and limited aggregate tests, boundaries could not be drawn, and information is presented as individual sample data in Drawing 2.

Appendices contain tables summarizing the basic data collected during Ertec's supplemental field investigations, the results

of Ertec Western's supplemental testing programs, and existing test data gathered from various outside sources (Appendix A). Also included in appendices are an explanation of caliche development (Appendix B), the Unified Soil Classification System (Appendix C), photographs of typical aggregate sources within the study area (Appendix D), and a geologic unit cross-reference table (Appendix E).

2.5 PRELIMINARY CLASSIFICATION OF POTENTIAL AGGREGATE SOURCES

A system was developed to preliminarily classify all potential aggregate sources in the study area. This classification is designed to present the best potential sources of coarse, fine, coarse and fine (multiple source), and crushed-rock aggregate types within a valley-specific area (Drawing 2) based on potential aggregate use (Table 2). Concrete aggregate parameters are the principal consideration in this report since materials suitable for use as concrete aggregate are generally acceptable for use as road-base material. Therefore, the three classifications described below were based primarily on results of the abrasion, soundness, and alkali reactivity tests.

Class I Potentially suitable concrete aggregate or road-base material source. Coarse and crushed-rock aggregates which either passed abrasion, soundness, and alkali reactivity tests or passed abrasion and soundness tests and were not tested for alkali reactivity; fine aggregates which either passed soundness and alkali reactivity tests or passed soundness tests and were not tested for alkali reactivity.

Class II Possibly unsuitable concrete aggregate/potentially suitable road-base material source. Coarse, fine, and crushed-rock aggregates which either failed the soundness and/or alkali reactivity tests or were classified only by field visual observations or other test data.

AGGREGATE CHARACTERISTIC ¹			AGGREGATE USE CLASSIFICATION		
			CLASS I	CLASS II	CLASS III
ABRASION RESISTANCE, PERCENT WEAR ²			< 50	< 50	> 50
SOUNDNESS, PERCENT LOSS ³	COARSE AGGREGATE	Na SO ₄	< 12	> 12	> 12
		Mg SO ₄	< 18	> 18	> 18
	FINE AGGREGATE	Na SO ₄	< 10	> 10	> 10
		Mg SO ₄	< 15	> 15	> 15
POTENTIAL ALKALI REACTIVITY ⁴			INNOCUOUS TO POTENTIALLY DELETERIOUS	DELETERIOUS	DELETERIOUS

1. AGGREGATE CHARACTERISTIC BASED ON STANDARD TEST RESULTS
2. ASTM C131 (500 REVOLUTIONS)
3. ASTM C88 (5 CYCLES)
4. ASTM C289



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PRELIMINARY AGGREGATE CLASSIFICATION
SYSTEM, VALLEY-SPECIFIC AGGREGATE
RESOURCES STUDY

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TABLE 2

Class III Unsuitable concrete aggregate or road-base material source. Coarse and crushed-rock aggregates which failed the abrasion test and were excluded from further testing. Fine, and rarely coarse aggregates composed of significant amounts of clay- and silt-sized particles.

Sources not specifically identified as Class I, II, or III from the three critical test results or have high clay- and silt-sized particle (less than .0029 inch [.074 mm]) content are designated as Class II sources. All classifications are preliminary with additional field reconnaissance, testing, and case history studies needed to confirm adequacy, delimit areal boundaries, and define exact physical and chemical characteristics.

The following publications/sources were used in defining the three use classifications:

1. ASTM C33-74A Standard Specifications for Concrete Aggregate;
2. SSPWC Part II Construction Sections 200-1.1, 1.4, 1.5, and 1.7;
3. Literature applicable to concrete aggregates;
4. Industrial producers of concrete aggregates; and
5. Consultants in the field of concrete aggregates.

3.0 GEOLOGIC SETTING

3.1 PHYSIOGRAPHY

The study area lies entirely within the Basin and Range Physiographic Province (Fenneman, 1946). Primary physiographic features are controlled by block faulting which has produced the uplifted north-south trending mountains and intervening down-dropped, alluvium-filled basins.

Four major mountain ranges bound the study area. These ranges are the Confusion and Wah Wah ranges on the west and the Fish Springs and House ranges on the east (Drawing 2). The Black Hills and Swasey Mountains form significant mountain ranges within the House Range. Topographic relief between mountain ridges and basins is generally greatest along the western valley margin where it averages approximately 3000 feet (914 m). Elevations within the valley range from less than 4300 feet (1310 m) near the northern end of Tule Valley to approximately 5200 feet (1585 m) in the extreme southern section of the study area.

Drainage in the main section of Tule Valley is closed to the central basin area. The extreme northern and southern parts of the study area drain into the Great Salt Lake Desert and the Wah Wah Valley Hardpan, respectively.

3.2 LOCATION AND DESCRIPTION OF GEOLOGIC UNITS

Rocks of the Paleozoic, Mesozoic, and Cenozoic eras are exposed within the study area. These rocks are of various igneous (intrusive and extrusive), metamorphic, and sedimentary lithologies (Drawing 2).

Paleozoic rocks are present throughout the study area. They consist predominantly of limestone and dolomite with appreciable thicknesses of orthoquartzite and minor thicknesses of interbedded sandstone, siltstone, and shale. Major exposures are located in all the mountain ranges throughout the study area.

Rocks of Mesozoic age are of limited areal extent within the study area. They consist of marine clastic sediments and intrusive igneous rocks. The marine sediments are thin- to thick-bedded calcareous marine shale with interbedded siltstone and sandstone. These rocks crop out in the northern Confusion Range. Intrusive igneous rocks consist of medium to coarse crystalline porphyritic granite exposed only in the central House Range.

Cenozoic rocks in the area consist predominantly of Tertiary igneous extrusives. These rocks are comprised of ashflow and air-fall tuffs and lava flows ranging in composition from basaltic to rhyolitic and are exposed in the extreme southern and northern parts of the study area.

Cenozoic basin-fill deposits unconformably overlie older units and consist primarily of alluvial fan, older lacustrine, stream-channel and terrace, and eolian deposits (Drawing 2). Alluvial fans are the most extensive and widespread deposit within the study area. These deposits reach a combined thickness of many hundreds to thousands of feet in the valley axis.

These geologic units have been grouped into eight rock units and four basin-fill units for use in discussing potential aggregate sources. Grouping of these units is based on similarities in physical and chemical properties and map-scale limitations. The resulting units allow for simplicity of discussion and presentation without altering the conclusions of this study.

3.2.1 Rock Units

Geologic rock units were grouped into the following eight categories (Drawing 2): quartzite (Qtz), limestone (Ls), dolomite (Do), carbonate rocks undifferentiated (Cau), sedimentary rocks undifferentiated (Su), granitic rocks (Gr), basalt (Vb), and volcanic rocks undifferentiated (Vu).

3.2.1.1 Quartzite - Qtz

Two quartzite units are present in the study area. They are the Cambrian Prospect Mountain Quartzite, and the Ordovician Eureka Quartzite.

The Cambrian Prospect Mountain Quartzite crops out in the northern House Range (Drawing 2). This formation is over 2000 feet (610 m) thick and consists of reddish-brown to white, thin- to thick-bedded, well-indurated, fine-grained orthoquartzite. The unit contains interbeds of less resistant quartzite, micaceous shale, pebble conglomerate, and arkosic sandstone layers.

The Ordovician Eureka Quartzite crops out locally in the southwestern portion of the study area within the southern Confusion Range (Drawing 2). It is generally less than 500 feet (165 m)

thick and is closely associated and often mapped with dolomitic rock (Do). The formation is white or light-gray in appearance, vitreous, fine- to medium-grained, massive orthoquartzite and quartz sandstone. Shale and dolomitic sandstone are exposed at the top and base of the formation.

3.2.1.2 Limestone - Ls

Limestone is a carbonate rock which is hard, durable, and forms resistant outcrops within the study area. Mapped units consist of the Cambrian Marjum, Weeks, and Orr formations, Ordovician Pogonip Group, and Mississippian Joana and Pennsylvanian Ely limestones. These units are typically thin- to thick-bedded, fine- to coarse-grained, light- to dark-gray limestone with interbedded chert, sandstone, siltstone, and shale. Locally, these units may be fossiliferous. Limestone units are mapped in the Wah Wah, Confusion, and House ranges.

3.2.1.3 Dolomite - Do

Dolomite, a high magnesium content carbonate rock, is an abundant lithologic unit in the Paleozoic section. Units mapped as dolomite are the Ordovician Fish Haven, Silurian Laketown, and the Devonian Sevy and Simonson formations. They are typically medium- to thick-bedded, fine- to coarse-grained, medium- to dark-gray dolomite with interbedded chert, sandstone, and siltstone. These units are exposed in the southern and northern Confusion Range and in the northern Fish Springs Range.

3.2.1.4 Carbonate Rocks Undifferentiated - Cau

Undifferentiated carbonate rock units comprise the largest portion of the Paleozoic section. They were mapped where complex, interbedded sequences of limestone and dolomite were present or where map scale prevented delineation of individual units. Principal mapped units include the Cambrian Notch Peak and Devonian Guilmette Formations and exposures of upper Paleozoic carbonate rocks. The lithology of these units varies considerably but is typically medium- to thick-bedded, fine- to medium-grained, medium- to dark-gray dolomite and limestone with interbedded chert and sandstone. Undifferentiated carbonate rocks crop out throughout the study area.

3.2.1.5 Sedimentary Rocks Undifferentiated - Su

Undifferentiated sedimentary rocks were mapped where interbedded sandstone, siltstone, shale, limestone, and/or dolomite are exposed. The highly interbedded nature of these units and map-scale limitations prevent separation into individual rock types. Principal units consist of numerous lower to upper Cambrian formations, the Devonian Pilot and Mississippian Chainman shales and the Permian Arcturus and Triassic Thaynes formations. Undifferentiated sedimentary rocks are exposed in the northern House Range and the Confusion Range.

3.2.1.6 Granitic Rocks - Gr

Granitic rocks of Mesozoic age are exposed in the central House Range. This unit is typically medium- to coarse-grained, moderately well-jointed, gray to brownish-gray porphyritic

granite. Large sills and small dikes extend into adjacent sedimentary rocks.

3.2.1.7 Basalt -Vb

Basaltic flows of Tertiary age are mapped in northern Tule Valley. The basalt is typically medium- to thick-bedded, very dense, brown to black, vesicular, and moderately well-jointed.

3.2.1.8 Volcanic Rocks Undifferentiated - Vu

Undifferentiated volcanic rocks consist of a variety of inter-layered volcanic ashflow and air-fall tuffs and lava flows of Tertiary age. Composition ranges from basaltic to rhyolitic but is generally dacitic to rhyolitic. Volcanic units are extensively exposed at the southern end of Confusion and House ranges and in small isolated areas west of the Fish Springs Range.

3.2.2 Basin-fill Units

Four basin-fill units are mapped within the study area (Drawing 2). They consist of older lacustrine deposits (Aol), alluvial fan deposits (Aaf), stream-channel and terrace deposits (Aal), and undifferentiated deposits (Au). Gravel (g) and sand (s) grain-size designations (e.g., Aafg) have been assigned to basin-fill units in the Verification mapped areas. Basin-fill units which have high silt and/or clay content are considered unsuitable aggregate sources (Class III) and will not be discussed. These units are active playas, alluvial fans, or older lacustrine deposits located generally near the valley center.

3.2.2.1 Older Lacustrine Deposits - Aol

Widespread older lacustrine deposits in Tule Valley were formed during the existence of Pleistocene Lake Bonneville. Shoreline strand deposits are particularly well developed at elevations of approximately 4800 to 5200 feet (1440 to 1585 m) above mean sea level. These lacustrine deposits are typically poorly to moderately well-graded, moderately to well-stratified, loose to medium-dense sandy gravel and gravelly sand derived from quartzitic and carbonate source rocks. Clasts are subrounded to rounded; consist of gravel, cobbles, and boulders; and comprise between 18 and 87 percent of the deposit.

3.2.2.2 Alluvial Fan Deposits - Aaf

Alluvial fans bordering the mountain fronts and extending out into the valley basins are the most extensive potential basin-fill aggregate deposits mapped and labeled within the study area (Drawing 2). They are typically homogeneous to poorly stratified mixtures of boulders, cobbles, gravel, sand, silt, and clay that grade from very coarse-grained near the rock/alluvium contact to fine-grained near the valley centers.

Individual fan units contain poorly to moderately well-graded, angular to subangular particles that exhibit considerable lateral and vertical textural variation. Composition of the surrounding source rock strongly controls the textural properties of material formed in alluvial fan deposits. Fan units formed at the base of carbonate or quartzitic rocks are characteristically coarse-grained, whereas fans developed from volcanic

sources tend to be fine-grained. Caliche development in soils (Appendix B), a natural process of soil development in arid climates, ranges from none in younger fans to Stage III in older units.

3.2.2.3 Stream-Channel and Terrace Deposits - Aal

Stream-channel and terrace deposits are widespread throughout the study area although most are too small to depict at the 1:125,000 map scale. Deposits that were mapped represent significantly large drainages and are typically poorly graded, moderately well-stratified sand with some gravel, cobbles, and boulders. Locally, these units may be predominantly gravel. Most ephemeral streams commonly transect alluvial fan deposits and trend normal to the ranges toward the valley axis. These streams join the trunk ephemeral drainage system in the central basin, which drain into the central valley hardpans of either Tule Valley, Wah Wah Valley, or the Great Salt Lake.

3.2.2.4 Alluvial Deposits Undifferentiated - Au

Undifferentiated alluvial deposits consist primarily of eolian deposits located in the central basin areas. These eolian deposits are stratified mixtures of sand and silt derived from a wide range of rock types.

4.0 POTENTIAL AGGREGATE SOURCES

Based on the results of field visual observations and aggregate testing, potential basin-fill and rock sources were divided into three basic material types (i.e., coarse, fine, and crushed rock) and classified into one of the three use categories (Section 2.5). Basin-fill deposits tested in the study area may also be placed within a multiple-type category (coarse and fine aggregate source). Coarse aggregate (gravel to boulders) included material predominantly retained on the No. 4 sieve (0.185 inch [4.75 mm]). Fine aggregate (predominantly sand) includes material entirely passing the 3/8-inch sieve (0.375 inch [9.5 mm]), almost entirely passing the No. 4 sieve (0.187 inch [4.75 mm]), and retained on the No. 200 sieve (0.0029 inch [0.074 mm]).

Classification boundaries (Drawing 2) of basin-fill aggregate sources were generalized and will require additional studies to accurately define their location. Boundaries of identified crushed-rock sources are based on the areal extent of the geologic formations tested (i.e., Prospect Mountain Quartzite, Fish Haven Dolomite) and not on the aggregate geologic unit (i.e., Qtz, Do) described in Section 3.2.1.

In the following discussion, coarse, fine, or crushed-rock sources are discussed in that order. Within these headings Class I sources are presented first, followed by sources with successively lower potential (Class II and Class III). Aggregate sources presented in Class I and Class II categories are

discussed in order of their relative potential (best followed by successively lower potential) as concrete or road-base aggregate sources. This ranking of deposits is preliminary and based upon an analysis of Ertec and existing data.

4.1 BASIN-FILL SOURCES

4.1.1 Coarse Aggregate

4.1.1.1 Potentially Suitable Concrete Aggregate or Road-Base Material Sources - Class I

In Tule Valley, Class I coarse aggregate sources are located in alluvial fan deposits (Aafg, Aafs) along the western side of the House Range and the Fish Springs Range (Drawing 2). These fan units are predominantly poorly to moderately well-stratified, medium-dense sandy gravel and gravelly sand composed predominantly of subangular to subrounded quartzite, limestone, and dolomite clasts. Laboratory tests show acceptable abrasion, soundness, and alkali reactivity (where tested) results (Table 2). Overburden, ranging from 1 to 3 feet (0.3 to 0.9 m), consists of soil horizons with Stage I to III caliche development. Sieve analyses of these samples indicate that the fan deposits are poorly to moderately well-graded and generally have oversize material for crushing. Fine aggregate material comprises from 17 to 71 percent of the tested samples. Good access to these deposits is provided by numerous unpaved roads which transect the area and connect with U.S. Highway 6 and 50 to the south. Minability is considered good to excellent. Class I boundaries are tentative, and additional field investigations will be necessary to accurately define the limits of these sources.

Extensive Class I coarse aggregate sources are also located along the western side of Tule Valley within alluvial fan (Aafg) deposits that border the Confusion Range (Drawing 2). Alluvial units consist predominantly of medium-dense to dense, poorly to moderately well-stratified sandy gravel composed predominantly of subangular carbonate clasts. Laboratory test data indicate these deposits have acceptable abrasion and soundness values for Class I coarse material (Table 2). Alkali reactivity tests were not performed on these samples. Sieve analyses indicate that the fan deposits are poorly graded and generally have sufficient oversize material for crushing. Fine aggregates comprise as much as 22 percent of the tested deposits. Overburdened averages 3 to 4.5 feet (1.0 to 1.3 m) thick and consists of slightly cemented gravel (Stages I to II caliche development). Access to these deposits is provided by U.S. Highway 6 and 50 which traverses the area and by numerous unpaved roads. Minability is considered good to excellent. Additional field reconnaissance and testing will be necessary to accurately define the boundaries of these potential sources.

Class I aggregate sources were identified in older lacustrine deposits (Aolg, Aols) throughout the basin (Drawing 2). Field observations indicate these deposits consist of poorly stratified to stratified, loose to medium-dense gravelly sand or sandy gravel. Gravel comprises from 34 to 87 percent of these sources and consists primarily of subrounded carbonate, quartzite, and sandstone clasts. These deposits passed abrasion, soundness and alkali reactivity (where tested) requirements for Class I

sources. Sieve analyses for these samples indicate that the deposits are typically well-graded and generally contain sufficient oversize material for crushing. Overburden ranged from 1 to 3 feet (0.5 to 0.9 m) consisting of slightly cemented sand and gravel (Stages I to II caliche development). Boundaries of these units are tentative where shown and will require additional field investigations for accurate definition. The access and minability of these sources varies with individual location but are generally considered good to excellent.

Field observations suggest that most alluvial fan units and older lacustrine shoreline units located basinward from the rock/alluvium contact of Class I and possibly Class II carbonate or quartzitic rocks may qualify as Class I coarse aggregate sources.

4.1.1.2 Possibly Unsuitable Concrete Aggregate/Potentially Suitable Road-Base Material Sources - Class II

No Class II coarse aggregate sources were identified in the Tule Valley study area from laboratory test results. However, based on field observations, Class II coarse material is available in alluvial fan (Aafg, Aafs) and older lacustrine deposits (Aolg, Aols) throughout the valley area. Access and minability will vary but should generally be good.

4.1.1.3 Unsuitable Concrete Aggregate or Road-Base Material Sources - Class III

No unsuitable coarse aggregate sources were identified in the Tule Valley study area.

4.1.2 Fine Aggregate

4.1.2.1 Potentially Suitable Concrete Aggregate or Road-Base Material Sources - Class I

A Class I fine aggregate source was delineated in alluvial fan deposits (Aafg) east of the southern Confusion Range. This area is mapped as a multiple source because of the presence of Class I coarse aggregates (Section 4.1.1.1). These deposits are poorly to moderately well-graded, medium-dense to dense, poorly to moderately well stratified sandy gravel with subangular clasts composed predominantly of dolomite and limestone. Sand comprises from 19 to 22 percent of the tested samples. Tests for soundness were within acceptable limits for Class I fine aggregate. Overburden is generally less than 3 feet (0.9 m) and consists of a soil horizon with Stage I to Stage II caliche development. Numerous unpaved roads transect the area and connect with U.S. Highway 6 and 50 to the north. Minability is considered very good.

Class I fine aggregate sources are located in older lacustrine deposits (Aolg, Aols) throughout the valley basin. Some of these deposits are also mapped as multiple sources because of the high Class I coarse aggregates content (Section 4.1.1.1). Deposits are typically poorly to moderately well-graded, poorly stratified to stratified, loose to medium-dense sandy gravel and gravelly sand composed predominantly of dolomite and limestone clasts. Gravel comprises from 18 to 75 percent of the deposits. Laboratory testing indicates acceptable soundness and alkali reactivity (where tested) results. Overburden consists of 0 to

3 feet (0 to 0.9 m) of poorly developed soil with Stage I to II caliche. Minability and access are considered good to excellent for these sources. Boundaries of Class I fine aggregate sources are tentative where shown and will require additional field investigations for accurate delimitation.

A Class I fine aggregate source was identified in a stream-channel deposit (Aals) on the east side of Tule Valley, 8 miles north of U.S. Highway 6 and 50. This unit is typically moderately well to well-graded, crudely stratified gravelly sand. Gravel comprises as much as 27 percent of this source with clasts composed predominantly of granite rock fragments. Soundness test results are within acceptable standards for Class I fine aggregate. The accessibility and minability of this source is generally very good. Boundaries of this source could not be defined and will require additional field studies and testing to accurately define.

Based on field observations, additional Class I fine aggregate sources may exist in alluvial fans (Aafs, Aafg) located adjacent to Class I and/or Class II crushed-rock sources and in unmapped and mapped older lacustrine (Aolg, Aols) units.

4.1.2.2 Possibly Unsuitable Concrete Aggregate/Potentially Suitable Road-Base Material Sources - Class II

Class II fine aggregate sources were identified from test results in alluvial fan (Aafs) and older lacustrine (Aolg, Aols) deposits throughout the study area. Tested samples failed to meet acceptable Class I standards for soundness and/or alkali

reactivity. The physical properties, composition, and source of these samples is variable. Field observations and laboratory test data for the sources are presented in Appendix A. Additional Class II fine aggregate sources should be available from most Class I and Class II basin-fill areas depicted in Drawing 2.

4.1.2.3 Unsuitable Concrete Aggregate or Road-Base Material Sources - Class III

Class III fine aggregate sources are generally located in the central valley basins and are comprised predominantly of older lacustrine and recent playa deposits (Drawing 2). These sediments are typically interbedded, medium-dense fine sand and soft to stiff silt and clay.

4.2 CRUSHED-ROCK SOURCES

4.2.1 Potentially Suitable Concrete Aggregate or Road-Base Material Sources - Class I

Class I crushed-rock aggregate sources are distributed throughout the study area, occurring in the Confusion, Wah Wah, Fish Springs, and House ranges. Mapped units consist of undifferentiated carbonate rocks (Cau) of the Notch Peak and Guilmette formations; dolomite (Do) from the Laketown, Sevy, and Simonson formations; quartzite (Qtz) from the Prospect Mountain Formation; limestone (Ls) from the Marjum Formation; and basalt (Vb).

The Cambrian Notch Peak Formation (Cau) is exposed predominantly in the Wah Wah, Fish Springs, and House ranges (Drawing 2). It

is typically hard, medium- to thick-bedded, fine- to medium-grained, medium- to dark-gray interbedded limestone and dolomite. Locally, some interbedded shale is exposed. Laboratory data for the Notch Peak Formation indicate acceptable results for abrasion, soundness, and alkali reactivity. Test data from Wah Wah Valley (FN-TR-37-g) which lies south of the present study area indicate similar results. Accessibility and minability are good to excellent especially in the small hills in the central basin east of the Confusion Range.

The Devonian Guilmette Formation (Cau) was not tested within the study area but is considered a Class I source from test results in nearby Snake (FN-TR-37-b) and Hamlin (FN-TR-37-e) valleys. This unit is exposed in the northern and southern Confusion Range (Drawing 2). It consists of hard, thick-bedded, light- to dark-gray interbedded limestone and dolomite which may be locally sandy and/or silty. Field observations indicate that splitting characteristics are favorable for crushing. Accessibility and minability range from poor to good depending on location within the study area.

The Ordovician Fish Haven, Silurian Laketown, and Devonian Simonson and Sevy dolomites (Do) are exposed in the northern and southern Confusion Range and northern Fish Springs Range (Drawing 2). They consist primarily of dolomites with thin interbeds of chert, sandstone, siltstone, and sedimentary breccia. The dolomites are typically hard, medium- to thick-bedded, fine- to coarse-grained, medium- to dark-brown or gray and have favorable

splitting characteristics for crushing. Abrasion, soundness, and alkali reactivity tests (performed only on Fish Haven) indicate these units are within Class I standards for crushed-rock aggregates (Simonson and Fish Haven dolomites tested in Hamlin Valley, FN-TR-37-d; and Pine Valley, FN-TR-37-g; respectively). Alkali reactivity tests were not performed on the Laketown, Simonson and Sevy dolomites, however, field observations indicate potentially deleterious reactions may result from chert lenses and nodules occurring in these formations. The access and minability of these dolomites is considered good to excellent especially east of the Southern Confusion Range.

The Cambrian Prospect Mountain Quartzite (Qtz) was identified as a Class I crushed-rock source within the Swasey Mountains at the north end of the House Range (Drawing 2). Field observations indicate that the unit is very hard, thin- to thick-bedded, fine-grained, reddish-brown quartzite. The rock unit has slabby splitting characteristics and no deleterious materials. Abrasion, soundness, and alkali reactivity tests are within Class I standards for crushed-rock aggregate. Good to excellent access is provided by numerous unpaved roads. Minability is generally very good.

The Cambrian Marjum Formation (Ls) is exposed in the Swasey Mountains in northwestern Wah Wah Valley. The Marjum is hard, thin- to very thick-bedded, fine- to coarse-grained, dark-gray limestone with interbedded light-gray shaley dolomite in the upper part. Laboratory tested samples (Whirlwind Valley Report,

FN-TR-37-e; Pine and Wah Wah Valley Report, FN-TR-37-g) meet acceptable Class I standards for abrasion and soundness but were untested for alkali reactivity. Splitting characteristics, minability, and accessibility are moderately good to good.

Tertiary basalt exposed in northern Tule Valley is considered a Class I source. This unit consists of hard, medium- to thick-bedded, slightly vesicular, dark-brown basalt with moderately good splitting characteristics. Accessibility and minability are very good to excellent. The basalt was tested and found to meet Class I requirements for abrasion, soundness, and alkali reactivity.

4.2.2 Possible Unsuitable Concrete Aggregate/Potentially Suitable Road-Base Material - Class II

Class II crushed-rock aggregate sources were not specifically identified from the laboratory testing program. Extensive rock units, indicated in Drawing 2 as Class II crushed rock sources, were classified only by field visual observations. Paleozoic carbonates (Cau, Ls), undifferentiated sedimentary units (Su), and undifferentiated volcanics (Vu) comprise the predominant rock types in this category.

4.2.3 Unsuitable Concrete Aggregate or Road-Base Material Sources - Class III

The Ordovician Eureka Quartzite (Qtz) within the Confusion Range in southern Tule Valley failed to meet Class I abrasion standards and is classified as a Class III source. This unit is a very hard, thin- to thick-bedded, white- or light-gray, fine- to medium-grained, massive orthoquartzite. Because this formation

has passed Class I crushed-rock requirements in northern Pine Valley (FN-TR-37-g), further field investigations will be necessary to accurately define its lithology and determine an overall classification.

5.0 CONCLUSIONS

Results of the valley-specific aggregate investigation indicate that potentially good- to high-quality (Class I and II) basin-fill and crushed-rock aggregate sources are present within the Tule Valley valley-specific area to meet construction requirements of the MX system (Drawing 2).

5.1 POTENTIAL BASIN-FILL AGGREGATE SOURCES

5.1.1 Coarse Aggregate

Major Class I coarse aggregate deposits listed in order of potential suitability, have been identified within the following areas:

1. Extensive alluvial fan (Aafg, Aafs) deposits west of the House Range and Fish Springs Range in the eastern part of the study area;
2. Extensive coarse alluvial fan (Aafg) deposits bordering the Confusion Range along the western side of the valley; and
3. Older lacustrine shoreline (Aolg, Aols) deposits throughout the valley basin.

Field observations and laboratory testing indicate additional sources of Class I coarse aggregate are available in alluvial fan deposits (Aafg, Aafs) adjacent to Class I and/or Class II crushed-rock sources and in older lacustrine deposits (Aolg, Aols) throughout the valley.

Based on field observation and limited test results, potentially suitable Class II coarse aggregate sources are widespread and extensive in the study area. Although boundaries of specific

deposits could not be delineated, they are typically located within older lacustrine deposits (Aolg, Aols) or alluvial fans (Aafg, Aafs) flanking Class I and/or Class II rock sources.

5.1.2 Fine Aggregate

While most coarse aggregate sources will supply quantities of fine aggregate (multiple source) either from the natural deposits or during processing, several fine aggregate sources were sampled and tested. They are:

1. Extensive alluvial fan (Aafg) deposits east of the southern Confusion Range;
2. Older lacustrine (Aolg, Aols) deposits located throughout the valley basin; and
3. A stream-channel (Aals) deposit west of the House Range in east-central Tule Valley.

Further field reconnaissance will be required to identify and delineate additional Class I fine aggregate sources, however, based on field observations, potential sources may exist in alluvial fan units (Aafg, Aafs) derived from Class I and/or Class II rock sources and in older lacustrine shoreline units (Aolg, Aols).

Potential Class II fine aggregate sources are widespread and extensive throughout the study area. Specific boundaries could not be delineated but typically occur in alluvial fan (Aafs, Aafg) and older lacustrine (Aolg, Aols) deposits basinward of most Class I and Class II rock exposures.

5.2 POTENTIAL CRUSHED-ROCK AGGREGATE SOURCES

Class I crushed-rock sources exist in several sections of the study area. The most suitable deposits and their corresponding

locations are as follows:

- | | |
|---|---|
| 1. Fish Haven Laketown, Sevy, and Simonson dolomites (Do) and the Notch Peak and Guilmette formations (Cau) | - Southern Tule Valley study area (southern Confusion and House ranges and the northern Wah Wah Range). |
| 2. Notch Peak and Guilmette formations (Cau), Laketown, Sevy, and Simonson dolomites (Do) and basalt (Vb) | - Northwestern Tule Valley study area (northern Confusion Range and adjacent valley areas). |
| 3. Prospect Mountain Quartzite (Qtz), Marjum Limestone (Ls), Notch Peak Formation (Cau), and the Fish Haven Laketown, Sevy, and Simonson dolomites (Do) | - Northeastern Tule Valley study area (northern House Range and the Fish Springs Range). |

Carbonate (Cau, Do) Class I crushed-rock sources, exposed in southern Tule Valley (near Highway 6 and 50) and in small hills east of the Confusion Range, could provide crushed-rock material for much of the study area because of their good to excellent access and minability.

Undifferentiated volcanic rocks (Vu), limestone (Ls), and undifferentiated carbonate (Cau) and sedimentary rocks (Su), which are widely distributed throughout the study area, compose most of the Class II crushed-rock sources classified by field visual observations and delineated in Drawing 2.

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APPENDIX A

ERTEC WESTERN FIELD STATION AND
SUPPLEMENTARY TEST DATA AND EXISTING
TEST DATA SUMMARY TABLES
TULE VALLEY, UTAH

EXPLANATION OF ERTEC WESTERN
FIELD STATION AND SUPPLEMENTARY
TEST DATA

Ertec Western field stations were established at locations throughout the Valley-Specific Study Area where detailed descriptions of potential basin-fill or rock aggregate sources were recorded (Drawing 1). All field observations and laboratory test data on samples collected at selected stations are presented in Table A-1. Data entries record conditions at specific field station locations that have been generalized in the text and Drawing 2. Detailed explanations for the column headings in Table A-1 are as follows:

<u>Column Heading</u>	<u>Explanation</u>
Map Number	This sequentially arranged numbering system was established to facilitate the labelling of Ertec Western field station locations and existing data sites in Drawing 1 and to list the correlating information in Tables A-1 and A-2 in an orderly arrangement.
Field Station	Ertec Western field station data are comprised of information collected during: - o The Valley-Specific Aggregate Resources Study; sequentially numbered field stations were completed by two investigative teams (A and B). - o The general aggregate investigation in Utah (UGS). - o The Verification study in Tule Valley; trench data (TL-T) were restricted to information below the soil horizon (3 to 12 feet [1 to 4 m]).
Location	Lists major physiographic or cultural features in/or near which field stations or existing data sites are situated.

<u>Column Heading</u>	<u>Explanation</u>
Geologic Unit	Generalized basin-fill or rock geologic units at field station or existing data locations. Thirteen classifications, emphasizing age and lithologic distinctions, were developed from existing geologic maps to accommodate map scale of Drawing 2.
Material Description	Except in cases where soil or rock samples were classified on laboratory results, the descriptions are based on field visual observations utilizing the Unified Soil Classification System (see Appendix C for detailed USCS information).
Field Observations	
Boulders and/or Cobbles, Percent	The estimated percentage of boulders and cobbles is based on an appraisal of the entire deposit. Cobbles have an average diameter between 3 and 12 inches (8 and 30 cm); boulders have an average diameter of 12 inches (30 cm) or more.
Gravel	Particles that will pass a 3-inch (76 mm) sieve and are retained on No. 4 (4.75 mm) sieve.
Sand	Particles passing No. 4 sieve and retained on No. 200 (0.075 mm) sieve.
Fines	Silt or clay, soil particles passing No. 200 sieve.
Plasticity (Index)	Plasticity index is the range of water content, expressed as percentage of the weight of the oven-dried soil, through which the soil is plastic. It is defined as the liquid limit minus the plastic limit. Field classification followed standard descriptions and their ranges are as follows: None - Nonplastic (NP) (PI, 0 - 4) Low - Slightly plastic (PI, 4 - 15) Medium - Medium plastic (PI, 15 - 30) High - Highly plastic (PI, > 31)
Hardness	A field test to identify materials that are soft or poorly bonded by estimating their resistance to impact with a rock hammer; classified as either soft, moderately hard, hard, or very hard.

<u>Column Heading</u>	<u>Explanation</u>
Weathering	Changes in color, texture, strength, chemical composition or other properties of rock outcrops or rock particles due to the action of weather; field classified as either fresh or slight(ly), moderate(ly) or very weathered.
Deleterious Materials	Substances potentially detrimental to concrete performance that may be present in aggregate; includes organic impurities, low-density material, (ash, vesicules, pumice, cinders), amorphous silica (opal, chert, chalcedony), volcanic glass, caliche coatings, clay coatings, mica, gypsum, pyrite, chlorite, and friable materials; also, aggregate that may react chemically or be affected chemically by other external influences.

Laboratory Test Data

Sieve Analysis (ASTM C 136)	The determination of the proportions of particles lying within certain size ranges in granular material by separation on sieves of different size openings; 3-inches, 1 1/2-inches, 3/4-inch, 3/8-inch, No. 4, No. 8, No. 16, No. 30, No. 50, No. 100 and No. 200.
No. 8, No. 16, No. 30, No. 50	Asterisked entries used No. 10, No. 20, No. 40, and No. 60 sieves, respectively.
Abrasion Test (ASTM C 131)	A method for testing abrasion resistance of an aggregate by placing a specified amount in a steel drum (the Los Angeles testing machine), rotating it 500 times, and determining the material worn away.
Soundness Test (ASTM C 88) CA, FA	CA = Coarse Aggregate FA = Fine Aggregate The testing of aggregates to determine their resistance to disintegration by saturated solutions of magnesium sulfate. It furnishes information helpful in judging the soundness of aggregates subject to weathering action, particularly when adequate information is not available from service records of the material exposed to actual weathering conditions.

<u>Column Heading</u>	<u>Explanation</u>
Specific Gravity and Absorption (ASTM C 127 and 128)	Methods to determine the Bulk Specific Gravity, Bulk SSD Specific Gravity (Saturated - Surface Dry Basis), and Apparent Specific Gravity and Absorption as defined in ASTM E 12-70 and ASTM C 125, respectively.
Alkali Reactivity (ASTM C 289)	This method covers chemical determination of the potential reactivity of an aggregate with alkalis in portland cement concrete as indicated by the amount of reaction during 24 hours at 80°C between 1 N sodium hydroxide solution and aggregate that has been crushed and sieved to pass a No. 50 (300 m) sieve and be retained on a No. 100 (150 m) sieve.
Aggregate Use	I = Class I; potentially suitable concrete aggregate and road-base material source II = Class II; possibly unsuitable concrete aggregate/potentially suitable road-base material source III = Class III; unsuitable concrete aggregate or road base material source c = coarse aggregate f = fine aggregate f/c = fine and coarse aggregate cr = crushed rock All sources not specifically identified as Class I, II, or III from the abrasion, soundness, or alkali reactivity tests or the content of clay- and silt-sized particles are designated as Class II sources.

MAP NUMBER	FIELD STATION	LOCATION	GEOLOGIC UNIT	MATERIAL DESCRIPTION	USCS SYMBOL	BOULDERS AND/OR COBBLES, PERCENT	DISTRIBUTION OF MATERIAL FINER THAN COBBLES, PERCENT	
							GRAVEL	SAND
1	TL-A1	Tule Valley	Aolg	Sandy Gravel	GM			
2	TL-A2	Tule Valley	Aafs	Sandy Gravel	GP-GM	5	55	35
3	TL-A3	Tule Valley	Aolg	Gravelly Sand	SW-SM			
4	TL-A4	Tule Valley	Aolg	Gravelly Sand	SP-SM	T	35	60
5	TL-A5	Chalk Knoll	Cau	Limestone				
6	TL-A6	Tule Valley	Aolg	Sandy Gravel	GP-GM	T	55	40
7	TL-A7	Lodger Canyon	Aalg	Sandy Gravel	GP	3	60	35
8	TL-A8	Cowboy Pass	Aols	Gravelly Sand	SW			
9	TL-A9	Cowboy Pass	Aafs	Gravelly Sand	SP	T	40	60
10	TL-A10	Cowboy Pass	Aafs	Gravelly Sand	SW-SM			
11	TL-A11	Tule Valley	Aols	Gravelly Sand	SW-SM			
12	TL-A12	Tule Valley	Aolg	Sandy Gravel	GW			
13	TL-A13	Tule Valley	Aolg	Sandy Gravel	GP	10	65	35
14	TL-A14	Tule Valley	Aafs	Gravelly Sand	GP-GM	0	40	50
15	TL-A15	Tule Valley	Aolg	Sandy Gravel/ Gravelly Sand	GP/SP	T	50	50

FIELD OBSERVATIONS														
BOULDERS AND/OR COBBLES, PERCENT	DISTRIBUTION OF MATERIAL FINER THAN COBBLES, PERCENT			PLASTICITY	HARDNESS	WEATHERING	DELETERIOUS MATERIALS	SIEVE ANALYSIS, PERCENT PASS						
	GRAVEL	SAND	FINES					3"	1½"	¾"	¾"	NO. 4	NO. 8	NO. 1
				Low			Caliche Coatings, Chert	100	87.6	63.3	45.2	34.8	27.4	21
5	55	35	10	None			None							
				None			Clay Coating		100	98.3	87.6	58.5	38.4	24
T	35	60	5	None			None							
					Hard	Slight to Moderate	Chert, Calcite Veins							
T	55	40	5	None			Chert							
3	60	35	5	None			Chert, Friable Material							
				None			Chert, Friable Material	97.7	93.7	91.2	82.9	65.9	54.6	3
T	40	60	T	None			Chert							
				Low			Chert, Caliche Coatings		98.1	96.3	85.0	62.4	44.4	2
				None			Chert, Caliche Coatings	100	99.4	97.4	93.2	81.6	58.3	2
				None			Caliche Coatings	100	98.4	90.2	68.8	33.6	25.9	
10	65	35	0	None			Caliche Coatings							
0	40	50	10	None			Caliche Coatings, Chert							
T	50	50	T	None			Caliche Coatings, Chert							

LABORATORY TEST DATA

ANALYSIS, PERCENT PASSING (ASTM C 136)								ABRASION TEST (ASTM C 131)	SOUNDNESS TEST (ASTM C 88)		SPECIFIC GRAVITY AND ABSORPTION (ASTM C 127 AND C 128)						
											COARSE AGGREGATE			FINE AGGREGATE			
											SPECIFIC GRAVITY			PERCENT ABSORPTION	SPECIFIC GRAVITY		
3/8"	NO. 4	NO. 8	NO. 16	NO. 30	NO. 50	NO. 100	NO. 200	PERCENT WEAR	PERCENT LOSS		BULK	BULK SSD	APPAR- ENT		BULK	BULK SSD	APPAR- ENT
									CA	FA							
45.2	34.8	27.4	22.3	19.0	15.9	13.2	12.6	24.5	2.5	9.8							
87.6	58.5	38.4	24.5	16.2	11.8	9.3	6.9		3.6	9.1							
								38.4	14.6		2.63	2.66	2.71	1.15			
82.9	65.9	54.6	36.6	17.1	5.7	2.7	1.7	25.6	5.8	7.7					2.64	2.67	2.71
85.0	62.4	44.4	28.6	20.2	15.0	12.7	10.5		7.9	21.9							
93.2	81.6	58.3	26.5	13.6	10.5	8.7	5.4			15.0							
68.8	33.6	25.9	23.5	18.6	11.8	6.1	3.6	26.7	2.3	15.9							

SPECIFIC GRAVITY AND ABSORPTION (ASTM C 127 AND C 128)							ALKALI REACTIVITY (ASTM C 289)		AGGREGATE USE
COARSE AGGREGATE		FINE AGGREGATE							
GRAVITY	PERCENT ABSORPTION	SPECIFIC GRAVITY			PERCENT ABSORPTION				
APPAR- ENT		BULK	BULK SSD	APPAR- ENT					
						CA	FA		
2.71	1.15					Innocuous		Ic/f	
							Deleterious	IIc/f	
								II f/c	
								II f/c	
								Icr	
								IIc/f	
								IIc/f	
		2.64	2.67	2.73	1.30		Innocuous	If/c	
								II f/c	
								II f/c	
								If	
								Ic	
								II f	
								IIc/f	
								II f/c	
								IIc/f	



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ERTEC WESTERN FIELD STATION
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TABLE A-1

MAP NUMBER	FIELD STATION	LOCATION	GEOLOGIC UNIT	MATERIAL DESCRIPTION	USCS SYMBOL	BOULDERS AND/OR COBBLES, PERCENT	DISTRIBUTION MATERIAL FINER THAN COBBLES PERCENT	
							GRAVEL	SAND
16	TL-B1	Tule Valley	Aolg	Sandy Gravel	GP			
17	TL-B2	Tule Valley	Su	Orthoquartzite				
18	TL-B3	Tule Valley	Aafg	Sandy Gravel	GW			
19	TL-B4	Blind Valley	Aalg	Sandy Gravel	GP	2	60	35
20	TL-B5	Barn Hills	Do	Dolomite				
21	TL-B6	Tule Valley	Aolg	Gravelly Sand	SW/GW			
22	TL-B7	Tule Valley	Aafs	Sandy Gravel	GW-GM			
23	TL-B8	Tule Valley	Aals	Gravelly Sand	SW			
24	TL-B9	Tule Valley	LS	Limestone				
25	TL-B10	Swasey Mountains	Su	Limestone				
26	TL-B11	Tule Valley	Aafs	Gravelly Sand	SP	2	45	50
27	TL-B12	Tule Valley	Aafs	Gravelly Sand	SP	5	45	50
28	TL-B13	Tule Valley	Aafg	Sandy Gravel	GW			
29	TL-B14	Tule Valley	Aafs	Gravelly Sand	SP	10	45	50
30	TL-B15	Tule Valley	Aafs	Sandy Gravel	GP	3	55	40
31	TL-B16	Tule Valley	Aolg	Sandy Gravel	GP-GM	T	50	40

S DL	FIELD OBSERVATIONS								SIEVE ANALYSIS, PERCENT PASS					
	BOULDERS AND/OR COBBLES, PERCENT	DISTRIBUTION OF MATERIAL FINER THAN COBBLES PERCENT			PLASTICITY	HARDNESS	WEATHERING	DELETERIOUS MATERIALS						
		GRAVEL	SAND	FINES					3"	1½"	¾"	⅜"	NO. 4	NO. 8
					Low			Caliche Coatings, Fines	100	85.8	41.0	25.5	21.1	
						Mod. Hard	Slight	None						
					None			Caliche Nodules	100	75.3	52.8	35.0	26.4	22.6
	2	60	35	5	None			Caliche Coatings						
						Hard	Slight	Chert						
					None			Chert	100	99.5	91.7	75.4	50.8	34.6
					Low			Fines	93.1	84.5	72.6	57.5	41.9	31.3
					None			None		100	99.0	94.9	73.4	50.2
						Hard	Slight	Calcite Veins						
						Hard	Slight	Calcite Veins						
	2	45	50	5	None			Caliche Coatings						
	5	45	50	5	None			Caliche Coatings						
					Low			Friable Material	96.5	85.7	62.9	35.2	18.2	13.0
	10	45	50	5	None			Caliche Coatings, Friable Material						
	3	55	40	5	None			Friable Material						
	T	50	40	10	Low			Caliche Coatings						

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LABORATORY TEST DATA

LYSIS, PERCENT PASSING (ASTM C 136)								ABRASION TEST (ASTM C 131)	SOUNDNESS TEST (ASTM C 88)		SPECIFIC GRAVITY AND ABSORPTION (ASTM C 127 AND C 128)								
											COARSE AGGREGATE			FINE AGGREGATE					
											SPECIFIC GRAVITY			PERCENT ABSORPTION	SPECIFIC GRAVITY				
NO.	NO. 4	NO. 8	NO. 16	NO. 30	NO. 50	NO. 100	NO. 200	PERCENT WEAR	PERCENT LOSS		BULK	BULK SSD	APPAR- ENT			BULK	BULK SSD	APPAR- ENT	
									CA	FA									
5.5	21.1							20.0	1.4										
5.0	26.4	22.6	19.5	17.0	12.9	7.6	4.7	22.8	1.8	11.4									
								25.7	1.5										
5.4	50.8	34.6	18.5	10.8	5.1	1.6	0.9	39.9	2.8	13.0	2.67	2.69	2.72	0.59	2.60	2.64	2.71		
7.5	41.9	31.3	22.8	16.9	12.4	9.1	6.2	30.7	4.7	14.2	2.78	2.80	2.84	0.66	2.63	2.67	2.73		
4.9	73.4	50.2	27.9	14.4	6.9	3.9	2.5			9.5									
5.2	18.2	13.0	9.5	7.7	6.1	4.8	3.9	24.0	2.9	23.8									

SPECIFIC GRAVITY AND ABSORPTION (ASTM C 127 AND C 128)						ALKALI REACTIVITY (ASTM C 289)		AGGREGATE USE
COARSE AGGREGATE		FINE AGGREGATE						
TYPE	PERCENT ABSORPTION	SPECIFIC GRAVITY			PERCENT ABSORPTION	CA	FA	
		BULK	BULK SSD	APPAR- ENT				
								Ic
								IIcr
								Ic/f
								IIc/f
								Icr
2	0.59	2.60	2.64	2.71	1.67	Innocuous	Innocuous	If/c
4	0.66	2.63	2.67	2.73	1.34	Innocuous	Innocuous	Ic/f
								If
								IIcr
								IIcr
								IIf/c
								IIf/c
								Ic
								IIf
								IIf/c
								IIc/f
								IIc/f



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TABLE A-1

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MAP NUMBER	FIELD STATION	LOCATION	GEOLOGIC UNIT	MATERIAL DESCRIPTION	USCS SYMBOL	BOULDERS AND/OR COBBLES, PERCENT	DISTRIBUTION OF MATERIAL FINER THAN COBBLES, PERCENT		
							GRAVEL	SAND	FINES
32	TL-B17	Tule Valley	Aafg	Sandy Gravel	GP-GM	T	50	40	10
33	TL-B18	Tule Valley	Aols	Gravelly Sand	SP	T	35	65	T
34	TL-B19	Tule Valley	Vb	Basalt					
35	TL-B20	Tule Valley	Aolg	Sandy Gravel	GP	T	52	48	T
36	TL-B21	Tule Valley	Do	Dolomite					
37	TL-B22	Granite Mountain	Cau	Limestone					
38	TL-B23	Confusion Range	Cau	Limestone & Sandstone					
39	TL-B24	Tule Valley	Aolg	Sandy Gravel	GP	2	52	48	T
40	TL-B25	Tule Valley	Aafs	Sandy Gravel	GP	3	55	40	5
41	TL-B26	Blind Valley	Aafg	Sandy Gravel	GP				
42	TL-B27	Blind Valley	Aafg	Sandy Gravel	GP	3	65	35	T
43	TL-B28	Tule Valley	Aafs	Sandy Gravel	GP	1	65	30	5
44	TL-B29	Black Hills	Ls	Limestone					
45	TL-B30	Tule Valley	Aafs	Gravelly Sand	SP	0	48	52	T
46	TL-B31	Tule Valley	Aols	Gravelly Sand	SP-SM	2	44	46	10
47	TL-B32	Tule Valley	Aafs	Sandy Gravel	GP-GM	T	55	35	10
48	TL-B33	Tule Valley	Aolg	Sandy Gravel	GW				

FIELD OBSERVATIONS

SIEVE ANALYSIS, PERCENT PASSING (ASTM)

PERCENT	DISTRIBUTION OF MATERIAL FINER THAN COBBLES, PERCENT			PLASTICITY	HARDNESS	WEATHERING	DELETERIOUS MATERIALS	SIEVE ANALYSIS, PERCENT PASSING (ASTM)							
	GRAVEL	SAND	FINES					3"	1½"	¾"	3/8"	NO. 4	NO. 8	NO. 16	NO. 30
50	40	10	Low				Caliche Coatings								
35	65	T	None				None								
					Hard	Slight	Volcanic Glass								
52	48	T	None				None								
					Hard	Slight to Moderate	None								
					Hard	Slight	None								
					Hard	Slight	None								
52	48	T	None				Chert								
55	40	5	Low				Chert								
			None				None	100	90.9	61.2	35.5	22.3	16.4	13.3	11
65	35	T	None				None								
65	30	5	None				None								
					Hard	Slight	Chert								
48	52	T	Low				Caliche Coatings, and Nodules								
44	46	10	Low				Chert								
55	35	10	Low				Caliche Coatings								
			None				Caliche Coatings	100	96.7	68.6	42.0	25.4	13.1	9.7	

LABORATORY TEST DATA

PERCENT PASSING (ASTM C 136)							ABRASION TEST (ASTM C 131)	SOUNDNESS TEST (ASTM C 88)		SPECIFIC GRAVITY AND ABSORPTION (ASTM C 127 AND C 128)							
										COARSE AGGREGATE				FINE AGGREGATE			
										SPECIFIC GRAVITY			PERCENT ABSORPTION	SPECIFIC GRAVITY			PERCENT ABSORPTION
										BULK	BULK SSD	APPAR- ENT		BULK	BULK SSD	APPAR- ENT	
NO. 8	NO. 16	NO. 30	NO. 50	NO. 100	NO. 200	PERCENT WEAR	PERCENT LOSS CA FA		BULK	BULK SSD	APPAR- ENT	PERCENT ABSORPTION	BULK	BULK SSD	APPAR- ENT	PERCENT ABSORPTION	
						23.4	0.7		2.81	2.82	2.83	0.24					
						24.1	0.8										
3	16.4	13.3	11.6	9.3	6.4	3.7	23.0	1.2	10.8								
							46.9	24.1									
4	13.1	9.7	2.6	1.9	1.6	1.3	23.7	1.7	6.9								

STRENGTH AND ABSORPTION (ASTM C 127 AND C 128)					ALKALI REACTIVITY (ASTM C 289)		AGGREGATE USE
FINE AGGREGATE							
SPECIFIC GRAVITY			PERCENT ABSORPTION	CA	FA		
BULK	BULK SSD	APPAR- ENT					
				Innocuous		IIc/f	
						II f/c	
						Icr	
						IIc/f	
						Icr	
						IIcr	
						IIcr	
						IIc/f	
						IIc/f	
						Ic/f	
						IIc/f	
						IIc/f	
						IIcr	
						II f/c	
						II f/c	
						IIc/f	
						Ic/f	



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TABLE A-1

MAP NUMBER	FIELD STATION	LOCATION	GEOLOGIC UNIT	MATERIAL DESCRIPTION	USCS SYMBOL	BOULDERS AND/OR COBBLES, PERCENT	DISTRIBUTION OF MATERIAL FINER THAN COBBLES, PERCENT	
							GRAVEL	SAND
49	TL-B34	Tule Valley	Aols	Sandy Gravel	GW-GM			
50	TL-B35	Tule Valley	Aafg	Sandy Gravel	GP	5	65	30
51	TL-B36	Tule Valley	Aols	Sandy Gravel	GW-GM			
52	TL-B37	Tule Valley	Aafs	Sandy Gravel	GP	12	60	40
53	TL-B38	Tule Valley	Aafs	Sandy Gravel	GP-GM			
54	TL-B39	Swasey Mountains	Qtz	Quartzite				
55	TL-B40	Tule Valley	Aolg	Sandy Gravel	GW			
56	WA-B1	Confusion Range	Cau	Dolomite				
57	WA-B2	Confusion Range	Qtz	Orthoquartzite				
58	WA-B3	Tule Valley	Vu	Intravolcanic Sandstone				
59	WA-B4	Black Hills	Ls	Limestone				
60	WA-B9	Grassy Cove	Ls	Limestone				
61	WW-A16	House Range	Ls	Limestone				
62	WW-A17	House Range	Gr	Granite				
63	WW-A18	House Range	Su	Limestone				

FIELD OBSERVATIONS

SIEVE ANALYSIS, PERCENT PAS

BOULDERS AND/OR COBBLES, PERCENT	DISTRIBUTION OF MATERIAL FINER THAN COBBLES PERCENT			PLASTICITY	HARDNESS	WEATHERING	DELETERIOUS MATERIALS	SIEVE ANALYSIS, PERCENT PAS						
	GRAVEL	SAND	FINES					3"	1½"	¾"	⅜"	NO. 4	NO. 8	
5	65	30	5	None			Caliche Coatings	93.4	73.8	52.8	42.4	30.1	21.3	
				None			Caliche Coatings							
				None			None	90.2	79.3	67.8	54.7	41.4	29.0	
12	60	40	T	None			Caliche Coatings							
				None			Friable Material	100	83.8	60.4	39.3	26.6	19.4	
				None			Very Hard	Slight	None					
							Caliche Coatings		83.0	69.8	52.6	37.5	24.8	
							Hard	Slight	Chert					
							Very Hard	Slight	None					
							Soft	Slight	Volcanic Glass & Ash, Friable Material					
							Hard	Slight	Chert					
							Hard	Slight	Chert, Calcite Veins					
							Very Hard	Slight	Chert, Friable Material					
							Very Hard	Moderate	None					
							Very Hard	Fresh	Chert					

LABORATORY TEST DATA

ANALYSIS, PERCENT PASSING (ASTM C 136)									ABRASION TEST (ASTM C 131)	SOUNDNESS TEST (ASTM C 88)		SPECIFIC GRAVITY AND ABSORPTION (ASTM C 127 AND C 128)						
												COARSE AGGREGATE			FINE AGGREGATE			
												SPECIFIC GRAVITY			PERCENT ABSORPTION	SPECIFIC GRAVITY		
3/8"	NO. 4	NO. 8	NO. 16	NO. 30	NO. 50	NO. 100	NO. 200	PERCENT WEAR		PERCENT LOSS		BULK	BULK SSD	APPAR- ENT		PERCENT ABSORPTION	BULK	BULK SSD
									CA	FA								
3	42.4	30.1	21.3	15.9	12.9	10.5	8.5	6.5	29.0	1.0	10.8	2.69	2.70	2.73	0.65			
3	54.7	41.4	29.0	21.6	16.7	12.1	8.6	6.1	25.8	1.7	8.7							
4	39.3	26.6	19.4	15.2	12.8	11.0	9.6	8.1	26.9	4.7	25.2	2.65	2.68	2.74	1.21			
									25.4	0.4		2.64	2.65	2.66	0.26			
5	52.6	37.5	24.8	13.8	10.3	3.0	1.3	0.9	20.4	0.7	7.8					2.78	2.80	
									56.7									

**SPECIFIC GRAVITY AND ABSORPTION
(ASTM C 127 AND C 128)**

(ASTM C 127 AND C 128)								ALKALI REACTIVITY (ASTM C 289)		AGGREGATE USE
GRAVITY		FINE AGGREGATE								
APPAR- ENT	PERCENT ABSORPTION	SPECIFIC GRAVITY			PERCENT ABSORPTION	CA	FA			
		BULK	BULK SSD	APPAR- ENT						
2.73	0.65					Innocuous			Ic/f IIc/f Ic/f IIc/f	
2.74	1.21					Innocuous			Ic IIc Icr	
2.66	0.26					Innocuous				
		2.78	2.80	2.83	0.54		Innocuous		Ic/f IIc IIIc IIc IIc IIc IIc IIc IIc	



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**ERTEC WESTERN FIELD STATION
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TABLE A-1

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MAP NUMBER	FIELD STATION	LOCATION	GEOLOGIC UNIT	MATERIAL DESCRIPTION	USCS SYMBOL	BOULDERS AND/OR COBBLES PERCENT	DISTRIBUTION OF MATERIAL FINER THAN COBBLES, PERCENT		
							GRAVEL	SAND	FINES
64	WW-A22	House Range	Cau	Limestone					
65	WW-A24	House Range	Su	Limestone					
66	WW-B8	Swasey Mountains	Su	Limestone					
67	WW-B9	Tule Valley	Aafs	Sandy Gravel	GP	15	70	25	5
68	UGS-A8	Tule Valley	Aolg	Sandy Gravel	GW				
69	UGS-A9	Tule Valley	Aols	Sandy Gravel	GW				
70	UGS-A20	Barn Hills	Do	Dolomite					
71	UGS-A21	Black Hills	Cau	Limestone					
72	UGS-A22	Tule Valley	Aolg	Sandy Gravel	GP	0	80	20	T
73	UGS-A23	Tule Valley	Vu	Welded, Ash-flow Tuff					
74	UGS-A24	Barn Hills	Qtz	Quartzite & Sandstone					
75	UGS-A25	Barn Hills	Do	Dolomite					
76	UGS-A26	Barn Hills	Do	Dolomite					

FIELD OBSERVATIONS

DISTRIBUTION OF
MATERIAL FINER
THAN COBBLES,
PERCENT

GRAVEL

SAND

FINES

PLASTICITY

HARDNESS

WEATHERING

DELETERIOUS
MATERIALS

SIEVE ANALYSIS, PERCENT PASSING (ASTM)

3"

1½"

¾"

¾"

NO.
4NO.
8NO.
16NO.
30

70

25

5

None

Very
Hard

Slight

None

Very
Hard

Fresh

Friable Material

Hard

Moderate

None

Caliche and
Clay Coatings

None

Caliche Coatings

100

99.0

85.1

44.1

13.4

6.8

4.2

3.4

None

Caliche Coatings

100

97.1

79.4

48.7

7.4

7.2

3.7

2.4

Very
Hard

Fresh

Chert

Very
Hard

Fresh

Chert

80

20

T

None

Chert, Caliche
CoatingsVery
Hard

Fresh

Volcanic Glass
and PumiceVery
Hard

Fresh

Friable Material

Very
Hard

Fresh

Chert

Very
Hard

Fresh

None

LABORATORY TEST DATA

PERCENT PASSING (ASTM C 136)						ABRASION TEST (ASTM C 131)	SOUNDNESS TEST (ASTM C 88)		SPECIFIC GRAVITY AND ABSORPTION (ASTM C 127 AND C 128)								
									COARSE AGGREGATE				FINE AGGREGATE				
									SPECIFIC GRAVITY			PERCENT ABSORPTION	SPECIFIC GRAVITY			PERCENT ABSORPTION	
									NO. 8	NO. 16	NO. 30		BULK	BULK SSD	APPAR- ENT		
NO. 50	NO. 100	NO. 200	PERCENT WEAR	PERCENT LOSS CA FA		BULK	BULK SSD	APPAR- ENT	PERCENT ABSORPTION	BULK	BULK SSD	APPAR- ENT	PERCENT ABSORPTION				
			28.3			6.73			2.97	2.98	3.02	0.57			Inn		
6.8	4.2	3.7	3.5	2.4	0.5	22.2	0.73										
7.2	3.7	2.7	2.2	1.7	1.1	26.1	1.75										

PERMEABILITY AND ABSORPTION (ASTM C 127 AND C 128)					ALKALI REACTIVITY (ASTM C 289)		AGGREGATE USE
PERCENT ABSORPTION	FINE AGGREGATE			PERCENT ABSORPTION			
	SPECIFIC GRAVITY				CA	FA	
	BULK	BULK SSD	APPAR- ENT				
0.57					Innocuous		Icr
							IIcr
							IIcr
							IIC
							Ic
							Ic
							IIcr
							IIcr
							IIC
							IIcr
							IIcr
							IIcr
							IIcr



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TABLE A-1

1 4

MAP NUMBER	FIELD STATION	LOCATION	GEOLOGIC UNIT	MATERIAL DESCRIPTION	USCS SYMBOL	BOULDERS AND/OR COBBLES, PERCENT	DISTRIBUTION OF MATERIAL FINER THAN COBBLES, PERCENT		
							GRAVEL	SAND	FINES
77	UGS-A27	Tule Valley	Aolg	Sandy Gravel	GP	T	90	10	T
78	UGS-A28	Middle Range	Ls	Limestone					
79	UGS-A29	Tule Valley	Aolg	Sandy Gravel	GP	T	60	40	T
80	UGS-A30	Fish Springs Range	Ls	Limestone					
81	UGS-A52	Crystal Peak	Vu	Ash-flow Tuff					
82	UGS-A53	Tule Valley	Aafs	Sandy Gravel/ Gravelly Sand	GP/SP	5	50	50	T
83	UGS-A94	Confusion Range	Do	Dolomite					
84	UGS-A95	Tule Valley	Aolg	Gravelly Sand	SP	0	40	55	5
85	UGS-A96	Tule Valley	Aalg	Sandy Gravel	GP	T	55	45	T
86	UGS-A97	Plympton Ridge	Cau	Limestone					
87	UGS-A98	Tule Valley	Aols	Gravelly Sand	SP	T	35	65	T
88	UGS-A99	Granite Mountain	Cau	Limestone					
89	UGS-B15	Fish Spring Range	Vb	Basalt					
90	UGS-B21	Coyote Knolls	Ls	Limestone					

FIELD OBSERVATIONS

DISTRIBUTION OF
MATERIAL FINER
THAN COBBLES,
PERCENTGRAVEL
SAND
FINES

PLASTICITY

HARDNESS

WEATHERING

DELETERIOUS
MATERIALS

SIEVE ANALYSIS, PERCENT PASSING (ASTM)

3" 1½" ¾" ¾" NO. 4 NO. 8 NO. 16 NO. 30

90	10	T	None			Mica							
				Mod. Hard	Moderate	Chert							
60	40	T	None			Chert							
				Hard	Slight	Calcite Veins							
				Soft	Slight	Volcanic Glass and Ash							
50	50	T	None			Caliche Coatings							
				Very Hard	Fresh	None							
40	55	5	None			None							
55	45	T	None			None							
				Hard	Slight	Chert, Calcite Veinlets							
35	65	T	None			Chert, Caliche Coatings							
				Very Hard	Slight	Calcite Veinlets							
				Very Hard	Slight	Vesicules							
				Very Hard	Slight	Chert							

SPECIFIC GRAVITY AND ABSORPTION (ASTM C 127 AND C 128)						ALKALI REACTIVITY (ASTM C 289)		AGGREGATE USE
COARSE AGGREGATE		FINE AGGREGATE						
APPAR- ENT	PERCENT ABSORPTION	SPECIFIC GRAVITY			PERCENT ABSORPTION	CA	FA	
		BULK	BULK SSD	APPAR- ENT				
								IIc
								IIcr
								IIc/f
								IIcr
								IIcr
								IIc/f
								IIcr
								IIf/c
								IIc/f
								IIcr
								IIf/c
								IIcr
								IIcr
								IIcr



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TABLE A

MAP NUMBER	FIELD STATION	LOCATION	GEOLOGIC UNIT	MATERIAL DESCRIPTION	USCS SYMBOL	BOULDERS AND COBBLES PERCENT	DISTRIBUTION OF MATERIAL FINER THAN COBBLES PERCENT		
							GRAVEL	SAND	FINES
91	UGS-B26	Swasey Mountains	Qtz	Orthoquartzite					
92	UGS-B27	Tule Valley	Do	Dolomite					
93	UGS-B28	Tule Valley	Aafg	Sandy Gravel	GP	5	60	40	T
94	UGS-B55	Gray Hills	Do	Dolomite					
95	UGS-B56	Tule Valley	Aafs	Gravelly Sand	SP	5	45	15	T
96	TL-T1	Tule Valley	Aols	Silty Sand	SM	0	25	45	30
97	TL-T2	Tule Valley	Aols	Sandy Gravel	GM				
98	TL-T3	Tule Valley	Unsuitable	Sandy Silt	ML		0	8	92
99	TL-T4	Tule Valley	Aols	Sandy Gravel	GM	10	50	36	14
100	TL-T7	Tule Valley	Aafs	Sandy Gravel	GP-GM		50	40	10
101	TL-T8	Tule Valley	Aolg	Gravelly Sand	SM-GM		45	48	7
102	TL-T9	Tule Valley	Aolg	Sandy Gravel	GP				
103	TL-T10	Tule Valley	Aafs	Sandy Gravel	GP-GM				
104	TL-T11	Tule Valley	Aafs	Gravelly Sand	SM				
105	TL-T12	Tule Valley	Aafg	Sandy Gravel	GM		45	40	15
106	TL-T13	Tule Valley	Aafs	Gravelly Sand	SW-SM				

FIELD OBSERVATIONS								SIEVE ANALYSIS, PERCENT					
SAND/GR. COBBLES, PERCENT	DISTRIBUTION OF MATERIAL FINER THAN COBBLES, PERCENT			PLASTICITY	HARDNESS	WEATHERING	DELETERIOUS MATERIALS						
	GRAVEL	SAND	FINES					3"	1 1/2"	3/4"	3/8"	NO. 4	NO. 8
					Very Hard	Slight	None						
					Hard	Slight	Chert						
5	60	40	T	None			Caliche Coatings						
					Hard	Slight	Chert						
5	45	55	T	None			Caliche Coatings						
0	25	45	30	Low			Caliche Coatings						
				None			Caliche Coatings			90.6	71.6	49.9	36.
	0	8	92	Low			Caliche Coatings						
0	50	36	14	None									
	50	40	10	None			Caliche Coatings and Nodules						
	45	48	7	None			Low Density Volcanics						
				None			Low Density Volcanics		93.8	71.2	27.8	7.1	3.
				None			Caliche Coatings			95.0	81.1	51.3	28.
				Low			Caliche Coatings, Low Density Volcanics			98.5	93.7	79.9	64.
				Low			Caliche Coatings						
				Low			Caliche Coatings			97.1	89.6	70.3	54.

LABORATORY TEST DATA

SIS, PERCENT PASSING (ASTM C 136)								ABRASION TEST (ASTM C 131)	SOUNDNESS TEST (ASTM C 88)		SPECIFIC GRAVITY AND ABSORPTION (ASTM C 127 AND C 128)						
											COARSE AGGREGATE			PERCENT ABSORPTION	FINE AGGREGATE		
											SPECIFIC GRAVITY				SPECIFIC GRAVITY		
NO. 4	NO. 8	NO. 16	NO. 30	NO. 50	NO. 100	NO. 200	PERCENT WEAR	PERCENT LOSS		BULK	BULK SSD	APPAR- ENT	BULK	BULK SSD	APPAR- ENT		
								CA	FA								
6	49.9	36.4*	29.9*	26.3*	20.9*	17.5	14.9										
8	7.1	3.8*	3.1*	2.6*	2.3*	1.7	0.9										
1	51.3	28.8*	17.7*	13.1*	10.9*	9.5	7.8										
7	79.9	64.4*	49.9*	40.5*	33.7*	28.2	21.0										
6	70.3	54.2*	39.1*	25.9*	16.3*	11.4	8.6										

DENSITY AND ABSORPTION (127 AND C 128)						ALKALI REACTIVITY (ASTM C 289)		AGGREGATE USE
FINE AGGREGATE								
ABSORPTION	SPECIFIC GRAVITY			PERCENT ABSORPTION	CA	FA		
	BULK	BULK SSD	APPAR- ENT					
							IIcr	
							IIcr	
							IIc/f	
							IIcr	
							IIf/c	
							IIf/c	
							IIc/f	
							IIIf	
							IIc/f	
							IIc/f	
							IIf/c	
							IIc	
							IIc/f	
							IIf/c	
							IIc/f	
							IIf/c	



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MAP NUMBER	FIELD STATION	LOCATION	GEOLOGIC UNIT	MATERIAL DESCRIPTION	USCS SYMBOL	BOULDERS AND/OR COBBLES, PERCENT	DISTRIBUTION OF MATERIAL FINER THAN COBBLES, PERCENT		
							GRAVEL	SAND	FINES
107	TL-T14	Tule Valley	Aols	Sandy Gravel	GP		76	20	4
108	TL-T15	Tule Valley	Aafs	Gravelly Clay	CL		35	5	60
109	TL-T16	Tule Valley	Aafs	Sandy Gravel	GM				
110	TL-T17	Tule Valley	Aafs	Sandy Gravel	GP-GM				
111	TL-T18	Tule Valley	Aafg	Sandy Gravel	GP-GM	T	50	40	10
112	TL-T19	Tule Valley	Aafs	Silty Sand	SM	5	4	48	48
113	TL-T20	Tule Valley	Aafs	Gravelly Sand	SM		30	55	15
114	TL-T21	Tule Valley	Aols	Silty Sand	SM		10	70	20
115	TL-T22	Blind Valley	Aafg	Sandy Gravel	GP-GM				
116	TL-T23	Tule Valley	Aafg	Sandy Gravel	GP				
117	TL-T24	Tule Valley	Aafs	Gravelly Sand	SM		35	45	20

FIELD OBSERVATIONS																	
BOULDERS AND/OR COBBLES, PERCENT	DISTRIBUTION OF MATERIAL FINER THAN COBBLES, PERCENT			PLASTICITY	HARDNESS	WEATHERING	DELETERIOUS MATERIALS	SIEVE ANALYSIS, PERCENT PASSING									
	GRAVEL	SAND	FINES					3"	1½"	¾"	¾"	NO. 4	NO. 8	NO. 16			
T 5	76	20	4	None			Caliche Coatings and Nodules										
	35	5	60	Med.													
				Low			Low Density Volcanics		91.4	79.7	53.7	34.3	28.0	24.7			
				None			Caliche Coatings				98.2	77.4	22.3	9.0	7.0		
	50	40	10	None													
	4	48	48	Low													
	30	55	15	Low			Caliche Coatings										
	10	70	20	Low			Caliche Coatings										
				None					70.4	52.4	40.7	34.7	30.7	28.0			
				None			Caliche Coatings				96.8	76.1	50.1	37.6	30.0		
	35	45	20	Low													

LABORATORY TEST DATA

ANALYSIS, PERCENT PASSING (ASTM C 136)								ABRASION TEST (ASTM C 131)	SOUNDNESS TEST (ASTM C 88)	SPECIFIC GRAVITY AND ABSORPTION (ASTM C 127 AND C 128)						
										COARSE AGGREGATE				FINE AGGREGATE		
										SPECIFIC GRAVITY			PERCENT ABSORPTION	SPECIFIC GRAVITY		
NO.	NO. 4	NO. 8	NO. 16	NO. 30	NO. 50	NO. 100	NO. 200	PERCENT WEAR	PERCENT LOSS		BULK	BULK SSD		APPAR- ENT	BULK	BULK SSD
									CA	FA						
3.7	34.3	28.0*	24.7*	22.7*	21.0*	19.4	16.9									
7.4	22.3	9.0*	7.8*	7.4*	7.1*	6.5	5.4									
10.7	34.7	30.7*	28.2*	24.9*	20.0*	15.0	11.0									
16.1	50.1	37.6*	30.3*	24.8*	20.0*	6.0	3.2									

GRAVITY AND ABSORPTION (C 127 AND C 128)						ALKALI REACTIVITY (ASTM C 289)		AGGREGATE USE
SAYE	FINE AGGREGATE							
	PERCENT ABSORPTION	SPECIFIC GRAVITY			PERCENT ABSORPTION	CA	FA	
BULK		BULK SSD	APPAR- ENT					
								IIC
								IIIf
								IIC
								IIC
								IIC/f
								IIIf
								IIIf/c
								IIIf
								IIC/f
								IIC/f
								IIIf/c



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TABLE A-1

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EXPLANATION OF EXISTING DATA

Existing data pertaining to aggregates were extracted from the Utah State Department of Highways' Materials Inventory county reports. These reports are compilations of available site data from existing files and records and are intended to accurately locate, investigate, and catalog materials needed for highway construction. Explanations for column headings which appear in Table A-2, that have not been previously discussed in Table A-1, are given below.

<u>Column Heading</u>	<u>Explanation</u>
Site Number	Utah State Department of Highways pit or site number. Locations correspond to map numbers listed on this table and placed in Drawing 2.
Material Description USCS Symbol	To maintain conformity within the study, the Utah State Department of Highways classification system (A.A.S.H.O.) was converted to the Unified Soil Classification System (USCS) utilizing the sieve analyses' size distribution and the plasticity indices.
Sieve Analysis	The size distribution of fine and coarse aggregate samples was determined by sieving. In some samples, particles greater than 1 inch in size (>1 inch) were crushed to 1 inch maximum size and remixed with the remaining sample before sieving. In these cases, data entries under 1 inch are 100 percent, preceded by before-crushing percentages.
No. 10, No. 40	Samples tested after mid-1963 used No. 8 and No. 50 sieves, respectively. These entries are marked with asterisks.
Soundness Test	The testing of aggregates to determine their resistance to disintegration by saturated solutions of sodium sulfate. It furnishes information helpful in judging the soundness of aggregates subject to weathering action,

Column HeadingExplanation

Soundness Test
(cont.)

particularly when adequate information is not available from service records of the material exposed to actual weathering conditions.

MAP NUMBER	SITE NUMBER	DATA SOURCE	LOCATION	GEOLOGIC UNIT	MATERIAL DESCRIPTION	USE SYM
118	14098	USDH Millard Co.	Tule Valley	Aafs	Sandy Gravel	GP
119	14099	USDH Millard Co.	Tule Valley	Aafs	Sandy Gravel	GP
120	14100	USDH Millard Co.	Tule Valley	Aafs	Sandy Gravel	GP
121	14101	USDH Millard Co.	Tule Valley	Aols	Sandy Gravel	GP
122	14102	USDH Millard Co.	Tule Valley	Aolg	Sandy Gravel	GP
123	14103	USDH Millard Co.	Tule Valley	Aafg	Sandy Gravel	GP

USCS SYMBOL	SIEVE ANALYSIS								ABRASION TEST (ASTM C 131) PERCENT WEAR	SOUNDNESS TEST (ASTM C 88) PERCENT LOSS		PLASTICITY INDEX (ASTM D 423 and D 424)
	BEFORE CRUSHING, PERCENT		PERCENT PASSING AFTER CRUSHING TO 1" MAXIMUM SIZE							PERCENT LOSS		
	> 3"	> 1"	1"	½"	NO. 4	NO. 10	NO. 40	NO. 200		CA	FA	
GP	0	28.6	100		38.9	31.5	13.7	2.1	24.4			NP
GP-GM	18.5	31.8	100		30.4	22.7	16.6	7.8	18.7			NP
GP-GM	0	10.3	100	81.6	49.7	31.7	8.2	6.8	25.1			NP
GP		44.0	100		24.6	18.9	8.7	1.6	22.1			NP
GP-GM	0	17.6	100		42.6	23.8	15.8	7.7	16.6			NP
GP-GM		13.4	100		47.0	29.3	14.3	6.0	22.1			2



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EXISTING TEST DATA
TULE VALLEY, UTAH

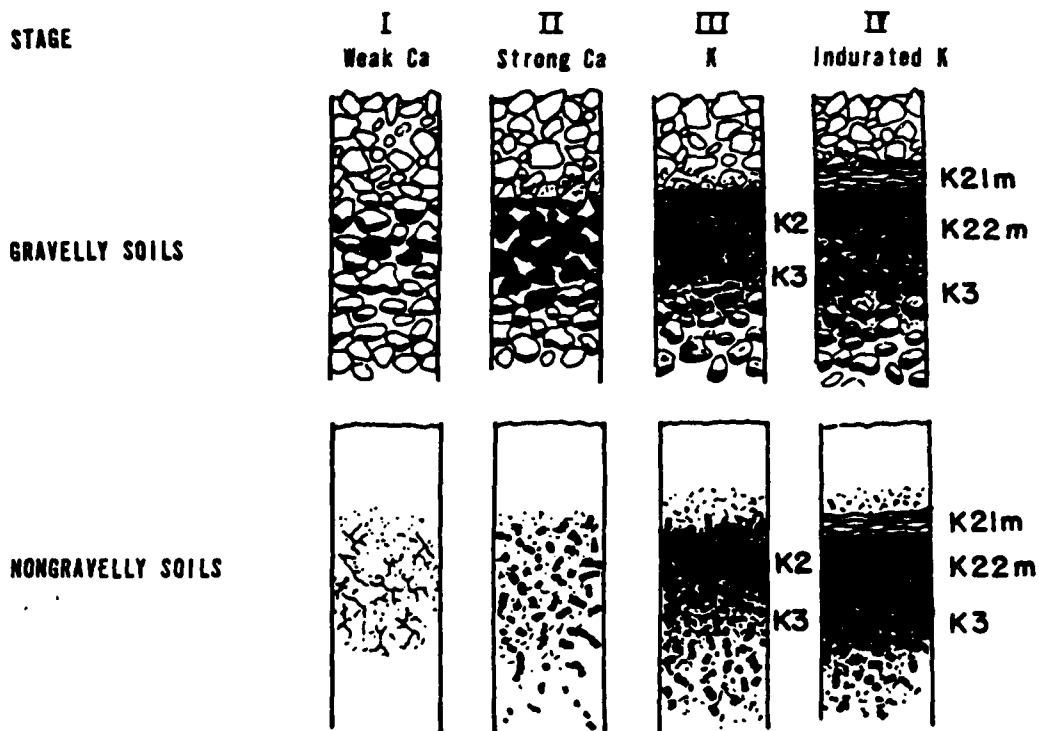
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APPENDIX B
SUMMARY OF CALICHE DEVELOPMENT

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



Reference: Gile, L.M. 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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BMO/AFRC-MX

SUMMARY OF CALICHE DEVELOPMENT

2 JUL 81

APPENDIX B

APPENDIX C
UNIFIED SOIL CLASSIFICATION SYSTEM

AD-A112 975

ERTEC WESTERN INC. LONG BEACH CA

F/6 8/7

MX SITING INVESTIGATION. AGGREGATE RESOURCES STUDY, TULE VALLEY--ETC(U)

JUL 81

F04704-80-C-0006

UNCLASSIFIED

E-TR-37-H

NL

2 of 2

ADA

12/2/81

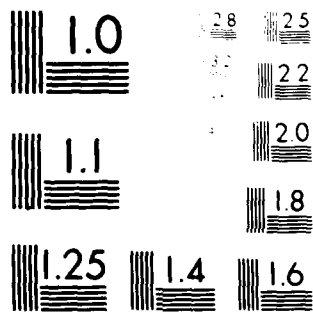


END

DATE

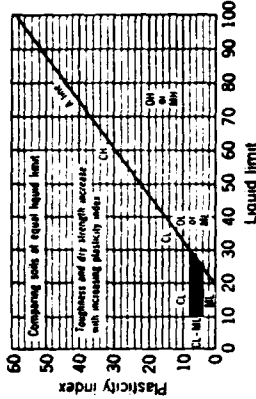
104-82

DTIC



MICROCOPY RESOLUTION TEST CHART
NBS 1010-A

Field Identification Procedures (Excluding particles larger than 3 in. and testing fractions on estimated weights)				Group Symbols		Typical Names		Information Required for Descriptive Soils		Laboratory Classification Criteria	
Coarse-grained soils More than half of material is larger than No. 200 sieve size	Gravels More than half of coarse fraction is larger than 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-mixtures, little or no fines		Give typical names: indicate approximate percentages of sand and gravel, maximum size, and nature of the coarse and fine fractions. Use descriptive terms and symbols in parentheses.	200 sieve and finer (fraction smaller than No. 200 sieve) GW, GP, GM, GC, SW, SP, SM, SC	Not meeting all gradation requirements for GW	Above "A" line with P_1 between 5 and 7 are required use of dual symbols
			Predominantly one size or a range of sizes with some intermediate sizes missing								
Fine-grained soils More than half of material is smaller than No. 200 sieve size	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 structure, stratification, consistency, moisture conditions and drainage characteristics. Example: Silty sand, gravelly, about 20% hard angular gravel particles in-between sand; rounded and subangular sand grains coarse to fine, about 15% non-plastic fines with low dry strength, well compacted and in place, alluvial sand; (SM)	5% to 12% GW, GP, GM, GC, SW, SP, SM, SC	Not meeting all gradation requirements for SW	Above "A" line with P_1 between 5 and 7 are required use of dual symbols
			Predominantly one size or a range of sizes with some intermediate sizes missing								
Highly Organic Soils	Silt and clay Liquid limit greater than 50	Silt and clay Liquid limit greater than 50	Identification Procedures on Fraction Smaller than No. 40 Sieve Size	ML		Inorganic silt and very fine sand, rock flour, silty or clayey fine sand with slight plasticity		Give typical names: indicate degree of plasticity, amount of organic matter, color, odor, and other pertinent descriptive information, and symbol in parentheses. Example: Clayey silt, brown, slightly plastic; small percentage of fine sand; numerous vertical root holes; firm and dry in place; (ML)	5% to 12% GW, GP, GM, GC, SW, SP, SM, SC	Not meeting all gradation requirements for ML	Above "A" line with P_1 between 5 and 7 are required use of dual symbols
			Identification Procedures on Fraction Smaller than No. 40 Sieve Size								
Highly Organic Soils	Silt and clay Liquid limit greater than 50	Silt and clay Liquid limit greater than 50	Identification Procedures on Fraction Smaller than No. 40 Sieve Size	CL		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays		Give typical names: indicate degree of plasticity, amount of organic matter, color, odor, and other pertinent descriptive information, and symbol in parentheses. Example: Clayey silt, brown, slightly plastic; small percentage of fine sand; numerous vertical root holes; firm and dry in place; (ML)	5% to 12% GW, GP, GM, GC, SW, SP, SM, SC	Not meeting all gradation requirements for CL	Above "A" line with P_1 between 5 and 7 are required use of dual symbols
			Identification Procedures on Fraction Smaller than No. 40 Sieve Size								
Highly Organic Soils	Silt and clay Liquid limit greater than 50	Silt and clay Liquid limit greater than 50	Identification Procedures on Fraction Smaller than No. 40 Sieve Size	OL		Organic silts and organic clays of low plasticity		Give typical names: indicate degree of plasticity, amount of organic matter, color, odor, and other pertinent descriptive information, and symbol in parentheses. Example: Clayey silt, brown, slightly plastic; small percentage of fine sand; numerous vertical root holes; firm and dry in place; (ML)	5% to 12% GW, GP, GM, GC, SW, SP, SM, SC	Not meeting all gradation requirements for OL	Above "A" line with P_1 between 5 and 7 are required use of dual symbols
			Identification Procedures on Fraction Smaller than No. 40 Sieve Size								
Highly Organic Soils	Silt and clay Liquid limit greater than 50	Silt and clay Liquid limit greater than 50	Identification Procedures on Fraction Smaller than No. 40 Sieve Size	MH		Inorganic silts, mucous or silty silts, elastic silts		Give typical names: indicate degree of plasticity, amount of organic matter, color, odor, and other pertinent descriptive information, and symbol in parentheses. Example: Clayey silt, brown, slightly plastic; small percentage of fine sand; numerous vertical root holes; firm and dry in place; (ML)	5% to 12% GW, GP, GM, GC, SW, SP, SM, SC	Not meeting all gradation requirements for MH	Above "A" line with P_1 between 5 and 7 are required use of dual symbols
			Identification Procedures on Fraction Smaller than No. 40 Sieve Size								
Highly Organic Soils	Silt and clay Liquid limit greater than 50	Silt and clay Liquid limit greater than 50	Identification Procedures on Fraction Smaller than No. 40 Sieve Size	CH		Inorganic clays of high plasticity, fat clays		Give typical names: indicate degree of plasticity, amount of organic matter, color, odor, and other pertinent descriptive information, and symbol in parentheses. Example: Clayey silt, brown, slightly plastic; small percentage of fine sand; numerous vertical root holes; firm and dry in place; (ML)	5% to 12% GW, GP, GM, GC, SW, SP, SM, SC	Not meeting all gradation requirements for CH	Above "A" line with P_1 between 5 and 7 are required use of dual symbols
			Identification Procedures on Fraction Smaller than No. 40 Sieve Size								
Highly Organic Soils	Silt and clay Liquid limit greater than 50	Silt and clay Liquid limit greater than 50	Identification Procedures on Fraction Smaller than No. 40 Sieve Size	OH		Organic clays of medium to high plasticity		Give typical names: indicate degree of plasticity, amount of organic matter, color, odor, and other pertinent descriptive information, and symbol in parentheses. Example: Clayey silt, brown, slightly plastic; small percentage of fine sand; numerous vertical root holes; firm and dry in place; (ML)	5% to 12% GW, GP, GM, GC, SW, SP, SM, SC	Not meeting all gradation requirements for OH	Above "A" line with P_1 between 5 and 7 are required use of dual symbols
			Identification Procedures on Fraction Smaller than No. 40 Sieve Size								
Highly Organic Soils	Silt and clay Liquid limit greater than 50	Silt and clay Liquid limit greater than 50	Identification Procedures on Fraction Smaller than No. 40 Sieve Size	FI		Peat and other highly organic soils		Give typical names: indicate degree of plasticity, amount of organic matter, color, odor, and other pertinent descriptive information, and symbol in parentheses. Example: Clayey silt, brown, slightly plastic; small percentage of fine sand; numerous vertical root holes; firm and dry in place; (ML)	5% to 12% GW, GP, GM, GC, SW, SP, SM, SC	Not meeting all gradation requirements for FI	Above "A" line with P_1 between 5 and 7 are required use of dual symbols
			Identification Procedures on Fraction Smaller than No. 40 Sieve Size								



Plasticity chart
for laboratory classification of fine grained soils

From Wagner, 1957.
These procedures are to be performed on the minus No. 40 sieve size particles, approximately 1/4 in. For field classification purposes, screening is not intended, simply remove by hand the coarse particles that interfere with the tests.

Field Identification Procedure for Fine Grained Soils or Fractions
A 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 soil 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 soil which is squeezed between the fingers. The water and silt disappear from the surface, the soil 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 silty sands and clay silts give a moderately quick reaction. A typical rock flour, shows a moderately quick reaction.

Boundary classifications. Soil possessing characteristics of two groups are designated by combinations of group symbols. For example GW-GC, well graded gravel-sand mixture with clay binder.

Field Identification Procedure for Fine Grained Soils or Fractions
A 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 soil 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 soil which is squeezed between the fingers. The water and silt disappear from the surface, the soil 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 silty sands and clay silts give a moderately quick reaction. A typical rock flour, shows a moderately quick reaction.

Field Identification Procedure for Fine Grained Soils or Fractions
A 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 soil 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 soil which is squeezed between the fingers. The water and silt disappear from the surface, the soil 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 silty sands and clay silts give a moderately quick reaction. A typical rock flour, shows a moderately quick reaction.

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UNIFIED SOIL CLASSIFICATION SYSTEM

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APPENDIX C

APPENDIX D
TULE VALLEY
STUDY AREA PHOTOGRAPHS



Alluvial Fan Deposit (Aafs) in east central Tule Valley;
Class I coarse aggregate source (Station 53).

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TULE VALLEY
STUDY AREA PHOTOGRAPH

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FIGURE D 1



Older Lacustrine Shoreline Deposit (Aolg) along east central Tule Valley;
Class I coarse aggregate source (Station 68).

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TULE VALLEY
STUDY AREA PHOTOGRAPH

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FIGURE D-2



Older Lacustrine Deposit (Aolg) in southern Tule Valley;
Class I coarse and fine (multiple) aggregate source (Station 21).

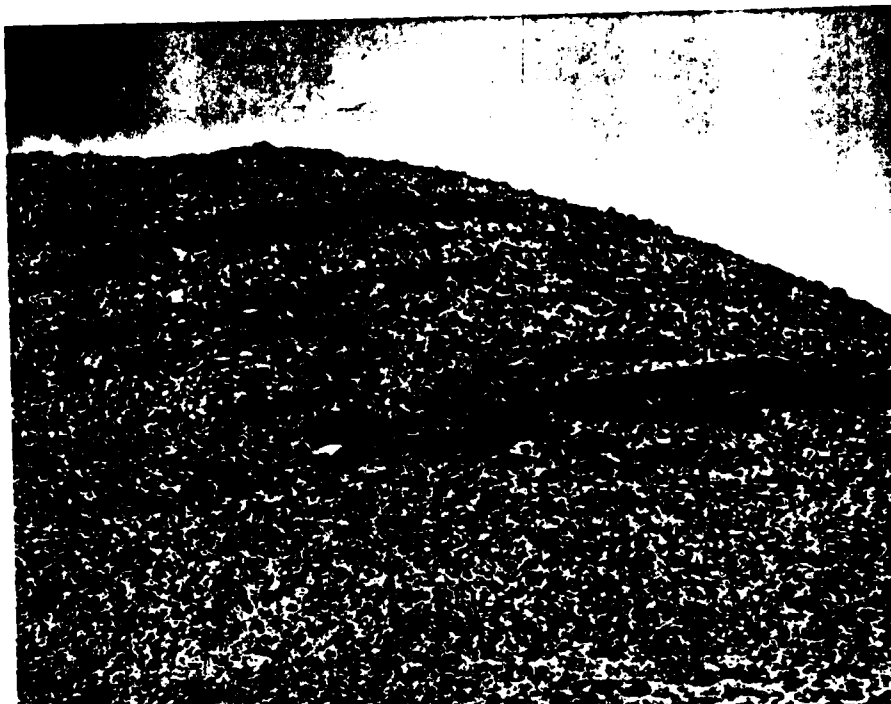
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TULE VALLEY
STUDY AREA PHOTOGRAPH

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FIGURE D 3



Prospect Mountain Quartzite (Qtz) in Swasey Mountain;
Class I crushed rock aggregate source (Station 54).

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TULE VALLEY
STUDY AREA PHOTOGRAPH

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FIGURE D-4



Notch Peak Formation (Cau) in the Gray Hills, southern Tule Valley;
Class I crushed rock aggregate source.

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TULE VALLEY
STUDY AREA PHOTOGRAPH

2 JUL 81

FIGURE D-5



Laketown Dolomite (Do) in the Contusion Range;
Class I crushed rock aggregate source (Station 20).

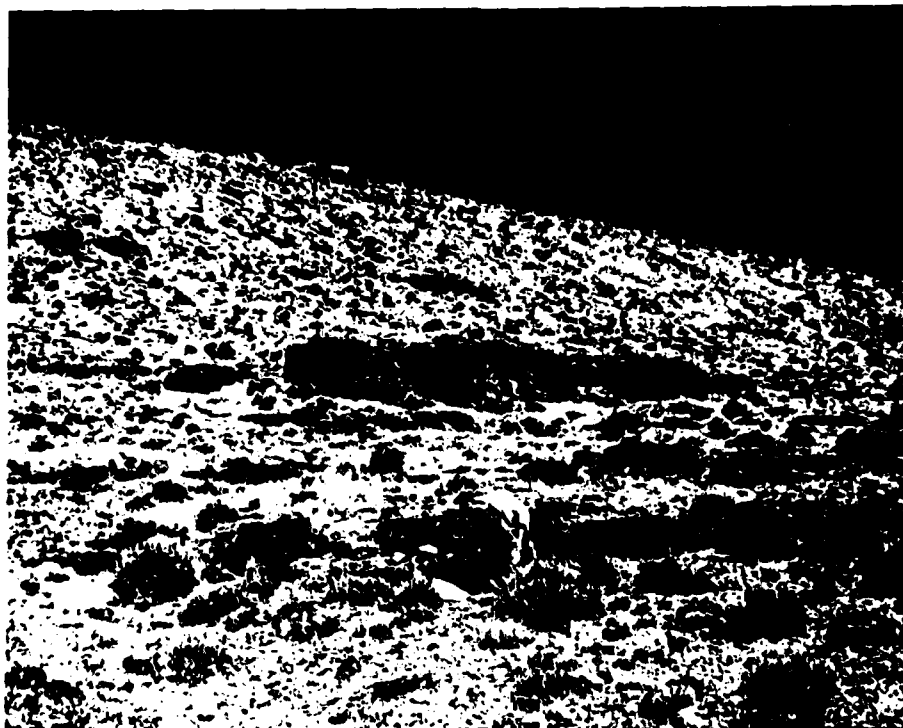
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TULE VALLEY
STUDY AREA PHOTOGRAPH

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FIGURE D 6



Basalt (Vb) in northern Tule Valley; Class I crushed rock aggregate source (Station 34).

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TULE VALLEY
STUDY AREA PHOTOGRAPH

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FIGURE D 7

APPENDIX E

ERTEC WESTERN GEOLOGIC UNIT
CROSS REFERENCE

AGGREGATE RESOURCES GEOLOGIC UNIT ERTEC WESTERN GENERAL GEOLOGIC SYMBOLS UNIT EXPLANATION

IGNEOUS (AND DIFFERENTIATED)	
Shown in regions where rock is exposed, the igneous predominance (greater than 75 percent) rock type is indicated. In those areas where two rock types occur the predominant rock type is shown followed by the subordinate rock type in a smaller font. Rock may be subdivided into subtypes.	
Gr	1 Intrusive (and differentiated) Rocks formed by solidification of a molten or partially molten mass
Vu	1 Extrusive (and differentiated) Rocks formed by solidification of molten material beneath the surface (e.g., granite, granodiorite, diorite, gabbro)
Vb	1 Extrusive (intermediate and acidic) Volcanic rocks of intermediate and acidic composition formed by solidification of molten material at or near the surface (e.g., andesite, rhyolite, basalt, basaltic andesite)
Vu	1 Extrusive (basic) Volcanic rocks of basic composition generally formed by solidification of molten material at or near the surface (e.g., basalt, andesite, gabbro)
Su	5 Sedimentary (undifferentiated) Rocks formed by accumulation of clastic solids, organic solids and/or chemically precipitated minerals
Su, Qtz	5 Archaean and/or Siliceous Rocks: Composed of sand size particles (e.g., sandstone, arkose, siltstone) or of crystalline silica (e.g., quartz, chert)
Ls, Do, Cau	5 Carbonate Rocks: Composed predominantly of calcium carbonate (limestone) or chemical precipitates (e.g., limestone, dolomite, chert)
	5 Argillaceous Rocks: Composed of clay and silt-sized particles (e.g., siltstone, shale, claystone)
	5 Evaporite Rocks: Precipitated from solution as a result of evaporation (e.g., halite, gypsum, anhydrite, etc.)
Su	5 Coarse Clastic Rocks: Composed of gravel-sized or larger clasts (e.g., conglomerate, breccia)
Mu	6 Metamorphic (undifferentiated) Rocks formed through recrystallization in the solid state of preexisting rocks by heat and pressure
Mu	6 Coarse grained rocks formed by higher-grade regional metamorphism (either banded or granular) (e.g., gneiss, granulite, amphibolite)
Mu	6 Fine grained rocks formed by lower grade regional metamorphism (e.g., schist, slate, phyllite)
Mu	6 Metakonglomerate rocks formed chiefly by contact metamorphism (e.g., hornfels, marble)
Qtz	6 Metagranite rocks formed by metamorphism of highly siliceous rocks
SEDIMENT-FILL	
A	
Aal	A1 Younger Fluvial Deposits: Older modern stream channel and flood-plain deposits
Au, Aal	A2 Older Fluvial Deposits: Older incised stream channel and flood-plain deposits in elevated terraces bordering older modern drainages
Au	A3 Eolian Deposits: Wind-blown deposits of sand, occurring as either thin sheets (Aa1) or dunes (Aa2)
Aol	A4 Flood and Lacustrine Deposits: Deposits occurring in modern active playas (Aa1) or in either inactive playas or older lake beds and abandoned shorelines associated with extinct lakes (Aa2)
Aaf	A5 Alluvial Fan Deposits: Alluvial deposits consisting of debris from and water-laid alluvium near mountain fronts, grading into predominantly water-laid alluvium deposited in shifting distributary channels near the basin center (Younger Aa1, intermediate Aa2, and older Aa3 alluvial fans are differentiated by surface soil development, terrain conditions and present depositional environment)
Au	A6 Broad non-river units: Best broadly extensive unit is listed first
Aaf	A7 (Aa1) Perennial unit underlying thin veneer of overlying mapped unit

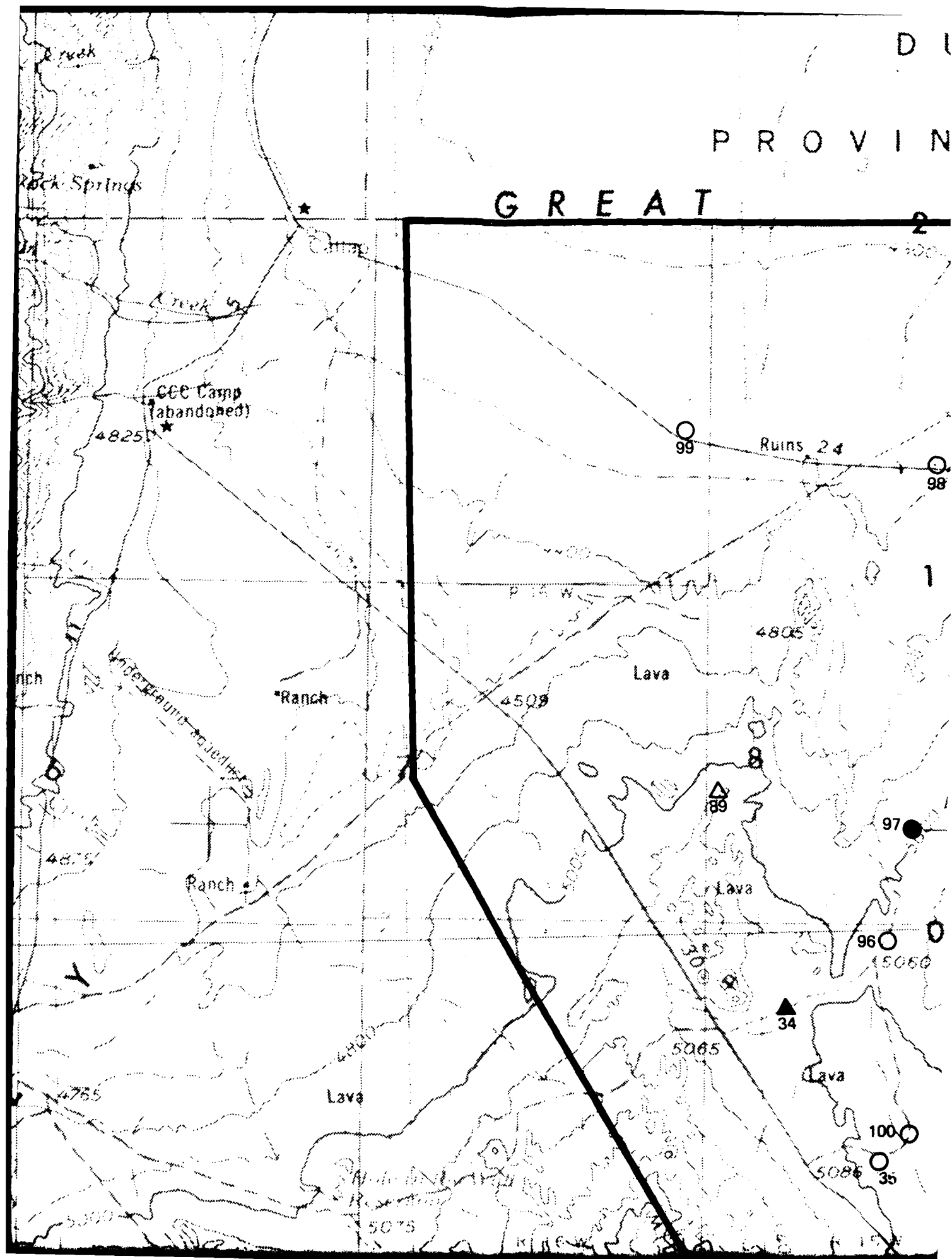
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DEPARTMENT OF THE AIR FORCE
BMO/AFRC-MX

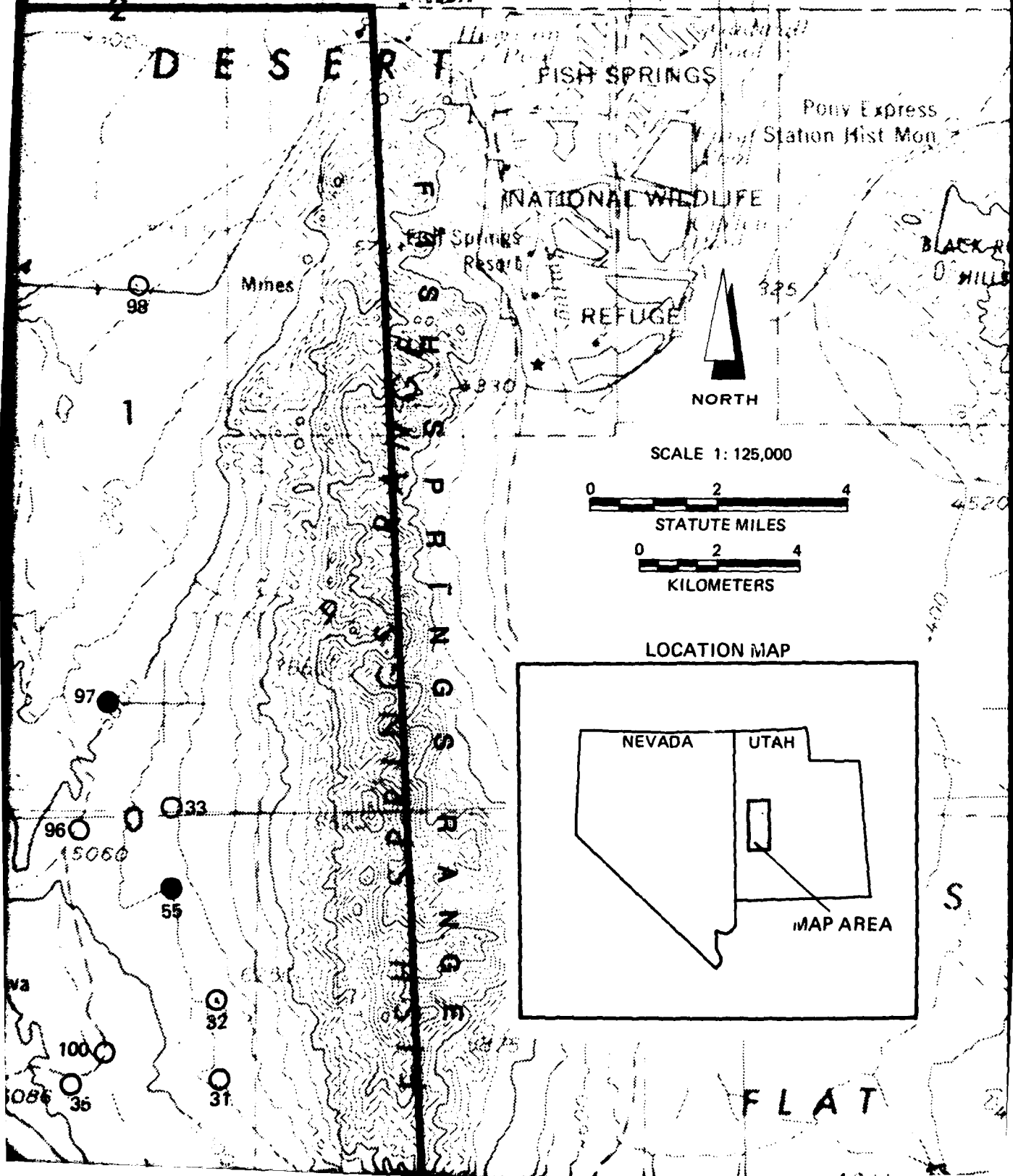
ERTEC WESTERN GEOLOGIC UNIT
CROSS REFERENCE

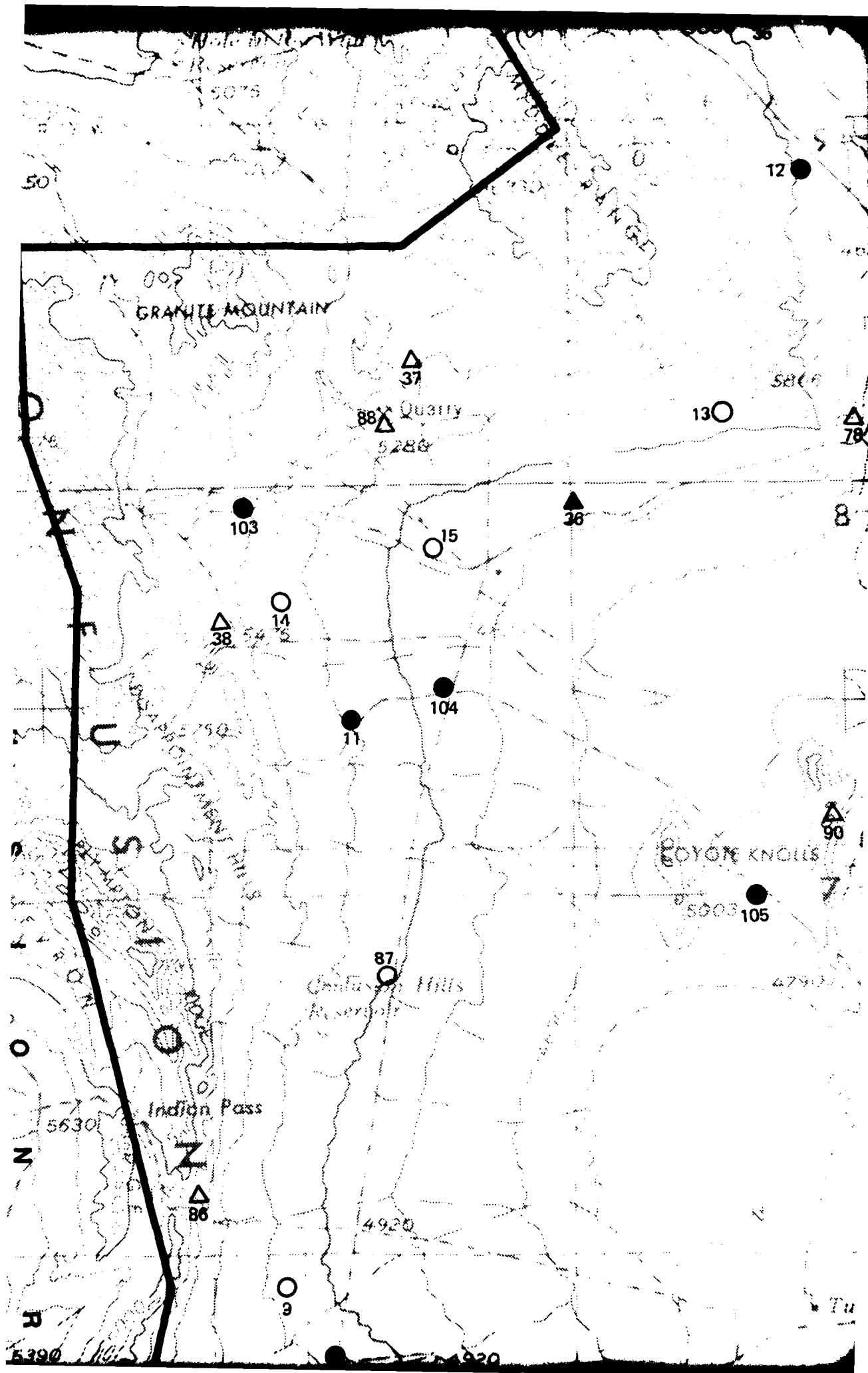
2 JUL 81

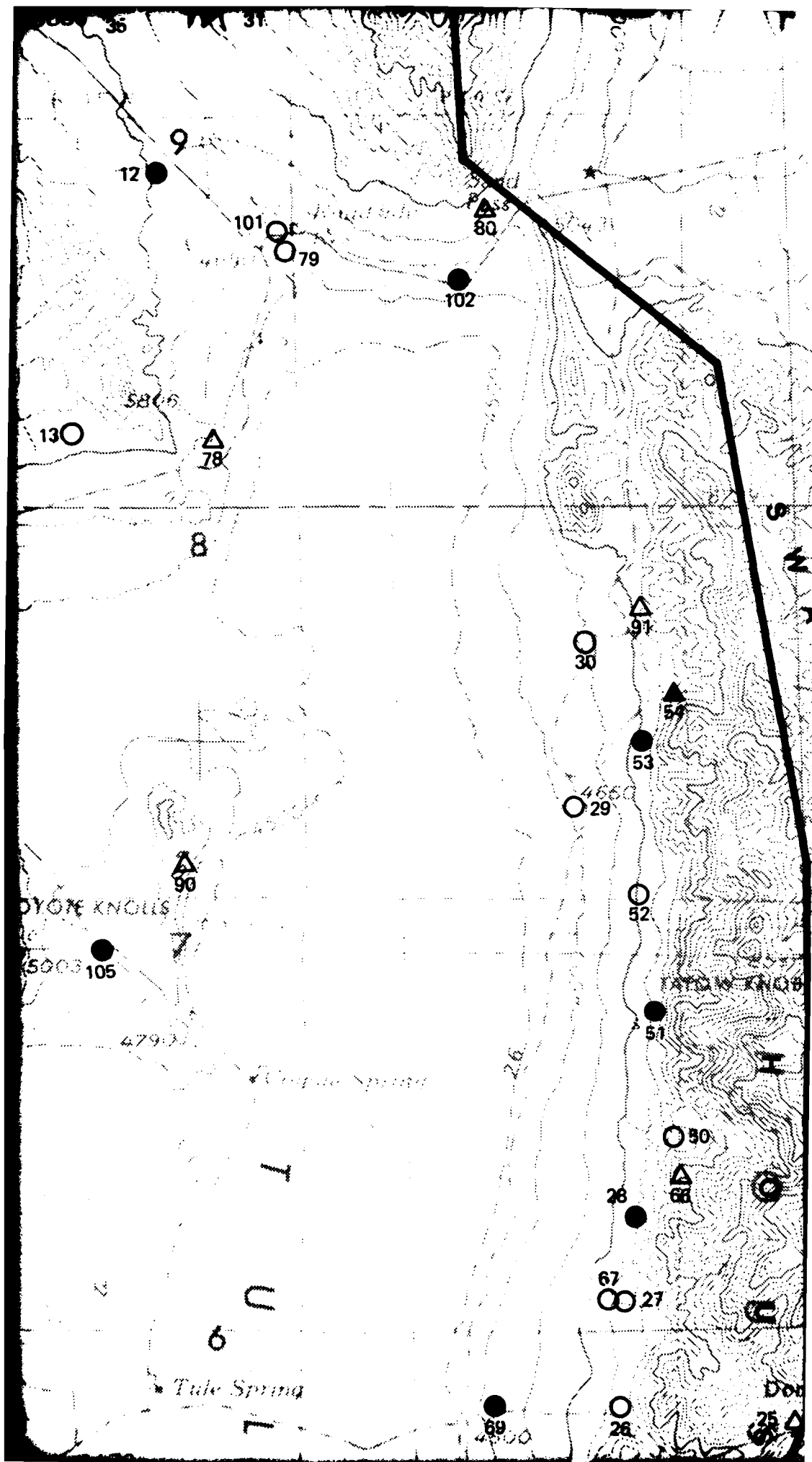
APPENDIX E

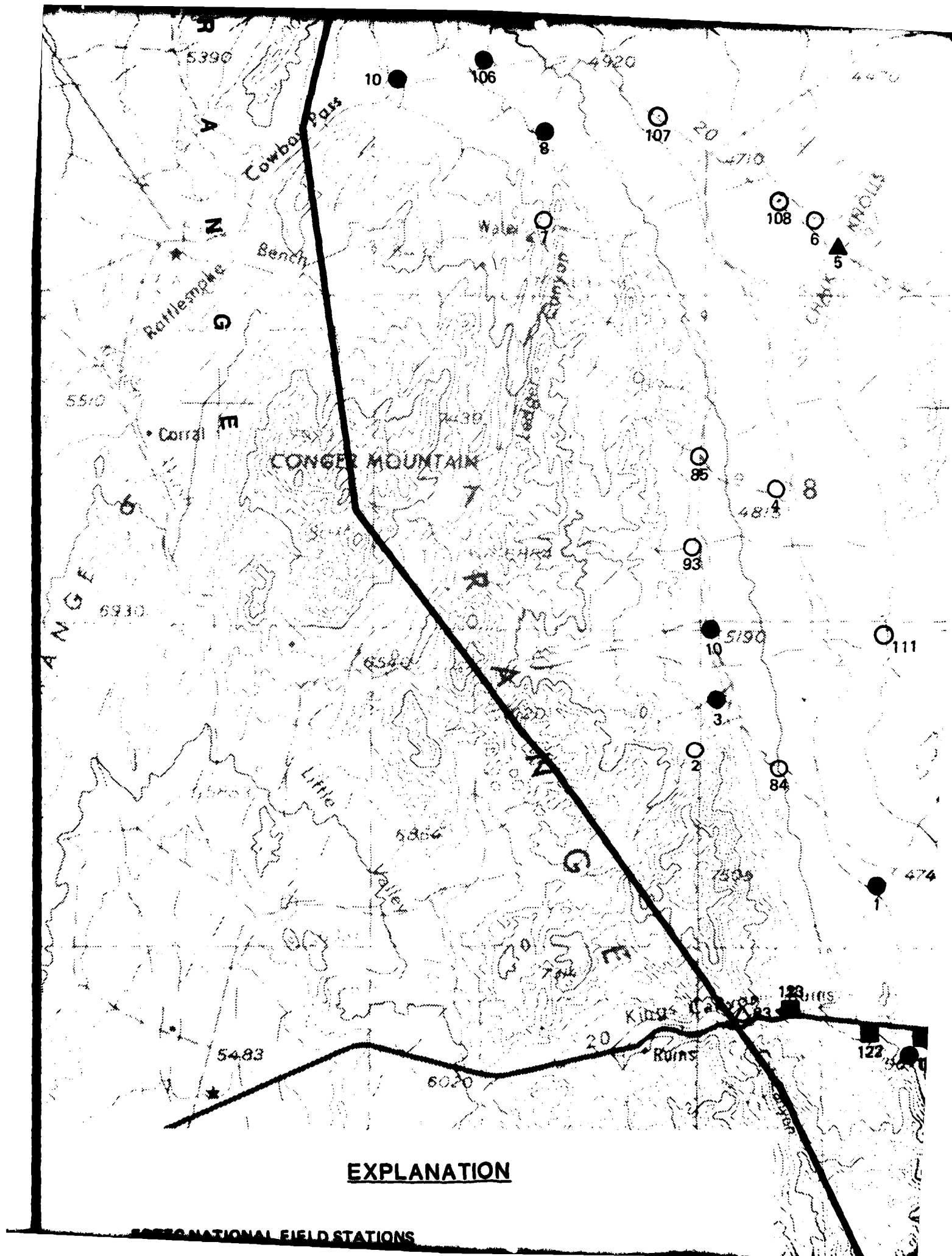


DUGWAY VING GROUND SALT LAKE

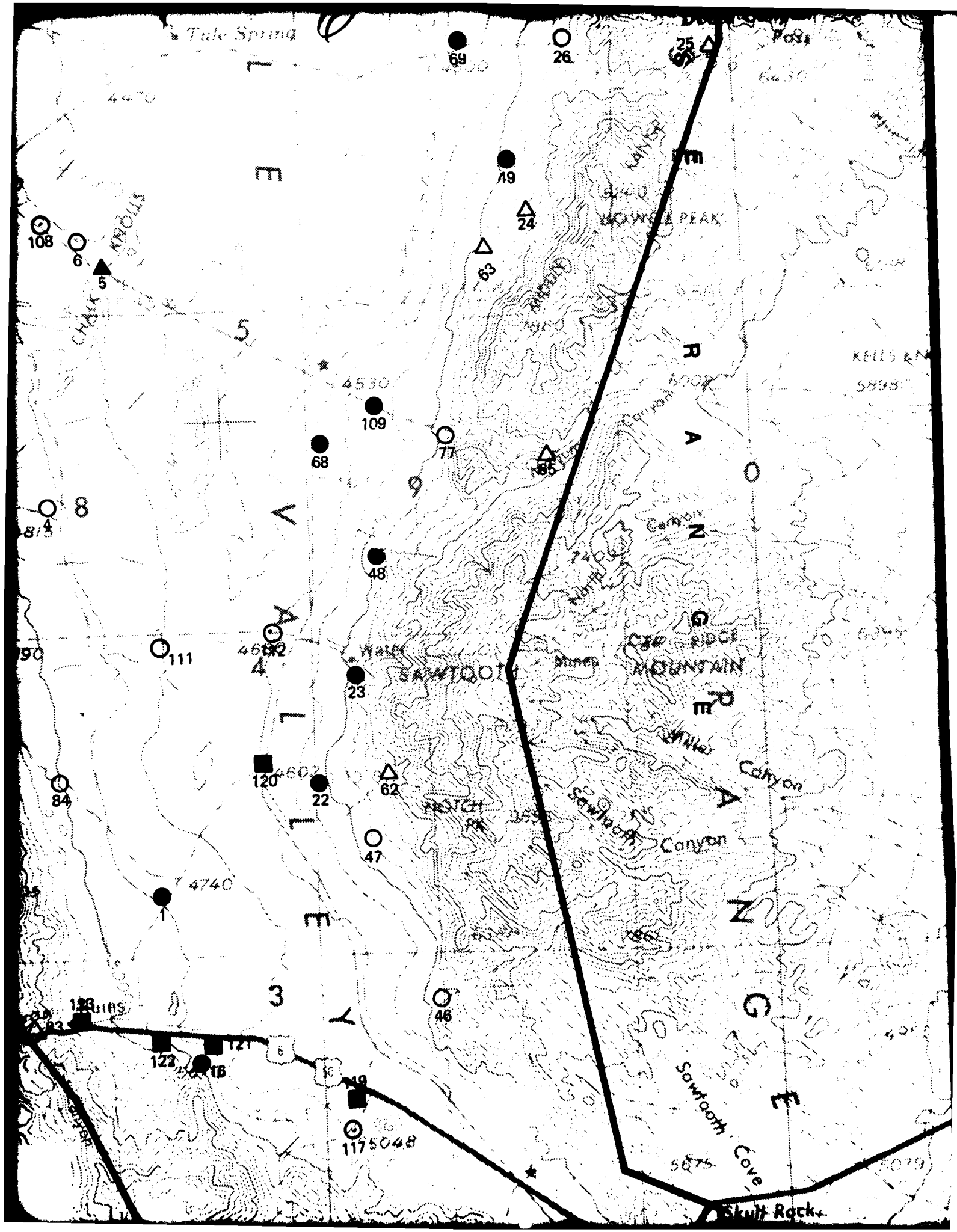








Tule Spring



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ERTEC NATIONAL FIELD STATIONS

BASIN-FILL UNITS

(Potential Coarse and/or Fine Aggregates)



ROCK UNITS

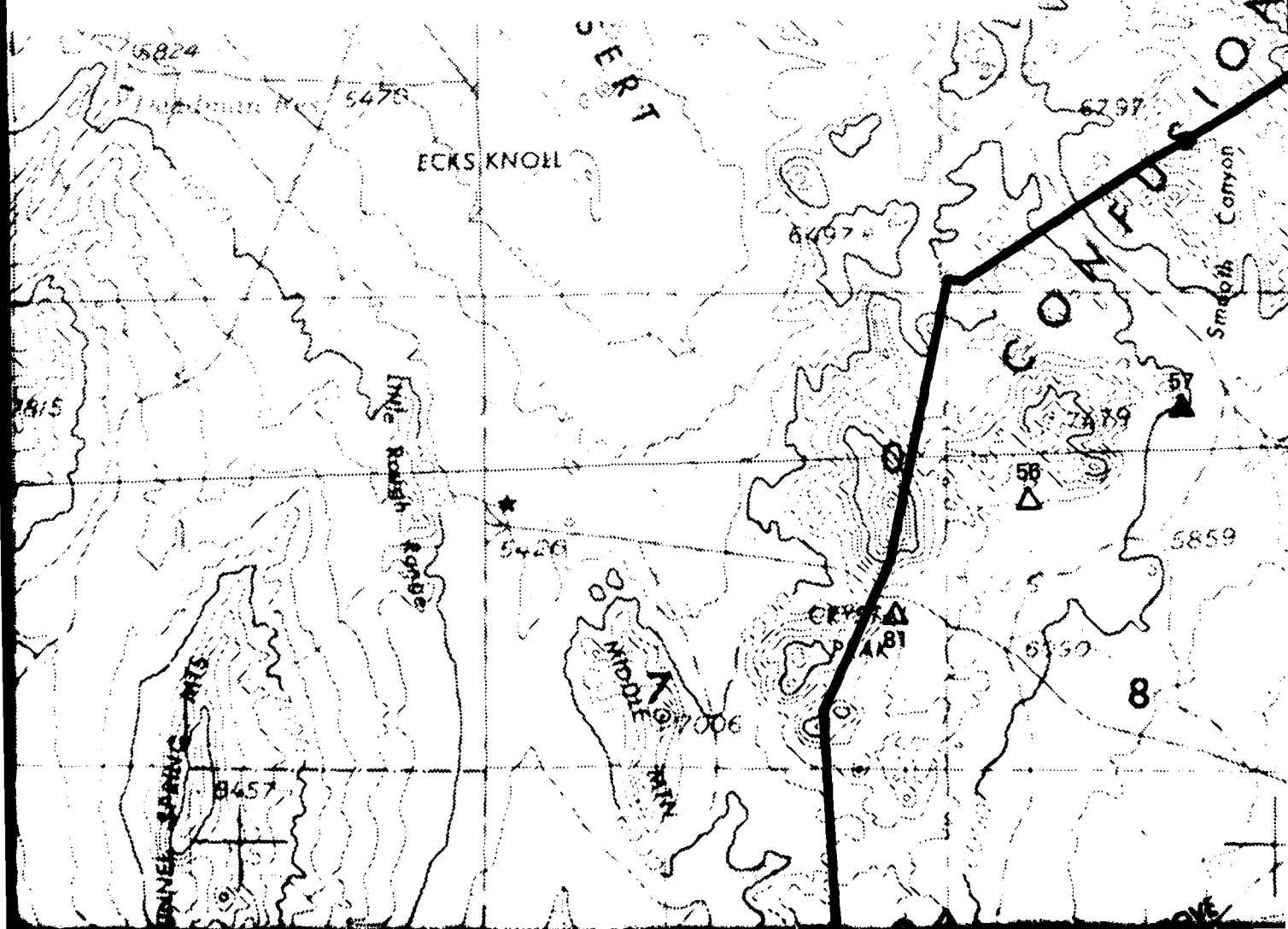
(Potential Crushed Rock Aggregates)

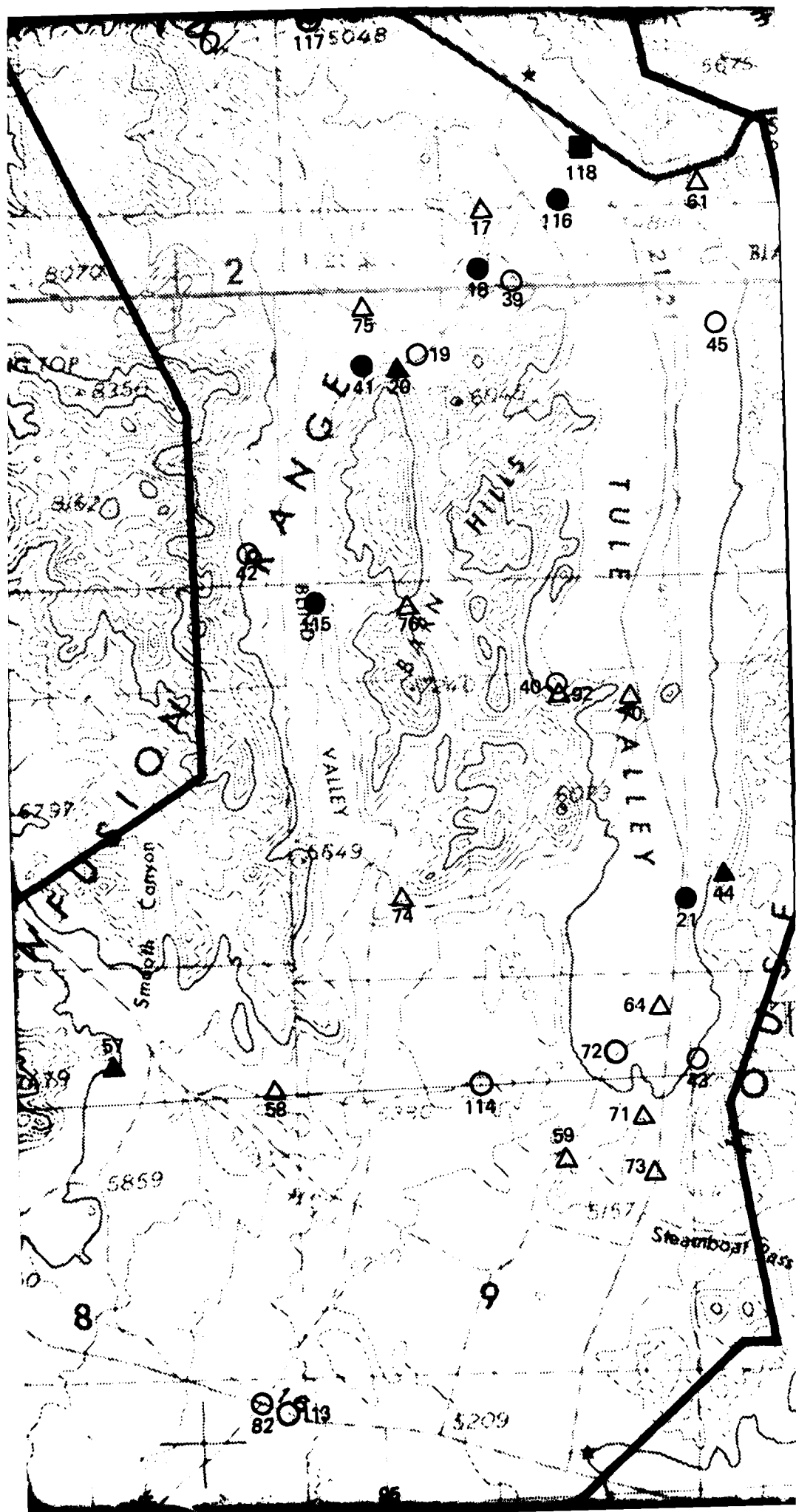


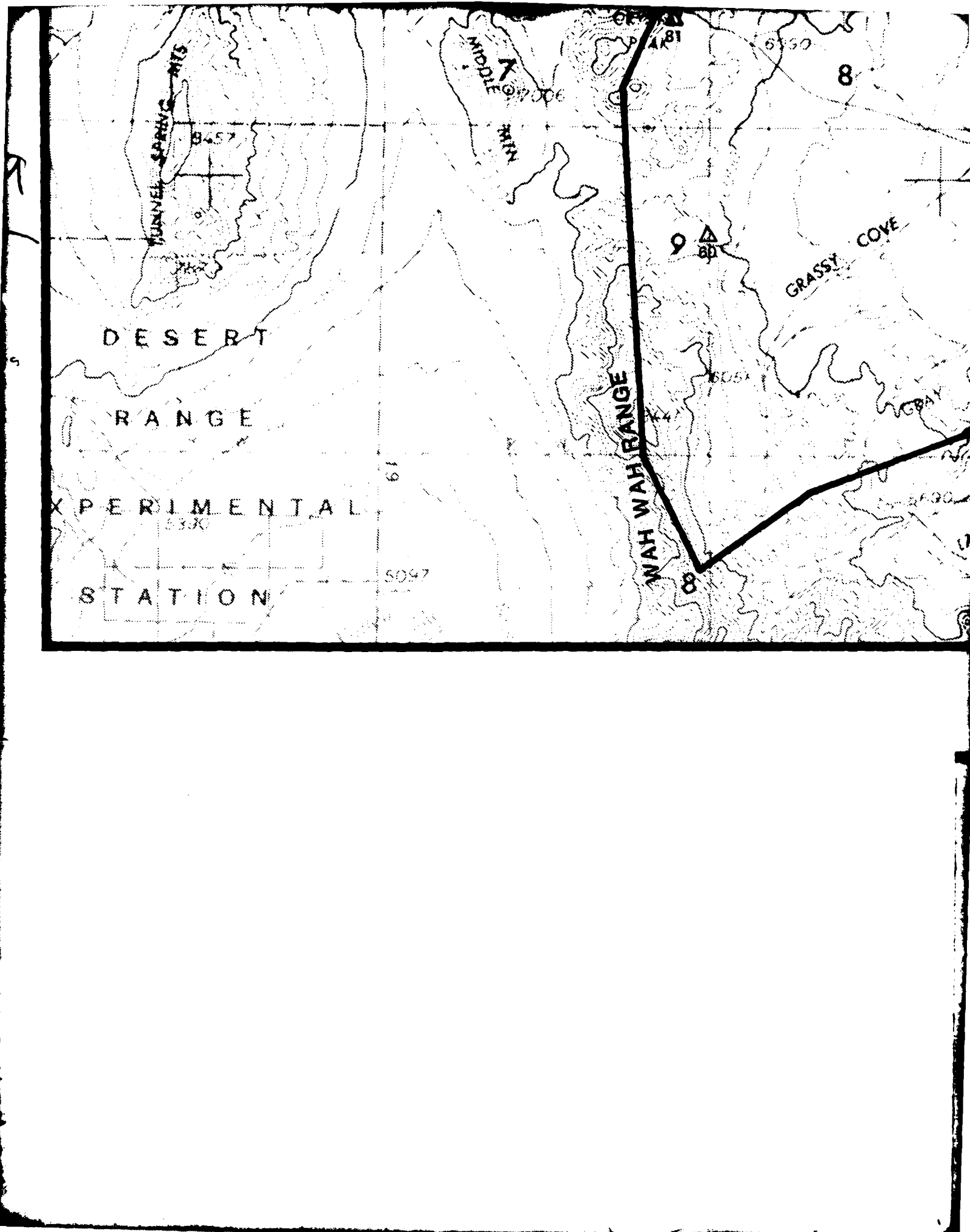
EXISTING TEST DATA SITES



Note: See Corresponding Map Number in Appendix A for Detailed Information







DESSERT

RANGE

EXPERIMENTAL

STATION

MIDDLE MOUNTAIN

TUNNEL SPRING MTS

GRASSY COVE

WAH WAH RANGE

GRAY

9

8

8

61

5097

6181

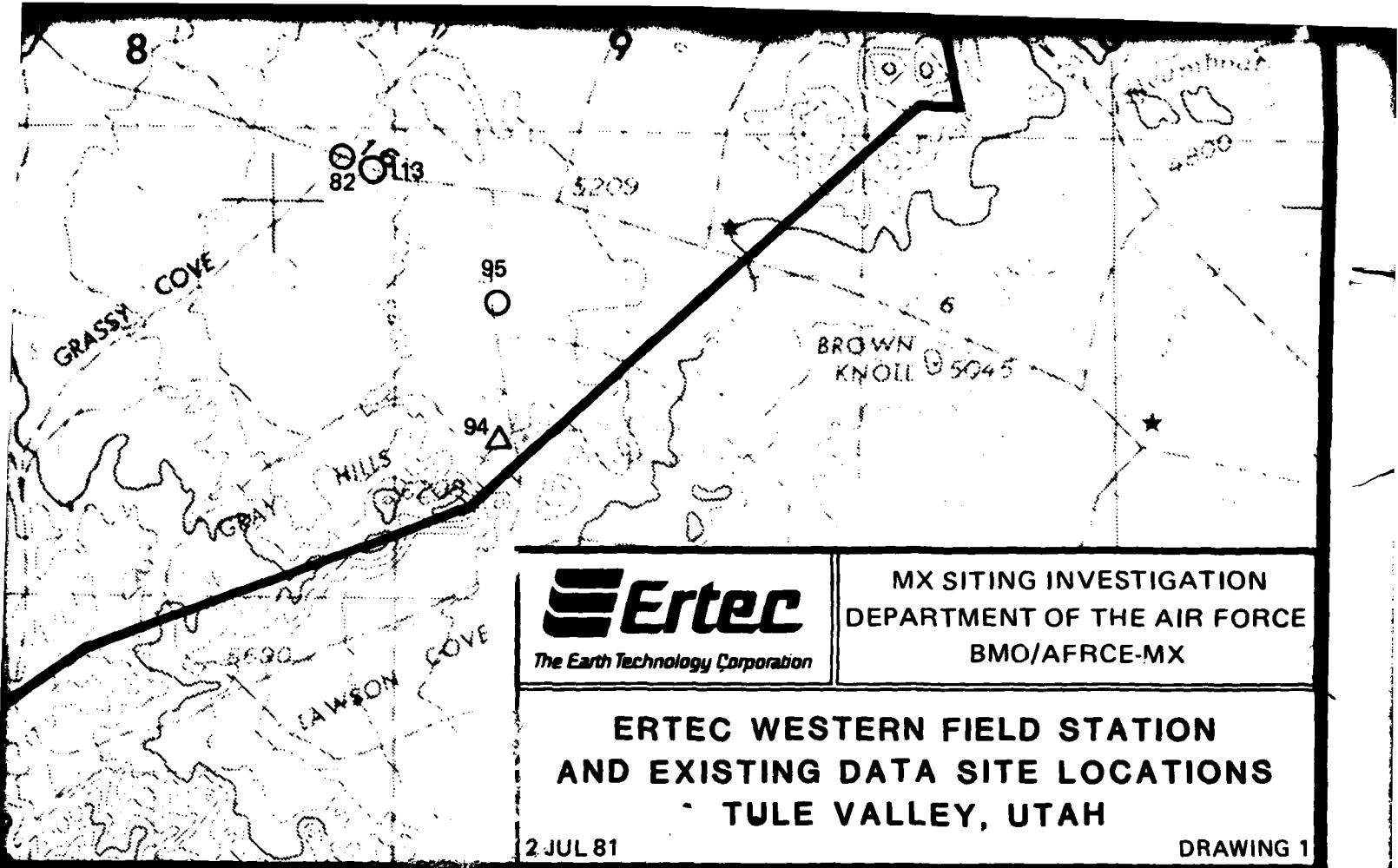
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6051

6090

6157

6152



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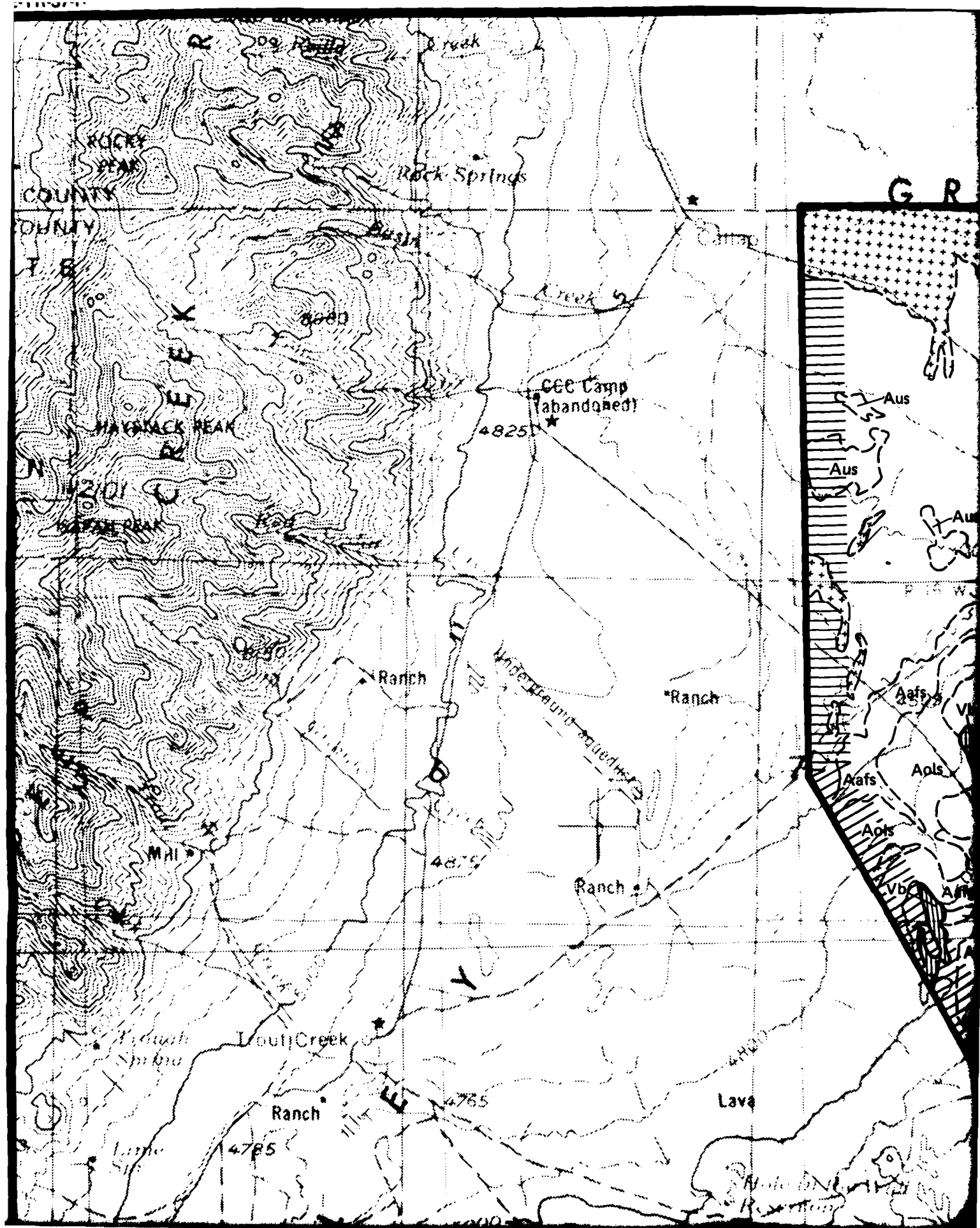
MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE
BMO/AFRCE-MX

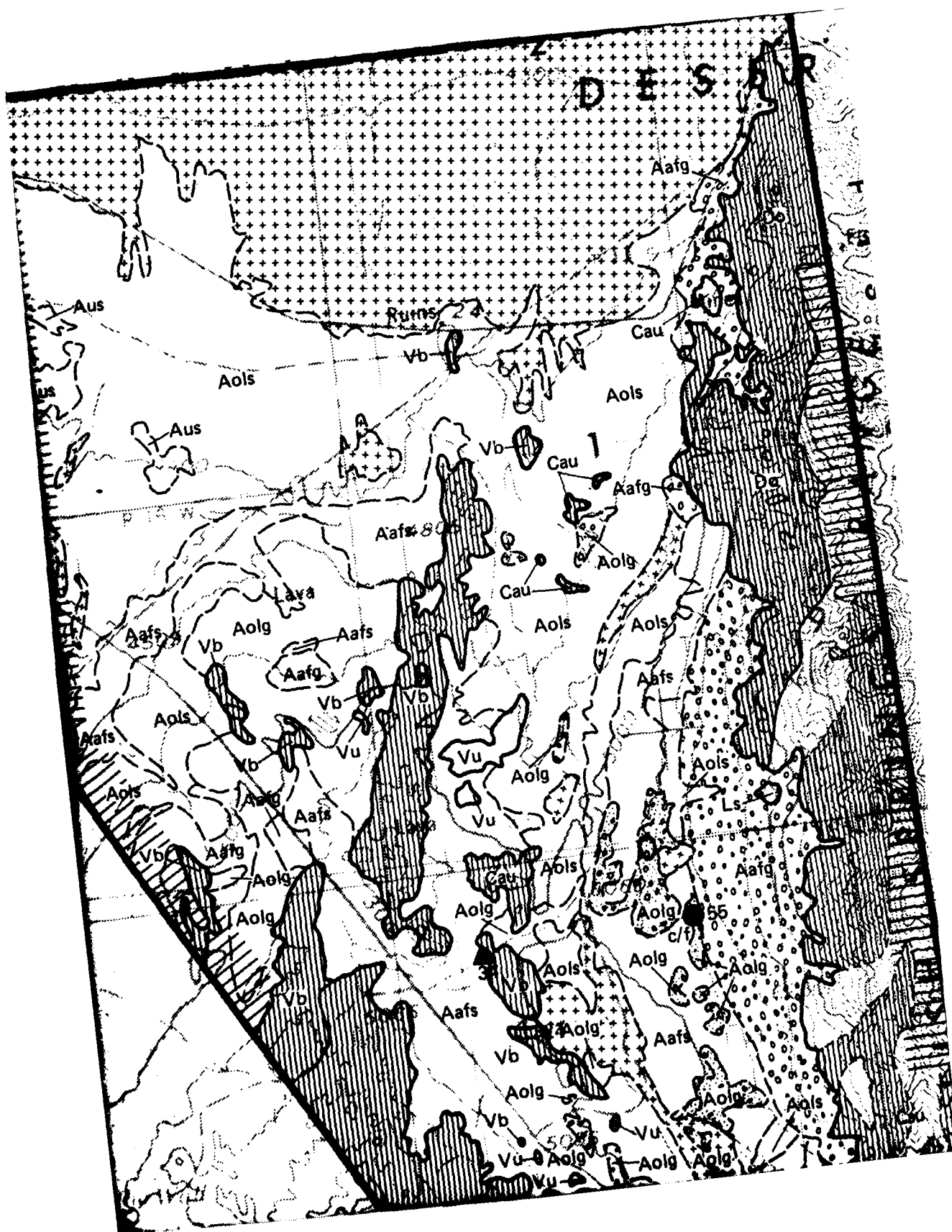
**ERTEC WESTERN FIELD STATION
AND EXISTING DATA SITE LOCATIONS
TULE VALLEY, UTAH**

2 JUL 81

DRAWING 1

10





LAKE

SPRINGS

WILDLIFE

REFUGE

Spring

TV

UV

TU

RU

SPRINGS

FLAT

TOGELE COUNTY
JUAB COUNTY

BLACK ROCK
HILLS

CASPER
MTN

PYRAMID PEAK

Dugway
Pass

HEMLOCK
MOUNTAIN

TOPAZ MOUNTAIN

84941

5203

4778

4520

4430

4883

5620

5278

Mines

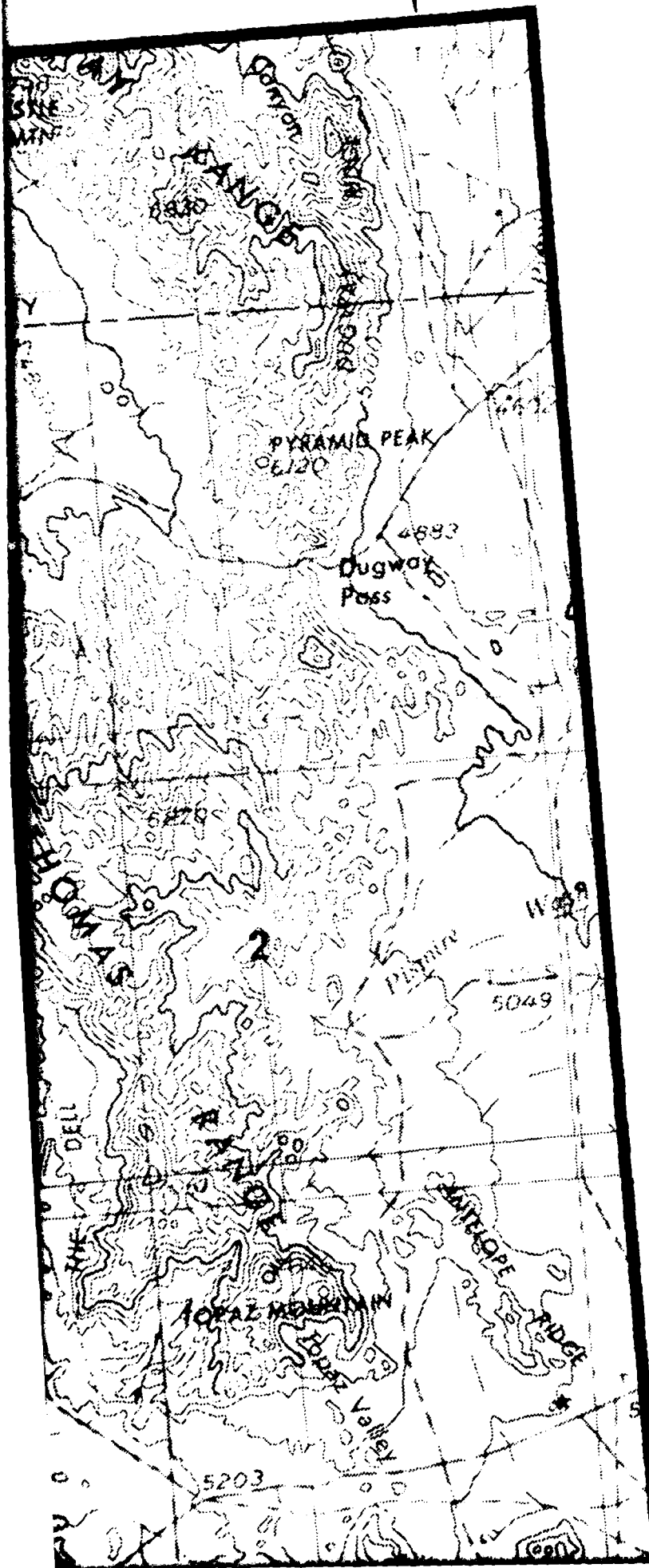
DELL

Plum

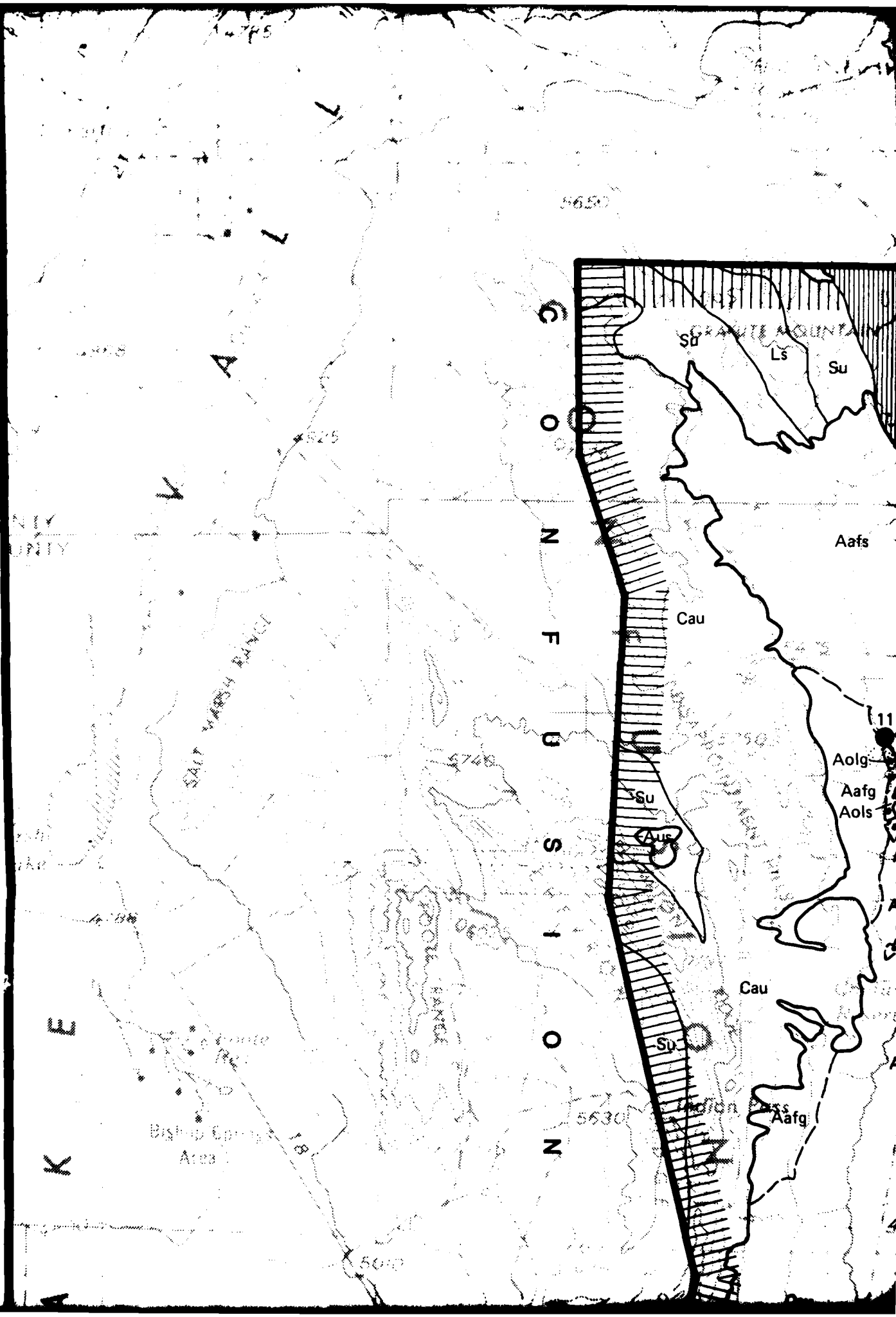
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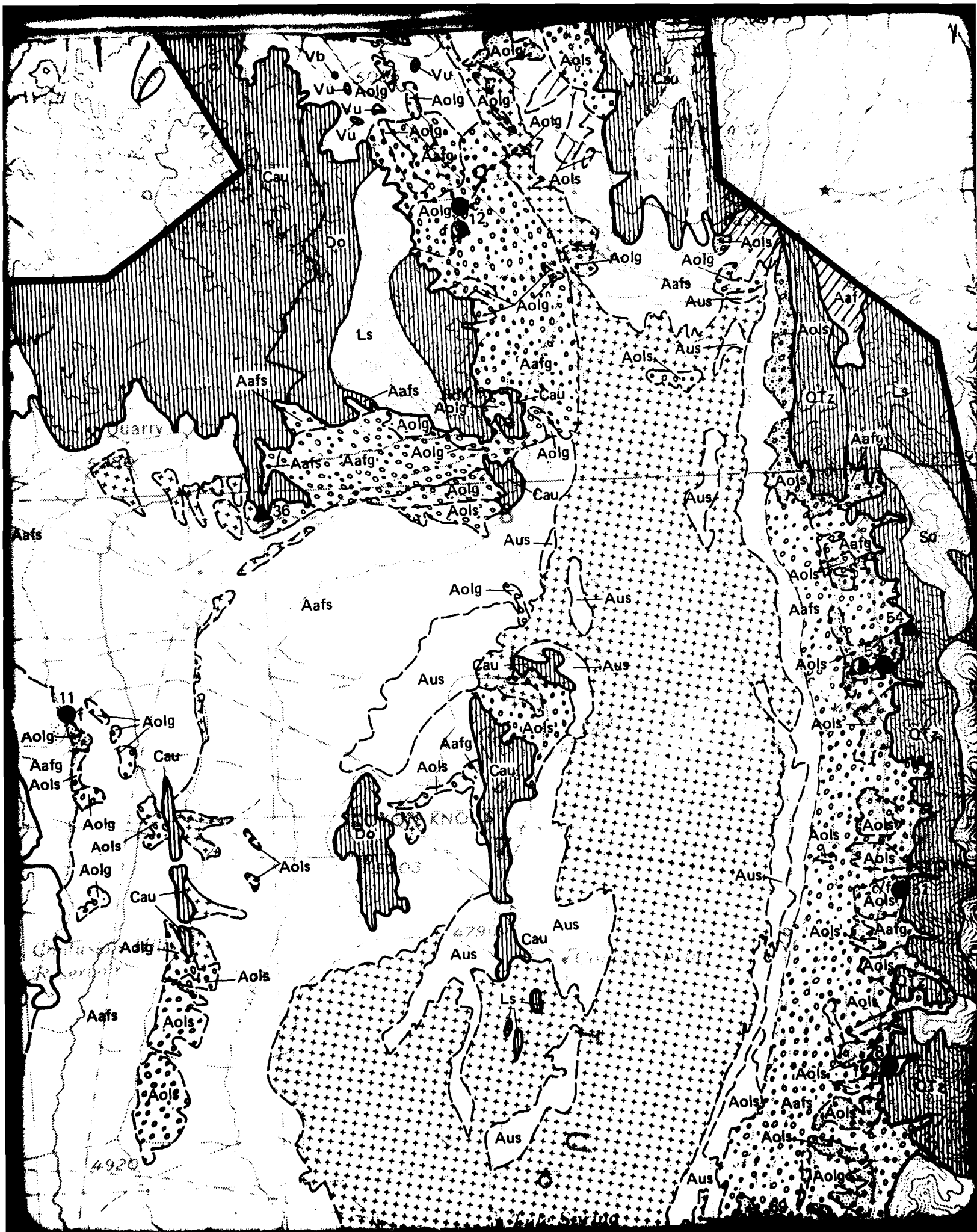
ANTHONY

14



5





FLAT

4841

20

4803

Miles

4736

Corral

6438

5793

5204

SWASEY
BOTTOM

5370

Loading pen

52201

5339

Underground aqueduct

Sill

Swasey Spring

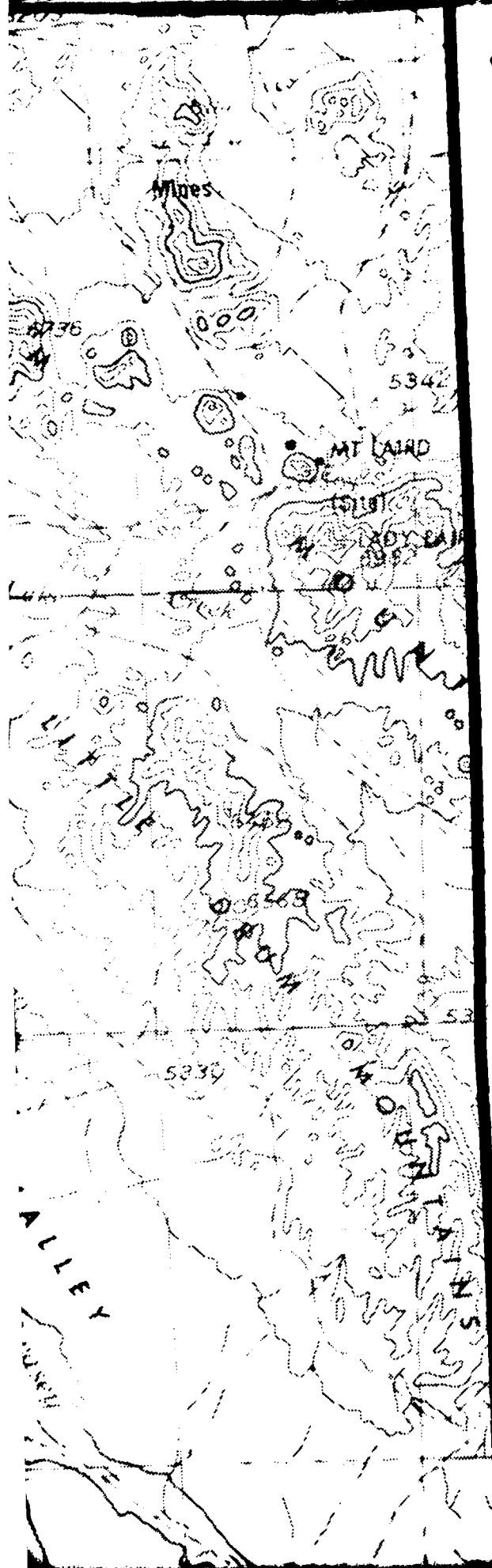
SWASEY SPRING

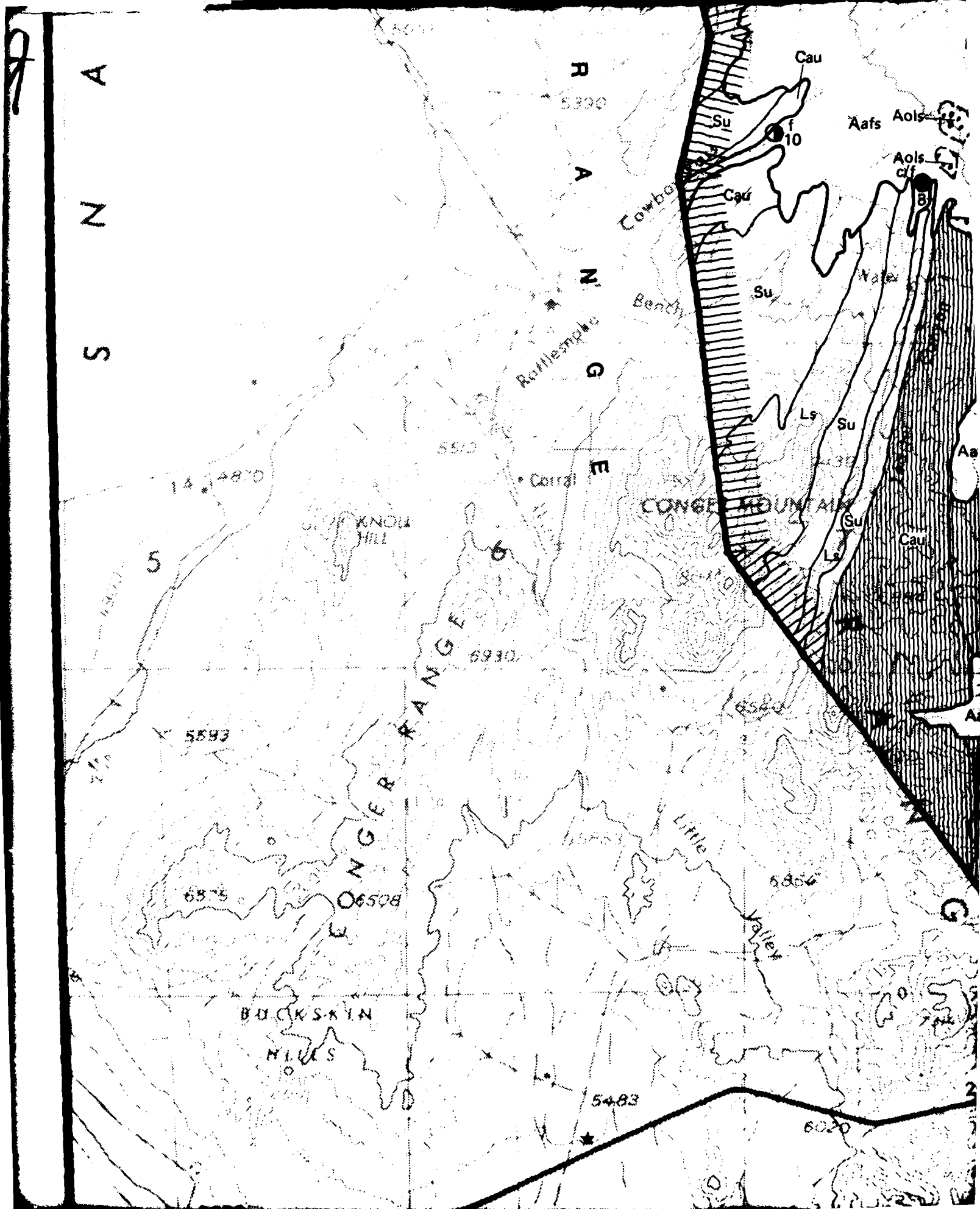
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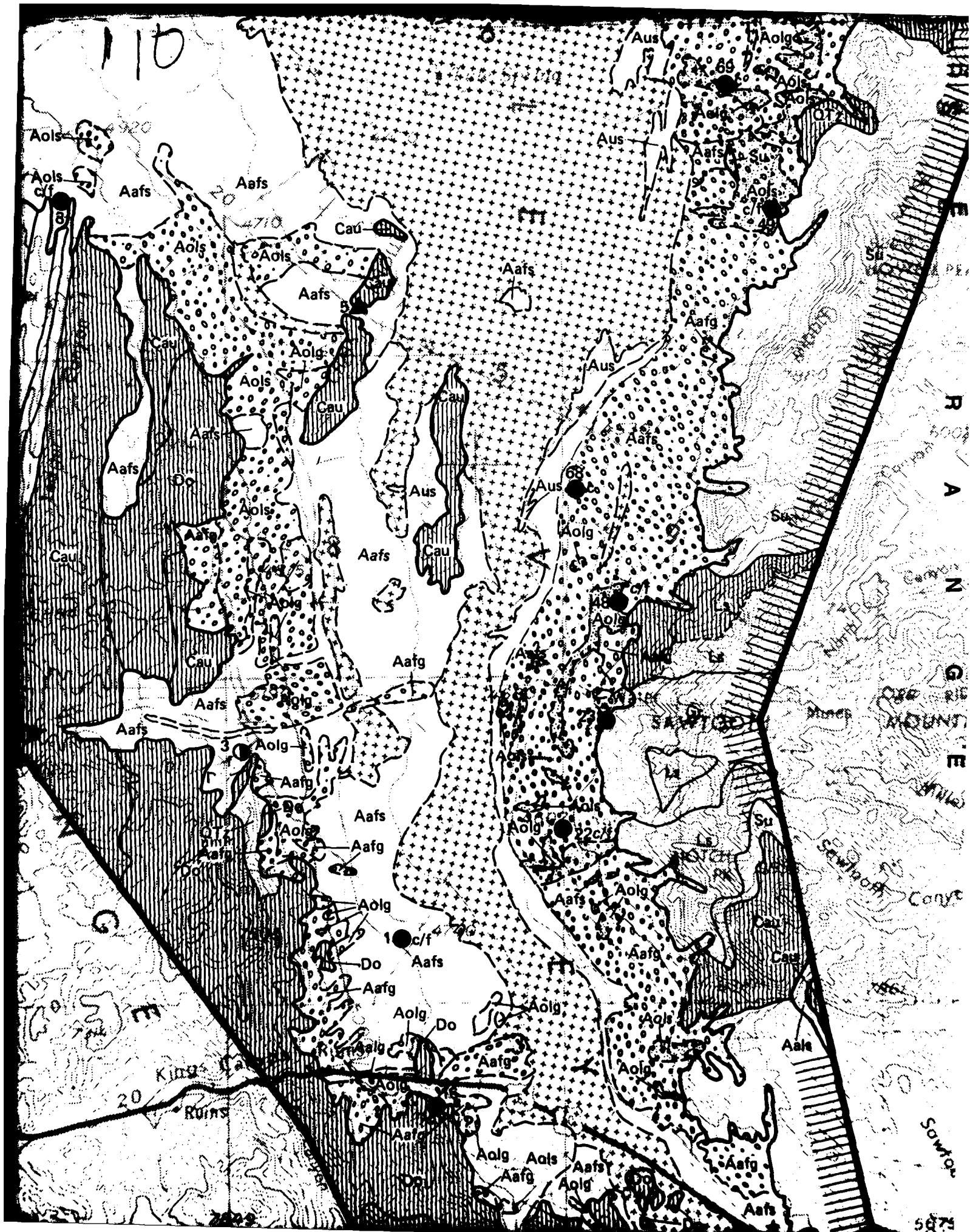
SWASEY MOUNTAIN

WIRIND VALLEY

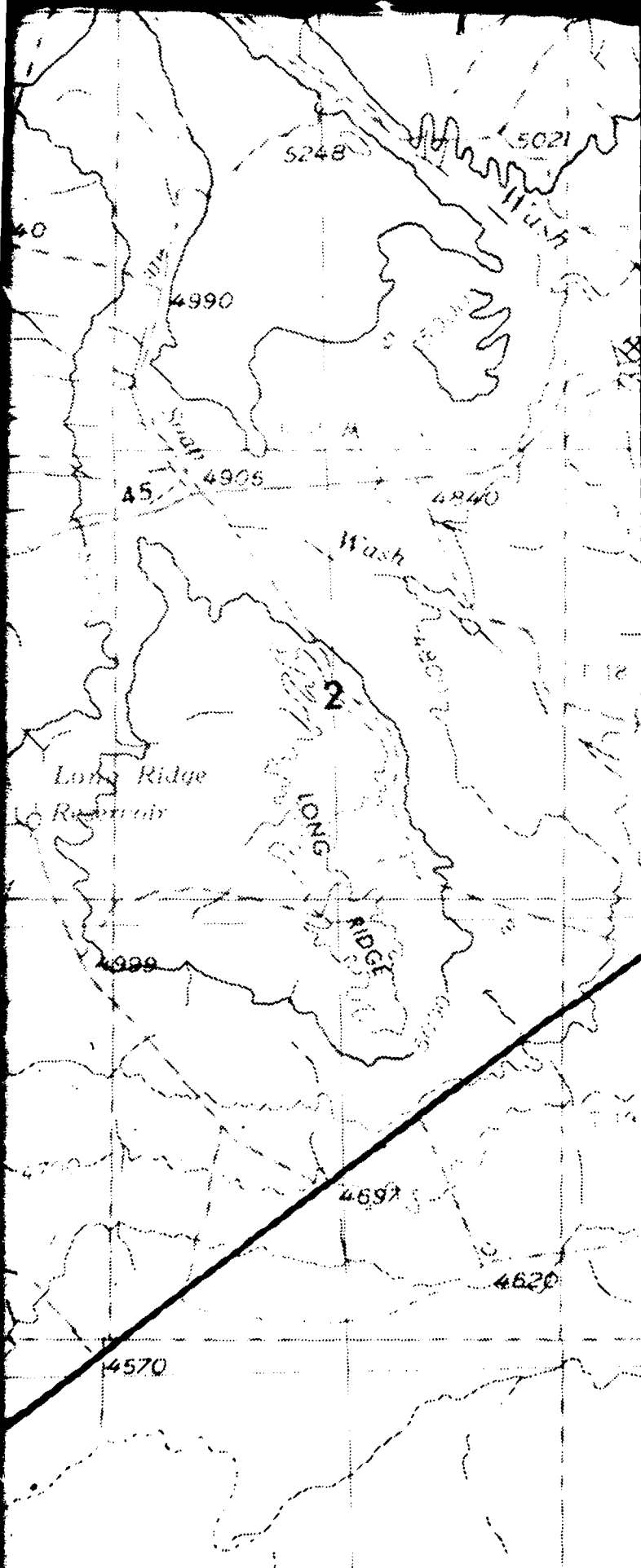








12



EXPLANATION

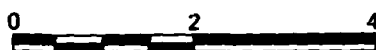
5030

5260



NORTH

SCALE 1:125,000

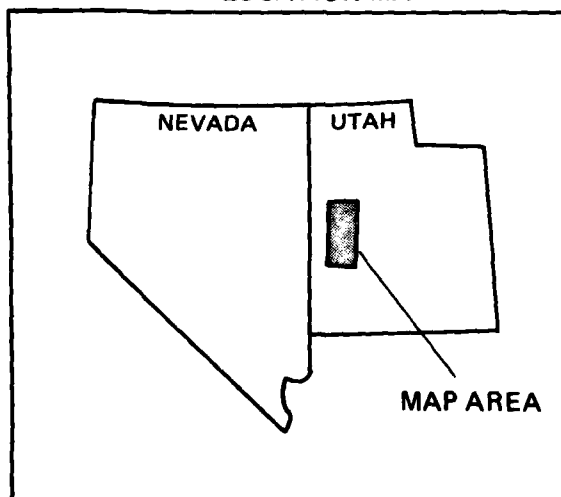


STATUTE MILES



KILOMETERS

LOCATION MAP



BASIN-FILL SOURCES



Class I - Potentially Suitable Coarse,
Concrete Aggregate or Road - Base Material Source



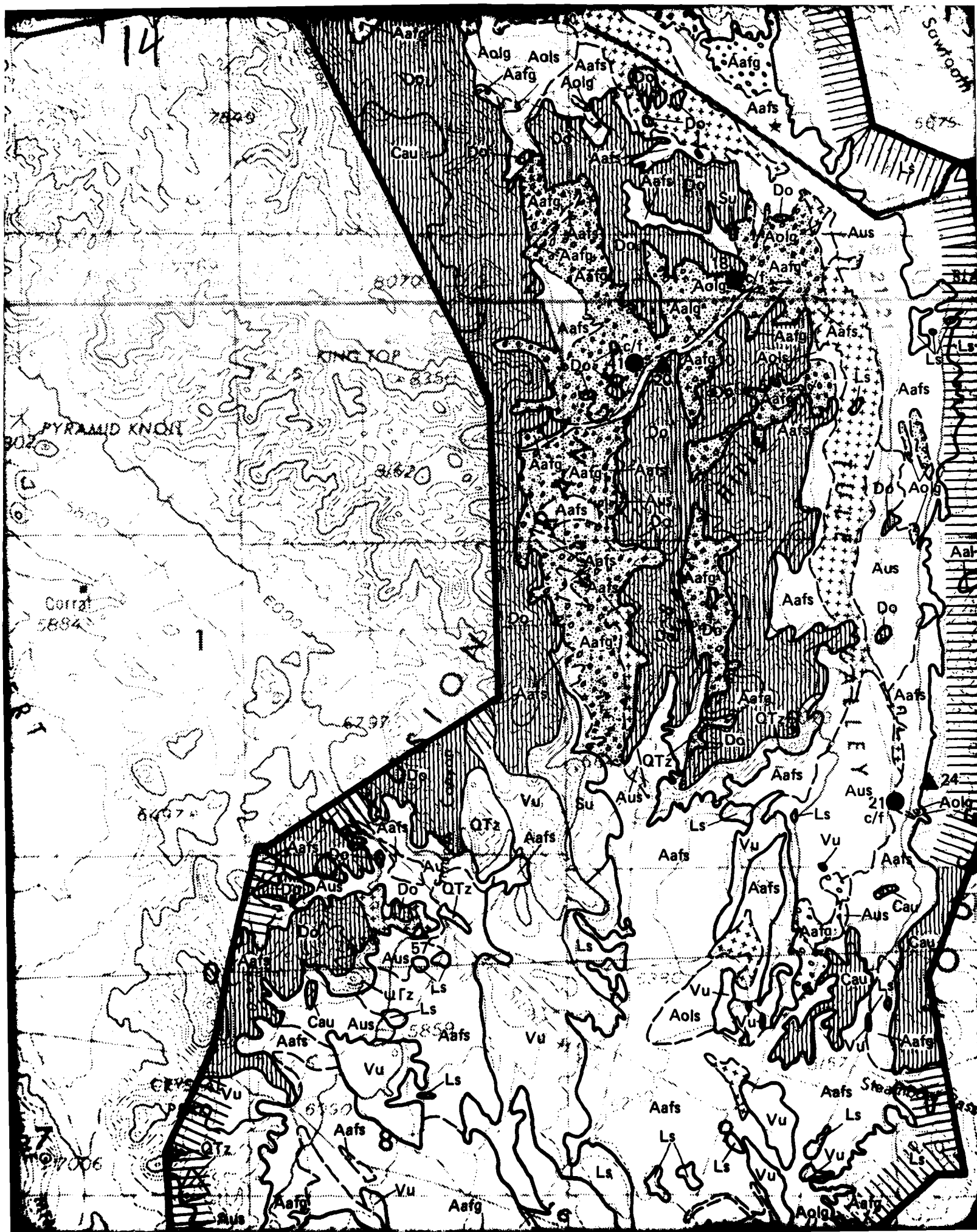
Class I - Potentially Suitable Coarse and Fine (Multiple Source)
Concrete Aggregate or Road-Base Material Source

ROCK SOURCES

PYRAMID

Corr 21
5884

MOORE
57006



[illegible]

BASIN-FILL UNITS *

Aal	Stream Channel and Terrace Deposits
Aaf	Alluvial Fan Deposits
Aol	Older Lacustrine Deposits
Au	Alluvial Deposits Undifferentiated
Vb	Basalt
Vu	Volcanic Rocks Undifferentiated
Gr	Granitic Rock
Qtz	Quartzite
Ls	Limestone
Do	Dolomite
Cau	Carbonate Rocks Undifferentiated
Su	Sedimentary Rocks Undifferentiated

* Reference Appendix E for Symbol Expl

Aafg Material type (Aaf) and Grain Size
Grain size designations are gravel

— — — — — Geologic Contact, Dashed Where

----- Approximate Concrete Aggregate
Road-Base Materials Source Bound

Verification Study Area (Within

ERTEC WESTERN AGGREGATE R
SAMPLED AND TESTED FIELD S

BASIN-FILL AGGREGATE SAMPLE
COARSE (c) AND FINE (f)

CRUSHED RO
SAMPLE



EXPLANATION

POTENTIAL AGGREGATE SOURCES

BASIN-FILL UNITS *

al	Stream Channel and Terrace Deposits	(A1)
af	Alluvial Fan Deposits	(A5)
ol	Older Lacustrine Deposits	(A4o)
Au	Alluvial Deposits Undifferentiated	
Vb	Basalt	(I 3)
Vu	Volcanic Rocks Undifferentiated	(I 2 and/or I 4)
Gr	Granitic Rock	(I 1)
Qtz	Quartzite	(M4 and/or S1)
Ls	Limestone	(S2)
Do	Dolomite	(S2)
Cau	Carbonate Rocks Undifferentiate	(S2)
Su	Sedimentary Rocks Undifferentiated	(S)

Reference Appendix E for Symbol Explanation and Comparison

lg Material type (Aaf) and Grain Size Designation (g).
Grain size designations are gravel (g) and sand (s).

— — Geologic Contact, Dashed Where Approximate

— — Approximate Concrete Aggregate and/or
Road-Base Materials Source Boundary

 Verification Study Area (Within Hachures)

ERTEC WESTERN AGGREGATE RESOURCES SAMPLED AND TESTED FIELD STATIONS

AGGREGATE SAMPLE	CRUSHED ROCK	
AND FINE (f)	SAMPLE	CLASSIFICATION
		CLASS I
		CLASS II



Class I — Potentially Suitable Coarse and Fine (Multiple Source)
Concrete Aggregate or Road-Base Material Source

ROCK SOURCES



Class I — Potentially Suitable Crushed Rock,
Concrete Aggregate or Road-Base Material Source

BASIN-FILL AND ROCK SOURCES



Class II — Possibly Unsuitable Coarse, Fine and/or Crushed Rock Concrete
Aggregate/Potentially Suitable Road-Base Material Source



Class III — Unsuitable Coarse, Fine and/or Crushed Rock Concrete
Aggregate or Road-Base Material Source

EXPERIMENTAL
STATION

BROWN-FILL AGGREGATE SAMPLE

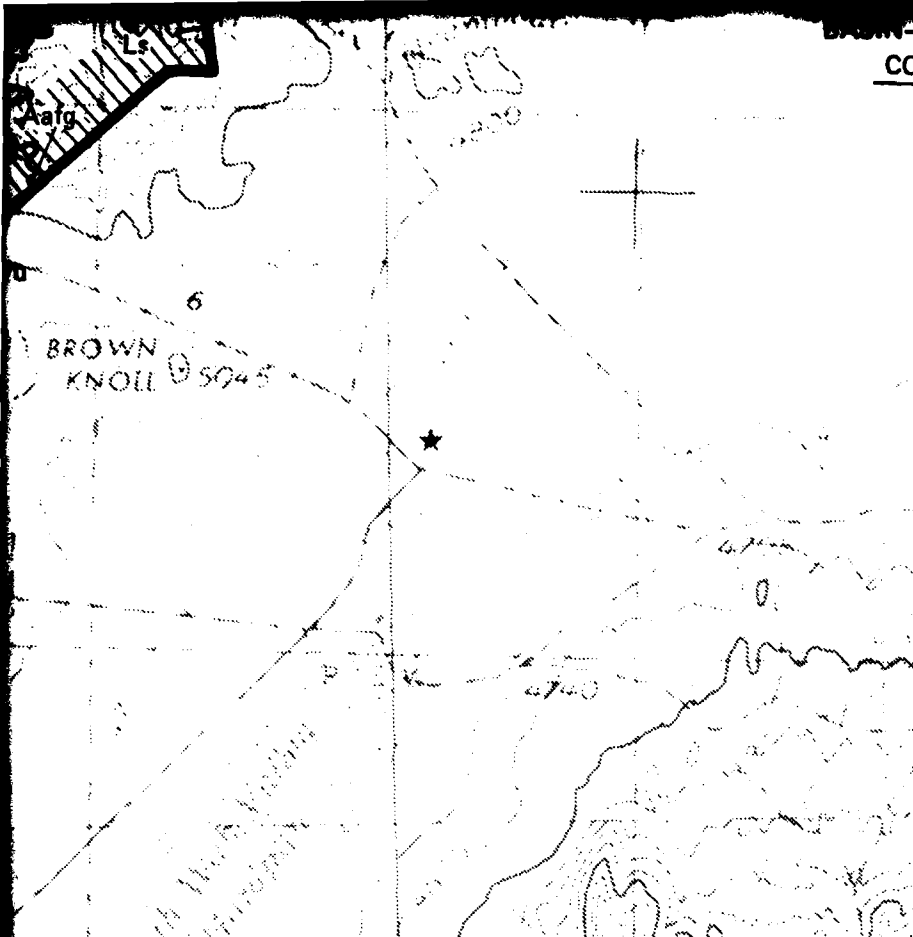
CRUSHED ROCK

COARSE (c) AND FINE (f)

SAMPLE



NOTE: SEE CORRESPONDING MAP NUMBER IN APP
DETAILED INFORMATION



Ertec

The Earth Technology Corporation

MX SITING INV
DEPARTMENT OF
BMO/AFR

AGGREGATE RESOURCES
TULE VALLEY, UTAH

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CLASS I
CLASS II
CLASS III

NOTE: SEE CORRESPONDING MAP NUMBER IN APPENDIX A FOR
DETAILED INFORMATION



MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE
BMO/AFRCE-MX

AGGREGATE RESOURCES MAP
TULE VALLEY, UTAH

2 JUL 81

DRAWING 2

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