PRELIMINARY REPORT ON

RETURN FLOW STUDY OF DUCHESNE RIVER

PREPARED BY DIVISION

OF WATER RIGHTS

JUNE 26, 1978

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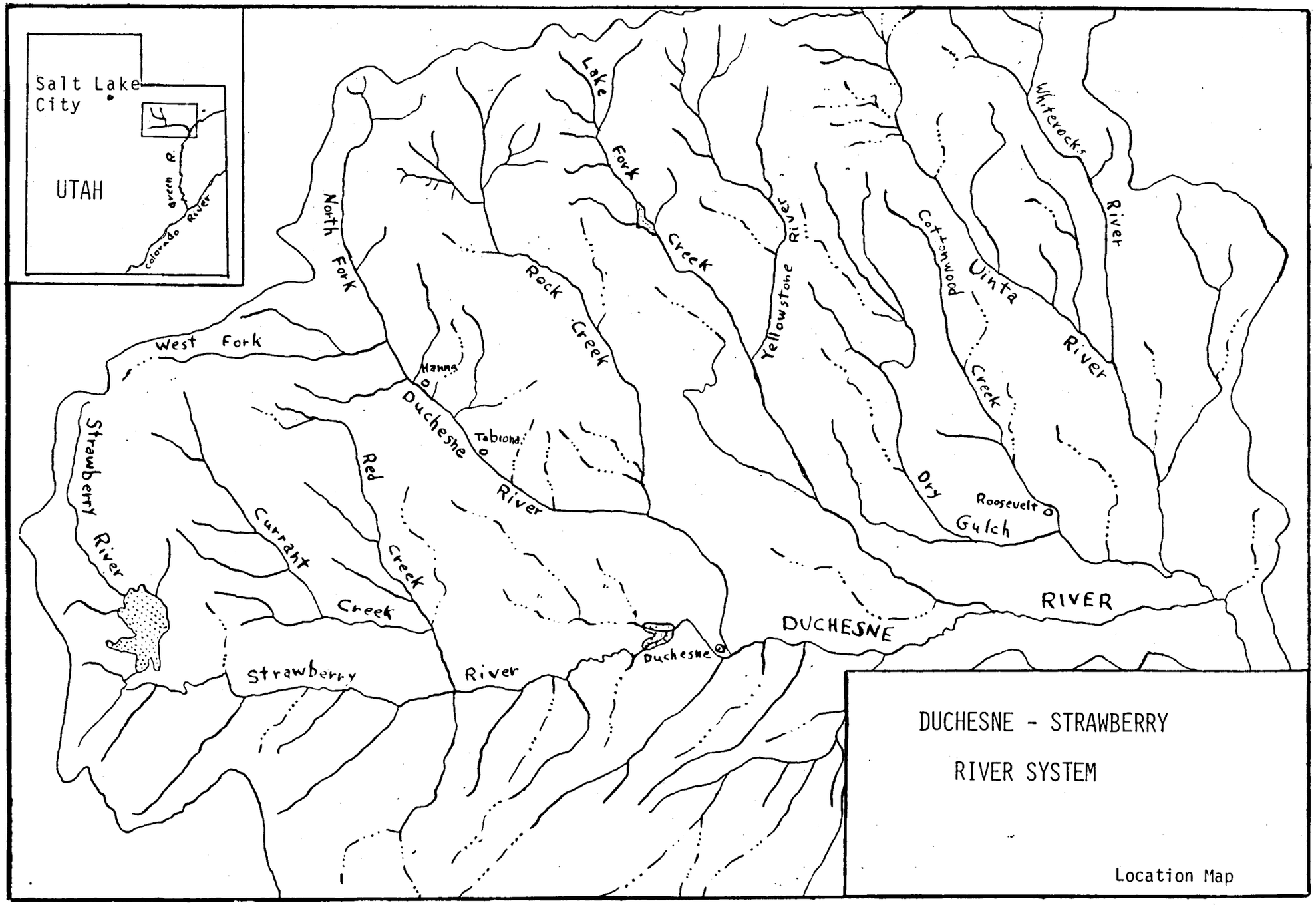

Salt Lake City
UTAH
Green R.
Colorado River
Lake Fork Creek
Yellowstone River
Whiterocks River
Cottonwood Creek
Uinta River
North Fork
Rock Creek
West Fork
Hanna
Duchesne River
Tabiona
Red Creek
Strawberry River
Currant Creek
Dry Gulch
Roosevelt
DUCHESNE RIVER
Duchesne
Strawberry River
DUCHESNE - STRAWBERRY
RIVER SYSTEM
Location Map

I. Introduction

The duty of water on the Duchesne River System has been the subject of repeated discussion in recent years. On January 26, 1974, the duty question was one of the topics in a hearing before the Fourth Judicial District Court. Those in attendance were in general agreement that every effort should be made to determine the duty of water to be allocated from the Duchesne River as soon as practicable.

The quantity of water which returned to the natural channel after diversion and use of the water to irrigate adjacent lands is one facet of the duty question which has been of concern to the users and upon which it did not appear that there was sufficient factual data available. To assist the water users and the Court in the resolution of this problem, the State Engineer agreed to start gathering data in an effort to determine return flow on this system and to arrive at a depletion figure applicable to the canals diverting water from the Duchesne River. This investigation, of course, was to be framed within the budgetary and staff limitations of the Division of Water Rights. The discussion which follows is the result of the State Engineer's investigation into the matter.

II. Physiography of Basin

The Duchesne River heads in the Uintah Mountains in northeastern Utah at elevations approaching 12,000 feet and trends generally southeasterly to its confluence with the Green River at an elevation of approximately 4,700 feet. The glaciated slopes of the Uintah Mountains, the steep narrow canyons, and the lack of a deep soil-retaining mantle gives the Duchesne River a runoff pattern of high spring flows and rapidly dropping summer flows; e.g., 4,420 second-feet was measured June 10, 1922, and 15 second-feet was measured July 11, 1931, near Duchesne City. A hydrograph of the West Fork below Dry Hollow and the Duchesne River near Tabiona for the year 1958 (which is close to an average year) is included on Page 3 of this report.

The Duchesne River Valley was formed by alluvial material carried by the Duchesne River and its many tributaries and deposited in the narrow confines of the steep side slopes bordering the river or alluvial fans at the mouths of the many small intersecting canyons.

The development of irrigated land has generally been confined to these areas of deposition with construction of canals along the topographic high borders of these arable and the irrigation being applied adjacent to the main river, particularly in the portion of the canyon above the Town of Duchesne. The major canal systems in the Hanna-Myton area are shown on Pages 20 and 21.

III. Climate

The Hanna-Myton area has a semiarid to arid, continental climate. It is characterized by wide daily and annual variations in temperature and by well-defined seasons. The winters are generally cold but the snow fall is light. Summers are generally mild.

The climate of the area is suitable for alfalfa, clover, small grains, corn, potatoes and other hardy crops.

The following table gives climatic data for the Duchesne, Myton and Hanna Areas.

April
May
June
July
August
September
1500
1000
100
10
HYRDOGRAPH OF DUCHESNE RIVER - 1958
Duchesne River near Tabiona
West Fork below Dry Hollow
HYDROGRAPH FOR DUCHESNE RIVER - 1958
15 20 25 30 5 10 15 20 25 30 5 10 15 20 25 30 5 10 15 20 25 30 5 10 15 20 25 30 5 10 15 20 25

TABLE I

Climatic Data

Month	DUCHESNE /1		MYTON /2		HANNA /3	
	1941-1975 mean precip. (inches)	1941-1975 mean temp. (degree F)	1931-1963 mean precip. (inches)	1961-1975 mean temp. (degree F)	1951-1960 mean precip. (inches)	1961-1975 mean temp. (degree F)
Jan.	.50	18.4	.35	14.6	.87	20.6
Feb.	.46	24.9	.30	23.7	.77	25.4
Mar.	.58	36.1	.47	35.9	.47	32.2
Apr.	.66	44.9	.50	45.4	.51	39.1
May.	.82	55.3	.58	56.1	1.22	49.8
June	1.01	63.7	.55	65.1	.76	57.5
July	.76	70.7	.54	72.1	.97	65.6
Aug.	1.05	68.9	.90	70.0	1.64	63.4
Sept.	.81	59.5	.60	59.5	1.23	54.6
Oct.	.93	48.1	.69	48.3	.90	45.5
Nov.	.49	32.9	.42	32.5	60	32.2
Dec.	.64	21.1	.48	17.9	.79	21.7
Annual	8.71	45.4	6.35	45.1	10.73	42.3

1/ About 55 percent of the precipitation occurs during the growing season. The growing season averages about 164 days from April 28 to October 9. The frost-free period is about 120 days.

2/ About 50 percent of the precipitation occurs during the growing season. The growing season averages about 168 days from April 25 to October 10. The frost-free period is about 125 days.

3/ About 48 percent of the precipitation occurs during the growing season. The growing season averages about 139 days from May 18 to October 4. The frost-free period is about 93 days.

The following table gives the estimated monthly evapotranspiration rates from the Blainey-Criddle method for Hanna, Duchesne and Myton, Utah, based on the period of time water is diverted in the canals.

TABLE 2

Estimated Evapotranspiration
In Inches

MONTH	HANNA	DUCHESNE	MYTON
	Etp	Etp	Etp
May	4.24	4.70	4.78
June	4.93	5.45	5.58
July	5.69	6.14	6.26
August	5.14	5.59	5.68
September	3.89	4.24	4.24
October	2.99	3.17	3.18
TOTAL	26.88	29.29	29.72

IV. Irrigation

Crops grown in the area must be irrigated as precipitation is not sufficient for dry land farming. Most of the water used for irrigation is obtained from snow melt from the Uintah Mountains, which border the area on the north. Tables 10-14 give the streamflow measurements from selected U.S.G.S.gaging stations on the Duchesne River and its tributaries above Duchesne, Utah. Pages 22 to 26 of this report.

During fall, winter, and early spring, the flow of water in the Duchesne River is low. During late spring and early summer run-off is rapid and streams are high. There is a shortage of irrigation water both before and after the period of high water with the critical period extending from mid-July to the end of August. During this period the late priority water diversion has historically been curtailed.

Some of the water diverted for irrigation in the Duchesne River Basin is lost before application to the irrigated lands. The water is lost by seepage through the bottoms and banks of the canals, by evapotranspiration from the growth along the canals, and by leakage through the banks and the bottoms of canals not sealed by fine material. This water is lost to use by the water user in the canal, but it is believed that most returns to the river or other canals and is rediverted by water users farther downstream. Tables 8 through 11 summarize the water diverted and delivered in the major canal systems. Pages 27 to 30 of this report.

During 1971 and 1972, the Division of Water Rights made measurements in selected canals and ditches diverting from the Duchesne and Strawberry Rivers to determine the degree of water loss. The 1971-1972 study indicates that in the four canals the amount of water lost ranges from 8 percent in the Gray Mountain Canal to 63 percent in the Rhoades Canal. Tables 15 through 18, pages 27 to 30 of this report show estimated evapotranspiration and average precipitation for these four canals.

V. Soils[1/]

Five soil assoications are found in the Roosevelt-Duchesne Area. Each association consists of two or more dominate soils and, as a rule, contain several other soils of lesser extent. Within each association the soils occur on the landscape in a pattern that is characteristic and recurring, although of course it is not strictly uniform. The soil associations are as follows:

1. Naples-Billings-Fruita Association. This association consists of deep soils on recent alluvium. In addition to the dominate soils, this association includes soils of the Redfield, Green River, Ravola and Navajo series. The soils occur on alluvial fans and on low terraces and valley flood plains. They are among the arable soils in the area.

2. Mesa-Neola-Avalon Association. The soils of this association have very gently sloping relief. They occur on benches and mesas, mostly on smooth slopes. The soils of the mesa and avalon series have strong cemented hardpans of lime carbonate.

The soils of this association are used both for crops and pasture. Under general irrigation farming, yields on the deeper soils are only moderate. The shallow soils are best suited to irrigated pasture.

3. Ashley - Myton Association. This association consists of shallow soils that overlie beds of cobblestones and gravel. The soils occur on the flood plains of rivers and on the low terraces along rivers. In addition to the Ashley and Myton series, the association includes soils of the Leeton series.

[1/] From Soil Survey - Roosevelt - Duchesne Area Utah - United States Department of Agriculture, Soil Conservation Service.

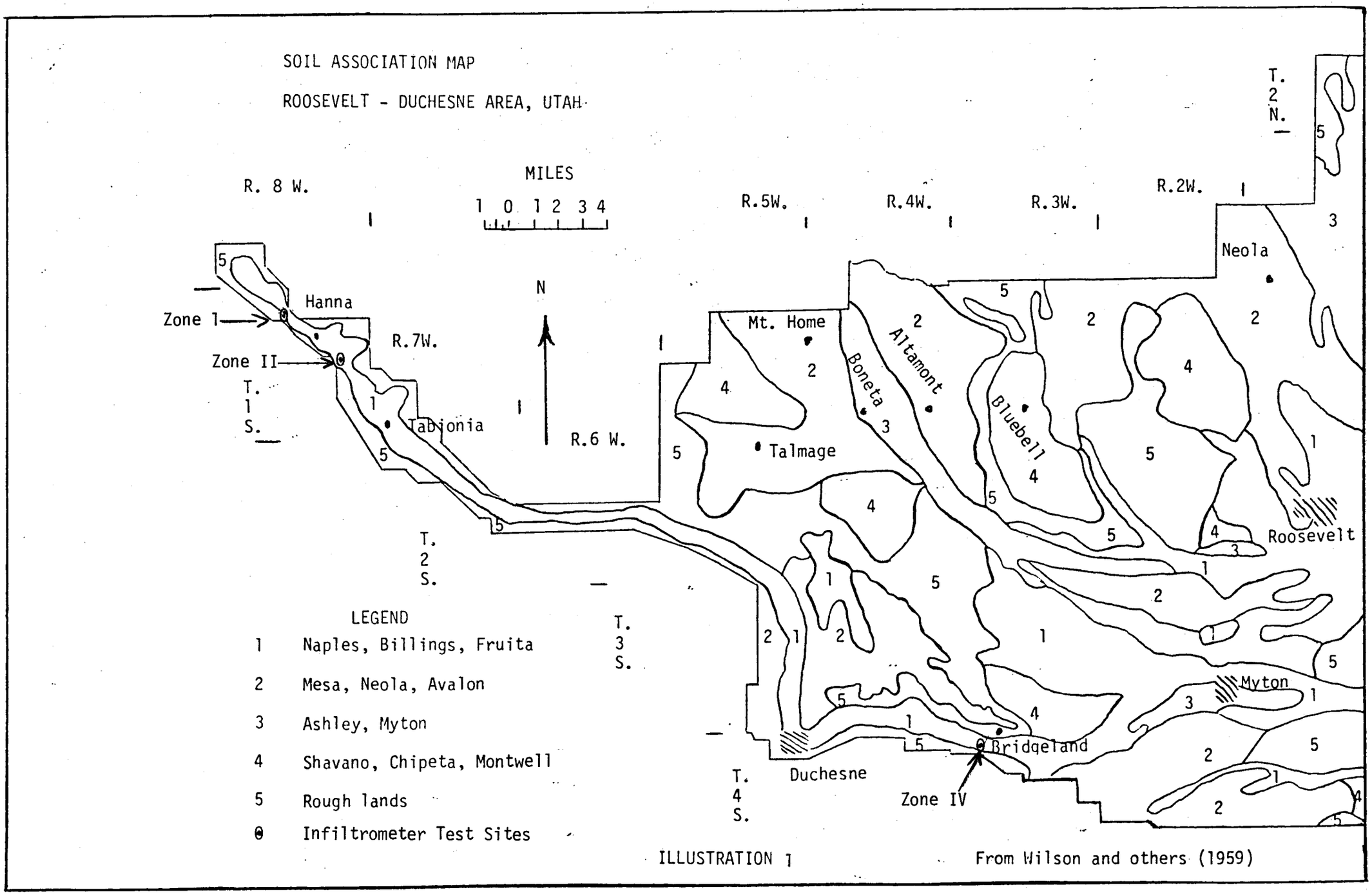


ILLUSTRATION 1

From Wilson and others (1959)

The soils of this association are used largely for irrigated or non-irrigated pasture.

4. Shavano-Chipeta-Montwel Association. This association is composed of shallow and moderately deep soils, most of which have developed from weathered bedrock. In addition to the dominate soils, this association includes soils of the Pariette and Sheppard Series. The soils occur mainly in nearly level to sloping areas in the uplands. Differences in the profile layers are only slightly defined in the Shavano and Chipeta soils, but are well defined in the Montwel and Parietta Soils.

In general, the soils of this association are unsuitable for crops, but some of the deeper soils of the Montwel and Shavano series are used to grow irrigated crops.

5. Rough Lands. This association is made up of miscellaneous land types consisting mainly of rough, steep lands that have little or no true soil.

Illustration 3 shows the soil associations in the Duchesne-Roosevelt area and is included as page 6.

On three selected areas along the Duchesne River, infiltrometer measurements were made. Zone I was located about one mile to the northwest of Hanna. Zone II was located about two miles to the southeast of Hanna. Zone IV was located about one mile to the west of Bridgeland. Graphs 1 through 10 on pages 31 to 40, show the calculated intake curves for the three areas.

The soils on the sites in Zone I and Zone II in the Hanna-Tabiona area range from loams to clay loams. The infiltrometer tests made on these soils gave an average intake rate of about 18 inches for the first hour. The tests show that texture, structure, degree of dispersion, depth to water table and vegetative cover all contribute to a high flow rate for the irrigation water to return to the river. The Return Flow Studies of the Duchesne River show that the area does have the highest river flow increases, averaging 182 percent for the reaches and segments of the study.

The rate of water infiltration into soils depend on soil texture, structure, degree of dispersion, and on depth to the water table. When adequate drainage has been provided, the structure of the soil and other soil properties are dominate in influencing intake rates.

Soils are seldom homogenous. The premeability of a soil not only varies from point to point but the value of the permeability in one direction is different from the value in another direction even at a given point within the soil. This lack of uniformity becomes most extreme in alluvial soils. Because of the extensive variability which can, and does, frequently occur from point to point in a soil, the results of intake or permeability measurements, which are essentially point observations, should be used cautiously.

VI. Scope of Investigation

The threshold question for this return flow investigation was to divide the river system into hydrologic segments which could be managed and which would yield information on the actual return flows. At the beginning of the 1974 irrigation season, a reconnaissance of the Duchesne River was made, and a section of the river about 54 miles long was selected for study which begins part way up the two main tributaries, the North Fork and the West Fork as follows:

1. From the confluence of the North Fork and Haydes Creek.
2. From the confluence of the West Fork and Dry Hollow.

From these two points the section extends downstream to the crossing of Highway 40 and the Duchesne River near Myton. It was felt that this was an area where the water supply and diversions could be measured with minimum interference from headgate changes, rain, irrigation changes, and fluctuations in stream flow, and could be correlated with measurements of stream gauges maintained by the United States Geologic Survey.

This section of the river was then divided into four reaches. The four reaches are as follows and are illustrated on a map as Char 1 on page 8 of this report.

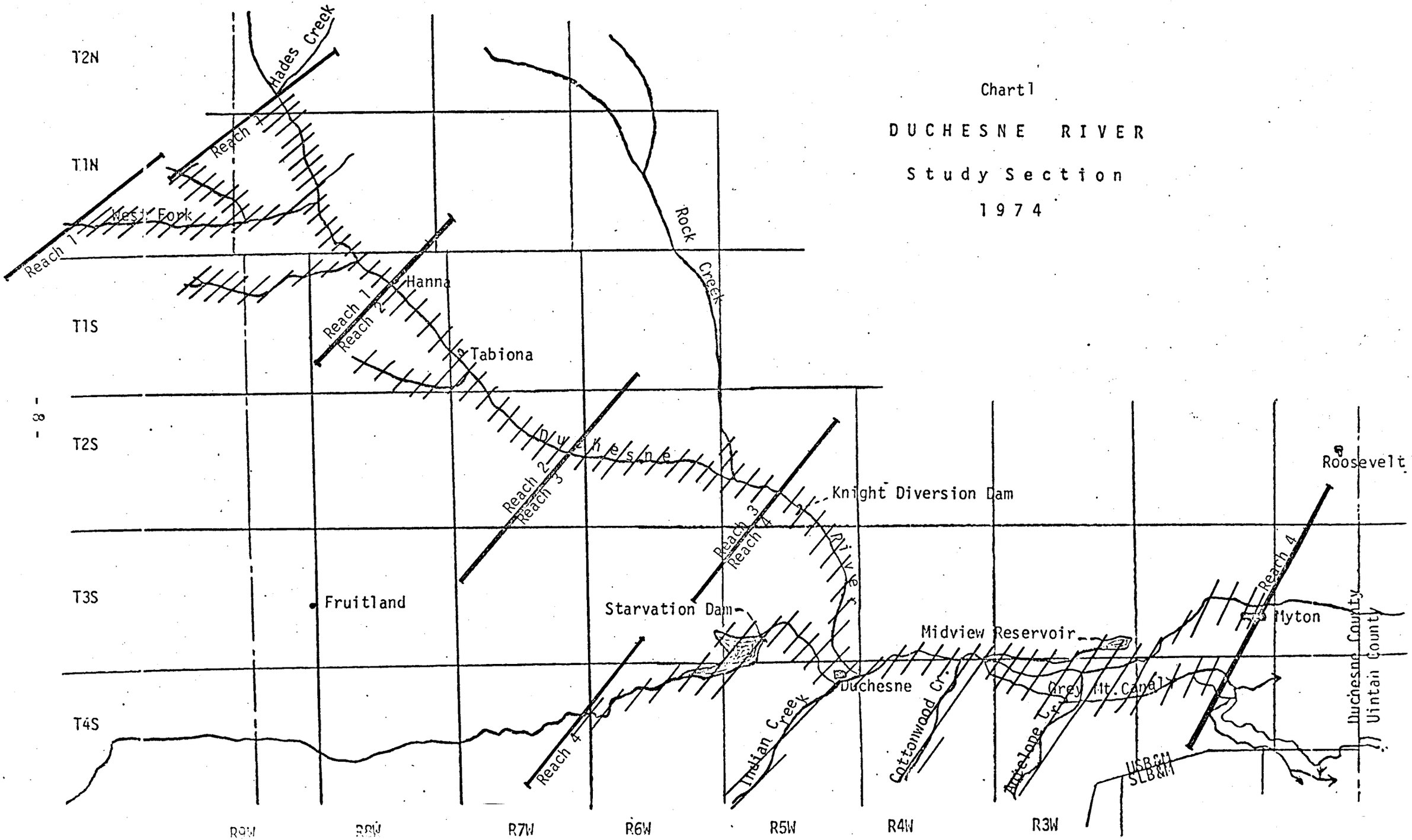


Chart 1
DUCHESNE RIVER
Study Section
1974
T2N
T1N
T1S
T2S
T3S
T4S
R9W
R8W
R7W
R6W
R5W
R4W
R3W
Hades Creek
Reach 1
West Fork
Reach 1
Hanna
Reach 1
Reach 2
Tabiona
Rock Creek
Duchesne
Reach 2
Reach 3
Knight Diversion Dam
Reach 3
Reach 4
River
Roosevelt
Fruitland
Starvation Dam
Midview Reservoir
Myton
Duchesne
Grey Mt. Canal
Reach 4
Reach 4
Indian Creek
Cottonwood Cr.
Antelope Cr.
USB&M
SLB&M
Duchesne County
Uintah County

1. Reach 1 covers about 10 miles and begins part way up the two main tributaries, the North Fork and the West Fork, as follows:

   A. From the confluence of the North Fork and Haydes Creek.

   B. From the confluence of the West Fork and Dry Hollow.

   From these two points the section extends downstream to the bridge across the Duchesne River near the Town of Hanna.

2. Reach 2 covers about 15 miles and extends from the bridge across the Duchesne River in the Town of Hanna to the bridge on Highway 35 across the Duchesne River approximately 8 miles southeast of Tabiona.

3. Reach 3 covers about 10 miles and extends from the bridge across the Duchesne River about 8 miles southeast of Tabiona to the bridge on Highway 35 across the Duchesne River about 4 miles downstream from the confluence of Rock Creek and the Duchesne River.

4. Reach 4 covers about 19 miles and extends from the bridge on Highway 35 across the Duchesne River about 4 miles below the confluence of Rock Creek and the Duchesne River to the gaging station just below the crossing of Highway 40 and the Duchesne River near Myton.

Two series of measurements were made on this section of the river-the first on July 17 and 18, 1974, and the second on August 28 and 29, 1974. Hereinafter the process which involved the taking of this series of measurements will be referred to as a "run". Each run consisted of obtaining measurements of the river and tributaries at 13 points and the measurement of 47 canals and ditches. Personnel involved in these runs were Donald C. Norseth, Robert F. Guy, and Gary Cupp of the Division of Water Rights and David Clayburn, Duchesne River Commissioner. Personnel of the United States Geological Survey, Nick Panas, Leon Jensen, and Dale Webb, provided stream-gaging data and measurements which were very helpful in correlating stream-flow. Leo Brady of the Central Utah Project provided the Strawberry River inflow to Starvation Reservoir and releases from the reservoir.

During the runs it was found that attempting to determine the return flow from each canal was impractical because the water from the upper canals was observed flowing over the ground surface into other canals before reaching the river. The influence of irrigation onto the river-adjacent lands on stream flow was impracticable to evaluate at the times of the runs because infiltration into the river from irrigated lands, inflow from springs, swamps, and small tributaries could not be separated and identified. The field work in 1974 was expended in measuring the river and the canals and ditches to determine the effect that the diversion of water had on the flow of the Duchesne River in the selected reaches. A graphic flow chart of the section is included as Chart 3 on Page 41. The measurements made during 1974 for the four reaches are tabulated below.

VII. Tabulation of 1974 Measurements

Table 3

Reach 1:

Place of Measurements	c.f.s.	c.f.s.
First Run		
Streamflow:		
Big Springs Area	10.4	
West Fork below Dry Hollow	24.5	
Wolf Creek below Rhoades Canyon	10.2	
North Fork below Haydes Creek	48.4	
Total		93.5

Reach 1 Con't:

Place of Measurements	c.f.s.	c.f.s.
Diversions:		
Orven J. Moon No. 1 (322)	0.0	
Orven J. Moon No. 2 (322)	0.0	
Orven J. Moon No. 1 (320)	3.0	
Orven J. Moon No. 2 (321)	3.0	
Orven J. Moon No. 3 (217)	2.9	
Orven J. Moon No. 4 (241)	2.9	
Orven J. Moon No. 3 (322)	3.0	
Willis Moon (282)	5.0	
Alfonzo Defa	6.0	
Tayne Wilkens	0.5	
McAffe (Swift Creek)	6.0	
Big Springs	6.9	
Rhoades	38.1	
Turnbow	3.6	
unnamed	1.5	
Total		82.4
Second Run		
Streamflow:		
Big Springs Area	6.1	
West Fork below Dry Hollow	12.1	
Wolf Creek below Rhoades Canyon	7.8	
North Fork below Haydes Creek	30.5	
Total		56.5
Diversions:		
Orven J. Moon No. 1 (322)	0.0	
Orven J. Moon No. 2 (322)	0.0	
Orven J. Moon No. 1 (320)	0.0	
Orven J. Moon No. 2 (321)	1.5	
Orven J. Moon No. 3 (217)	0.0	
Orven J. Moon No. 4 (241)	0.0	
Orven J. Moon No. 3 (322)	1.5	
Willis Moon (282)	0.2	
Alfonzo Defa	2.0	
Tayne Wilkins	no measurement	
McAfee (Swift Creek)	no measurement	
Big Springs	3.6	
Rhoades	19.6	
Turnbow	2.0	
Total		30.4

Reach 2:

Place of Measurement	c.f.s.	c.f.s.
First Run		
Streamflow:		
Duchesne River at Hanna	76.0	
Farm Creek	3.0	
Total		79.0
Diversions:		
Orven N. Moon (211)	0.0	
Defa (244)	0.0	
Little Farm Creek	2.7	
Farm Creek	44.9	
Jessop Thomas	0.0	
Jasper Pike	19.0	
Tabby	34.9	
Jim Bridger	abandoned right changed to Tabby	
Hicken	12.4	

Place of Measurement	c.f.s.	c.f.s.
Wagstaff	4.0	
Brown	3.9	
Jesse Peterson (Abplanab)	1.8	
Total		123.6
Second Run		
Streamflow:		
Duchesne River at Hanna	58.0	
Farm Creek	2.0	
Total		60.0
Diversions:		
Orven N. Moon (211)	0.0	
Defa (244)	0.0	
Little Farm Creek	2.0	
Farm Creek	31.7	
Jessop Thomas	3.6	
Jasper Pike	17.4	
Tabby	18.1	
Hicken	8.5	
Wagstaff	2.2	
Brown	2.0	
Jesse Peterson (Abplanab)	1.0	
Total		86.5

Reach 3

Place of Measurement	c.f.s.	c.f.s.
First Run		
Streamflow:		
Duchesne River near Tabiona	102.0	
Rock Creek near Talmage	158.0	
Total		255.0
Diversions:		
Broadhead	17.0	
Jones No. 1	2.0	
West Rock Creek	1.5	
Indian (James Mountain)	1.5	
Knight	8.0	
Shanks	9.5	
Pioneer	26.3	
Total		65.8
Second Run		
Streamflow:		
Duchesne River near Tabiona	93.0	
Rock Creek near Talmage	60.7	
Total		152.7
Diversions:		
Broadhead	7.5	
Jones	1.2	
West Rock Creek	1.4	
Indian (James Mountain)	1.0	
Knight	5.5	
Shanks (7.0 c.f.s. is project water)	11.0	
Pioneer	26.7	
Total		54.3

Reach 4:

Place of Measurement	c.f.s.	c.f.s.
First Run		
Streamflow:		
Duchesne River about Knight Diversion	193.0	
Strawberry River above Starvation Res.	85.0	
Starvation Reservoir Storage Release	309.0	
Total		587.0
Diversions:		
Knight Diversion	0.0	
Murray-White	16.0	
Rocky Point	51.8	
Madsen	3.0	
Yannaward (City Ditch)	3.0	
Porter Merrill Pump	0.0	
Child (not being used)	0.0	
Hamilton (Hollenbeck	6.0	
Meacham	0.0	
Duchesne Feeder	160.0	
Grey Mountain	270.0	
Pahcease (diverting through Duchesne Feeder)		
Myton Townsite	122.5	
Total		633.2
Second Run		
Streamflow:		
Duchesne River about Knight Diversion	92.0	
Strawberry River about Starvation Res.	46.0	
Starvation Reservoir Storage Release	306.0	
Total		444.0
Diversion:		
Knight Diversion	0.0	
Murray-White	19.0	
Rocky Point	45.0	
Madsen	1.5	
Yannaward (City Ditch)	4.5	
Porter Merrill Pump	0.0	
Child (not being used	0.0	
Duchesne City	3.0	
Hamilton (hollenbeck)	4.0	
Mecham	6.5	
Duchesne Feeder	129.0	
Grey Mountain	255.0	
Pahcease (diverted through Duchesne Feeder)		
Myton Townsite	59.0	
Total		526.5

The 1974 study showed the need for additional measurements to refine data in the following respects:

1. To determine the contribution of Warm Springs and Big Springs to the river flow in Reach 1.

2. To determine the relative contribution of West Fork and North Fork to the Duchesne River.

3. To determine spring flow accretion in Reach 2 and to locate possible existing geologic barriers that could affect underflow.

4. To determine the contribution of Rock Creek to the Main River and check river loss in late Summer in Reach 3.

5. To correlate water quality data with streamflow and diversion.

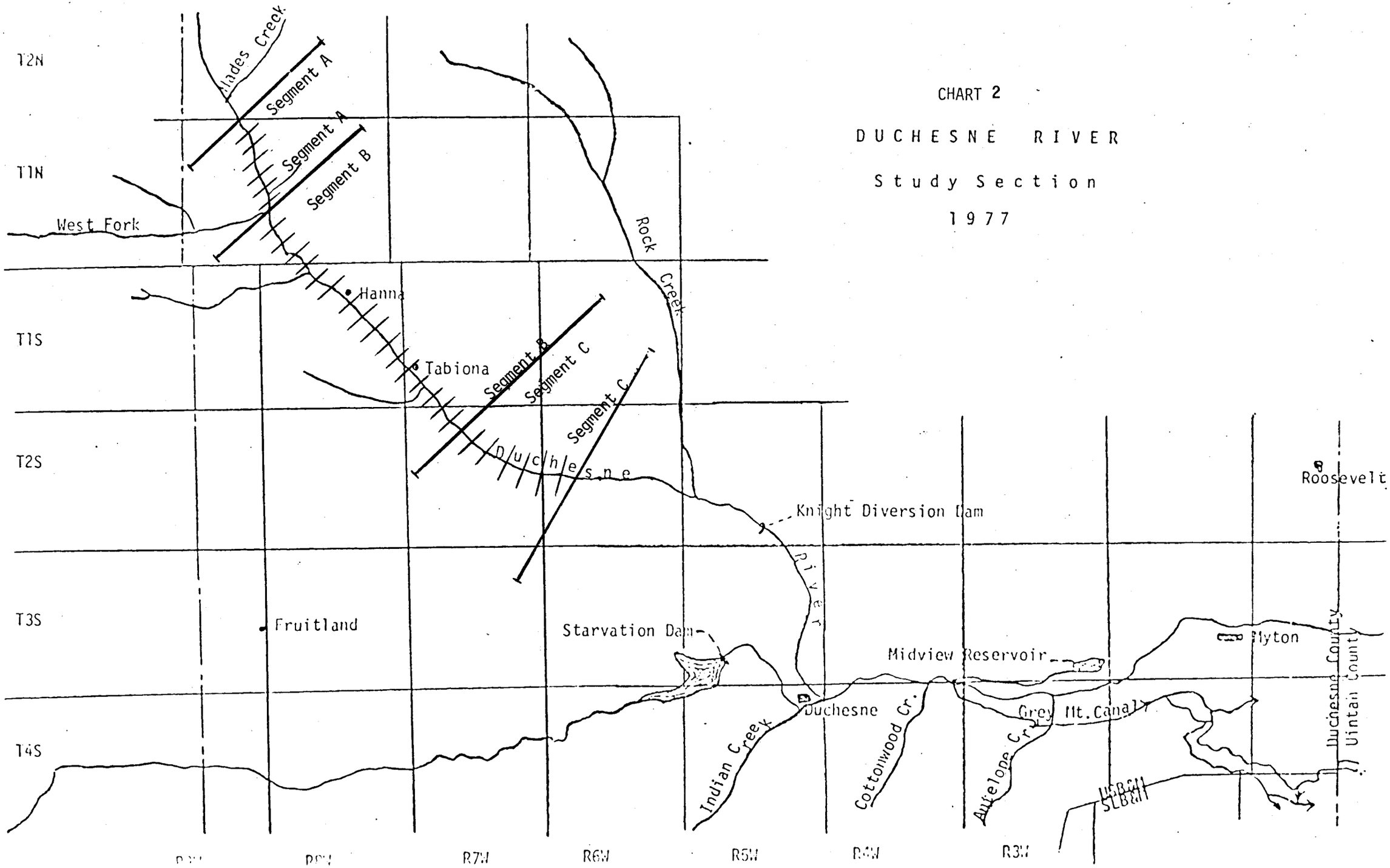


CHART 2
DUCHESNE RIVER
Study Section
1977
T2N
T1N
T1S
T2S
T3S
T4S
R7W
R6W
R5W
R3W
Alades Creek
Segment A
Segment A
Segment B
West Fork
Hanna
Tabiona
Segment B
Segment C
Segment C
Rock Creek
Duchesne
Knight Diversion Dam
River
Roosevelt
Fruitland
Starvation Dam
Midview Reservoir
Flyton
Duchesne
Indian Creek
Cottonwood Cr.
Antelope Cr.
Grey Mt. Canal
Duchesne County
Uintah County

The 1975-1976 time period was utilized in the analysis of existing data on the soils, intake rate of the soils, and stream flow records. Correlation and analysis of the stream flow records towards the contribution of the various sources of water to the Duchesne were made in 1977 to clarify and to add to the previous measurements made in 1974.

The purpose of the 1977 investigation was to gather return flow information on the Duchesne River in the Hanna-Tabiona area and to collect additional information to refine the 1974 data in the following areas:

1. To determine the relative contribution of the West Fork and the North Fork to the Duchesne River.

2. To determine the contributions of Rock Creek to the Main River.

A section of river about 22 miles long was selected for additional study. The section begins part way up the North Fork above the Aspen campgrounds and extends downstream to the bridge on Highway 35 across the Duchesne River about 8 miles southeast of Tabiona.

This section of the river was then divided into three segments. These three segments are as follows and are illustrated on a map as Chart 2 on page 13 of this report.

1. Segment A covers about 4 miles and begins part way up the North Fork above the Aspen Campgrounds and extends downstream to the bridge across the north fork on Highway 35 near the confluence of the north fork and the west fork of the Duchesne River.

2. Segment B covers about 13 miles and extends from the bridge on Highway 35 near the confluence of the west fork and the north fork of the Duchesne River to the bridge on Highway 208 across the Duchesne River about 3 miles southeast of Tabiona.

3. Segment C covers about 5 miles and extends from the bridge on Highway 208 across the Duchesne River about 3 miles southeast of Tabiona to the bridge across the Duchesne River on Highway 35 about 8 miles southeast of Tabiona.

Two series of measurements were made, the first on September 29 and 30, 1977 and the second on October 6 and 7, 1977. Each series consisted of obtaining measurements of the river at 4 points and 1 gaging station and measurements of 12 canals and ditches. Personnel involved in these measurements were Ted Baldwin of the Division of Water Rights and David Clayburn, Duchesne River Commissioner.

VIII. TABULATION OF 1977 MEASUREMENTS

TABLE 4

Segment A:

PLACE OF MEASUREMENT	c.f.s.	c.f.s.
FIRST RUN:		
Streamflow:		
North Fork Duchesne above Aspen Campgrounds	22.04	
Big Springs Area	2.00	
Total		25.04
Diversions:		
Rhodes Canal	15.50	
Big Springs	.90	
Total		16.40

SECTION A CON'T:

PLACE OF MEASUREMENT	c.f.s.	c.f.s.
SECOND RUN		
Streamflow:		
North Fork Duchesne River above Aspen Campgrounds	36.02	
Big Springs Area	3.00	
Total		39.02
Diversions:		
Rhodes Canal	16.20	
Big Springs	1.50	
Total		17.70

SECTION B:

PLACE OF MEASUREMENT	c.f.s.	c.f.s.
FIRST RUN:		
Streamflow:		
North Fork Duchesne below Highway 35 Bridge	20.48	
West Fork Duchesne near Highway 35 Bridge	14.44	
Total		34.92
Diversions:		
Turnbow Ditch	2.00	
Defa Ditch	.33	
Farm Creek Canal	21.75	
Little Farm Creek Canal	1.76	
Jasper Pike Canal	13.60	
Thomas Ditch	.00	
Tabby Canal	2.00	
Hicken Canal	2.86	
Total		44.30
SECOND RUN:		
Streamflow:		
North Fork Duchesne below Highway 35 Bridge	27.05	
West Fork Duchesne near Highway 35 Bridge	17.96	
Total		45.01
Diversions:		
Turnbow Ditch	2.00	
Defa Ditch	.33	
Farm Creek Canal	21.00	
Little Farm Creek Canal	1.94	
Jasper Pike Canal	16.20	
Thomas Ditch	4.00	
Tabby Canal	2.00	
Hicken Canal	5.11	
Total		52.58

SECTION C:

PLACE OF MEASUREMENT	c.f.s.	c.f.s.
FIRST RUN:		
Streamflow:		
Duchesne River above Highway 208 Bridge	63.61	
Total		63.61
Diversions:		
Wagstaff Ditch	1.50	
Brown Ditch	.50	
Private Ditches	2.00	
Total		4.00
SECOND RUN:		
Streamflow:		
Duchesne River above Highway 208	72.04	
Total		72.04
Diversions:		
Wagstaff Ditch	1.50	
Brown Ditch	.50	
Private Ditches	2.00	
Total		4.00

Measurements of the North Fork and the West Fork of the Duchesne River were utilized with data from U.S.G.S. gaging stations on the West Fork of the Duchesne, on Wolf Creek and on the Duchesne River to Determine the contribution of these sources to the base flow of the Duchesne River in the Hanna-Tabiona Area. Correlation of historical streamflow with commissioner records and the 1977 measurements suggest the North Fork and the West Fork contribute an average of about 62 percent of the flow of the Duchesne River in the Hanna-Tabiona area with Springs, and small tributaries contributing about 38 percent. The following table summarizes the information.

CONTRIBUTION OF WEST FORK AND
NORTH FORK TO DUCHESNE RIVER

TABLE 5

ITEM	FLOW			PERCENT OF FLOW OF DUCHESNE RIVER NEAR TABIONA		
	1945-1975 30 year average	1977 Run 1	1977 Run 2	30 yr. avg.	Run 1	Run 2
	c.f.s.	c.f.s.	c.f.s.	%	%	%
West Fork Duchesne River	56.8	14.44	17.96	28	23	25
North Fork Duchesne River		20.48	27.05		32	38
Total of West & North Fork		34.92	45.01		55	62
Duchesne River near Tabiona	202.0	63.61	72.04	100	100	100

The records from the U.S.G.S.gaging stations on Rock Creek and the Duchesne River were utilized to determine the contribution of Rock Creek to the flow of the Duchesne River above the Knight Diversion. The records of the gaging stations show that Rock Creek contributes an average of 49 percent of the flow of the Duchesne River above the Knight Diversion. The following table summarizes the information.

CONTRIBUTION OF ROCK CREEK TO
DUCHESNE RIVER

TABLE 6

I T E M	FLOW 1963 - 1975 12 year average	PERCENT OF FLOW OF DUCHESNE RIVER ABOVE KNIGHT DIVERSION 12 YEAR AVERAGE
	c.f.s.	%
Rock Creek	195	49
Duchesne River above Knight Diversion	397 (5 yr. avg. 1970-1975)	

IX. SUMMARY

The Duchesne River return flow study was partially completed during the 1974 irrigation season. During 1975 and 1976, analyses were made of existing data on soils and on stream flow records. Additional measurements were made in 1977 near the end of the irrigation season on a segiment of the river in the Hanna-Tabiona area. The 1974 work was carried out in two phases during July and August when river flow and diversions were stable enough for measurements without large fluctuations. Field work was reconnoitering the river area, selecting a section for study, and gathering basic data on stream flow and diversions to determine the effect of the diversions on river flow. The 1977 work was carried out in two phases during September and October. The field work followed the same pattern as was set in 1974.

SUMMARY OF 1974 and 1977 MEASUREMENTS

TABLE 7

1974

1	2	3	4	5	6	7	8	9	10	11
Reach	Run	Inflow 1/	Diverted	Outflow 2/	Flow 3/ Depletion		Flow 3/ Increase		Flow Increase in Reach 4/	
		c.f.s.	c.f.s.	c.f.s.	c.f.s.	%	c.f.s	%	c.f.s.	%
1	1	93.5	82.4	76.0	17.5	18.7			64.9	69.4
1	2	56.5	30.4	58.0			1.5	2.7	31.9	56.6
2	1	79.0	123.6	102.0			23.0	29.1	146.6	185.6
2	2	58.0	86.5	67.2			7.2	12.0	93.7	156.2
3	1	255.0	65.8	193.0	62.0	24.3			41.5	16.3
3	2	152.7	54.3	92.0	60.7	39.8			-6.4	-4.2
4	1	587.0	633.2	175.0	412.0	70.2			221.2	37.7
4	2	44.0	526.5	47.4	396.6	89.3			129.9	29.3
Total Inflow in All Reaches from All Sources								Run 1: 474.2 Run 2: 249.1		
Average Percentage Increase of All Reaches								Run 1: 77.3 Run 2: 59.5		

1/ Measured flow at top of reach.

2/ Measured Flow at botton of reach.

3/ Difference between Columns 3 and 5.

4/ Increase or decrease in water supply due to inflow between measuring points at bottom and top of reach.

1977

TABLE 8

1	2	3	4	5	6	7	8	9	10	11
Segment	Run	Inflow 1/	Diverted	Outflow 2/	Flow 3/ Depletion		Flow 3/ Increase		Flow Increase in Segment	
		c.f.s.	c.f.s.	c.f.s.	c.f.s.	%	c.f.s.	%	c.f.s.	%
A	1	25.04	16.40	20.48	4.56	18.2			11.84	47.3
A	2	29.02	17.70	27.05	11.97	30.6			5.73	17.7
B	1	34.92	44.30	63.61			28.69	82.2	72.99	209.0
B	2	45.01	52.58	72.04			27.03	60.1	79.61	176.9
C	1	63.61	4.0	59.10	4.51	7.1			-.51	- .8
C	2	72.04	4.0	62.30	9.74	13.5			-5.74	-7.9
Total Inflow in All Segments from All Sources							Run 1: 84.32 Run 2: 79.60			
Average Percentage Increase of All Segments							Run 1: 85.2 Run 2: 61.2			

1/ Measured flow at top of segment.

2/ Measured flow at bottom of segment.

3/ Difference between Columns 3 and 5.

4/ Increase or decrease in water supply due to inflow between measuring points at bottom and top of segment.

As a part of the 1977 study, information was gathered on the West Fork of the Duchesne River, the North Fork of the Duchesne River and on Rock Creek pertaining to their contribution to the water supply. This information is summarized below.

The West Fork of the Duchesne River has a drainage area of about 79 square miles. This drainage yields an average of 41, 160 acre feet of water annually based on records of 30 years from 1945 to 1975 at the U.S.G.S. gaging stations located on Wolf Creek, about 9 miles northwest of Hanna, and on the West Fork of the Duchesne River, about 7 miles northwest of Hanna. The watershed contributes about 28 percent of the flow of the Duchesne River in the Hanna-Tabiona Area.

No gaging stations are located on the North Fork of the Duchesne River. But measurements made on the North Fork show it contributing about 35 percent of the flow of the Duchesne River in the Hanna-Tabiona area. Adjusting this figure on the basis of the 30 year average of flow records for the West Fork, it might be expected that the North Fork would contribute an average of 40 percent of the flow of the Duchesne River in the Hanna-Tabiona area.

Rock Creek has a drainage area of 240 square miles. This drainage yeilds an average of 141,300 acre-feet of water annually based on the records of 12 years from 1963 to 1975 at the U.S.G.S. Gaging Station located near the mouth of Rock Creek and about 11 miles northwest of Duchesne. The watershed contributes about 49 percent of the flow of the Duchesne River above Duchesne.

It was concluded that from the tabulation of measurements contained herein, stream accretion varied in quantity through the study section and consisted of inflow from (1) small tributaries, (2) spring flow, (3) river underflow, (4) conveyance losses, and (5) filtration from irrigated lands. The isolation and identification of these different sources was concluded to be impractical in this study. To provide what information is available at this time for all of the canals involved, a general estimate of the

return flow was made in 1974 as shown in table 9.

TABLE 9

Estimate of 1974 Return Flow

Run	Reach 1	Reach 2	Reach 3	Reach 4	Average
	%	%	%	%	%
1	46	70	16	38	43
2	26	66	0	29	29

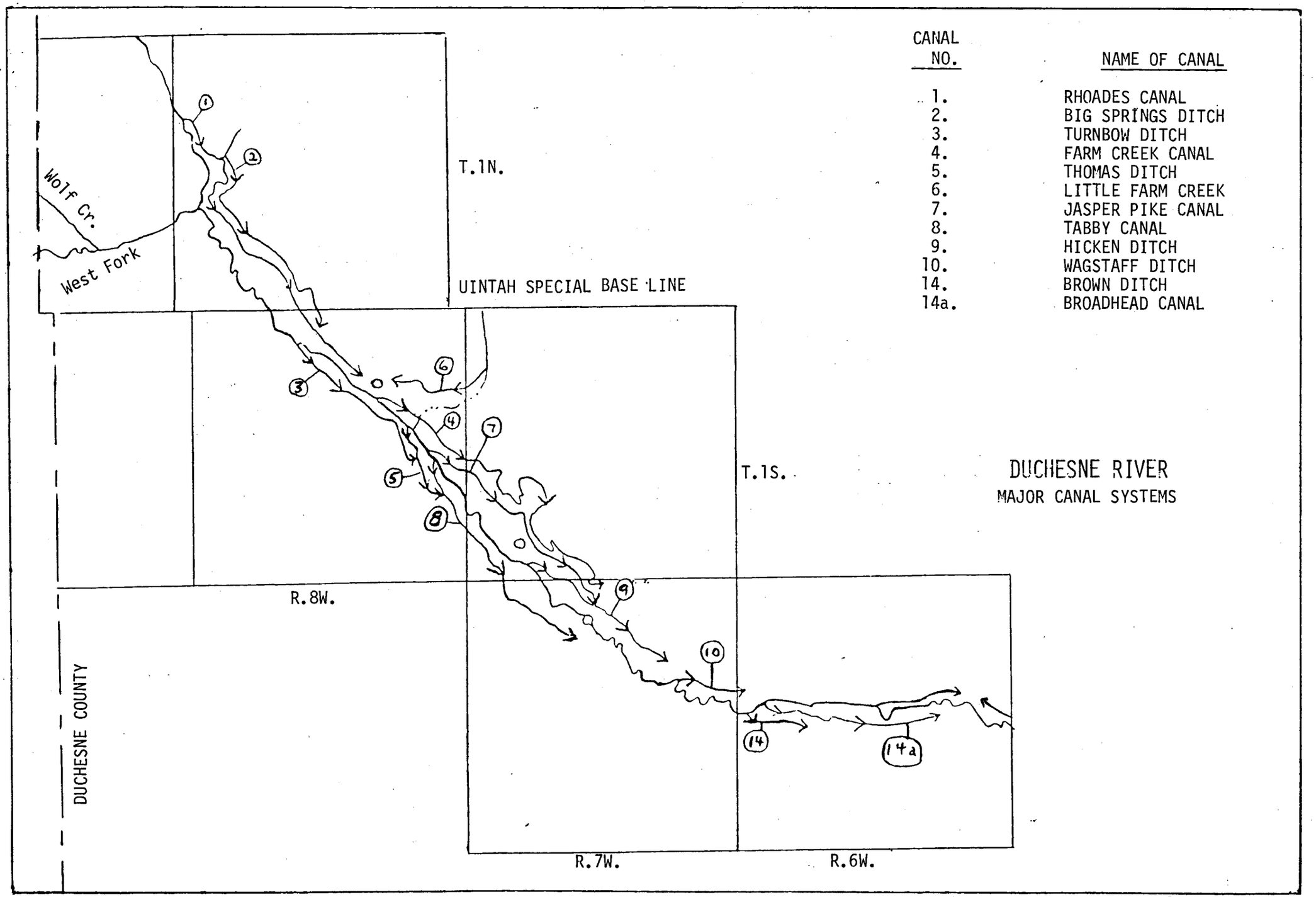
1/ This estimate is probably on the low side as present data is not sufficient to allow a more accurate determination. It must be emphasized that the estimates set forth in Table 9 are very preliminary and subject to revision as additional data is obtained.

Infiltrometer studies in Zone I and Zone II in the Hanna-Tabiona area indicate that the soils have a high intake flow rate. The texture, structure, degree of dispersion, depth to water table and vegetative cover of the soils contribute to a high flow rate, about 18 inches for the first hour. The Return Flow Studies of the Duchesne River show that the area has the highest river flow increases averaging 182 percent, for the reaches and segments of the study.

An average of 99,043 acre-feet of water is diverted into the Rhoades Canal, the Pioneer Canal, the Rocky Point Canal, the Grey Mountain Canal during an irrigation season, based on diversions from 1961 to 1977, to irrigate an average of 19,354 acres. Using data from the State Engineer's study of canal losses for these canals, it is calculated that 85,027 acre-feet of water was delivered to the farm headgate under these canals.

Considering the following parameters, further study suggested an average return flow figures as shown below. An average of 244,413 acre-feet of water is diverted into all the canals in the Duchesne River Area during an irrigation season based on diversions from 1961 to 1977 to irrigate an average of approximately 45,334 acres. It is estimated that 210,195 acre-feet was delivered to the farm headgate for all canals.

With the information from the return flow studies by the Division of Water Rights and United States Geological Survey, and using the calculations of the water diverted, delivered and used, a general estimation of return flow can be made for the Duchesne River Area. The return flow is estimated to be about one-third of the water diverted for irrigation. The remaining two-thirds is used by vegetation along the canals and field ditches and by crops, is lost from water and soil surface by evaporation and is lost into the ground by deep infiltration.



CANAL NO.	NAME OF CANAL
1.	RHOADES CANAL
2.	BIG SPRINGS DITCH
3.	TURNBOW DITCH
4.	FARM CREEK CANAL
5.	THOMAS DITCH
6.	LITTLE FARM CREEK
7.	JASPER PIKE CANAL
8.	TABBY CANAL
9.	HICKEN DITCH
10.	WAGSTAFF DITCH
14.	BROWN DITCH
14a.	BROADHEAD CANAL

DUCHESNE RIVER
MAJOR CANAL SYSTEMS

ILLUSTRATION 2

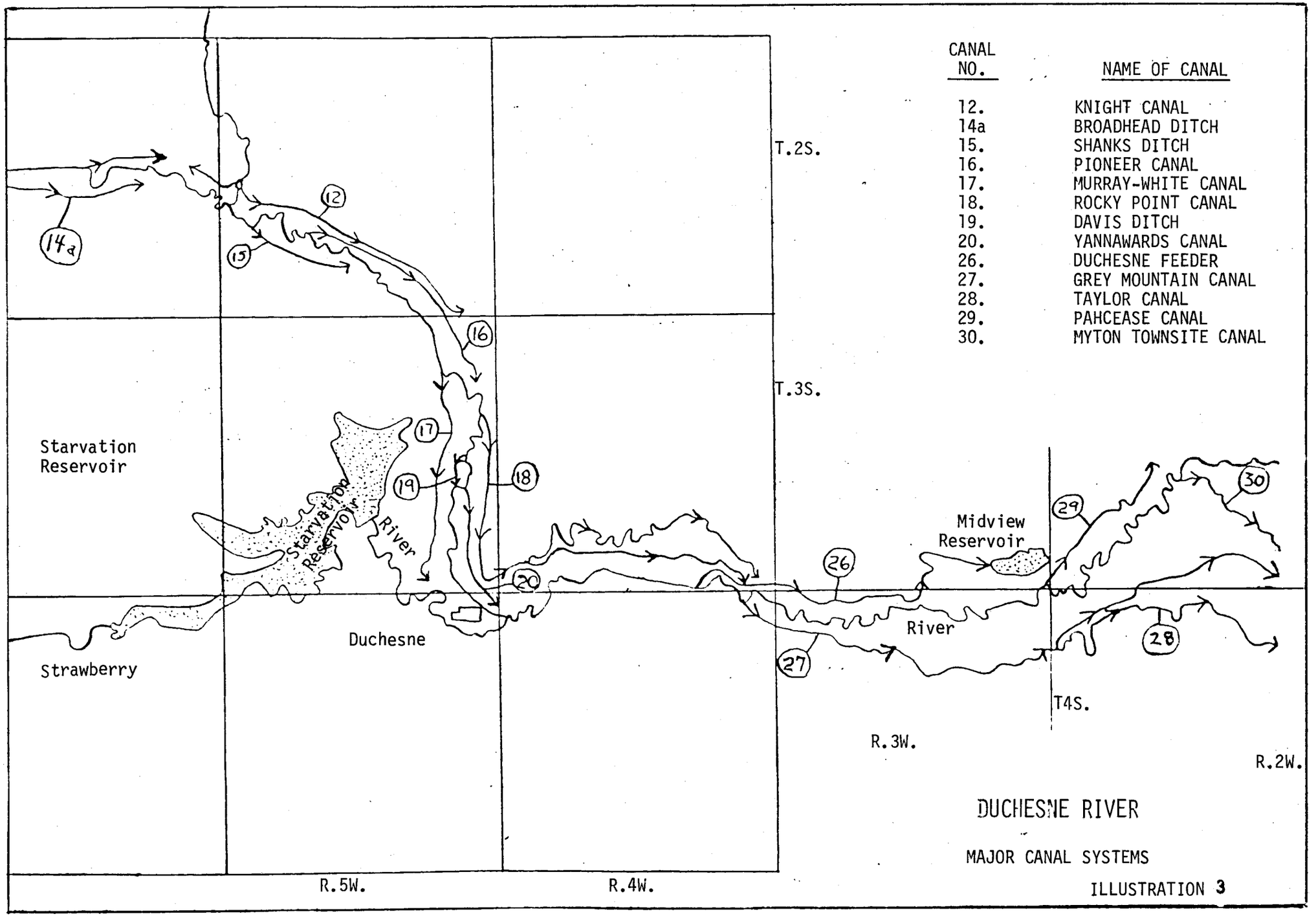

CANAL NO.
NAME OF CANAL
12. KNIGHT CANAL
14a BROADHEAD DITCH
15. SHANKS DITCH
16. PIONEER CANAL
17. MURRAY-WHITE CANAL
18. ROCKY POINT CANAL
19. DAVIS DITCH
20. YANNAWARDS CANAL
26. DUCHESNE FEEDER
27. GREY MOUNTAIN CANAL
28. TAYLOR CANAL
29. PAHCEASE CANAL
30. MYTON TOWNSITE CANAL
T.2S.
T.3S.
T4S.
R.5W.
R.4W.
R.3W.
R.2W.
Starvation Reservoir
Starvation Reservoir
Duchesne River
Strawberry
Midview Reservoir
Duchesne River
14a
12
15
16
17
18
19
20
26
27
28
29
30
DUCHESNE RIVER
MAJOR CANAL SYSTEMS
ILLUSTRATION 3

TABLE 10

HANNA - DUCHESNE AREA STREAMFLOW MEASUREMENTS

MONTH 1962	Location of Gaging Stations					
	Hades Creek near Hanna	Duchesne River near Hanna	West Fork Duchesne near Hanna	Wolf Creek above Rhodes Canyon near Hanna	Duchesne River near Tabiona	Duchesne River at Duchesne
	Acre Feet	Acre Feet	Acre Feet	Acre Feet	Acre Feet	Acre Feet
January	225	409	593	123	4,800	7,850
February	199	379	601	115	4,780	10,940
March	164	405	674	130	5,920	11,830
April	524	4,000	4,900	239	18,190	29,440
May	1,600	13,170	15,780	961	32,870	58,050
June	2,850	13,440	14,000	1,650	32,310	86,420
July	1,880	3,140	3,790	844	12,570	29,250
August	492	1,130	1,770	502	6,860	11,240
September	162	770	1,310	355	6,150	8,250
October	85	694	1,220	336	7,220	11,770
November	173	572	984	271	6,230	8,950
December	195	479	940	249	6,700	9,300
Annual	8,549	38,588	46,562	5,775	144,600	283,290

TABLE 11

HANNA - DUCHESNE AREA STREAMFLOW MEASUREMENTS

MONTH 1966	Location of Gaging Stations					
	Hades Creek near Hanna	West Fork Duchesne near Hanna	Wolf Creek above Rhodes Canyon near Hanna	Duchesne River Near Tabiona	Rock Creek near Talmage	Duchesne River at Duchesne
	Acre feet	Acre feet	Acre feet	Acre feet	Acre feet	Acre feet
January	296	966	329	9,050	3,590	12,760
February	198	750	259	6,730	2,680	10,370
March	182	1,250	273	9,260	3,940	13,530
April	314	4,260	378	13,900	7,070	20,020
May	1,270	11,700	1,170	22,730	35,290	51,940
June	904	4,340	740	9,720	19,930	23,670
July	520	1,970	528	8,500	8,450	12,830
August	286	1,340	386	5,720	6,260	8,370
September	130	1,200	317	5,700	5,730	8,430
October	71	1,080	286	5,800	5,540	9,900
November	185	897	241	5,800	4,480	9,050
December	114	881	222	7,120	4,410	11,970
Annual	4,470	30,634	5,129	110,030	107,370	192,840

TABLE 12 HANNA - DUCHESNE AREA STREAMFLOW MEASUREMENTS

MONTH 1970	Location of Gaging Stations					
	West Fork Duchesne River near Hanna	Wolf Creek above Rhodes Canyon near Hanna	Duchesne River near Tabiona	Rock Creek near Talmage	Duchesne River above Knight Diversion	Duchesne River at Duchesne
	Acre feet	Acre feet	Acre feet	Acre feet	Acre feet	Acre feet
January	1,080	300	6,540	2,750	---	4,130
February	918	241	6,090	2,560	---	1,080
March	962	238	6,000	2,880	---	1,810
April	1,250	234	6,180	2,900	8,490	6,110
May	9,680	898	16,920	22,620	35,480	---
June	9,380	1,110	28,140	41,460	67,230	---
July	2,550	629	9,230	12,940	21,580	---
August	1,420	488	5,150	6,160	10,130	---
September	1,160	423	5,120	5,850	10,320	---
October	1,220	324	5,820	4,140	11,100	---
November	1,050	277	7,640	4,170	11,970	---
December	988	259	6,050	3,670	10,140	---
Annual	31,658	5,421	108,880	112,100	---	---

TABLE 13 HANNA - DUCHESNE AREA STREAMFLOW MEASUREMENTS

MONTH 1974	Location of Gaging Stations				
	West Fork Duchesne River near Hanna	Wolf Creek above Rhodes Canyon near Hanna	Duchesne River near Tabiona	Rock Creek near Talmage	Duchesne River above Knight Diversion
	Acre Feet	Acre Feet	Acre Feet	Acre Feet	Acre Feet
January	1,140	203	6,900	3,030	11,330
February	899	167	5,340	2,290	9,270
March	1,230	176	6,760	2,870	11,850
April	1,570	188	6,840	3,680	12,330
May	14,390	1,230	46,970	32,040	88,690
June	8,100	1,240	36,510	36,100	72,430
July	2,410	657	7,110	10,270	13,920
August	1,360	472	4,880	4,870	7,480
September	1,050	366	4,630	3,170	6,280
October	1,180	314	6,340	3,840	9,940
November	1,070	272	7,030	3,480	10,190
December	1,040	260	6,230	3,230	9,470
Annual	35,439	5,545	145,510	108,870	263,180

TABLE 14

STREAM FLOW RECORDS OF U.S.G.S. GAGING STATIONS
IN HANNA - DUCHESNE AREA

GAGING STATION	YEAR				AVERAGE DISCHARGE	YEARS OF RECORD		Sq./miles
	1962	1966	1970	1974		No. of Years	Years	
	ac./feet	ac./feet	ac./feet	ac./feet	c.f.s.			
Hades Creek near Hanna	8,549	4,470	---	---	8.77	17	1949-1966	7.5
Duchesne River near Hanna	38,588	---	---	---	---	13	1949-1962	78
West Fork Duchesne River near Hanna	46,562	30,634	31,658	35,439	48.9	30	1922-1923 1945-1974	61
Wolf Creek above Rhodes Canyon near Hanna	5,775	5,129	5,421	5,545	7.63	29	1945-1974	9
Duchesne River near Tabiona	144,600	110,030	108,880	145,510	201	56	1918-1974	352
Rock Creek near Talmage	---	107,370	112,100	108,870	153	11	1963-1974	240
Duchesne River above Knight Diversion	---	---	---	263,180	---	4	1970-1974	620
Duchesne River at Duchesne	283,290	192.840	---	---	357	49	1917-1966	660

TABLE 15

ACRE INCHES OF WATER DIVERTED AND DELIVERED - RHOADES CANAL

MONTH	YEAR 61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	Avg. Inches	Etp.[1/] Inches	Avg.[2/] Precip. Inches
APRIL: Diversion	4.1																	
Delivery	1.5																	
MAY Diversion	12.9	29.0	16.3	9.0	8.1	22.3	9.5	8.8	21.3	11.2	15.1	19.9	7.7	12.6	1.4	14.4		
Delivery	8.9	10.8	6.1	3.3	3.0	8.2	3.5	3.3	7.9	4.2	5.6	7.4	2.9	4.7	.5	5.4	4.2	1.2
JUNE Diversion	21.1	43.8	24.5	39.4	36.5	31.5	27.2	29.6	33.4	27.7	29.6	34.7	25.3	19.3	18.3			
Delivery	7.8	16.3	9.1	14.6	13.5	11.7	10.1	11.0	12.4	10.3	11.0	12.9	9.4	7.2	6.8	10.9	4.9	.8
JULY Diversion	5.3	38.0	17.6	33.6	33.3	13.5	34.9	28.5	25.5	19.7	28.4	18.7	14.5	17.0	22.4	23.4		
Delivery	2.0	14.1	6.5	12.5	12.4	5.0	13.6	10.6	9.5	7.3	10.5	6.9	5.4	6.3	8.3	9.8	5.7	.9
AUGUST Diversion	7.1	20.1	12.1	11.7	27.6	10.6	16.1	24.4	15.5	13.1	13.4	12.8	15.9	9.8	15.6	15.1		
Delivery	2.6	7.5	4.5	4.3	10.3	3.9	6.0	9.1	5.8	4.9	5.0	4.8	5.9	3.7	5.8	5.6	5.1	1.6
SEPTEMBER Diversion	10.6	10.7	9.7	7.3	15.8	8.3	10.8	22.6	11.5	9.8	13.9	12.5	13.4	7.0	10.3	11.6		
Delivery	3.9	4.0	3.6	2.7	5.9	3.1	4.0	8.4	4.3	3.6	5.2	4.6	5.0	2.6	3.8	4.3	3.9	1.2
OCTOBER Diversion	4.1	9.2	9.2	7.0	12.2	4.9	10.9	11.5	14.2	5.0	7.5	7.6	7.1	2.6	6.0	7.9		
Delivery	1.5	3.4	3.4	2.6	4.5	1.8	4.0	4.3	5.3	1.9	2.8	2.8	2.7	1.0	2.2	2.9	2.9	.9

1/ Evapotranspiration

2/ Average precipitation

TABLE 16

ACRE INCHES OF WATER DIVERTED AND DELIVERED - PIONEER CANAL

MONTH	YEAR															Avg. Inches	Etp.[1/] Inches	Avg.[2/] Precip. Inches
	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75			
APRIL: Diversion	1.8	.9	3.5			2.8					2.3	1.0		.2		1.8		
Delivery	1.1	.5	2.1			1.6					1.3	.6		.1		1.1		
MAY Diversion	9.9	14.4	12.3	11.5	8.0	11.9	14.0	9.7	15.9	13.2	12.2	13.9	8.2	13.3	1.4	11.3		
Delivery	5.8	8.5	7.2	6.8	4.7	7.0	8.2	5.7	9.3	7.8	7.2	8.2	4.8	7.8	.8	6.6	4.7	.8
JUNE Diversion	8.7	12.3	12.4	10.8	11.3	15.3	5.8	12.0	7.0	11.2	10.6	9.2	13.0	9.2	18.3	11.1		
Delivery	5.1	7.2	7.3	6.4	6.6	9.8	3.4	7.1	4.1	6.6	6.2	5.4	7.6	5.3	10.8	6.5	5.5	1.0
JULY Diversion	5.2	14.9	11.5	15.0	14.3	9.5	13.5	14.8	15.2	15.0	12.3	14.8	9.9	10.9	22.4	13.3		
Delivery	3.1	8.8	6.8	8.8	8.4	5.6	7.9	8.7	8.9	8.8	7.2	8.7	5.8	6.4	13.2	7.8	6.1	.8
AUGUST Diversion	5.3	8.4	7.6	8.5	5.9	7.4	9.6	5.9	9.6	8.2	9.1	8.3	8.2	10.3	15.6	8.5		
Delivery	3.1	4.9	4.5	5.0	3.5	4.4	5.6	3.5	5.6	4.8	5.3	4.9	4.8	6.1	9.2	5.0	5.6	1.1
SEPTEMBER Diversion	3.2	7.5	.1	6.2	5.5	4.7	8.2	10.3	7.8	7.1	8.6	6.6	7.0	5.6	10.3	6.6		
Delivery	1.9	4.4	.1	3.6	3.2	2.8	4.8	6.1	4.6	4.2	5.0	3.9	4.1	3.3	6.0	3.9	4.2	.8
OCTOBER Diversion	2.5	.5	4.2	7.3	.0	2.7	3.5	4.2	2.7	5.3	4.5	3.1	8.5	4.1	6.0	3.9		
Delivery	1.5	.3	2.5	4.3	.0	1.6	2.1	2.5	1.6	3.1	2.7	1.8	5.0	2.4	3.5	2.3	3.2	.9

1/ Evapotranspiration

2/ Average precipitation

TABLE 17 ACRE INCHES OF WATER DIVERTED AND DELIVERED - ROCKY POINT CANAL

MONTH	YEAR 61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	Avg. Inches	Etp.[1/] Inches	Avg.[2/] Precip. Inches
APRIL: Diversion	8.1	3.6	7.4	2.7	.5	3.7	3.3	2.0	1.9	6.9	5.4	6.8		1.4		4.1		
Delivery	7.6	3.4	6.9	2.5	.4	3.5	3.1	1.8	1.7	6.5	5.1	6.4		1.3		3.8		
MAY Diversion	11.1	12.8	12.1	12.3	12.9	13.8	13.3	11.2	13.7	10.7	11.7	10.4	7.1	10.2	9.5	11.5	4.7	
Delivery	10.4	12.0	11.3	11.6	12.1	12.9	12.5	10.5	12.8	10.0	10.9	9.8	6.7	9.6	8.9	10.8		.8
JUNE Diversion	9.3	12.0	10.0	12.9	12.8	12.8	8.9	12.1	13.8	12.8	13.9	12.0	13.7	9.4	8.5	11.7		
Delivery	8.7	11.3	9.4	12.1	12.0	12.0	8.4	11.4	12.9	12.0	13.1	11.3	12.8	8.8	7.9	10.9	5.5	1.0
JULY Diversion	5.7	12.6	8.8	11.9	10.0	9.6	15.5	14.5	14.5	11.8	13.1	11.5	13.7	10.0	10.6	11.6		
Delivery	5.3	11.8	8.3	11.2	9.4	9.0	14.6	13.6	13.6	11.1	12.3	10.8	12.9	9.4	9.9	10.9	6.1	.8
AUGUST Diversion	5.1	8.0	9.0	8.6	9.3	7.3	9.1	10.5	10.5	9.4	10.1	11.3	9.5	10.2	9.2	9.2		
Delivery	4.8	7.5	8.5	8.1	8.7	6.7	8.5	9.9	9.9	8.8	10.0	10.6	8.9	9.6	8.6	8.6	5.6	1.1
SEPTEMBER Diversion	5.2	6.5	7.3	6.2	4.2	9.0	10.8	9.4	7.1	7.2	10.4	9.5	9.1	7.9	6.0	7.7		
Delivery	4.9	6.1	6.9	5.8	3.9	8.5	10.1	8.8	6.7	6.8	9.8	8.9	8.5	7.4	5.6	7.2	4.1	.8
OCTOBER Diversion	1.7	7.6	8.0	3.1	1.7	4.0	7.2	4.4	6.3	6.7	8.9	5.4	6.6	5.1	5.9	5.5		
Delivery	1.6	7.1	7.5	2.9	1.6	3.8	6.8	4.1	5.9	6.3	8.4	5.1	6.2	4.8	5.5	.2	3.2	.9

1/ Evapotranspiration

2/ Average precipitation

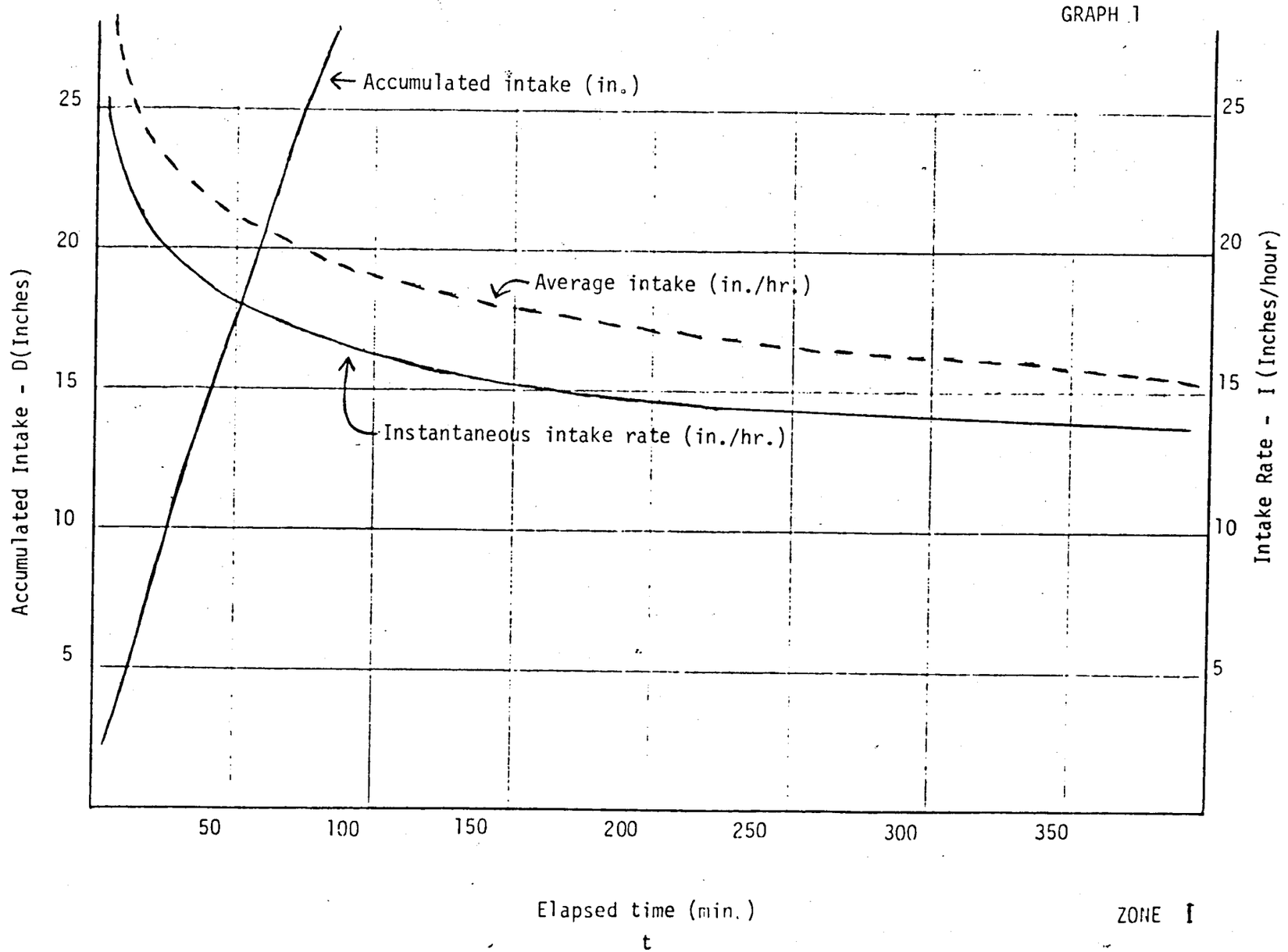
TABLE 18 ACRE INCHES OF WATER DIVERTED AND DELIVERED - GRAY MOUNTAIN CANAL

MONTH	YEAR 61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	Avg. Inches	Etp. 1/ Inches	Avg. 2/ Precip. Inches
APRIL: Diversion	6.1	.6	7.2	4.2	.3	5.0	1.2	2.2	.3	2.0	5.1	3.4		5.2		3.3		
Delivery	5.6	.5	6.6	3.9	.3	4.6	1.1	2.0	.3	1.8	4.7	3.1		4.8		3.0		
MAY Diversion	8.0	8.1	21.5	15.5	10.9	22.2	16.8	14.5	23.4	16.0	12.7	11.4	6.8	13.7	9.1	14.0		
Delivery	7.4	7.4	19.8	14.3	10.0	20.4	15.4	13.3	21.5	14.7	11.7	10.5	6.2	12.6	8.4	12.9	4.8	.8
JUNE Diversion	5.6	13.7	17.0	12.4	8.2	15.6	7.4	13.0	8.9	10.2	11.8	11.3	12.3	12.8	8.7	11.3		
Delivery	5.1	12.6	15.6	11.4	7.5	14.3	6.8	11.9	8.2	9.4	10.8	10.4	11.3	11.8	8.0	10.4	5.6	1.0
JULY Diversion	6.7	11.5	11.1	15.5	12.0	9.3	16.6	18.9	17.5	11.7	14.3	11.4	13.2	14.1	11.9	13.0		
Delivery	6.2	10.6	10.0	14.3	11.0	8.5	15.3	17.4	16.1	10.8	13.1	10.5	12.1	12.9	10.9	11.9	6.2	.8
AUGUST Diversion	5.2	5.5	10.2	9.5	10.5	7.2	8.7	4.1	11.8	6.4	10.7	8.2	10.1	9.5	10.4	8.5		
Delivery	4.8	5.1	9.4	8.7	9.7	6.6	8.0	3.8	10.8	5.9	9.8	7.5	9.3	8.7	9.6	7.8	5.7	1.0
SEPTEMBER Diversion	.8	3.7	7.0	5.4	6.2	5.1	6.3	8.7	5.8	4.9	9.1	7.2	8.0	8.0	8.6	6.3		
Delivery	.7	3.4	6.4	4.9	5.7	4.7	5.8	8.0	5.3	4.5	8.4	6.6	7.4	7.4	7.9	5.8	4.2	.8
OCTOBER Diversion	.6	16.1	5.8	2.8	4.1	3.3	3.2	2.8	4.1	1.9	0	4.8	4.6	3.4	6.8	4.3		
Delivery	.5	14.8	5.3	2.6	3.7	3.0	2.9	2.6	3.8	1.7	0	4.4	4.2	3.1	6.2	3.9	3.2	.9

1/ Evapotranspiration

2/ Average precipitation

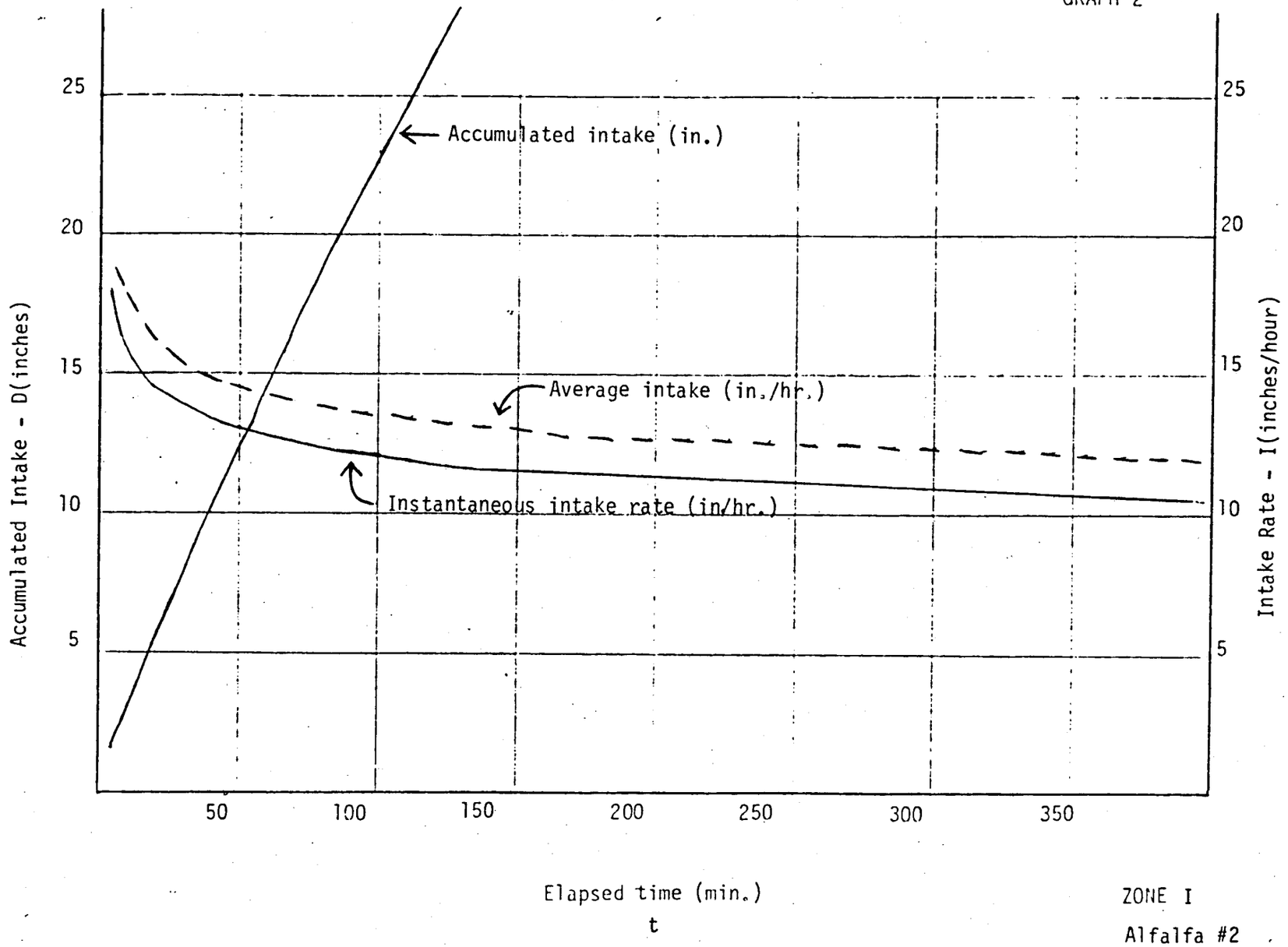
GRAPH 1



ZONE I

Alfalfa #1

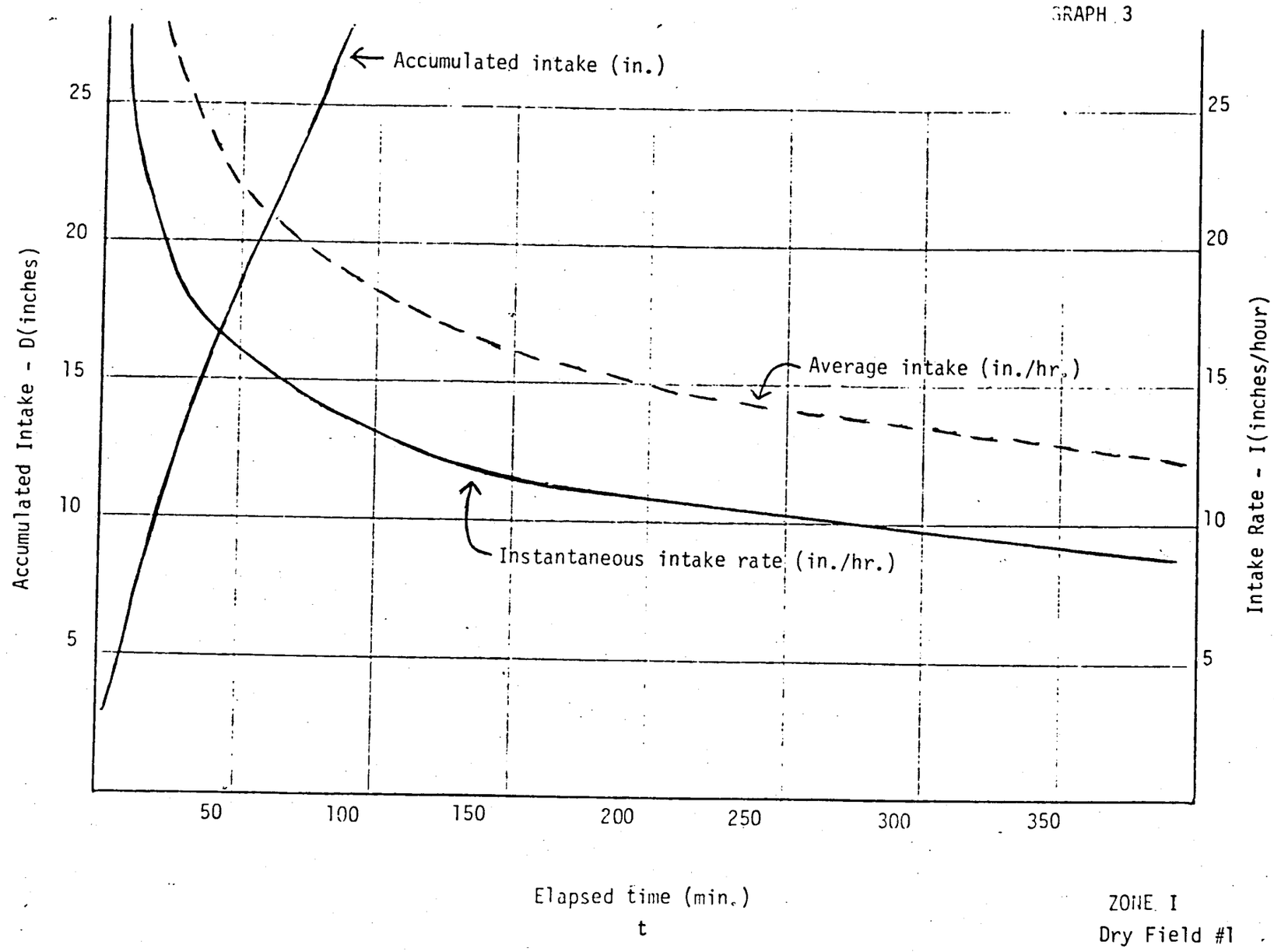
GRAPH 2



ZONE I

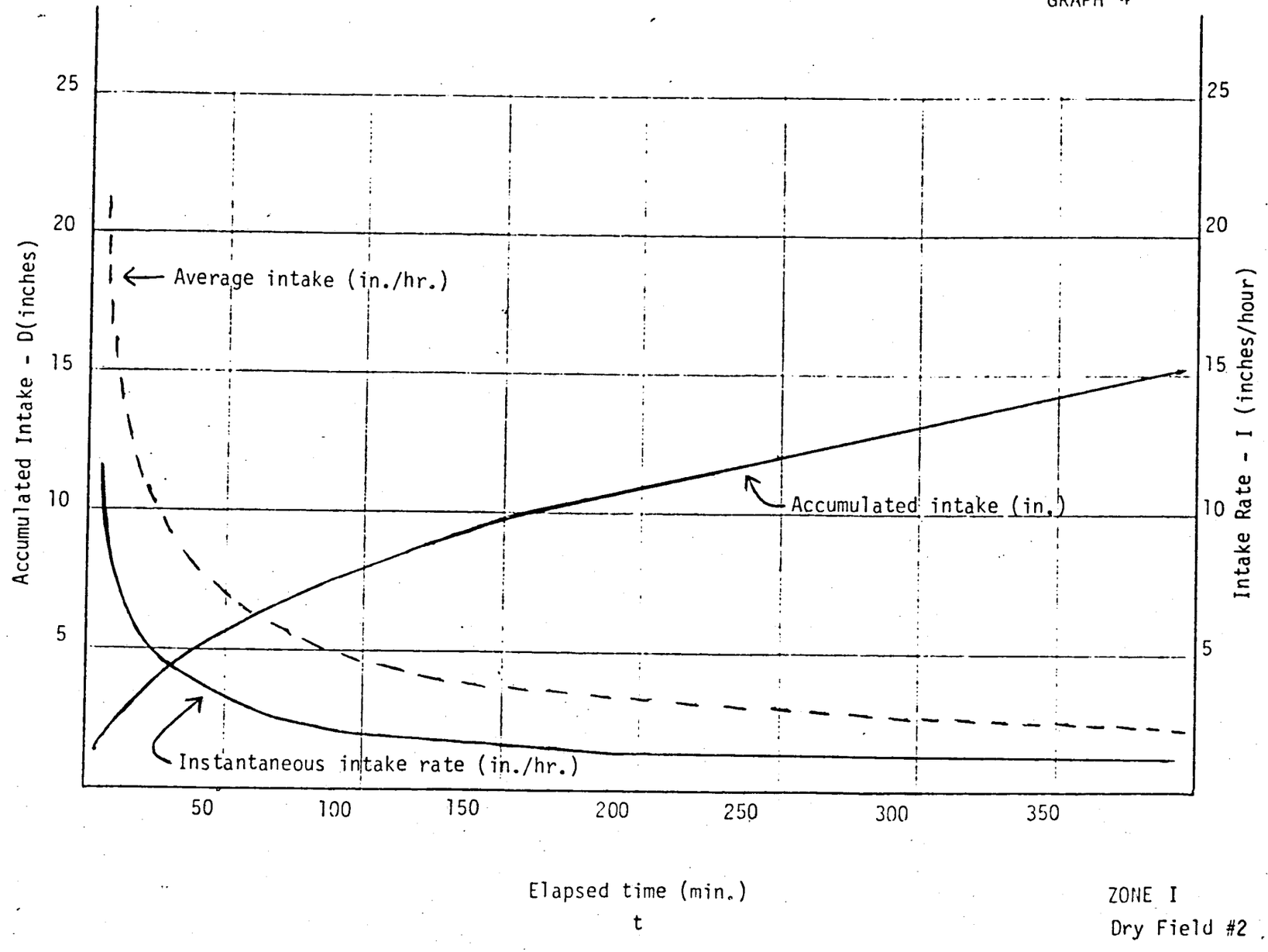
Alfalfa #2

GRAPH 3



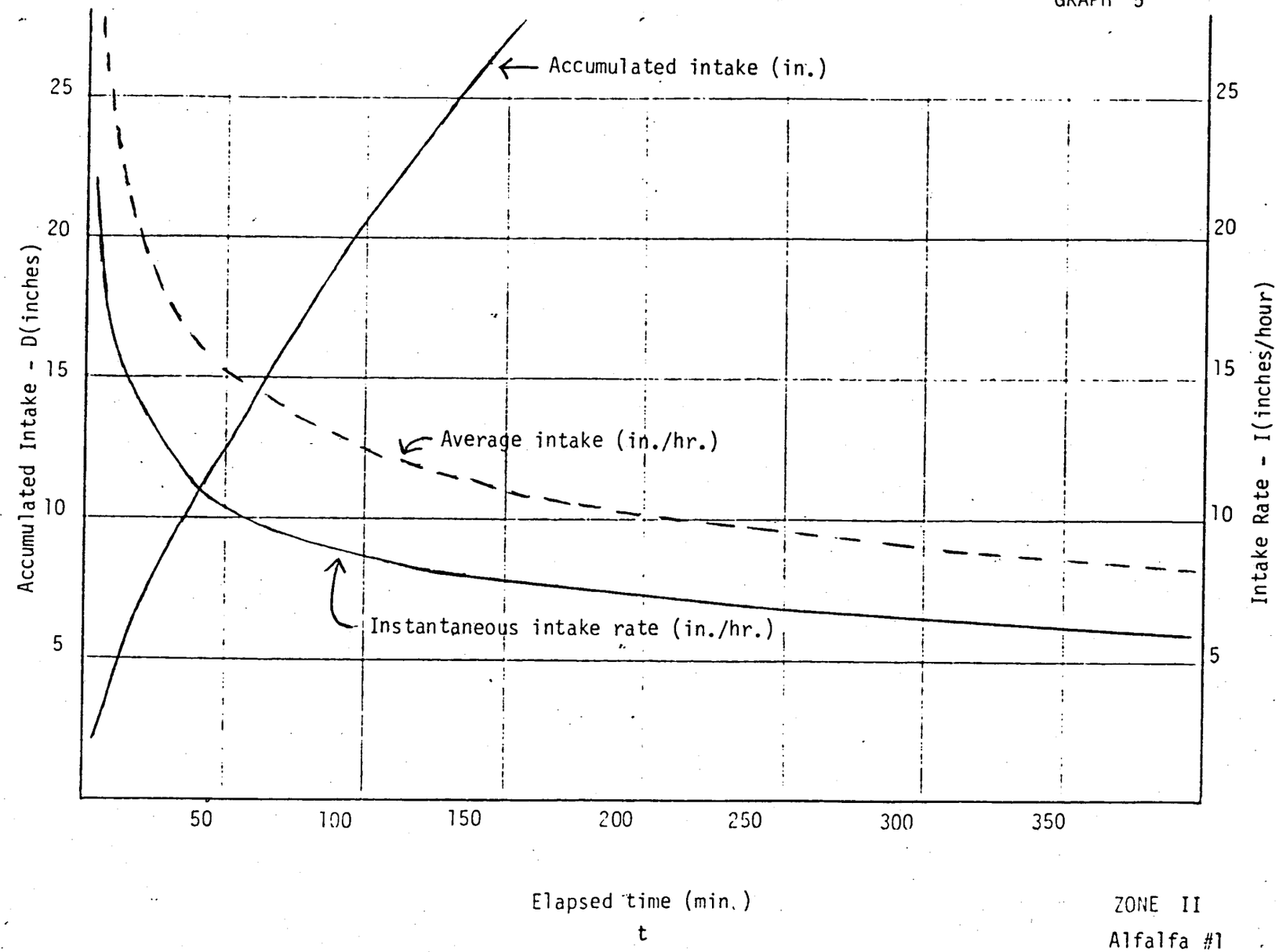
ZONE I
Dry Field #1

GRAPH 4



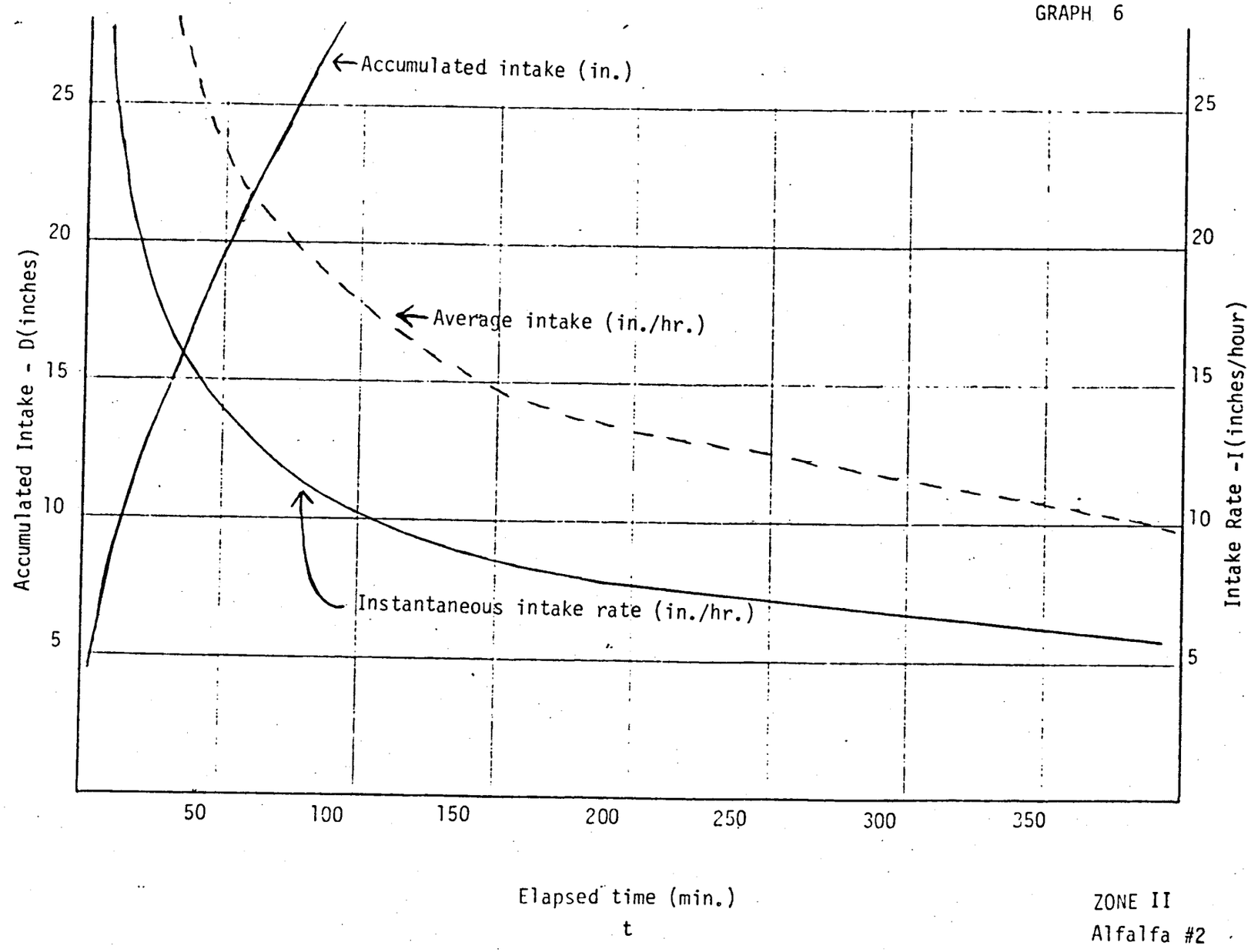
ZONE I
Dry Field #2

GRAPH 5



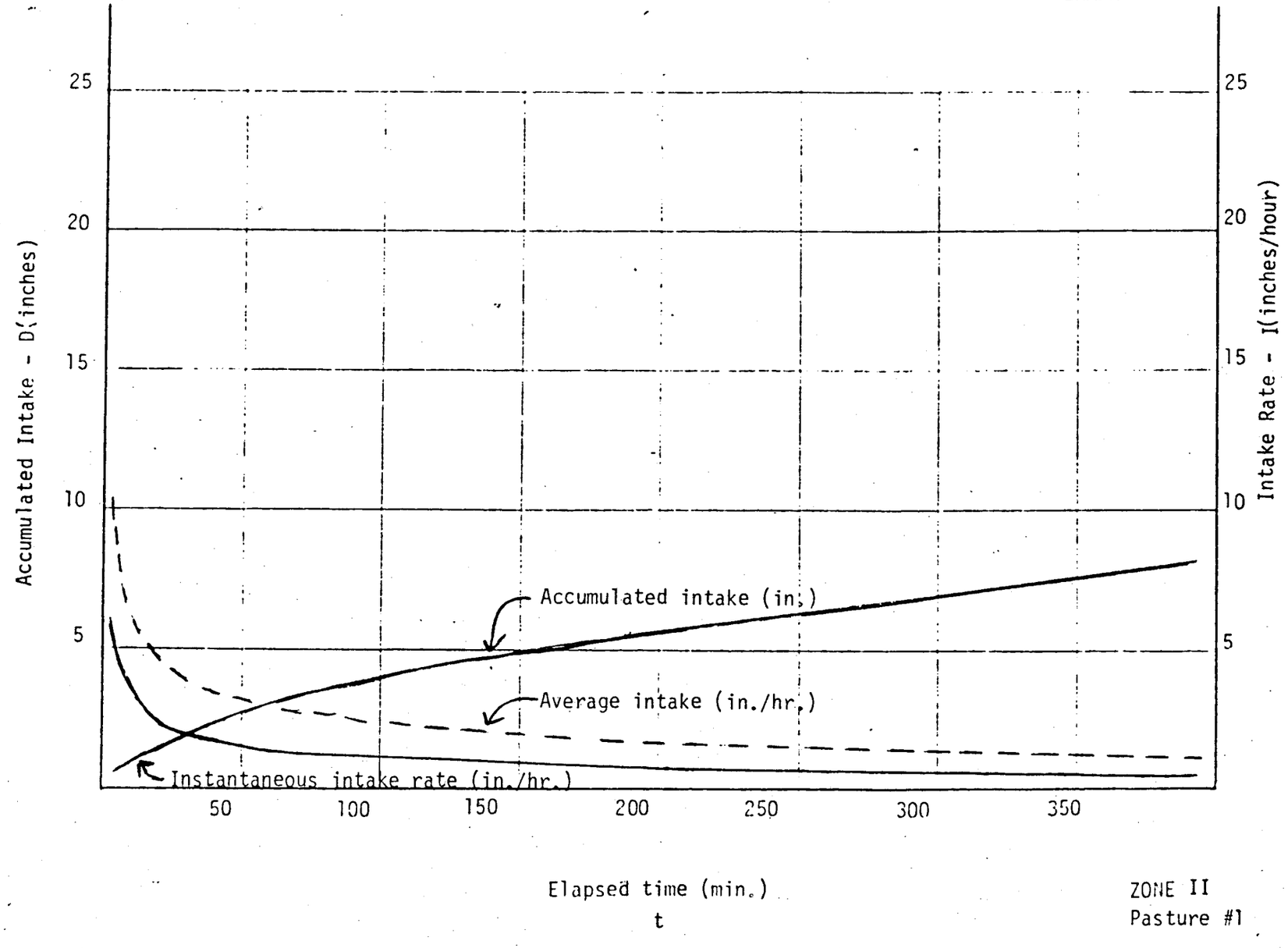
ZONE II
Alfalfa #1

GRAPH 6



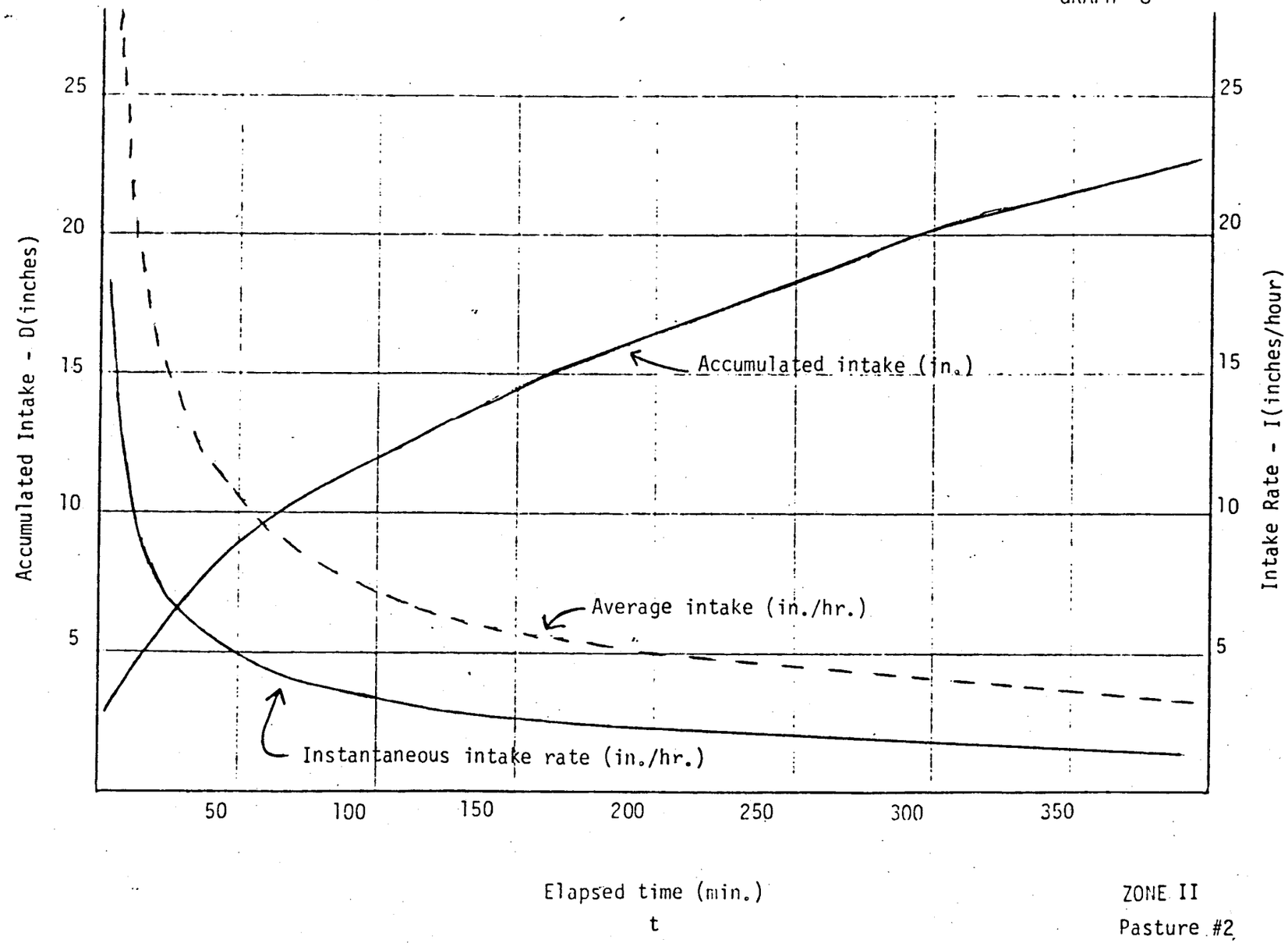
ZONE II
Alfalfa #2

GRAPH 7

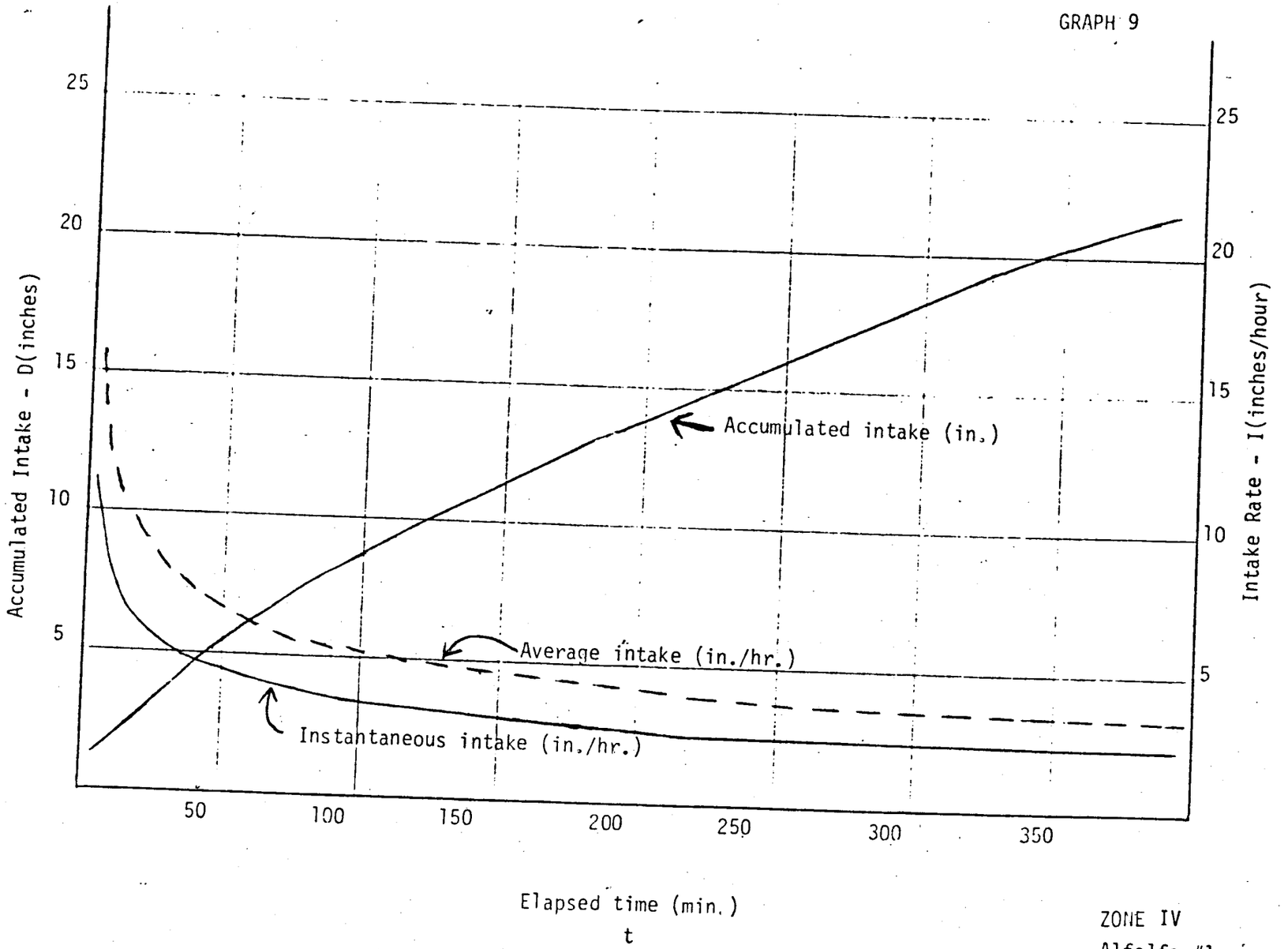


ZONE II
Pasture #1

GRAPH 8



ZONE II
Pasture #2



ZONE IV
Alfalfa #1