UNITED STATES
DEPARTMENT OF THE INTERIOR
Fred A. Seaton, Secretary

BUREAU OF RECLAMATION
W. A. Dexheimer, Commissioner
E. O. Larson, Regional Director

V E R N A L U N I T
C E N T R A L U T A H P R O J E C T

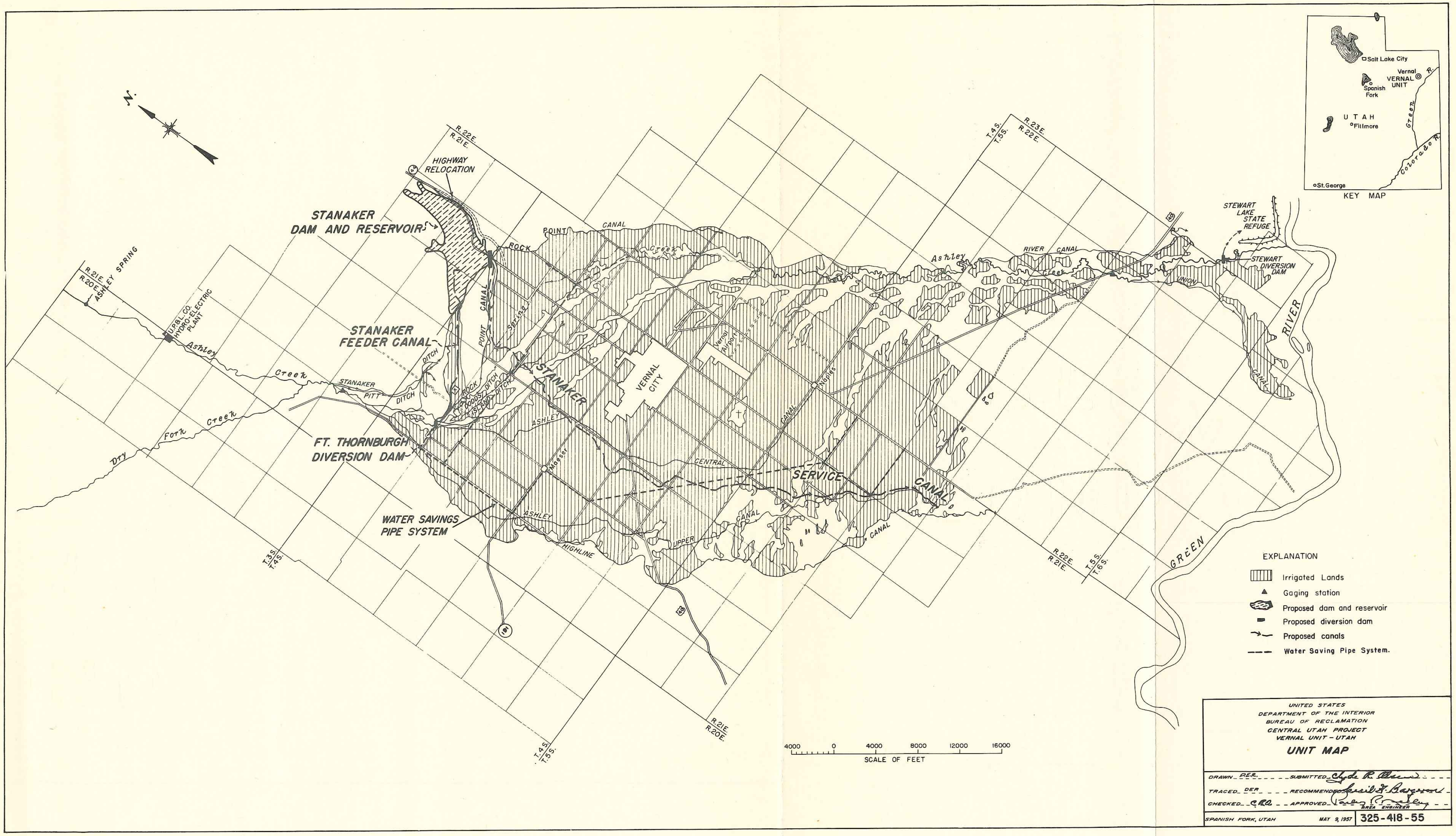
DEFINITE PLAN REPORT

APPENDIX A
PROJECT LANDS
LAND DRAINAGE

May 1957

Region 4

Salt Lake City, Utah


N.
HIGHWAY RELOCATION
STANAKER DAM AND RESERVOIR
ASHLEY SPRING
U.P.&L.CO. HYDRO-ELECTRIC PLANT
STANAKER FEEDER CANAL
STANAKER PITT DITCH
FT. THORNBURGH DIVERSION DAM
WATER SAVINGS PIPE SYSTEM
Dry Fork Creek
Ashley Creek
ROCK POINT CANAL
STANAKER
VERNAL CITY
Vernal Airport
ASHLEY CENTRAL SERVICE CANAL
ASHLEY UPPER CANAL
HIGHLINE
Ashley River Canal
UNION
STEWART LAKE STATE REFUGE
STEWART DIVERSION DAM
GREEN RIVER
R.22E. R.21E.
R.21E. R.20E.
R.23E. R.22E.
T.4S. T.5S.
T.3S. T.4S.
T.5S. T.6S.
4000 0 4000 8000 12000 16000
SCALE OF FEET
Salt Lake City
Vernal
VERNAL UNIT
Spanish Fork
UTAH
Fillmore
Green R.
Colorado R.
St. George
KEY MAP
EXPLANATION
Irrigated Lands
Gaging station
Proposed dam and reservoir
Proposed diversion dam
Proposed canals
Water Saving Pipe System.
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL UTAH PROJECT
VERNAL UNIT - UTAH
UNIT MAP
DRAWN D.E.R. SUBMITTED Clyde R. Olsen
TRACED DER RECOMMENDED Cecil H. Bargeron
CHECKED C.R.O. APPROVED Parley R. Neeley AREA ENGINEER
SPANISH FORK, UTAH MAY 9, 1957 325-418-55

Appendixes to the Vernal Unit Definite Plan Report have been issued in four volumes with the data grouped as shown below.

APPENDIX A
PROJECT LANDS
LAND DRAINAGE

APPENDIX B
WATER SUPPLY

APPENDIX C
DESIGNS AND ESTIMATES

APPENDIX D
AGRICULTURAL ECONOMY
FINANCIAL ANALYSIS

SUMMARY SHEETS

Vernal Unit--Central Utah Project

LOCATION: Northeast Utah in Ashley Valley of the Uinta Basin, approximately centered by Vernal, Utah.

AUTHORIZED: Initial phase of the Central Utah project, including the Vernal unit, authorized as a participating project with the Colorado River Storage project by the Act of April 11 1956 (70 Stat. 105).

PLAN

Through storage regulation and water exchanges, the Vernal unit will provide supplemental irrigation water for 14,781 acres of land and 1,500 acre-feet of water annually to supplement the municipal supplies of Vernal, Naples, and Maeser. The unit will also provide benefits to fish and wildlife and recreation. Excess flows of Ashley Creek will be diverted at the Ft. Thornburgh Diversion Dam into the Stanaker Feeder Canal and conveyed to the Stanaker Reservoir. Water stored in the reservoir will be released into the Stanaker Service Canal and delivered to existing irrigation canals and ditches. The water will in part replace Ashley Creek water, including releases from upstream reservoirs. Some of the replaced water will be used on lands above the Stanaker Service Canal and some will be diverted from Ashley Spring on Ashley Creek into the municipal pipeline. Land drains will be provided as needed and some sections of existing canals will be lined to prevent seepage. A pipe system will be constructed for stock-watering purposes during the nonirrigation season to save for unit storage and use water now lost through open canals. Recreational and fishing attractions will be provided at Stanaker Reservoir. Small tracts of land distributed among the unit area will be acquired and developed for upland game, and a pump and pipeline will be installed to deliver water from Green River to the Stewart Lake State Refuge. Repayment of reimbursable construction costs will be completed in 50 years, following a 3-year development period. Irrigation costs that are beyond the repayment ability of the irrigators will be paid from the Upper Colorado River Basin Fund.

SUMMARY SHEETS (Continued)

CONSTRUCTION COSTS 1/$6,874,000

Stanaker Dam and Reservoir	$3,870,000
Ft. Thornburgh Diversion Dam . . .	200,000
Stanaker Service Canal	1,060,000
Stanaker Feeder Canal	570,000
Water Savings pipe system	340,000
Stanaker Canal laterals.	40,000
Vernal area drainage system . . .	675,000
Recreation	92,000
Fish and wildlife	27,000

1/ Estimated at January 1957 prices.

BENEFITS, ALLOCATIONS, AND REPAYMENT

Unit purpose	Benefits (annual)	Allocations (tentative) Construction costs	Allocations (tentative) Annual O.M.& R. costs
Irrigation	$253,500	1/$6,154,000	$12,700
Municipal water . . .	23,800	2/619,000	1,800
Recreation	14,200	3/92,000	7,100
Fish and wildlife . .	13,600	3/27,000	1,200
Total.	305,100	2/6,892,000	22,800

1/ $1,500,000 will be repaid by Vernal unit irrigators through the Upper Colorado River Basin Fund and the remaining $4,654,000 will be paid from other revenues in the basin fund apportioned to Utah.

2/ Includes $18,000 in interest during construction.

3/ Nonreimbursable

Average annual water costs per acre-foot

	Construction repayment	O.M.& R. costs
Irrigation water	$1.65	$0.70
Municipal water	1/	1.20

1/ Municipal water payment will increase from $12.00 per acre-foot during first 10 years to $22.13 during last 10 years of 50-year repayment period.

BENEFIT-COST RATIO 1.44 to 1

REPAYMENT ORGANIZATION

The Uintah Water Conservancy District has been organized in accordance with Utah State law and will contract with the United States for the repayment of irrigation and municipal water costs.

SUMMARY SHEETS (Continued)

IRRIGATION

Irrigable area furnished supplemental water	Acres
Class 1	3,286
Class 2	5,357
Class 3	5,801
Unclassified (town site)	337
Total	14,781

Elevation of farm lands (avg. feet msl)	5,300
Frost-free period (avg. days annually)	119
Effective precipitation (avg. inches annually)	3
Diversion requirement (avg. ac.-ft. annually)	51,700
Increase in water supply (avg. ac.-ft. annually)	18,000
Increased depletion of Colorado River from unit operation (avg. ac.-ft. annually)	11,800

UNIT WORKS

Stanaker Dam

Located on offstream Stanaker Draw, 3.5 miles north of Vernal.

Type	rolled earth-fill
Height above ground	140 ft.
Height above foundation	145 ft.
Volume of embankment	1,820,000 cu. yds.
Spillway capacity	(emergency only)
Outlet capacity (at res. elev. 5,472)	300 sec.-ft.

Stanaker Reservoir

Elevation at normal water surface (37,560 ac.-ft.)	5,516.2 ft.
Active storage capacity	33,200 ac.-ft.
Inactive storage capacity	4,360 ac.-ft.
Total storage capacity	37,560 ac.-ft.
Reservoir surcharge capacity above normal water surface elevation	2,170 ac.-ft.

Stanaker Feeder Canal

Length	3.1 miles
Capacity	400 sec.-ft.

Stanaker Service Canal

Length	11.8 miles
Capacity at head	300 sec.-ft.

Water Savings Pipe System

Length	17.3 miles
Capacity at head	289 gal. per min.

SUMMARY SHEETS (Continued)

HYDROLOGY

Ashley Creek at "Sign of the Maine" gage

Drainage area.	241 sq. mi.
Period of record	1940-56
Average runoff, 1940-56	92,800 ac.-ft.
Maximum annual runoff.	142,300 ac.-ft.
Minimum annual runoff.	52,400 ac.-ft.
Maximum daily discharge of record.	2,650 sec.-ft.
Minimum daily discharge of record.	14 sec.-ft.

CONTENTS

Project Lands

CONTENTS (Continued)

Project Lands (Continued)

CONTENTS (Continued)

Project Lands (Continued)

Drainage

CONTENTS (Continued)

Drainage (Continued)

MAPS AND CHARTS

Project Lands

Drainage

PROJECT LANDS APPENDIX

Prepared by Grant R. Lamb, Soil Scientist,
Supervised by O. D. Mohlman, Soil Scientist,
Under direction of Parley R. Neeley, Area Engineer

Technical supervision and review by O. F. Bartholomew,
Chief, Land Resources and Laboratory Branch, Regional
Project Development Division, under direction of Reid Jerman,
Regional Project Development Engineer.

7-1594
(AUG. 1954)
BUREAU OF RECLAMATION

LAND CLASSIFICATION--SUMMARY DATA

DATE April 1957

1. AREA

REGION 4

PROJECT Central Utah

DIVISION

UNIT Vernal

OTHER

2. BASE MAPS

AERIAL PHOTO [X] SCALE 400 ft. = 1 inch

TOPOGRAPHIC [ ] SCALE

PLANE TABLE [ ] SCALE

OTHER [ ] SCALE

3. FIELD WORK INIT. 1955 COMP. 1956 OTHER APPENDIX REPORT April 1957

4. ACREAGE CLASSIFIED

	TOTAL SURVEY	PROJECT OR UNIT IRRIGATED	NONIRRIGATED	TOTAL
CLASS 1	3,554	3,286		3,286
CLASS 2	5,843	5,357		5,357
CLASS 3	6,226	5,801		5,801
CLASS 4				
SUBTOTAL	15,623	14,444		14,444 *
CLASS 5	845	337		337 1/
~~CLASS 5~~ Town-site	8,658			
CLASS 6	15,653			
R.O.W.	918			
TOTAL	41,697	14,781		14,781

* IRRIGABLE AREA. PRODUCTIVE AREA 14,041

ACREAGE NOT CLASSIFIED

5. NUMBER OF BORINGS AND PITS

	MINIMUM	AVERAGE	TOTAL
SHALLOW (5')	36	46	2,778
DEEP (OVER 10')	1	1	52
OPEN PIT OR DEEP PROFILES			34

6. SUPPLEMENTAL PROCEDURES

SALINITY	360 [X]	SODIUM	[ ]
pH	360 [X]	GYPSUM	[ ]
LINE	360 [X]	LEACHING	[ ]
MECH. ANAL.	[ ]	ORG. MATTER	[ ]
H_2O CONDUCT.	245 [X]	FIELD CAPACITY	[ ]
INFILTRATION	[ ]	WILTING POINT	[ ]
BULK DENSITY	[ ]	H_2O STABILITY	[ ]
OTHER	[ ]		

7. SPECIFICATIONS AND INFORMATIVE APPRAISALS

TYPE OF SPECS.: GENERAL OR REGIONAL [ ] PHYSICAL [ ] PROJECT [X] OTHER [ ]

ESTIMATE OF PAY. CAPACITY OF IRRIGABLE LAND CLASSES: $9.90 | $ 7.70 | $ 4.60 | $

TYPE OF APPRAISALS: LAND USE [X] PRODUCTIVITY [X] LAND DEVEL. [X] WATER REQUIR. [X]

LAND DRAINABILITY [ ] OTHER [ ]

DESCRIPTION OF CLASS 4:

DESCRIPTION OF CLASS 5:

8. DETERMINATION OF IRRIGABLE AREA (STEPS COMPLETED)

WATER SUPPLY [X] DISTRIBUTION SYSTEM PLAN [X] DRAINAGE SYSTEM PLAN [X] PAYMENT CAPACITY [X]

FARM UNIT LAYOUT [ ] REVIEW BY WATER USERS [ ] O.M.+ R [ ]

9. USE OF LAND CLASSIFICATION

WATER REQUIREMENTS [X] DISTRIBUTION SYSTEM PLAN [X] DRAINAGE SYSTEM PLAN [X] IRRIGATION ASSESSMENTS [ ]

LAND APPRAISAL [ ] FARM UNIT DEVELOPMENT [ ] LAND USE AND MANAGEMENT [ ] IRRIGATION BENEFITS [X] OTHER [ ]

10. PRIOR SURVEYS OR CLASSIFICATIONS

TYPE AND AGENCY	YEAR	SCALE	COVERAGE
Soil Survey USDA	1920	1"=1 mi.	All
Reconnaissance Land Class	1937	1"=1000'	All
Semidetail	1947		All
USDA - SCS Farm Survey			Partial

11. REVIEWS AND COOPERATION

OFFICE OR AGENCY	DATE
USDA - SCS	1956
	1956

12. DATE OF SECRETARIAL CERTIFICATION

1/ 337 acres of the 845 acres in townsite are to be supplied with unit water.

GPO 843209

PROJECT LANDS

CHAPTER I

GENERAL DESCRIPTION

Introduction

This report is a summary of the information obtained from the detailed land classification survey of the Vernal unit of the Central Utah project, which is a participating project of the Colorado River Storage Project, and this summary is prepared as part of the Definite Plan Report. The lands of the unit were investigated and classified as to suitability for supplemental irrigation development.

Authority to make this investigation is provided in the Federal Reclamation laws (Act of June 17, 1902, 32 Stat. 388, and acts amendatory thereof or supplementary thereto.)

The introduction and general description of the unit area are presented in Chapter I. Chapter II is a detailed discussion of the soils, topography, drainage, salinity and alkalinity conditions in the various soil divisions within the unit. The quality of water is reviewed in Chapter III. Chapter IV discusses the land classification methods, specifications and results. Conclusions are made in Chapter V and the supporting data are listed in Chapter VI.

Purpose of the Investigation

The 1953 appropriation act provides that the Secretary of the Interior "shall certify to the Congress that an adequate soil survey and land classification has been made and that the lands to be irrigated are susceptible to the production of agricultural crops by means of irrigation."

The Fact Finders Act of 1924 points out that the specific purpose of land classification is to classify lands with respect to their capacity, under a proper agricultural program, to support a farm family and pay water charges. Another purpose of this classification is to provide definite, basic data to be used in solving agronomic, economic and engineering problems associated with this unit.

Nature, Date and Extent of Survey

The land classification herein reported is of a detailed nature and follows the specifications recommended by the Bureau of Reclamation.

The field survey work was begun in July 1955 and completed in 1956. To determine the lands which should be included in this unit, 41,697 acres were classified. This survey includes only irrigated lands, cultivated and non-cultivated. Six classes of land were delineated. The classification work was completed by Chester E. Wright and Edison C. Breckenridge, Soil Scientists, under the direction of O. D. Mohlman, Soil Scientist. Inspection and review was made by O. F. Bartholomew, Chief, Land Resources and Laboratory Branch, Regional Project Development Division.

Location

The Vernal Unit is located in the central portion of Uintah County, which is situated in the northeastern part of the State of Utah, and is about 175 miles east of Salt Lake City. All of the unit area is within the confines of the Ashley Valley, which extends from northwest to southeast and is bounded on the north by the lower slopes of the Uinta range of mountains, on the southwest by the Asphalt Ridge, on the northeast by the shale mesa and on the eastern and southern sides by Green River. Ashley Creek, which rises in lakes near the summit of the Uinta Mountains, traverses the area and then empties into the Green River. Vernal, the county seat of Uintah County, is situated in the west central part of the valley, and other towns within the area are Maeser and Naples. Highway U. S. 40, the main route from Salt Lake City, Utah, to Denver, Colorado, traverses most of the area, entering near Jensen at the east end and leaving about 5 miles southwest of Vernal.

Physiographically, the lands described in this report are located for the most part in the northwest two-thirds portion of Ashley Valley. This is a valley filled with alluvial material which has been transported in by stream action from the Uinta mountains and the surrounding hills. In addition, there are isolated areas of residual material along the west side of the unit, next to Asphalt Ridge. The main stream traversing the valley in Ashley Creek, which enters from the northwest and flows through the valley to the southeast. Ashley Valley is an elongated area approximately 15 miles long and 5 miles wide. The valley floor, where this unit is located, is relatively smooth, with about 2% general grade, but slopes up on either edge. The main drainage is to the southeast, and the side drainage is from the west and the east. The southeast portion of the valley is characterized by rolling hills and isolated benches or terraces, traversed by numerous well defined drainage ways. These rough broken lands are impossible to irrigate and are not included in this area. The lands of the unit area range in elevation from 4,820 to 5,700 feet above sea level.

To illustrate the physiography of the area, two detailed multiple profiles are shown on pages 4 and 5 One is of a north-south line $1\frac{1}{2}$ miles west of Vernal, Utah, and one is of an east-west line located one mile south of Vernal. Location of these profiles appears on the soil divisions map on page 9.

Geology

The Vernal unit area is situated along the south flank of the Uinta Mountains, which form the largest east-west trending range in the United States, approximately 160 miles in length and averaging 45 miles in width. It extends from Kamas, Utah, on the west to Cross or Junction Mountain, Colorado, on the east. The Uinta Mountains, a broad anticlinal arch with an east-west axis, have a maximum relief of about 8,500 feet. The highest point is Kings Peak, 13,500 feet above sea level. The postmature surface has been incised by deep canyons and pronounced glaciation is evident in all areas. Rocks varying in age from the old precambrian to recent are exposed on the south flanks. They are all sedimentary and all dip to the south in well defined strata, often spectacular in colors of red, purple, green, yellow and white hues.

The Uintas were first folded during the late Cretaceous to the Eocene periods, followed by post-folding, then verticle uplift. Large scale faulting occurred during the post-Cretaceous time. Erosion during the moist Oligocene period reduced the Uintas to low relief followed by renewed uplift in the late pliocene or early pleistocene periods.

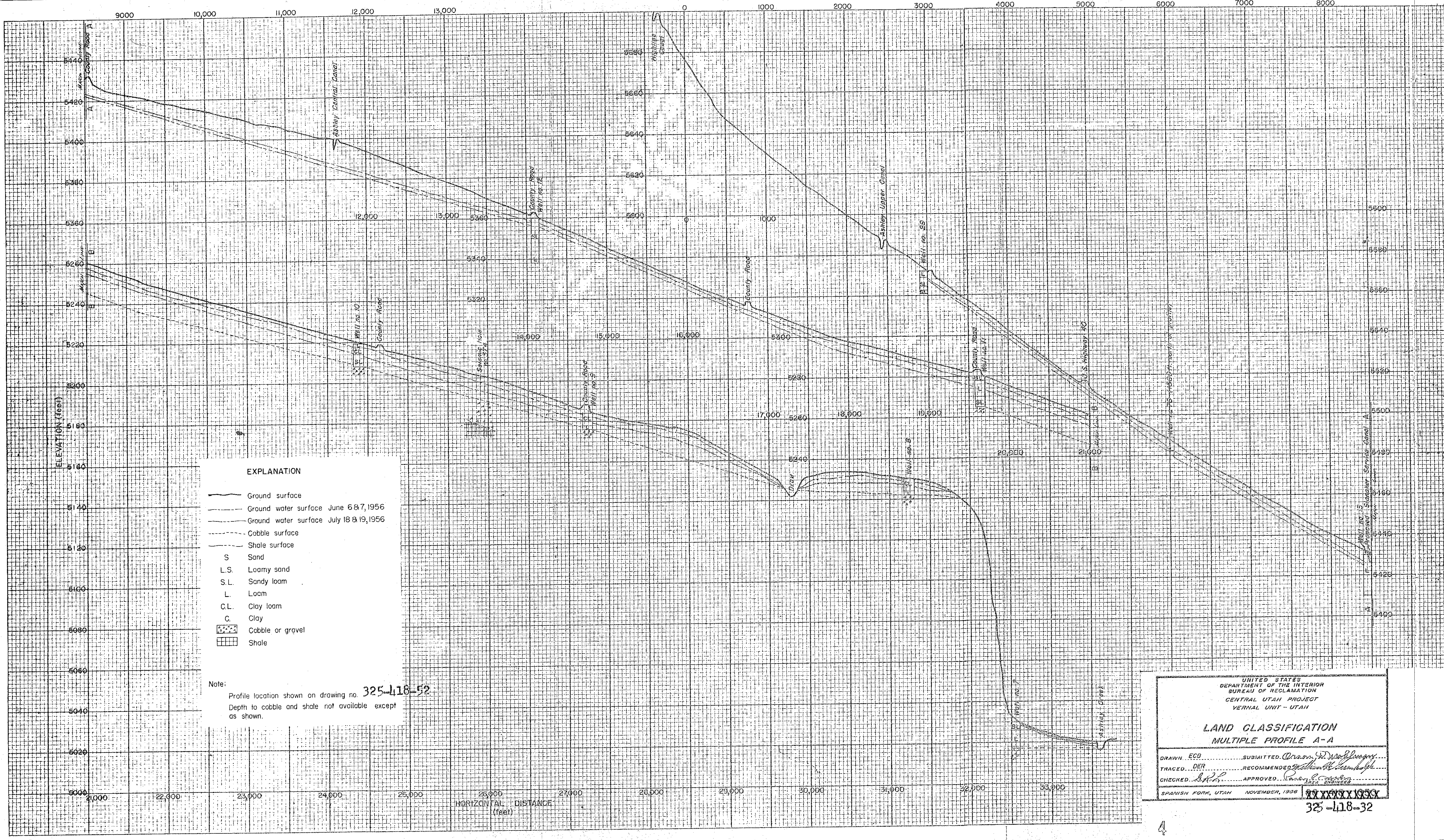
During this process of folding and erosion of the Uinta Mountains Ashley Valley has been eroded through the overlying upper Cretaceous and Tertiary formations and into the very soft shales of Mancos formation, which were at one time tilted and exposed to the surface. A layer of waterworn cobblestone and gravel lies immediately above the Mancos shale. This is presumably material from the Bishop Conglomerate of the Miocene age, and consists of rounded to subangular, tan, purple or red quartzite boulders from the pre-Cambrian Uinta quartzite series, in a sand matrix from the Uinta Mountains, plus rocks from other formations exposed by earlier erosion.

The valley alluvium, which varies in depth from a few inches to about 60 feet, is part of the great quantities eroded from the crest of the Uintas and transported by the numerous streams emerging along the south flank. It is composed of the finer materials, mainly--clays, silts, sands, gravels, tuffs, and carbonaceous material from the various sedimentary strata comprising the limbs of the south flank of the Uinta Range.

Ashley Creek, the main source of water for this unit, is an important watershed of the eastern Uinta Basin, heading in the high Uinta Mountains and coming out into the flat flood plain of Ashley Valley about 6 miles northwest of Vernal, Utah.

Climate

The climate under which the soils of the area have developed is of a temperate and arid continental nature with a low rainfall and results in



EXPLANATION

- Ground surface
- Ground water surface June 6&7, 1956
- Ground water surface July 18&19, 1956
- Cobble surface
- Shale surface

S	Sand
L.S.	Loamy sand
S.L.	Sandy loam
L.	Loam
C.L.	Clay loam
C.	Clay
	Cobble or gravel
	Shale

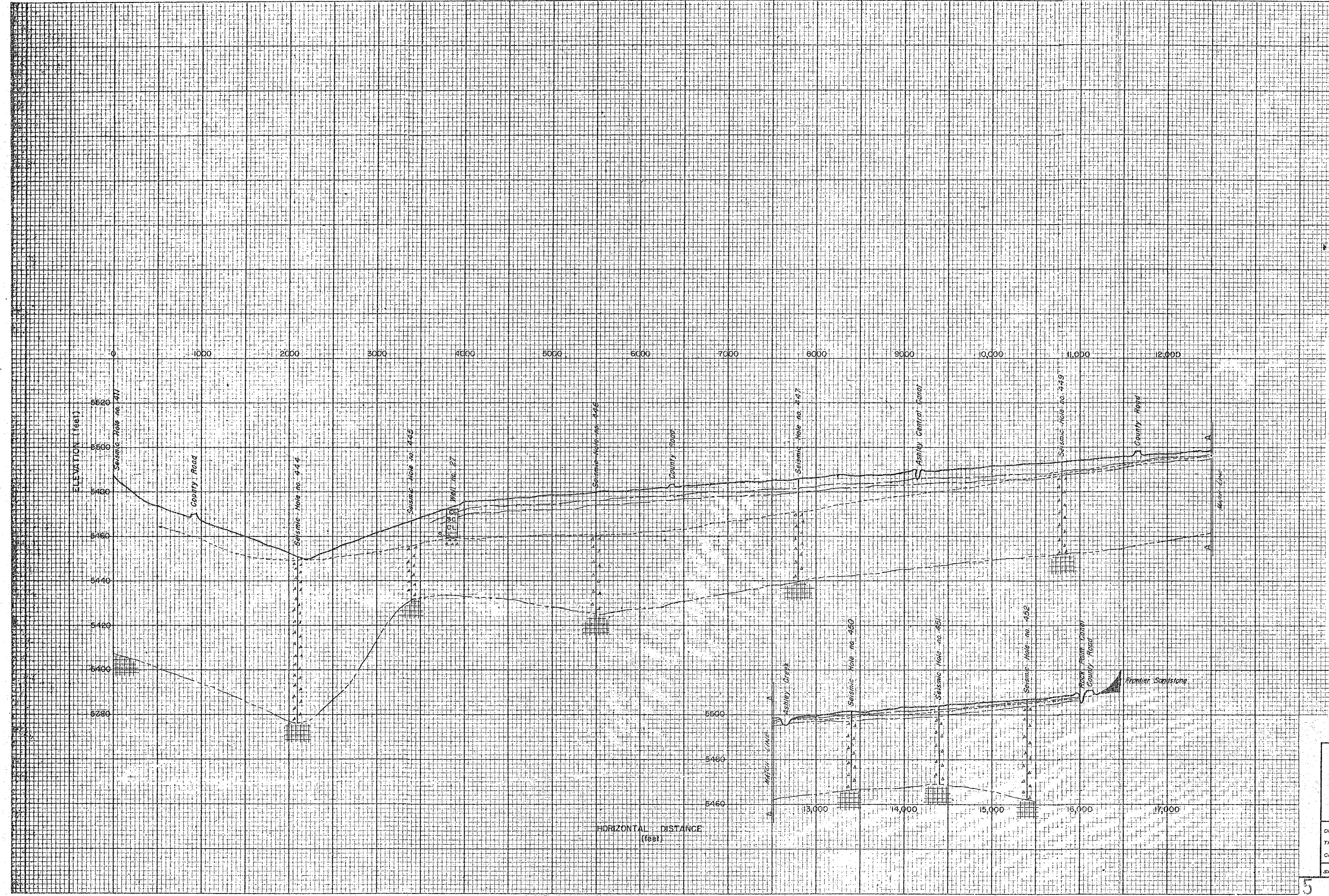
Note:
Profile location shown on drawing no. 325-418-52.
Depth to cobble and shale not available except as shown.

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL UTAH PROJECT
VERNAL UNIT - UTAH

LAND CLASSIFICATION
MULTIPLE PROFILE A-A

DRAWN ECO SUBMITTED Orson D. Wolfgang
TRACED DER RECOMMENDED William W. Greenhalgh
CHECKED S.R.L. APPROVED Carl C. Carter AREA ENGINEER
SPANISH FORK, UTAH NOVEMBER, 1956 ~~XXXXXXXXXX~~
325-418-32

4



EXPLANATION

———	Ground surface
— - —	Ground water surface June 6 & 7, 1956
— - - —	Ground water surface July 18 & 19, 1956
- - - -	Cobble surface
— - - -	Shale surface
S	Sand
LS	Loamy sand
SL	Sandy loam
L	Loam
CL	Clay loam
C	Clay
▵▵▵	Cobble or gravel
▦	Shale

Note:

Profile location shown on drawing no. 325-418-
Depth to cobble and shale not available except as shown.

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

CENTRAL UTAH PROJECT
VERNAL UNIT – UTAH

LAND CLASSIFICATION
MULTIPLE PROFILE B-B

DRAWN ECB SUBMITTED
TRACED DER RECOMMENDED
CHECKED APPROVED
AREA ENGINEER

SPANISH FORK, UTAH NOVEMBER, 1956

5

325-418-33

a sparse vegetative cover. As a result of this dry climate there has been a limited amount of leaching of the plant nutrients originally present in the soil. The native vegetative cover was influenced by the climate. It consisted mainly of sagebrush, greasewood and desert type shrubs. The organic matter content of the soil was also relatively low.

According to records of the Weather Bureau, the mean annual temperature at Vernal, Utah, elevation 5,280, is 44.2° F. The summers in the area are characterized by warm days and cool nights and the winters are cold. The extremes range from 103° F. in the summers of 1939 and 1931, to -38° in the winters of 1952 and 1937; however, the mean summer temperature is 60.0° F. and the mean winter temperature is 28.5°. The average frost-free period (days between temperature of 32°) consists of 119 days, from May 29 to September 25. The prevailing winds are from the westerly direction; however, violent windstorms are almost unknown.

Climatological records show a long time average annual precipitation of 8.52 inches, and the extremes are high of 14.78 inches in 1941 and low of 4.62 inches in 1934. Approximately 65% of the precipitation is recorded during the growing season from April through October. The rainfall is not sufficient to allow dry farming in this area. All of the land now under cultivation is receiving at least some irrigation water.

Agricultural History

In the summer of 1776, ten Spaniards, led by Father Escalante, a Catholic Priest, passed through the valley in their quest for a direct route from Santa Fe to Monterey, California. These were the first white men to enter and they reported a land dry and arid with sandy soil. The vegitation was sage brush, cactus and desert plants. They also recorded wild animals and Indians living there.

General Wm. N. Ashley entered the area in 1825, leaving his name to both Ashley Creek and Ashley Valley. He was on a trapping expedition with Jim Bridger and Andrew Henry, founder of the Rocky Mountain Fur Company.

Pardon Dodd built the first house in Ashley Valley in 1873 out of timber and mud. He was Indian agent at White Rocks form 1868 to 1872 prior to moving into this valley to become a stockman. Agriculture began in the valley in the spring of 1874 when a ditch was dug to irrigate land on the Dodd ranch. Settlers from Salt Lake City arrived in 1877 and by 1880 three large canals, Ashley Central, Ashley Upper, and Rock Point, were built.

It was necessary for the settlers to make their communities self-supporting because of isolation due to the bad roads and lack of railroad facilities. The first crops grown in the valley were corn, wheat, and potatoes. Alfalfa, small grains, and pasture have been the principal crops of the unit area. Then, as well as now, there were few immediate cash crops, livestock and animal products being the source of cash income. The Ashley Valley area is well adapted to the production of livestock because of the excellent pasturage afforded by the Uinta Mountains and also the irrigated pasturage in the valley. Sheep and cattle raising are both important branches of livestock production there.

PROJECT LANDS

CHAPTER II

SOIL DIVISIONS

In order to facilitate the discussion of soils, topography and drainage, as related to the suitability of the lands for irrigation, the unit has been divided into five divisions based on the geological origin, topographic positions, and general soil characteristics, namely:

1. Youthful Soils Division.
2. Mature Soils Division
3. Alluvial Soils Division
4. Slopewash Soils Division
5. Lower Ashley Creek Division

A map showing these 5 divisions of the unit appears on page 9.

Youthful Soils Division

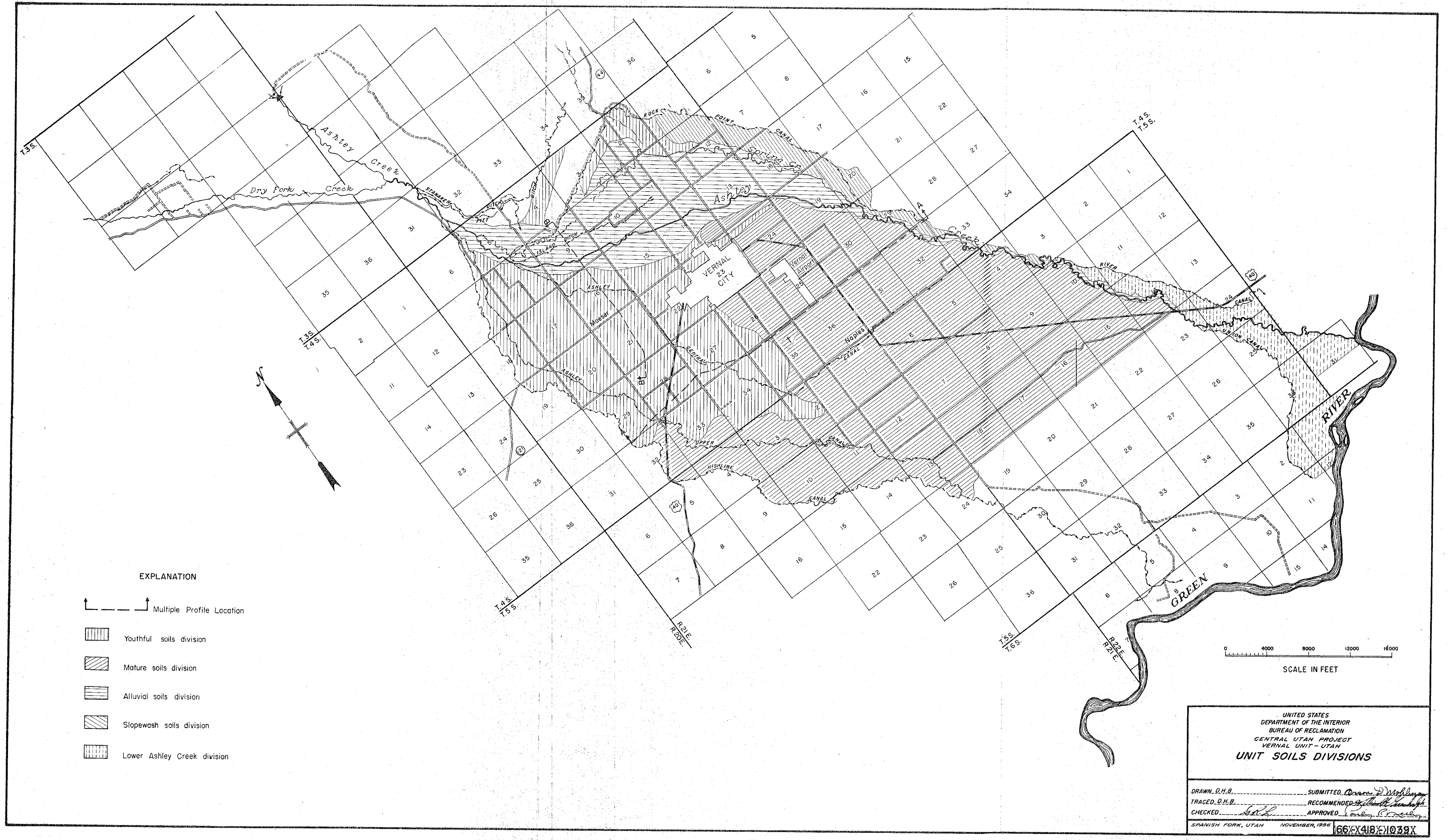
Soils

General Characteristics

The deepest soils and the most productive lands of the Vernal unit are found in this division. The soils are composed primarily of deposits transported there by stream action from the various sedimentary strata comprising the south limbs of the Unita Mountains. Here, as in most all of Ashley Valley, the soil is underlain by a layer of water-worn cobble and gravel and this all rests upon the Mancos formation. The shallower soils to gravel and rock are located along the slopes next to the western foothills, while the deeper soils are found further eastward toward Vernal.

Description of Principal Soil Bodies

Location and extent.--The main area is situated in the northwest portion of the unit. It is bounded on the west and on the north by Asphalt Ridge. On the north it reaches almost to Ashley Creek and extends into the valley as far east as the city of Vernal and to the south of Vernal about 3 miles. This contains approximately 8,200 acres. A smaller triangular-shaped area of about 700 acres is located at the mouth of Stanaker Draw in the extreme northeast corner of the unit and is about 3 miles north of Vernal. This division comprises about 25% of the land area of the Vernal unit, and contains 2,882 acres of class 1, 2,709 acres of class 2 and 793 acres of class 3. The soils divisions are presented on a map on page 9.



EXPLANATION
Multiple Profile Location
Youthful soils division
Mature soils division
Alluvial soils division
Slopewash soils division
Lower Ashley Creek division
SCALE IN FEET
0 4000 8000 12000 16000
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL UTAH PROJECT
VERNAL UNIT - UTAH
UNIT SOILS DIVISIONS
DRAWN D.H.B.
TRACED D.H.B.
CHECKED
SUBMITTED
RECOMMENDED
APPROVED
SPANISH FORK, UTAH NOVEMBER, 1956
66-X418-1039X
VERNAL CITY
Vernal Airport
Naples
Maeser
Ashley Creek
Dry Fork Creek
Spring Cr.
GREEN RIVER
ROCK POINT CANAL
STEINAKER DITCH
ISLAND DITCH
ASHLEY CENTRAL CANAL
UPPER HIGHLINE CANAL
NAPLES CANAL
RIVER UNION CANAL
T.3S.
T.4S.
T.5S.
T.6S.
R.20E.
R.21E.
R.22E.

325-418-52

The soil is all of intermediate development and the parent material was derived from sedimentary rock, mainly sandstone and shale. The soil survey designations, taken from the survey of Ashley Valley, by the Bureau of Soils in 1924, are: Naples fine sandy loam, Naples loam, and Redfield fine sandy loam. Four canals furnish most of this area with a partial water supply. They are: Ashley Central, Ashley Upper, Highline, and Rock Point. The town of Maeser is located in this division.

Typical profile.--These soils are of an intermediate development, consisting of older material from the Uinta Mountains with an over-capping in some places of recent alluvium from the nearby Asphalt Ridge and Unita Mountain foothills. The soil layers are highly stratified due to the stream action which has worked and reworked the material. A typical profile, however, shows about 9 inches of grayish brown silt loam to loam with a strong, medium crumb structure. This overlies a layer from about 9 to 30 inches of light grayish-brown loam or fine sandy loam of weak, fine crumb structure very slightly compacted with some lime streaks and blotches. The bottom layer extending from about 30 to 60 inches consists of yellowish-brown loam to sandy loam with a very weak, fine crumb structure. A typical profile in the heavier soils shows about 10 to 12 inches of grayish-brown silt loam or clay loam over a layer all the way to 60 inches of gray silty clay loam or silty clay. This profile description will change somewhat with position; that is, the sandy soils predominate nearer the hills while more silts and clay loams appear farther down into the valley. The area north of Vernal has reddish-brown sandy loam soils but is otherwise similar to this typical profile.

The soils of this division are deep, varying from about 10 to 25 feet, with a usual depth of about 15 feet. This is the depth of soil over cobble, which in turn overlies the Mancos shale. Fifteen deep auger borings were drilled in this area and cobble or rock was encountered in the surface soils in only 5 of these, which were located next to the foothills.

There are also 21 observation wells set in the division area at an average depth of 16 feet.

The permeability of all of the soil layers is good, the rates varying from .11 to .91 inches per hour, depending upon the location. The water holding capacity is also good and is usually over 7 inches of available water in the 5-foot depth. The organic matter content varies from good to medium. The soils are generally calcareous with only slight development of a lime zone in the subsoil.

The soils are very productive, having been developed under a low rainfall from alluvial formations. They have lost but little of the high content of plant nutrients present in the parent material. Evidence of the high fertility of the land is shown in the crop yields obtained there now with only a partial water supply. About 85% of the Class 1 land in the unit is located in this soils division.

There is no layer or layers in the profile which will impede drainage through the soil. Laboratory results show no excessive amounts of alkalinity or salinity in the soil. There are no rocks or stones which will interfere with cultivation.

The native vegetation was sagebrush and native grasses, and the present land use is all crops which are climatically adapted to the area. These lands are highly suitable for irrigation.

Topography

The area as a whole is relatively smooth and gently sloping toward the center of the valley with an average slope of 1 to 3%. The steeper slopes are near Asphalt Ridge and the Uinta Mountain foothills. Also, in a small part of the southern end of the area, the topography becomes somewhat rolling with an increase in the percent of slope.

The principal method of irrigation employed in this area is by corrugations; a little is done by furrows and flooding, and there are no border ditches. There is an absence of adequate water control structures on the farm and the irrigation practices could be improved. Suitable turnout weirs and measuring devices are located along the main canals.

Practically all these lands are cultivated and the topography is such that they are easily irrigated without much difficulty. Light leveling or smoothing of some of the lands will no doubt greatly facilitate its irrigation; however, in isolated places where deep leveling is required for more economical and efficient water distribution the deep soil will withstand the cuts very well. Private farm levelers have been employed in the past to accomplish the land leveling which has been done. This method will probably take care of the future leveling and smoothing adequately in this area.

Erosion is not a serious problem on most of these irrigated lands. Only on the steeper slopes must caution be exercised to prevent excessive erosion.

The elevation of this division ranges from 5,700 to 5,340 feet above sea level.

Drainage

There are areas in this division where there is a rise in ground water level in the early part of the irrigation season. The reasons for this are: obstructed natural drainage outlets, canal seepage and excessive early irrigation. It is contemplated that a portion of this division will be provided with unit drainage. For additional information on drainage of the unit area reference is made to the Drainage Appendix. Areas of high water table, which will not be corrected by unit drainage, can be improved through farm drainage at a minimum cost to the individual farmer. This can be accomplished by improving irrigation methods and practices through proper disposal of waste water and refraining from excessive irrigation early in the season.

There are 2 main natural drainage ways which traverse this division; they are approximately one mile apart and are about 4 to 5 feet in depth. In addition to these, there are several very shallow swales, these average about one-third mile distant and are 1 to 3 feet deep. The shallow swales remove only small quantities of excess water but are wet enough to support a good growth of grass, which indicated a local poor drainage condition. The natural drainage ways are all stable, most of them being covered with a good growth of sod. Deep, entrenched drainage ways or arroyos are not to be found in this area.

Because of the light texture and the open structure of the soil and the slopes on the majority of the lands, all of the soils of this division were classified with an "X" (good) drainability.

The results of the permeability analysis show that water will pass through the soil very readily. The average permeability rate of all of the samples run is .45 inches per hour with the extremes of .11 and .91 inches per hour.

Salinity and alkalinity

The lands investigated in this area are relatively free of excessive concentrations of alkilinity and salinity. Samples were collected while classifying and brought into the laboratory for salt analysis and these show but few concentrations which would be harmful to the growth of irrigated crops.

The soluble salt range is from .03% to .46% with a median of .09%, and it is expected that the concentrations of salt will be greatly reduced with the anticipated drainage program. The pH range is from 7.4 to 8.4 while the median is 8.0. There are no indications of black alkali or "slick spots" in the area. The only salts present are neutral salts or white alkali. Crystals of gypsum are readily identified in many soil profiles. Most of these soils have a good permeability rate which makes it possible for the salt to be leached from the few isolated places where it is now found. Since the salinity and alkalinity content is low, the soil is of a porous nature and the drainage can be made adequate with project drainage. It is relatively certain that no excess salt condition will develop.

Mature Soils Division

Soils

General Characteristics

The division of the relatively mature soils comprises the largest land area of the unit. The soils are largely developed on stream terrace material which was moved into the valley by stream action from the sedimentary strata of the Uinta Mountains. Here are found the zonal soils of the unit as is evidenced by the advanced maturity of the profile; however, stringers of youthful soils, mainly along the drainageways, are included in this division. Most of this area is underlain by the waterworn cobble and gravel, with a sandy matrix, which rests upon the Mancos shale. Included in this division are small areas of residual soil formed in place from shale and sandstone. These residual soil areas are mixed in with areas of alluvial material and are not of sufficient size to warrant their separation into an individual division, so they are described with the more mature soils of this group.

Description of Principal Soil Bodies

Location and extent.--This large body of land includes the southeast and central portions of the unit. It extends from about 2 miles north of Vernal to the south end of the unit. It is bounded on the west by Asphalt Ridge and on the east by Ashley Creek. The division contains approximately 18,800 acres, which is about 55% of the unit area, and the arable land is distributed as follows: 441 acres of class 1, 2,167 acres of class 2, and 3,955 acres of class 3. The section in which the residual material is located is the northwest end of this division adjacent to Asphalt Ridge containing approximately 2,000 acres. Most of the residual soils were classified as class 3, 6w, or 6.

The 1924 "Soil Survey of Ashley Valley" designations of this area are: Mesa very fine sandy loam, Mesa fine sandy loam, and Shavano fine sandy loam. The canals which are presently serving a partial water supply to this division are Highline, Ashley Upper, and Ashley Central. This division contains the city of Vernal as well as the town of Naples.

Typical profile.--This area is characterized by a relatively shallow soil over gravel or cobble. The soil was formed from outwash material from the south flank of the Uinta Mountains. The north part of the area, within about a 2-mile radius around the city of Vernal, contains probably the most mature soils of the unit. Here is found a distinctive layer of partially cemented calcareous material which is readily discernible where exposed in cuts along roads, ditches, etc. The soil is generally very shallow, usually only 3 to 5 feet over cobble and gravel. In the southeastern section, the largest part of the division, where the topography becomes rolling, the soil is somewhat deeper. On the crest of the hills the gravel and cobble layer becomes thin to almost nonexistant and the Mancos shale layer is much nearer to the surface. In the valleys and depressions the soils and gravel layers are considerably thicker over the shale.

A typical profile has about 9 inches of light brown fine sandy loam or loam with a weak, fine crumb structure. This is over a layer of approximately 9 to 32 inches of whitish gray loam partially cemented lime layer. The structure is moderate to medium platy. About 32 to 46 inches is brownish gray loam to fine sandy loam with a moderate, medium crumb structure and this is over gravel or cobble. In the Class 1 lands a typical profile shows 40 to 60 inches of loam, or fine sandy loam, which is calcareous and has a reddish brown color. Class 2's profile usually has from 24 to 30 inches of light brown fine sandy loam over cobble or rock. The fairly well developed lime zone is in the 9 to 32 inch layer. The main variations of this profile exist in the depth to rock and cobble. This varies from 2 feet to beyond the 5-foot depth.

The residual soils are brownish gray, fine sandy loam, silt loam, and clay loams closely resembling the underlying material. The surface soils rest directly on the adjacent rock at depths varying from only a few inches to more than 5 feet. Only the deeper soils are considered arable.

To aid in the study of these soils, deep auger holes were dug on most of the section corners in the area. Twenty-five deep borings were made which averaged about 9 feet in depth.

The permeability of the soils of this area is good. The median permeability rate is .54 inches per hour. The extremes are high of 2.51 inches per hour and low of .16 inches per hour. The water-holding capacity is good, generally above 6.5 inches of available water in the 4-foot profile. The soils are all calcareous and there is usually a well developed, partially cemented lime zone layer in the subsoil. The organic matter content is medium to low. The fertility of the soil of this division is only medium because of the shallowness of the soils over shale, cobble or sandstone; the presence of the partially cemented lime zone in the subsoil; or the presence of an inhibiting amount of total soluble salt in the soil.

Although drainage is a problem in some places, there is usually no inhibiting layer in the soil porfile. Alkalinity and salinity are low in most of the area; however, in places where the drainage problems exist, there are relatively high amounts of soluble salts in the soil. There is very little rock in the soil profile which will interfere with cultivation. The original vegetation was mostly native grasses with scattered sagebrush and rabbitbrush. The land use at present is mainly pasture, alfalfa, and small grains. The lands of this area are moderately suitable for irrigation.

Topography

A wide variation exists in the topography of this division. The north end of the area around Vernal is relatively smooth with a gentle slope toward Ashley Creek. The average slope is 1 to 2%. That portion containing the residual material is quite irregular and hummocky. The percent of slope varies considerably, but the general slope is toward the east. The southeast portion, south of the town of Naples, consists of a series of rolling ridges and isolated mesas, traversed by numerous well defined drainageways. The ridges and mesas between the draws, which are fairly large and are smooth to gently rolling, contain the cultivated lands while the steeper side slopes are primarily utilized as pasture. The natural drainageways run toward the east, the direction of the general slope, and empty into Ashley Creek.

Most of the irrigation in this area is done by flooding and corrugation methods. The pastures are for the most part flooded while the alfalfa and small grains are nearly all corrugated. Good turnout weirs and measuring devices are found along the canals, but there are only a very few control structures on the individual farms. Irrigation practices could be improved considerably by reducing the amounts of early water used, controlling the waste water and installing water control structures.

The lands of this division are practically all irrigated. There has been some local leveling with farm equipment, and more smoothing and light leveling on much of the area would greatly facilitate irrigation and aid in the efficient distribution of water. Because of the shallow soil over the lime layer, rock or shale, it is not anticipated or recommended that heavy leveling with deep cuts be attempted. Irrigation erosion has been only a minor problem. With good irrigation practices and caution on steeper slopes, erosion should not be a serious problem after project development.

The elevations range from 5,700 feet to 4,820 feet above sea level for lands of this division.

Drainage

The drainability of most of the soils in this division is good. They were classified as "X" in the field. The texture is usually light and they have an open structure; however, there are many local drainage problems in the division. The heavy lime layer apparently offers only slight impediment to the moving of water.

The area containing residual soils and the steeper slopes adjacent to Asphalt Ridge present almost no problem. The soils there are quite sandy and the topography is conducive to good drainage.

The reasons for impeded drainage in the area are canal seepage, and excessive early irrigation. Much of this area is characterized by numerous swales and some deeper draws where the excess water appears on their sides from the smoother benches and mesas. These swales and draws are usually wet, but the movement of water through the bottom lands is slow and crop production is confined to relatively poor pasture. Rapid evaporation occurs in these areas of poor drainage, leaving an accumulation of soluble salts, which also inhibits the growth of most plants. The narrow swales or draws are not suitable for drainage because of their size and shape and they will not receive unit water.

There are places on the mesas proper which are affected with drainage deficiencies. This is due to excessive spring irrigation and restricted lateral movement of water through the soil at the periphery of the mesas. This is particularly true at the periphery of the slope along the eastern edge of the division, as it drops to the level of the Ashley Creek flood plain. There are three hypotheses advanced to explain this impeded drainage condition. One is that there is a pile-up of lime at the edge of the mesas, and that this comes about through the precipitation of calcium carbonate from the soluble calcium bicarbonate which is carried to the edge of the break by the percolating water. Lime and other salts are deposited as the water evaporates near the surface in the cobble layer above the shale. These deposits have created a cemented condition or dyke effect which in turn is responsible for a rise in the ground water elevations under the lands immediately adjacent to the topographic break. This impermeable deposit at the mesa's edge has built up over a period of many years; in fact, indications are that this process was operating before the introduction of irrigation water.

Another theory is that the cobble layer, or water bearing stratum, decreases in thickness toward the topographic breaks, which causes a decrease in water carrying capacity and a subsequent rise in adjacent water tables.

The third possibility is that in certain localities the impermeable shale tilts upward near the edge of the mesas, creating a water barrier which results in a rise of the water tables.

The drainage deficiencies along these topographic breaks may be caused by any one of these theories or a combination of all three operating together.

Thirty-three observation wells have been established in the area for the purpose of studying the ground water fluctuation. Permeability samples were collected as these wells were dug and brought into the laboratory for analysis. The average permeability of these samples is .54 inches per hour and range from 2.51 to .16 inches per hour.

The drainability of the soils in the area is expected to remain good with unit development.

Salinity and alkalinity

There are areas in this group where the soluble salt content is sufficiently high to restrict the growth of crops. These areas are usually found in places of impeded drainage where the drainage water moves laterally over the shale and reaches the surface in swales and low areas bringing with it varying amounts of salt. The drainage water then evaporates rapidly, leaving an accumulation of soluble salts. These salts are all of the neutral type, mainly sodium chloride and sodium sulphate, in fact there is no evidence of black alkali in the area. Lands which do not have high ground water tables and are free of drainage problems are also low in alkalinity and salinity content. This indicates that the alakalinity and salinity content of the soil is intimately associated with poor drainage.

Laboratory results of the samples analyzed for total soluble salt and pH show the median salt content to be about .18% with extremes of .03% to 1.05%. The median pH is 8.0 and there were no pH values exceeding 8.4. The high accumulations of salt were found in areas of restricted drainage and constitute only a small part of the division. These poorly drained areas, which were placed in a nonarable class, support a good growth of salt tolerant grasses and plants, showing that the salt content of the surface seldom exceeds 1% of neutral soluble salts. The irrigable soils of this division show low concentrations of total soluble salts and low pH values.

There is no reason to believe that project development will create an increase in salinity or alkalinity of the soil in this area.

Alluvial Soils Division

Soils

General Characteristics

The soils which comprise this small group are all of recent alluvial origin. The area is small and is situated on the flood plain of Ashley Creek. It is underlain also by shale of the Mancos formation, and above the shale is a layer of well rounded cobble in a sandy matrix. Shot point holes and churn drill explorations have proved the cobble layer to be from about 12 to 35 feet in depth in this area. These cobble mainly from the Bishop conglomerate are mostly large, ranging from 6 to 12 inches in diameter, although a few weigh as much as about 500 pounds, and there are only small amounts of gravel present. This would indicate that as the huge amounts of alluvial material were carried by streams from the Uinta Mountains, the larger rock and boulders were deposited near the mouth of the canyons, as the streams came out upon the smoother valley floor.

The shallow layer of soil above the cobble is of recent origin. It has been moved there mainly by Ashley Creek and originated from sedimentary strata which comprise the limbs of the south flank of the Uinta range of mountains.

Description of Principal Soil Bodies

Location and extent.--This division comprises the alluvial soils of the Ashley Creek flood plain. The location is the north and northeast portion of the unit. It begins at the mouth of Ashley Canyon, where the creek enters Ashley Valley and continues down Ashley Creek through the length of the unit. At the widest point it is about 2 miles wide and pinches down to almost nothing in the southern end. There are about 5,300 acres included in this area, containing 40 acres of class 1, 505 acres of class 2, and 525 acres of class 3. Ashley Creek traverses the length of the area and lands are located on either side of the creek. The Soil Survey of Ashley Valley of 1924 reports the designations to be Ashley fine sandy loam, Naples fine sand, Ashley clay loam, Ashley gravelly fine sand, and Redfield fine sandy loam.

This area receives a partial water supply from several canals and private ditches, the principal ones being Rock Point, Spring Creek and Island Canals.

Typical profile.--This division is characterized by extremely shallow recent alluvial soil over a very thick layer of boulders and cobble. The soil is highly stratified due to the reworking of the alluvial material by Ashley Creek.

The typical profile has about 12 inches of light brown sandy loam with a single grained structure and contains varying amounts of gravel. This is over the layer of water rounded rock and cobble. From 12 to about 30 to 36 inches the matrix in the cobble is sandy loam and below 30 to 36 inches the matrix is loamy sand. There are a few areas of deeper soils in the division, a profile of which shows light brown fine sandy loam for about the first 12 inches with a weak, very fine crumb structure. From approximately 12 to 30 inches the color is grayish brown, the texture is loam and the structure is weak, fine crumb. This is above a layer of reddish brown fine sandy loam from about 30 to 50 inches and the structure is very weak, fine crumb, and this overlies the thick cobble layer. The depth of the soil over the cobble is the main profile variation, and this varies from the surface to 4 or 5 feet. There were 6 deep power auger holes dug to an average of 5 feet, two churn auger holes were dug and the logs of several shot point holes drilled by the Pure Oil Company of Billings, Montana, were studied. There were also 12 wells placed in the area, to study the water table variations, most of which had to be dug with a backhoe because of cobble. In all instances the soil was shallow over cobble.

The water holding capacity of the soil is medium to low, about 3 inches or less of available moisture in a 4-foot profile. The permeability is good to excessive. The soils are all calcareous, but there is no development of a lime zone layer in the subsoil and the organic matter content is medium to low.

The fertility of the soil of this division must be rated low. Because of the shallowness of the soil and the presence of cobble on the surface, farming in much of the area is restricted to pasture and most of the lands of this division were classified in Class 6W and 6. The drainability of the soil is good and it contains very little alkalinity or salinity. Rock and cobble present a serious problem; in fact, they are the limiting factor in this soils division.

The native vegetation was native grasses, cottonwood trees and sagebrush. The present land use is mostly pasture, and almost one-fourth of the area is covered with trees and brush. Only a small percentage of this division will be served with unit water.

Topography

The broad, overall topography of this division is fairly smooth and gently sloping toward the southeast, with an average slope of 1 to 2%. The surface, however, is quite undulating, being broken by numerous, old river channels. These channels average about 2 to 4 feet in depth and are quite close together, often only 200 feet apart. It would not be feasible to fill in the channels by leveling because of the shallow soil over boulders. It is anticipated that there will be practically no leveling or smoothing done in this division.

These are low-lying, bottom lands along Ashley Creek flood plain which are often inundated in periods of floods or high water in the spring. Erosion from irrigation is not a problem in this area as pasture is grown on most of the irrigated lands. The erosion problem appears when the area is covered with flood waters. Most of the irrigation is done in this division by wild flooding methods. The water is usually led along the ridges and allowed to flow by gravity over the pasture lands. There is also a little corrugation and furrow irrigation done in the area. The measuring devices and turnout weirs along the canals are adequate but there are no control structures on the farms. Irrigation methods could definitely be improved. Stock water is allowed to run on most of the pastures during the winter months, which saturates the soil.

The lands of this division range in elevation from 5,055 to 5,710 feet above sea level.

Drainage

There are several drainage problems of this division, but they are of such a nature that it will not be feasible to correct them. These problems are caused principally by the low lying position of the lands, which subjects them to flood waters, and the absence of natural drainage outlets. The well readings show that the ground water tables are highest from about October to June when cattle are wintered in the area and water is diverted for their consumption. Water tables fluctuate directly with the amounts of water applied and with the level of the water in the river. The numerous old river channels, which are about 2 to 4 feet below the ground surface, have high water tables and indications of poor drainage.

The drainability of the soil is good to excessive because of the light texture, open structure and the rocky condition in the substrata. The permeability of the soil is also good as is pointed out previously in this chapter.

In the northern section of this division, there is an extensive spring area with well defined spring openings which creates a wet and seeped area of approximately 250 acres. The water arising in these springs is diverted through private ditches and used to irrigate adjacent lands.

It is not expected that the drainability of the soil will change any with unit development and no unit drainage is anticipated for this division. Farm drainage could be accomplished by the farmer without any great cost by improvements in his irrigation practices.

Salinity and alkalinity

There were no indications of alkalinity nor salinity noted in the cropped areas at the time of classification, and the results of the laboratory analysis of the soil also fail to show any harmful concentrations of soluble salts or any excessively high pH rates.

There is a high ground water table in much of this division during most of the year, but because it is a fluctuating and a moving condition it has not been the cause of a soluble salt accumulation.

It is almost certain that no serious alkalinity nor salinity problems will occur with further development because of the high permeability and the good drainability of the soil and rocky condition of the substrata.

Slopewash Soils Division

Soils

General Characteristics

This group of soils is the smallest of the five divisions herein described. The soil was formed from recent alluvial material which has been eroded from the nearby shale mesa to the east and transported into place by stream action. The deep underlying strata is shale of the Mancos formation. The soil over the shale is fairly deep, from about 10 to 25 feet. It is shallower near the shale mesa and deeper at the toe of the slope near Spring Creek and Ashley Creek.

Description of Principal Soil Bodies

Location and extent.--This division is located at the extreme northeast edge of the unit. It is small in size, containing only 1,200 acres, which is about 4 percent of the unit. It is a long, narrow strip of land, bounded on the northeast by the shale mesa and also by Rock Point and River irrigation canals which run along the foot of the mesa. The northwest boundary is Spring Creek until it joins Ashley Creek, then Ashley Creek forms the boundary. The widest part is about 2 miles northeast of Vernal and it is not over one mile wide at any point. The area is approximately 8 miles long and in the southeast section it gradually pinches down to nothing. There was no class 1 land found in this division. All the arable soils were placed in class 2 or 3. There were 258 acres of class 2 and 648 acres of class 3.

The old Soil Survey of Ashley Valley designated this area as Billings Clay. The present partial water supply is received mainly from Rock Point Canal and lesser amounts from Spring Creek Canal and from private ditches.

Typical profile.--The soil is all from recent outwash from the shale hills and is usually fairly deep to shale or cobble. It is also the heaviest soil of the unit.

A typical profile has about 8 inches of topsoil which is brownish gray clay loam or silty clay with a strong, medium subangular blocky structure. From approximately 8 to 22 inches is brownish gray silty clay loam or clay, having a moderate, thick platy structure. The bottom layer, from about 22 to 60 inches, is also silty clay or clay loam. The color, however, is somewhat lighter, having a yellowish cast to the brownish gray. The structure is weak, fine subangular. The principal variation is in the texture of the soil, which varies from clay loam to heavy clay. Characteristic of the clay topsoil is its tendency to shrink and form large cracks when it becomes dry. There is also evidence of concentrations of gypsum in the soil profile.

There were 3 deep auger holes dug to an average depth of 20 feet to aid in the subsoil exploration and study. Three wells were also placed for ground water observation at an average depth of 14 feet. The deep holes indicate fairly thick heavy soils over the rock or shale layer.

Even though the texture of the soil is of a clay nature, it usually has a good structure and consequently the permeability is normally good as is shown by the laboratory results. The average permeability of the soils tested is .41 inches per hour, and the extremes are .61 and .10 inches per hour. The water holding capacity of the soil is good. Results show more than 10 inches of available water in the 5-foot depth. The organic matter content is low. The soils are calcareous but there is no lime zone development. The fertility of these soils is only medium. The drainability is fairly good and there is very little salt or pH in the soil. There are practically no rocks in the profile.

Native grasses, greasewood and rabbitbrush constituted the native vegetation and the present land use is mainly alfalfa, small grains, and pasture. The suitability of this division for irrigation is good to fair.

Topography

The topography of this division as a whole is gently sloping in a southwesterly direction. The surface is relatively smooth and the average slope is 2 to 3%. The cultivated lands in the area are all irrigated, with very little irrigation erosion being observed. Some of the farms have been smoothed with private levelers. More smoothing and leveling of the surface would greatly facilitate economical and efficient distribution of water. This could be handled by the individual farmer without the cost being prohibitive.

The majority of this area is irrigated by use of corrugations, and a little is done by flooding. Irrigation practices could be improved in the future through better use of the water. Turnout weirs and measuring devices are located along the canals but there is a lack of water control structures on the farms.

The range in elevation of the lands in this division is from about 4,900 to 5,400 feet above sea level.

Drainage

There are areas of restricted drainage in this division, located usually at or near the base of the slopes. The high ground water tables in these areas are caused by shallow soil over impermeable shale, excessive early irrigation, canal seepage and heavy spring runoff. The ground water apparently flows laterally over the shale layer and at the toe of the slope. Where the soil over shale becomes shallow, the water approaches the surface. These areas are wet and usually support a growth of wire or salt grass. The poor drainage is reflected in the farming operations and also in the land classification.

These poorly drained areas are usually classified into Class 6w and because of their size and location project drainage would not be economically feasible. Most of the soils of the area were mapped with a "Y" or restricted drainability because of their heavy texture.

This elongated body of land is very narrow, the length of the irrigation runs are short, and the excess surface water drains into Ashley Creek or Spring Creek, which forms the southwest boundary of the division. There are no deeply entrenched drainageways through the area itself.

The contemplated unit drainage plan does not extend into this area; however, many of the drainage deficiencies can be overcome through farm drainage at a minimum cost to the farmer. Heavy spring use of irrigation water has resulted in a rise in ground water table each year, but experience shows it has dissipated rapidly without apparent detrimental effect to the soil. It is anticipated that project development will result in a lowering of the ground water table.

Drainage problems are not expected to increase with unit development. Infiltration of the soil could be increased by the addition of organic matter through application of barnyard manure or green manure crops.

Salinity and alkalinity

The close relationship between poor drainage and concentrations of soluble salt is also evident in this division. Salts in large amounts are not present in most of the area where drainage is good. Only in the smaller areas of restricted drainage is the salt concentration high. These are neutral salts, being mainly sodium chloride and sodium sulphate. There is no evidence of alkaline salts in the area.

The median total soluble salt content of the samples analyzed was about .15% and the median pH value was 8.0. The fairly good permeability rate and low total salt content for the majority of the soils in this division indicate that most of the soluble salts originally present in these soils have been leached out.

It is not anticipated that additional salinity or alkalinity problems will be caused by further development.

Lower Ashley Creek Division

The lands of this division are not included as a part of the irrigable area of the Vernal unit at the present time. They are, however, described in this report to provide a complete inventory of land classification findings. If at a future date their development proves to be feasible they can be added to the unit.

These lands have all been covered with a detailed classification. However, the laboratory testing has not been completed. At present all lands are irrigated with return flow and flood flow water which analysis shows is of a very inferior quality, especially the return flow in the late irrigation season when the flow is lowest.

The inclusion of these lands into the unit depends largely upon the future quantity and quality of the return flow water or if an adequate supplemental source of irrigation water can be supplied. It also depends upon the adequacy of subsurface drainage to allow leaching of excess salts. The drainage requirement cannot be determined without explicit knowledge concerning the salt load of the irrigation water. To maintain a salt balance the lands must be capable of transmitting the leaching requirement and concomitant surface and deep percolation losses. These studies as well as the completion of the laboratory data on the soils are presently being made.

Soils

General Characteristics

The soils of this division are very similar to those described in the slopewash soils division. The soils are formed from recent alluvial material eroded from the adjacent shale and sandstone hills and mesas. The soil is about 5 to 15 feet deep over a layer of water rounded rock and cobble, which rests upon the thick layer of Mancos shale.

Description of Principal Soil Bodies

Location and extent.--The lands described in this division are located along the lower Ashley Creek. They are southeast of the Vernal unit proper and constitute an elongated area about 6 miles long and not over a mile wide at the widest point. The area contains 3,274 acres of land, only 700 acres of which are in an arable class.

This area is all irrigated by return flow and flood flow waters through the River Irrigation and Union Canals. These canals form the boundary of the division. The soils are designated mainly as Billings Clay by the 1924 Soil Survey of Ashley Valley.

Typical profile.--The soils east of Ashley Creek which are under the River Irrigation Canal are heavy, resembling those described in the slopewash soils division, while those west of Ashley Creek, under the Union Canal, vary from very heavy to fairly light. A typical profile of the River Irrigation area is about 0 to 10 inches of brownish gray silty clay, having a strong medium subangular blocky structure. From 10 to 24 inches is silty clay loam to silty clay, brownish gray in color, and has a moderate medium subangular blocky structure. From 24 to 60 inches is usually light brownish gray, silty clay with a moderate, fine, subangular structure.

A typical profile in the Union Canal area is approximately 8 inches of brownish gray silt loam with a weak, fine subangular structure. Then 8 to 30 inches is clay loam having a moderate, thick platy structure, and 30 to 60 inches is light brownish gray silty clay with a moderate, medium subangular structure. The principal variation is in the texture of the soils in the Union Canal area and these vary from sandy loam to silty clay.

Of the samples analyzed which were collected from arable classes of land, the median permeability was about .22 inches per hour and the high and low were .52 and .02 inches per hour. It is anticipated that additional samples will be carefully collected and further permeability and infiltration studies will be conducted in this area. The water holding capacity is good, the organic matter content is low to medium and the soils are all calcareous with no lime zone development. The fertility of these soils is only medium. The lands which were classified into one of the three arable classes contain only small amounts of salt, low pH, and the drainability is fairly good. There is no rock in the profile which will interfere with cultivation.

The native vegetation was greasewood, rabbitbrush, and native grasses while the present land use is mainly pasture, alfalfa and small grains. The suitability of this area for irrigation is fair.

Topography

The topography of this area is also similar to that described in the Slopewash Soils division. It is relatively smooth to gently sloping in a southeasterly direction with an average slope of 2 to 4%.

These arable lands are all irrigated and the principal methods used are corrugations and wild flooding. Very few furrows and no border ditches are being used. Irrigation practices could definitely be improved. Measuring devices and turnout weirs are located on the canals but there are practically no water control structures on the individual farms. There was very little erosion from irrigation observed. Smoothing and leveling of the surface would facilitate economical and efficient distribution of irrigation water. The farmer could accomplish this at a reasonable cost.

The range in elevation of this area is from about 4,820 to 4,700 feet above sea level.

Drainage

There has been no unit drainage investigation accomplished in this area. Areas of restricted drainage and high ground water tables were observed by the land classifiers in the field. This condition is due to impeded drainage outlets, excessive early irrigation and areas of restricted internal permeability. These observations indicated that irrigability could not be established without unit drainage investigations.

The main natural drainageway for the area is Ashley Creek which flows to the southeast and empties into Green River. Most of the lands slope toward Ashley Creek or toward Green River. This body of land is narrow, the irrigation runs are short, and the excess surface water is removed fairly rapidly. The individual farmer may be able to prevent many deficiency problems through farm drainage at a minimum cost by improving irrigation practices and properly disposing of waste water.

The heavier textured soils of the area were mapped with a "Y" or restricted drainability while the lighter soils were placed in the "X" good drainability category.

Salinity and alkalinity

The lands, which were placed in one of the three arable classes, are relatively free of total soluble salts or high pH values. High accumulations of salts are found in areas of impeded drainage. These are practically all neutral salts, predominantly magnesium and sodium sulphates. The pH values are all relatively low, indicating little or no alkaline salts present.

The median total soluble salt content for all samples analyzed was about .27% and the extremes were .05% and 2.00%. However, concentrations of over .50% are not found in the arable classes. The median pH value was 8.1 with a high of 8.7.

The irrigation water used to irrigate these lands is mostly return flow water and is very high in total soluble salt content. The River Irrigation Company diversion is above the source of much of the salt burden and only in the very late irrigation season is the water above the acceptable limits for usable water. The sodium hazard is negligible. It is possible under existing conditions to apply copious amounts of early season water of low salinity and thus remove any accumulations from the previous season. The available data are presented in table 1 on page 28. It will be necessary to improve the quality of the late season irrigation water before this area can be included in the irrigable area.

The Union Canal Company's diversion is at a lower point on Ashley Creek and the presently available water is of very poor quality, except during periods of high runoff. The upstream diversions use the entire flow of Ashley Creek after the late spring period, leaving only return-flow water for this canal. The quality of this return-flow water is presented in Table 4. The present irrigators are practicing salinity control measures and producing semitolerant crops with very good yields.

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WATER ANALYSIS

REGIONAL LABORATORY

Table 1

Collected by .... Date .... Project Ashley Creek

Submitted by .... Date .... Location Ashley Creek at River

Analyzed by .... Date .... Irrigation Company diversion

Lab. No.	Field No.	ECx10[6] @ 25° C.	pH	Sus-pended solids p.p.m.	Total dis-solved salts p.p.m.	Boron p.p.m.	% So-dium	Ca	Mg	Na	K		CO_3	HCO_3	SO_4	Cl	NO_3	
								Equivalents per million or milliequivalents per liter: Cations					Anions					
CW-32		7/21/55	2082	8.0	1812	.60	14.9	1.2	None		10.65	11.89	3.98	.08	.48	4.51	.52	20.96
CW-53		9/27/55	2969	8.0	2788	.27	20.3	2.0	None		15.12	16.73	8.16	.15	.99	3.92	1.08	34.17
CW-98		6/11/56	2035	7.8	1776	.44	18.1	1.4	None		10.83	10.20	4.68	.13	.00	5.17	.63	20.04
Equivalent Weights								20.0	12.2	23.0	39.1		30.0	61.0	48.0	35.5	62.0	

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PROJECT LANDS

CHAPTER III

QUALITY OF WATER

Source of Water Supply

The source of the partial supply of irrigation water that the unit lands are now receiving is mainly from Ashley Creek. Small amounts of irrigation water are supplied from springs within the area.

The source of unit water will be totally from Ashley Creek. Ashley Creek has its heading in the southern slopes of the high Uinta Mountains, the peaks of which reach an elevation of 13,500 feet above sea level. The stream is supplied with water by the melting snows and mountain springs then drops from these heights to an elevation of about 5,620 feet at the point of diversion. The waters of the creek will be diverted at this point, through a feeder canal, into Stanaker Reservoir, where it will be stored for later irrigation use.

Suitability of Water for Irrigation

There are two sources of information on the quality of water from Ashley Creek. Samples taken 7/2/49 and 9/9/49 from canals north of Vernal, near the point of diversion, were analyzed and reported by J. P. Thorne and D. W. Thorne in 1951. This report, Bulletin 346 Irrigation Waters of Utah, was published by Utah Agricultural Experiment Station. Results of these analyses are summarized and shown in table 2 on page 30. Water samples were also taken from Ashley Creek in 1955 and 1956 at the official gaging station called "Sign of the Maine," which is about 2 miles upstream from the point of diversion. These samples were analyzed chemically in the Region 4 laboratory at Salt Lake City, Utah, the results of which appear in table 3 on page 31. Both of these studies show that the quality of Ashley Creek water is exceptionally good and will be highly suitable for irrigation of any crops which may be grown in this unit. The quality of the water used to irrigate lands of any project is of vital importance. The salinity, alkalinity or boron content of the soil may be increased materially with many years of irrigation, if the water contains appreciable amounts of soluble salts. The most important factors used to determine the quality of irrigation water are total dissolved solids, total sodium, the carbonate-bicarbonate concentration, and the amounts of boron or other toxic elements.

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WATER ANALYSIS

REGIONAL LABORATORY
TABLE NO. 2

Collected by Thorne and Thorne Date Project Vernal Unit

Submitted by Date Location Canals, near point of

Analyzed by Thorne and Thorne Date Diversion

Lab. No.	DATE ~~Field No.~~	$ECx10^6$ @ 25° C.	f/a/ft ~~pH~~	Suspended solids p.p.m.	Total dissolved salts p.p.m.	Boron p.p.m.	% Sodium	Cations 1/ Ca	Mg	Na	K	SAR	Anions 2/ CO_3	HCO_3	SO_4	Cl	NO_3	CLASS
1	1949 7/2	130	.10			.18	4.0	.90	.12	.04	.03	.06	.07	1.02	.23	.03	.5	1A
2	1949 9/9	270	.27			.04	6.0	1.45	.58	.13	.05	.13	0	2.16	.46	.03	.3	1A
Equivalent Weights								20.0	12.2	23.0	39.1		30.0	61.0	48.0	35.5	62.0	

Equivalents per million or milliequivalents per liter

1/ Bureau of Reclamation computation

2/ Class standards by Thorne and Thorne

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WATER ANALYSIS

REGIONAL LABORATORY

TABLE NO. 3 UNIT WATER SUPPLY

Collected by .... Date .... Project Vernal Unit

Submitted by .... Date .... Location "Sign of the Maine"

Analyzed by Regional Laboratory Date ....

Lab. No.	Field No.	$ECx10^6$ @ 25° C.	pH	DATE	Total dissolved salts p.p.m.	Boron p.p.m.	% Sodium	Equivalents per million or milliequivalents per liter: Cations					Anions					
								Ca	Mg	Na	K	SAR	CO_3	HCO_3	SO_4	Cl	NO_3	CLASS
CW- 33	5F-1	194	7.8	1955 7/21	109	.12	1.0	1.41	.47	.02	.02	.02	None	1.64	.22	.01		C1-S1
" 47	" 2	233	7.8	1955 9/26	107	.04	3.4	1.57	.68	.08	.03	.08	.21	1.78	.40	.05		C1-S1
" 73	" 3	335	8.1	1956 3/14	197	.01	2.3	2.27	1.05	.08	.03	.06	.34	2.15	.84	.10		C2-S1
" 84	" 4	102	8.4	1956 5/24	75	None	5.9	.74	.19	.06	.02	.09	None	.73	.27	.01		C1-S1
" 116	" 5	165	8.2	1956 7/9	100	.08	6.2	1.14	.35	.10	.02	.11	None	1.46	.14	.01		C1-S1
" 120	" 6	195	8.2	1956 8/7	113	.10	2.7	1.34	.41	.05	.02	.05	None	1.68	.14	None		C1-S1
Equivalent Weights								20.0	12.2	23.0	39.1		30.0	61.0	48.0	35.5	62.0	

Total dissolved solids

The total dissolved solids may be expressed either as the electrical conductivity or by the quantity in tons per acre foot or parts per million (ppm). If irrigation water which is high in concentrations of total dissolved solids is used over a period of several years it might create a marked increase in the salinity of the soil.

Of the six samples analyzed in the Regional Laboratory, only one has quantities of total dissolved solids which would keep the water out of Class C1. The average electrical conductivity for the 6 samples is 204 micromhos per centimeter, and the average total dissolved solids expressed in ppm is 117. Those analyzed by Thorne and Thorne average 200 micromhos per centimeter and show an average of .18 tons of dissolved solids per acre-foot. This water, from a standpoint of the total dissolved solids, is Class C1 water and is of excellent quality for irrigation.

Total sodium

The sodium hazard involved in the use of a water for irrigation is determined by the concentration and proportion of the cations. If the proportion of sodium is high, the sodium hazard is high; and conversely, if calcium and magnesium predominate, the hazard is low. The sodium adsorption ratio is a good index of the sodium hazard of the water, and the percent sodium is also used.

The average sodium adsorption ratio of all the samples analyzed is only .08 and the average percent sodium is 3.9% with the highest being 6.2%. This irrigation water then would be placed in Class S1, low sodium water, and will not create an alkali hazard to the soil with continued usage.

Carbonate-bicarbonate

If the bicarbonate ion concentration is high in the water, then calcium and magnesium will precipitate as carbonates as the soil solution becomes more concentrated. When the concentrations of calcium and magnesium are thus reduced, the sodium ion proportion is increased, and the sodium hazard appears. Residual sodium-carbonate is one way of expressing this relationship. It is obtained by subtracting the sum of the calcium and magnesium ions from the sum of the carbonate and bicarbonate ions. The residual sodium carbonate for the 6 samples analyzed in Salt Lake City were all 0, and those by Thorne and Thorne were .07 epm and .13 epm. This indicates a safe sodium condition for the irrigation water.

Boron

Boron is a constituent of most natural waters. Its concentration varies from a trace to several parts per million. It is essential to plant growth, but at concentrations only slightly above optimum it is exceedingly toxic. Injury often occurs in concentrations of over 1 ppm. The waters of Ashley Creek have an average boron content of only .07 ppm, and the highest is .18 ppm, which is well within the safe limits.

Quality of drain waters

Numerous chemical analyses have been made on waters from drains and streams of return flow in the unit. Results of these analyses show that the return flow waters are usually high in total dissolved solids and the farther from the point of diversion that the samples are taken the higher the concentrations become. The concentration of total dissolved solids is higher in late summer when the flows are lowest. Results of the chemical analysis from 4 of the return flow streams as a representative sample appear in Table 4, page 34.

During the major part of the irrigation season, the return flow waters are not suitable for use and are only moderately suitable for irrigation when mixed with unit water in a proportion of more than 5 parts of natural flow water to one part of drainage water.

Additional chemical analysis data on water from return flow, drains, and streams and their locations in the unit are given in the Water Supply Appendix.

Locations

The locations of the 4 previous representative samples of drain water are as follows:

9Mb- North Vernal Drain, at the mouth. sec. 20, T. 4 S., R. 22 E.

10Na- Rock Point Canal and East Slope Drain. Center of sec. 29,T. 4 S., R. 22 E.

11L- South Fork of Naples Drain, sec. 35, T. 4 S., R. 21 E.

15R- Ashley Creek at gaging station near Jensen. sec. 23, T. 5 S., R. 22 E. This contains drainage water from the entire unit and is the water available at the Union Canal diversion.

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WATER ANALYSIS

REGIONAL LABORATORY

TABLE NO. 4

UNIT DRAINAGE WATER

Collected by .... Date .... Project Vernal Unit

Submitted by .... Date .... Location ....

Analyzed by Regional Laboratory .... Date ....

34

Lab. No.	Field No.	ECx10^6 @ 25° C.	pH	DATE ~~Sus-pended solids p.p.m.~~	Total dis-solved salts p.p.m.	Boron p.p.m.	% So-dium	Equivalents per million or milliequivalents per liter: Cations: Ca	Mg	Na	K	SAR	Anions: CO3	HCO3	SO4	Cl	NO3	CLASS
CW-52	9-Mb1	1167	8.1	1955 9/27	826	.10	11.2	6.72	5.70	1.58	.13	.6	.81	6.56	6.22	.54		C3-S1
" 74	" 2	2000	8.1	1956 3/13	1668	.32	17.8	11.33	9.57	4.54	.09	1.4	.74	4.42	19.59	.78		C3-S1
" 99	" 3	847	7.5	1956 6/11	593	.30	9.5	4.71	4.08	.93	.08	.4	.00	5.42	4.16	.22		C3-S1
"103	" 4	987	8.0	1956 7/10	707	.18	10.4	5.52	4.80	1.21	.10	.5	.00	6.66	4.59	.38		C3-S1
"126	" 5	1187	8.1	1956 8/7	868	.22	11.0	6.31	5.61	1.49	.08	.6	.00	7.44	5.50	.55		C3-S1
CW- 62	10-Na1	3031	8.0	1955 11/8	2914	.56	24.6	14.77	15.61	9.96	.15	2.6	.60	3.17	35.84	.88		C4-S1
" 100	" 2	1803	8.0	1956 6/11	1522	.56	28.2	8.03	7.81	6.28	.14	2.2	.00	5.00	16.86	.40		C3-S1
" 114	" 3	3441	8.0	1956 7/9	3388	.70	22.1	20.07	16.68	10.48	.18	2.4	.40	5.78	40.45	.78		C4-S1
" 121	" 4	3965	8.0	1956 8/7	3968	.76	34.0	21.82	19.59	13.12	.16	2.9	.49	5.71	47.45	1.04		C4-S2
CW- 68	11 L1	5538	7.7	1955 11/7	6300	1.08	27.3	23.04	38.27	23.10	.13	4.2	.69	5.76	74.58	3.56		C4-S2
95	" 2	3442	7.9	1956 6/11	3388	.81	24.6	14.68	20.97	11.67	.20	2.8	.67	4.28	41.02	1.55		C4-S1
" 104	" 3	5917	8.0	1956 7/10	6468	1.26	27.6	24.58	40.10	24.75	.20	4.4	.33	7.04	78.95	3.31		C4-S2
" 131	" 4	6595	8.0	1956 8/7	7508	1.70	29.1	26.67	45.00	29.47	.23	4.9	.45	6.90	89.78	4.24		C4-S3
Equivalent Weights								20.0	12.2	23.0	39.1		30.0	61.0	48.0	35.5	62.0	

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WATER ANALYSIS

UNIT DRAINAGE WATER
REGIONAL LABORATORY

TABLE 4 (continued)

Collected by .... Date .... Project ...... Vernal Unit ......

Submitted by .... Date .... Location ....

Analyzed by ...... Regional Laboratory ...... Date ....

Lab. No.	Field No.	$ECx10^6$ @ 25° C.	pH	DATE ~~Sus-pended solids p.p.m.~~	Total dis-solved salts p.p.m.	Boron p.p.m.	% So-dium	Ca	Mg	Na	K	SAR	CO_3	HCO_3	SO_4	Cl	NO_3	CLASS
								Equivalents per million or milliequivalents per liter: Cations					Anions					
CW-31	15-R-1	5366	8.0	1955 7/21	5504	1.50	37.2	17.17	29.69	27.86	.27	5.8	1.09	3.70	65.98	3.34		C4-S2
" 54	" 2	4235	8.1	1955 9/27	4256	.66	32.7	14.73	23.83	18.81	.22	4.3	.61	2.97	51.80	2.21		C4-S2
" 74	" 3	2000	8.1	1956 3/14	1668	.32	17.8	11.35	9.57	4.54	.09	1.4	.74	4.42	19.59	.78		C3-S1
" 88	" 4	581	8.1	1956 5/25	413	.09	15.4	3.05	2.15	.96	.06	.6	.06	2.22	3.80	.14		C2-S1
" 111	" 5	3555	8.1	1956 7/10	3438	.77	27.2	15.05	19.49	12.99	.21	3.1	.16	5.13	40.82	1.63		C4-S1
" 128	" 6	5300	8.1	1956 8/7	5500	1.00	33.4	18.06	30.82	24.66	.25	5.6	.11	5.14	65.29	3.25		C4-S2
" 157	" 7	4385	7.9	1956 9/18	4584	1.11	30.6	16.32	25.51	18.55	.21	4.0	.87	4.16	53.29	2.27		C4-S2
" 174	" 8	3840	8.1	1956 10/18	3858	.81	29.1	11.54	21.48	13.62	.18	3.4	.88	2.29	41.90	1.75		C4-S2
Equivalent Weights								20.0	12.2	23.0	39.1		30.0	61.0	48.0	35.5	62.0	

PROJECT LANDS

CHAPTER IV

LAND CLASSIFICATION

General Description of Land Classification Survey

Objective

The detailed land classification survey has been accomplished in order to determine the extent and character of the lands of the unit and to classify them according to their productive capacity under an approved irrigation program which will support a farm family and pay water charges.

Factors Considered

The important factors considered which influence the segregation of lands into different classes were: characteristics of the soil, subsoil, and substratum; topographic features, drainage conditions, total salt content; anion and cation content; exchangeable cation status; and land development requirements. These were considered as they occurred either singularly or in combination with each other. Land development requirements have only a minor significance as all lands are presently developed.

Segregations

While being classified in the field, the lands of the unit were separated into arable and nonarable classes. The arable classes are 1, 2, and 3. Class 6W, water right class, will not be supplied with unit water. Class 5 was temporarily nonarable and since has been placed into its proper arable class or eliminated with class 6W. Class 6 lands are permanently nonarable. The classes of land are described in detail in Table 5 on page 42.

Type of Survey

The land classification used for this unit and discussed in this report is detailed in scope. The superior quality of a detailed land classification is due largely to the thorough coverage of the area and the resulting greater degree of refinement thus established. The specifications used in this survey are summarized in Table 5, page 42. The minimum requirements used comply with the Bureau of Reclamation standards for a detailed survey which are necessary for project authorization and Secretarial Certification and exceed them in many items.

Previous Surveys

In 1920 a soil survey was made of the Ashley Valley, by the Bureau of Soils, United States Department of Agriculture. The work was done by A. T. Strahorn, Scott Ewing and D. S. Jennings. The soils were surveyed as to series and types and published in 1924 as the "Soil Survey of the Ashley Valley."

The Soil Conservation Service has completed numerous farm planning surveys of individual farms in the Vernal Unit area within the past several years. This work, although not published, is available at the Soil Conservation Service field office at Roosevelt, Utah.

The Bureau of Reclamation personnel made a reconnaissance classification in 1935-1937 of the Vernal area. The survey was made by planetable methods on a scale of 1,000 feet to the inch and was used as part of a complete study of the Colorado River Basin. These lands were reclassified in 1947, in a semidetailed survey by the Bureau of Reclamation. This latter survey was done on aerial photographs having an approximate scale of 1,000 feet to the inch.

These previous surveys were adequate for the purpose for which they were intended; however, they are not adequate to supply the data required for a detailed study which is essential for a definite plan report.

Cooperation With Other Agencies

Field conferences have been held with personnel from the Soil Conservation Service, Agricultural Research Service, and the Utah State Experiment Station, at which time the land classification specifications were discussed and the procedures and results were reviewed.

Methods

Maps and Equipment

All the detailed land classification work was accomplished on rectified aerial photographs, the scale of which is 400 feet to the inch. Each photo contains one section of land and is about $26\frac{1}{2}$ by $27\frac{1}{2}$ inches in overall size. The land classification data was recorded directly onto the photos in pencil by the classifiers in the field. The aerial photos were matched, checked for accuracy and then inked for a permanent record. The acreages were computed by planimetering directly from the photos in 160 acre sub-divisions.

Establishing Delineations

The delineations were made in the field after careful examination and appraisal of all physical factors. The deficiencies which caused the land to be graded down in class were designated on the aerial photographs by letters: soil deficiency by the letter "s," topography by the letter "t," farm drainage by the letter "d," and excessive salinity or alkalinity by the letter "a." The accumulative effects of two or more of these deficiencies usually cause the land to be placed in a lower class. These letters appear in the numerator of the symbol. A sample classification symbol is $\frac{\text{3stda}}{\text{L22BY}}$. The number preceding the letters in the numerator indicates the land class, while the letters and numbers in the denominator indicate, in sequence, present land use, productivity, land development, farm water requirement and drainability. Distances were determined from discernible physical features on the aerial photographs or by pacing.

Detail of Coverage

To enable close examination and separation between land classes and subclasses, an average of 5 traverses were made in each section of land.

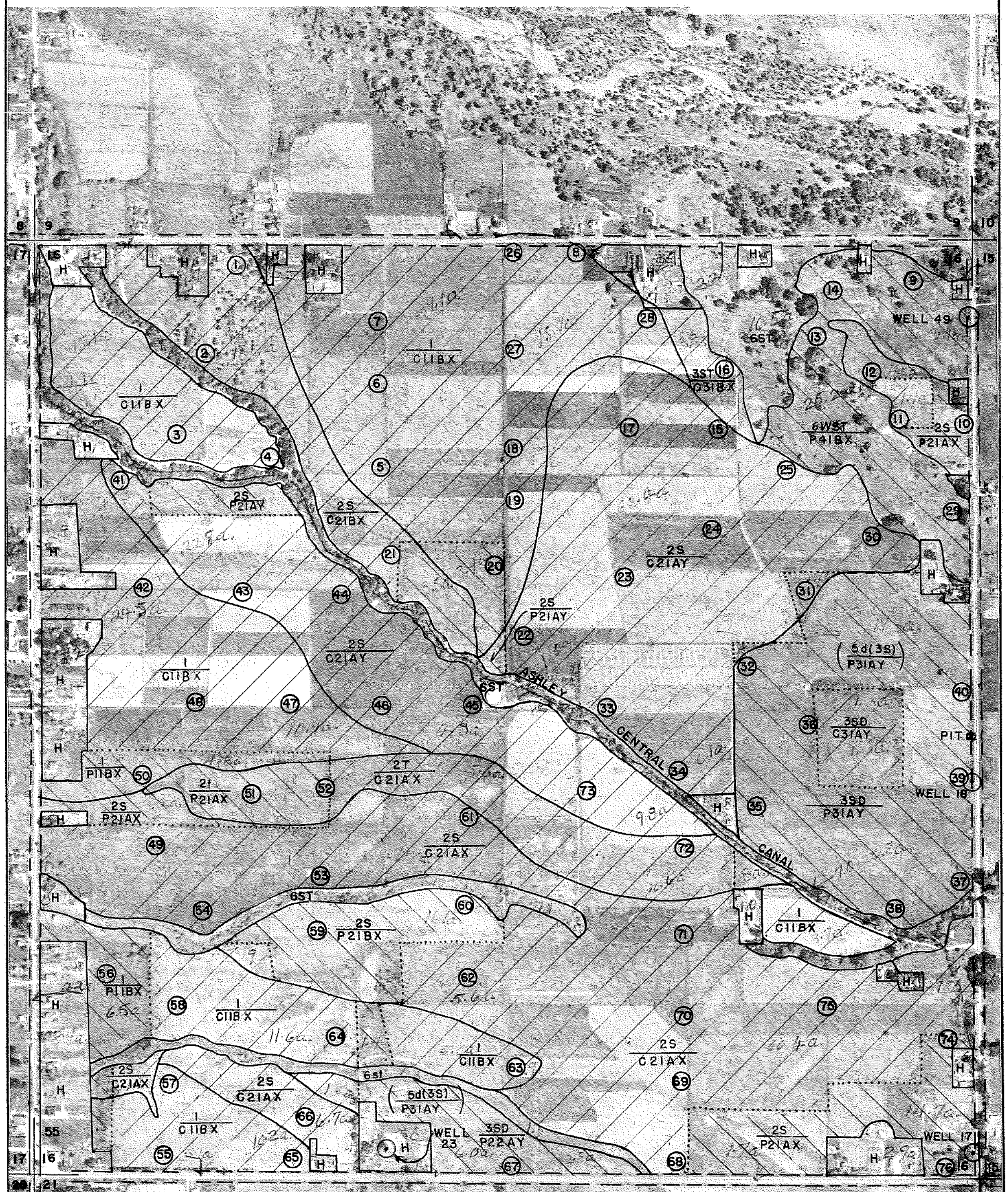
A minimum of 36 five-foot auger borings was made per section. The logs and profile descriptions were logged in peg books in the field. These were copied on the back of the photos in the office as a permanent record. Other notes pertinent to the particular area were also recorded with the profile, such as slope in degrees, depth to water tables, and present vegetation or land use. A screw-type power auger mounted on a jeep was used on much of the unit area for deep hole exploration and drainage studies. Holes were dug on most of the section corners to a depth of from 20 to 30 feet where the rocky substrata would permit. A backhoe was used in the more rocky areas where it was impossible to use other type augers; 27 backhoe holes were dug. Seven holes were also dug using a large, bucket-type power auger. The soil removed from these deep holes was examined and logged as to texture and structure. Then samples were collected for permeability studies and salt analysis. Depth to ground water, when encountered, was also logged.

A sample field sheet, which is a reproduction of an aerial photograph used in the field, is shown on page 39. Also shown on page 40 are 2 typical logs of 5 foot profiles which show the texture of the soil, the class of the area, the slope, vegetation, the total soluble salt percentage, pH and the lime reaction. The deep hole profile sample indicates the depths and textures of soil, the permeability rates of samples analyzed and the depth to ground water table with the date. The logs of all 5 foot profiles and the deep holes have been recorded on the back of the photos for a permanent record.

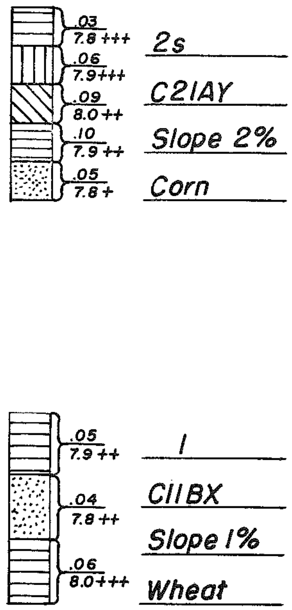
The soil samples collected in the field were analyzed in the Spanish Fork Development Office laboratory, for the determination of salinity,

DETAILED LAND CLASSIFICATION
CENTRAL UTAH PROJECT
VERNAL UNIT - UTAH
CLASSIFIER ----C.E.WRIGHT
DATE ------ 8 / 23 / 55

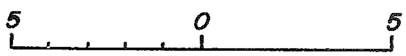
SEC. 16
T4S R21E SLB&M
DRY-5K-118

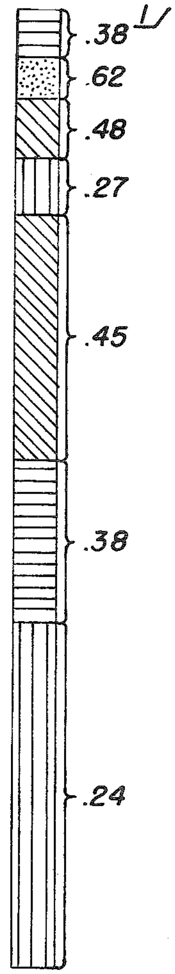


Typical Land Classification Field Sheet - Sec. 16



5 FOOT LOGS





Water Table 11 feet—6/10/56

DEEP HOLE

1/ PERMEABITILY RATES IN INCHES PER HOUR.

SOIL PROFILE SYMBOLS

Sands
Loamy sands
Sandy loams
Loams and silt loams
Clay loams
Very permeable clays
Permeable clays
Slowly permeable clays
Shale or raw soil from shale
Creviced rock
Gravel or cobble
Solid rock

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL UTAH PROJECT
VERNAL UNIT — UTAH

TYPICAL LOG and DEEP HOLE PROFILES

DRAWN J.P. SUBMITTED Orson P. Mobley
TRACED J.P. RECOMMENDED W. M. Greenhalgh
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AREA ENGINEER

SPANISH FORK, UTAH NOVEMBER 1956 SHEET 1 OF 1
66-418-1049

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alkalinity, presence of lime, and permeability rates. The procedures followed for the laboratory determinations were according to those outlined in Volume V of the Bureau of Reclamation Manual, Part 2. Total salt and pH determinations were made on soil paste, and permeability analysis were run on disturbed cores prepared from samples collected for that purpose.

Classification Specifications

Review of Specifications

The specifications which were used on this project were developed in the Spanish Fork Development Office with assistance from regional personnel, and are presented in Table 5 on page 42. These specifications are based on a correlation of the physical land features of soil, topography, and drainage with the land development costs, production costs, and anticipated crop production under irrigated farming with a full supply of water.

In general the specifications conform with those outlined in Volume V of the Bureau of Reclamation Manual, except for additional information on land development costs, permeability and infiltration rates. Also excessive alkalinity or salinity in the soil profile was indicated in the classification symbol by the letter "a."

The land development costs were established in cooperation with the Agricultural Economy section. Actual contact and consultation with farmers was made as a basis for preparing a farm budget. The farm budget was used in establishing the anticipated payment capacity for Class 1, 2s, and 3s and is as follows:

	Class 1	Class 2	Class 3
Anticipated payment capacity per acre:	$9.90	$7.70	$4.60

The adopted minimum development cost necessary to irrigate one acre of land is as follows:

Land Class	Clearing	Leveling	Farm Drainage	Irrigation Structure	Total
1	$10.00	$5.00	0	$10.00	$25.00
2s	10.00	5.00	0	10.00	25.00
3s	10.00	5.00	0	10.00	25.00

The maximum development costs for the land classes 2s and 3s are determined by capitalizing at 5 percent the decrease in payment capacity from Class 1 and adding this amount to the minimum development costs. These computations are shown in the table on page 43.

CENTRAL UTAH PROJECT

VERNAL UNIT

Table 5

SPECIFICATIONS FOR DETAILED LAND CLASSIFICATION

Land Characteristic	Class 1 arable	Class 2 arable	Class 3 arable	Class 6w nonarable	Class 6 nonarable
Soils (S) (0-5')					
Texture					
0-3'	Medium sandy loam to friable clay loam	Loamy fine sand to very permeable clay	Loamy sand to permeable clay	Loamy sand to slowly permeable clay	Lands which do not meet the minimum requirements for a higher class. Also small or isolated areas of arable land. Also arable land above any contemplated plan of development
3'-5'	Sandy loan to clay loam	Loamy sand to permeable clay	Loamy sand to permeable clay	Loamy sand to slowly permeable clay	
Internal characteristics					
Exchangeable sodium	Less than 10 %	Less than 15%	Less than 15%	Less than 20%	
Salinity	Less than 0.2%	Less than 0.5%	Less than 0.5%	Less than .75%	
Alkalinity	Less than pH 8.6	Less than pH 9.0	Less than pH 9.0	Less than pH 9.0	
Permeability	No layer less than .5 in. per hr.	No layer less than .2 in./hr. with most layers greater than .3"/hr.	No layer less than .1 in./hr. with most greater than .2 in./hr.	No layer less than .07 in./hr. with most greater than .1	
Infiltration	.5 to 1.0 in./hr.	.25 to 1.5 in./hr.	.15 to 2.5 in./hr.	.1 to 3.00 in./hr.	
Available H_2O	greater than 4.5 inches in 4'	greater than 3.75" in 4'	greater than 3.5" in 4'	greater than 3.0" in 4'	
Depth					
To sand or gravel	42" for sandy loams 36" for loam and clay loams	42" for loamy fine sands 36" for sandy loams 30" for loams, clay loams and clays	36" for loamy sands 30" for sandy loams 24" for loams, clay loams & clays	30" for loamy sands 24" for sandy loams 18" for loams and clay loams 12" for clays	
To broken nonsaline rock	60"	48"	36"	24" on slopes - 30" on flat areas	
To solid nonsaline rock	Same but with 6" highly permeable layer above rock	Same but with 6" highly permeable layer above rock	36" with 6" highly permeable layer above rock	Same but with 6" highly permeable layer above rock	
To Saline shale	60" with 12" highly permeable layer above broken shale	48" with 12" highly permeable layer above broken shale	36" with 12" highly permeable layer above broken shale	24" on slopes - 30" on flat areas with 12" permeable layer above shale	
To penetrable lime zone	24" with 60" penetrable	18" with 48" penetrable	14" with 36" penetrable	12" with 24" penetrable	
Topography (t)					
Smooth slopes in one plane	.5 to 3% in general gradient	up to 7% in general gradient	up to 11% in general gradient	up to 20% in general gradient	
Surface 1/	Areas greater than 500' in direction of irrigation runs leveled by moving less than 175 cu.yds. per ac.1/minimum depths required after leveling	Areas greater than 300' in direction of irrigation runs leveled by moving less than 300 cu.yds. per ac.1/minimum depths required after leveling	Areas greater than 200' in direction of irrigation runs leveled by moving less than 700 cu.yds. per ac.1/minimum depths required after leveling	Areas greater than 150' in direction of irrigation runs leveled by moving less than 175 cu.yds. per ac.1/minimum depths required after leveling	
Cover					
Brush or Rocks	Clearing costs less than 35 per ac.	Clearing costs less than 55 per ac.	Clearing costs less than 115 per ac.	Clearing costs less than 35 per acre.	
Drainage					
Farm drainage (d)	Corrected at costs less than 25 per ac.	Corrected at costs less than 45 per ac.	Corrected at costs less than 105 per ac.	Corrected at costs less than 25 per ac.	
Project Drainage class 5	Must meet all requirements for class 1 with completion of project works	Must meet all requirements for class 2 with completion of project works	Must meet all requirements for class 3 with completion of project works	Project drainage not applicable to pasture class land	
Maximum development costs to reach class 1 productivity	$50	$70	$130	$50	

1/ at 15 cents per cu. yd.

Basic land development Costs (Class 1, 2s, 3s) per ac.

Clearing	10 - 35
Rock	
Brush	
Leveling	
Smoothing	5 - 30
Cut and fill	0 - 25
Farm structures	
laterals	10 - 35
headgates	
drops	
wasteways	
Drains, farm	0 - 25
Total basic costs	25 - 50

Land Class	1	2	3
		(Dollars per Acre)	
Anticipated payment capacity	$9.90	$7.70	$4.60
Difference in payment capacity (From Class 1)	-	2.20	5.30
Differential capitalized at 5%	-	44.00	104.00
Rounded to		45.00	105.00
Minimum development costs	25.00	25.00	25.00
Maximum permissible dev. costs	50.00 1/	70.00	130.00

1/ It is assumed that a maximum of $25.00 could be used to develop Class 1 land in addition to the minimum development cost of $25.00, which would make a total of $50.00 as the maximum permissible development cost for Class 1.

The estimated payment capacities, which were set up before the land classification was begun, were used to determine the maximum permissible development costs. The actual payment capacities, as shown in the Agricultural Economy appendix, will be somewhat different from the estimated capacities used in this report. This difference will not be serious on the Vernal Unit since only a small acreage has been delineated which shows that a Class 2 land development cost is involved. A larger difference may occur in the maximum permissible development costs at the Class 3 level; however, there is no land within the irrigable area that requires a land development expenditure within the Class 3 range.

These total permissible development costs were used in the soil classification to determine the land class where the correctable deficiencies occur which must be incurred by the farmer to bring his land to a state of productivity achieved by class 1 land.

Special Use Classes

No special use classes were delineated for this unit.

General Description

The description of the various classes of land is as follows:

Class 1--Arable

Lands that are highly suitable for irrigation farming, being capable of producing sustained and relatively high yields of a wide range of climatically adapted crops at reasonable costs. They are smooth lying with gentle slopes. The soils are deep and of medium to fairly fine texture with mellow, open structure allowing easy penetration of roots, air and water and having free drainage yet good available moisture capacity. These soils are free from harmful accumulations of soluble salts.

Both soil and topographic conditions are such that no specific farm drainage requirements are anticipated. Only minimum erosion will result from irrigation, and land development can be accomplished at relatively low costs. These lands potentially have a relatively high payment capacity.

Class 2--Arable

This class comprises lands of moderate suitability for irrigation farming, being measurably lower than Class 1 in productive capacity, adapted to slightly smaller range of crops, more expensive to prepare for irrigation or more costly to farm. They are not so desirable, nor of such high value as lands of Class 1 because of certain correctable or noncorrectable limitations. They may have a lower available moisture capacity, as indicated by coarse texture or limited soil depth; they may be only slowly permeable to water because of clay layers or compaction in the subsoil; or they may also be moderately saline which may limit productivity. Topographic limitations include uneven surface requiring moderate costs for leveling, short slopes requiring shorter length of runs, or steeper slopes necessitating special care and greater costs to irrigate and prevent erosion. Adverse potential drainage conditions, correctable at a reasonable cost, may be anticipated. Any one of the limitations may be sufficient to reduce the lands from Class 1 to Class 2, but frequently a combination of two or more of them is operating. The Class 2 lands have intermediate payment capacity.

Class 3--Arable

Lands that are suitable for irrigation development but are approaching marginality for irrigation and have distinctly restricted suitability because of more extreme deficiencies in the soil, topographic, or drainage characteristics than described for Class 2 lands. They may have uneven topography, moderate to high concentration of salines or restricted drainage, susceptible of correction but only at relatively high costs; or they may have inferior soils which would restrict crop yields and adaptability. Greater risk is involved in farming these lands than the better classes of land, but under proper management they are expected to have adequate payment capacity.

Class 5--Temporarily Nonarable

The Class 5 lands are presently nonarable or their productivity is greatly reduced because they lack facilities to provide adequate drainage. These lands have a potential value sufficient to warrant tentative segregation for special study and differ from the arable classes only in amount of soluble salt and depth of water table. They were changed to the proper arable class or to Class 6W depending upon the severity of the drainage deficiencies and whether they would be affected by project drainage.

Class 6W--Nonarable

The lands in this class do not meet the minimum requirements for an arable class and in cases of correctable deficiencies their payment capacity will not permit their development to a higher class. These lands are mostly irrigated at present, but additional unit water will not be allocated to them. The lands of this class are mainly restricted to the production of pasture crops because they have an excessive specific deficiency in one or more factors which prevents their inclusion in an arable class. They may be deficient in soils, light textured or excessively shallow over gravel, boulders or shale; they may be deficient in topography with rolling or steep slopes of 11 to 20%; or may have inadequate drainage resulting in high ground water tables.

Class 6--Nonarable

Class 6 lands include those considered permanently nonarable because of their failure to meet the minimum requirements for the other classes of land. They also include small isolated arable tracts, within the Class 6 areas not large enough to warrant their segregation. Class 6 land comprises steep, rough and broken lands or shallow soils over gravel, shale or cobble. Lands of this class do not have sufficient payment capacity to justify their consideration for irrigation.

Determination of Irrigable Area

Review of Classification by Technicians

The Regional land classification specialists have inspected and reviewed the land classification and assisted in the presentation of the data in this report.

The Agricultural Economist assisted in the formulation of the specifications used for permissible development costs. At the completion of the classification the Economist reviewed and used the data in the determination of the total project repayment and the agricultural benefits.

In determining the flows storable at Stanaker Reservoir the Hydrologist deducted from natural stream flows the quantity of water presently used on class 1, 2, 3, and 6w land. Unit water will be used only on class 1, 2, and 3 land, however.

The classification data were reviewed by the Drainage Engineer to determine an efficient drainage plan. Areas which are seeped have a high ground water table or contain heavy soils were the principal items utilized in the drainage plan.

Selection of irrigable land

All of the lands which were classified with the Vernal unit are presently irrigated. Unit water will be provided for all lands of the 3 arable classes except those lying under the Union and River Irrigation Canals and the Stanaker and Pitt ditches. The arable acreage under these four ditches amounts to 938 acres, all of which are excluded from the irrigable area. The lands under the Union and River Irrigation Canals will not be served under the current plan because of the interrelated water quality and quantity and drainage problems. The lands under the Pitt and Stanaker ditches are excluded because they are located above the proposed diversion and distribution system.

Unit Plan

The unit plan contemplates the construction of an off-stream reservoir in Stanaker Draw, a feeder canal leading from Ashley Creek to the Stanaker Reservoir and a service canal from the reservoir to the project lands as shown on the frontispiece of this report. Spring flows, during the high runoff period, that cannot be beneficially used on existing irrigated lands, would be diverted to the reservoir along with available winter water for storage until the late irrigation season.

Drainage facilities will be provided where necessary along with whatever rehabilitation of existing canals is required for unit operation.

Through storage regulation and water exchanges, the area's needs for increased municipal water use and late season irrigation water would be supplied. The unit would also provide protection for fish and wildlife, development in new recreational areas, and incidental control of floods.

Fort Thornburgh Diversion Dam would be located on Ashley Creek at the head of the Stanaker Feeder Canal. Stanaker Feeder Canal will have a capacity of 400 c.f.s. Stanaker Reservoir with a capacity of 37,560 acre-feet will be formed by an earth fill dam at the mouth of Stanaker Draw about 3½ miles north of Vernal.

Results

In order to determine the lands which should be included in this unit, a total of 41,697 acres were classified. The lands under the Pitt and Stanaker ditches and the area of the Lower Ashley Creek division will not receive unit water, and are not included with the irrigable lands. The irrigable acreage consists of 14,781 acres; it includes 14,444 acres of Class 1, 2, and 3 lands and 337 acres within the Vernal townsite. The productive acreage, which is also used in the water supply and economic studies, was determined by deducting 5 percent from the irrigable acreage, thus, the total productive land, including the townsite, amounts to 14,041 acres. A summary of the detailed classification is shown in Table 6 on page 48, while the irrigable area is summarized in Table 7 on page 49. The location of the various classes of land which were classified is depicted on the map on pages 51 and 53.

Location, Extent, and Characteristics of Land in the Various Classes

Most of the class 1 land is located in the northwest portion of the unit in fairly large tracts. It contains the better soils of the unit. They are deep, at least 5 feet, are medium textured and have an open structure. Unit drainage will be required on some of these lands, but the permeability is good and the soil is free of concentrates of salinity and alkalinity. Smoothing and leveling will be at a minimum. There are 3,554 acres of class 1 land, or about 23% of the total arable area.

Class 2 land comprises 5,843 acres, which is 37% of the arable land. These lands are not of such high quality as class 1, usually because of shallowness of the soil over rock, cobble or shale or the heavy texture of the soil. They are fairly well scattered throughout the unit area.

Class 3 land, 40% of the arable area, or 6,226 acres, is located largely in the southern and eastern part of the unit. The majority of these lands are placed in class 3 because of the shallow or heavy textured soil or the rough topography of the land. Because of these deficiencies most of these lands will remain permanently class 3.

There were 8,658 acres classified as 6W. They are located mainly in the northern and southern portions of the unit, but small areas are found throughout the whole area. These are steep, broken lands, areas of restricted drainage not feasible of project drainage, or very shallow soils over cobble or shale. Unit water will not be provided for these lands.

Class 6 lands, mainly in the north and the southwest parts, constitute the rough broken lands, areas with cobble or shale exposed to the surface or restricted drainage coupled with high concentrations of salinity.

Lands which were classified into Class 5 in the field, due to drainage deficiencies, have been changed to their proper arable class when included in that area to be corrected by unit drainage. Areas of Class 5 not provided with unit drainage were down-graded according to the severity of the drainage deficiencies. If the deficiencies prohibit the inclusion of these lands in an arable class then they were reverted to Class 6W.

CENTRAL UTAH PROJECT
Vernal Unit
Table 6
1956 Detailed Land Classification
SUMMARY

Arable Acreages | April 1957

Canal	Irrigated Class 1	Irrigated Class 2	Irrigated Class 3	Irrigated Total 1-3	Class 6W	Class 6	R.O.W.	Town-site	Total
Above Unit Diversion									
Stanaker Ditch		85	11	96	44	479			619
Pitt Ditch		83	59	142	7	352	5		506
Total above Unit Diversion		168	70	238	51	831	5		1125
Above Stanaker Service Canal									
Highline	157	433	453	1043	791	3460	55		5349
Ashley Upper	1610	1390	231	3231	867	567	173		4838
Ashley Central	267	270	110	647	92	172	47		958
Rock Point		30	49	79	56	598	14		747
Island Ditch	6	34	61	101	54	118	11		284
Dodds Ditch		19	9	28	15	5			48
Colton Ditch	208	16		224	16	4	7		251
Hardy Ditch	24	6	19	49	7	4	2		62
Total above Stanaker Service Canal	2272	2198	932	5402	1898	4928	309		12,537
Below Stanaker Service Canal									
Ashley Upper	133	1051	2096	3280	2421	3425	234		9360
Ashley Central	700	1592	1885	4177	2162	1136	231	845	8551
Rock Point	237	449	572	1258	226	1770	41		3295
Island Ditch	4	92	78	174	545	293	39		1051
Dodds Ditch		3	16	19	50	17			86
Spring Creek		53	142	195	829	523	18		1565
Private Ditches	17	33	130	180	185	479	9		853
Total below Stanaker Service Canal	1091	3273	4919	9283	6418	7643	572	845	24,761
Lower Ashley Creek Division									
River Irrigation		18	165	183	200	1185	30		1598
Union	191	186	140	517	91	1066	2		1676
Total Ashley Creek Division	191	204	305	700	291	2251	32		3274
Total Arable	3554	5843	6226	15,623	8658	15,653	918	845	41,697

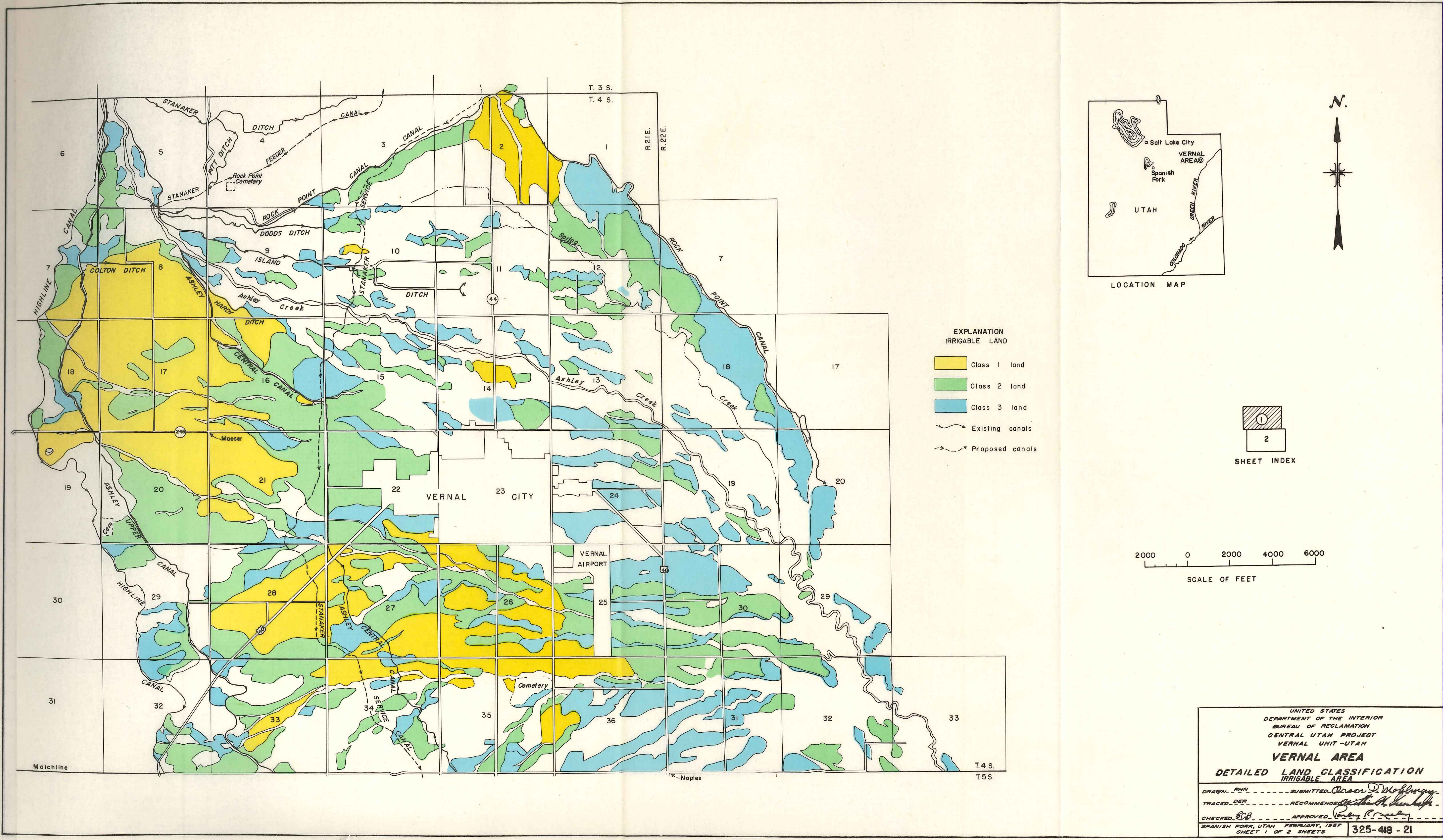
Central Utah Project
Vernal Unit
Table 7
Summary of Irrigable Area

Unit: Acres | April 1957

Canal	Irrigated Class 1	Irrigated Class 2	Irrigated Class 3	Total irrigable 1/
	Above Stanaker Service Canal			
Highline	157	433	453	1,043
Ashley Upper	1,610	1,390	231	3,231
Ashley Central	267	270	110	647
Rock Point		30	49	79
Island Ditch	6	34	61	101
Dodds Ditch		19	9	28
Colton Ditch	208	16		224
Hardy Ditch	24	6	19	49
Unit right-of-way 2/	-7	-8	-3	-18
Total above Stanaker Service Canal	2,265	2,190	929	5,384
	Below Stanaker Service Canal			
Ashley Upper	133	1,051	2,096	3,280
Ashley Central	700	1,592	1,885	4,177
Rock Point	237	449	572	1,258
Island Ditch	4	92	78	174
Dodds Ditch		3	16	19
Spring Creek		53	142	195
Private Ditches	17	33	130	180
Unit right-of-way 2/	-70	-106	-47	-223
Total below Stanaker Service Canal	1,021	3,167	4,872	9,060
Total above and below Stanaker Service Canal	3,286	5,357	5,801	14,444
Vernal townsite 1/				337
Total irrigable				14,781

1/ Irrigation water is to be supplied to 337 acres of the Vernal Townsite.

2/ Right-of-way required for unit features.


T. 3 S.
T. 4 S.
R. 21 E.
R. 22 E.
STANAKER DITCH
FEEDER CANAL
Rock Point Cemetery
PITT DITCH
ROCK POINT CANAL
DODDS DITCH
ISLAND DITCH
COLTON DITCH
HIGHLINE CANAL
ASHLEY HARDY DITCH
Ashley Creek
CENTRAL CANAL
STANAKER SERVICE CANAL
Spring
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VERNAL CITY
VERNAL AIRPORT
ASHLEY UPPER CANAL
Cem.
Cemetery
Naples
Matchline
T. 4 S.
T. 5 S.
EXPLANATION
IRRIGABLE LAND
Class 1 land
Class 2 land
Class 3 land
Existing canals
Proposed canals
LOCATION MAP
Salt Lake City
VERNAL AREA
Spanish Fork
UTAH
GREEN RIVER
COLORADO RIVER
N.
SHEET INDEX
SCALE OF FEET
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UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL UTAH PROJECT
VERNAL UNIT-UTAH
VERNAL AREA
DETAILED LAND CLASSIFICATION
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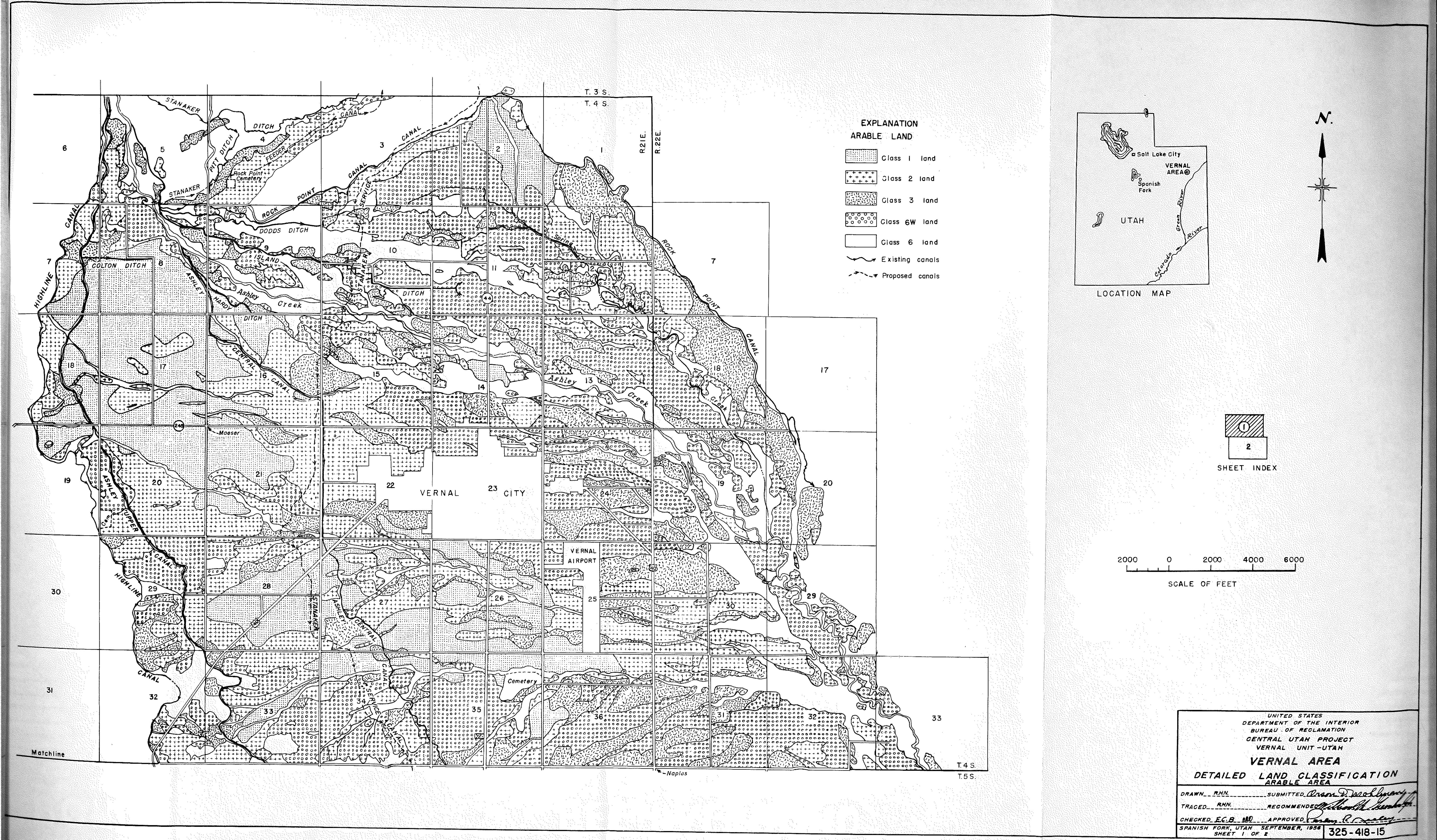

EXPLANATION
ARABLE LAND
Class 1 land
Class 2 land
Class 3 land
Class 6W land
Class 6 land
Existing canals
Proposed canals
LOCATION MAP
Salt Lake City
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Green River
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SHEET INDEX
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T. 5 S.
R. 21 E.
R. 22 E.
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VERNAL AIRPORT
STANAKER DITCH
PIT DITCH
FEEDER CANAL
Rock Point Cemetery
ROCK POINT CANAL
DODDS DITCH
ISLAND DITCH
COLTON DITCH
HIGHLINE CANAL
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Ashley Creek
CENTRAL CANAL
SERVICE CANAL
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VERNAL AREA
DETAILED LAND CLASSIFICATION
ARABLE AREA
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CHECKED E.C.B.
APPROVED
SPANISH FORK, UTAH SEPTEMBER, 1956
SHEET 1 OF 2
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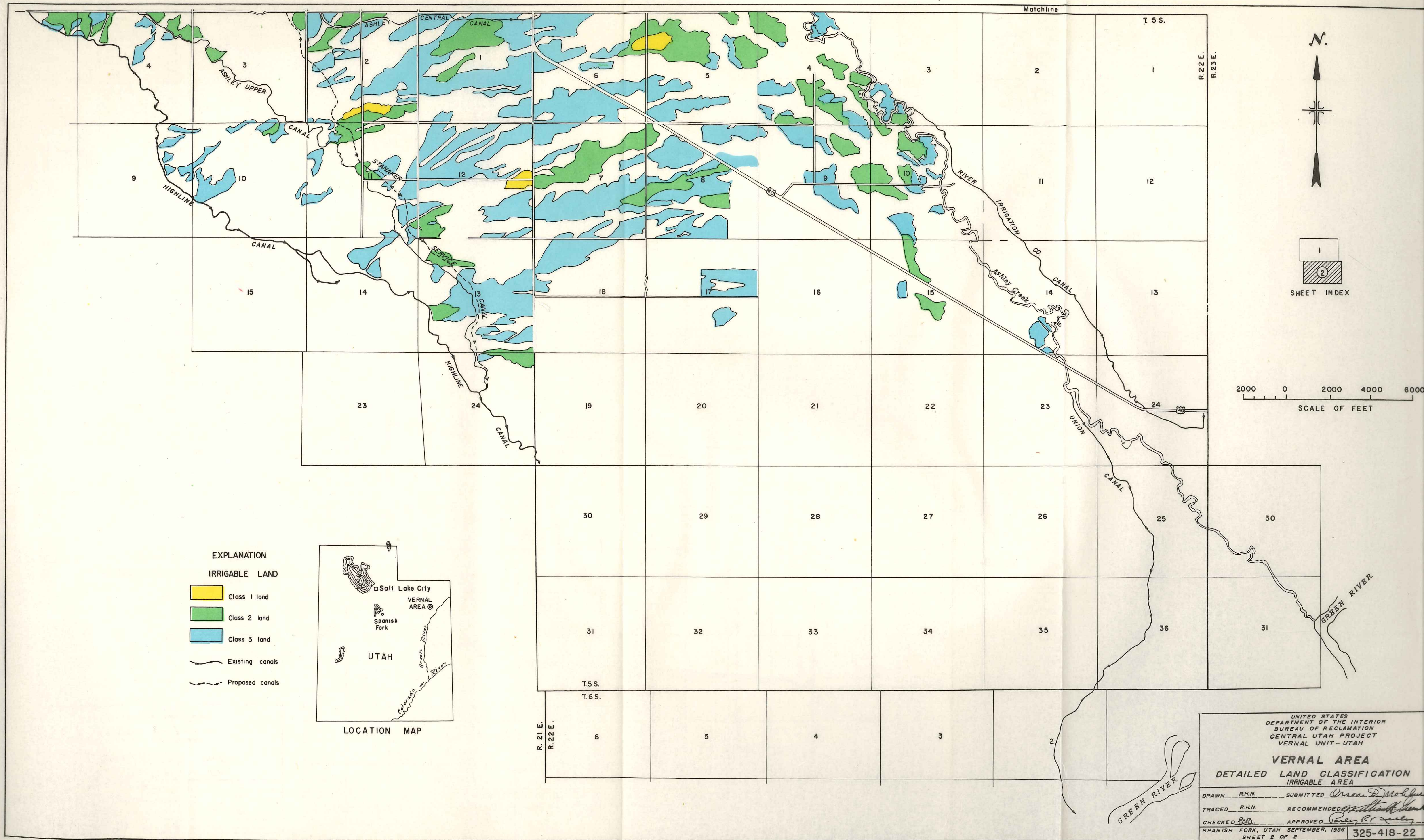
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ASHLEY UPPER CANAL
HIGHLINE CANAL
STANAKER SERVICE CANAL
RIVER IRRIGATION CO. CANAL
Ashley Creek
UNION CANAL
GREEN RIVER
T. 5 S.
T. 6 S.
R. 21 E.
R. 22 E.
EXPLANATION
IRRIGABLE LAND
Class 1 land
Class 2 land
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LOCATION MAP
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BUREAU OF RECLAMATION
CENTRAL UTAH PROJECT
VERNAL UNIT – UTAH
VERNAL AREA
DETAILED LAND CLASSIFICATION
IRRIGABLE AREA
DRAWN R.H.N. SUBMITTED Orson D. Mohlfeld
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APPROVED
SPANISH FORK, UTAH SEPTEMBER, 1956
SHEET 2 OF 2
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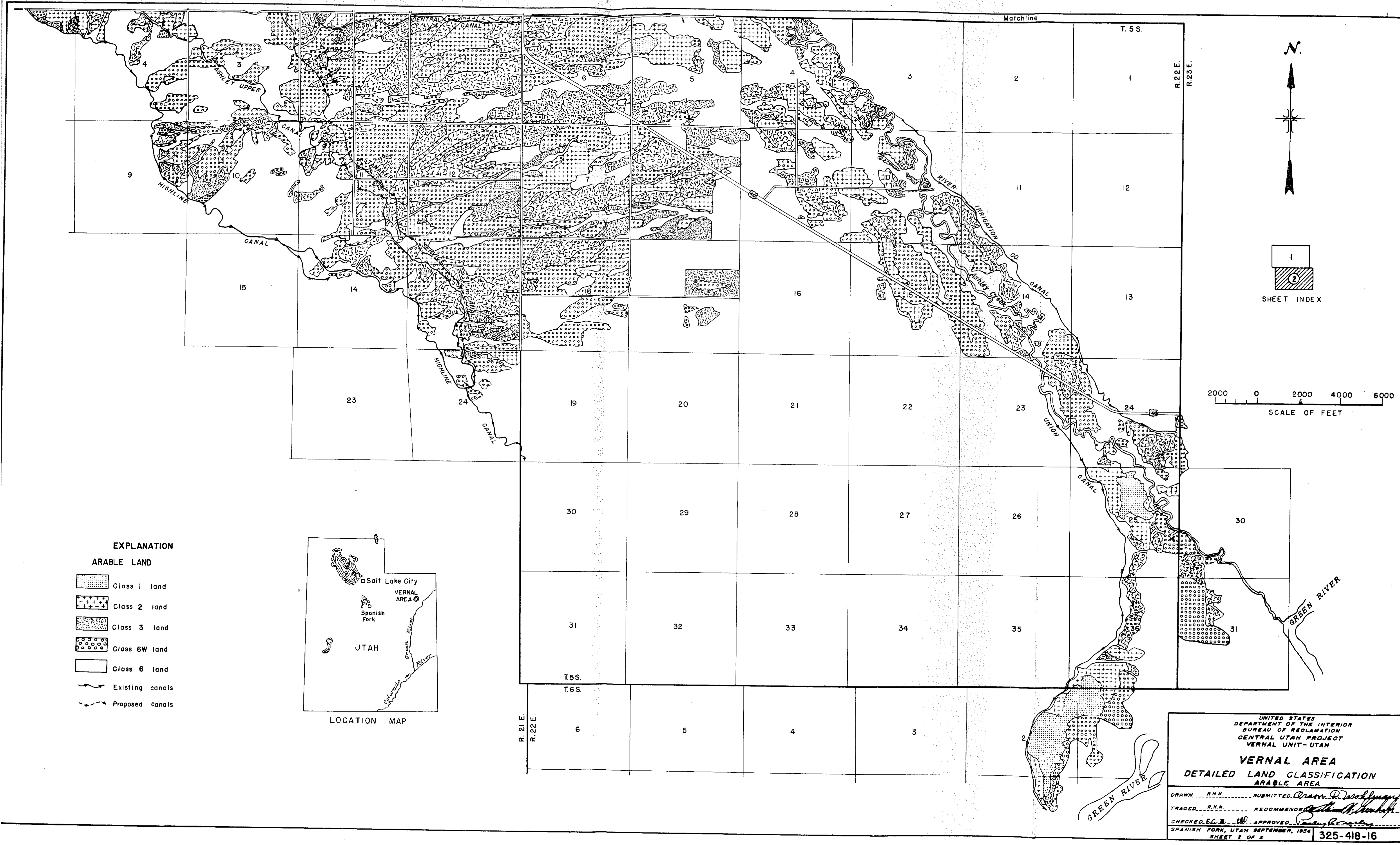

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R.23 E.
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ASHLEY UPPER CANAL
CENTRAL CANAL
HIGHLINE CANAL
RIVER IRRIGATION CO. CANAL
Ashley Creek
UNION CANAL
GREEN RIVER
SHEET INDEX
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SCALE OF FEET
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R. 21 E.
R. 22 E.
EXPLANATION
ARABLE LAND
Class 1 land
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VERNAL AREA
DETAILED LAND CLASSIFICATION
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DRAWN R.H.H. SUBMITTED
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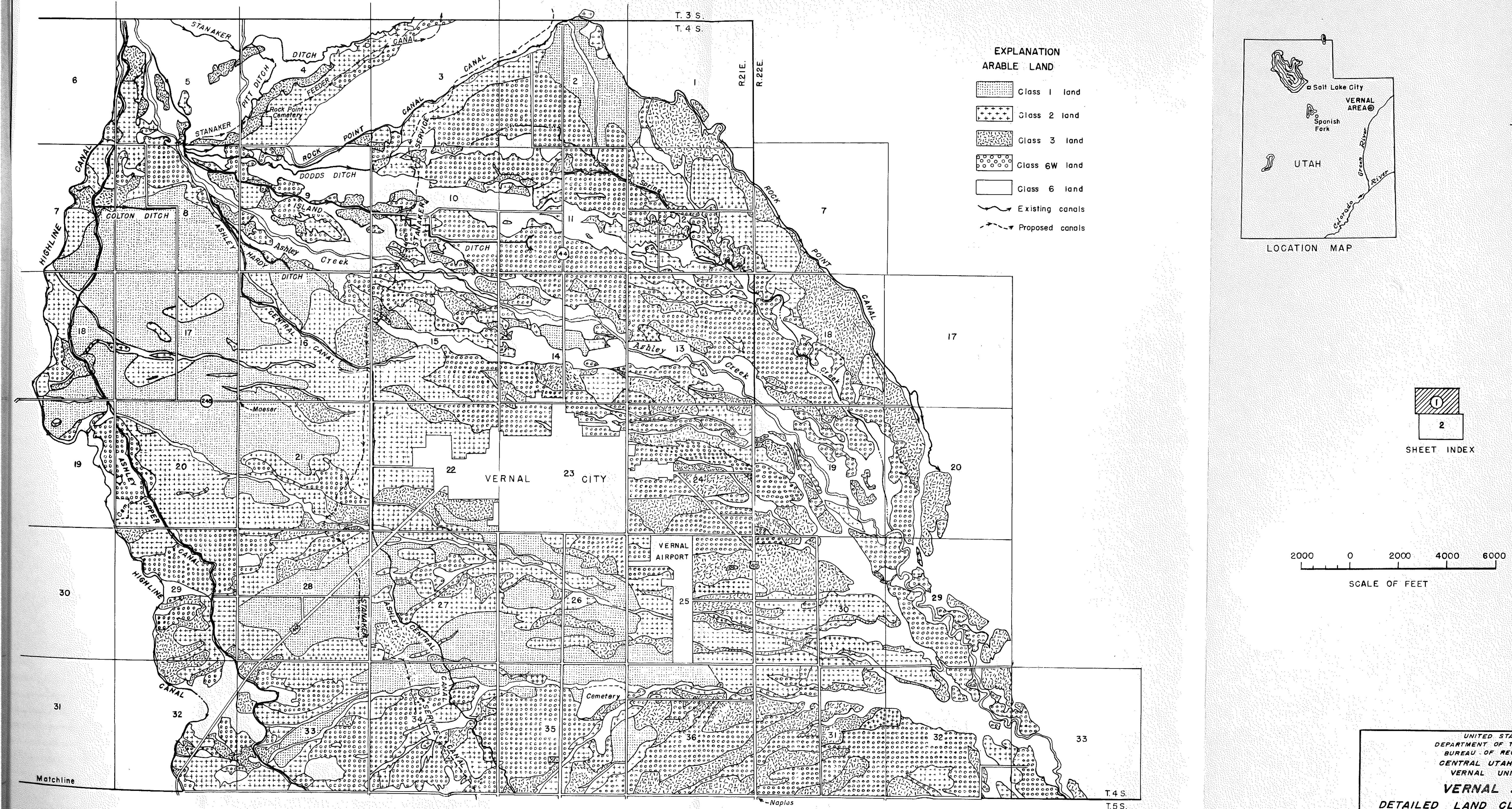

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL UTAH PROJECT
VERNAL UNIT - UTAH

VERNAL AREA

DETAILED LAND CLASSIFICATION
ARABLE AREA

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SPANISH FORK, UTAH SEPTEMBER, 1956
SHEET 1 OF 2

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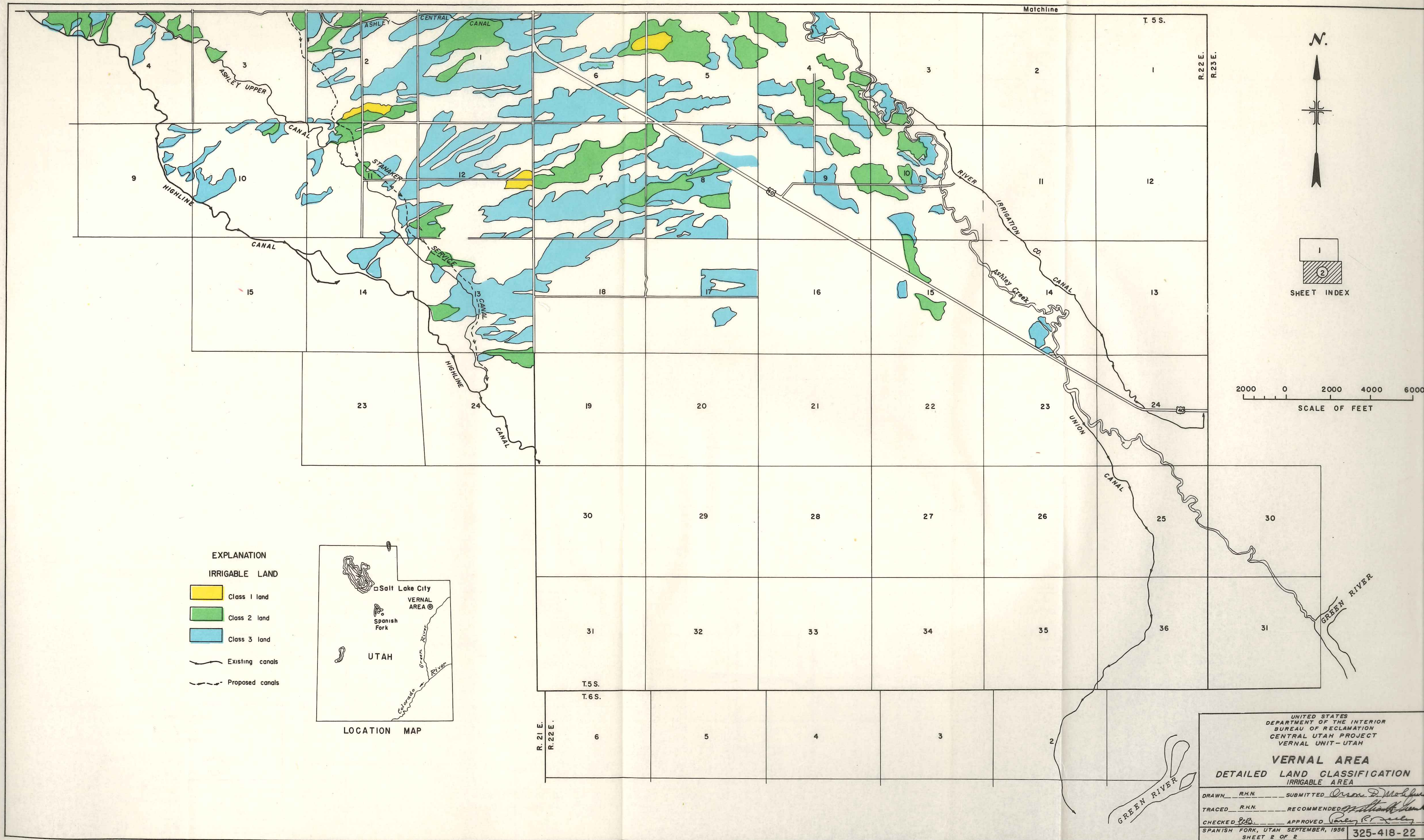
Matchline
T. 5 S.
R. 22 E.
R. 23 E.
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ASHLEY CENTRAL CANAL
ASHLEY UPPER CANAL
STANAKER
SERVICE
CANAL
HIGHLINE CANAL
HIGHLINE
CANAL
RIVER IRRIGATION CO. CANAL
Ashley Creek
UNION CANAL
GREEN RIVER
GREEN RIVER
40
SHEET INDEX
1
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2000 0 2000 4000 6000
SCALE OF FEET
T. 5 S.
T. 6 S.
R. 21 E.
R. 22 E.
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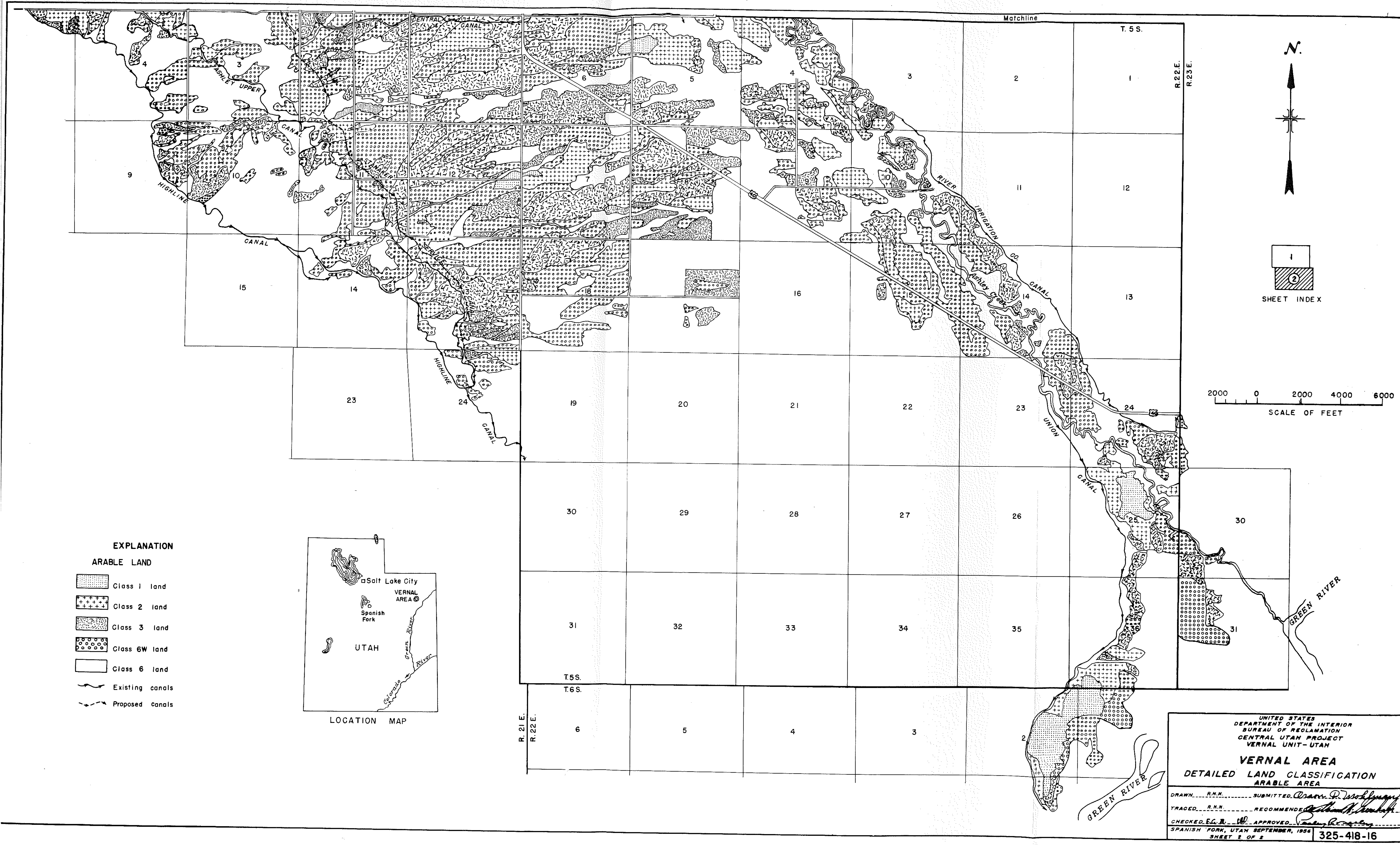
Proposed canals
Salt Lake City
VERNAL AREA
Spanish Fork
UTAH
Green River
Colorado River
LOCATION MAP
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL UTAH PROJECT
VERNAL UNIT – UTAH
VERNAL AREA
DETAILED LAND CLASSIFICATION
IRRIGABLE AREA
DRAWN R.H.N. SUBMITTED Orson D. Mohlman
TRACED R.H.N. RECOMMENDED
CHECKED E.C.B. APPROVED
SPANISH FORK, UTAH SEPTEMBER, 1956
SHEET 2 OF 2
325-418-22


Matchline
N.
T. 5 S.
R. 22 E.
R. 23 E.
ASHLEY UPPER
CANAL
HIGHLINE
CANAL
CENTRAL CANAL
RIVER
IRRIGATION
CO.
CANAL
Ashley Creek
UNION
CANAL
GREEN RIVER
SHEET INDEX
2000 0 2000 4000 6000
SCALE OF FEET
EXPLANATION
ARABLE LAND
Class 1 land
Class 2 land
Class 3 land
Class 6W land
Class 6 land
Existing canals
Proposed canals
Salt Lake City
VERNAL AREA
Spanish Fork
UTAH
Green River
Colorado River
LOCATION MAP
T.5S.
T.6S.
R. 21 E.
R. 22 E.
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL UTAH PROJECT
VERNAL UNIT–UTAH
VERNAL AREA
DETAILED LAND CLASSIFICATION
ARABLE AREA
DRAWN R.H.H. SUBMITTED
TRACED R.H.H. RECOMMENDED
CHECKED APPROVED
SPANISH FORK, UTAH SEPTEMBER, 1956
SHEET 2 OF 2
325-418-16

Characteristics and Extent of Various Subclasses of Land

There were 9 different subclasses of land deliniated in the Vernal unit. The distribution of the irrigable lands (the 337 acres within the Vernal townsite were not classified) within these various subclasses is as follows:

Land Class	Acreage	Percent of Irrigable
1	3,286	23
2s	2,138	15
2t	2,724	19
2d	5	0
2st	490	3
3s	340	2
3t	124	1
3st	5,252	36
3sd	85	1
Total irrigable	14,444	100

Class 1. About 85% of all of the land placed in Class 1 is found in the youthful soils division. These soils have a good deep profile and are very productive, being capable of growing all crops climatically adapted to the area. The present land use is principally alfalfa, small grains, and corn. With unit development and supplemental water, it is anticipated that yields will be increased considerably and a more efficient rotation program can be adopted.

A typical profile of the Redfield soils, in the north part of the Youthful Division, has about 60 inches of reddish brown, very fine sandy loam with a single grained structure. A typical profile of the majority of class 1 in this division shows about 12 inches of yellowish brown loam to very fine sandy loam. From 12 to about 30 inches is grayish brown loam or silt loam, and the bottom layer from about 30 to 60 inches is dark gray fine sandy loam to loam.

The Class 1 typical profile in the Mature Soils Division shows from 40 to 60 inches of calcareous, reddish brown loam or fine sandy loam. The Class 1 soils in this division are the higher lands and occupy the crest of the mesas and terraces.

There is only 40 acres of class 1 in the Alluvial Soils Division and none in the Slopewash Division.

The topography of the Class 1 lands is smooth to gently rolling with no slope of over 3%, and is conducive to efficient irrigation without costly preparation. Erosion from irrigation is not a problem. Corrugations and furrows are the principal methods of irrigation used, but irrigation practices

practices could be improved by the installation of control structures, efficient use of water, and properly disposing of waste water.

The drainability of the soils of Class 1 is very good, there are no appreciable amounts of alkalinity or salinity present and the fertility is high. In fact, there are no deficiencies in these soils which will prohibit the production of sustained, high yields.

Class 2s. The lands in this class have noncorrectible deficiency in soils which somewhat reduces their productive capacity. This soil deficiency in this unit is either heavy texture or shallow soil over cobble and rock. In the Youthful Soils Division, a typical profile shows the soil to be deep, but of a heavy nature. There is usually about 12 inches of light brown silt loam or loam over a heavier layer from about 12 to 60 inches of clay loam to silty clay. There is a little Class 2s land in the Slopewash Division; it has a profile of about 24 inches of brownish gray silt loam over clay.

A typical profile of Class 2s land, in the Mature and Alluvial Division is from 24 to 30 inches of brownish gray loam to fine sandy loam over rock or cobble. These soils are all calcareous and in the Mature Division, they may have a zone of partially cemented lime immediately above the cobble.

The topography of the Class 2s lands is smooth to gently rolling; in fact, the same topographic specifications are met as in Class 1. These lands then are easy to irrigate and erosion is not a problem. The land use is mostly small grains and alfalfa but the yields are somewhat lower than Class 1. Supplemental water will no doubt result in an increased yield; also, irrigation practices could be improved as described for Class 1. The main irrigation method used is by corrugations. There are no appreciable amounts of alkalinity or salinity present; the permeability and the drainability is good and the fertility is fairly high.

Class 2t. These lands have a topographic deficiency, but have a Class 1 profile. They are fairly well scattered throughout the unit area. The deficiency may include uneven surface, requiring moderate leveling or be difficult to irrigate; or have short slopes requiring shorter lengths of runs; or they may be steeper slopes requiring special care and greater costs to irrigate and prevent erosion. The smooth slopes in one plane do not exceed 7% slope. Most of these lands are irrigated with the use of corrugations and irrigation practices could definitely be improved through greater use of control structures and care to prevent erosion. Small grains and alfalfa are the principal crops grown, and with supplemental water it is anticipated that yields will be increased. The drainability of Class 2t lands is very good; they contain very little salinity or alkalinity and the fertility is high.

Class 2st. The lands in this class have a deficiency in both topography and soils, neither of which is very great, but just enough to keep them out of Class 1. They are uneven or have a slope of over 3%; also, they have a heavier textured soil or it is shallow over rock and cobble. These lands are generally as productive as Class 2s or 2t and require no more care or cost in irrigation. Small grains and alfalfa are the main crops grown. The rotation program and the irrigation methods could be improved, and unit development should increase their yields.

Class 3s. The deficiency of this subclass is in the soils, while the topography meets the requirements for Class 1. A typical 3s profile in the Youthful Division shows about 10 to 12 inches of grayish brown silty clay loam over light brown silty clay. There is also a small area of loamy sand classified as 3s. In the Mature Soils Division, a typical 3s profile is about 18 to 24 inches of silt loam to fine sandy loam over cobble or the cemented lime zone. There were only 340 acres of 3s in the unit, very little of which is located in the Alluvial Division and none in the Slopewash Division. The Class 3s lands are either too heavy or too shallow to be very productive and the yields are considerably lower than those for Class 2. The main crop grown on these lands is alfalfa and the anticipated yield increases will not be as great as those for other classes.

Class 3st. All the lands placed in this class have a deficiency in both soils and topography; however, in all cases both of these deficiencies are of a class 2 severity rather than Class 3. Both Class 2 deficiencies present in the same soils result in their being placed in Class 3st. The majority of these lands are located in the Mature Soils Division and the principal crop grown on them is alfalfa with some small grains and pasture. They are irrigated mainly through use of corregations and some wild flooding. Irrigation practices could be improved by use of control structures and shorter runs to prevent erosion. The drainability of these soils is usually good and salinity and alkalinity is relatively low. The fertility is not high, being considerably lower than Classes 1 or 2.

A typical profile in the Mature and Alluvial divisions is about 24 to 30 inches of loam to fine sandy loam over cobble, rock or the lime zone. In the Youthful and Slopewash division, it is usually clay loam over silty clay.

Other Classes. The other sub-classes do not contain sufficient acreage to warrant their detailed discussion. Clsss 2d contains only 5 acres, Class 3t has 124 acres and 3sd only 85 acres. Class 3t is deficient in topography with uneven surface or smooth slope up to 11%, but with a good soil profile. Class 3sd, as well as having a soil deficiency, also has a deficiency in drainage which must be corrected through farm drainage by the individual farmer.

The Unit development, with supplemental water, will result in an increase in the payment and amortization capacities for all classes and subclasses of land.

CHAPTER V

CONCLUSIONS

Suitability for Development under Sustained Irrigation

Soils

The majority of the soils of the Vernal Unit are formed from alluvial sediments, transported into the valley from the Uinta mountains and the surrounding foothills. They are mainly of medium texture and open structure, having a moderate permeability and good available moisture capacity. They are relatively low in soluble salt and alkalinity. Their inherent fertility is high and with efficient application of fertilizer it may be maintained or increased. These soils are highly to moderately suitable for irrigation farming and are capable of producing sustained high yields of adapted crops with proper management at a reasonable cost.

Topography

In general, the topography is conducive to efficient irrigation without costly preparation of the lands. The surface relief of the area is smooth to gently sloping. The general slope is toward the southeast and the side slopes to the east and to the west, the average slope being 2 to 3 percent. Deep leveling will not be required; however, surface leveling will materially aid in the economical and efficient water distribution. Erosion from irrigation presents no serious problem.

Drainage

The favorable texture, structure, and permeability of the soil, together with a layer of cobble and gravel in a sandy matrix underlying most of the area, provide a very favorable internal drainage condition on most of the arable lands. Ashley Creek provides the main drainage way for the valley. There are some lateral drains; however, the principal drainage problem is in providing natural drainage ways for areas of high ground water tables. These areas are caused largely by canal seepage, excessive early irrigation and heavy spring runoff. No further drainage problems are anticipated with project development

CHAPTER VI

SUPPORTING DATA

The following supporting data for this report are on file in the development office at Spanish Fork, Utah, for future reference.

1. Detailed land classification photographs.
2. Acreage tabulation data.
3. Logs and descriptions of 5-foot auger holes.
4. Logs of deep holes.
5. Results of permeability tests.
6. Salinity and alkalinity analysis.
7. Climatological data.
8. Location map of deep holes and wells.

LAND DRAINAGE APPENDIX

Prepared by Cloyd L. Christensen, Hydraulic Engineer,
and Edison C. Breckenridge, Soil Scientist,
Under direction of Parley R. Neeley, Area Engineer

Technical supervision and review by D. A. Barker,
Chief, Drainage Branch, under direction of
Reid Jerman, Regional Project Development Engineer

LAND DRAINAGE

CHAPTER I

INTRODUCTION

Purpose of Appendix

This appendix is written to support and provide further data for the statements made in the definite plan report and outline future drainage investigations necessary in preparing for the construction of the drainage system. Essentially, data contained in this appendix evaluates the drainage problem within the unit.

Location of Unit

Unit lands described in this report are located principally in the Northwest two-thirds portion of Ashley Valley. The City of Vernal is located near the center of the unit lands. The main stream traversing the area is Ashley Creek which enters from the Northwest and flows through the Valley to the Southeast. Unit lands range in elevation from 4,800 to 5,700 feet.

Unit Plan

The unit plan contemplates the construction of an off-stream reservoir in Stanaker Draw, a feeder canal leading from Ashley Creek to the Stanaker Reservoir and a service canal from the reservoir to the unit lands. Spring flows, during the high runoff periods, that cannot be beneficially used on existing irrigated lands, would be diverted to the reservoir. Available winter flows of Ashley Creek would also be diverted to storage for use during the late irrigation season.

Drainage facilities will be provided where necessary along with whatever rehabilitation of existing canals is required for unit operation.

Through storage regulation and water exchanges, the area's need for increased municipal water use and late season irrigation water would be supplied. The unit would also provide protection for fish and wildlife development in new recreational areas and incidental control of floods.

Fort Thornburgh Diversion Dam would be located on Ashley Creek at the head of the Stanaker Feeder Canal. Stanaker Reservoir, with a capacity of 37,560 acre-feet, will be formed by an earth fill dam at the mouth of Stanaker Draw about $3\frac{1}{2}$ miles North of Vernal. The reservoir will have 33,200 acre-feet of active capacity.

Climate

Ashley Valley is characterized by rather wide extremes in temperature and precipitation. Maximum and minimum temperatures recorded at Vernal are 103° F. and -38° F., respectively. The mean annual temperature is 44° F. and the growing season temperatures average 60° F. The frost-free period averages 119 days with killing frosts occurring as late as the middle of June and as early as the last day of August.

Precipitation recorded at the Vernal weather station averages 8.52 inches annually with extremes of 14.8 inches in 1941 and 4.6 inches in 1934. About 65% of the annual precipitation occurs during the growing season from April through October. Summer rains frequently augment the stream flow during July, August, and September.

Agricultural and Urban Development

Settlement of Ashley Valley began in 1873 with the establishment of a ranch on Ashley Creek North of the present site of Maeser. In the following years other settlers made their homes in the valley, constructed canals, and began irrigating large tracts of land from Ashley Creek. The first ranches were devoted to livestock which utilized the grazing resources adjacent to the valley. General farming subsequently became the standard agricultural pattern. By 1900 most of the irrigable land in Ashley Valley had been cultivated and placed under irrigation. Since 1900 a few small areas have been developed through extension of canal systems.

Agricultural development centers around livestock production and the raising of forage crops and small grains. Several small industries centered around agricultural production have been established in the unit area. These include creameries, a flour mill, and meat processing plants.

The City of Vernal, the major community within the unit area, is situated near the center of Ashley Valley and is the largest trading center within a radius of 80 miles. The farm population is concentrated in the rural communities of Maeser, Naples, Glines, South Vernal, Ashley, and Davis. The 1940 and 1950 Census reports place the population of Vernal at 2119 and 2845 with the population of rural communities within the area, as mentioned above, at 3372 and 3358, respectively. A marked increase in population has resulted since 1944 from expansion of the oil industry at Rangely, Colorado, 50 miles east of the unit area, and from a new oil field in Ashley Valley. As a result the City of Vernal has absorbed most of the influx of workers and prospectors. Many new homes and business buildings have been constructed to meet housing and business needs.

Drainage Concepts

The following concepts of unit drainage are as set forth in the Commissioner's letter of May 21, 1951, subject "Drainage and Land Classification," and has been reaffirmed by the Commissioner in his letter of October 30, 1953, subject "Drainage Policy."

> "Project drainage is all drainage necessary in addition to farm drainage to establish and maintain productivity of project lands and to provide protection for non-project lands. It will consist of the facilities necessary to control excess water resulting from project development or from prior concentration of off-farm water. This will be accomplished through the use of intercepting and outlet drains, pumping, and correction of the conditions which contribute to hydrostatic pressure. As a minimum, project drainage will include outlets to each farm unit necessary for the disposal of excess surface and subsurface water. The extension of project drainage to lands that require multiple drains within farm units generally cannot be justified."

There is no anticipated need for farm drainage within this unit as soils and subsoils generally have good drainage characteristics. Unit drainage would therefore provide control of ground water levels for irrigable lands within the unit which have a drainage deficiency.

Drainage Requirement

It is anticipated that the drainage problems can be relieved by the construction of subsurface drainage facilities, the lining of a portion of the existing major canals serving the unit area, and the improvement of irrigation practices.

The cost for drainage to permit the contemplated crop production on the unit area is estimated at $675,000, or $45 per acre for the irrigable lands in the unit area. This cost includes $100,000 for lining a portion of the existing major canals serving the area.

LAND DRAINAGE

CHAPTER II

DRAINAGE CHARACTERISTICS AND PROBLEMS

Nature of Drainage Problem

Excessive irrigation during the early irrigation season and canal seepage are major factors contributing to the high ground water table. Due to insufficient upstream storage, irrigation water is applied excessively during the spring runoff utilizing every opportunity to keep the lands wet in the fear that each irrigation may be the last. This contributes to the high water tables which exist on much of the unit area during the early spring months.

Designation of Drainage Problem Areas

The unit lands have been divided into areas of similar drainage characteristics, namely: (1) Naples Area, (2) River Bottoms Area, (3) Stanaker-Northeast Slope Area, and (4) Maeser-Vernal Area. These designated areas are located on maps nos. 325-418-23 and -24.

It appears that the highest water table on unit lands during the early spring months is found in the Maeser-Vernal area.

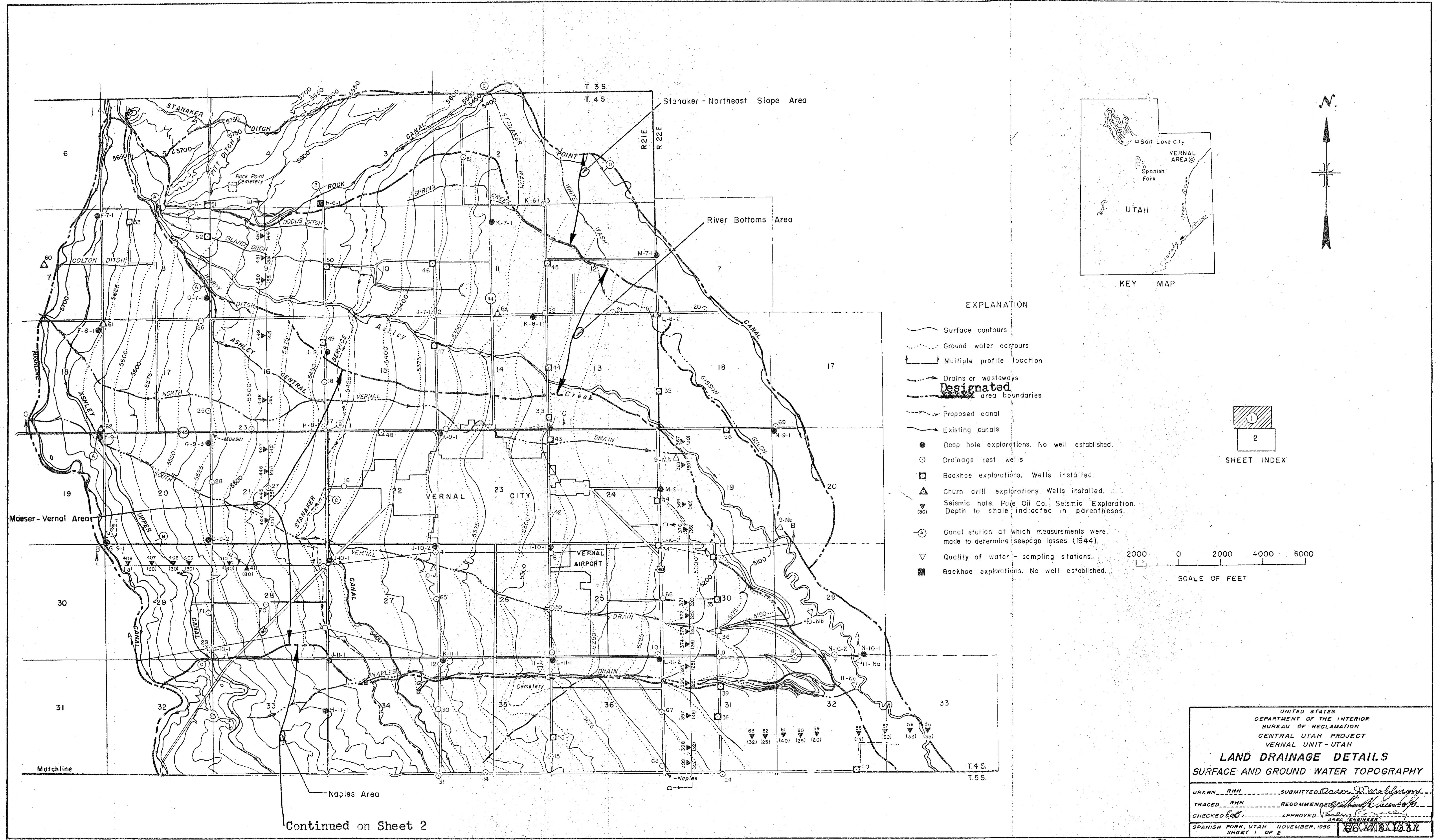
Geology

General

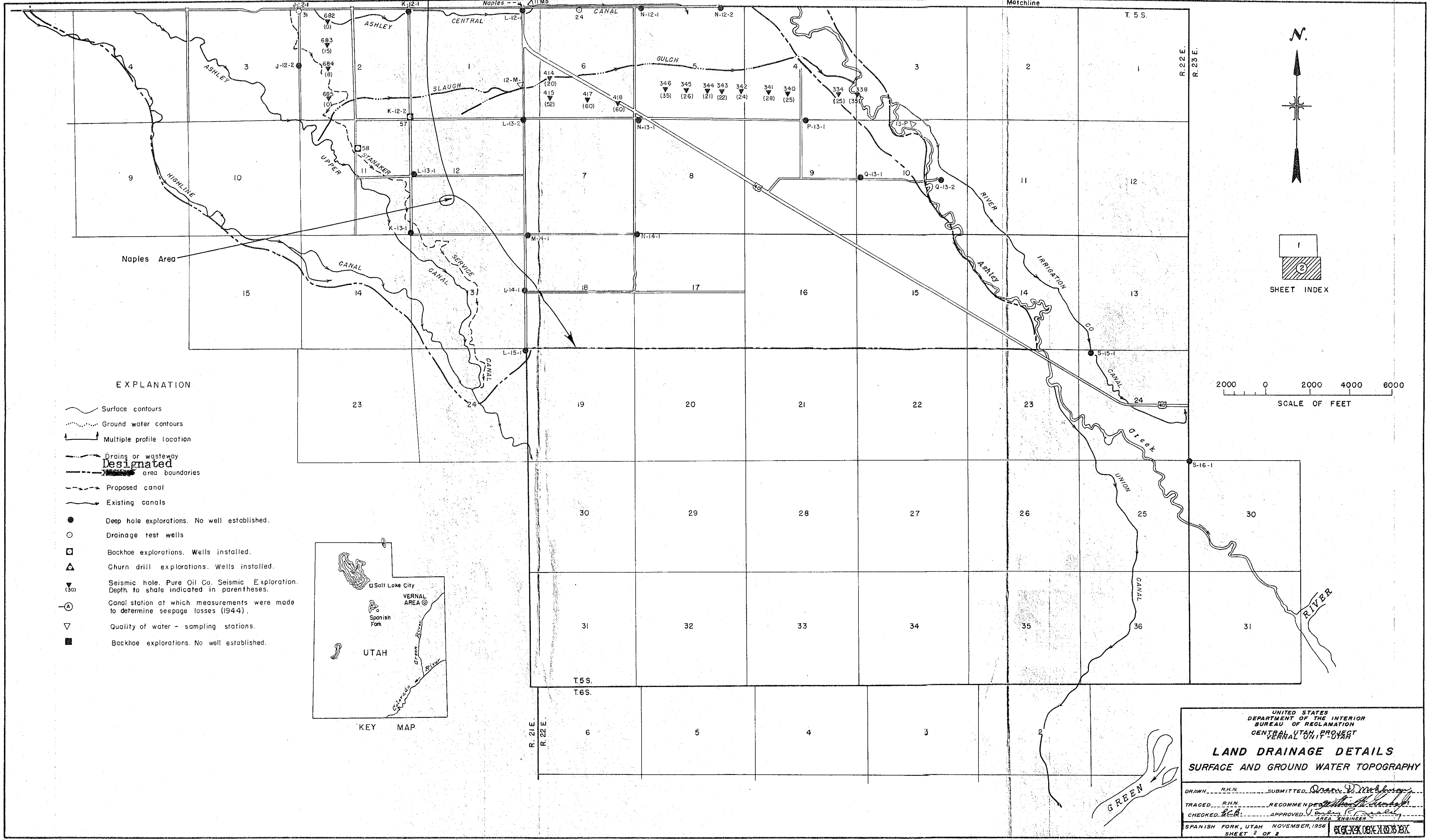
Ashley Valley lies on the south flank of the Uinta Mountain and is eroded into the beds of soft Mancos shale which were tilted and exposed during the rise of the anticline that formed the Uinta Mountains. The valley floor was later covered in large part by coarse gravel or cobble which was then covered by a soil mantle of alluvial origin varying in depth from 0 to about 20 feet. Erosion channels have been cut into the soil mantle and in some areas through the gravels into the shale. Ashley Creek has become deeply entrenched into the shales of the valley floor beginning at a point east of the city of Vernal. East of the Vernal airport the river flood plain is entrenched 80 to 100 feet.

The gravel consists of water-worn rounded to subangular quartzite boulders from the Uinta Precambrian series in a sand matrix plus rocks from other formations exposed by earlier erosion.

The soil mantles capping the gravel consists largely of alluvial deposits transported by numerous streams emerging from the south flank of


Stanaker - Northeast Slope Area
River Bottoms Area
Maeser - Vernal Area
Naples Area
Continued on Sheet 2
Matchline
T. 3 S.
T. 4 S.
T. 5 S.
R. 21 E.
R. 22 E.
STANAKER DITCH
PIT DITCH
Rock Point Cemetery
ROCK POINT CANAL
DODDS DITCH
ISLAND DITCH
COLTON DITCH
HARDY DITCH
ASHLEY CENTRAL SERVICE
NORTH VERNAL
HIGHLINE
ASHLEY UPPER
SOUTH
Maeser
STANAKER
VERNAL CANAL
UPPER CANAL
NAPLES DRAIN
SPRING CREEK
STANAKER WASH
WHITE WASH
Ashley Creek
DRAIN
GIBSON CANAL
GIBSON GULCH
VERNAL CITY
VERNAL AIRPORT
Cemetery
Naples
EXPLANATION
Surface contours
Ground water contours
Multiple profile location
Drains or wasteways
Designated area boundaries
Proposed canal
Existing canals
Deep hole explorations. No well established.
Drainage test wells
Backhoe explorations. Wells installed.
Churn drill explorations. Wells installed.
Seismic hole. Pure Oil Co. Seismic Exploration. Depth to shale indicated in parentheses.
Canal station at which measurements were made to determine seepage losses (1944).
Quality of water - sampling stations.
Backhoe explorations. No well established.
2000 0 2000 4000 6000
SCALE OF FEET
KEY MAP
Salt Lake City
VERNAL AREA
Spanish Fork
UTAH
Green River
Colorado River
N.
SHEET INDEX
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL UTAH PROJECT
VERNAL UNIT - UTAH
LAND DRAINAGE DETAILS
SURFACE AND GROUND WATER TOPOGRAPHY
DRAWN RHN
SUBMITTED Orson D. Goldsmith
TRACED RHN
RECOMMENDED
CHECKED
APPROVED
AREA ENGINEER
SPANISH FORK, UTAH NOVEMBER, 1956
SHEET 1 OF 2

325-418-23


EXPLANATION
Surface contours
Ground water contours
Multiple profile location
Drains or wasteway
Designated area boundaries
Proposed canal
Existing canals
Deep hole explorations. No well established.
Drainage test wells
Backhoe explorations. Wells installed.
Churn drill explorations. Wells installed.
Seismic hole. Pure Oil Co. Seismic Exploration. Depth to shale indicated in parentheses.
Canal station at which measurements were made to determine seepage losses (1944).
Quality of water - sampling stations.
Backhoe explorations. No well established.
Naples Area
Matchline
T. 5 S.
T. 6 S.
R. 21 E.
R. 22 E.
R. 23 E.
ASHLEY CENTRAL CANAL
ASHLEY HIGHLINE CANAL
UPPER STANAKER SERVICE CANAL
SLAUGH
GULCH
ASHLEY RIVER
ASHLEY CREEK
IRRIGATION CO CANAL
UNION CANAL
GREEN RIVER
N.
SHEET INDEX
2000 0 2000 4000 6000
SCALE OF FEET
KEY MAP
UTAH
Salt Lake City
VERNAL AREA
Spanish Fork
Green River
Colorado River
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL UTAH PROJECT
VERNAL UNIT - UTAH
LAND DRAINAGE DETAILS
SURFACE AND GROUND WATER TOPOGRAPHY
DRAWN R.H.N. SUBMITTED
TRACED R.H.N. RECOMMENDED
CHECKED APPROVED
AREA ENGINEER
SPANISH FORK, UTAH NOVEMBER, 1956
SHEET 2 OF 2

325-418-24

the Uinta Mountains. It is composed of the finer materials, namely clays, silts, sands and gravels from the various sedimentary strata comprising the limbs of the south flank of the Uinta range.

Maeser-Vernal area

In this area the soil and substrata consists of fine-textured alluvial deposits washed from the shale hills to the west and the sand-stone hills to the Northwest. This alluvium is about 20 feet in thickness underlain in the majority of this area by cobble. The cobble layer is about 40 feet in thickness in the central portion and becomes nonexistent at the upper portion near Asphalt Ridge. Moving down the slope from the central portion to the escarpment adjacent to Ashley Creek, East of Vernal and South to the Naples Drain, the finer-textured alluvium and cobble layers both become thinner. This entire area is underlain with the Mancos shale formation. See Multiple Profile drawings Nos. 325-418-26,-27, -28 and -29

Naples area

Fine-textured alluvium and cobble have been deposited over the majority of this area in the past by stream flows and outwashes from the hills to the West and Southwest. Through the years natural drainage ways have developed leaving a series of swales and ridges. On the ridges in the central portion there is a fine-textured alluvium of about 3 feet in thickness over cobble. In the upper portion near Asphalt Ridge this fine-textured alluvium lies on sandstone. In the swales the cobble has been eroded leaving a thin, fine-textured alluvium directly on Mancos shale.

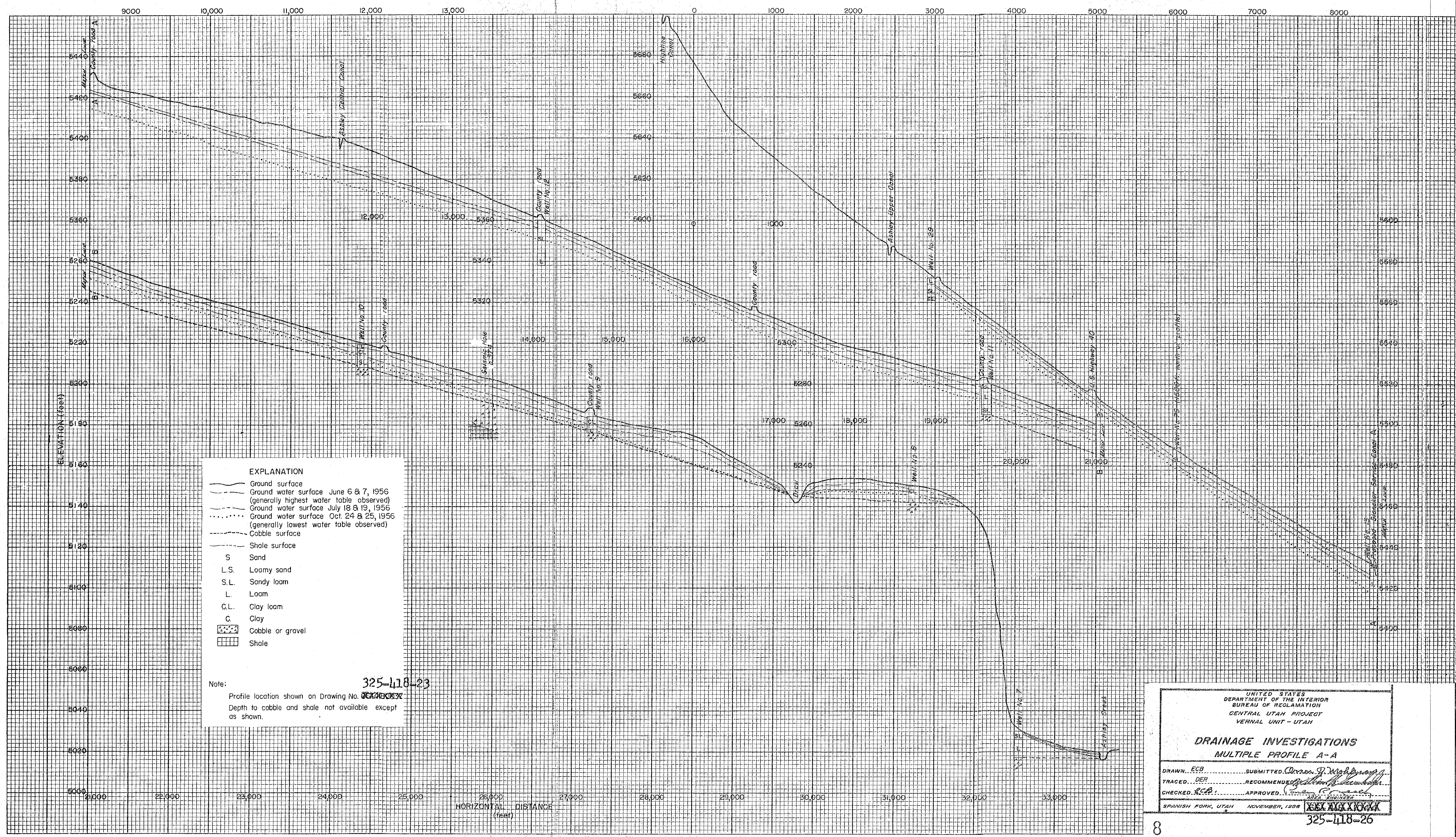
River Bottom area

The River Bottom area, as the name implies, embraces the present Ashley Creek flood plain and in its lower reaches is deeply entrenched below the general valley level. This area is underlain by Mancos shale at depths of 17 to 45 feet capped by 20 to 45 feet of coarse gravels. The soils over the gravels range in thickness from 0 to 5 feet, being generally thinner in the upper portion of the area north of Maeser and Vernal and thicker in the entrenched portions east of Vernal and Naples. The soils are alluvial in origin and are generally gravelly, particularly in the upper reaches.

Stanaker-Northeast slope area

The greater portion of this area consists of an alluvial fan with outwash from the Moenkopi and Morrison formations. This fan is of considerable depth, consisting of open-textured soil over cobble.

To the west of this fan is a small area with soils of medium depth, darker in color, medium to light texture over cobble.



ELEVATION (feet)
HORIZONTAL DISTANCE (feet)
County road A
Ashley Central Canal
County road
Well No. 12
Highline Canal
Ashley Upper Canal
Well No. 29
Well No. 10
Seismic Hole
County road
Well No. 5
Draw
Well No. 8
Well No. 11
U.S. Highway 40
Well No. 7
Ashley Creek
EXPLANATION
Ground surface
Ground water surface June 6 & 7, 1956 (generally highest water table observed)
Ground water surface July 18 & 19, 1956
Ground water surface Oct. 24 & 25, 1956 (generally lowest water table observed)
Cobble surface
Shale surface
S Sand
L.S. Loamy sand
S.L. Sandy loam
L. Loam
C.L. Clay loam
C. Clay
Cobble or gravel
Shale
Note:
Profile location shown on Drawing No. 325-418-23
Depth to cobble and shale not available except as shown.
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CENTRAL UTAH PROJECT
VERNAL UNIT - UTAH
DRAINAGE INVESTIGATIONS
MULTIPLE PROFILE A-A
DRAWN ECB
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SPANISH FORK, UTAH
NOVEMBER, 1956
325-418-26
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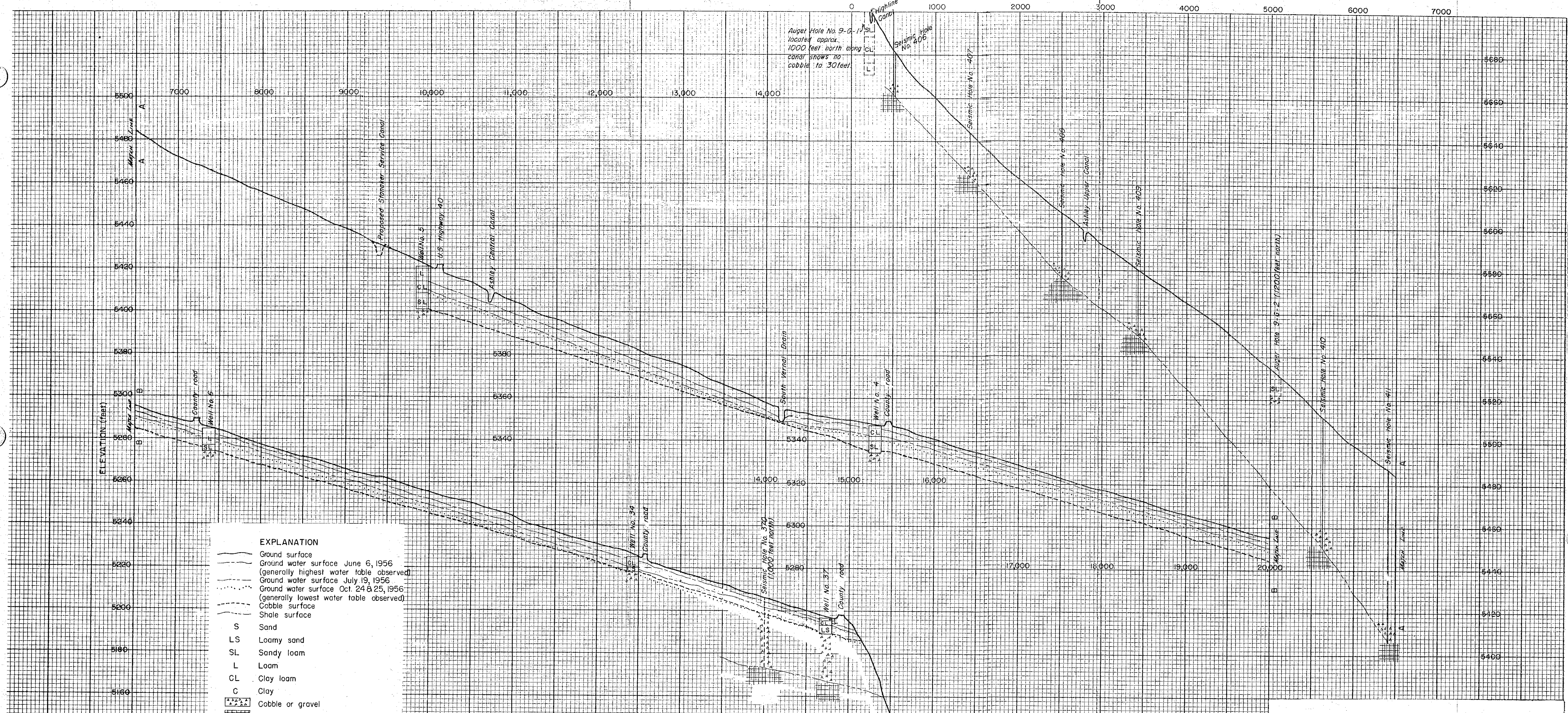

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VERNAL UNIT – UTAH

DRAINAGE INVESTIGATIONS
MULTIPLE PROFILE B-B

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TRACED DER — RECOMMENDED [signature]
CHECKED E.C.B. — APPROVED [signature] AREA ENGINEER

SPANISH FORK, UTAH NOVEMBER, 1956

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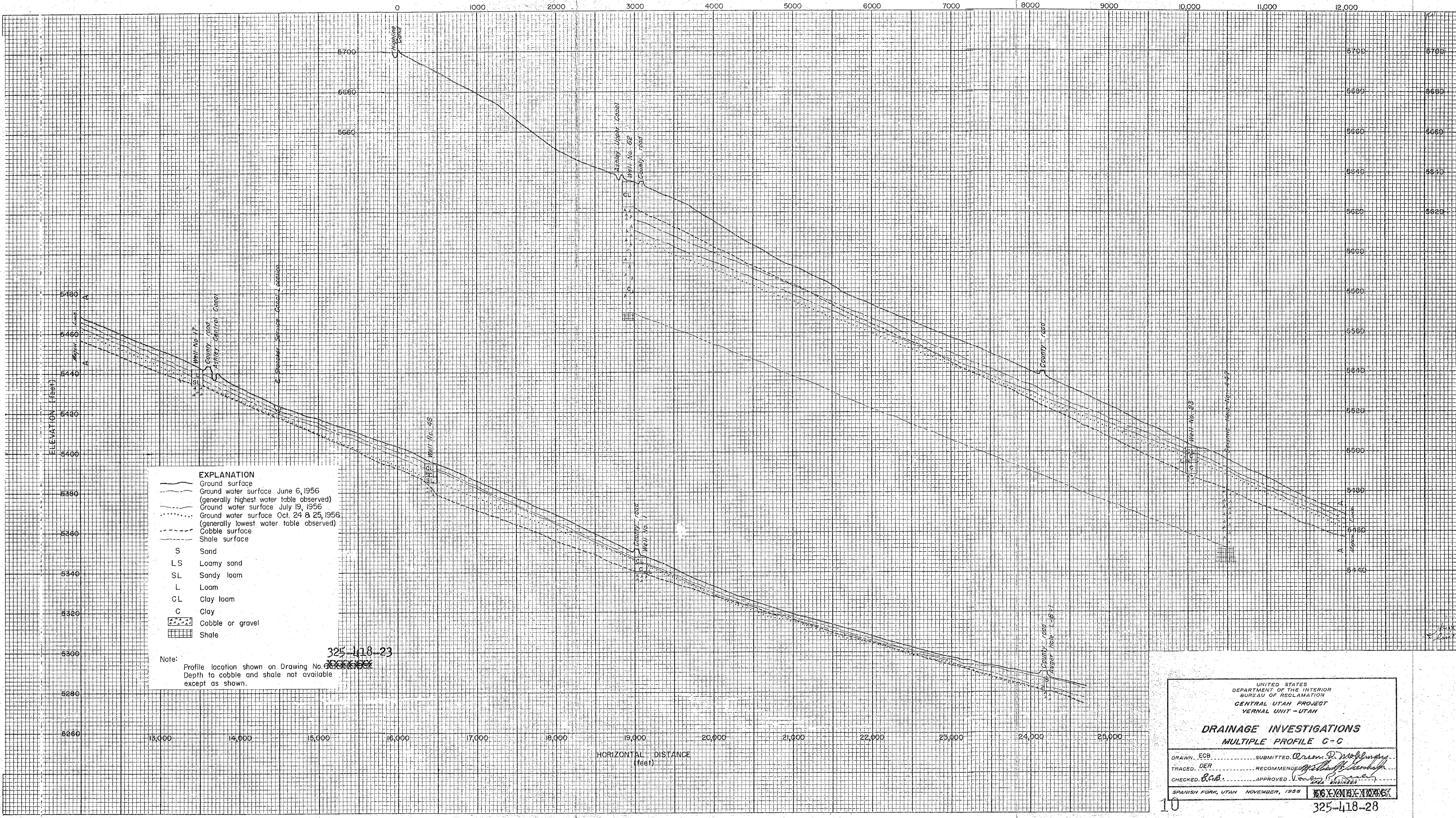

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BUREAU OF RECLAMATION
CENTRAL UTAH PROJECT
VERNAL UNIT – UTAH

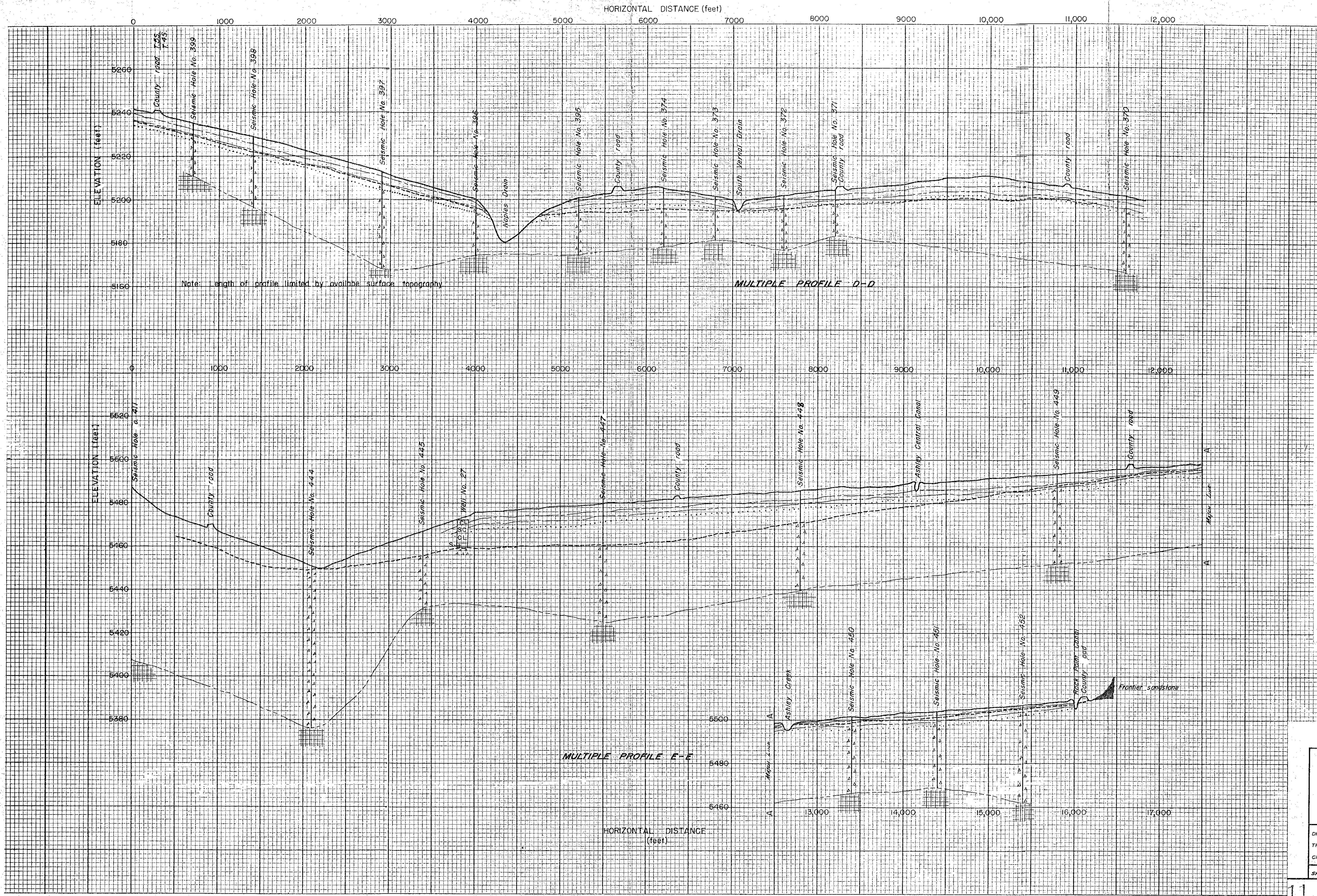
DRAINAGE INVESTIGATIONS
MULTIPLE PROFILE C-C

DRAWN ECB .... SUBMITTED Orson D. Wahlberg
TRACED DER .... RECOMMENDED [signature]
CHECKED E.A.B. .... APPROVED [signature] AREA ENGINEER

SPANISH FORK, UTAH NOVEMBER, 1956 ~~XXXXXXXX~~

10

325-418-28



EXPLANATION

Ground surface
Ground water surface June 6 & 7, 1956 (generally highest water table observed)
Ground water surface July 18 & 19, 1956
Ground water surface October 24 & 25, 1956 (generally lowest water table observed)
Cobble surface
Shale surface
S Sand
LS Loamy sand
SL Sandy loam
L Loam
CL Clay loam
C Clay
Cobble or gravel
Shale

Note:
Profile location shown on Drawing No. ~~66-418-103XX~~ 325-418-23
Depth to cobble and shale not available except as shown.

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VERNAL UNIT – UTAH

DRAINAGE INVESTIGATIONS
MULTIPLE PROFILES D-D & E-E

DRAWN ECB — SUBMITTED Orson D. Mohlgaard [signature]
TRACED DER — RECOMMENDED William H. Greenhalgh [signature]
CHECKED E.C.B. — APPROVED [signature] AREA ENGINEER

SPANISH FORK, UTAH NOVEMBER, 1956 | ~~66X418X104X~~
325-418-29

To the southeast of this fan lies an alluvial area derived from the Mancos shale hills located to the northeast. This alluvium is heavy-textured with a relatively slow permeability. No cobble was encountered in this area at depths of 30 feet.

Physiography and Topography

General

As previously described, Ashley Valley is a slightly elongated area approximately 15 miles long and 5 miles wide. The main stream traversing the valley is Ashley creek which enters from the northwest and flows through the valley to the southeast. The unit area is located principally in the upper or northwest two-thirds portion of Ashley Valley. The unit lands vary from smooth to rough, ranging in slope from 4 percent near the western boundary of the unit to 1 percent along portions of the river bottoms area. Ashley Creek, the major drainage way traversing the area, flows to the southeast while the minor drainage channels and swales slope from the west and southwest through the major portions of the unit area.

Maeser-Vernal area

The Maeser-Vernal area is located adjacent to and directly south of Ashley creek. These lands are relatively smooth and slope generally to the east with an average slope varying from 1 to 3 percent. The steeper slopes are located near the upper or western edge of the area directly east of Asphalt Ridge. There are at least two significant natural drainage ways, ranging in depth from 3 to 10 feet, traversing the area.

Naples area

The topography of the western 3/4 of this area is characterized by numerous long, narrow swales alternating with equally narrow ridges. These swales gradually increase in depth toward the lower or east end of the area. The general slope of the area is to the east and ranges from 3 to 7 percent. The lateral slopes of the swales range from 10 to 15 percent in the higher reaches of the area and from 15 to 20 percent in the lower reaches.

The eastern 1/4 of the Naples area is formed by three long, narrow river terraces paralleling Ashley Creek. These terraces are cut into short segments by the lower ends of the swales and drainages described above.

River Bottom area

This area encompasses the present flood plain of Ashley Creek. The upper and major portion of the area lying north of Vernal and Maeser has a general slope ranging from 1.5% to 2% in an easterly direction parallel to Ashley Creek. This portion of the area has little or no slope lateral to Ashley Creek, but is cut by numerous old stream channels producing a number of isolated low flat-topped ridges. The present channel of Ashley Creek is seldom over 5 feet deep.

The lower and smaller portion of the area lying east of Vernal and Naples is deeply entrenched and has a general slope of about 1% paralleling Ashley Creek.

Stanaker-Northeast slope area

This area forms the north boundary of the unit area. The central portion of this area lies on an alluvial fan at the mouth of Stanaker Draw. This fan has slope to the south of about 2% and is cut by a draw ranging from 5 to 20 feet in depth. The portion of the area immediately east of the Stanaker fan lies on a series of coalescent alluvial fans with a slope of 2% to 3% to the southwest to the Ashley Creek flood plain.

Ground Water Table

Sources contributing to the water table

Irrigation Practices

Present irrigation practices in the unit area is far from being ideal. Lacking storage facilities the farmers depend upon direct flow of Ashley Creek to supply their irrigation needs. High spring runoff for a period of about 3 weeks during April, May or June provides an over supply for irrigation requirements while late summer flows are inadequate to meet the needs for irrigation. Because of this situation the general practice is to divert for irrigation all of the available flows of Ashley Creek limited only by the combined capacity of the canals (approximately 700 cfs) serving the unit area. This practice results in a heavy contribution to the ground water as evidenced from the behavior of the ground water fluctuation cycle shown in the subsequent section on Ground Water Fluctuation.

Winter Season Diversions

The existing canals divert winter water from Ashley Creek for domestic and stockwater purposes to most of the rural areas within the unit boundary. The present practice is to divert all of the winter flows of Ashley creek amounting to an average of 10,000 acre-feet during the winter season for this purpose. These diversions are practically all lost through canal seepage and deep percolation to the underground water supplies.

Canal Losses

Supplies contributing to the water table from canal losses are also of major significance in the unit area. Observation of conditions along the canals indicate excessive leakage in a few localized areas bordering the Ashley Central and the Ashley Upper Canals. The most significant of these leakage areas is in Sections 28 and 29, T. 4S., R. 21 E., near observation well no. 29 where the Ashley Upper Canal passes over outcrops of soft, sandy shale and sandstone. Water table levels at this well are much higher than those observed in surrounding areas. Other excessive leakage along the Ashley Upper Canal is evidenced by high water tables principally in swale areas located immediately below the canal and scattered through the Naples area. (See Minimum Depth to Ground Water Map no. 325-418-51.)

Records of canal losses in the area are very meager and limited to seven short canal sections on three major canals serving the unit area. This investigation made by the Bureau of Reclamation was conducted during low water stages, August 23 to September 18, 1944. As these data are very meager and limited to one season during the low water period only, they should not be assumed to represent average conditions. It is probable that the total seepage is greater when the canal is operating at higher stages; however, the overall percentage loss, based on total diversions, would probably be smaller.

A summary of the canal losses determined during this investigation follows:

Name of canal	Canal section 1/	Length of sec. (mi.)	Avg. 2/ inflow to sec. (cfs)	Avg. 2/ loss in sec. (cfs)	Avg. 3/ loss per mi. (%)
Ashley Upper Canal	Sta. A to Sta. B	1.1	20.8	1.5	6.3
	Sta. B to Sta. C	1.3	22.3	2.2	7.7
Ashley Central Canal	Sta. A to Sta. B	1.5	24.8	1.0	2.7
	Sta. B to Sta. C	0.7	26.5	3.3	17.7
Rock Point Canal	Sta. A to Sta. B	1.5	15.6	0.7	3.0
	Sta. B to Sta. C	2.0	15.1	0.9	3.0
	Sta. C to Sta. D	1.6	14.1	1.3	6.0

1/ See Map No. 66-418-1037 for location of canal stations at which measurements were made.

2/ The average flows and losses shown are representative of 4 to 7 measurements made during the period August 23 to September 18, 1944.

3/ Percent loss based on inflow to section.

These data were also projected during the 1944 studies to include an overall seepage estimate for the full length of the respective canals assuming they were flowing at maximum capacity. The average losses under this condition, based on the gross diversion at the head of the canal, was estimated as shown on the following page.

Ashley Upper Canal	29%
Ashley Central Canal	28%
Rock Point Canal	14%

Assuming that the above losses are representative of the seepage problems in the area, a reduction in canal seepage by lining portions of canals, as subsequently explained, appears to be highly desirable as a more economic alternate to the construction of at least a portion of the drains required for the unit. Further study will be required to determine the canal sections which may require lining.

Precipitation

In general, direct precipitation on the unit lands is a minor source of ground water. This is evidenced by the long time precipitation record at the Vernal weather station which indicates an average annual precipitation of 8.52 inches (see record shown below) with about 65% occurring during the irrigation season. Ground water fluctuation charts show some evidence that water tables during March begin to rise as a result of local snow melt. Some flash rain storms also influence the water table as evidenced by the fluctuation charts during the late August 1955.

The mean monthly precipitation recorded at the Vernal Weather Station as taken from the Utah Climatological Data publications and the greatest 24-hour precipitation at this Weather Station for 52 years of record and recorded in Technical Paper No. 16, "Maximum 24-hour Precipitation in the United States", by the U. S. Department of Commerce, Weather Bureau, January 1952, Washington, D. C., is as follows:

Month	1926-1955 Mean Monthly (inches)		Greatest Precipitation in 24 hours (inches)
January	0.55		0.75
February	0.49		1.11
March	0.69		0.90
April	0.91		1.00
May	0.79		0.92
June	0.68		1.36
July	0.53		0.90
August	0.82		1.15
September	0.84		1.30
October	0.97		1.34
November	0.57		1.60
December	0.68		1.19
Total	8.52	Maximum Recorded	1.60

Floods

In general, floods are of two types--rain and snow melt. Such floods as occur from flash rainstorms are small in magnitude, of short duration, and are not considered to be a problem. Ashley Creek floods are confined almost entirely to those resulting from snow melt. These floods usually occur during the period May 1 to June 30 and are of about 3 weeks duration. The maximum flood flow of record on Ashley Creek near Vernal occurred in 1921 on May 29 when an instantaneous peak 2051 second-feet was recorded. From newspaper clippings and discussions with old residents in the area it was evident that this was the maximum flood since 1890. A flood of considerable magnitude occurred between 1880 and 1890 which caused Ashley Creek to change its course for a distance of about 8 miles. Ashley Creek has remained in this new channel except for minor changes since then.

These flood flows do not generally influence the water tables in areas outside of the River Bottoms area. Poor irrigation practices contribute to high water tables in the River Bottoms area and heavy applications are concurrent with the occurrence of floods.

Unit lands are few and scattered in the River Bottoms area and are generally located from 2 to 4 feet higher topographically than surrounding areas. Such areas are thus protected from small and medium flood flows.

Artesian Leakage

At the present time there have been no piezometers installed to determine possible artesian leakage; however, the data acquired from installing drainage test wells gave no evidence of artesian pressures. The rapid fluctuation of the water table in phase with the irrigation cycle as shown by the ground water fluctuation charts, pages 22 and 23, gives evidence that artesian pressures are not present. On the other hand, the geologic formation and topographic situation is favorable for a shallow artesian effect. See Multiple Profile B-B, Drawing No. 325-418-27. This profile shows that the cobble aquifer decreases in thickness down the moderately steep slopes and is confined by the less permeable overlying loams. Such condition could give rise to upward leakage during periods when the aquifer is overloaded.

Further investigation should be made to determine conclusively the effect, if any, of artesian leakage in the area.

Investigations

In November 1954, a preliminary subsurface exploration was made using a 4-inch power auger. Fifty-one holes were drilled on a one-half to one mile grid. From the above exploration detailed plans were made for installing water table observation wells and for further exploration. It was evident that the 4-inch power auger could not be used for well installation or deep exploration over much of the area where cobbles and gravels were encountered. A 21-inch bucket-type power auger was tried in these areas with but little success. A tractor-mounted backhoe, the only backhoe available, was next tried, and although a large machine would have been desirable, it would excavate from 8 to 10 feet and permitted the installation of wells in the cobble area. A limited number of holes were drilled with a cable tool rig through the cobbles to shale but this method was slow and expensive. Later at a time when a power auger was not available, a $3\frac{1}{2}$" hand auger was used to install wells in an area where cobbles were not encountered.

A total of 71 wells were installed, 16 during July 1955, using the 4" power auger, 8 during December 1955, with the 21" power auger, 27 during April and May 1956, using the backhoe, 5 during June 1956, using cable tool rig, and 15 during June 1956, using the hand auger.

All but two of the wells were cased with 3" perforated downspout. The remaining two wells which were drilled to 40 and 65 feet with a cable tool rig were cased with $2\frac{1}{2}$" x $\frac{1}{4}$ perforated steel well casing. All 3" downspout was backfilled with pea gravel and a concrete collar set around the casing at ground surface to anchor the casing and seal out surface water. Each well was equipped with an insert-type metal cap.

Well Observations

Well observations have been made at 2-week intervals during the April to August period and at 4-week intervals during the period September to March. The future well observation program during the heavy irrigation season includes a semi-weekly observation on all wells and a daily observation schedule on wells within the portion of the unit which appears to be the drainage problem area.

Study and Interpretation of Data

Depth to ground water, ground water contour maps, multiple profiles, ground water fluctuation charts, and a hydrograph at Ashley Creek at "Sign of Maine" were used in the study of the ground water characteristics.

Extent and depth to water table

General

High water tables occur for only a few days during the spring months of April, May or June when Ashley Creek is at high flood stages which lasts for about the 3-week period as previously mentioned under Irrigation Practices. Observation of minimum water depths for the unit area as determined from the established wells for the period

May 23 to June 7, 1956, is shown at 2-foot intervals on Maps Nos. 325- -418-50 and -51. The depth to ground water on approximately 3/5 of the unit area is greater than 5 feet. In the remaining unit area the water table appears to be less than 5 feet during the months of April, May or June for about a 3-week period.

The extent and depth to water for each area follows:

Maeser-Vernal Area

Approximately 1/2 of the land in this area, or 4,400 acres, has minimum depths to ground water of greater than 5 feet. In the remaining area approximately 2,900 acres are subject to a prevailing depth to water of 3 to 5 feet during the heavier irrigation season for a period of about 3 weeks and minimum depths of 2 to 4 feet, lasting only a few days. About 1,500 acres are subject to a prevailing depth to water of 2 to 3 feet during the heavier irrigation season for a period of about 3 weeks and minimum depths of 1 to 2 feet lasting only a few days. Following the heavy irrigation application the water table recedes to depths generally greater than 5 feet during the remainder of the year for the entire area. Irrigable lands included in this area which have high water tables are economically feasible to drain. Other lands within the area subject to high water tables are in permanent pasture classes and are not generally economically feasible to drain.

Naples Area

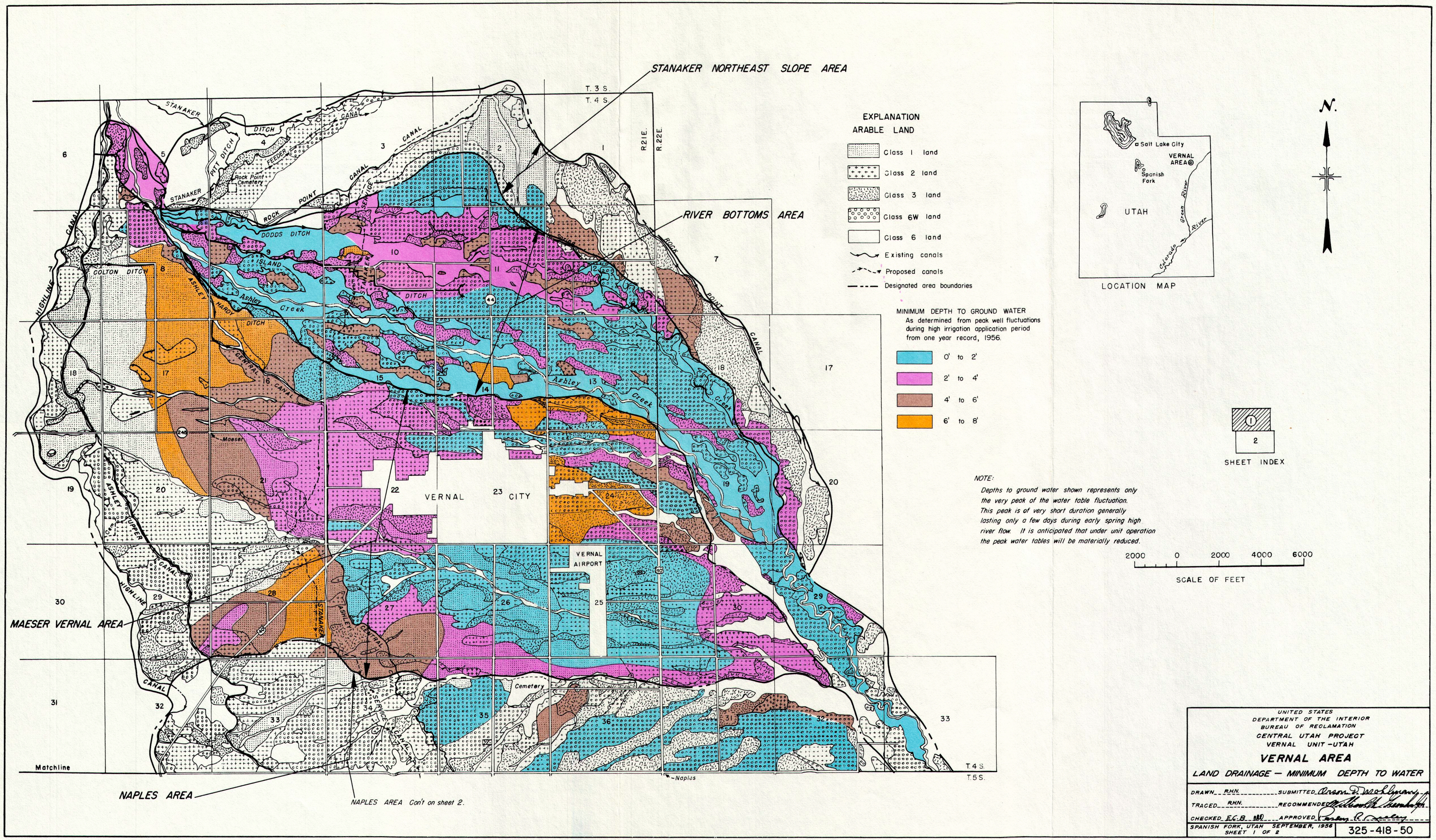
Unit lands (Classes 1-3) in this area are generally not affected by high water tables.

Available depth to water table data in this area shows that only about 1/7 of the area, or 1,370 acres, is affected by high water tables with prevailing depths to water of 2 to 3 feet during the heavier irrigation season for a period of about 3 weeks and minimum depths of 1 to 2 feet lasting only a few days. Following the heavy irrigation application the water table recedes to depths generally greater than 4 feet during the remainder of the year. These lands are in the permanent pasture class and are generally located in swales and scattered throughout the area. Drainage is not generally economically feasible on these lands.

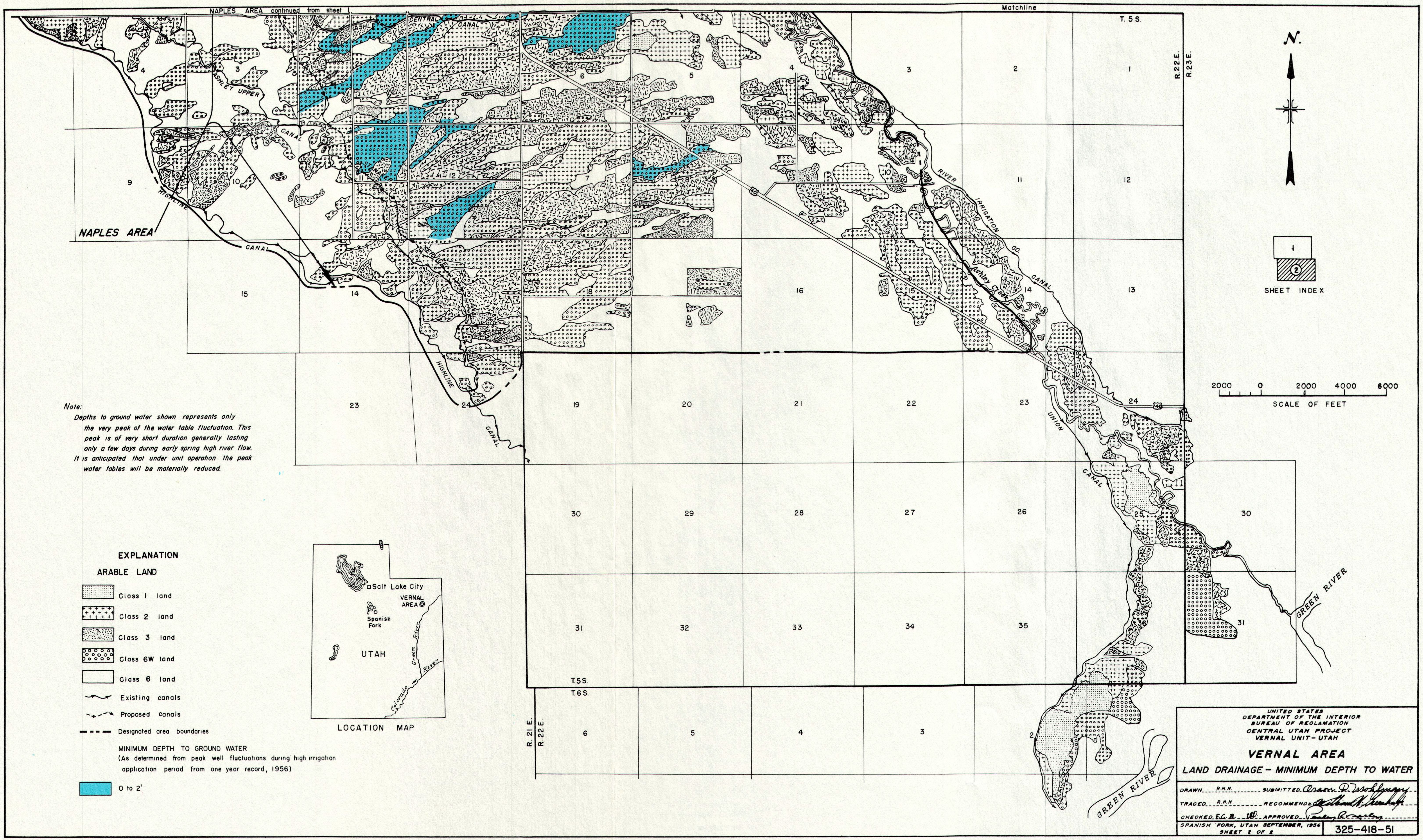
River Bottoms Area

Unit lands (Classes 1-3) in this area are generally located, topographically, 2 to 4 feet above surrounding areas and are not affected by high water tables which might impair the productivity contemplated in the land classification as shown.

Approximately 2/3 of the area, or 2,000 acres, have water tables with minimum depths of less than 4 feet for a period of about 3 weeks



STANAKER NORTHEAST SLOPE AREA
RIVER BOTTOMS AREA
MAESER VERNAL AREA
NAPLES AREA
NAPLES AREA Con't on sheet 2.
Matchline
T. 3 S.
T. 4 S.
T. 4 S.
T. 5 S.
R 21 E.
R 22 E.
STANAKER
DITCH
PITT DITCH
FEEDER
CANAL
STANAKER
Rock Point Cemetery
ROCK POINT
DODDS DITCH
ISLAND
COLTON DITCH
HIGHLINE
CANAL
ASHLEY
HARDY
DITCH
Ashley Creek
CENTRAL
CANAL
Maeser
ASHLEY UPPER
HIGHLINE
CANAL
ROCK POINT
CANAL
VERNAL CITY
VERNAL AIRPORT
Cemetery
Naples
STANAKER
EXPLANATION
ARABLE LAND
Class 1 land
Class 2 land
Class 3 land
Class 6W land
Class 6 land
Existing canals
Proposed canals
Designated area boundaries
MINIMUM DEPTH TO GROUND WATER
As determined from peak well fluctuations during high irrigation application period from one year record, 1956.
0' to 2'
2' to 4'
4' to 6'
6' to 8'
Salt Lake City
VERNAL AREA
Spanish Fork
UTAH
Green River
Colorado River
LOCATION MAP
N.
SHEET INDEX
1
2
NOTE:
Depths to ground water shown represents only the very peak of the water table fluctuation. This peak is of very short duration generally lasting only a few days during early spring high river flow. It is anticipated that under unit operation the peak water tables will be materially reduced.
2000 0 2000 4000 6000
SCALE OF FEET
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL UTAH PROJECT
VERNAL UNIT – UTAH
VERNAL AREA
LAND DRAINAGE — MINIMUM DEPTH TO WATER
DRAWN R.H.N. SUBMITTED Orson D. Wohlman
TRACED R.H.N. RECOMMENDED William W. Greenhalgh
CHECKED E.C.B. APPROVED
SPANISH FORK, UTAH SEPTEMBER, 1956
SHEET 1 OF 2
325 - 418 - 50


NAPLES AREA continued from sheet
Matchline
T. 5 S.
R. 22 E.
R. 23 E.
N.
ASHLEY UPPER
CANAL
CENTRAL CANAL
HIGHLINE
NAPLES AREA
CANAL
HIGHLINE
CANAL
RIVER IRRIGATION CO. CANAL
Ashley Creek
UNION CANAL
GREEN RIVER
GREEN RIVER
T. 5 S.
T. 6 S.
R. 21 E.
R. 22 E.
SHEET INDEX
2000 0 2000 4000 6000
SCALE OF FEET
Note:
Depths to ground water shown represents only the very peak of the water table fluctuation. This peak is of very short duration generally lasting only a few days during early spring high river flow. It is anticipated that under unit operation the peak water tables will be materially reduced.
EXPLANATION
ARABLE LAND
Class 1 land
Class 2 land
Class 3 land
Class 6W land
Class 6 land
Existing canals
Proposed canals
Designated area boundaries
MINIMUM DEPTH TO GROUND WATER
(As determined from peak well fluctuations during high irrigation application period from one year record, 1956)
0 to 2'
Salt Lake City
VERNAL AREA
Spanish Fork
UTAH
Green River
Colorado River
LOCATION MAP
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL UTAH PROJECT
VERNAL UNIT - UTAH
VERNAL AREA
LAND DRAINAGE - MINIMUM DEPTH TO WATER
DRAWN R.H.H. SUBMITTED
TRACED R.H.H. RECOMMENDED
CHECKED APPROVED
SPANISH FORK, UTAH SEPTEMBER, 1956
SHEET 2 OF 2
325-418-51

20

duration which represents the peak irrigation diversion period during April, May or June. Those lands within the area, approximately 1,600 acres, which are subject to a prevailing depth to water of 1 to 3 feet during the heavier irrigation season of about 3 weeks period and a minimum depth of 0 to 2 feet lasting for only a few days are in the permanent pasture class and drainage for this area would be economically infeasible.

Stanaker-Northeast Slope Area

Unit lands (Class 1-3) in this area are generally not affected by high water tables.

Only 10 percent of the area or 190 acres, are subject to a prevailing depth to water of 2 to 4 feet during the heavier irrigation season of about 3 weeks period and minimum depths of 1 to 3 feet lasting only a few days. These lands are in the permanent pasture class as drainage would be economically infeasible to provide.

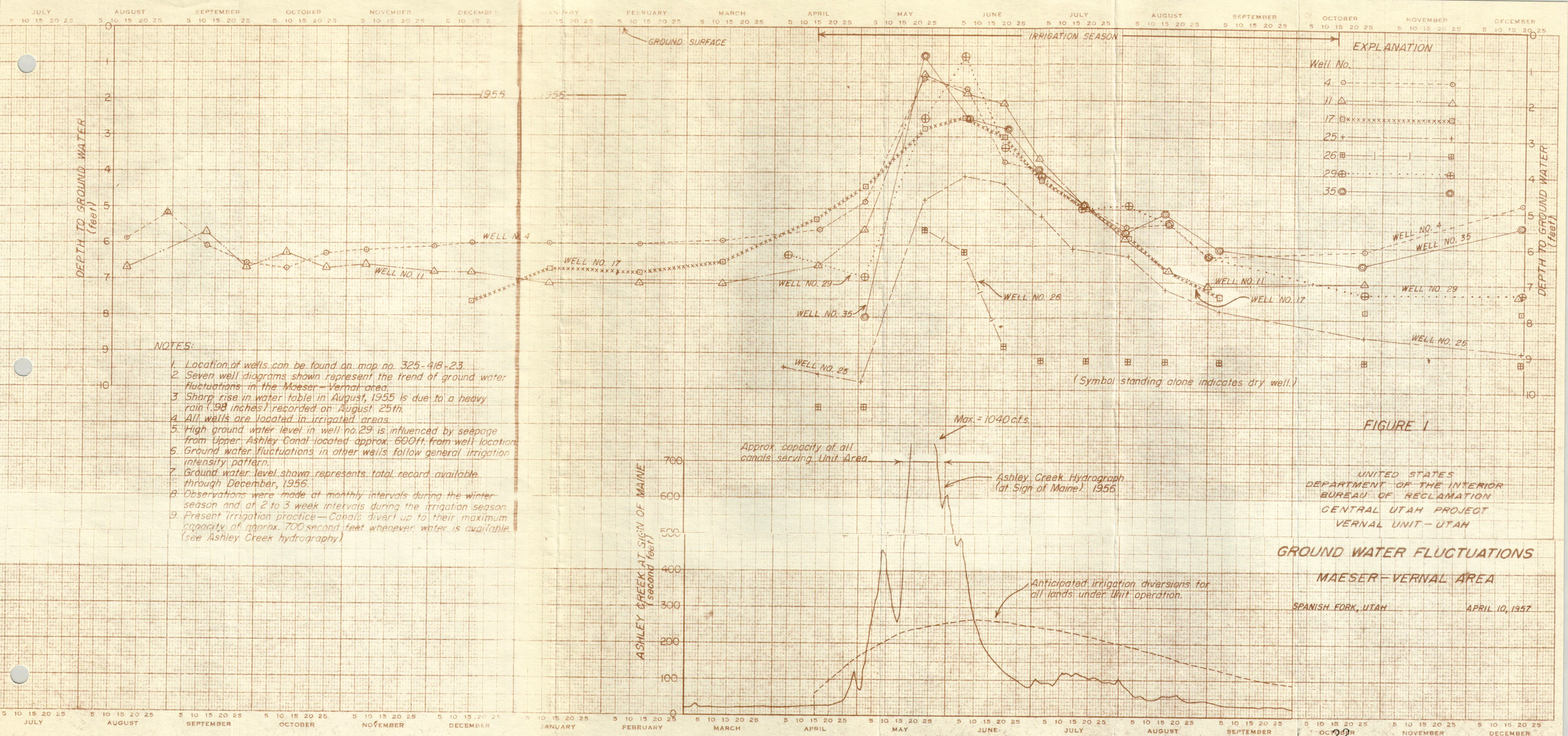
Fluctuation of water table

In general, the fluctuation of the ground water levels follows the same cycles during the year throughout the unit area. The fluctuation cycle of the water table is generally in phase with irrigation application in the area. Examples of the fluctuation cycles are shown in Figure I, Ground Water Fluctuations, Maeser-Vernal area and in Figure II, Ground Water Fluctuations in the Naples, River Bottoms and Stanaker-Northeast Slope areas.

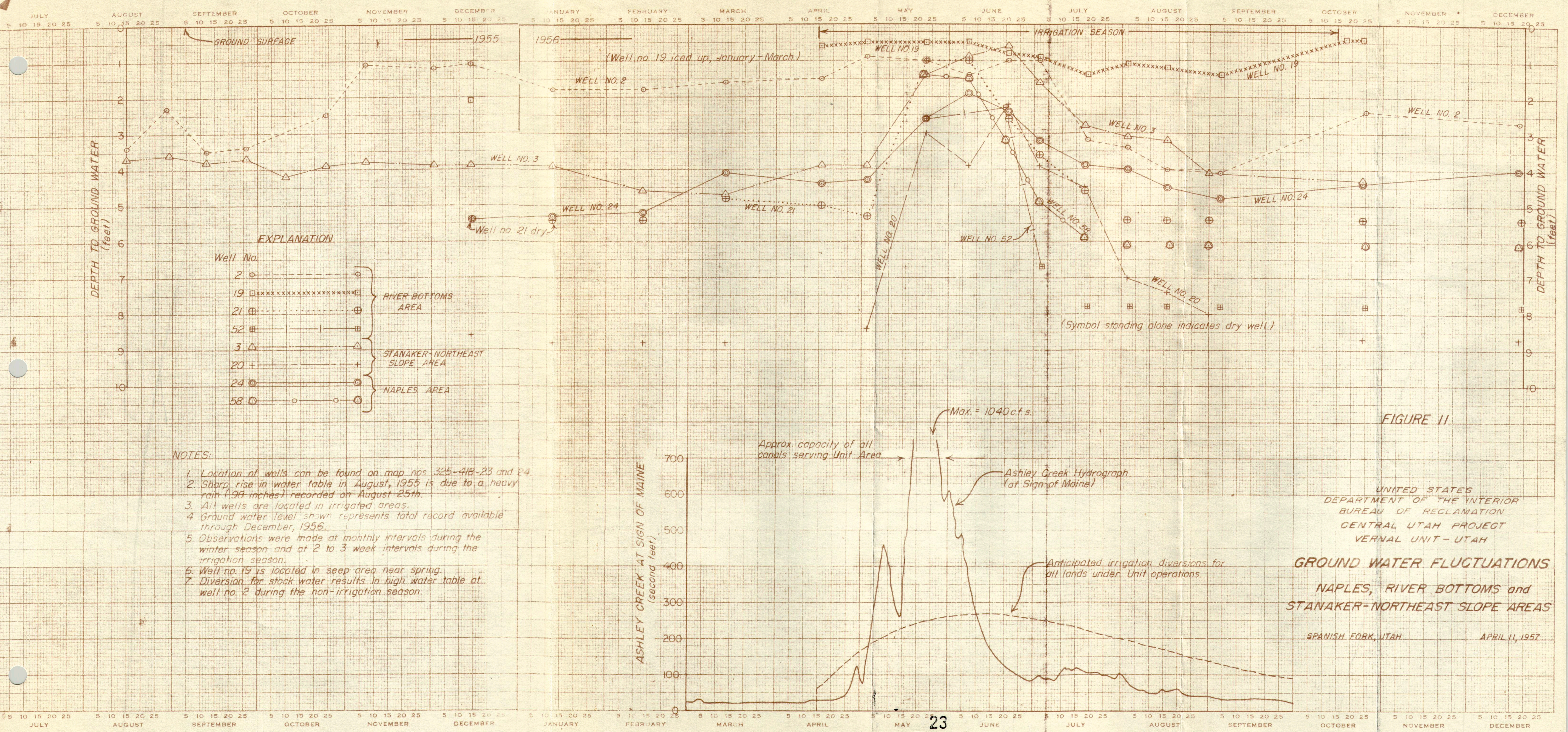
Maeser-Vernal Area

The water table fluctuation cycle in this area is illustrated by water table data from 7 observation wells as shown in Figure I. Also shown on these fluctuation graphs is the Ashley Creek Hydrograph limited by 700 second-feet (the approximate combined canal capacities serving the unit area) which represents the present irrigation diversion practice. For purposes of comparison, the anticipated irrigation diversion pattern for all lands with the unit in operation is also shown in this chart.

From inspection of these graphs it is noted that the water table rises from a low beginning the first part of May to a high near the latter part of May and recedes to safe depths by approximately the first of July. It is significant also that these rises parallel the Ashley Creek hydrograph and the recessions lag the hydrograph by approximately 2 weeks. The increased distance from the canal to well location does not seem to affect the period of lag. Although the topographical and geological situation within the area is favorable to a change in fluctuation characteristics between wells located in the upper and the



GROUND SURFACE
IRRIGATION SEASON
EXPLANATION
Well No.
4
11
17
25
26
29
35
1955
1956
DEPTH TO GROUND WATER (feet)
WELL NO. 4
WELL NO. 11
WELL NO. 17
WELL NO. 25
WELL NO. 26
WELL NO. 29
WELL NO. 35
(Symbol standing alone indicates dry well.)
NOTES:
1. Location of wells can be found on map no. 325-418-23.
2. Seven well diagrams shown represent the trend of ground water fluctuations in the Maeser-Vernal area.
3. Sharp rise in water table in August, 1955 is due to a heavy rain (.98 inches) recorded on August 25th.
4. All wells are located in irrigated areas.
5. High ground water level in well no. 29 is influenced by seepage from Upper Ashley Canal located approx. 600 ft. from well location.
6. Ground water fluctuations in other wells follow general irrigation intensity pattern.
7. Ground water level shown represents total record available through December, 1956.
8. Observations were made at monthly intervals during the winter season and at 2 to 3 week intervals during the irrigation season.
9. Present irrigation practice—Canals divert up to their maximum capacity of approx. 700 second feet whenever water is available (see Ashley Creek hydrography)
Max. = 1040 c.f.s.
Approx. capacity of all canals serving Unit Area
Ashley Creek Hydrograph (at Sign of Maine) 1956
Anticipated irrigation diversions for all lands under Unit operation.
ASHLEY CREEK AT SIGN OF MAINE (second feet)
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
FIGURE 1
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL UTAH PROJECT
VERNAL UNIT—UTAH
GROUND WATER FLUCTUATIONS
MAESER-VERNAL AREA
SPANISH FORK, UTAH
APRIL 10, 1957



GROUND SURFACE
1955
1956
(Well no. 19 iced up, January - March)
IRRIGATION SEASON
WELL NO. 19
WELL NO. 2
WELL NO. 3
WELL NO. 24
WELL NO. 21
WELL NO. 20
WELL NO. 58
WELL NO. 52
(Well no. 21 dry)
(Symbol standing alone indicates dry well.)
DEPTH TO GROUND WATER (feet)
EXPLANATION
Well No.
2
19
21
52
3
20
24
58
RIVER BOTTOMS AREA
STANAKER-NORTHEAST SLOPE AREA
NAPLES AREA
Max. = 1040 c.f.s.
Approx. capacity of all canals serving Unit Area
Ashley Creek Hydrograph (at Sign of Maine)
Anticipated irrigation diversions for all lands under Unit operations.
ASHLEY CREEK AT SIGN OF MAINE (second feet)
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
NOTES:
1. Location of wells can be found on map nos. 325-418-23 and 24.
2. Sharp rise in water table in August, 1955 is due to a heavy rain (.98 inches) recorded on August 25th.
3. All wells are located in irrigated areas.
4. Ground water level shown represents total record available through December, 1956.
5. Observations were made at monthly intervals during the winter season and at 2 to 3 week intervals during the irrigation season.
6. Well no. 19 is located in seep area near spring.
7. Diversion for stock water results in high water table at well no. 2 during the non-irrigation season.
FIGURE 11
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL UTAH PROJECT
VERNAL UNIT - UTAH
GROUND WATER FLUCTUATIONS
NAPLES, RIVER BOTTOMS and
STANAKER-NORTHEAST SLOPE AREAS
SPANISH FORK, UTAH
APRIL 11, 1957

lower lands, such changes are not evidenced by the ground water fluctuation charts.

While a full year's record is not available on all wells, the rise and fall in water levels from minimum to maximum as indicated by the available records range from 0.6 to over 10 feet and average about 4.5 feet for the Maeser-Vernal area. The average rate of rise is about .08 feet per day and varies from .02 feet to .19 feet per day. The average rate of fall is about .09 feet per day and ranges from .01 to .27 feet per day.

Some ground water fluctuations not shown but which are representative of the upper portion of this area are indicated by the fluctuation of Wells No. 61 and 62. Depths to water tables at these wells range from a maximum of 26.7 feet to a minimum of 19 feet. Also, not shown on the fluctuation charts are water surface variations for Wells No. 4 and 11, located south of Vernal, which show a water table rise in October. This is due to a late-season diversion for stock water which influences surrounding water tables. (Additional details are shown on Fluctuation Chart, Figure I.)

Naples Area

The water table fluctuation in this area generally follows the irrigation cycle as is shown by the water level fluctuations at Wells No. 24 and 58 located in this area. (See Fluctuation Chart, Figure II.)

The rise and fall in water levels from minimum to maximum as indicated by the available records range from 1.8 to 6.8 feet and average about 4.5 feet for the Naples area. The average rate of rise is about .12 feet per day and varies from .04 feet to .35 feet per day. The average rate of fall is about .08 feet per day and ranges from .03 to .11 feet per day.

River Bottoms Area

In part of this area the yearly water table fluctuation departs from the irrigation cycle, remaining relatively high over much of the year, showing less drop at the end of the irrigation season and a secondary rise in the late fall, as illustrated by the graphs of Wells No. 2 and 19, Figure II. This is attributed to two factors: first, much of the area is used for fall and winter pasturage and the canals and ditches are filled with stock water during this time; second, there are two groups of small springs in Sections 10 and 3 that have been developed for irrigation and which provide a continuous contribution to ground water.

The rise and fall in water levels from minimum to maximum as indicated by the available records range from 1 to 7 feet and average about

4 feet for the River Bottoms area. The average rate of rise is about .04 feet per day and varies from .01 feet to .21 feet per day. The average rate of fall is about .08 feet per day and ranges from .01 to .34 feet per day.

Stanaker-Northeast Slope Area

Ground water fluctuations at Wells No. 3 and 20 shown on Figure II represent conditions along the lower fringe of this area. These fluctuations also follow the irrigation pattern as previously indicated. Although there are no observation wells to determine water fluctuations along the upper portions of this area, deep auger hole data indicates that the depth to water in this area is in the neighborhood of 20 to 30 feet.

The rise and fall in water levels from minimum to maximum as indicated by the available records range from 2 to 7 feet and average about 4 feet for the Stanaker-Northeast Slope area. The average rate of rise is about .08 feet per day and varies from .02 feet to .26 feet per day. The average rate of fall is about .08 feet per day and ranges from .05 to .12 feet per day.

Movement of water table

A comparison of the subsurface ground water contours and the ground surface contours in the areas where both are available, as evidenced by Map Nos. 325-418-23 and -24, show that they practically parallel each other, indicating that the ground water flows at right angles to the ground surface contours.

Probable conditions under unit operations

Under unit operation it is anticipated that water users will cooperate in adopting more efficient irrigation practices. Efficiency to a limited degree will be imposed of necessity by the unit operation as most of the surplus or excess water will be diverted to the unit reservoir. It is anticipated that unit operation may mitigate many of the present drainage problems. This would be accomplished as previously indicated by shifting the irrigation distribution from the present diversion pattern, of diverting all of the Ashley Creek flow during the high water period of about 3 weeks in April, May or June, to the ideal requirement distribution as proposed under unit operation and lining of a portion of the existing major canals. The total seasonal diversion would be approximately the same under either condition.

A percentage comparison of the monthly diversion distribution for present versus unit conditions is shown on the following page.

Irrigation diversion distribution (percent)

	April	May	June	July	Aug.	Sep.	Oct.	Total
Present 1/	5	47	25	11	7	3	2	100
Proposed under unit operation	5	17	20	23	18	12	5	100

1/ Represents flow of Ashley Creek (1956 record) limited by 700 s.f. or combined capacity of canals.

It is impossible to estimate the present average delivery per acre to unit lands as there are many classes of water rights which affect, to varying degrees, the irrigation of lands in the unit area.

With the unit in operation the anticipated monthly farm delivery, per acre, for unit lands will be as follows:

	April	May	June	July	August	Sept.	Oct.	Total
A.F./acre	0.14	0.52	0.61	0.70	0.55	0.36	0.15	3.03

Under unit operation it is anticipated that the average conveyance losses for all canals serving the unit area would be approximately 18 percent of the gross diversion at the head of the canals. Based on this estimate, the annual diversion per acre for unit lands would be 3.7 acre-feet with 0.67 acre-feet per acre charged to seepage and administrative losses from the canals.

A water savings pipe line system is included in the unit plan which will replace canal diversions during the winter season for culinary and stock water uses. This, together with other water conservation measures shown, will result in a favorable effect on ground water tables.

The proposed Stanaker Service Canal will replace Ashley Central Canal from a point approximately northwest of Vernal where these two canals intersect for a distance of approximately 3 miles to the point where the Ashley Central Canal turns eastward toward Naples. An overall reduction in seepage losses would result as the Stanaker Service Canal will be lined to prevent excessive leakage.

The unit costs include funds for lining portions of existing canals in sections which contribute to the drainage problem.

It is concluded that the design and construction of the drainage system should be deferred until the effect of increased irrigation efficiency and reduced canal seepage is made manifest under unit operation.

Salinity and Alkalinity

General

In general, the unit lands are relatively free of salinity and alkalinity in amounts which are detrimental to the growth of most irrigated crops. The soluble salts which are present in applicable amounts are usually found in areas of impeded drainage, and are practically all neutral salts. Alkalinity is not a problem in the Vernal Unit.

Maeser-Vernal area

The major part of the Maeser-Vernal area is unaffected by salinity and alkalinity. The results of the laboratory analysis show no appreciable concentrations of total soluble salts in most of the area. There are, however, a few very shallow swales, about 1 to 3 feet deep, scattered throughout the area where drainage is somewhat restricted. These swales, which are wet enough to support a good growth of grass most of the year, contain relatively high concentrations of neutral salts.

Naples area

There are places in the Naples area where the drainage water moves laterally over the underlying shale layers and reaches the surface in swales and draws, bringing with it varying amounts of salt. The drainage water then evaporates rapidly, leaving an accumulation of neutral salts. Only a small part of the Naples area is affected with excessive salt concentrations, and these areas support a fair growth of salt-tolerant grasses. The majority of the cultivated lands are free of high water tables and have a low salinity and alkalinity content.

River Bottoms area

In the River Bottoms area the soil is very shallow over rock and cobble. The texture of the soil is light and the permeability is good to excessive. Visible evidence and laboratory analysis indicate no excessive accumulations of salinity or alkalinity.

Stanaker-Northeast Slope area

Most of the Stanaker-Northeast Slope area is also free from high salinity and alkalinity concentrations. Here, as in other sections of the unit, the close relationship between poor drainage and accumulations of soluble salt is evident. The areas of high salinity are relatively small and are located for the most part along the southern fringe of the area.

It is almost certain that no serious salt problems will occur in any of the areas with unit development because of the good drainability of the soil.

Salinity and alkalinity has been discussed in more detail in the Unit Lands Appendix.

Drainability of Subsoil and Substrata

Investigations

Subsurface Explorations

The occurrence of cobble and gravel under most of the unit area made deep subsurface exploration particularly difficult and limited the amount of information that could be obtained. As discussed in the preceding pages on Ground Water Table Investigations, several methods of drilling were employed and backhoe excavation was found to be the only practical means of penetrating the cobble layer for well installation. However, the depths that can be penetrated by a backhoe are limited by practical considerations as well as by the size of the machine in a developed area due to the size of the excavation. The number of holes that can be put down by cable tool is limited by the time and expense involved in this method. Four weeks or 640 man-hours were required to drill five holes totaling 218 linear feet of hole.

Fortunately, information on the depth to shale was made available by the Pure Oil Company who kindly furnished the logs on 56 seismic exploration holes drilled recently in Ashley Valley.

A total of 123 holes, varying in depth from 5 to 65 feet, including those in which wells were installed, were put down.

All holes were logged in accordance with land classification textural classes. Samples were taken from each hole of every textural class and color change, including samples of the matrix of the cobbles in the backhoe excavations.

Permeability Studies

Permeability tests were made on approximately 140 disturbed samples including 42 samples of the material from the cobbles smaller than a No. 4 U. S. Standard Screen.

Attempts were made to measure permeability in the field by running recovery tests on 11 observation wells, 9 of which were to the cobbles, 1 which bottomed 10 feet in sandy loam, and 1 which bottomed

15 feet in loam. A bailer made from a section of 2" electrical conduit fitted with a leather foot valve was used to bail the hole. However, the rate of recovery in all the holes was so rapid that an accurate measurement could not be obtained with tape and stop watch. Thus far there has not been an opportunity to use a pump, electrical sonde and stop watch, which method should enable a measurement of the rate of recovery.

Permeability of soils and subsoils is good as indicated by the following correlation of the soil texture to permeability rate. The following results are taken from samples collected from test wells Nos. 30 to 71, inclusive, and are representative of the entire Vernal unit.

Soil Texture	Permeability Variation (in. per hr.)	Average Permeability (in. per hr.)
Sand (Matrix in Cobble)	13.27 to 1.24	5.98
Loamy Sand	10.10 to .95	2.16
Sandy Loam	1.46 to .46	.74
Loam	1.40 to .21	.56
Clay Loam	1.24 to .20	.54

A wide variation in permeability was caused by conditions under which samples were collected. Many were in a wet and puddled condition which tends to break down the natural structure, causing slow permeability rate.

Subsoil and substrata permeability

General

Soils in the Vernal Unit have been discussed in considerable detail in the land classification appendix. A brief discussion of soils as they pertain to the drainage problem follows:

The fine-textured alluvium varies in depth from about 3 to 20 feet underlain in the majority of the area with a layer of cobble which varies from about 15 to 40 feet in thickness. The entire unit has an underlying substrata or bedrock of Mancos shale.

Maeser-Vernal Area

In the upper and central portion of the area the soils and fine-textured substrata are found to be about 20 feet in thickness. A cobble layer underlies the majority of the area, which varies in thickness from about 40 feet in the central portion to nonexistant at the upper portion near Asphalt Ridge. Moving down the slope from the central portion the soils and fine-textured substrata become thinner. At the escarpment adjacent to Ashley Creek there is about 8 feet of soil and fine textural substrata over cobble. The cobble in this area is about 16 feet in thickness.

In the general vicinity of Vernal the thickness of the fine-textured alluvium over cobble varies from about 5 feet adjacent to Ashley Creek north of Vernal to approximately 15 feet near the Naples drain south of Vernal.

The entire Maeser-Vernal area is underlain with Mancos shale.

River Bottoms Area

The upper portion of this area has a sandy loam to loamy sand over cobble. The majority of the upper portion is shallow over cobble; however, there are some scattered areas which have deeper soil and subsoil. These vary from 2 to 5 feet in depth. This is underlain with well-rounded unassorted cobble having a sand matrix. The cobble varies from 20 to 45 feet in thickness.

As Ashley Creek entrenches about due east of Vernal the soil and subsoil is deeper and varies from 3 to 5 feet over cobble. The texture of the entrenched area varies from sandy loam to loam. The cobble in the entrenched portion of the area is smaller in size and shallower in thickness, varying from 17 to 30 feet.

Naples Area

This area has a wide variation in depth to shale, sandstone and cobble. The swales have eroded down through the cobble into the shale. There is a mantle of silty clay loam to loam of about 6 feet depth over-lying the Mancos shale. The ridges have a mantle of 3 feet of loam to sandy loam over cobble. In the upper portion of the area near Asphalt Ridge there is about 3 feet of sandy loam to loam over sandstone or shale.

Stanaker-Northeast Slope Area

Soils and fine alluvial substrata in this area consist of loam to clay. North of Vernal City just below Stanaker Draw, an alluvial fan has developed. This is somewhat stratafied, of medium to heavy textured alluvium over cobble. Cobble is encountered at about 20 feet on this fan. The northeast slope portion to the southeast of the fan is heavy-textured clay loam to clay to about 8 feet. Stratified clay, sandy loam and sand is then encountered to about 30 feet below the surface. Cobbles were not encountered in this portion of the area. To the west of the Stanaker alluvial fan is a narrow strip extending to the west. This portion has a soil and substrata of loam to sandy loam intermixed with some gravel. These materials are underlain with cobbles in the lower portion and sandstone in the upper portion to the north.

Barrier strata and special formations

The underlying Mancos shale forms a barrier that practically stops all downward percolation.

A barrier formation of a different type occurs around the margins of the escarpments east of Vernal and presumably in the banks of the deeper natural drainages. This barrier consists of cemented gravels and cobbles. This seems to have been formed as a hardpan by evaporation from the water table surface and from the land surface which precipitates calcium carbonate and other salts in the interstices of the gravels. This barrier has the effect of a dike around the perimeter of the escarpments and ridges restricting the flow of ground water through the face of the escarpments and into the natural drainage ways. These cemented dikes have been observed and studied in several places where they have been exposed by road cuts and gravel pits. They do not appear to extend more than 50 to 150 feet under the edge of the escarpments with their width possibly increasing inversley with the slope of the escarpment face.

Land drainability

Based on land classification criteria, the majority of soils from 0 to 5 feet have good drainability. The land classification criteria used in this area is as follows:

X (Good) Drainability	= 1.0" per hour or more
Y (Restricted) "	= 0.5" - 1.0" per hour
Z (Poor) "	= 0.5" or less per hour

The only area in which the soils deviate from the X factor is in the eastern portion of the Stanaker Northeast Slope Area and the swales in the Naples Area where they have a Y or restricted drainability. These permeabilities are adequate, however, for the downward movement of water through the top 5 feet and consequently do not affect the classification of the drainage requirements.

Natural drainage channels

<u>Effective as Drains</u>

The natural drainage channels traversing the unit area are highly effective as surface drains but are limited in varying degrees in their effectiveness as subsurface drains. In the upper reaches of the area these channels are shallow, seldom more than five feet in depth. Whereas, the cobble layer of this area is approximately 10 to 20 feet below the surface.

Although in the lower reaches of the unit area these natural drainage channels become entrenched to depths of as much as 100 feet, the cemented zone and barrier strata in this area (as discussed in detail under barrier strata and formations) restrict their effectiveness as subsurface drains.

Utility as Drainage Outlets

The general slope of the land, which is from 60 to 100 feet drop in elevation per mile, lends well to the using of these channels as drainage outlets. To serve effectively, however, as outlets for proposed drains, some improvements of these channels would be required. The majority of these improvements would be required on the South Vernal drain which may serve as a principal drainage outlet.

Quality of Irrigation Water

Practically all of the water used for irrigation, within the unit area, is derived from the flows of Ashley Creek. The high quality of this water for irrigation purposes is supported by at least two sources of information. Samples taken July 2, 1949 and September 9, 1949 from canals near their point of diversion northwest of Vernal were analyzed and reported by J. F. Thorne and D. W. Thorne in Utah State Agricultural Experiment Station Bulletin 346, entitled "Irrigation Waters of Utah". The results of these analyses indicate the waters of Ashley Creek are of excellent quality for irrigation. Water samples were also collected from Ashley Creek, at the "Sign of the Maine" gaging station in 1955 and 1956, and analyzed chemically in the Region 4 laboratory at Salt Lake City, Utah. The results of these tests are presented in tabular form under Quality of Irrigation and Drainage Waters tabulation, pages 35 and 36. (For more details and description of all samples collected see Water Supply Appendix and Land Classification Appendix, tables 1 and 2.) The results of these analyses also indicate that Ashley Creek waters at the point of diversion for unit lands are of excellent quality for irrigation of any crops to be grown in the unit area.

Drainage Flows

Investigations

There are 21 sampling stations established, within the unit area, on natural drainage ways, spring areas, and on the lower reaches of

Ashley Creek and Ashley Central Canal. For location of all sampling stations and more details see Quality of Water Sampling Station Map found in the Water Supply Appendix. For reference purposes the names of these natural drainage ways are shown in order from North to South on map nos. 325-418-23 and -24 as follows: Gibson Gulch, North Vernal Drain, South Vernal Drain, Naples Drain, and Slaugh Gulch. Samples were collected at most of the stations in September and November in 1955, then resumed in June, 1956, and continued through the irrigation season at monthly intervals.

Quality and quantity

The chemical analyses of drainage waters sampled from the lower reaches of Ashley Creek and the several drainage ways draining the unit area show qualities unsuitable for irrigation under normal conditions. A cross-section of the quality of drainage waters is shown in the "Quality of Drainage Water--Summary," pages 35 and 36. The location of sampling stations shown in this summary are located on map nos. 325-418-23 and -24. This analysis shows that these waters are generally high in dissolved salts and the farther from the head of the area or point of diversion the samples were taken, the higher the salt concentrations become. There is some boron present in the waters of the Naples drain but in small concentrations not exceeding 1 p.p.m. which is within the safe toxic limit for most crops. In like manner small concentrations of sodium, as shown in the quality of water table, do not create an alkalinity hazard in areas using such water.

The quantity of drainage flow at the respective sampling stations is shown, where available, in the Quality of Irrigation and Drainage Water - Summary. The quality of these drainage waters as related to the quantity of flow indicates that the concentration of total dissolved salts, boron and sodium, is greater during period when drainage flows are small. These periods occur before and after the heavy diversions for irrigation or high stage of Ashley Creek flows.

Use for irrigation

Some drainage waters commingled with varying amounts of direct flow water are presently being used for irrigation purposes along all of the natural drainage ways and the lower reaches of the Ashley Central Canal. The majority of the drainage flows, however, are diverted to lands under the River Irrigation and Union Canals located below the unit area.

Due to high salt concentrations, lands receiving only drainage waters are usually less productive than areas receiving direct flow waters. Under unit development the salinity of these drainage waters may be improved during the late irrigation season, while the salinity of the early season flows may be increased. This possibility would result through storage of excess flows during the high runoff period and later diverted to unit lands and thus early season return flows may decrease while the later season return flows may be increased. The desirability of return flow use in the River Irrigation and Union Canals, however, could only be determined after the beginning of unit operation. The water quality sampling program will be continued in order that sufficient factual data will be available for evaluating the quality conditions with and without the Vernal Unit.

Under unit operation it is anticipated that only a minor amount of the return flows will be used on unit lands, whereas the major use would be on lands below the unit area.

Quality of Irrigation and Drainage Water - Summary

Stream or Drain	Sampling Station and Location	Field No.	Date	Flow (cfs)	Total Dissolved Salts (PPM)	Boron (PPM)	Sodium %	S.A.R.	Class 1/ C	B	S
Ashley Creek	"Sign of Main" (above diversions)	5-F-1	7-21-55	109	109	.12	1.0	0.3	1	1	1
		-2	9-26-55	--	107	.04	3.4	0.7	1	1	1
		-3	3-14-56	24	197	.01	2.3	0.6	2	1	1
		-4	5-24-56	797	75	None	5.9	0.8	1	1	1
		-5	7- 9-56	125	100	0.8	6.2	.1	1	1	1
		-6	8- 7-56	59	113	0.1	2.7	.1	1	1	1
	11-Na (above Naples drain)	11-Na-1	7-21-55		1812	.60	14.9	1.2	3	1	1
		-2	9-26-55		1848	.52	14.3	1.1	3	1	1
		-3	6-11-56	(E)25	1242	.45	16.1	1.1	3	1	1
	13-P (at River Irrigation Canal)	13-P-1	9-27-55	--	2788	.27	20.3	2.2	4	1	2
		-2	6-11-56	(E)20	1776	.44	18.1	1.4	3	1	1
		-3	7-10-56	--	2348	.54	21.1	1.9	4	1	1
	15-R (at gauge near Jensen)	15-R-1	7-21-55	--	5504	1.5	37.2	7.2	4	3	3
		-2	9-22-55	--	4256	.66	32.7	5.2	4	1	2
		-3	3-14-56	29	1668	.32	17.8	1.4	3	1	1
		-4	5-25-56	--	413	.09	15.4	.5	2	1	1
		-5	7-10-56	8	3438	.77	27.2	3.1	4	2	1
		-6	8- 7-56	1	5500	1.0	33.4	5.0	5	2	2
		-7	9-18-56	7	4584	1.11	30.6	4.0	4	2	1
Ashley Central Canal	11-Mb (at Naples)	11-Mb-1	11-8-55	--	1144	.14	6.7	.2	3	1	1
		-2	3-13-56	(E) 5	567	0.1	5.2	.2	3	1	1
		-3	5-25-56	(E)10	353	0.6	11.7	.3	2	1	1
		-4	7-10-56	(E) 9	293	.04	6.6	.2	2	1	1
		-5	8- 7-56	(E) 7	313	.03	5.7	.2	2	1	1
North Vernal Drain	9-Mb (at Mouth)	9-Mb-1	9-27-55	(E) 3	826	.10	11.2	.6	3	1	1
		-2	3-13-56	(E) 3	567	.01	5.2	.2	3	1	1
		-3	6-11-56	(E) 3	593	.30	9.5	.4	3	1	1
		-3	7-10-56	(E)1.5	707	.18	10.4	.5	3	1	1
		-4	8- 7-56	(E) .7	868	.22	11.0	.6	3	1	1

Quality of Irrigation and Drainage Water - Summary (Cont.)

Stream or Drain	Sampling Station and Location	Field No.	Date	Flow (cfs)	Total Dissolved Salts (PPM)	Boron (PPM)	Sodium %	S.A.R.	Class 1/ C	B	S
South Vernal Drain	10-J (3½ mi. above mouth)	10-J-1	11-7-55	(E) 1.5	1599	.25	3.5	.1	3	1	1
		-2	6-11-56	(E) 5	619	.09	4.2	.2	3	1	1
	10-Nb (at mouth)	10-Nb-1	9-26-55	--	1578	.14	8.2	1.7	3	1	1
		-2	7-10-56	(E) 6	1464	.30	6.4	.4	3	1	1
		-3	8- 7-56	(E) .5	1644	.40	6.9	.5	3	1	1
Naples Drain	11-K (2-3/4 mi. above mouth)	11-K-1	11-7-55	(E) 1	1864	.33	13.2	1.1	4	1	1
		-2	6-11-56	(E) 2½	931	.32	19.6	1.7	3	1	1
		-2	7-10-56	(E) 3	1730	.30	13.3	1.0	3	1	1
		-3	8- 7-56	(E) 2	1592	.30	11.2	.8	3	1	1
	11-Nc (at Mouth)	11-Nc-1	9-26-55	(E) 5	3398	.34	14.9	1.5	4	2	1
		-2	7-10-56	(E) ¼	3438	.80	14.7	1.6	4	2	1
		-3	8- 7-56	(E) 3	3794	.79	17.4	2.0	4	2	1
Slaugh Gulch	12-M (3 miles above Mouth)	12-M-1	3-13-56	(E) 3	413	.01	7.4	2.7	2	1	1
		-2	5-25-56	(E) 6	537	.12	11.1	4.9	2	1	1
		-3	7-10-56	(E) 4	940	.21	11.5	.6	3	1	1
		-4	8- 7-56	(E) 1	433	.05	8.5	.3	2	1	1
Gibson Gulch	9-Nb (at Mouth)	9-Nb-1	11-8-55	--	3102	.50	22.8	2.4	4	1	1
		-2	7- 9-56	(E) 3	2986	.53	20.7	2.1	4	1	1
		-3	8- 7-56	(E) 2	3792	.70	20.6	2.4	4	2	1

(E) - Estimates

1/ Waters have been classified in 3 separate categories as follows:

(C) Based on total Salt Concentrations.
(B) Based on Boron Concentration.
(S) Based on Sodium Adsorption Ratio.

LAND DRAINAGE

CHAPTER III

DRAINAGE REQUIREMENT

General

The surface drainage is adequate for the Vernal unit as the steep surface slopes, coupled with the well-developed natural drains, provide adequate surface drainage. A drainage plan for the Vernal unit, therefore, should provide for the construction of a system of deep drains in those areas where subsurface drainage is economically feasible and is found to be needed under unit operation. Such a plan would recognize that improvement of the drainage situation may take place under unit operation due to the following reasons: (1) elimination of winter diversions for stock-watering purposes by the construction of a water savings pipe system; (2) reduction of irrigation diversion during the high runoff season of about a 3 week period occurring in April, May, or June, as most of these flows would be diverted to Stanaker Reservoir for storage; (3) reduction in canal seepage losses resulting from the lining of portions of the major canals. Accordingly, the construction of the subsurface drainage system will not be undertaken until unit operation has shown to what degree drainage conditions will improve and what area will require drainage.

In the Vernal unit there are 1555 acres which were classified as nonirrigable lands and downgraded to a 6W class. Drainage in these areas was not practicable from an economic standpoint and in much of the area the farmers were not interested in drainage, desiring to retain the area as pasture lands.

There are about 2,950 acres of the irrigable area or unit lands which may require drainage in varying degrees in order to retain the land classification as shown for the unit.

A summary of lands within the unit is presented in the following tabulation.

Unit Lands Summary

	Maeser-Vernal Area	Naples Area	River Bottoms Area	Stanaker Northeast Slope Area	Total Vernal Unit
Irrigable lands which will remain irrigable with unit drainage	1/ 7,367	4,781	975	1,658	14,781
Permanent pasture lands 2/	1,430	4,002	1,177	152	6,761
Nonirrigable lands 2/	70	468	828	189	1,555
Total acreage (except 6st lands)	1/ 9,867	9,251	2,980	1,999	23,097

1/ Includes 337 acres within Vernal townsite.
2/ Will not receive unit water.

Drainage Requirement

The drainage requirement for the lands which may be improved in the unit area have been estimated by two methods. First, using the Glover formula for drain spacing and second, inflow-outflow method to determine miles of drains required. The Maeser-Vernal area, having the greater percentage of irrigable lands which may require drainage to retain the present classification, was used to apply the formulas in determining the drainage requirement for the unit.

The conditions effecting drain spacing by the Glover formula were reviewed. Although this formula is not strictly applicable, as the drains will function in part as interceptor drains, an analysis was made applying this method. Spacings were computed for the two general geologic situations involved, (1) drains which will penetrate the cobble, and (2) drains which will not penetrate the cobble. The results of this method indicate a general drain spacing of 1/2 mile where drains penetrate the cobble and 1/4 mile where drains do not penetrate the cobble.

The inflow-outflow, or second method applied in the determination of length of drains required, indicate a length of 14.3 miles. The analysis of this method is discussed as follows:

The input to ground water in the area contributing to the drainage problem is considered to occur from 3 sources, namely; canal seepage, lateral losses, and deep percolation from irrigation application. It is anticipated that seepage from approximately 3.8 miles of the Highline Canal and a combined length of 6.2 miles of the Ashley Upper and Stanaker Service Canals will contribute to the drainage problem. However, since these canals will be lined the seepage rates will be cut to a minimum. Estimated seepage rates and average canal flow passing through the contributing area and applied in this study are as follows:

	Loss Per Mile	Equivalent Seepage Rate Cu. ft/sq ft/day	Average Canal Flow
Highline Canal	2.0%	0.24	13.5 cfs
Ashley Upper) Stanaker Service)	0.5%	0.25	120 cfs

Based on the foregoing criteria the total canal seepage contributing to the underground water in the problem area is 4.7 cfs.

Deep percolation losses from irrigation applications which contribute to the drainage problem are estimated to occur from an area of approximately 5,800 acres. In the determination of these losses the following estimates per irrigation was applied.

Gross irrigation application	7"
Irrigation interval	21 days
Farm lateral losses at 7% of gross application......	0.5"
Surface losses at 20% of gross application..........	1.4"
Deep percolation at 15% of gross application........	1.0"

Thus, the deep percolation losses from the contributing area would be 483 acre-feet, or 11.5 cfs during a 21 day interval.

Lateral losses estimated to occur on the contributing area are based on 7 percent of the gross irrigation application and amount to 237 acre-feet per irrigation, or 5.6 cfs for a 21-day interval.

A summary of the total **input** to ground water within the contributing area follows:

Canal seepage losses	4.7 cfs
Deep percolation	11.5 cfs
Lateral losses	5.6 cfs
Total	21.8 cfs

The natural outflow from the contributing area is estimated as follows: During the winter months the consumptive use is low and the depth to ground water under most of the unit lands is about that desired for the irrigation season with unit development. Also all flow entering the valley in Ashley Creek is diverted for stock water. Consequently, the return flow during the period is assumed to represent natural outflow under unit development. This natural outflow is represented by the November to February return flows measured at the lower Ashley Creek gage near Jensen. These return flows average 2,700 acre-feet per month, or 45 cfs, and represent outflow from 23,097 acres within the unit boundary. The natural outflow from the area contributing to the drainage problem is assumed to be proportionate to the outflow from the total area. Thus the 5,800 acres which contribute to the problem area would yield a natural outflow of 11.1 cfs.

The water to be removed by the unit drains is represented by the total input to ground water which contributes to the problem area less the natural outflow from the same area (21.8 - 11.1) or 10.7 cfs. It is estimated that the drains penetrating the cobble will yield 1 cfs and drains not penetrating cobble will yield 0.5 cfs. Assuming the drains would be about equally divided between those penetrating the cobble and drains not penetrating the cobble the average yield per mile of drain would be 0.75 cfs.

Unit Drainage Costs

The cost for drainage is estimated at $675,000 or $45 per acre for the irrigable lands in the unit area. This cost includes $100,000 for lining a portion of the existing major canals serving the area.

OM&R Costs

Operation, maintenance and replacement costs are estimated at $2,200 per year.

Future Investigations

It is essential to continue with the collection of data which will be required for design and construction of the drainage system after the unit has been in operation.

Ground water

As the unit is developed, and for several years afterward, the water table elevation data should be collected from the present 71 wells, with a more detailed study on the 35 wells in the Maeser-Vernal area. Ground water elevations should be obtained before and after the irrigation season and at least once each month during the season. From this data the effect of unit operation on the drainage problem areas would indicate the extent to which unit drainage would be required to correct any drainage deficiencies.

Additional wells should be established and a few sets of piezometers should also be installed adjacent to new or existing wells to determine if there is any shallow artesian leakage which influences ground water tables.

Canal lining improvement

A plan should be developed for canal lining as it is usually more economical to reduce excessive canal losses than to recover the seepage by drainage construction.

Pilot drains

As a basis for actual drain design and construction,pilot drains should be constructed. These test drains could be constructed under three major conditions: (1) one which reaches to the cobble and extends from 1/2 to 3/4 of a mile in length, (2) one which does not reach to the cobble but extends approximately the same length as No. 1, (3) one which provides outlet through the barrier or cemented zone on the margin of the lower area. Lines of observation wells should also be installed across these pilot drains. The wells should be extended to cover the anticipated area which will be affected by the pilot drains. In the finer materials a few piezometers should be installed, at least one in the pilot drain and others adjacent to the observation wells. If possible, observation wells should be installed one year in advance of the pilot drain construction.

Recorders should be installed and samples taken to determine the quantity and quality of the flows collected in these pilot drains.

Drainability

Efforts should be made to obtain additional data on depth to shale from the several oil companies that have conducted seismic explorations in Ashley Valley.

A sufficient number of field permeability tests should be run to provide representative data of the several types of substrata materials occurring in the Maeser-Vernal area.