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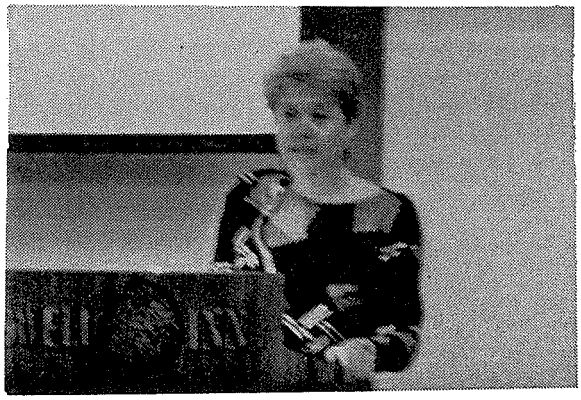

TRANSFERS OF NEW MEXICO WATER
A SURVEY OF CHANGES IN PLACE AND/OR PURPOSE OF USE, 1975-1987

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INTRODUCTION

In a region like our own, where most available water is appropriated and in use, a successful water policy must confront the need to provide new users with water. New Mexico's water administration has relied on privately arranged transfers of water (water marketing) to fill this need. Water markets are a decentralized approach to resource-use decisions, and ideally can give a water-allocation system flexibility, security, and resilience.

However, water is difficult to define as a private transferrable asset. It flows from user to user and the hydrologic system is not amenable to being chopped into discrete physical units of property. Private transfers of water, therefore, require a water administration system that can account for the relationships between water users who jointly depend on a common resource, translating the unified hydrologic reality into discrete legal claims in changing places and circumstances of use. In New Mexico, this is the responsibility of the State Engineer Office (SEO).

Water users who wish to change the place and/or purpose for which their water is used must show the State Engineer that the proposed change does not impair existing rights. The change must also be consistent with the public welfare and the conservation of New Mexico waters. For markets to be a flexible and inexpensive means of providing water to new uses, the process of reviewing these applications must be expeditious and simple; for private water rights to be secure, the process must be thorough and careful.

The ongoing research reported later is aimed at assessing the speed and expense of the application

process and exploring criteria that might increase the speed and reduce the expense with minimal loss in thoroughness and care. The project began with a comprehensive census of applications to change place and/or purpose of use (ACPPU) and a survey of a small sample of applicants to gather information about prices, transactions costs, and time delays.

The census and survey show that while some ACPPU are slow and costly to process, most are processed quickly and cheaply. More than half of the applications recorded in the census were processed in less than three months; an additional 25% took between three and six months; only 10% took more than a year (Figure 1). The survey collected estimates of attorney fees, court costs, hydrological expenses, and filing and publication fees for 87 ACPPUs. In 76% of these, applicants spent less than \$50/AFCU[1]; 5% had transactions costs greater than \$1000/AFCU (Figure 2). In terms of volumes of water in ACPPUs, 95% of the water was processed at costs below \$10/AFCU (1988\$); transactions costs were above \$100/AFCU for less than 2%.

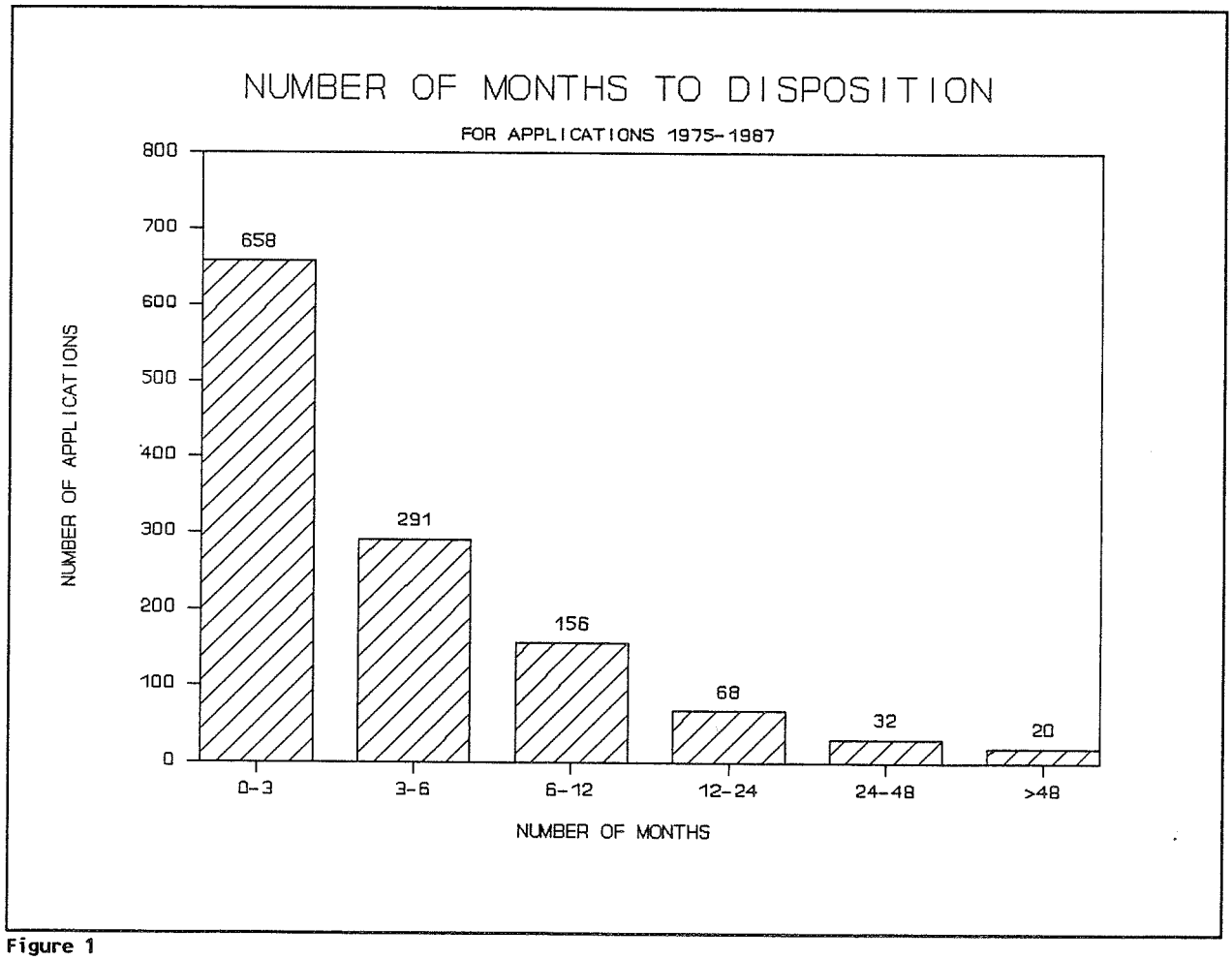


Figure 1

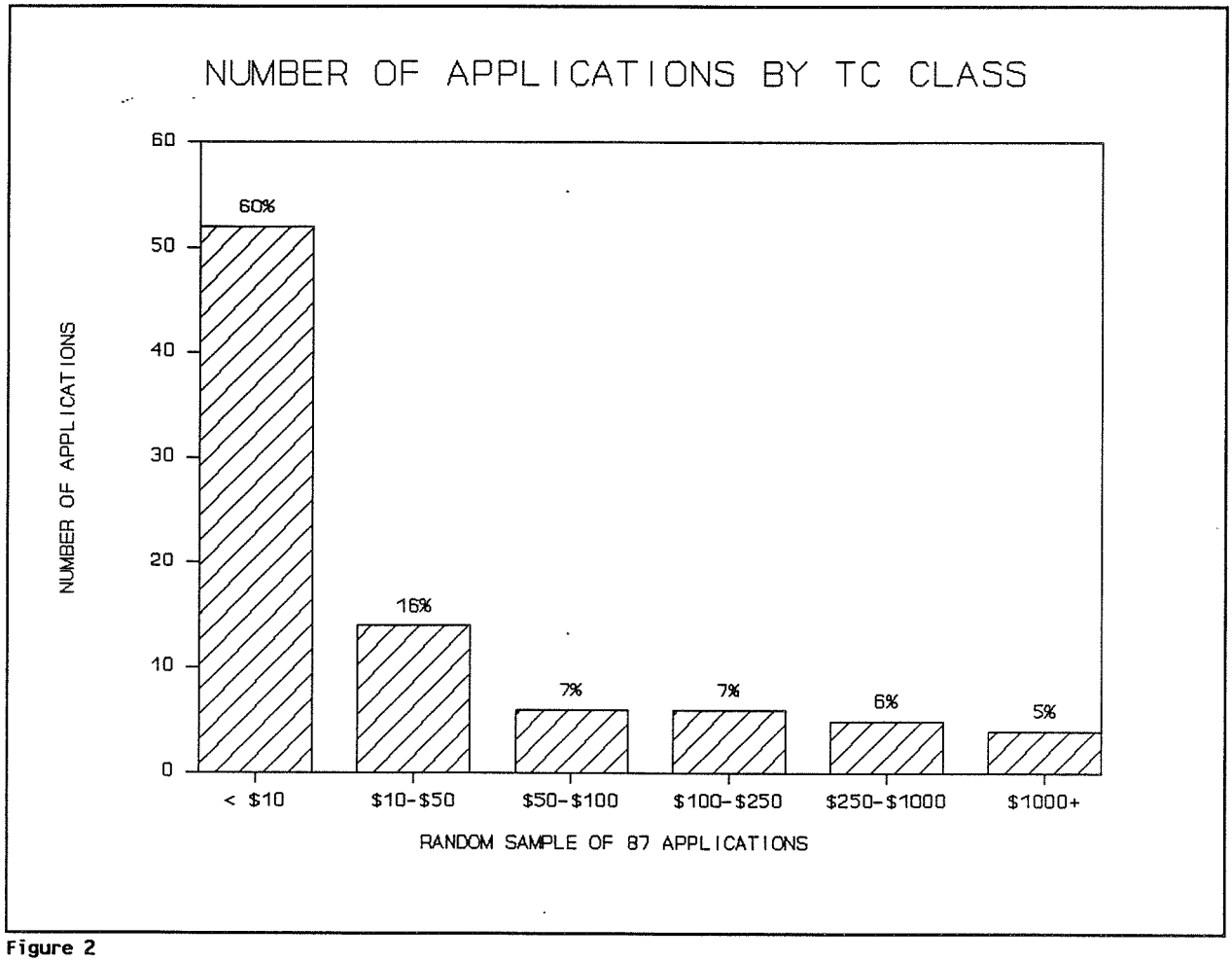


Figure 2

The second step in our research is to identify what causes the occasional long delays or high costs, and explore ways of addressing these situations. It has proved difficult to define these circumstances through statistical analysis. What I can report now is a summary of some of the data we have assembled. I am open to suggestions as to explanations of these data and productive avenues to explore.

For the purposes of the survey, the state was divided into twelve water regions. The objective of the division was twofold. For surface and surface-related water rights, we wished to collect all water rights that were related to one another. Therefore, we considered, for example, the Pecos River, its tributaries, the Rio Hondo, Rio Peñasco, Rio Ruidoso, and Hagerman Canal, and the related ground-water basins, the Roswell artesian and shallow water aquifers, Carlsbad, Capitan, Fort Sumner, and Upper Pecos as a single group. Surface rights in the Gila and San Francisco Rivers and ground-water rights in the Gila-San Francisco Basins were likewise considered as a group. The Rio Grande was divided into three segments, the Upper, Middle, and Lower Rio Grande. While the river is hydrologically connected, considerations arising from the terms of the compact with Texas have resulted in a policy not to permit water uses to move from Rio Grande associated waters above the Otowi Bridge gauge to points below Otowi, or from points above Elephant Butte to below the Butte. Surface rights in the San Juan and ground-water rights in the Animas shallow water aquifer are considered together, as are surface and ground-water rights in the Bluewater and Canadian drainage.

We collected the enclosed ground-water basins in the same region in a group. The groups thus defined are: Central Ground-water basins, Estancia and Sandia; Southeast Ground-water basins, Lea

County and Portales; Southwest Ground-water basins, Mimbres, Playas Valley, Lordsburg Valley, Nutt-Hockett, and Animas; and the South Central Ground-water basin, the Tularosa. While these basins are hydrologically separate, they are probably affected by similar economic and climatic forces. The twelve water regions are shown in Figure 3.

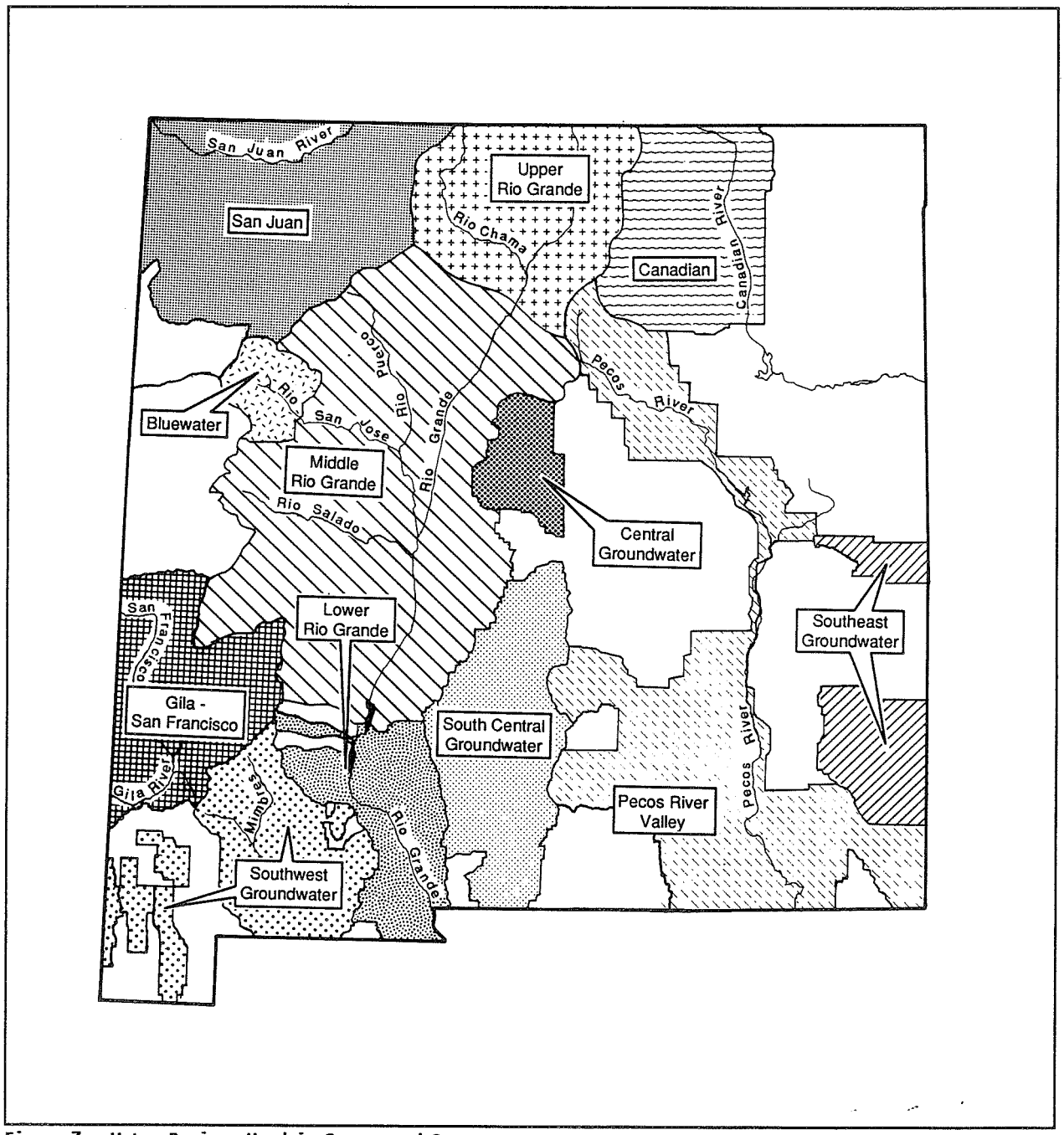


Figure 3: Water Regions Used in Census and Survey

TECHNICAL CONSIDERATIONS IN REVIEWING ACPPU

Before reporting the data, it is useful to review the considerations in evaluating an ACPPU for different types of water resources: streams, tributary aquifers, and nonstream related ground-water basins.

A. Surface Water Rights: In New Mexico, both surface and ground-water rights are held under the doctrine of prior appropriation. This means that during times of shortage, the most recently established water uses will be shut down to protect the earliest established rights. When water is short or, as in the Pecos Valley, when rights are asserted that exceed the capacity of the stream, priority dates become important.

On a fully appropriated stream, the only way to establish a new use is to acquire an existing right and file an ACPPU with the State Engineer Office (SEO) to change the place and purpose of use. The SEO will permit the change if it does not impair existing rights and it is consistent with the public welfare and conservation of the waters of New Mexico. The major cause of impairment in a transfer of a surface right is the resulting change in the pattern of return flows to the stream. Figure 4 provides an illustration.

The hypothetical stream in the Figure 4 has annual streamflow of 500 af in a normal year. Recognized rights exist to divert 750 af/yr; it is possible to divert more water than there is in the stream because the first three users consume less than they divert, and their return flows are available to downstream users.

Suppose the user at position (1) has the highest priority in the stream, and wishes to move the place of use from (1) to position (5). If this move is approved, the stream will be unbalanced. Only 100 af of water will exist at position (5), not enough to satisfy the 250 af diversion right now held by position (1).

Requiring a lower-priority user (say position (4)) to shut down 150 af/yr of its established use in order to allow the user at position (1) to change the place of use would impair the low-priority right. To avoid this impairment, the user at position (1) might only be allowed to move the 100 af/yr that was *consumptively* used in the original use, in order to maintain the other water users in their original position.

Technical questions addressed in transfers of surface rights: In considering an ACPPU of a surface water right, the SEO evaluates the effect of the changes in return flow patterns on existing rights. To do this, the SEO must determine consumptive use and return flows at the original use and at the new use. For many uses, particularly irrigation, area averages are used for this purpose; occasionally, however, consumptive use is evaluated on a site-specific basis. Such evaluations are costly and time-consuming.

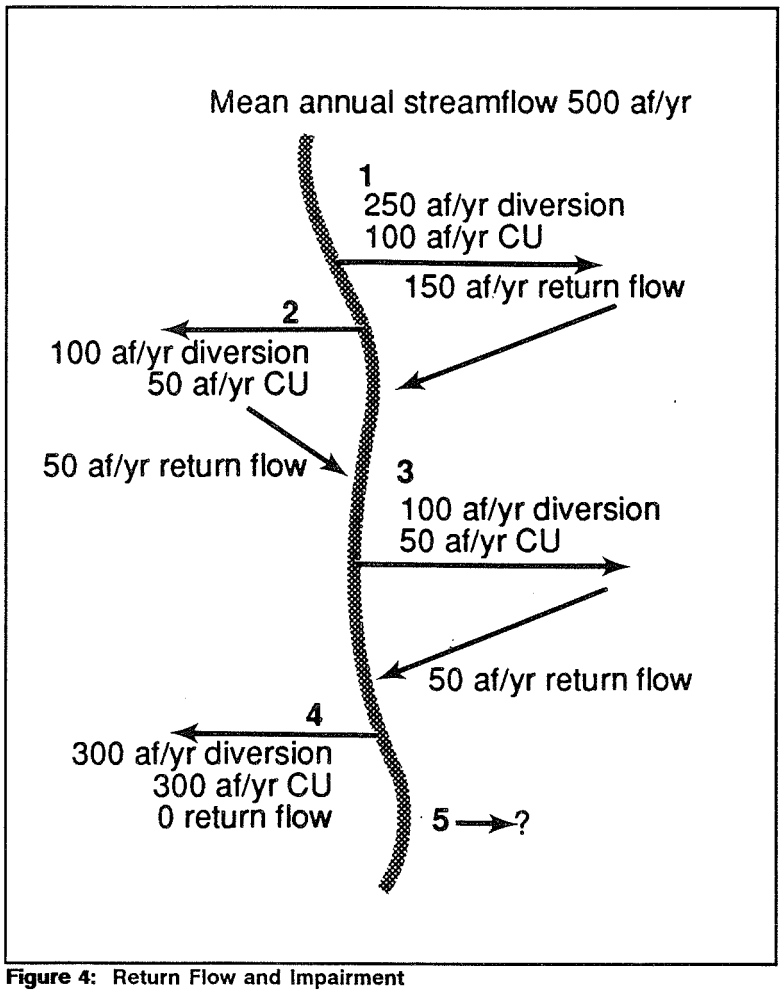


Figure 4: Return Flow and Impairment

B. Rights on a Tributary Aquifer: Many important ground-water rights in New Mexico are in stream-related aquifers. An appropriation of water on a stream-related aquifer will eventually have an impact on streamflows.

As shown in Figure 5, pumping dewaters a portion of the aquifer, creating what is called a "cone of depression." If the ground-water flow is toward the stream, a part of the water withdrawn from the well is at the expense of stream flow.

To protect prior rights in the stream, the State Engineer requires, as a condition of granting an application to appropriate or change a tributary ground-water use, that the applicant acquire rights in the stream in the amount of the impact on the stream and dedicate those to the State Engineer.

In the Pecos Valley, ground-water pumping was already impairing rights on the stream by the time the ground-water basins were first administered. The New Mexico Supreme Court, in Templeton v. Pecos Valley Artesian Conservancy District, 65 N.M. 59, 332 p.2d 465 (1958), ruled that when appropriations from a stream-related aquifer depleted streamflows, surface right holders could "follow the source of their original appropriation." The court ordered that such surface right holders should be allowed to appropriate water from the tributary aquifer, even though no appropriable water existed in the aquifer.

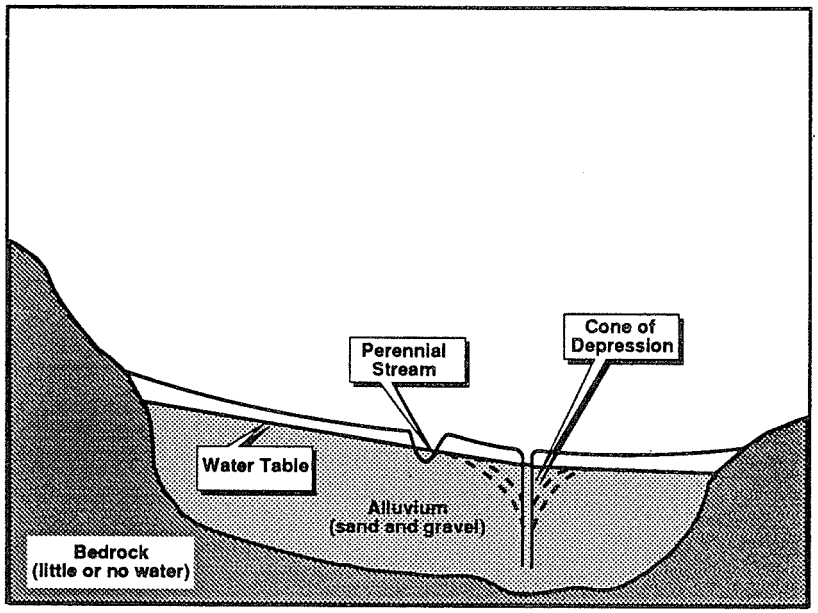


Figure 5. Effect of a Well on Streamflows in a Tributary Aquifer

Technical questions addressed in transfers of tributary ground-water rights: In considering an ACPPU of a ground-water right on a tributary aquifer, the SEO must evaluate the impact of the new well on the stream. In most of the state's basins, standard models with given assumptions on aquifer parameters are used to calculate stream impact. When these models change or are challenged, the hydrological work required to show site-specific effects of a well on a stream can be demanding and costly.

C. Rights in an Enclosed Ground-Water Basin: New Mexico was the first state in the West to apply prior appropriations to ground water. Priorities in a mined ground-water basin have different implications from priorities in surface water. For a surface right, priority tells water users how likely they are to get their water in a particular year under a particular streamflow condition. In contrast, a ground-water right is not subject to annual variability in precipitation and runoff; a well in an enclosed basin will yield in wet years and dry. However, in a mined basin, the more water pumped per year, the shorter the future of the basin as a water resource.

Administration of rights in an enclosed basin involves a tradeoff: on one hand, it is desirable to make water available for as many beneficial uses as possible; on the other, water users typically make long-term investments related to their water use, and they need to be secure in their expectations of future water availability. The more water users on an enclosed basin, the shorter the future expectations for each. This tradeoff has been made by administering the basin so as to secure to water users an expectation of a "reasonable" economic lifetime after declaration of the basin, usually 40 years. Very roughly speaking, rights are granted so long as they are not expected to bring water levels below an economic pumping lift for the marginal water user (usually irrigation) during the 40-year period. This allows exploitation (mining) of the basin, while providing security for water users.

This guideline is interpreted in the context of hydrologic conditions on the basin to develop criteria for granting permits to appropriate water from the basin. The criteria may be expressed as limitations in the number of feet the water table may be lowered in a 40-year period (Mimbres) or in terms of the amount of water available for appropriation (Portales).

Each enclosed ground-water basin is administered under the same set of criteria. However, all points in the basin are not equivalent. Lateral movement of ground water is slow. Depending on the aquifer's transmissivity, the major impact of a well on water levels over a 10, 20 or even a 100-year period may be confined to the well's immediate vicinity. To account for this localized impact, the SEO divides the basin into administrative units, each viewed as a sort of subbasin. To determine whether there is appropriable water in an administrative unit, the SEO applies the basin-wide criteria to the unit.

Figure 6 shows a map section of the Mimbres Basin used for making administrative decisions about water applications. In each 4-square mile administrative block, the upper number shows the calculated nonpumping water level at the end of 1994 for existing rights; the lower number shows the average calculated annual water level decline. The Mimbres criteria provide that rights may not be granted that bring the projected 1994 non-pumping water levels above 128 ft, or that increase the rate of annual drawdown to more than 2.5 ft/yr. In the block indicated, the criterion for nonpumping water level has already been exceeded, and no water would be available for appropriation. Similar (but not identical) criteria are used in other enclosed basins.

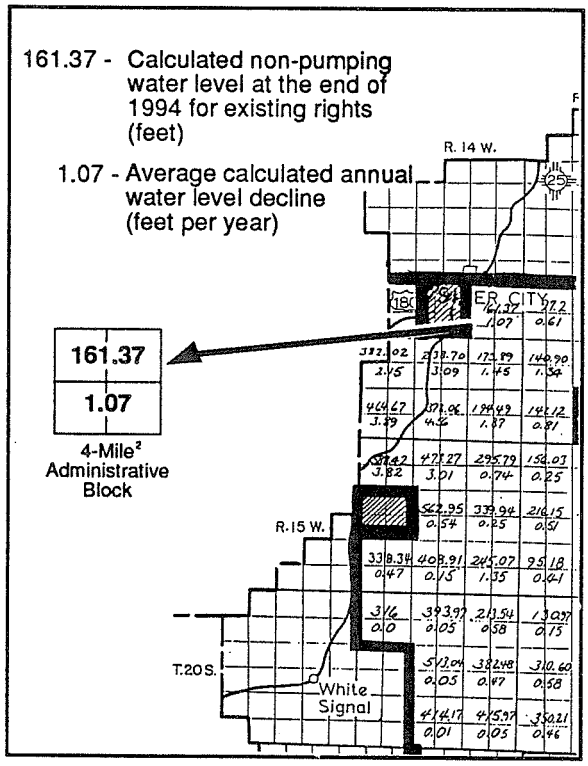


Figure 6. Section of the Mimbres Basin administrative map

Technical questions addressed in considering transfers of rights in an enclosed basin: ACPPU for water in an enclosed basin are very much like applications for new appropriations. Unless the new use is in the same administrative block as the old one, the water freed up by suspending the original use is not likely to count as water available for the new use. In considering these applications, the SEO needs to estimate the impact of the well on water levels within the pertinent time frame, and perhaps to calculate the new well's contribution to annual rate of drawdown.

D. Other Considerations: For any type of application, the SEO also considers local effects on nearby wells or diversions, and the impact on water quality. While an increase in pumping lift for a nearby well, even such an increase as would require drilling a new well, is not automatically considered a local impairment, there is some threshold that will cause such an impact to be considered impairment. Similarly, if it appears an application will have a negative effect on water quality, the SEO may consider this effect to be an impairment.

LEVEL OF ACTIVITY: CHANGES IN PLACE/ PURPOSE OF USE OF WATER RIGHTS

The census reviewed 2313 applications. On about 835 of these, no census form was taken because they were judged to involve irrigators moving their water rights around their own acreage. Of the remaining 1478, 25 were for dates outside the 1975-1987 period, and others were missing data; 1309 contained the basic data on quantity of water and date of application and disposition used for census records. Comparing this figure with the annual reports of the SEO, it appears that census takers

reviewed about 80% of the applications made over these twelve years. The state engineer and others familiar with water administration during this period were of the opinion that the census is reasonably representative of the applications during this time.

There are two alternative ways to measure the level of activity represented by the ACPPUs reviewed - the number of applications and the volume of water represented by applications. These measures tell different stories.

The number of census applications per year rose to 147 in 1979, remained high until 1983, since then it has declined (Figure 7). It may be worth noting that the compound annual rate of growth in population in New Mexico during the seventies was 2.51%, falling to 1.83% in the eighties, while employment growth rates also fell from 4.2% to 2.3% in the same periods.

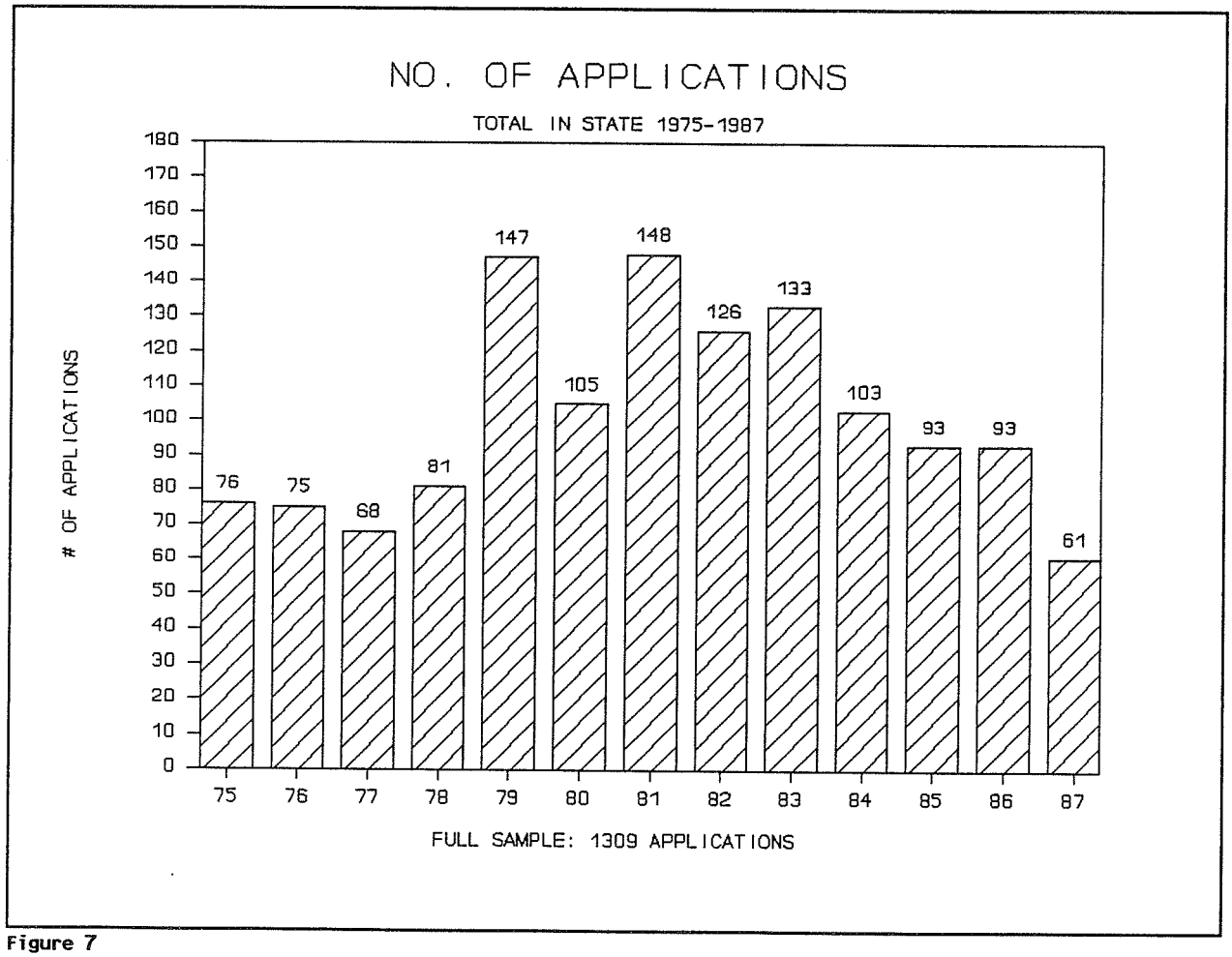
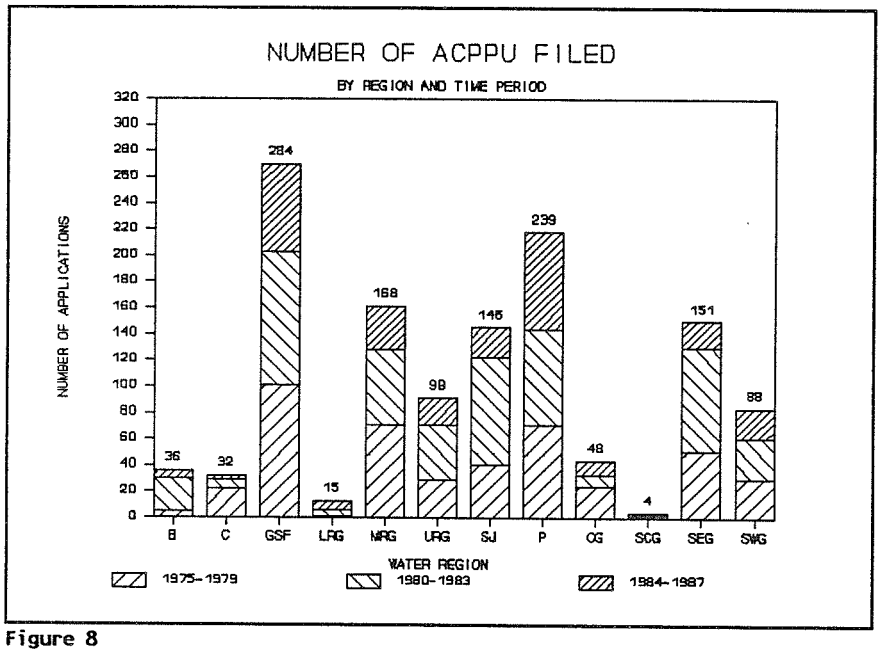


Figure 7

The number of applications in a water region will be affected by water-related regional economic activity, the regional water supply, population and physical extent of the region, and region-specific administration, quite a hodgepodge of determinants. Figure 8 shows the Gila-San Francisco Basin leading the state in number of applications, followed by the Pecos, the Middle Rio Grande, the Southeast Ground-water region and the San Juan Basin. The Gila-San Francisco has a large number of applications because the basin is administered under the Supreme Court decree in Arizona v. California, 373 U.S. 546 (1963). As administered, basin homeowners must acquire water rights even for domestic use and home irrigation, while in other parts of the state, up to 3 acre-feet/year may be pumped without a right for domestic purposes. Second place is taken by the Middle Rio Grande, the most populous and economically active of the water regions; third and fourth places by the Southeast Ground-water and San Juan basins, where energy-related water use is significant.



WATER REGIONS
(refer to Figure 3)

B	Bluewater
C	Canadian
GSF	Gila San Francisco
LRG	Lower Rio Grande
MRG	Middle Rio Grande
URG	Upper Rio Grande
SJ	San Juan
P	Pecos River Valley
CG	Central Ground Water
SWG	Southwest Ground Water
SCG	Southcentral Ground Water
SEG	Southeast Ground Water

Figure 8

Measurement of the volume of water in these applications required the development of a common metric. Some applications give the quantity of water to be moved in terms of diversion rights, others in consumptive use rights, and others give both. Consumptive use at the destination, or "move to" use (AFCU) was chosen as the index of quantity; wherever consumptive use was not stipulated, it was estimated by applying the average ratio of consumptive use/diversion to the diversion right. The ratio used is specific to the type of use in the original location. For transfers from agricultural uses, the average ratio in ACPPUs in the census is .534; from municipal uses, .459; from industrial uses, .663. These ratios were applied to all applications that lacked a consumptive use measure in the destination use. This procedure is an approximation which has been judged to involve fewer errors than the alternatives.

Thus defined, the volume of water in applications for change over time (in AFCU) does not follow the same pattern as the number of applications. AFCU in applications for change has declined since 1975-1976, except for 1986 (Figure 9).

What we see in this time series is the dominance of specific projects in determining the volume of water in ACPPUs. In 1975, for example, Carlsbad acquired nearly 3,000 AFCU of ground-water rights in Lea County, with the intent of eventually piping that water to Carlsbad. In 1976, the Public Service Company applied to change the place and purpose of use of nearly 12,000 AFCU of San Juan Chama Diversion water. In 1986, applications to move almost 5,000 AFCU were made to fill Brantley

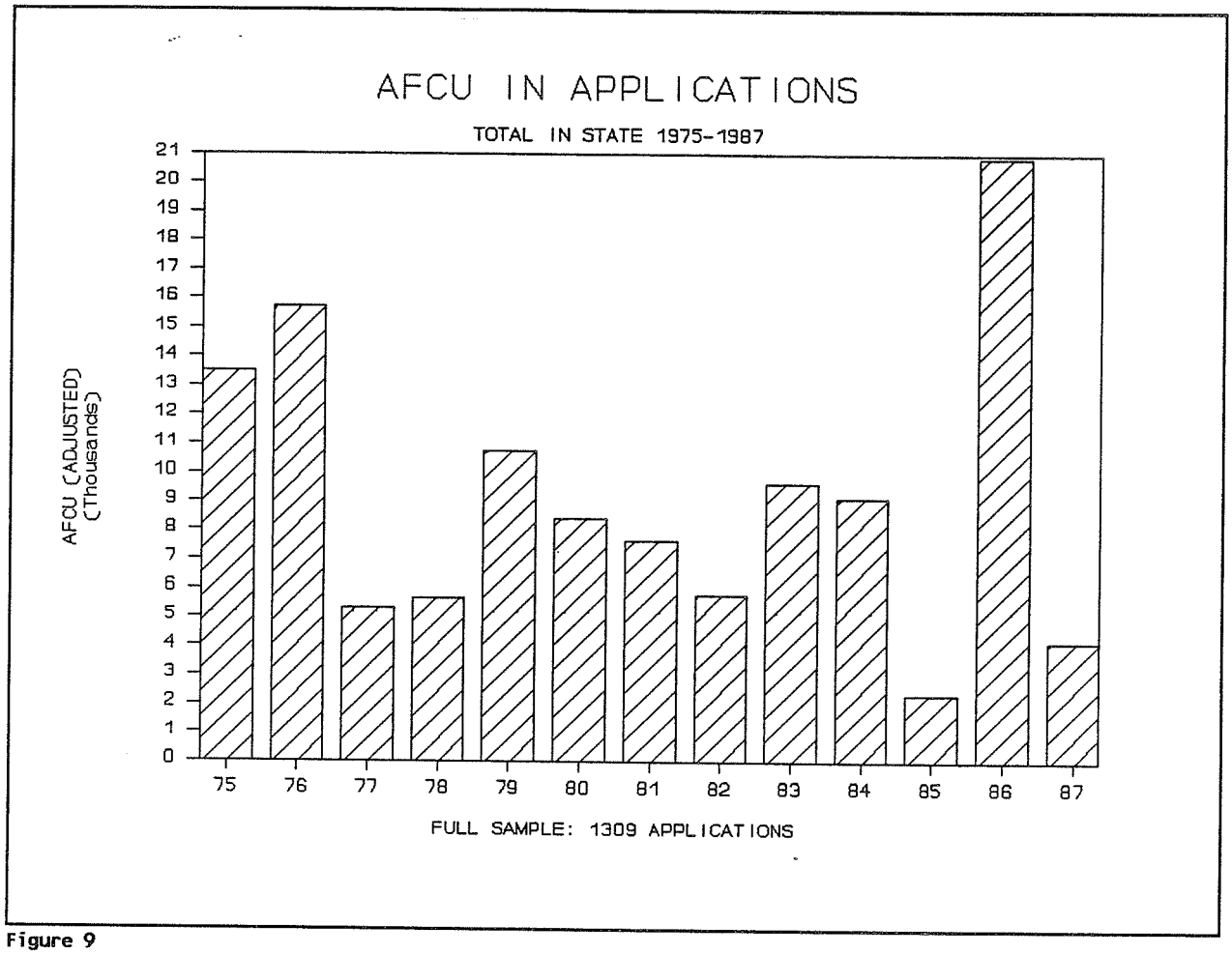


Figure 9

Dam Reservoir. In addition, 1986 figures are pushed up by a single application by a wine grower's association to move nearly 9,000 AFCU of San Juan Chama Diversion water.

Shifting our perspective from looking across time to one of looking across the water regions, the difference between number of applications and consumptive use in applications persists. The Middle Rio Grande has the greatest volume over the entire period (recall that the Gila-San Francisco had the greatest number of applications). Pecos River Valley (where ACPPU's involved a greater volume than the Middle Rio Grande during the 1980-1987 period) is second. A substantial amount of water was also moved in Southeast Ground-water basins (Figure 10).

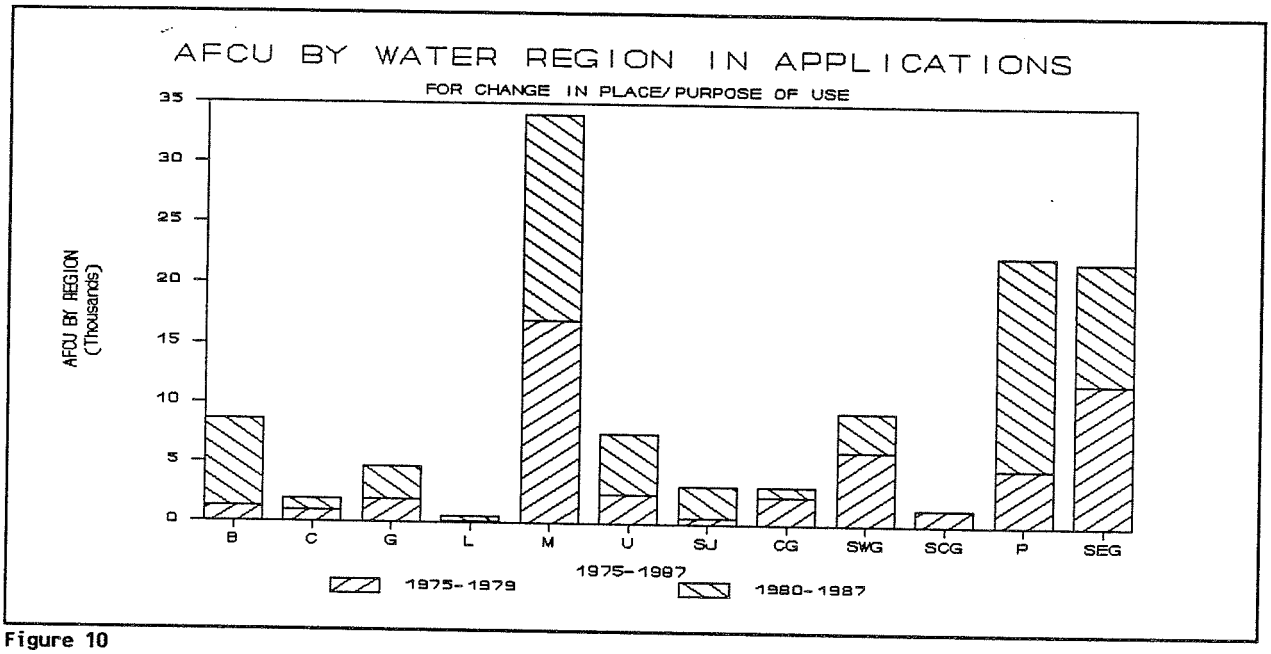


Figure 10

The difference between the patterns of consumptive use and number of users in applications has to be in the average size of application. As mentioned above, the Gila-San Francisco Basin has many small applications to move water rights because of a court order. Applications in most water regions involved, on average, less than 250 AFCU; average size of application tends to be smaller from 1980-1987 than from 1975-1979. One large application in the Southcentral Ground-water region (Tularosa basin) pushes its average off the chart, to 1328 AFCU (Figure 11).

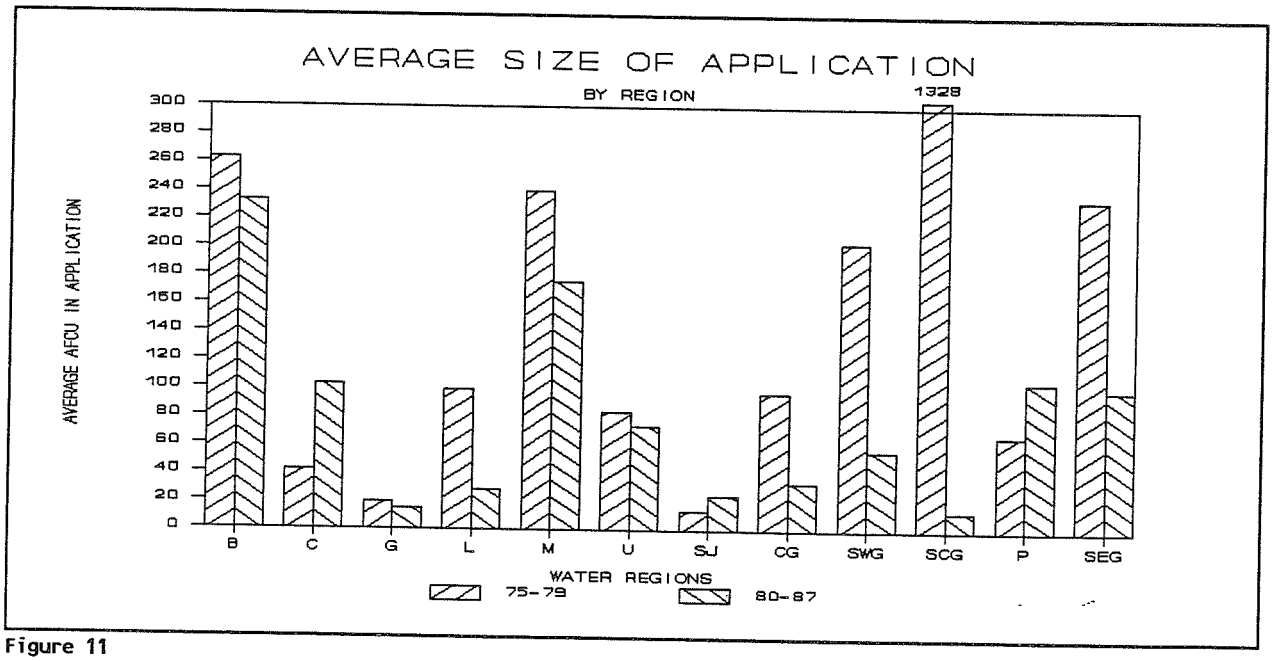


Figure 11

To summarize, we see a system in which movements in *volumes* of water over time are dominated by single events. These large transfers are usually special cases reflecting one-time needs or opportunities (such as the filling of Brantley Dam, or the availability of San Juan Chama water) rather than a continuous adjustment to changing economic conditions. The *number of applications* may be a better measure of the ongoing adjustment process; it seems to correlate roughly with population growth and growth in employment.

It is difficult to interpret the differences in ACPPU activity among regions, because the regions differ in size, population, level of economic activity, and quantity of appropriable water. We could compare the intensity of activity in changes in water use among regions by looking at the percentage of total water rights in the region that is involved in ACPPU's. Unfortunately, the total water rights data is not available. Lee Brown, of the University of New Mexico's Natural Resources Center, in a related study of transactions costs, used the SEO's five-year estimate of annual consumptive use of water as a rough proxy for volume of water rights. These estimates are made by river basin and by county, so there is no figure to compare with our enclosed ground-water regions, and even the surface-water basins are not all comparable to the regions defined in this study. However, the Rio Grande (Upper, Middle, and Lower as a group), the San Juan, the Gila-San Francisco, and the Pecos appear to be roughly comparable.

Table 1 shows the total volume in ACPPUs in the census as a percent of depletions in these four basins. Almost 10% of Gila-San Francisco estimated depletions were involved in ACPPUs during the 13-year period, a high intensity consistent with the Gila-San Francisco's more rigorous requirements on accounting for domestic uses. ACPPUs contained 5.4% of the estimated depletions in the Pecos River Valley, 2.5%, or almost half, of these were related to the filling of Brantley Dam Reservoir. In the Rio Grande as a whole, ACPPUs in the census involved 4.8% of estimated annual depletions in the whole stream. In the San Juan Basin, which had a high number of applications but relatively low volume of water, ACPPUs involved only 1.1% of estimated depletions.

COMPARISON OF VOLUMES IN ACPPUs
WITH REGIONAL DEPLETIONS
(IN AFCU)

WATER REGION	VOLUME IN ACPPUs	DEPLETIONS	ACPPU AS % OF DEPLETIONS
Rio Grande	42,069	883,300	4.8%
San Juan	3,157	299,500	1.1%
Pecos	22,510	414,300	5.4%
Gila-San Francisco	4,665	48,400	9.6%

From Summary Statistics section of F. Lee Brown, draft report to U.S.G.S., November, 1989; estimated depletions taken from Water Use in New Mexico in 1985, Brian Wilson, New Mexico State Engineer Office Technical Report 46, November, 1986.

Table 1

PRICES AND COSTS OF TRANSFERRING WATER RIGHTS

Price and cost data on water sales is notoriously hard to come by. Only a subset of the ACPPUs represented in the census involve sales; others are permanent or temporary changes by a water rights owner of the place and/or purpose of use of that right without change in ownership. The SEO records on ACPPUs do not indicate whether an application represents a sale, a lease, or an owner seeking to change its water use. A field test of the survey instrument revealed that many of the changes within agriculture and from agriculture to domestic use did not involve sales. These applications were removed from the census, and a random sample of the remaining applications was surveyed. Of the 368 applications drawn, 110 responses have been collected to date. Sixty-three represented sales, 15 leases, and 32 changes in use by the owner. We asked applicants from this small sample what they paid or received for the water right, how much money and time they spent on the application process itself, and how strongly the application was protested. Of the respondents involved in sales and leases, 62% provided price information and 79% of all respondents provided information on transactions costs.

Prices: Of the 34 applications for which we have data on sales price, the average sales price was $2316, with quantities converted to consumptive use units and price expressed in constant 1988 dollars (Figure 12). This average covers a substantial variability: the standard deviation is $2043/AFCU (that is, if the population is normally distributed, 68% of the prices lie between $273 and $4359, a wide range). There is also considerable variation among and within regions. In the Southeast Ground-water basins, for example, the average price was $174/AFCU; in the Pecos River Valley, $2609/AFCU, with individual prices ranging from $347/-AFCU to $11,134/AFCU.

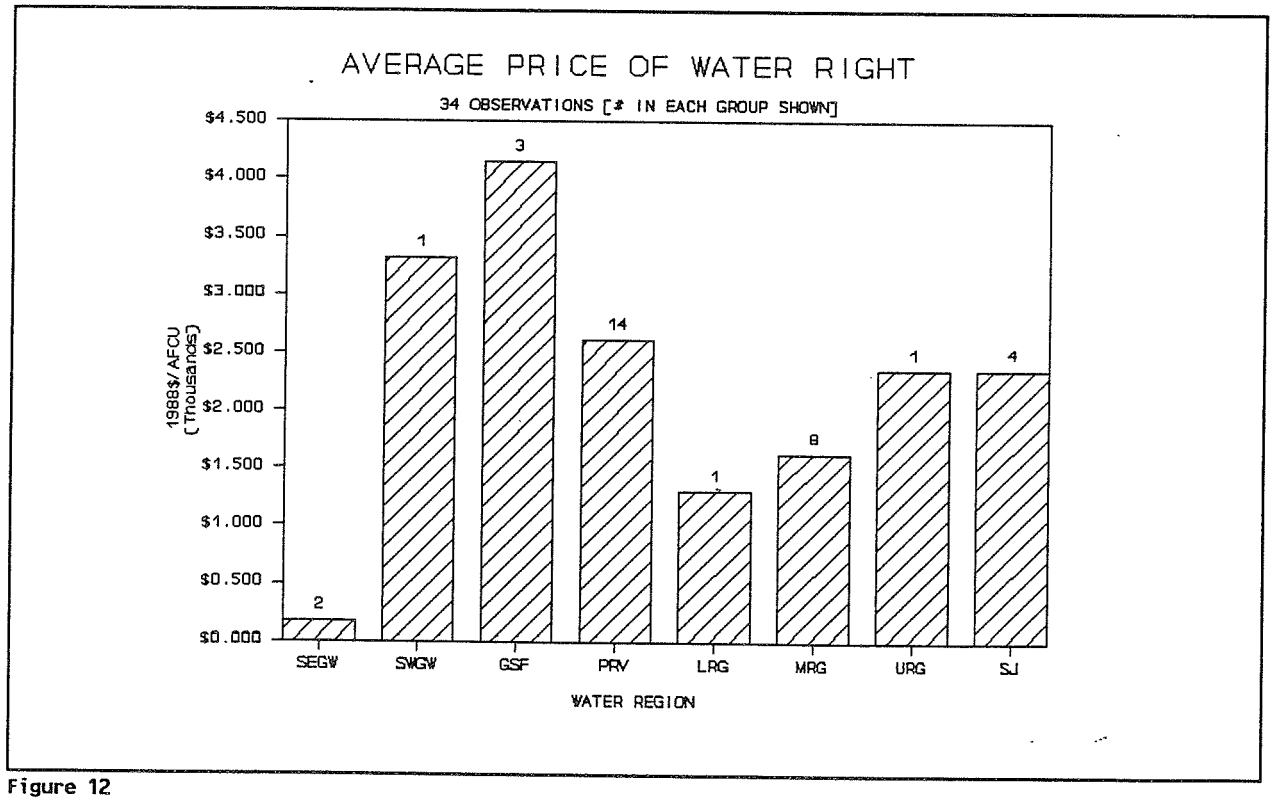


Figure 12

Over the state as a whole, prices appear to be rising somewhat over time. The average of the six prices reported in the 1975-1979 period is $1379/AFCU; of the 13 prices reported in the 1980-1983 period, $2121/AFCU; of the 15 prices reported in the 1984-1987 period, $2860/AFCU. These prices have been adjusted using the Consumer Price Index (CPI), and are expressed in 1988$, so this represents a rise in real relative price as compared with the goods indexed in the CPI.

Purchases of less than 5 AFCU tend to be higher priced than larger transactions (averaging $4051), but this tendency does not continue as the size of transaction increases above 5 AFCU (Figure 13).

Lease rates: Annual charges for the 14 leases of water rights ranged from $148/AFCU to $1843/AFCU, with an average of $364/AFCU, and a standard deviation of $448/AFCU. Eight of the leases drawn in the sample were from the Gila-San Francisco region during 1979 and 1980; this leased water was moved to municipal, industrial, and domestic uses, with lease rates all close to $150/-AFCU. The other six in the sample were leases for pipeline pressure testing, highway construction, commercial uses, mining and metallurgical uses, gas and oil drilling, and construction. If this very small sample is representative, lease rates differ from prices in that they do not appear to be higher for leases of less than 5 AFCU (Figure 14).

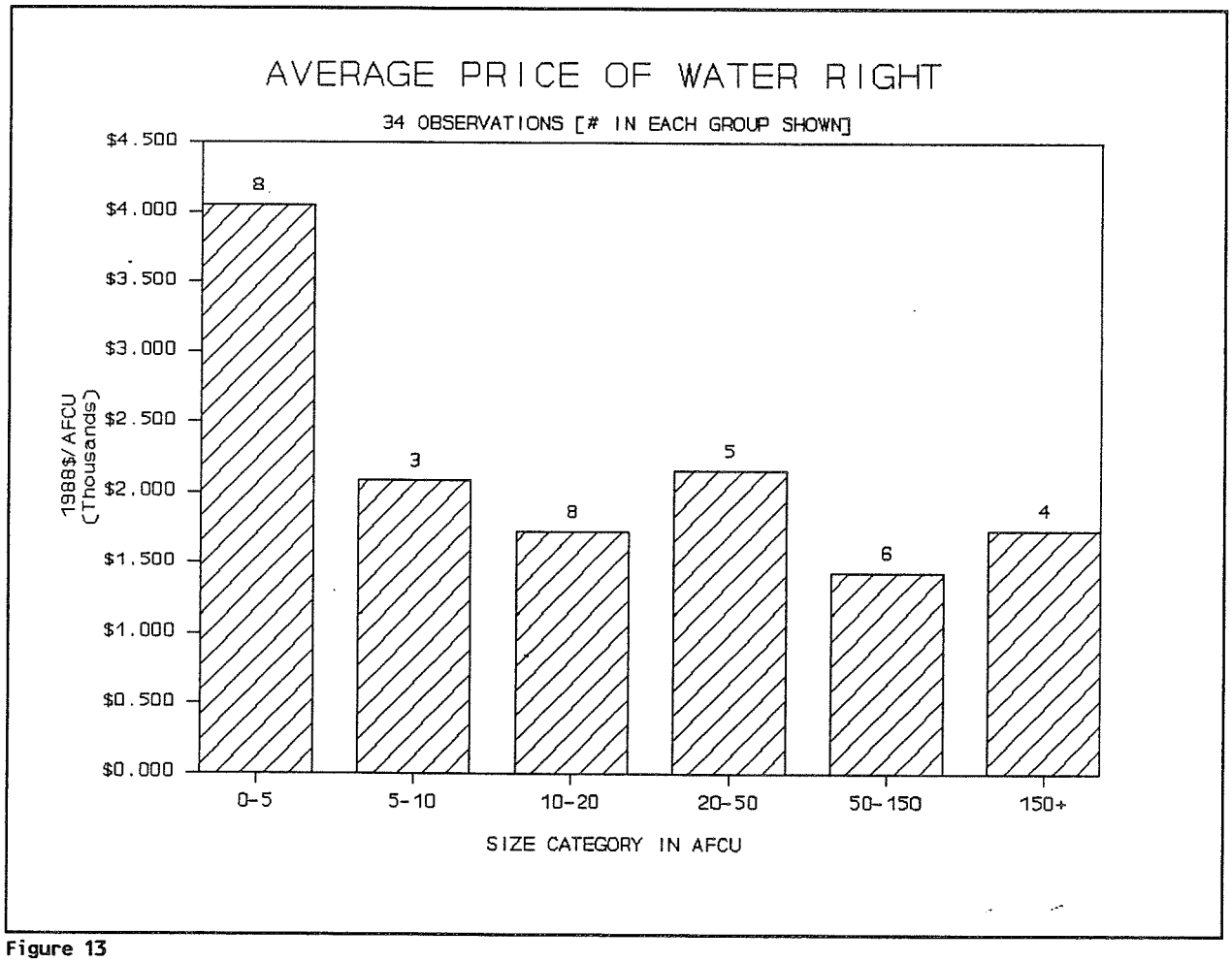


Figure 13

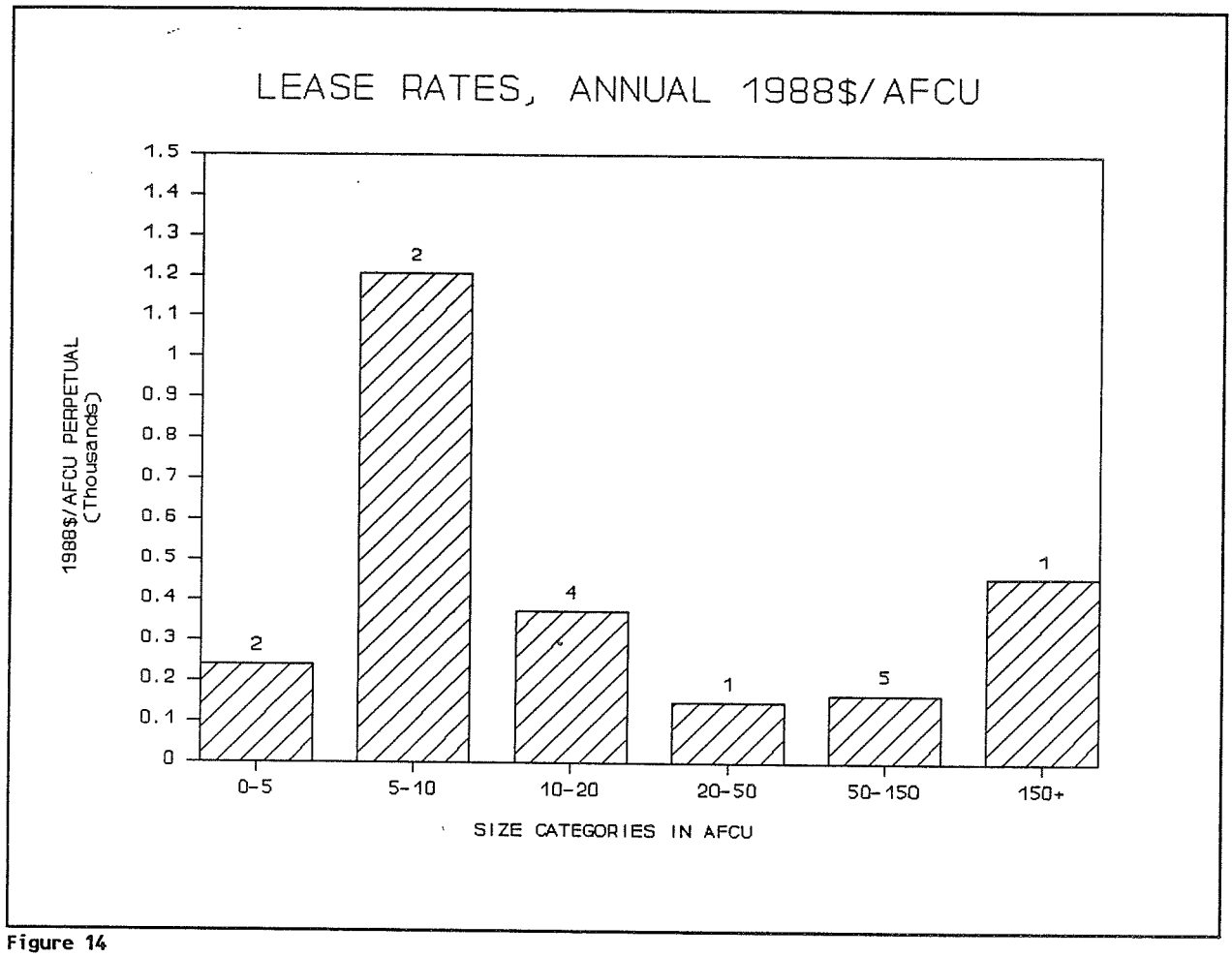


Figure 14

Transactions Costs: The filing and publication fees, hydrologic studies, attorney's fees and court costs paid by the applicant averaged $191/AFCU over the 87 survey responses that gave transactions costs. As with prices, there is high variability; the standard deviation for the whole sample is $712. There are large differences in average transactions costs among water regions (Figure 15), where averages range from $1.34 in the Southeast Ground-water region to $1083.77 in the Upper Rio Grande, as well as variation within regions, such as the Pecos River Valley, where transactions costs per single application range from $.05/AFCU to $1117/AFCU.

Transactions costs, like prices, are rising over time. The average transactions cost for 27 reported in the 1975-1979 period was $16/AFCU; for the 29 reported in 1980-1983, $216/AFCU; for the 31 reported in 1984-1987, $328/AFCU. Again, all costs are expressed in 1988$, so this increase represents an increase in real cost relative to the items indexed in the CPI.

Transactions costs decline with the size of application, as prices do. However, while prices declined for sales of more than five AFCU, average transactions costs remain quite high for applications between 10-20 AFCU ($395/AFCU). Average transactions cost falls to $60/AFCU for applications in the 20-50 AFCU range, to $36/AFCU for applications in the 50-150 AFCU range, and to $3.82 for those greater than 150 AFCU (Figure 16).

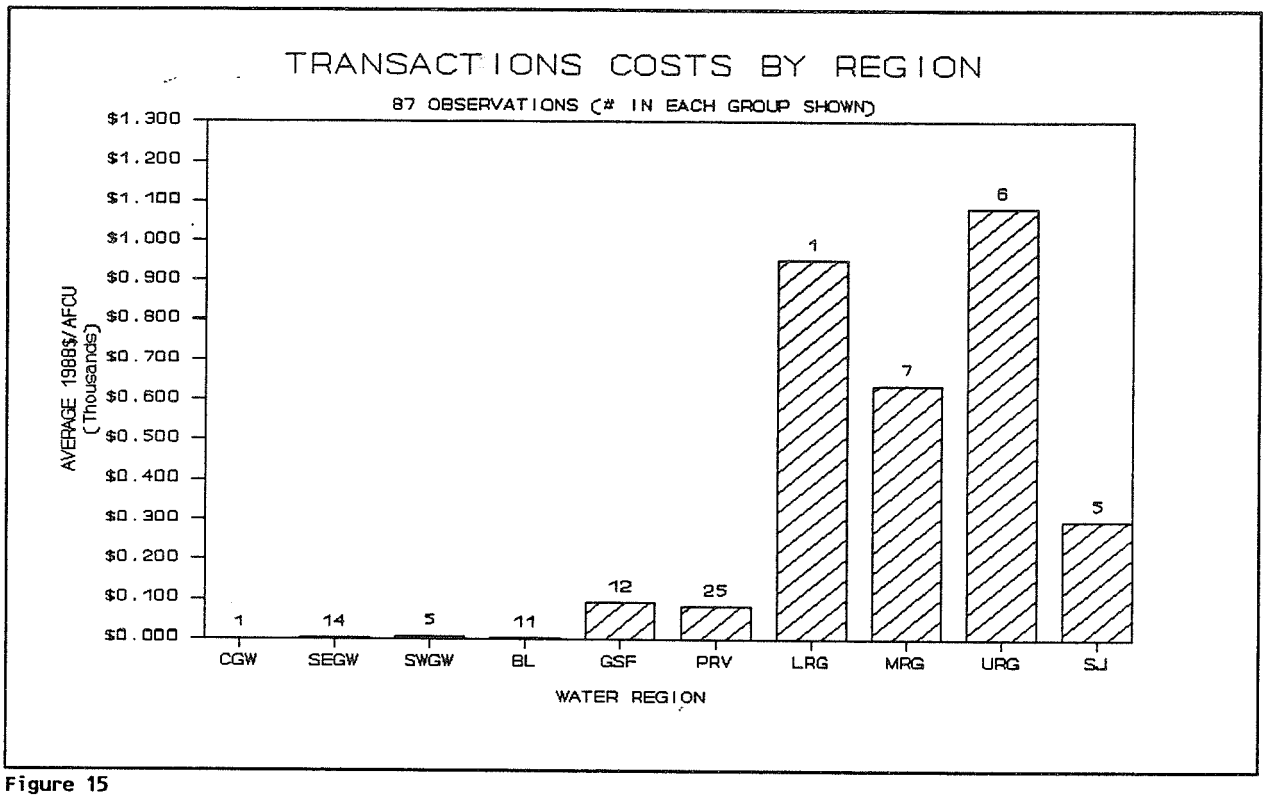


Figure 15

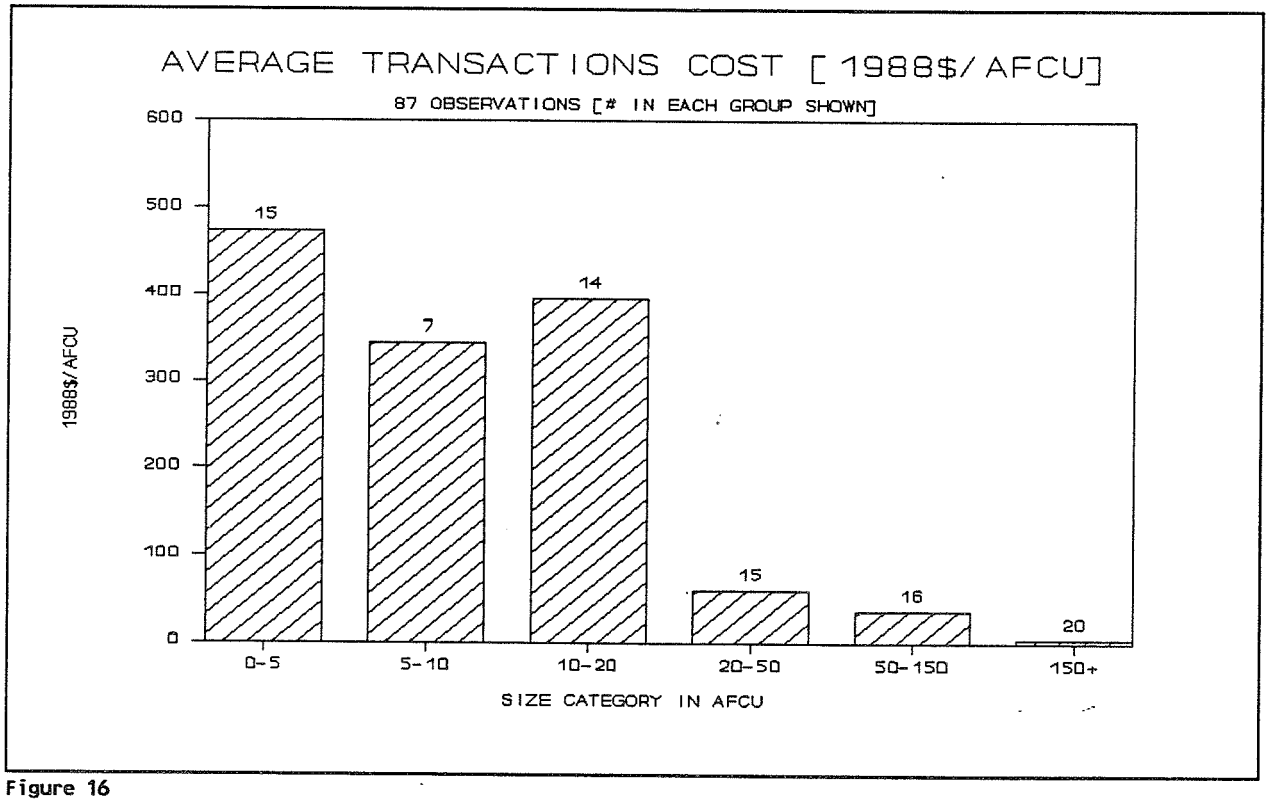


Figure 16

Types of Uses: We are, of course, interested to what uses water is moving. Table 2 shows the percentage of water in the whole census that changed from sector to sector. Because the applications use general and noncomparable terms for water uses, these sectors are extremely coarse, but the directions of movement are still interesting. Applications seeking to change place and purpose of use *within* agriculture make up 26.3% of the AFCU in the census. Since simple shifts in irrigation from field to field were eliminated from the census, most of these represent a change in the type of agricultural use or a change in the agricultural user. This indicates a great deal of activity in changes in water use in agriculture. Movements *out of* agriculture make up 29.4% of the AFCU in the census, while movements *into* agriculture make up 3.9%, indicating, as expected, that agriculture's share in the state's water rights is declining. More than a third (37.9%) of the AFCU in the census involve movements from one nonagricultural use to another, many of these municipalities adjusting their water management practices.

DIRECTION OF CHANGES IN WATER USE

Moved from Sector to Sector in ACPPU	% of all water
Agriculture to Agriculture	26.3%
Agriculture to Ag and Nonagriculture	2.6%
Agriculture to Nonagriculture	29.4%
Nonagriculture to Agriculture	3.9%
Nonagriculture to Nonagriculture	37.9%

Table 2

A finer breakdown of sectors is possible for the survey data. In the 109 survey responses that give data on the use to which water was moved, the leading use is municipal, with 31.6% of the consumptive use in the whole group (Figure 17). This is followed by industrial uses with 25.1%; construction with 16.8% (many are applications from the state Highway Department); irrigation, mostly urban irrigation of parks and golf courses, with 8.3% (recall that changes from agriculture to agriculture were removed from the survey population); energy and mining, with 8.2%; and commercial uses (many are trailer parks), with 2.2%. The "other" category includes dairy uses, domestic, fishery, recreation, and storage, which together sum to 4.2%. Of the consumptive use represented in the survey, 3.5% was moved to multiple uses - municipal, industrial, and commercial.

SUMMARY AND CONCLUSIONS

The data collected thus far in the census of ACPPU and the follow-up survey of a random sample have raised more questions than they answer, but they do provide some clarification of the nature of the transfer process. First, to the surprise both of the research team and many people familiar with water administration in New Mexico, most applications to change place and/or purpose of use are processed quickly and cheaply: 75% within six months, and 76% at costs less than $50/AFCU. Some, however, are both costly and time-consuming: 5% of the finalized applications took more than two years, and 5% (not necessarily the same applications) cost more than $1,000/AFCU.

On the basis of the scanty data supplied by the survey, it appears all three sections of the Rio Grande have relatively high transactions costs. The high cost of transactions may be seen as consistent with the Rio Grande's higher population density, competition between long established users and emerging uses, and intensive conjunctive management of ground and surface waters on the river.

It is interesting that water *prices* on the Rio Grande, again on the basis of sparse data, are not among the highest in the state. The high transactions costs coupled with moderate prices suggest competition among Rio Grande water users has been more strongly expressed through actions aimed at protecting ownership interests in water rights (a competition that creates transactions costs) than in competing for acquisition of new rights (a competition that presses prices up). If we look at the ratio of transactions costs/AFCU to purchase price/AFCU (with a healthy skepticism due to the very small sample size) this distinction is highlighted (Table 3). While the Lower Rio Grande ratio of 73% can be discounted as there is only one observation each of price and transactions costs, the Middle Rio Grande ratio (39%) is based on 7 observations of transactions costs and 8 of price, and is not so likely to be spurious. The low ratios of both the Pecos River Valley (3.1%) and the San Juan Basin (12.6%) are likewise based on several observations. Price competition serves a valuable allocation function; while the protection of ownership rights is important, a high cost for this service suggests that net gains can be achieved by finding less costly ways to protect ownership interests. This appears to hold particular promise on the Rio Grande.

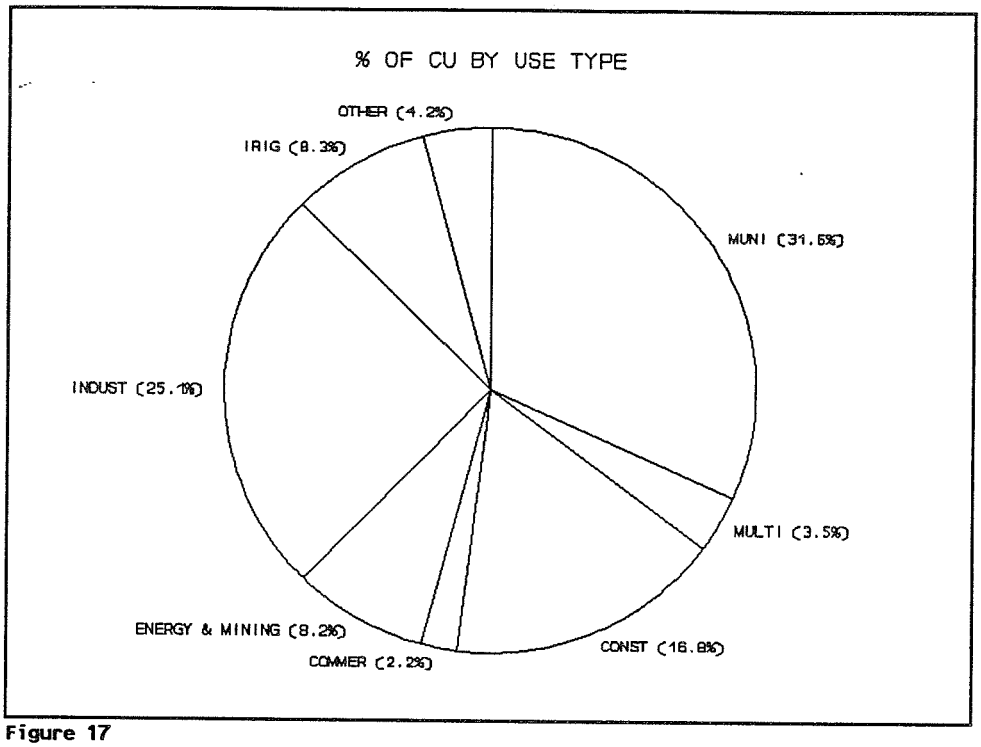


Figure 17

Transactions Costs/Price for Eight Water Regions

	Average TC	Average Price	TC/P
SEG	$1.34	$174	.8%
SWG	$6.89	$3316	.2%
GSF	$91.03	$4145	2.2%
P	$81.66	$2609	3.1%
LRG	$951.35	$1301	73.1%
MRG	$636.53	$1629	39.1%
URG	$1083.77	$2354	46.0%
SJ	$297.18	$2360	12.6%

Table 3

Prices and transactions costs both seem to be rising over time, but prices are rising slower than costs. The increase in average price in the sample from the 1975-79 period to the 1980-83 period was 5.3%; the increase in average transactions cost in the same period was 1205%. In the next period (between 1980-83 and 1984-87) the rate of increase in price rose to 34.8%, and the rate of increase in transactions cost fell to 51.8%, remaining higher than the price rate. Again, while the price increase reflects growing competition for water, the more rapid increase in transactions cost reflects a growing need for mechanisms to settle questions about changes in water uses.

None of these data speak to the nature of the questions that create transactions costs. This research was initiated on the premise that many of these questions would be hydrologic in nature, and that a more explicit technical standard could reduce uncertainty and transactions costs. While this has not been refuted as yet by the data, neither has it been confirmed. An alternative possibility is that there exist specific areas of potential impairment which have not yet been clarified in law, giving rise to protests and high costs in an effort to make law in the protestant's interest. If this is the case, attention could profitably be paid to clarifying these impairment questions specifically. The relatively new public welfare criterion may be one such area.

While it is good news that the majority of applications to change place and/or purpose of use are quickly and cheaply processed, the minority of costly and drawn-out reviews deserve attention and

call for a remedy. Identification of the ambiguities that create these costs and delays will facilitate policy to resolve water-based conflicts more expeditiously. This is the objective to which this work is ultimately directed.

[1]AFCU: acre-foot (af) per year of consumptive use. This is a right to *consume* 325,900 gallons of water per year. Since most water uses have return flows, it is generally associated with a diversion right in a larger quantity.