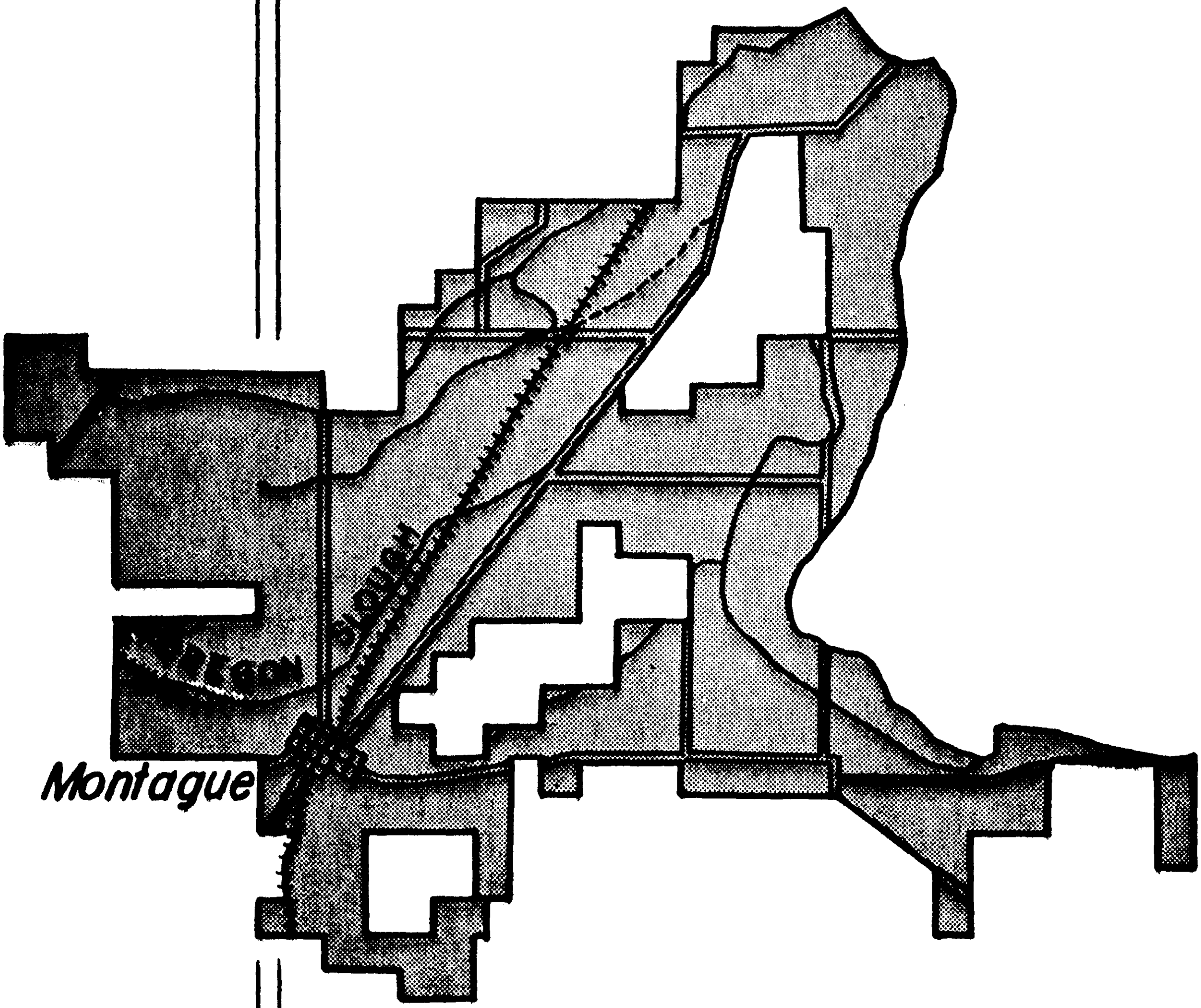
ANALYSIS OF THE MONTAGUE WATER CONSERVATION DISTRICT



UNIVERSITY OF CALIFORNIA

AGRICULTURAL EXTENSION SERVICE

Yreka, California

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AN ANALYSIS OF THE
MONTAGUE WATER CONSERVATION DISTRICT

SUMMARY

The Montague Water Conservation District serves about 11,000 acres of irrigable land of which about 5,000 acres are actually irrigated at the present time.

The source of water is Shasta River and Parks Creek with storage in Dwinnell Reservoir. The distribution system consists of over 60 miles of canals and laterals. Deliveries of water are made to farms on a rotation basis of about 21 days frequency. Crops irrigated are about 75 percent alfalfa, 15 percent grain and 10 percent pasture.

The District has been faced with water shortages during some years, particularly in 1955. With the present irrigated acreage it can be expected that there will be a shortage of water to some degree about one-half the time. The efficient distribution and use of water is essential to the continued success of this District.

The Agricultural Extension Service of the University of California has been requested by the District to analyze and report on the operations of the District and point out needed improvements.

The following recommendations are made as a result of that analysis:

1. Investigate the feasibility of increasing the water supply by pumping from wells. This analysis indicates that costs to the farmer may be only slightly more than the present costs of water. This cost may be cheaper than increasing supplies from the present reservoir.

2. Line only the worst sections of the canal and do only a reasonable amount each year, Investigate the possibility of pooling the members benefits to obtain payments through the Agricultural Stabilization and Conservation Service. Make careful study of the economy of purchasing lining equipment.
3. Consider the possibility of using parallel lateral ditches to direct water into some of the users ditches.
4. Enlarge the"B" Lateral to allow irrigation frequency of 10 to 14 days.
5. Weed control measures using Karmex should be instituted to facilitate the movement of water through the canals.
6. Encourage improved irrigation practice on the farms so as to conserve water and increase crop yields.

The following items either require further study or valued judgments on your part:

1. The wisdom of purchasing a dragline will depend to a large extent on how important it is to have the machine available as needed and on how much outside work would be available.
2. Attempt to seal Dwinnell Resorvoir only after a reputable engineering geologist has reported on the feasibility of such a project.

RESOURCES OF THE DISTRICT

Land Area

There is a gross of 17,225 acres in the district according to figures supplied by the Siskiyou County Assessors Office. (Appendix Table 1). About 11,000 acres are irrigable but there are only 70 acres of this amount that are considered very good land with no cultivation limitations, as-defined by the Soil Conservation Service. The balance of the irrigable acres have one or more limitations of hard pan, gravel, improper drainage, or other conditions.

Soils and Topography

The soil survey of Shasta Valley classifies about one-third of the district as Montague clay loam adobe, a little more than one-fourth as agate gravelly and sandy loams, about one-seventh as "scabland", the remainder ranging between sandy and clay loams.* The soils are generally underlain with hardpan at depths of 6 inches to 4 feet. The hardpan layer over most of the area varies in thickness from 6 to 12 inches, has a coarse, granular composition, and is permeable to water. The topography is that of a valley fill over a lava flow. Lava buttes and outcrops are frequent throughout the valley, but most of these have been excluded from the district. The average altitude is about 2,500 feet. Natural drainage conditions are considered good.

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* U. S. Department of Agriculture, Bureau of Soils, Soil Survey of the Shasta Valley Area, California,

Climate*

Rainfall - The mean annual rainfall at Montague is about 12 inches, distributed through the year as follows:

	inches		inches
January	1.7	July	.4
February	1.5	August	.2
March	1.2	September	.5
April	.8	October	.9
May	.7	November	1.8
June	.7	December	1.8
		Total	12.3

Temperature -

January Average	34°F.
July Average	73°F.
Maximum	110°F.
Minimum	-15°F.

Killing Frosts Average Dates-

Last in Spring - - May 14
First in Fall - - October 2
Growing Season - - 141 Days

Facilities

Dwinnell Reservoir has a storage capacity of approximately 50,000 acre-feet and there are approximately 60 miles of canals.

The main canal is of sufficient capacity to take care of the maximum water requirements of the lands presently being irrigated within the District. With proper maintenance, including weed control of this canal, it is not expected that any enlargement of this section is needed. One mile of the main canal has been concrete lined through the area of greatest seepage loss.

Parshall measuring flumes have been installed at three locations along the Main Canal, and measurements of flows are available since 1952.

* U, A. D. A. Climate and Manual, 1941 - Year Book of Agriculture. Superintendent of Documents, Washington, D. C.

Analysis of these records show an average of 22 percent loss between Flume 1, located one mile below the dam, and Flume 3, located about nine miles below. The losses are slightly greater between Flume 1 and Flume 2 than they are between Flume 2 and Flume 3. There is no significant relationship between the percentage of loss and the amount of water flowing in the canal. The losses vary between wide limits at all flows. A loss of 22 percent in nine miles of canal (one mile of which is concrete lined and 1750 feet of which is carried in a metal flume) amounts to about 3 percent for each mile of earthen canals in other areas. With a flow of 75 cubic feet per second in the canal the loss can be estimated to be 2¼ cubic feet per mile of canal. During a five months irrigation season this will amount to a loss of 675 acre-feet per mile of earthen canal, or if water is valued at $2.00 an acre-foot this amounts to a loss of income to the District of $1,350 per mile of canal.

Equipment

Ditcher
Jeep
Pick-up
Dump truck
Trailer -- 4 wheel
Survey instruments
Water recorders
Office equipment

Water Supply

The district has a number of water rights which in general allow some 60,000 acre-feet of water to be stored in the dam from October to June 15. The rights have a priority date of 1923.

Unpublished studies of the State Division of Water Resources show an average natural flow of the Shasta River at Edgewood Bridge (including actual diversions from Park6 Creek) of 44,100 acre-feet annually for the period 1920-52. Deducting from this tho estimated consumptive use of 3,500 acre-feet annually by upstream users leaves an average annual flow of about 40,600 acre-feet available at Dwinnell Reservoir.

Operational studies of Dwinnell Reservoir by the Division of Water Resources indicate that 15 to 20 percent of the water left in storage is lost each month by evaporation and percolation. For this reason it is improbable that any considerable amount of water can be carried over in storage from one season to the next.

Prior down stream rights amount to 2,500 acre-feet annually.

Actual field studies by the Division of Water Resources indicate that the consumptive use of water by crops *in* the Montague area has been 1.9 acre-feet per acre during the irrigation season.

Based on this data, the distribution of the available water and the acres which can be irrigated are as follows:

	Acre-Feet
Average annual flow into reservoir	40,600
Reservoir losses 15-20% per month	19,100
Available in reservoir	21,500
Prior downstream right	2,500
Amount available at head of canal	19,000
Canal losses 20.5%	3,900
Available at ranch	15,100
60% irrigation efficiency leaves available for irrigation	9,060
At 1.9 acre-feet per acre irrigated water is available to irrigate	4,770 acres

Studies of the reservoir operation of the period 1920-54 based on estimates of inflow and reservoir losses indicate that a supply of 21,500 acre-feet would have been available for release from the reservoir in 19 of the 34 years, or a little more than half of the time.

PRESENT USE OF THE AREA

Size of Farm

The 93 farms *in* the Montague Water Conservation District in 1955 had from 0.5 to 1,336 acres within the district. No data is available on land which these ranchers may operate outside of the district. Twenty-one percent of the farms are less than 25 acres in size and 44 percent are less than 100 acres. The average size of ranch is 159 acres.

These small farms place a serious limitation on the operation of the district. The crop which appears most profitable, but restricted to limited acreage, is irrigated alfalfa seed. The estimated income and expense to the operator raising this crop is:

Income - Hay - 1 ton @ $22.00			$ 22.00
Seed - 400 lb. @.25 cents			100.00
		Total income	$122.00
Expense -			
Cash - Tractor & equipment	- $ 9.00		
Materials	- 39.65		
Depreciation	- 10.35		
		Total cash & depreciation	$ 59.00
		Net Farm Income	$ 63.00

At this rate, an operator on a debt free farm and doing all his own labor would need 63 acres of alfalfa seed in order to return $4,000 per year.

With the acreage required for a suitable crop rotation system and time needed to establish a stand, it would require somewhat more than 63 acres of alfalfa seed. Experience in other areas indicate that a minimum of 100 acres of irrigated crop land are necessary to return a satisfactory standard of living for a long time period. Nearly half of the farms in this area are less than 100 acres in size.

The relatively short growing season and the smaller yields than in other parts of the state indicate that something more than 100 acres are necessary to return a satisfactory standard of living.

Land Use

The 1955 requests for water accounted for the following acreages:

	Acres	No. Farms	Acres Per Farm
Alfalfa	3,706	63	59
Grain	1,699	26	65
Irrigated pasture	1,084	31	35
Seed - not specified			
Other crops	124	70	
Total to be irrigated			
Dry farmed	3,253	35	
Unaccounted	,	68 93	70
Total			159

Relative Profitability

Estimated costs of production for the area and average prices for the past several years indicate the following relationships:

	Income	*Expense	Net
Alfalfa seed - irrigated	$122.00	$97.00	$25.00
Alfalfa hay - irrigated	77.00	58.00	19.00
Alfalfa hay - dry land	33.00	27.00	6.00
Wheat - irrigated	56.00	53.00	3.00
Alfalfa seed - dry land	25.00	46.00	-21.00
Wheat - dry land	38.00	60.00	-22.00
Irrigated pasture (14 day irrigation interval)	30.00	53.00	-23.00
Irrigated pasture (21 day irrigation interval)	20.00	47.00	-27.00

The costs listed here include all cash costs, depreciation, value of family labor, and interest on the investment, The net therefore is a true profit figure, The operator who is doing his own labor and not paying interest would need to add these two values to the "Net" to obtain his own return.

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* See Appendix tables for details

POSSIBLE USES FOR THE AREA

New Crops

The soils, climate, water supply, and markets of the district limit production to:

- Alfalfa hay
- Alfalfa seed
- Wheat, barley, oats, rye
- Irrigated pasture

There are no present indications of crops which can profitably replace those listed except on very minor acreages.

Changes In Present Crops

The analysis which follows indicates a substantial increase in the net income for the district by bringing as many acres under irrigation as possible and by shifting some acreage to more profitable crops.

If it were possible to irrigate the 11,000 irrigable acres in the district and to shift crops according to a soil use map of the district the crop acreage and net income to be expected are shown in the following chart.

Land Use	1955		If 11,000 acres are irrigated	
	Acres	Estimated Net Income	Acres	Net Income
Irrigated				
Alfalfa	3,706	$70,414	6,000	$114,000
Grain	1,699	5,097	2,750	8,250
Pasture	1,064	-29,268	1,760	- 47,520
Alfalfa seed	178	4,450	290	7,250
Other	124	560	200	1,540
Total Irrigated	6,791	$51,653	11,000	$ 83,520
Dry farmed	3,253	------	3,806	------
Unaccounted	4,762	------	-----	------
Total	14,806	$51,653	14,806	$ 83,520

The net income from crops listed in above chart may seem extremely low and is not what is ordinarily considered net income by farmers. Cash costs for these crops include the farmers own labor, equipment use, fertilizers, water, taxes, interest on land, interest and depreciation on stands of permanent type crops, and miscellaneous material and other overhead costs.

Where these crops are marketed through livestock, additional income oan be derived in normal years.

While income from pasture is lowest of all crops, it is the only crop which can be grown successfully on the very shallow soils. Gross returns per acre from pasture were computed on carrying capacity and prevailing pasture rental rates, while if the pasture was utilized by the farmers own livestock, greater returns would be realized.

RECOMMENDATIONS FOR THE DISTRICT

Some of the following recommendations are fairly definite and are consistent with good district management. Other recommendations need further technical study before definite decisions can be made. Others require some valued judgments on the part of the board as to which decision will be most desirable for the operation of the district.

Pumping Ground Water For Additional Water Supplies

An investigation should be made of the feasibility of increasing the water supply to the District by pumping from wells. Studies have been made by the U. S. Geological Survey of ground water conditions in the Shasta Valley. The results of these studies will be included in the final Klamath River Basin Investigation of the State Water Resources Board. It is possible that the District might be able to develop considerable amounts of water at reasonable costs from groundwater basins within the area.

Power costs for pumping water can be estimated at 2½ cents per acre-foot per foot of lift, and 2½ cents per acre-foot per foot of lift for interest and depreciation on wells and pumping equipment,a total of 5 cents per acre-foot per foot of lift. On this basis if the pumping lift is 40 feet the total cost would be $2.00 an acre-foot for pumping water, With a canal loss of 20 percent this would cost $2.40 per acre-foot delivered to the ranch or $7.60 per acre at the present efficiency of water use. Present operating costs of the district amount to about $7.00 per irrigated acre. These figures indicate therefore that additional supplies of water might be obtained at a cost not much higher than present costs.

Investment required for pumping is estimated as follows:

	Per 16" Well
Drilling - 100 feet @ $16.00	$1,600
Pump - 50 H. P., 3,000 g.p.m.	4,000
Miscellaneous	400
Total	$6,000

Each well would furnish approximately 3,000 g.p.m. which would be sufficient to irrigate 200 to 400 acres depending on the crops grown.

Lining Canal To Prevent Loss

The cost of concrete lining, similar to existing lining, is estimated to be $40,000 per mile of canal. With an expected life of 40 years and an interest rate of 5 percent, the annual fixed charges would be $2,000 for each mile of lined canal. Under these assumed conditions it does not appear to be economically feasible for the District to concrete line this canal. However, if the water is valued at $3.00 an acre-fact the value of the canal losses would amount to $2,025 per mile of canal.

It is suggested that the District consider budgeting a certain sum each year for lining the worst sections of the canal. Consideration should be given to the possibility of the District purchasing their own equipment for installing concrete linings. A ditch lining machine costs about $12,000. The annual overhead would be:

Depreciation - $12,000 @ 20 years	--	$600.00
Interest - @ 5%	--	300.00
Total	--	$900.00

This would require rather extensive operation in order to make economical use of the machine. However other economics might be affected through better use of existing equipment and personnel.

Use Of Pump To Lift Water Into Farmers Ditches

At some locations along the main canal it is necessary to raise the water level in the canal by means of check gates in order to divert water into some of the users ditches. When this is done there is considerable water lost by seepage through the banks of the canal. There are the possibilities of using a low-lift pump to raise water into these ditches, or the construction of parallel lateral ditches to convey water from a higher elevation along the main canal to these ditches.

Pump costs indicate an investment of about $2,000 necessary for a 4,000 g.p.m. plant. In addition there would be power or fuel costs for pumping the water and maintenance of the plant.

These costs indicate the desirability of careful consideration to parallel lateral ditches to eliminate the loss of water now being sustained.

Maintenance of Flume

The 1,750 foot Lennon type flume has apparently been maintained in good operating condition. This flume was constructed in 1928 and some of the supporting timbers are now showing weakness due to dry rot. A program of replacing these timbers has been inaugarated and should be continued. It is suggested that only No. 1 common Douglas Fir treated lumber be used for replacing these timbers. Where feasible, it would probably be better to install entirely new column supports rather than attach stubs to the posts that have been weakened. Some rat is occuring near the tops of the column posts and using stubs does not correct this weakness. Care should be taken to prevent any water leaking from the flume from dripping on the wooden timbers. Alternate wetting and drying accelerates rotting of the wooden timbers. Care should also be taken to keep soil from covering the tops of the concrete footings. Where this occurs the moisture held by the soil contribute6 to the rotting of the column posts,

Enlargement of "B" Lateral

The "B" Lateral is apparently one of the "bottlenecks" of the distribution system. The capacity of this canal is not sufficient to handle the peak demands of the water user6 during late season, particularly where an irrigation frequency of less than 21 days might be desirable. There are two factors which affect the capacity of this canal. One is the size and the other is weed growth in the canal. Some enlargement of the "B" Lateral is desirable,

Purchase of Dragline

One of the questions facing the District is whether to purchase excavating equipment or whether to employ a contractor with equipment to do this work. A new 3/8 yard dragline would cost about $11,000, or a good used machine might be purchased for $7,000 to $8,000. Assuming a 20 year life for a new dragline, the annual fixed Charge6 on the machine would be about $825 a year. If the machine is operated 640 hours a year, the fixed charges would amount to $1.28 per hour. Adding to this the charge6 for an operator, fuel, repair and maintenance it is possible that the District could operate their own machine for $4.00 to $5.00 an hour. This cost should be compared with a rental rate of around $8.50 an hour for a 3/8 yard dragline with operator.

There are certain advantages to the District in owning a dragline which would be available upon call in case of an emergency. On the other hand, if the dragline was only to be used a few weeks during each year, it might be better to employ a contractor for such work. It is possible that some of the water users might make use of a District owned dragline on a rental basis for doing work on their farms if this equipment was available.

The records of the district from 1951 to October 1955 show only $2,400 dragline work which would be approximately 280 hours of use. However, we understand that dragline work was continuing after October 1, Even if the 280 hours were doubled to 560 hours and spread over the 5 year period, it makes only 110 hours per year. This is not sufficient usage to warrant purchase of a machine. The amount of outside work for which the machine might be used therefore becomes the determining factor in any decision regarding such purchase.

Weed Control

Weed and brush control along irrigation ditches has been one of the major costs in maintenance and operation of a district, Unless weeds and brush are controlled, weed seeds are carried by the water on to farm land, transpiration losses of water result to a considerable degree and the slowing up of water in the ditches causes greater seepage losses and retardation of flow.

The extent of infestation of weeds and brush along district ditches consists of annual and perennial grasses, broad leafed weeds, juniper trees and willows. In some sections cattails and tules are found in the bottom of the ditches.

The most effective and most economical chemical used in control of grasses, annual broad leaf weeds, brush and tree6 is Karmex (formerly **CMU).** This material should be applied at the rate of 40 pounds per acre. Application should be made in the fall or early winter. Cost of the Karmex will be about $112 per acre or about $165 per mile of canal if 6 feet on each side of the canal is treated. This treatment should practically sterilize the ground for a period of from two to three years, then a light application of about 10 pounds per acre annually should produce weed-free ditches. Broad leaf, tap rooted perennials can be controlled by a 2,4-D spray. Recent tests with chemicals on tules and cattails have shown these aquatic weed6 can be successfully controlled with an application of amino triazole. The best rate seems to be 10 pounds of amino triazole in 150 gallons of water per acre.

It would seem that with 60 miles of ditches to spray the District could well afford to purchase a spray rig.

Change To A Shorter Irrigation Interval

The canal water is now being delivered to the farms on a 21-day rotation basis irrespective of the type of soil being irrigated or the crop grown. Assuming tho rate of water use during July and early August by crops grown in the Shasta Valley to be 0.3 inches of water per day; then in order to store a 21-day supply would require that the soil be able to hold 6.3 inches of' available water within the depth of rooting of the crop.

Many of the alfalfa fields are planted on shallow soils, or coarsetextured soils with low water holding capacity. In such cases, it might be desirable to irrigate alfalfa on a 15-day frequency. One or two irrigations are normally required before the first cutting of alfalfa which generally takes place during the latter part of May. Two additional irrigations are needed before the second cutting in late July. Two more irrigations should be applied before the third cutting which is made in early September. One irrigation should be applied following the last cutting. All together alfalfa will require from six to seven irrigations of 6-inches each or a total of 36 to 42 inches of irrigation water each season. Shallow soils should receive less water per irrigation but more frequent irrigations.

Ladino clover is a shallow rooted plant with few roots extending below a depth of two feet even when grown on a deep, permeable soil. For this reason it is recommended that Ladino clover be irrigated on a 10-day frequency during the summer months if maximum yields are to be obtained. Two irrigations a month during April and May are usually sufficient but three irrigations a month during June, July and August are desirable. Two irrigations during September and one during October are usually required, This gives a total of 16 irrigations each season, but because they are made at frequent intervals a 3-inch depth of water at each irrigation is usually sufficient. The total irrigation requirement for Ladino clover will be about 48 inches per season which is slightly higher than for alfalfa.

Improved Irrigation Practices

The success of any irrigation district is dependent to a large extent upon obtaining high yields from the crops being grown. The irrigation practices used by the farmers play an important part in bringing about maximum crop yields.

In order to apply light frequent irrigations without wasting water, considerable care is required in managing the water on the farms.

At present water is applied by controlled flooding and border check system. The border check method is more efficient than flooding but it entails extensive land preparation and more attention to water distribution during irrigation. Detailed surveys, system design, and improved water application practices are needed to obtain maximum efficiency from the water in the District. State and Federal agencies operating in the area can assist the farmers of the District in developing efficient irrigation system design and operation.

Calculations in other parts of this report are based on a 60 percent irrigation efficiency. On this basis, the average flow available at Dwinnell Reservoir will irrigate 4,770 acres under present conditions. Increasing the irrigation efficiency to 80 percent would increase the number of acres which can be irrigated to 6,370.

Sealing Dwinnell Reservoir

The question has been raised as to whether it would be possible to seal the Dwinnell Reservoir by some method to reduce percolation losses. It is suggested that before any expenditure is made for this purpose that a reputable engineering geologist be employed to report on the feasibility of such a project. It might be advisable for the Board of Directors of the District to budget funds for such an investigation.