UTAH STATE ENGINEER

INFORMATION BULLETIN NO. 15

GROUND-WATER CONDITIONS AND RELATED WATER ADMINISTRATION PROBLEMS IN CEDAR CITY VALLEY IRON COUNTY, UTAH

by

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and

Francis T. Mayo

Utah State Engineer's Office

February, 1966

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Salt Lake City, Utah

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UTAH STATE

ENGINEER'S OFFICE

WATER RESOURCE DIVISION

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OPEN-FILE REPORT

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By Jack A. Barnett 1/

Introduction

Cedar City Valley comprises about 192,000 acres in eastern Iron County. Most of the land is used for some form of agriculture activity. About one tenth of the land today is used to produce agricultural crops.

Because of the semi-arid climate, most agricultural crops require irrigation. The first irrigation in the area was accomplished by diverting the flow of Coal Creek and some of the smaller surface streams onto the land. As the agricultural economy has grown, however, additional sources of water were needed. This additional water has been developed from the ground-water reservoir which has water in storage beneath the land surface.

This pumpage, which appears to be at a rate greater than the natural recharge, has lowered the ground-water levels in the area and the ground-water levels continue to decline. The State Engineer's Office has, in the past, approved several applications to appropriate additional water from wells which have not been developed to date. There are also additional applications on file in the State Engineer's Office which have not been approved.

1/ Prepared by Jack A. Barnett, Hydrologic Engineer, Utah State Engineer's Office under the direction of Francis T. Mayo.

The State Engineer must now determine what policies the office will adopt concerning requests for extension of time in which to submit proof of appropriation on the already approved but unperfected well applications in Cedar City Valley. The office must also adopt a firm policy with respect to new unapproved well applications which request permission to develop additional ground water. The established water rights, present and past pumping rates, and the ground-water hydrology of the area must be understood and evaluated in the formulation of these policies.

Previous Investigations

The water resources of Cedar City Valley have been under investigation through cooperative agreements between the U. S. Geological Survey and the Utah State Engineer's Office at various levels of activity for the past 50 years. Several of the publications issuing from these investigations were referred to in preparing this report and are available, if additional information is desired. In 1946 the U. S. Geological Survey published Water-Supply Paper 993 entitled "Geology and Ground-Water Resources of Cedar City and Parowan Valleys". This comprehensive publication was authored by H. E. Thomas and G. H. Taylor. Technical Publication No. 7 of the State Engineer's Office published in 1952, includes a chapter by H. E. Thomas on Cedar City Valley. Thomas later authored Professional Paper 373-E for the U.S.G.S. entitled "Effects of Drought in Basins of Interior Drainage". In this publication he discusses water level declines in the Coal Creek Fan and their relation to streamflow and ground-water pumpage.

The relationship Thomas found compares favorably with more recent findings discussed later in this report. Much of the basic data used in this report was obtained from a report prepared by G. W. Sandberg of the U. S. Geological Survey and published as Basic-Data Report No. 6 by the State Engineer's Office. Additional information came from unpublished records on file in the U. S. Geological Survey's Office in Salt Lake City. The Utah Water and Power Board has published a report entitled "Ground-Water Conditions in Utah, Spring of 1964" which was also referred to. A report authored by G. W. Sandberg of the U.S.G.S. entitled "Ground-Water Resources of Selected Basins in Southwestern Utah" has recently been released to the open file and will soon be published by the State Engineer's Office as Technical Publication No. 13. The report by Sandberg should be referred to, if additional information is desired on the movement of ground water into and out of the basin. He also comments on the possible effect of additional development of ground water on water levels in the area. Information from Sandberg's report was freely drawn on in the preparation of this short Information Bulletin.

General Hydrologic Conditions

Cedar City Valley is essentially a closed inter-montane basin. Precipitation is light, amounting to little more than 10 inches a year on the valley floor. This lack of precipitation results in a semi-arid climate and virtually all of the water reaching the valley by precipitation, surface streamflow and underground seepage, is consumed within the valley. The very small amount of water not

consumed within the valley, discharges into other drainages in quantities illustrated in figure 1. Sandberg was able to compute movement of ground water between drainage basins from water-level data and a knowledge of the nature and extent of the sediments. He estimates that only about 1500 acre-feet of underground water seeps southward from the valley near Kanarraville annually. An additional 515 acre-feet flows from the valley to the north and west through Iron Springs gap, and 100 acre-feet through Twenty-Mile gap. This outflow of water is more than offset by the estimated 3000 acre-feet of underground water that annually seeps from Parowan Valley to Cedar City Valley through Winn gap and the adjacent mountain mass and reappears as springs near Enoch or recharges the ground-water reservoir directly.

Water level measurements indicate that an underground water high is present in the valley which essentially divides the valley into two separate underground water basins. This high is indicated by March 1962 water level measurements and is illustrated by the attached figure 1. This divide, or ground-water high, extends almost directly west from the community of Cedar City. The ground-water divide provides an opportunity to consider the valley as two separate sub-basins for underground water administration purposes. These basins are referred to in the report as the North Area and the South Area. Both of the basins have separate outlets from Cedar City Valley and both basins have separate playa lakes. The playa in the North Area is Rush Lake and the playa in the South Area is Quichapa Lake. Although it would be possible to move this divide north or south by ground-water development, it is unlikely that the present rate of

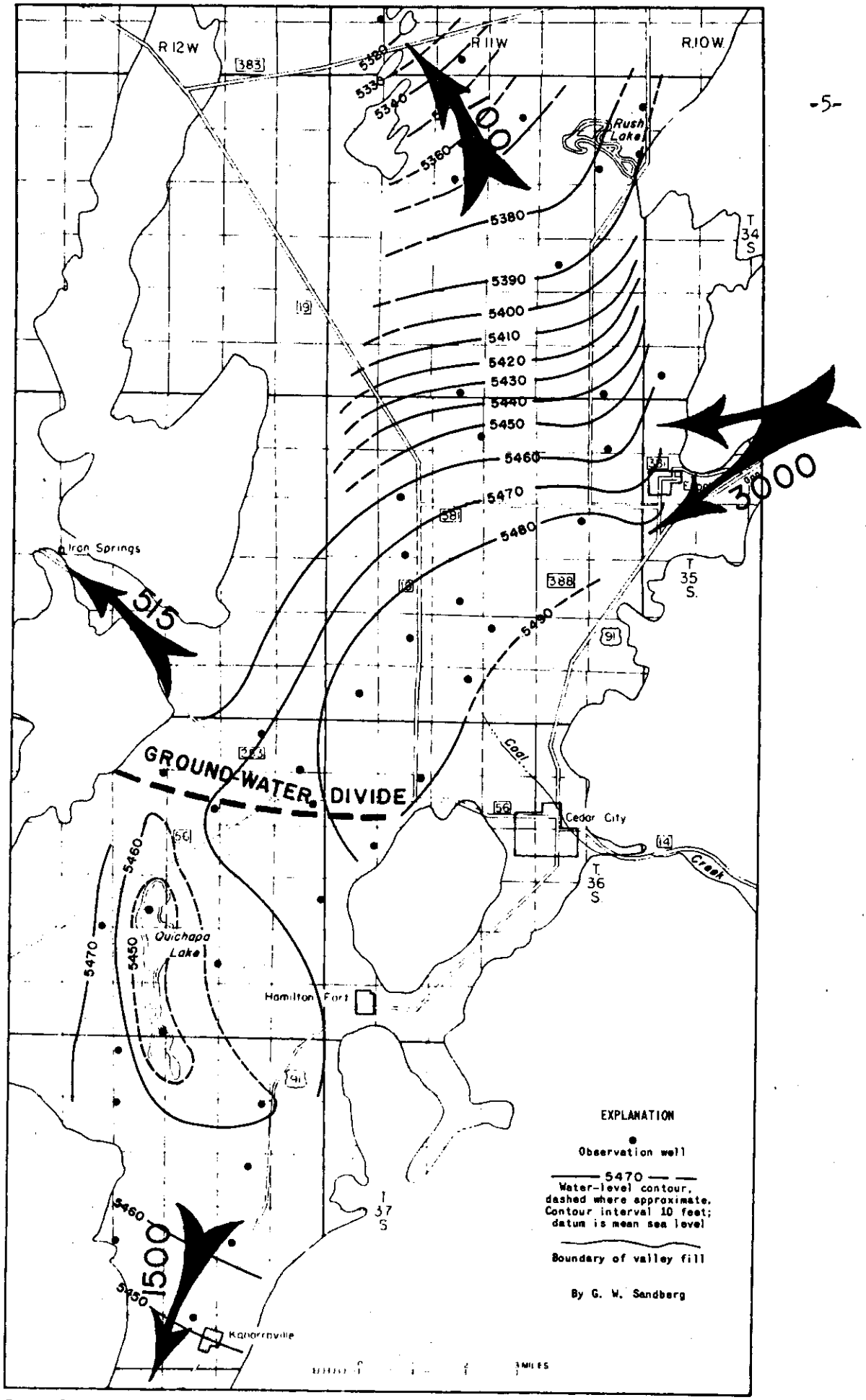


Figure 1 -- Map of Cedar City Valley showing water-level contours, March 1962. Map also illustrates the direction and amount of ground-water movement annually in acre-feet in or out of the Basin. (Ground-water divide is shown by heavy dashed line)

development in one area will interfere with development in the other area in the near future.

Some water in both areas is wasted each year by evaporation and transpiration from water surfaces and phreatophytes. It is estimated that 500 acre-feet annually is lost from the surface of Quichapa Lake to the atmosphere. This loss of water has been reduced in recent years by the lowering of the water levels. The lowering of ground-water levels in Cedar City Valley from March 1964 to March 1965 and the declines for selected wells from March 1950 to March 1965 is illustrated on the attached figure 2. The lowering of ground-water levels is also illustrated by the water-level declines measured in well (C-35-11)33aac-1 and recorded in a hydrograph on the attached figure 3. This figure graphically illustrates how the water levels in the Coal Creek alluvial fan have declined as the average precipitation in the area over the last decade has declined. The water level declines, although at a maximum in the Coal Creek fan, have been observed through the entire valley. Figure 2 indicates that water levels have declined in the last 15 years 34 to 40 feet in the Coal Creek fan northwest of Cedar City, 11 to 13 feet in the South Area near Kanarraville and Quichapa Lake and less than 2 feet in the Rush Lake area.

The figure 4 illustrates how the flow of Coal Creek has been below average in 9 of the 13 years from 1953 through 1965 and the pumpage in the North Area for irrigation has varied in response to these changes.

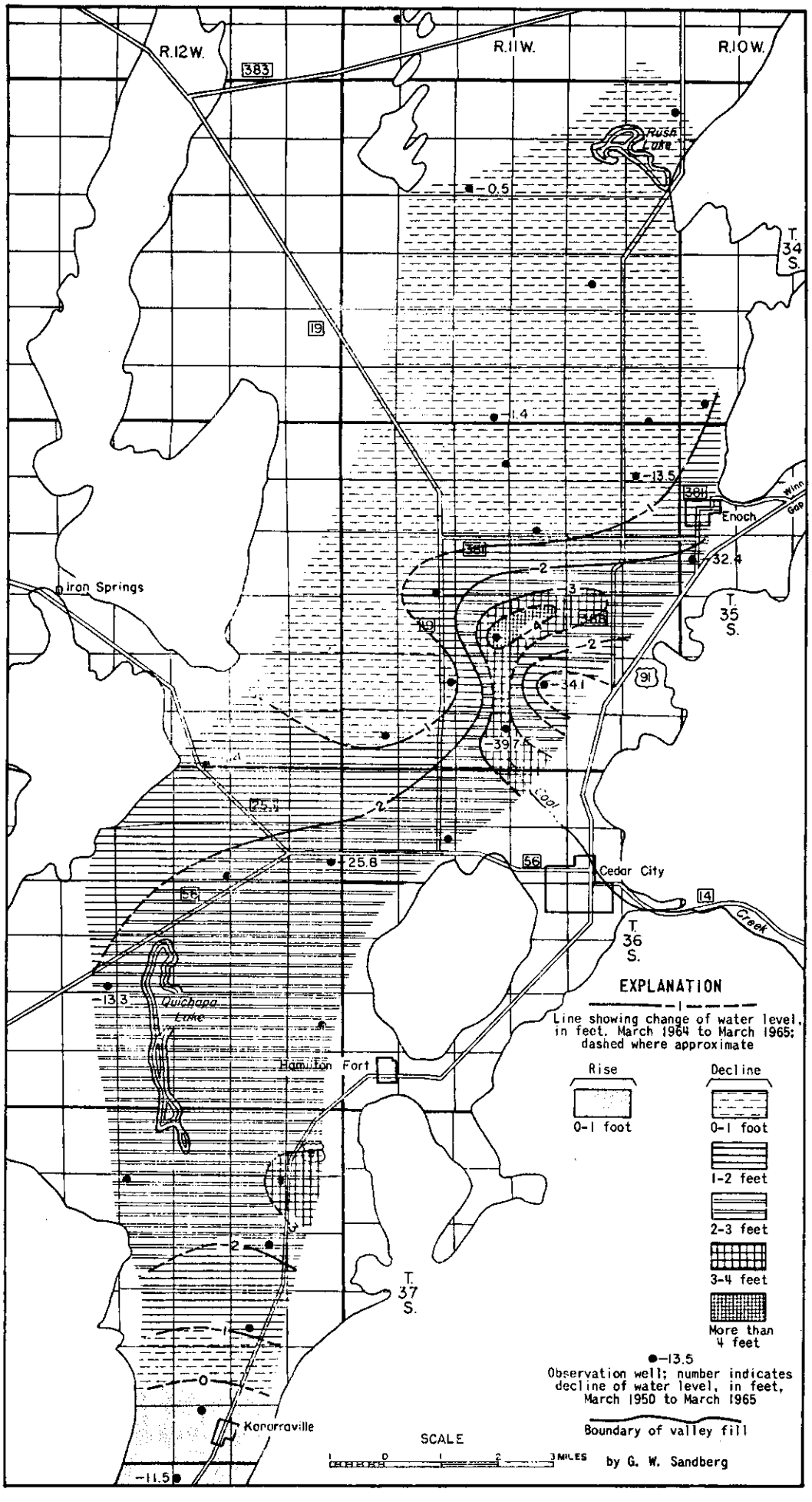


Figure 2.—Map of Cedar City Valley showing change of water levels, March 1964 to March 1965.

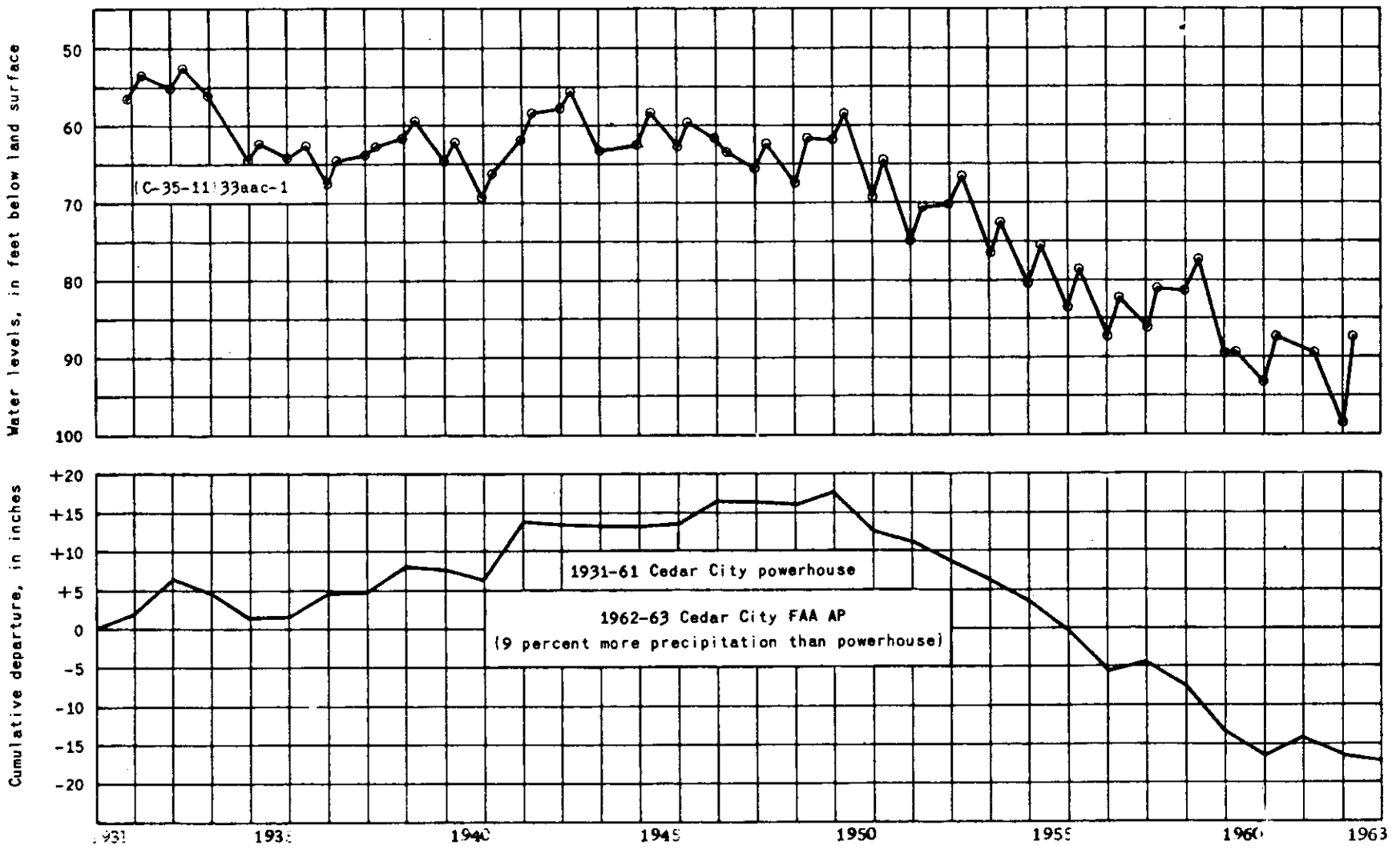
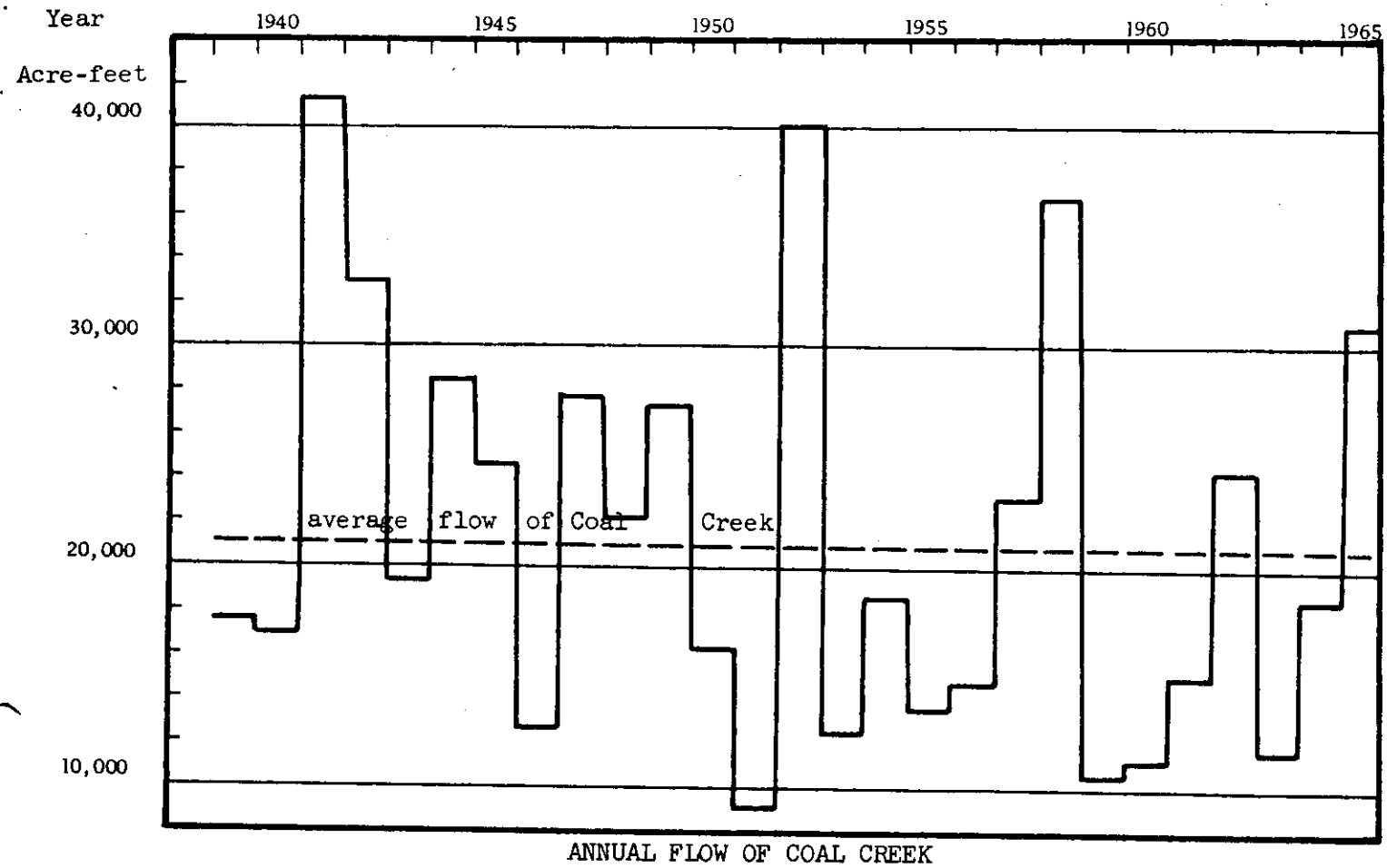
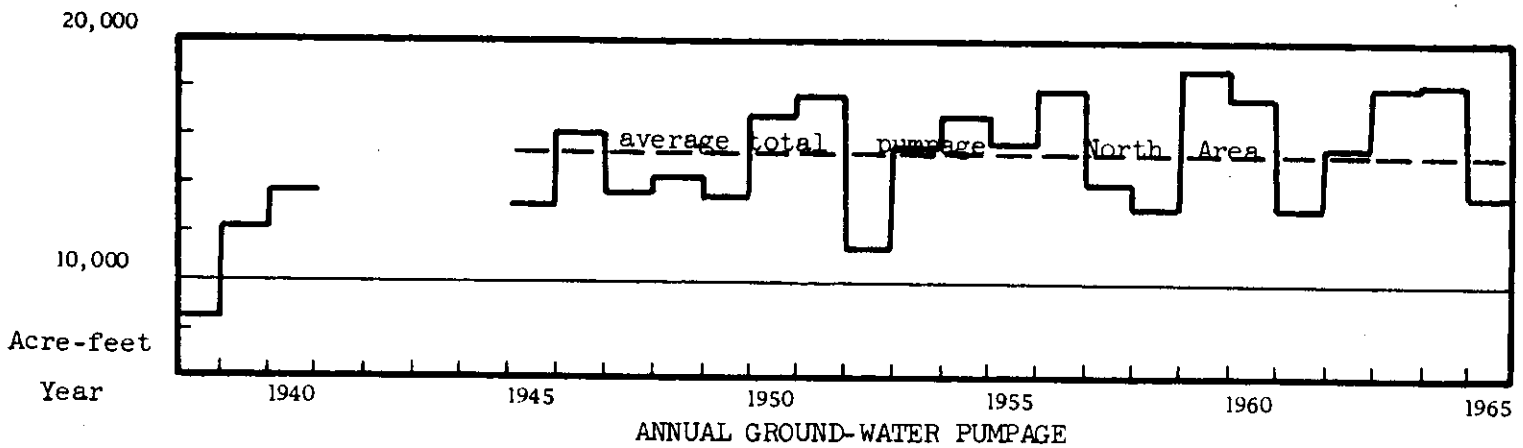


Figure 3 -- Hydrograph of well (C-35-11)33 aac-1 and cumulative departure from the 1931-60 normal annual precipitation at the Cedar City powerhouse.



ANNUAL FLOW OF COAL CREEK



ANNUAL GROUND-WATER PUMPAGE

Figure 4. -- Hydrograph of flow of Coal Creek for each water year from 1939 to 1965 and the total annual groundwater pumpage in the North Area from 1938 to 1940 and 1945 to 1965.

Present and Past Underground Withdrawals.

There are presently about 100 large diameter pumped wells in Cedar City Valley. Most of these have been used for irrigation purposes and in many cases, the wells are used as a supplemental supply to surface sources. The largest source of surface water is Coal Creek and figure 4 illustrates how the increase or decrease of flow in Coal Creek influences the pumpage for irrigation purposes. In years when the flow of the creek declines, the pumpage increases and as the streamflow increases the irrigation pumpage decreases. However, it would appear from the figure that an increase of flow in Coal Creek of 800 or 1,000 acre-feet results in a decrease in pumpage of only 200 or 300 acre-feet. It can also be seen in figure 4 that the average pumpage from the North Area for irrigation over the past 20 years has been about 15,560 acre-feet, and that over the years the annual pumpage has been increasing.

In 1964 there was just over 22,000 acre-feet pumped in Cedar City Valley for all uses combined. About 4,000 of this was pumped in the South Area and about 18,000 in the North Area. It is significant to note that water levels as indicated by the hydrograph in figure 3, have declined rather steadily since the annual pumpage approached 15,000 acre-feet in 1945. The generally below normal precipitation since 1950 has undoubtedly influenced the rate at which water levels have declined.

Authorized Future Withdrawals.

There are 24 approved applications, each to divert in excess of 0.1 cfs, for the development of additional groundwater in Cedar

City Valley in good standing in the State Engineer's Office. Table 1 illustrates that 13 of these applications are in the South Area and 11 are in the North Area. An attempt was made to estimate the additional diversion in acre-feet that has been authorized with the approval of these applications. Most of the applications were for irrigation purposes and a factor of 3 acre-feet per acre was used when the applications proposed the use of well water as a sole supply. For applications under which the wells are to be used as a supplemental supply, a factor of 1.5 acre-feet per acre was used, unless additional limitations in the application further restricted the water use. Application 27864 in the name of Cedar City for 5 c.f.s. presented a special problem. It was determined that at maximum development, the city might be allowed 10 acre-feet per day for 365 days a year.

As can be seen in table 1, these pending applications would allow the diversion of an estimated additional 19,438 acre-feet. Of this total, 9085 acre-feet could be developed in the South Area and 10,353 could be developed in the North Area. These figures may be conservative, as future court action may result in a higher duty of water per acre that could increase the estimates by as much as a third. The locations of these potential diversions are indicated in figure 5. The circles represent locations of approved well applications for more than .1 c.f.s. under which the well has not been drilled. The circles with an inclined line running through them, are locations of applications under which the well has been drilled.

Table 1. - Unperfected approved well applications on file in the State Engineer's Office January 1966

Area No.	App. No.	Owner	Location	Amt. filed for in cfs	Acres to irrigate		Date approved	Proof due date	Well Data			Estimated additional ac.-ft. authorized not in 1964 pumpage inventory
					Sole	Supp.			Dep.	Dia.	Pro. in gpm	
		South Area										
73-495	23642	L. Jones	(c-36-12)20acc	3		540	8-25-52	8-25-66	490	16		810
73-570	15265	W. Williams	(c-37-12)23cbd	3	80		5-9-44	12-31-65	247	12		240
73-663	24425	J. Thorley	(c-36-12)25bdd	4	160		10-23-53	12-31-65	300	14	1400	134
73-790	24547	Thorley Bros.	(c-36-11)31bda	3		200	2-4-56	12-31-65	*			300
73-1022	24819	J. Hamilton	(c-36-12)36ada	3		100	1-28-54	12-31-65	*			150
73-1049	27917	Spilsbury Land	(c-36-12)32dca	3		1440	5-4-60	6-28-65	305	16		1440
73-1052	28407	L. Prestwich	(c-37-12)15cdc	3	360		4-27-64	12-31-66	355	16		1080
73-1053	29181	J. Watson	(c-37-12)9acc	3		160	4-27-64	12-31-66				240
73-1303	36255	P. Williams	(c-37-12)21cab	.5	10		1-29-65	12-31-67	*			30
73-1835	27779	K. Middleton	(c-36-12)36add	5		369	7-5-57	12-31-65	288	16	1070	550
73-1878	29757	M. Vandenberghe	(c-37-12)5acc	2		238	4-27-64	12-31-66				177
73-1910	27902A	J. Watson	(c-37-12)9acc	1.5	95		4-17-61	12-31-65				285
73-1919	27864	Cedar City	(c-36-12)32ccc	5					*			3650
73-1919	27864	Cedar City	(c-37-12)5bbb		Mun.		10-31-56	12-31-65	336	16		
		Total in South Area		39	705	3047						9086
		North Area										
73-298	23204	Enoch Ward	(c-35-10)7caa	.1	Dom.		1-29-52	1-29-66	105	8		15
73-329	23275	Clark L. S.	(c-34-11)26add	9.5	440		3-31-65	12-31-67	*			1320
73-520	23692	Clark L. S.	(c-34-11)35dda	6	490		3-31-65	12-31-67	*			1470
73-520	23692	Clark L. S.	(c-34-11)35acd				3-31-65	12-31-67	*			
73-520	23692	Clark L. S.	(c-34-11)26ddd				3-31-65	13-31-67	*			
73-1023	25257	W. Leigh	(c-34-11)16bdc	5	300		3-18-54	12-31-66	*			900
73-1503	36656	L. Jones	(c-34-10)30ddd	3		320	7-20-65	12-31-67	*			480
73-1558	36385	R. Harris	(c-33-10)31dad	5	300		12-18-64	12-31-67	225	16		900
73-1912	32477	S. Benson	(c-34-11)1daa	3	560		4-10-61	12-31-66				1680
73-1917	34054	Y. Jones	(c-36-12)10aaa	1	40		4-27-64	12-31-66	*			120
73-1929	34982	G. Grimshaw	(c-34-11)36ccd	2	156		7-10-65	12-31-67	*			468
73-2055	35452	Rush Lake	(c-34-11)14bcc	5	500		7-23-64	12-31-66	*			1500
73-2056	35453	Rush Lake	(c-34-11)2cba	5	500		7-23-64	12-31-66	*			1500
		Total in North Area		44.6	3286	320						10353
		Total for Both Areas		83.6	3991	3367						19439

* Well not drilled

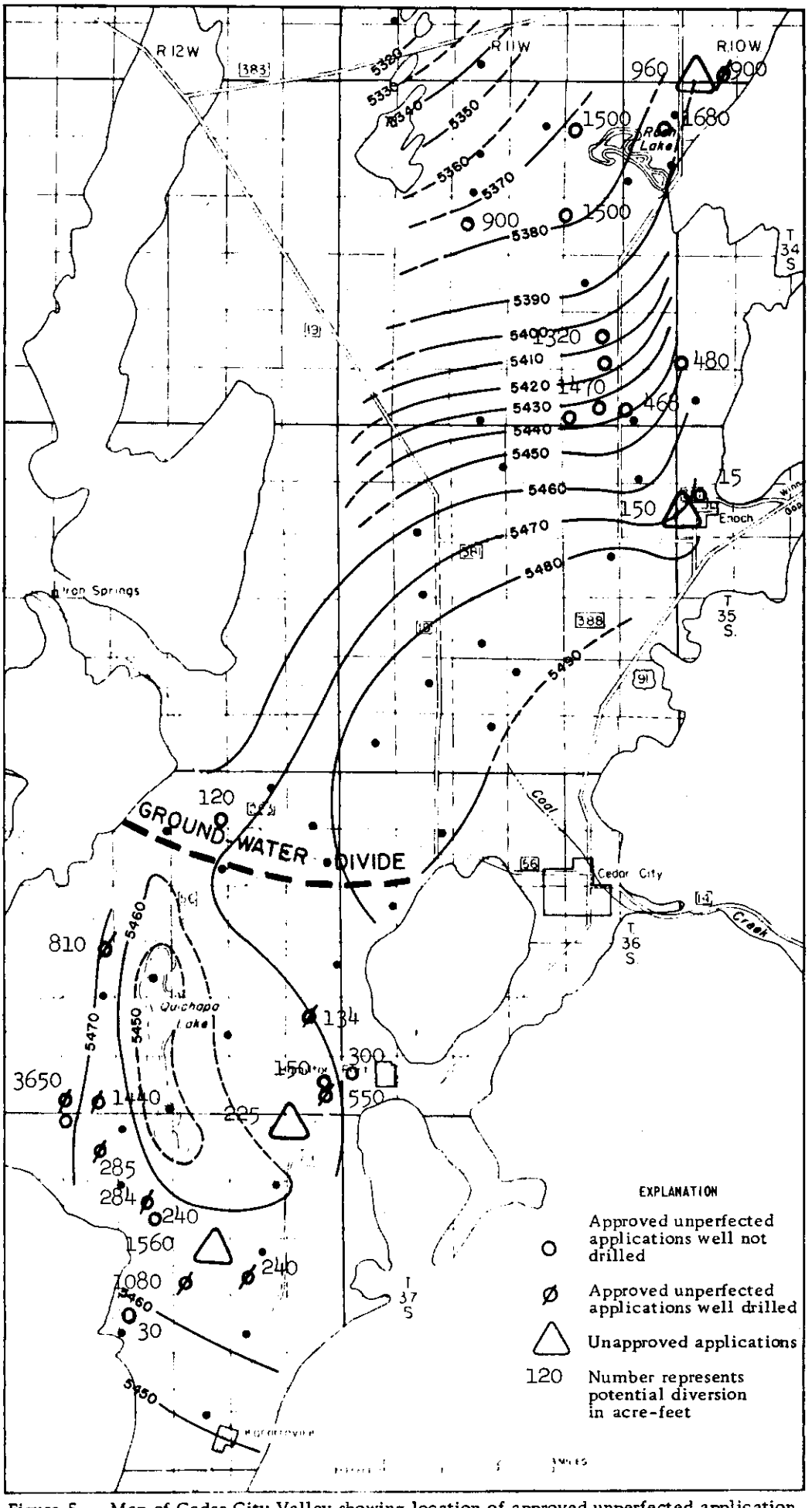


Figure 5 -- Map of Cedar City Valley showing location of approved unperfected application, unapproved applications and amounts in acre-feet of proposed ground-water diversions.

The four triangles represent the location of unapproved applications. The numbers to the side of the well locations are the amount of the estimated future potential acre-foot withdrawal.

All of the approved pending applications have proof-due dates in 1965, 1966 or 1967. This is illustrated by table 2. The table points out that the applications that have proof-due in 1965 are older applications, all in the South Area. Many of these applications have had some development. Almost all of the applications which require proof-due in 1967 are in the North Area and involve applications approved within the past two years, with no development accomplished to date. Fifty per cent of the 24 approved, pending applications were approved in the last two years.

Potential Withdrawals Recognized by the Proposed Adjudication.

The State Engineer's Office is presently engaged in the determination of water rights in Cedar City Valley drainage as part of a general adjudication of water rights being made by the District Court. Water rights have presently been established to irrigate about 18,200 acres of land in the Valley as tabulated in table 3. Of that total about 6,510 acres receive their sole supply of water from surface sources, 4,216 acres receive their sole supply of water from the underground sources and about 7,480 acres receive water on a supplemental basis from both surface and ground water sources. The 1964 Water Commissioner's Report indicates that in practice water use ranges from .07 to 14.17 acre-feet per acre per year. The proposed determination suggests a duty of 3 acre-feet per acre per year. At the rate

Table 2.--Well applications approved but not perfected over .1 cfs in Cedar City Valley listed by the year in which proof is due

NORTH AREA			SOUTH AREA		
Right Number	Estimated Authorized Withdrawal In Acre-Feet	Years, At Time Of Proof Due, That Application Will Have Been Approved	Right Number	Estimated Authorized Withdrawal In Acre-Feet	Years, At Time Of Proof Due, That Application Will Have Been Approved
Applications With Proof Due in 1965					
			73-570	240	21
			73-663	134	12
			73-790	300	9
			73-1022	150	11
			73-1049	1440	5
			73-1835	550	8
			73-1910	285	4
			73-1919	3650	9
Total	0			6749	
Applications With Proof Due in 1966					
73-298	15	14	73-495	810	14
73-1023	900	12	73-1052	1080	2
73-1912	1680	5	73-1053	240	2
73-1917	120	2	73-1878	177	2
73-2055	1500	2			
73-2056	1500	2			
Total	5715			2307	
Applications With Proof Due in 1967					
73-329	1320	2	73-1303	30	2
73-520	1470	2			
73-1503	480	2			
73-1558	900	3			
73-1929	468	2			
Total	4639			30	

Table 3.--Adjudicated acreage in Cedar Valley

Sole Supply Rights

Source	Acreage
Underground Water	4216.1
Coal Creek	4757.8
Quichapa Creek	593.7*
Duncan (Leeches) Creek	107.2
Walter Murie Creek	197.2
Shurtz Creek	793.5**
Braffits Creek	61.0
	10726.5

Supplemental Surface and Underground Rights

Coal Creek and Underground	5875.5
Quichapa Creek and Underground	169.0
Duncan (Leeches) and Underground	000.0
Walter Murie Creek and Underground	786.5
Shurtz Creek and Underground	000.0
Braffits Creek and Underground	648.5
	7479.5
Total	18206.0

*Pending well permit will be supplemental to this right.

**Pending well permits will be supplemental to part of this acreage.

of 3 acre-feet per acre, the proposed determination would allow the withdrawal from the underground of about 12,650 acre-feet of water per year as a sole supply for irrigation purposes. In a very dry year when little or no surface water is available to be used on farm acreage with a supplemental surface supply, an additional 22,450 acre-feet of water could be withdrawn to irrigate these supplemental lands. This means that in dry years a maximum of about 35,100 acre-feet of water could be withdrawn from wells under present established irrigation rights, with a duty of 3 acre-feet per acre. This is about 13,000 acre-feet more than the maximum withdrawn in any given year to date and does not include already established rights for the diversion of water for industrial, stockwatering, domestic or municipal uses.

Potential Future Withdrawals and Future Water-Level Declines

During the period between 1956 and 1964 the average total pumpage for all uses in all of Cedar City Valley was about 21,200 acre-feet. The water levels in this period have shown an almost constant decline. It is expected that the water levels will continue to decline, if the pumpage rates remain at about 21,200 acre-feet annually and the opportunities for recharge do not improve significantly. The authorized withdrawal of an additional 19,400 acre-feet, if accomplished, would bring the total withdrawal to over 40,000 acre-feet a year.

If maximum diversion of ground water was made under the irrigation rights set forth in the proposed determination at a duty of 3 acre-feet per acre, the total yearly withdrawal with the development of the approved applications would be over 55,000 acre-feet.

This would more than double the average withdrawals that have been recorded over the past 9 years. If future pumpage under presently established water rights continues at the present rate and the 24 approved applications are perfected and pumped to a maximum it would increase the pumpage in the North Area from 19,000 acre-feet in 1959 to over 29,000 acre-feet, and the pumpage in the South Area would increase from a maximum of 4,400 in 1960 to almost 14,500 acre-feet. The development of this amount of additional water can only be accomplished with a significant further lowering of the water levels.

An attempt was made to project future water level declines with the expected increased pumpage. It was found that a correlation exists in the North Area between the average annual water level changes in 8 selected wells, and the annual water year (October-September) difference between the flow of Coal Creek and the volume of groundwater pumped in the North Area. This is illustrated by a graph in figure 6. This graph indicates that water levels will decline when the flow of Coal Creek exceeds the annual pumpage by less than 12,000 acre-feet and that water levels will rise when the difference is greater than 12,000 acre-feet. The water level rise or decline as illustrated by the slope of the line in figure 6 will be at a rate of 1 foot for every 5,625 acre-feet of remainder above or below 12,000 acre-feet. This implies that with the present use of the stream, water levels would naturally decline in years when Coal Creek flows less than 12,000 acre-feet even if there was no groundwater development.

In the period from 1939 to 1964 Coal Creek has averaged a

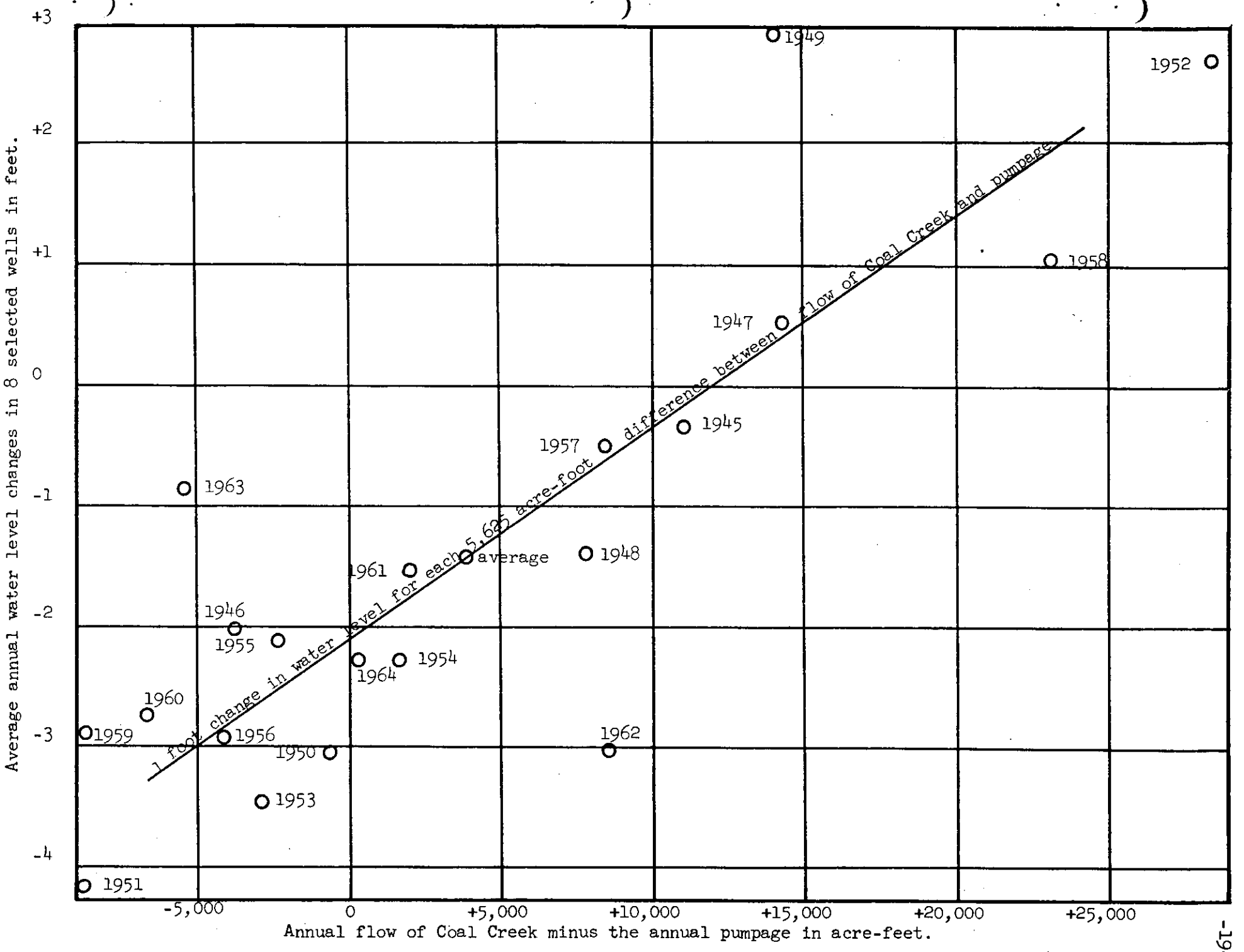


Figure 6. -- Change in water levels as related to the difference between the annual flow of Coal Creek and the annual pumpage in the North Area.

flow of a little over 21,000 acre-feet. This means that in a year of average streamflow conditions water levels will decline when pumpage in the North Area exceeds 9,000 acre-feet. Assuming a maximum pumpage of 29,000 acre-feet in the North Area for future withdrawals as was done earlier, predictions can be made of future ground-water level declines. With this amount of pumpage and with average streamflow, the water levels should decline at an average rate of 3.6 feet per year. If ground water is pumped in the North Area at the average rate of 29,000 acre-feet annually for the next 10 years, the average water level decline over that period should be about 36 feet. Pumpage data and streamflow records for the South Area are not sufficient to permit establishing a similar relationship for that portion of the valley.

Conclusions

Water levels have been declining for the past 20 years in Cedar City Valley and the rate of decline has been increasing in recent years. This is due to increased ground-water development and pumpage and below normal precipitation. The water rights already established as set forth in the pending adjudication and the additional approved applications, which can be developed, make it very likely that future ground-water pumpage will be significantly greater than at present. Barring a major upward trend in precipitation, the water levels should decline at an increased rate and pumping lifts and costs should become greater.

The approval of the 4 pending unapproved applications would

add an additional 2895 acre-feet to these totals. It would appear that if these additional applications were to be approved, it should be with the knowledge that it is very likely that the approval will be authorizing the mining of the groundwater of Cedar City Valley.

In the open file report entitled "Ground-Water Resources of Selected Basins in Southwestern Utah", by the U.S.G.S. the author, G. W. Sandberg, indicates that Cedar City Valley has the smallest potential for future development of any of the four Southwestern basins covered in the report. He does indicate, however, that some additional development may be feasible in a small part of the valley near Rush Lake. It would appear that perhaps this additional development may have been authorized by the approval of several applications in the last two years for development in this area. Very little development has taken place under these applications to date and their proofs of appropriation are due in 1966 or 1967 (fig. 5).