THE Cross SECTION

A Monthly Publication of the High Plains Underground Water Conservation District No. 1

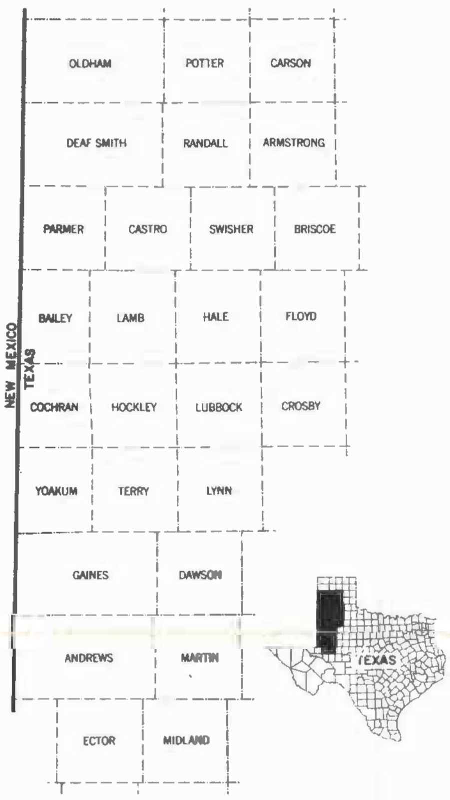
Volume 13—No. 8 "THERE IS NO SUBSTITUTE FOR WATER" January 1967

ARTIFICIAL RECHARGE

By F. A. RAYNER

There are presently no laws expressly prohibiting the artificial recharge of aquifers, provided such operations do not constitute waste with respect to use of water, or contanimation. There are only four statutes specifying the practice of artificial recharge. These statutes are embodied in underground water conservation district laws, codified as Art. 7880-c, 8280-219, 8280-297 and 8280-305, Vernon's Texas Civil Statutes. Certain provisions of the law authorize underground wate rconservation districts to:

. . . recharge the underground water reservoir or subdivision thereof . . . . to cause to be made by registered professional engineers surveys of the underground water . . . . developments and recharges needed for such underground water reservoir or subdivision thereof . . . . to carry out research projects . . . . the practicability of recharge of the underground water subdivision thereof; to publish such plans and information, bring them to the notice and attention of the users of such underground water within the District, and to encourage their adoption and execution . . .



SOUTHERN HIGH PLAINS OF TEXAS

A BRIEF HISTORY

Probably nobody knows who established the first recharge well in the High Plains of Texas. It was undoubtedly an individually thinking farmer, annoyed by the periodic inundation of part of his good farm land. Knowing that his farm was underlain by a thick sequence of sand—since such a section was drilled in his windmill well—and further realizing that dry sand has an affinity for water, he decided to drill or dig a hole into this sand and drain the water off of his fields. This first recharge well may have drained the first rainfall runoff, and possibly a few succeeding runoffs, however, experience dictates that such drainage holes soon clog and will not continue to accept water.

The Texas Agricultural Extension Service reports (1966) that there are about 200 recharge wells in the Southern High Plains. Most of these wells were established by the playa owners, for the primary purpose of draining water off of otherwise cultivatable land. Very few, if any, records are maintained on the performance of these farmer-operated installations, and a reliable assessment of their practicability is difficult to determine.

In 1953, the High Plains Underground Water Conservation District No. 1 pioneered artificial-recharge research in the High Plains with an initial project involving an attempt to recharge playa water into the Ogallala Formation, through a well located in southwestern Floyd County. Since 1953, the District has conducted, sponsored or cooperated in numerous artificial-recharge tests involving several experimental installations, and, as yet, an untabulated number of privately owned and operated wells. The results of some of this experimentation, and related artificial recharge reports, are presented in the thirty eight *"Cross Section"* articles listed at the end of this report. Also listed at the end of this article are nine reports of studies conducted, or sponsored (in part) by the District.

The reader is referred to the *Cross Section* articles, or to some of the other publications listed, to determine the types of lake modification, water filtration, well and supporting structure designs, flocculants, and agricultural practices and cropping patterns tested by the District and its cooperators—the multiplicity and magnitude of which are too numerous to present in this article.

The U. S. Geological Survey, in cooperation with the then Texas Board of Water Engineers and the City of Amarillo, conducted an extensive artificial recharge test in Amarillo's McDonald well field, Randall County. This test, commencing in September 1954 and extending to August 1955, consisted of recharging water pumped from the Ogallala Formation in the City's Palo Duro well field, located about 10 miles southwest of the test site, into two Ogallala wells located in the McDonald well field. The results of this test, published as Bulletin 5701 by the Texas Board of Water Engineers, indicated that such recharge operations are feasible and workable, under controlled conditions of injections and well development.

The U. S. Geological Survey, in cooperation with Harvest Queen Mills (Plainview) and the then Texas Board of Water Engineers, drilled and equipped a recharge well, and three observation wells, on the High Plains Research Foundation's farm at Halfway, in Hale County. The first artificial recharge test involving this well, in 1957, utilized water pumped from a nearby irrigation well. Jerry G. Cronin, U. S. Geological Survey reporting the results of these tests in Bulletin 6107 (published by the Texas Board of Water Engineers), noted that no unusual difficulties were encountered using groundwater for recharge. A recharge test, using rainfall—runoff playa—catchment, was conducted at the Halfway installation in June of 1959. During this test a total of 38.3 acre feet of water was recharged to the Ogallala Formation. Cronin reported that, ". . . no undue clogging was noticeable . . . ," but that during redevelopment, ". . . an abnormal amount of formation sand was pumped from the well."

In 1956, water from Southwestern Public Service's Gaines County well field was recharged to the aquifer beneath the well field in the immediate vicinity of the Denver City generating plant (about two miles east of Denver City, in Yoakum County). This test program was undertaken to determine the feasibility of augmenting the near-plant groundwater supplies. These tests were considered successful, however, contamination of the aquifer at the near-plant well field—by liquid wastes disposed at the land surface, not by the recharge operations—made further artificial augmentation impractical.

E. L. Reed, Consulting Groundwater Hydrologist (Midland, Texas) has conducted extensive artificial recharge tests involving the City of Midland's Paul Davis well field, in Martin County, and the McMillion well field, near Midland in Midland County. The object of these tests. in 1957 and 1961, was to determine the practicability and desirability of pumping water from the more distant Paul Davis field. and storing same in the aquifer beneath the McMillion well field, to better serve the City's peak water demand during the summer months. These tests were considered successful, and the City has since adopted this method of recharging the McMil-

(Continued on Page 2)

WATER DISTRICT ELECTION

The annual election of the High Plains Underground Water Conservation District was held January 10. This years' election was the most unique one since the formation of the District.

Three counties conducted ballotting to decide if they would become members of the District. All three, Hale, Swisher and Crosby Counties, turned down the proposal to join the High Plains Underground Water Conservation District No. 1. Hale and Swisher Counties defeated the proposal by large margins, Crosby County defeated the proposal by one vote.

Two District Directors were returned to their positions by voters of the District.

Andrew Kershen of Hereford, who represents Precinct 4, Armstrong, Deaf Smith, Potter and Randall Counties, was returned to the Board for a second two-year term. Also starting his second two-year term is Ross Goodwin of Muleshoe. Goodwin represents Bailey, Castro and Parmer Counties.

Twenty-six County Committeemen were elected to serve for three years. These individuals will serve their County on the local board, approving drilling permits and recommending policies to the District Board. These County Committees are the "backbone" of the High Plains Water District. Their ideas and recommendations are depended on greatly by the District Board.

INDIVIDUALS ELECTED TO THE COUNTY COMMITTEES ARE:

ARMSTRONG COUNTY:
James Bible, Wayside
Foster Parker, Happy

BAILEY COUNTY:
Ernest Ramm, Muleshoe
W. L. Welch, Maple

CASTRO COUNTY:
Frank Wise, Dimmitt
Dale Maxwell, Dimmitt

COCHRAN COUNTY:
Hugh Hansen, Morton
D. A. Ramsey, Morton

DEAF SMITH COUNTY:
L. B. Worthan, Hereford
Frank Zinser, Jr., Hereford

FLOYD COUNTY:
Tate Jones, Floydada
Pat Trizzell, Hockley

HOCKLEY COUNTY:
Jimmy Price, Levelland
J. E. Wade, Littlefield

LAMB COUNTY:
Jack Thomas, Olton
Lee Roy Fisher, Sudan

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THE Cross SECTION

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BILL J WADDLE
Editor

BOARD OF DIRECTORS

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(COCHRAN, HOCKLEY and LAMB COUNTIES)

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Ross Goodwin .... Muleshoe Texas

Precinct 4

(ARMSTRONG, DEAF SMITH, POTTER and RANDALL COUNTIES)

Andrew Kershen .... Rt. 4 Hereford Texas

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Mrs. Mattie K. Robinson .... Secretary

Field Office, Muleshoe

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COUNTY COMMITTEEMEN

Armstrong County

Cordell Mahler, 1968 .... Wayside, Texas
Foster Parker, 1967 .... Route 1, Happy
George Denny, 1969 .... Rt. 1, Happy, Texas
Guy Watson, 1968 .... Wayside, Texas
Jack McGehee, 1967 .... Wayside, Texas

Bailey County

Mrs. Billie Downing
High Plains Water District
Box 594 Muleshoe

Marvin Nieman, 1968 .... Rt. 1, Box 107, Muleshoe
James P. Wedel, 1967 .... Rt. 2, Muleshoe
Homer W. Richardson, 1968 ...... Box 56, Maple
W. L. Welch, 1967 .... Star Rt., Maple
J W. Witherspoon, 1969 ...... Box 261 Muleshoe

Committee meets last Friday of each month at 2:30 p.m., 217 Avenue B., Muleshoe, Texas

Castro County

E. B. Noble
City Hall, Dimmitt

Calvin Petty, 1969 ...... Box 605, Dimmitt, Texas
Ray Riley, 1967 .... 71 W. Lee, Dimmitt
Frank Wise, 1967 .... 716 W. Grant, Dimmitt
Donald Wright, 1968 .... Box 65, Dimmitt
Morgan Dennis, 1968 .... Star Rt. Hereford

Committee meets on the last Saturday of each month at 10:00 a.m., City Hall, Dimmitt, Texas.

Cochran County

W. M. Butler, Jr.
Western Abstract Co., Morton

D. A. Ramsey, 1967 .... Star Rt. 2, Morton
Ira Brown, 1968 .... Box 774, Morton, Texas
Willard Henry 1969 .... Rt 1, Morton, Texas
H. B. Barker, 1967 .... 602 E. Lincoln, Morton
E. J French, Sr. 1968 .... Rt. 3 Levelland, Texas

Committee meets on the second Wednesday of each month at 8:00 p.m., Western Abstract Co., Morton, Texas.

Deaf Smith County

Mrs. Mattie K. Robinson
High Plains Water District
317 N. Sampson, Hereford

W. H. Gentry, 1969 .... 400 Sunset, Hereford, Tex
Billy Wayne Sisson,, 1968 .... Rt. 5, Hereford
J. E. McCathern, Jr., 1967 .... Rt. 5, Hereford
Billy B. Moore, 1968 .... Wildorado, Texas
Charles Packard. 1967 .... Rt. 3, Hereford

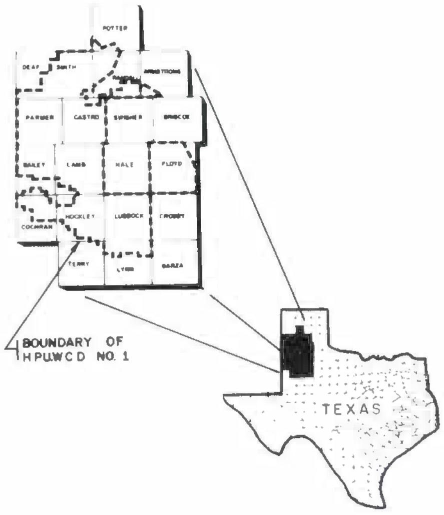
Committee meets the first Monday of each month at 7:30 p.m., High Plains Water District office, Hereford, Texas.

Floyd County

Sam Puckett
325 E. Houston St., Floydada

Bill Sherman, 1967 .... Route F, Lockney
J. S. Hale, Jr., 1969 .... Rt. 1, Floydada, Tex
Tate Jones, 1967 .... Rt. 4, Floydada
M. M. Julian, 1968 ...... Box 55 South Plains, Tex
M. J. McNeill, 1968 .... 833 W. Tennessee, Floydada, Texas

Committee meets on the first Tuesday of each month at 10:00 a.m., Farm Bureau Office, Floydada. Texas.



Hockley County

Mrs. Phyllis Steele
917 Austin Street, Levelland

Bryan Daniel, 1967 .... Rt. 2, Levelland
Preston L. Darby, 1968 .... Rt. 1, Ropesville
Leon Lawson, 1967 .... Rt. 3, Levelland
H. R. Phillip, 1968 .... Rt. 4 Levelland, Texas
S. H. Schoenrock, 1969 .... Rt. 2, Levelland

Committee meets first and third Fridays of each month at 1:30 p.m. 917 Austin Street, Levelland, Texas.

Lamb County

Calvin Price
620 Hall Ave. Littlefield

Willie Green, 1967 .... Box 815, Olton
Roger Haberer, 1968 .... Earth, Texas
W. B. Jones, 1969 .... Rt. 1. Anton, Texas
Troy Moss 1968 .... Rt. 1, Littlefield, Texas
Raymond Harper, 1966 .... Sudan, Texas

Committee meets on the first Thursday of each month at 8:00 p.m.. Crescent House Restaurant Littlefield, Texas.

Lubbock County

Mrs. Doris Hagens
1628 15th Street, Lubbock

Weldon M. Boyd, 1967 .... 732 6th Pl. Idalou
Bill Hardy, 1968 ...... Rt. 1, Shallowater, Texas
Bill Dorman, 1967 .... 1910 Ave. E., Lubbock
Edward Moseley 1969 .... Rt 2 Slaton, Texas
W. O. Roberts, 1968 ...... Rt. 4, Lubbock, Texas

Committee meets on the first and third Mondays of each month at 1:30 p.m., 1628 15th Street, Lubbock, Texas.

Lynn County

Mrs. Doris Hagens
1628 15th Street, Lubbock

Don Smith, 1969 .... Box 236 New Home
Harold G. Franklin, 1968 .... Rt. 4, Tahoka
Roy Lynn Kahlich, 1967 .... Wilson, Texas
Oscar H. Lowrey, 1967 .... Rt. 4, Tahoka
Reuben Sander, 1968 .... Rt. 1, Slaton, Texas

Committee meets on the third Tuesday of each month at 10:00 a.m., 1628 15th Street, Lubbock, Texas.

Parmer County

Aubrey Brock
Wilson & Brock Insurance Co., Bovina

Webb Gober, 1969 ...... R. F. D., Farwell, Texas
Henry Ivy, 1967 .... Rt. 1. Friona
Walter Kaltwasser, 1967 .... RFD, Farwell
Carl Rea, 1968 .... Bovina, Texas
Ralph Shelton, 1968 .... Friona, Texas

Committee meets on the first Thursday of each month at 8:00 p.m., Wilson & Brock Insurance Agency, Bovina, Texas.

Potter County

E. L. Milhoan, 1967 .... Wildorado
W. J. Hill. Jr., 1969 .... Bushland, Texas
L. C. Moore, 1968 .... Bushland, Texas
Jim Line 1968 .... Bushland, Texas
Eldon Plunk, 1967 .... Rt. 1, Amarillo

Randall County

Mrs. Louise Knox
Randall County Farm Bureau Office, Canyon

R. B. Gist, Jr., 1968 .... Rt. 3 Box 43 Canyon
Ralph Ruthart, 1969 ...... Rt 1, Canyon, Texas
Carl Hartman, Jr. 1968 .... Rt. 1, Canyon
Lewis A. Tucek, 1967 .... Rt. 1, Canyon
Ed Wieck, 1967 .... Rt. 1, Canyon

Committee meets on the first Monday of each month at 8:00 p.m., 1710 5th Ave., Canyon, Texas

Artificial Recharge—

(Continued from Page 1)

lion well field, during the winter months. Reed reported that well development problems have been avoided, by employing the control measures (particularly limiting injection pressures) developed during the pilot tests.

In 1960, the Colorado Municipal Water District (Big Spring, Texas) initiated a pilot artificial-recharge project in their Martin County well field. Water pumped from this well field is used to meet the peak summer requirements of the City of Odessa (Ector County). This initial artificial recharge test, using unfiltered water from Lake J. B. Thomas (Borden and Scurry Counties), was considered highly successful, in spite of some well "sanding" problems—probably created by excessive injection pressures. O. H. Ivie, District Manager and Chief Engineer, reports that the District commenced winter-season, full-scale artificial-recharge operations, using water from Lake J. B. Thomas, in the Martin County well field in 1964.

Lake J. B. Thomas water contains about 30 ppm (parts per million) suspended soils, and about 350 ppm dissolved solids. The injected water is maintained at 1 to 1½ ppm residual chlorene, and water samples are periodically analyzed for nuisance, toxic and other uncommon contaminants.

Injection pressures are controlled in order to prevent damage (realignment of the matrix) to the producing formation. About 2½ million gallons per day are being recharged to the Ogallala Formation.

Theses by T. A. Cullinan and R. M. Winn (1959 and 1960), submitted as a part of the requirements for a Masters Degree, Texas Technological College, described the results of artificial recharge tests performed on the Halfway installation (see previous text), and a recharge installation on the Sutton farm (see the *"Cross Section"*, April and June, 1959) in Castro County.

The thesis by Cullinan noted that only about 29 percent of the silt and clay injected into the well (at Halfway) during the recharge cycle was reclaimed during the pumping (and surging) redevelopment cycle, and that more than thirteen times as much sand was pumped from the well during redevelopment, than was injected during the much longer recharge cycles. Cullinan reported that, " . . . the rate of lateral water movement is slower than in previous years and that decreases in transmissability and permeability have been brought about through the use of untreated lake water for recharges." Water samples collected from an observation well, located about 125-feet from the injection well, contained silt and clay size particles correlatible to the suspended solids in the injecter water.

Winn, reporting on flocculating tests noted, that the use of a chemical flocculating agent removed twenty-nine to 76 percent of the suspended solids in playa water, depending upon the method of application, and some weather factors. Mr. Winn also noted that only about 5 percent of the suspended solids in the injected water (playa water previously treated to remove 29 percent of the suspended solids) were removed when the well was pumped after the recharging cycle.

Professor W. F. Schwiesow conducted artificial tests employing collecting pipes buried beneath different filtering materials in the bottom of a playa on the Texas Technological College campus (see the *Cross Section,* January, 1959). The results of these tests have not been published, however, it is believed that this type of filtering system will not continue to be effective, due to the sealing action of the fine clastics deposited in the lake bed.

Wayne Clyma, reporting on an artificial recharge test conducted in 1958 on a mutiple-purpose well located near Levelland, Hockley County, concluded, "The multiple-purpose well pumped large quantities of sand probably because it was not gravel packed. Eighty-nine to 93 percent of the clay that entered the well during recharge cycles was retained in the well after the 1-hour pumping cycles. Rapid clearing of the water when pumping indicates that additional pumping to remove sediments will have little effect. Sediments in the water injected into the well apparently reduced the specific capacity of the well from 20 to 2 g.p.m. per foot of drawdown." "The several techniques used to redevelop the well were unsuccessful." (Quotes from, "Artificial Groundwater Recharge by a Multiple-purpose Well, 1964", Texas A&M University, MP-712. Also see, "What Happens to Sediments in Playa Lake Water When Used for Underground Recharge in Wells," *Cross Section,* January, 1959)

This well continued to decline in production, and was abandoned in 1962.

James C. Valliant, Associate Soil Scientist, High Plains Research Foundation has conducted numerous artificial recharge, and playa-water filtering tests at the Foundation's two recharge well installations at Halfway, Hale County. The results of some of these tests have been presented in several publications, authored by Mr. Valliant.

In November 1966 issue of "Irrigation Age," Valliant states, "Results obtained at High Plains Research Foundation at Halfway, Texas, and several farm multiple-purpose (recharge) installations, indicate that multiple-purpose wells can be a profitable and useful tool." "Without both proper management and proper installation, solid particles can be a problem in artificial recharge. But with the potential to salvage two and

District Election—

(Continued from Page 1)

LUBBOCK COUNTY:
R. T. (Bob) Cook, Idalou
Bill Dorman

LYNN COUNTY:
Roger Blakney, Wilson
Roy Lynn Kahlich, Wilson

PARMER COUNTY:
H. R. Ivy, Friona
Jim Ray Daniel, Friona

POTTER COUNTY:
Vic Plunk, Amarillo
Fritz Menke, Amarillo

RANDALL COUNTY:
Marshall Rockwell, Canyon
Richard E. Friemel, Canyon

Staff members of the District will meet with every County Committee in the next few weeks. Purpose of these meetings will be to inform the committees of problems facing the District and get suggestions for solutions. All new committeemen will be briefed on their duties for the coming three years.

one-quarter million acre feet, it is time to take a positive approach instead of a negative."

Valliant, and the High Plains Research Foundation, advocates and actively promotes the installation of recharge wells, to inject playa water into the Ogallala Formation.

Valliant indicated that he intends to pursue the testing of recharge wells, on and off the Foundation's farm. He is presently trying to reclaim a damaged (clogged) multiple-purpose well, located in Lamb County.

The Agricultural Research Service, U. S. Department of Agriculture, has established an elaborate artificial recharge well installation in and near a playa on the Bushland Station, located about 15 miles west of Amarillo, Potter County. The results of artificial recharge tests performed on this installation are presented in the paper by Victor L. Hauser, "Artificial groundwater recharge through wells", presented at the 21st annual meeting, Soil Conservation Society of America, Albuquerque, New Mex., August 15-17, 1966. Hauser concludes, "Artificial groundwater recharge thru wells using local surface runoff appears to be an effective means for recharging the Ogallala Formation in the Southern High Plains. However, suspended solids in raw playa lake water clog the formation near recharge wells." Mr. Hauser further notes, "A field recharge system was tested which effectively removed over 90 percent of the suspended solids by flocculation and settling after treatment with a cationic polyelectrolyte and alum. The treated water was injected into the aquifer through inexpensive, 6-inch wells, but the aquifer near the wells was gradually clogged during recharge by the remaining turbidity. The 6-inch wells were successfully redeveloped by bailing." "The data showed that the aquifer removed nearly all of the coliform organisms within 66 feet of a recharge well and greatly reduced the chemical oxygen demand. It is concluded that groundwater recharge is not likely to cause aquifer pollution for more that a few feet from the recharge well."

In the Agricultural Research Service Conservation Research Report No. 8, Hauser states "The most efficient method for conserving runoff water impounded by playas is a combination detention resevoir and groundwater recharge."

Through a research grant, Professors Philip Johnson and Duane Crawford, Petroleum Engineering Department, Texas Technological College, has commenced an investigation to determine the possible application to artificial recharge some of the subsurface redevelopment techniques employed by the oil industry. Johnson and Crawford intend to hydraulically fracture the resevoir medium, thru a recharge well, in order to force continued acceptance of playa water containing considerable suspended solids. The results of these continuing tests have not been published.

THE ARTIFICIAL RECHARGE CONTROVERSY

Defining the artificial-recharge controversy is as difficult as trying to understand why it exists.

No reasonably well informed scientist, or layman, will deny the need for developing the techniques of artificially recharging the Ogallala Formation. Such practices must be efficiently developed if this area is to ever avail itself to the mass importation of water—a commodity essential to this area if it is to continue to expand, or even to maintain, its agricultural production. Importation of water will be needed if this area is to become the food and fiber supply center of the State, Nation and indeed the World. A role some already claim for the Nation's Great Plains physiographic province, the southern sector of which comprises the Southern High Plains of Texas and New Mexico.

If one can not accept the possibility of, or even appreciate the need for large scale importation of water, then he need not look far to observe other surface water that could be better utilized, if it could be safely and economically recharged to the Ogallala Formation. Cases in point being the operation of the Colorado Municipal Water District; the probable surplus water to be available to the member cities of the Canadian River Municipal River Authority, during some winter months; and the admittedly intermittent, and somewhat unreliable, playa catchment.

Nearly all scientists concerned with groundwater research will agree, that the Ogallala Formation, at least the presently dewatered portion of same, could be successfully recharged—providing the injected water is compatible to the aquifer, the well is correctly designed and equipped, and is operated in conjunction with a properly integrated surface groundwater management system.

If all these arguments are true, then the controversy must center around a misunderstanding as to what constitutes successful artificial recharge.

The practicability of artificial recharge depends upon several diverse factors, the primary one being—did the installation perform the desired task, or other spurious tasks, to such a degree as to satisfy the expectations of the well owner in respect to the money and effort expended.

In the case of the experimenter even negetaive results are some fulfillment of objectives.

In the case of the farmer, the criteria of success are as diverse as the number of owners of such installations.

SOME POINTS OF DISAGREEMENT

The dedicated "applied" researcher unconsciously attempts to force into practice any apparently beneficial development stemming from his research. This is to say, that if his test works he tends to apply his solution to all similar problems. Such universal adaptability is seldom if ever applicable to groundwater-reservoir systems.

As an example, assume that a "successful" (as defined by the well owner or operator) multiple-purpose well is installed in central Hale County, employing certain well completion, and management practices. The tendency is to accept the criteria for this well as best, and to be areally adaptable. However, when these same design and management parameters are applied to a recharge installation, say, in Hockley County, where the geological and hydrologic conditions are entirely different, and the well fails to perform satisfactorily, the tendency is to scrap the entire Hale County criteria—some of which may be adaptable to the Hockley County operation.

Thus have been developed the myrid of "recommended" specifications for multiple-purpose well design and management.

WHY SOME WELLS WORK

The one single parameter most controlling the workability of an artificial recharge (multiple-purpose) well is the transmissability of the aquifer. This hydraulic coefficient represents the product of the aquifer thickness and its permeability.

1967 Board of Directors of The High Plains Underground Water Conservation District, Left to Right: Chester Mitchell, Lockney, Andrew Kershen, Hereford, Russell Bean, Lubbock, Weldon Newsom, Morton, and Ross Goodwin, Muleshoe.

Multiple-purpose wells in aquifer areas of high transmissability are usually considered successful — that is to say, they are able to dispose into the subsurface considerable volumes of turbid playa water—all other design and management factors considered equal.

This generality is not applicable to some "high transmissability" parts of the Ogallala aquifer—where the permeability value is relatively small, and the aquifer is relatively thick; or where the permeability value is large, and the aquifer is relatively thin.

Therefore, a "median" trasmissability is desirable—and at considerable risk, I would suggest in areas where the aquifer is at least 100-feet thick, and the transmissability approaches 50,000 gallons per day per foot.

Although I have chosen to use transmissability as a "workability" parameter, the actual factors (which are an integral part of transmissability) controlling a wells long-term ability to continue to accept unfiltered playa water, are the unique combination of lithology and the aquifer—well energy balance. A combination requiring considerable explanation not important to this writing.

PLAYA WATER RECHARGE AREA

The buried Cretaceous escarpment (the occurance of rocks of Cretaceous age beneath the Ogallala Formation), approximately extending east and west along the northern Lubbock County line, thence northwest from the northwest corner of Lubbock County to the New Mexico-Texas State line in central Bailey County, appears to mark the southernmost boundry of the area wherein multiple-purpose wells, injecting playa water, are generally considered successful.

North of this buried Cretaceous escarpment the "desirable" geologic and hydrologic parameters, such as lithology (size and sorting) of the reservoir matrix, depth to the water table, thickness and permeability of the aquifer, are superior to these same characteristics of the Ogallala Formation to the south; hence the apparent general workability of playa-water-recharging, multiple-purpose wells in the northern part of the Southern High Plains.

CONTAMINATION

Until recently the artificial recharge controversy centered mostly around mechanical artificial-recharge problems. However, a new area of disagreement has come into focus, primarily as a result of the general publics interest in, and demand for "clean" water.

Those advocating the installation of enough multiple-purpose wells to recharge all playa catchment to the Ogallala Formation — possibly 20,000 wells—claim that such a program would not constitute a threat to the quality of the water in the Ogallala aquifer. However, there is a growing faction in disagreement with this opinion.

Very little is known about playa water quality. The ecologic, and quality of water characteristics of these lakes has never been thoroughly investigated.

The accelerating dependence of modern agriculture upon exotic chemicals, such as, herbicides, pesticides, defoliants, desicants, fungicides, fertilizers, and other toxic and nuisance chemicals, has received considerable public attention. The increasing use of such agricultural chemicals in the High Plains area has led to considerable speculation that rainfall runoff and tailwater playa-catchment may contain prohibitive amounts of such toxic and nuisance chemicals.

Playa water is known to be rich in biota, some playa water could also contain pathogens.

The accelerated development of recharge wells, by the general public, should be curtailed until more is known about playa water quality.

No unfiltered and/or untreated playa water should be injected in the porous limestone reservoirs underlying parts of Hale, Lubbock, Garza, Lynn, Borden, and Dawson counties.

Operators of artificial recharge wells should:

1) Recharge only into wells located a "safe" distance from wells supplying water for consumption or sanitary purposes.

2) Runoff from watersheds that have been treated with some of the

Artificial Recharge—

(Continued from Page 3)

more toxic chemicals, such as the chlorinated hydrocarbons and arsenates, should be checked for such chemicals before recharging into the Ogallala aquifer.

3) "Fresh" runoff should not be recharged directly to the aquifer. Runoff into playas should be permitted to remain in the lakes for several days, in order to permit settling of suspended solids and to enhance "self purification" (biodegradation of some "unspent" agricultural chemicals).

4) Playa catchment experiencing a general biological die-off should not be recharged to the Ogallala aquifer.

There is presently no widespread threat of contamination of the Ogallala aquifer resulting from the operation or recharge wells. This could only become a problem if this practice was adopted in mass by the playa owners.

MORE RESEARCH NEEDED

It is apparent that a considerable number of recharge "tries", tests, demonstration projects, and basic research have been completed and/or are in progress. The conclusions and recommendations drawn therefrom appear to be as numerous and diverse as are the number of recharge projects, which are surprisingly similar in scope. This diversity of opinion indicates a basic disagreement between idividual methods of testing and analysis, and is an indication that all necessary artificial-recharge research has not yet been completed.

The District has recommenced a project that will result in the coalescing and analysis of the results of all artificial-recharge projects in the High Plains area. Published and unpublished data concerning more than 20 projects, that have been conducted, sponsored by or otherwise involving the District, have been collected and cataloged. This compilation presently includes about 500 pages of text, data sheets, graphs, charts, and pictures. It is hoped this thorough, documented report, when published, will help prevent duplication of effort; answer several questions in regard to the preferred orientation of future artificial recharge tests, demonstration projects and other experimentation; and possibly provide the answer to the much debated question —are recharge wells in the Southern High Plains currently practicable.

Those who believe that the field of artificial-recharge research has become a trifle over-crowded, with researchers researching researchers, will find it necessary to adjust their perspective, because, in the future, the legions of artificial-recharge researchers is destined to increase. The apparently limitless abundance of money for research, combined with the romantism of artificial recharge, will surely draw additional talent into this still wide open and challenging field.

Artificial recharge experimentations should continue to be conducted by the numerous agencies, organizations, institutions, and individuals serving the many disciplines, however, there is an urgent need for orientation of effort, in order to prevent duplication—wasting scientific talent and money.

NEXT MONTH—Potential For Underground Storage.

LIST OF "CROSS SECTION" ARTIFICIAL-RECHARGE ARTICLES

1) Replenishment of Ground Water Reservoir Practices Being Studied, Cross Section January 1955.

2) Replenishment of Ground Water Reservoir Practices Being Studied, Cross Section, February 1955.

3) Rains Activate Recharge Experiment, Cross Section, June 1955.

4) Recharge Experiment In Arkansas Visited, Cross Section, August 1955.

5) Use of Runoff Water in Conservation, Cross Section, October 1955.

6) Water District Presents Brief to Water Resources Committee, Cross Section, January 1956.

7) Dowell Incorporated Discusses Recharge with Water District, Cross Section, April 1956.

8) Water District Seeks Conservation Assistance for High Plains Farmers and Ranchers, Cross Section, October 1956.

9) Amarillo Artificial Recharge Report Available From Board of Engineers, Cross Section, March 1957.

10) Approximately 102 Million Acre-Feet of Groundwater Originally in District, Cross Section, March 1957.

11) Artificial Recharge in the Texas High Plains, Cross Section, April 1957.

12) District Attempts to Establish Ground Water Recharge as Great Plains Practice, Cross Section, May 1957.

13) Experiment Recharge Well Taking Over One Million Gallons of Water Per Day, Cross Section, May 1957.

14) Multi-Purpose Recharge Well Program is Discussed With Soil Conservation Service, Cross Section, June 1957.

15) Declining Underground Water Levels Spur Interest in Wet-Weather Lake Water, Cross Section, June 1957.

16) Individuals Practice Various Ways of Putting Wet-Weather Lake Water Into the Underground Reservoir for Future Use, Cross Section, June 1957.

17) Recharge Wells To Be Television Topic, Cross Section, July 1957.

18) Another Recharge Well Does the Job, Cross Section, July 1957.

19) Rainfall Runoff Slavaged By Texas Tech College, Cross Section, October 1057.

20) Artificial Recharge Wells in Texas High Plains Will Aid in Prolonged Area Economy, Cross Section, April 1958.

21) Procedure Outlined for the Installation of a Recharge Well, Cross Section, June 1958.

22) Underground Water Resources of West Texas and the Economics of Their Uses, Cross Section, August 1958.

23) Texas Highway Department Will Drain Area Right-of-Way With Recharge Wells, Cross Section, October 1958.

24) What Happens to Sediments in Playa Lake Water When Used for Underground Recharge in Wells, Cross Section, January 1959.

25) Texas Technological College Constructs A Drainage-Filtering Recharge System in A Playa Lake, Cross Section, February 1959.

26) Tech Students Study Recharge Problem, Cross Section, February 1959.

27) Chemical Offers New Approach to Solving Problem of Sediments Suspended in Lake Water, Cross Section, April 1959.

28) Data Reveal Flocculating Chemical Clears Lake Water of Most Suspended Matter, Cross Section, June 1959.

29) Underground Dater District Promotes Water Conservation Programs, Cross Section, October 1959

30) Ground-Water Recharge Subject of Thesis, Cross Section, December 1959.

31) Hydrologist Will Speak During National Convention of A. W. W. A., Cross Section, April 1960.

32) How Much Does Recharge Water Cost, Cross Section, April 1960.

33) Recharge Well Used in Conducting Flocculating Chemical Test, Cross Section, July 1960.

34) Lake Water Represents Source of Economic Wealth in High Plains, Cross Section, July 1960.

35) Gravel Filters Used in Laboratory to Extract Suspended Solids from Water, Cross Section, May 1961.

36) District Installs New Experimental Recharge Well, Filter System, Cross Section, June 1961.

37) Gravel-Filter System and New Recharge Well Completed by High Plains Underground Water Conservation District, Cross Section, July 1961.

38) High Plains Water District Tries Centrifuge in Artificial Recharge Studies, Cross Section, August 1962.

PARTIAL LIST OF ARTIFICIAL-RECHARGE PUBLICATIONS

Billingsley, R., An economic appraisal of ground woter recharge through multi-purpose wells, High Plains of Texas, High Plains Underground Water Conservation District No. 1, 1957

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Water Is Your Future, Conserve It!

YOUR WATER STATEMENT

January in the Water District means income tax time for some, Christmas bills for others, seed and fertilizer buying time for many, and observation well measuring time for the personnel of the Water District.

Annually, the District makes water level measurements of more than 800 observation wells within the thirteen county area within the District.

The wells in the District are a portion of over 1,700 wells that will be measured by the High Plains Underground Water Conservation District, North Plains Water District and the Texas Water Development Board.

The importance of the observation well program to the landowner has been ably demonstrated by the tax depletion allowances that were allowed land owners last year for groundwater used in the business of irrigation farming. Data assembled, from detailed records kept on observation wells, was used to prove the annual decline of the water table under thousands of acres of farm land. This decline was used in calculating the tax depletion allowance.

The observation well program is the general basis for computing the decline of the water table for the entire District. A good thorough back log of data is available on every well and gives a good clear picture of what is happening to the groundwater reservoir in a certain area.

Observation wells in the Southern High Plains, South of the Canadian River, are the wells that determine the amount of decline shown in the Water District.

Water levels in the observation wells reflect the stages of the water reservoir. The readings reveal the extent to which water supplies are depleted by drought, by heavy pumping for irrigation, industrial uses and public water works, and also to the extent to which they are replenished by rainfall and snow.

The observation wells are measured in January of each year because of the ability to get a "fair" picture of the water table. By waiting until January to measure the well, it has had time to recover from the summer pumping. If the wells were measured in September, the reading would not give a true picture because of the pumping stress placed on it during the irrigation season.

The Water District has spent considerable time in establishing its fine system of observation wells, and they have proven to be of great value to all landowners of the Southern High Plains who are taking advantage of the water depletion ruling.

High Plains Underground Water
Conservation District No. 1
1628 Fifteenth Street
Lubbock, Texas 79401

Second Class Permit

THE Cross SECTION

A Monthly Publication of the High Plains Underground Water Conservation District No. 1

Volume 13—No. 9 **"THERE IS NO SUBSTITUTE FOR WATER"** *February 1967*

Potential For Storage Of Water In Southern High Plains Of Texas

By F. A. RAYNER

There is enough unused space within a 21 county area in the Southern High Plains of Texas to store nearly three times as much water as can be stored in all of Texas' major fresh-water lakes. This same space could store nearly 1½ times the total amount of water that could be stored in the existing major reservoirs in Texas, when added to the total storage of all the lakes proposed for construction, by the Texas Water Development Board, within the next 53 years.

If this unused space was filled with water, and could be withdrawn as needed, it would supply all of Texas' water requirements for more than eight years at the present rate of consumption, and it could supply all of Texas' water requirements for more than six years at the projected annual use by the year 2020.

This tremendously large storage space is located at the headwaters of the three major streams—Red, Brazos and Colorado—that drain more than 40 percent of all the land area in Texas.

This storage space has not been seen by the human eye, although an estimated 500,000 people live and prosper upon it.

This space is in ready access to the homes, farms, and cities throughout most of the Southern High Plains.

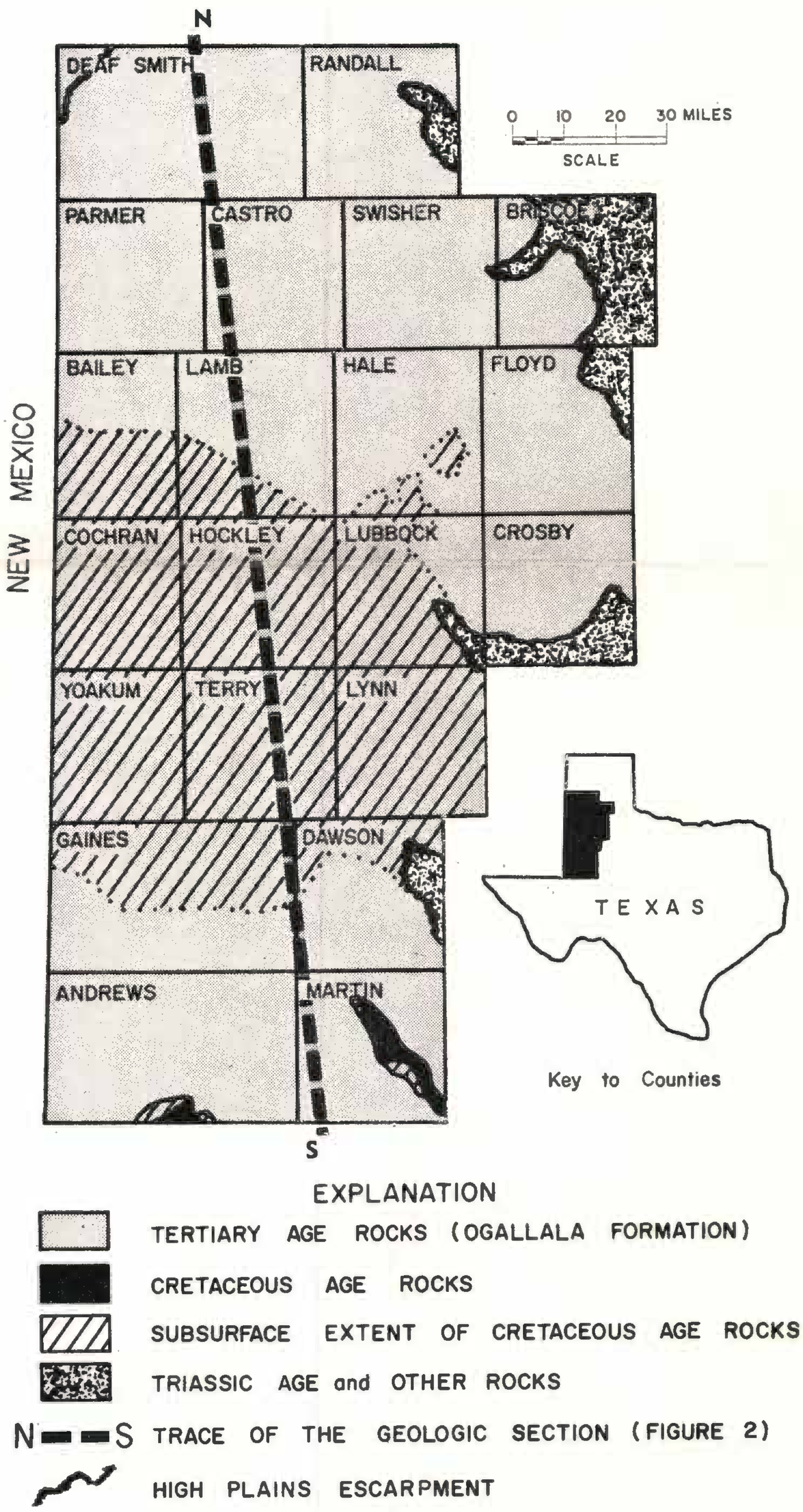
This space consists of the interconnected void between the individual grains of sand comprising the Ogallala formation — the Caprock — the Plains.

THE PLAINS

Within the area shown by Figure 1, the Southern High Plains in Texas consist of a gentle, southeast homoclinal plateau, ranging in altitude from about 2,600 feet in Martin County to more than 4,400 feet in Deaf Smith County. In this 21 county area, the featureless Plains topography is broken only by the escarpment in northwest Deaf Smith County—forming a part of the southern boundary of the Canadian River watershed "badland"—and the spectacular escarpment and reentrant canyons on the east, in Randall, Briscoe, Floyd, Crosby, Lubbock and Dawson Counties.

Although the land surface slopes to the southeast at about 10 feet per mile, the only perceptible relief are

(Continued on Page 3)



GENERALIZED GEOLOGIC MAP OF A PART OF THE SOUTHERN HIGH PLAINS OF TEXAS

FIGURE 1

COURT RULES ON WATER USE BY OIL COMPANY

In an opinion handed down February 20, 1967, the Court of Civil Appeals in Amarillo affirmed the judgment of Judge Ledbetter in Hockley County in the case of Sun Oil Company v. Earnest Whitaker, et al. The High Plains Underground Water Conservation District No. 1 was an intervenor in this case.

The Court of Civil Appeals held that Sun Oil Company failed to show its right to the free use of underground fresh-water for water-flooding purposes. Sun Oil Company contended that it had the right to use fresh water for water-flooding purposes by virtue of the "free wood and water" clause in its oil and gas lease. The Court rejected this contention pointing out that the intention of the parties should control and that the parties did not intend to allow the oil company to use water for this purpose when this particular lease was executed in 1946. The Court said in part,

"Principles of equitable justice must dictate that a grantor would not reasonably intend in the absence of specific language to the contrary, to grant a use which could, and under this record would, have the effect of substantially destroying the very estate the grantor reserved."

Chief Justice James Denton wrote the opinion. Attorneys for the High Plains Underground Water Conservation District No. 1 are Geo. W. McCleskey and Don Graf, of the firm of Nelson, McCleskey & Harriger of Lubbock, Texas. Attorneys for Mr. Earnest Whitaker are Earl Allison and Dwight Mann, of the firm of Allison, Mann & Allison of Levelland, Texas.

DECLINE MAPS AVAILABLE

Contour maps showing the decline of the water table in the Ogallala formation during 1966 were released by the District on February 15th.

These maps, one for each of the 13 counties in the High Plains Underground Water Conservation District No. 1, have been reviewed and accepted by Internal Revenue Service Engineers, and are to be used as guidelines in calculating cost-in-water-depletion, income-tax allowances.

In order to facilitate the location of individual parcels of land—expediting claims—a gridding system has been incorporated on the 1966 maps.

Copies of these maps can be obtained by contacting the District at 1623 15th Street Lubbock Texas 79401.

THE Cross SECTION

A MONTHLY PUBLICATION OF THE HIGH PLAINS UNDERGROUND WATER CONSERVATION DISTRICT No. 1

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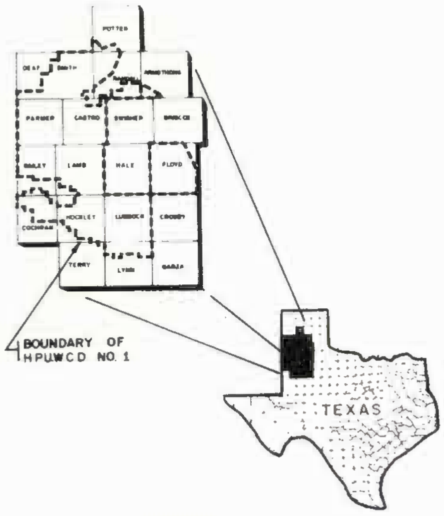
BILL J. WADDLE, Editor



Eighty percent of the Nation's population lives in cities, and use averages out to about 150 gallons of water per city-dweller per day, for a total of 23 trillion gallons daily supplied by 19,200 water works which cost about $50 billion.

The August 1966 Rain—Detriment or Asset

By F. A. RAYNER

The total August rainfall of 8.85 inches was the largest August rainfall in the past 56 years of record maintained at Lubbock, Texas by the U. S. Weather Bureau.

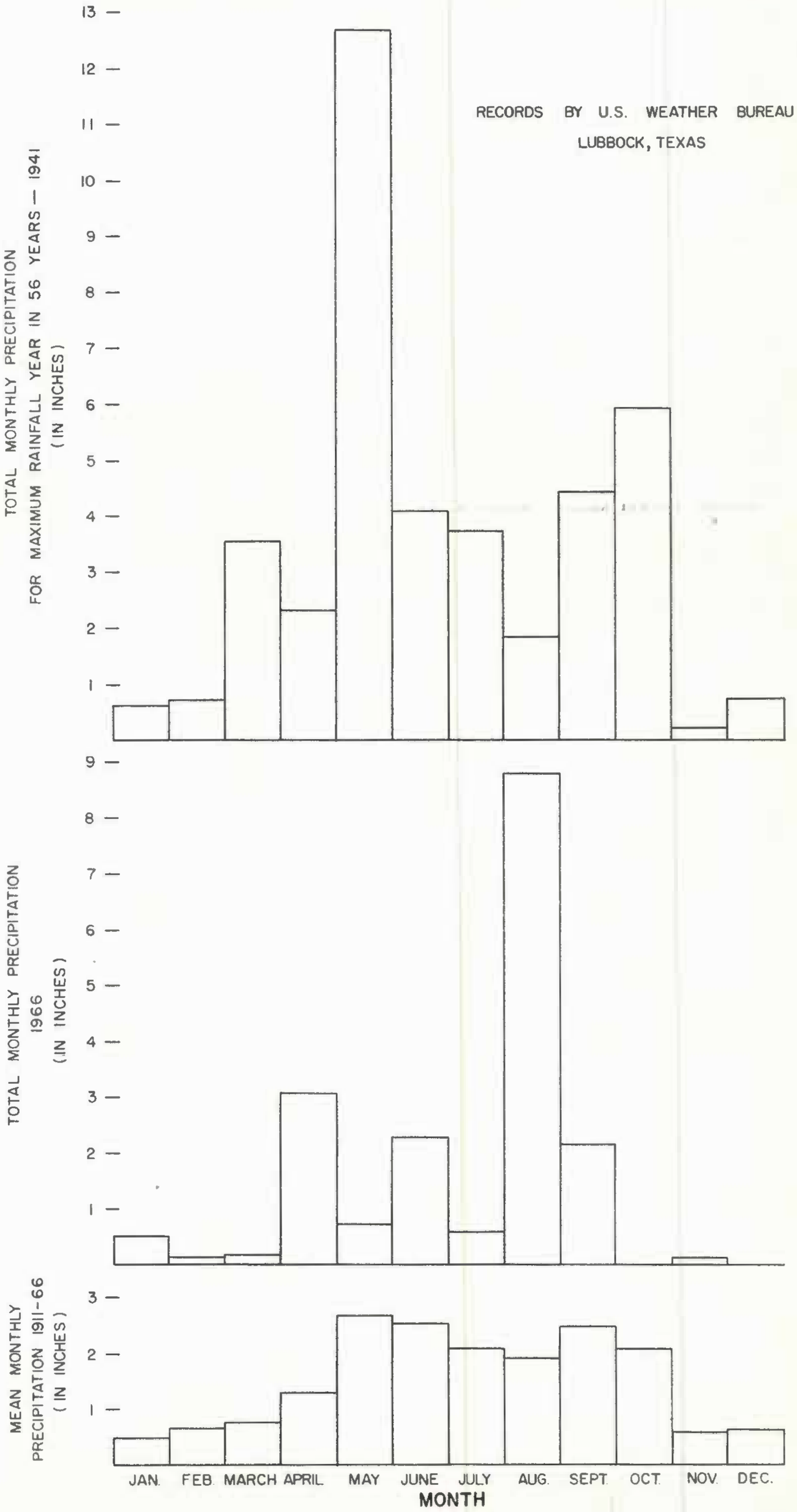
During this same month the record 24-hour rainfall of 3.78 inches, for any August day, was also established.

The August 1966 rainfall was 5.06 times greater than the 56-year mean August rainfall and 4.78 times greater than the total August rainfall during the maximum rainfall year of 1941.

This phenominal August rainfall once again demonstrated agricultures dependence upon the expected norm in weather conditions. Thousands of acres of "late" cotton still remains unharvested in the fields, to be plowed under in preparation for next years crop. A case of too much water—stimulating growth and retarding maturity—and a record early frost (the October 15 killing frost was 20 days premature of the average, November 4, occurance of the first killing frost).

Most agriculturists believe that the August 1966 rains, for the most part, were generally detrimental to the production of the major 1966-season "cash" crops.

Although the August rains could not be efficiently utilized by the 1966



season crops, the relatively small part of this surplus rainfall that resulted in deep percolation could, if properly utilized, prove to be a boom to the 1967 crop-year irrigator.

Bill Lyle, Area Irrigation Specialist, Texas Agricultural Extension Service, reports:

"Preplant irrigation should be lighter than usual this year due to the excessive moisture received last fall. Although the upper portion of the root zone is extremely dry at present from an unusually dry winter, reports from farmers and researchers over the plains indicate adequate subsoil moisture is present starting at depths ranging from about 12 to 18 inches below the surface. Therefore, it will be necessary to apply only enough preplant moisture to bring the top dry portion of the root zone to field capacity. It is suggested that each farmer sample his field to determine the depth at which moisture is adequate.

"The amount of water necessary to bring a dry soil to field capacity is dependent primarily on its texture. The approximate amounts required, expressed as inches of moisture per foot of soil depth, are as follows:

Coarse sand	0.75 to 1.1
Fine sandy loams	1.2 to 1.7
Loams	1.7 to 1.9
Clay loams	1.9 to 2.3
Clays	2.1 to 2.7

"Remember that irrigation systems are not 100 percent efficient, and that the values given are net amounts of water. Most irrigation application systems are estimated to be about 70 percent efficient. As an example, if 2-inches of water are required, about 3-inches should be delivered to the field."

The August rains provided runoff to partially fill thousands of playas. Unfortunately this playa catchment constituted surplus, surface-water supplies in respect to the areas agricultural needs — having accumulated at the end of the growing season. This surplus water was a strong stimuli to those advocating crash artificial recharge programs. However, a casual review of the precipitation history—as presented in the precipitation table and illustrated by the precipitation histogram—would tend to dispute the advisability of speculating on a water conservation program based upon a 56-year rainfall anomaly.

The 1966 year did not close on a note of surplus rainfall; quite the contrary, the total precipitation for October, November and December, 1966 (.14 inches) also closely approach the driest three end-of-year-months record established in 1921. The total precipitation of .24 inches, from October 1, 1966 to the date of this writing, February 17, 1967, establishes a 56-year record low precipitation for this 140 day period.

Water Is Your Future, Conserve It!

Precipitation At Lubbock, Texas—1911 To 1966

From Records by the U. S. Weather Bureau

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1911	.38	5.83	.43	2.36	.72	.28	6.75	.21	1.33	1.08	.22	1.55	21.14
1912	.02	1.28	.61	.50	1.58	.96	3.35	2.37	.73	2.81	.01	.38	14.00
1913	.04	.20	1.18	1.82	.24	5.88	.40	.32	4.19	1.53	1.54	2.13	19.47
1914	.15	.10	.29	1.47	4.04	3.86	6.17	5.95	.46	7.12	.35	1.47	31.43
1915	.09	3.00	2.52	6.18	1.52	4.01	1.42	2.96	7.86	1.52	.04	.76	31.88
1916	.17	T	1.15	2.63	.39	1.52	.36	2.45	2.79	2.91	.55	.11	15.03
1917	.35	.05	.21	.58	1.07	.64	1.42	1.16	3.03	.14	.08	T	8.73
1918	.84	.58	.05	.72	1.67	2.95	.53	.79	.79	.51	.69	2.03	12.15
1919	.12	.25	3.39	3.53	2.10	3.52	2.28	2.83	5.70	7.34	.36	.19	31.61
1920	.90	.11	.24	.15	2.91	3.66	2.19	2.64	1.63	1.43	2.21	.09	18.61
1921	.14	.45	1.47	.24	.43	7.71	.84	.92	4.50	.02	T	T	16.72
1922	.34	.20	.55	3.59	3.50	2.43	1.36	.28	.17	.60	1.50	.07	14.59
1923	.24	.76	1.04	3.18	2.77	3.98	1.65	1.59	2.67	6.80	.85	.64	26.17
1924	T	.17	.96	.88	.90	1.79	1.20	1.76	1.25	.47	.03	.06	9.45
1925	.65	.02	T	1.12	2.31	.86	3.38	3.32	9.44	1.33	.11	.21	22.75
1926	.56	.04	1.64	1.81	5.14	1.10	1.03	2.75	4.15	8.40	.67	1.77	29.06
1927	.79	.37	T	.40	T	2.91	2.16	.59	1.16	.40	T	.81	9.59
1928	.31	1.18	T	.09	3.08	1.06	6.78	4.04	.08	2.10	.74	.28	19.74
1929	.43	.34	2.03	.15	6.91	.90	.20	1.68	1.36	3.56	1.00	.07	18.63
1930	.61	.03	.45	1.04	1.71	1.70	.12	1.34	.11	3.91	.94	1.44	13.40
1931	.32	1.98	1.34	1.82	1.32	.95	2.17	2.44	.72	3.47	1.39	1.44	19.36
1932	.93	1.09	.04	1.84	2.37	5.66	1.90	3.15	3.41	1.29	T	2.48	24.16
1933	.37	.95	.02	.06	2.97	.21	1.36	2.19	.71	.42	.99	.06	10.31
1934	.06	.06	1.98	1.08	1.26	.28	.65	1.66	1.86	.28	.55	T	9.72
1935	.12	.60	.89	.04	3.49	2.57	1.25	1.69	3.02	1.22	2.04	.33	17.26
1936	1.08	T	.59	.92	5.86	.92	1.13	.13	13.93	1.52	.74	.21	27.03
1937	.26	.01	1.81	2.01	4.00	3.12	1.32	2.06	3.85	3.22	.07	.52	22.25
1938	.91	1.18	.49	.14	1.99	5.89	4.01	.47	.63	.51	.27	.03	16.52
1939	2.45	.19	.09	.28	1.82	.67	1.73	2.75	.01	.94	.18	.60	11.71
1940	.23	1.97	T	1.84	1.74	2.06	T	1.57	.73	1.07	2.35	.20	13.76
1941	.55	.61	3.56	2.23	12.69	4.13	3.68	1.85	4.47	5.89	.17	.72	40.55
1942	.04	.18	.51	3.25	.35	1.74	2.58	4.97	7.61	3.39	.01	2.70	27.33
1943	.04	.02	.25	.53	2.71	2.37	3.17	T	1.16	.10	.62	1.87	12.84
1944	1.28	1.36	1.09	.84	3.03	1.75	2.93	2.37	3.73	.80	1.27	1.64	22.54
1945	.69	.39	.10	.46	.46	.36	3.08	2.17	2.22	2.26	.27	.32	12.78
1946	1.18	.15	.76	.07	1.49	2.72	.58	3.55	3.49	4.67	.44	1.04	20.14
1947	.73	.02	.69	1.06	6.35	1.56	1.06	.06	.08	.37	1.43	.52	13.93
1948	.14	1.38	.17	.33	2.88	2.31	1.75	.31	1.45	.98	.03	.13	11.86
1949	4.05	.29	.80	1.84	7.80	4.65	1.18	2.07	4.76	1.49	T	.43	29.36
1950	.28	.18	T	.88	3.93	.68	3.12	2.08	3.74	.14	.03	.03	15.10
1951	.32	.66	.78	.58	2.63	4.19	2.04	2.62	.70	.93	.06	.02	15.53
1952	.98	.05	.04	2.30	1.39	1.94	3.24	1.88	.92	.00	.96	.06	13.76
1953	.34	.16	1.07	.62	1.37	.45	1.47	2.57	.04	4.01	.16	.05	12.31
1954	.06	T	.04	1.91	4.45	.51	.19	2.92	T	2.82	T	1.09	13.99
1955	.83	T	.03	.19	2.45	2.30	3.03	.62	2.76	4.53	.10	T	16.84
1956	.01	1.59	T	.36	1.80	3.26	.69	1.06	.03	1.73	T	.30	10.83
1957	.08	.73	.98	3.48	6.43	4.96	1.54	.32	.51	4.20	1.57	.06	24.56
1958	1.35	.33	3.23	1.97	2.94	.71	2.65	.21	2.90	.94	.34	.02	17.59
1959	.08	.07	T	1.28	2.15	7.25	1.30	.72	.89	.98	.02	1.47	16.21
1960	.66	.94	.61	.26	1.16	5.72	5.37	.05	.34	5.83	.00	1.25	22.19
1961	.56	2.51	1.34	.10	2.05	4.03	4.06	1.78	.18	.55	1.31	.35	18.82
1962	.26	.02	.10	1.20	.10	2.56	4.85	1.31	4.17	2.66	.45	.67	18.35
1963	.06	.54	.73	.25	6.79	2.10	.37	2.67	.78	.59	1.13	.20	16.21
1964	.45	.16	.64	.11	1.67	5.00	.82	1.16	2.46	.30	.57	.90	14.22
1965	.08	.35	.22	.41	1.63	1.44	2.14	.62	5.68	1.06	.02	.50	14.15
1966	.52	.06	.13	3.03	.67	2.27	.57	8.85	2.15	T	.11	.03	18.39

T—Trace

Potential For Storage—

(Continued from Page 1)

the thousands of shallow, saucer-like depressions termend "playas", and the relatively shallow dry draws—ancient tributaries to the Red, Brazos, and Colorado Rivers. The treeless Plains were aptly described by the person who noted that one could see for three days in any direction.

Nearly 18,000 square miles of the estimated 20,600 square miles shown on Figure 1 are 3,000 or more feet above sea level. This represents about 36 percent of the estimated 50,000 square miles in the High Plains and Trans Pecos, the only large areas in Texas more than 3,000 feet above sea level.

GENERAL GEOLOGY

The geologic units relevant to the subsurface, fluid-storage potential within the Plains are, in ascending order (oldest to youngest), the Triassic, Cretaceous and Tertiary age rocks.

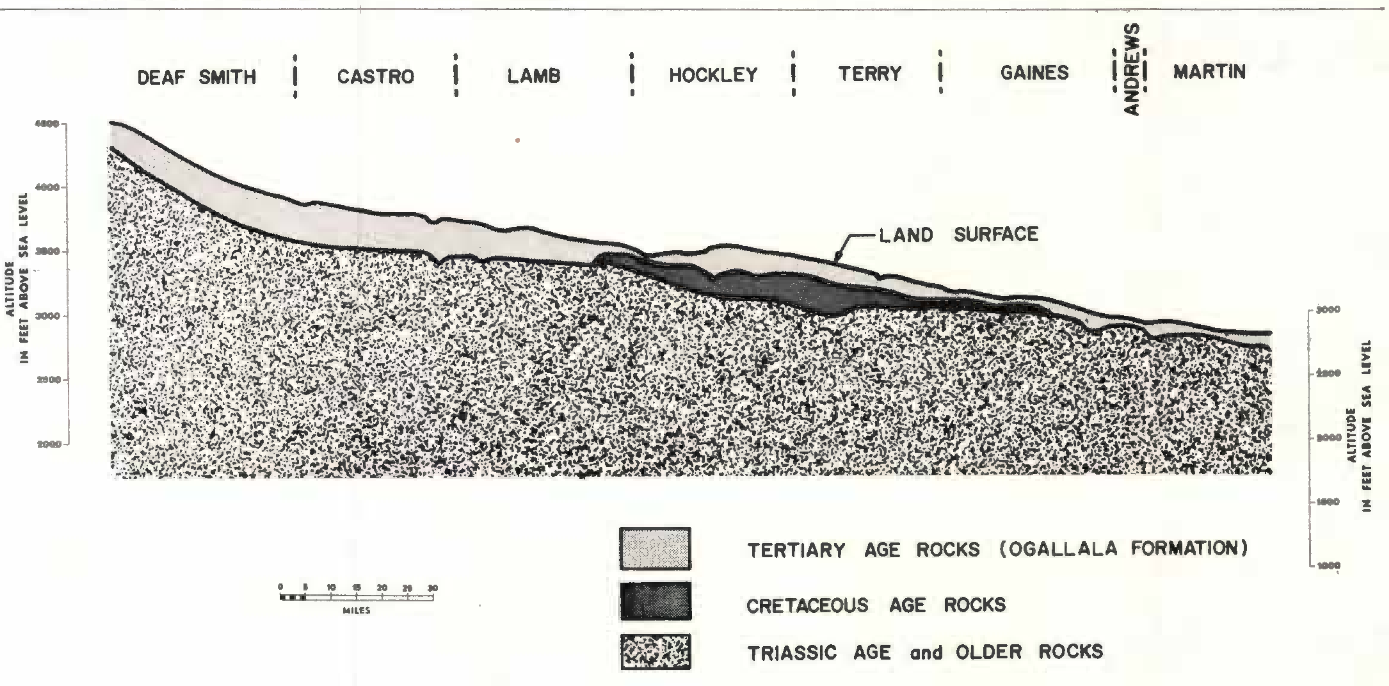
Triassic age rocks—the "red beds"—immediately underlie about 12,000 square miles of the Ogallala formation, nearly 60 percent of the area shown on Figure 1. Cretaceous age rocks, overlying Triassic rocks and underlying Tertiary age deposits, generally consist of a thin basal sand, thin-bedded limestones, and a relatively thick section of dark (organic) shale—described by well drillers as, "the blue".

The Ogallala formation of Tertiary age, consists of a heterogeneous series of gravel, sand, silt and clay horizons, and, near the land surface, an extensive series of caliche beds. These predominantly unconsolidated deposits extend up from the ancient land surface at the top of the Triassic and Cretaceous rocks, to the present-day land surface.

The vertical relationship of the Triassic, Cretaceous and Tertiary age rocks is illustrated by Figure 2.

The saturation in the Ogallala formation, commonly referred to as the Ogallala aquifer, constitutes the Plains only notable water supply.

More than 50,000 wells are pumping more than 6 million acre-feet of water each year from this aquifer.



APPROXIMATE GEOLOGIC SECTION ALONG LINE N—S, AS SHOWN ON FIGURE 1

FIGURE 2

STORAGE POTENTIAL IS INCREASING

Natural recharge to the Ogallala formation must come from the deep percolation resulting from the precipitation (averaging about 18 inches per year) that falls on the Plains in Texas and New Mexico. This natural replenishment is in the order of magnitude of .2 inches per year—about 250,000 acre-feet per year in the 21 counties.

This imbalance in the water budget is documented by the water-level measurements made annually in several hundred observation wells. These data show a trend to depletion of the aquifer — creating additional storage potential.

(To be continued)

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Rayner, F. A., The Ground Water Supplies of the Southern High Plains of Texas Proceedings of the Third West Texas Water Conference, Feb., 1965 Figures 1 and 2.

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Water Facts—

Water in the human body serves many uses—it cools, carries food to the cells, moistens and cleanses the eyes and eliminates waste production from the kidneys. Of the 50 quarts of water in the body, about 2½ quarts must be replaced each day to account for that used in food production, cooling (perspiration) and waste disposal.

In every stream much of the flow represents waste water returned from cities and industries. In periods of lowest flow, such as late summer, waste water may constitute almost the entire flow at some points.

Please Close Those Abandoned Wells!!!

WHEN YOU MOVE—

Please notify the High Plains Underground Water Conservation District, Lubbock, Texas on Post Office Form 22S obtainable from your local postmaster, giving old as well as new address, to insure no interruption in the delivery of "The Cross Section."

INCLUDE YOUR ZIP CODE NUMBER

West Texans Must Unite To Import Water

By BILL J. WADDLE

West Texas faces a great decision within the next 18 months. The decision is, "what can West Texans pay for imported surface water for irrigation?"

A preliminary State Water Plan has been prepared. Studies are now being conducted on the economics and feasibility of transporting water to West Texas. When the studies are completed it will be up to West Texans to make a decision on the amount they can pay for water and if they want water imported to our area.

Engineers have told officials of the High Plains Underground Water Conservation District that there is 16 million acre feet of surplus surface water that can be made available to West Texas.

Studies being conducted by the Bureau of Reclamation propose the diversion of water from the Mississippi River, up the Arkansas River into Oklahoma then to Texas. Another study is being conducted to bring water from the Mississippi into Texas, by pumping it up the Red River, and into the Panhandle of Texas. A third study proposes the movement of water from the Mississippi in Louisiana to the Colorado River. The water would then be pumped up the Colorado to West Texas.

Assuming all the studies being made prove that the importation of water to West Texas is feasible, what decisions will have to be made by the local people?

In a recent speech, Joe G. Moore, Jr., Executive Director, Texas Water Development Board, made the following statement:

"It is at this point that I want to speak frankly concerning some of the decisions that citizens living in West Texas are going to face with regard to the importation of water. You do not face these decisions alone—the cost of moving water in the amounts necessary to sustain the potential for irrigation in this area will require the combined resources of State and Federal agencies. But there are decisions you must make yourselves, here in West Texas, which will determine whether or not such an ultimate commitment by the rest of the State and by the Nation is either possible or feasible.

"First, it would be naive to believe that conveyance facilities on the scale we have been discussing could be financed, constructed or operated without the participation of Federal agencies and the use of Federal funds. To move several million acre-feet of water for the purpose of supplying present and potential irrigation development in West Texas will require Federal funds available under the Reclamation Acts as amended from time to time. These statutes presently limit the amount of water to which each individual land owner is entitled to that amount which is required for 160 acres, or 320 acres for a farmer and his wife. Such a limitation on individual irrigated farm units impinges directly upon the farming practices in the entire West Texas area where farms are generally considerably larger.

"There has been substantial opposition to prior attempts to amend or modify this acreage limitation. Nevertheless, these efforts continue. You in West Texas must make known to your Congressmen and be prepared to present before appropriate Congressional Committees your views as to the modification or removal of these acreage limitation provisions.

"Even if we assume that this constraint is in some way removed, and the construction and operation cost of the system to bring irrigation water to West Texas is provided interest-free, the costs—both initial capital costs and continuing annual operation and maintenance costs—will still be enormous.

"No construction can begin, and no water can move to West Texas, until there is a firm commitment on the part of a responsible political entity to contract for the repayment of the project costs allocated to the area. Such a contractual capability is not presently available to any political entity in the West Texas area. Ultimately, in order to make such a commitment, you must form a master district of some kind. Such a district will need broad powers including the following:

"1. Power to contract with the State or the United States for an imported water supply and to assure repayment of the costs for such a supply.

"2. Power to distribute water to users either through a surface or an underground distribution system or through a combination of both.

"3. Power to contract with local or subdistricts — for 'retail' distribution of water.

"4. Power to borrow money and incur indebtedness, issue bonds, and take all other required responsible financial actions necessary to repay obligations for the delivery of water.

"5. Power to charge direct water tolls and charge indirect beneficiaries who obtain water from underground sources recharged as a consequence of movement of water through delivery systems.

"6. Power to levy taxes on all land, improvements, and minerals within the geographical limits of the district to meet obligations for imported water above the revenues available from direct water tolls.

"7. Power to control the use of flood and storm waters within district boundries; to establish drainage systems where this becomes necessary; to appropriate water and water rights; to store water both on the surface and in underground reservoirs; to induce methods for the reclamation and reuse of water for all purposes;

"8. Power to construct, or finance the construction of facilities necessary to achieve the objectives of water supply within the district.

"9. Power of eminent domain so that properties required for the construction of facilities needed by the district can be condemned or otherwise acquired through legal process.

"10. Power to control the pumpage of ground water.

"11. Power to prevent the waste of water within the district boundaries.

"12. Power to prevent contamination or pollution of surface and underground sources of water within the district.

"13. Power to engage staff to conduct investigations or to have investigations made either on its own initiative or in cooperation with the State or with the Federal government."

It appears that Mr. Moore has mentioned some very important problems that a Master Water District will face.

A Master Water District, and it seems one will be a necessity if surface water is imported to West Texas, must include all the geographic area to be served by imported water.

Formation of a Master Water District will require a greater degree of understanding and acceptance than any undertaking which has ever faced the people of West Texas.

A source of water must be found for the area, a method of delivering this water to the people, and a method of paying for this water. Let us hope that West Texans can unify themselves and get the job done.

High Plains Underground Water
Conservation District No. 1
1628 Fifteenth Street
Lubbock, Texas 79401

Second Class Permit

THE Cross SECTION

A Monthly Publication of the High Plains Underground Water Conservation District No. 1

Volume 13—No. 10 **"THERE IS NO SUBSTITUTE FOR WATER"** *March 1967*

OBSERVATION WELL RECORDS . . .

THE ANNUAL WATER STATEMENT

By F. A. RAYNER and A. W. WYATT

During January 1967, personnel of the High Plains Underground Water Conservation District No. 1 and the Texas Water Development Board measured the depths to water in 711 "observation" wells.

This January' measurements constitue the continuation of an annual, water-level-measuring program initiated by the U. S. Geological Survey in 1936.

The Jauuary 1967, depths-to-water-below-land-surface measurements — made in observation wells located in Bailey, Castro, Cochran, Deaf Smith, Floyd, Hockley, Lamb, Lubbock, Parmer, Potter and Randall Counties, and in those parts of Armstrong and Lynn Counties in the District—are listed in the well tables on pages 2 through 7. These tables include only those observation wells for which valid, 1967, water-level measurements are available. They do not represent a list of all of the wells in the observation-well program in the respective counties. These tables also include the January 1962, depths-to-water measurements (if available); the total change in depth to water for the period of record included in these tables; and the decline per year for the years of record.

January 1963, 64 and 65 measurements are shown for those wells for which a Jaunary 1962 measurement was not available.

The locations of the wells listed in the well tables are shown on the county maps.

A summary of the annual, depth-to-water measurements is presented in the following table. This summary includes only those records covering the 5-year period from January 1962 to January 1967. It should be noted that these data do not represent a valid analysis of the amount of decline of the water levels throughout the respective counties—it only represents, and is included to facilitate, a generalized review of the 5-year water-level declines in some of the observation wells. Table next column:

COUNTY	No. of Wells With 5-Year Record	Avg. Decline, In Feet, Per Well
Armstrong	9	1.89
Bailey	42	1.71
Castro	39	3.77
Cochran	53	1.94
Deaf Smith	52	3.56
Floyd	77	4.56
Hockley	36	2.05
Lamb	32	2.31
Lubbock	93	2.73
Lynn	29	1.50
Parmer	41	4.09
Potter	3	2.93
Randall	15	1.93
TOTAL	522	2.92

HISTORY OF DEVELOPMENT

In 1936, the U. S. Geological Survey in cooperation with the Texas Board of Water Engineers (later the Texas Water Commission, now the Texas Water Development Board) commenced an inventory of wells, well logs, and water-level measurements in several counties in the High Plains. These, Works Progress Administration sponsored, studies provided the framework and the nuclei for the first observation-well program.

From 1936 to 1948, the observation-well program continued to expand, until about 500 wells were included in the Southern High Plains program. Some of these wells were widely-spaced, windmill wells—located near the arterial highways traversing the Plains. However, the majority of the annual, water-level measurements were being made in irrigation wells concentrated in irrigation enclaves near Hereford, Lockney, Lubbock, Muleshoe, and Plainview.

Throughout a considerable part of the early (formulative) years, geologists and engineers tended to concentrate the addition of wells to the observation-well program in their specific areas of concern—creating "spot" coverage, neglecting large areas of the reservoir system.

In 1956, District personnel added about 69 wells to the observation-well program, and commenced making some of the annual, water-level measurements in cooperation with the U. S. Geological Survey and the Texas Board of Water Engineers.

In September 1960, the Texas Board of Water Engineers assumed responsibility for the formerly joint (with the U. S. Geological Survey) program. Since that time the District has expanded its cooperation with the State—making about half of the measurements in the 13-county District area.

In August 1962, the District entered into a contract with the Texas Water Commission to expand, upgrade and revise a part of the observation-well network within the District. Under this contract about 210 new wells were added to the program, in areas not previously covered by the observation-well network. A detailed schedule (data sheet) and location sketch (map) was prepared for each of these new wells, and they were "tagged" (a metal identification plate affixed to the concrete pump-base). Several existing observation wells were also rescheduled and tagged.

As a result of this work, the number of "current" (a well maintained in the records as being measurable, and subject to annual measurements) observation wells in the District reached an all-time maximum of about 794 wells.

THE OBSERVATION WELL PROGRAM

On January 1, 1963, there were 794 current wells in the observation-well program within the District. At this same time there were 811 current, observation wells in the ten county area comprising all or parts of the District, and in the District part of Armstrong and Lynn Counties.

The 1963 total of 794 wells represents the maximum number of current wells ever included in the observation-well network within the District — during the 31-year (through January 1967) history of this program. This represents an observation well density of about one well per 10-square miles.

A pumping well creates a depression in the water level in the aquifer —similar in shape to an inverted cone. This cone of depression grows outward as the well continues to pump, and begins to fill when pumping is discontinued. The rate of the filling of this cone is dependent primarily on the hydrologic properties of the aquifer, in any event this cone fills at an ever decreasing rate. Since most of the observation wells are irrigation wells, the rest period prior to the annual measurement of water levels is somewhat critical—if representative "static" water levels are to be obtained.

Prior to the widespread acceptance of the practice of preplant irrigation (irrigating fallow land before seed-

(Continued on Back Page)

Becoming Involved

We are now living in the most prosperous society known to man. Living conditions are better than ever before, per capita income is at its highest, and per capita consumption of agricultural products is good and still rising at a brisk pace. This society must continue to prosper and grow.

What will it take to maintain or even improve our agricultural production and income on the High Plains of Texas?

*Two things—*Water and good Markets *for our products.*

How are we going about the task of attaining both?

The marketing sector of our economy is presently working to develop new outlets for our products. The cotton and grain industries are presently doing research and promoting their products on a world wide basis. Great strides have been made in both fields and even greater ones will be made in the future.

But what about the water situation? What is being done to prolong the life of our water supply? What are we going to do when it is gone? Will we regress back to the days of total dry land farming? Are you able to answer these questions? Probably very few people would even chance a guess. Why should many be afraid to guess what is going to happen to the High Plains of Texas?

The main reason would be because many people are afraid to become "totally involved" in what is happening around them.

This is no fault of any individual. It is just the product of our living as we do in the "Space Age Times".

Today all people are specialists. This is not a criticism of the specialist or of specialized knowledge as such. The world today needs specialists. However, when we specialize, we tend to forget or block out anything that does not fit into our particular specialization. Almost everyone is guilty of doing this. But are we not a little derilict in our duty to the community in which we live if we remain uninterested in its problems?

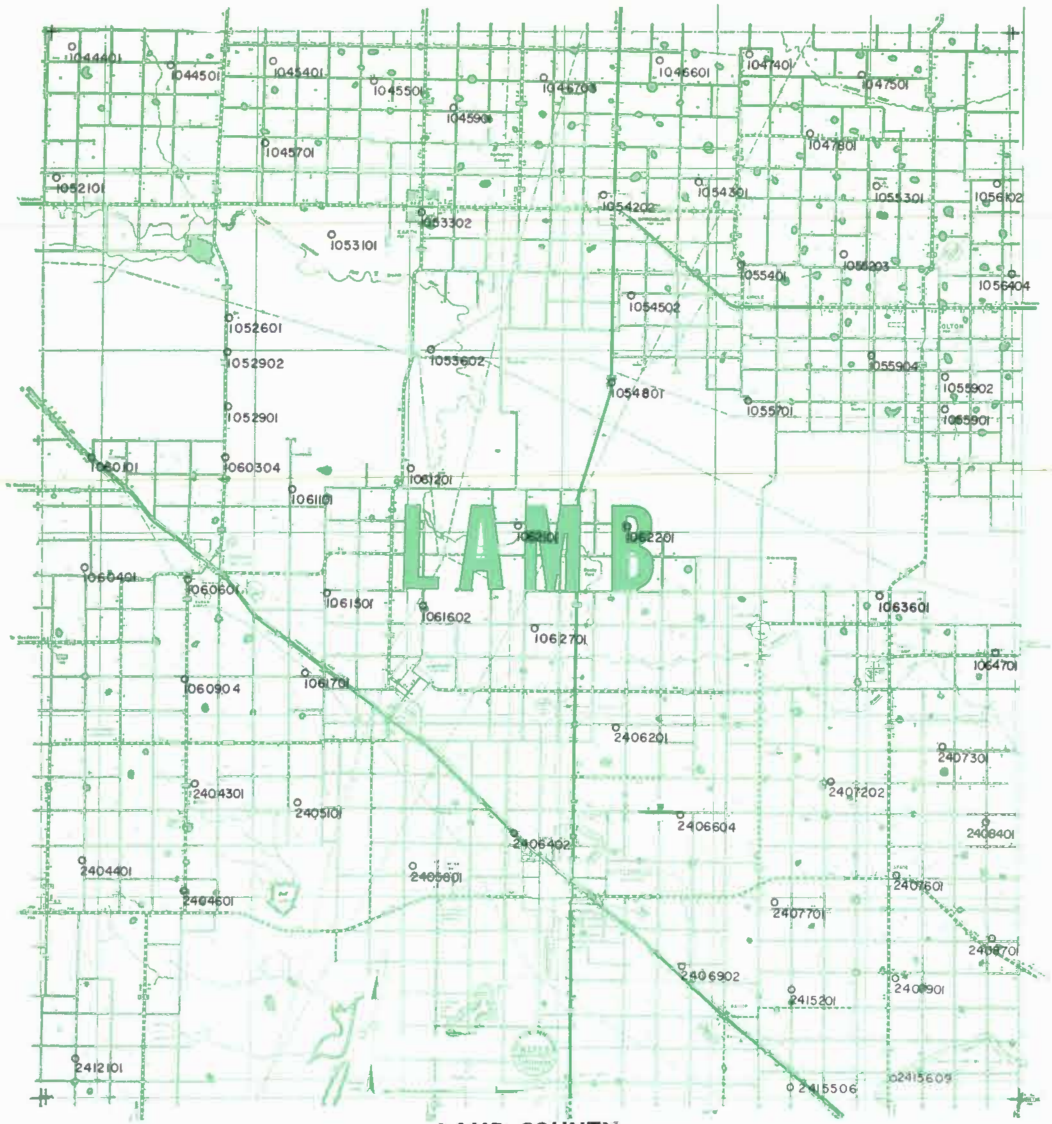
We must make some definite, deliberate changes in the near future if West Texas is to continue to prosper. We must all become "totally involved" in our water problem. Water is our life.

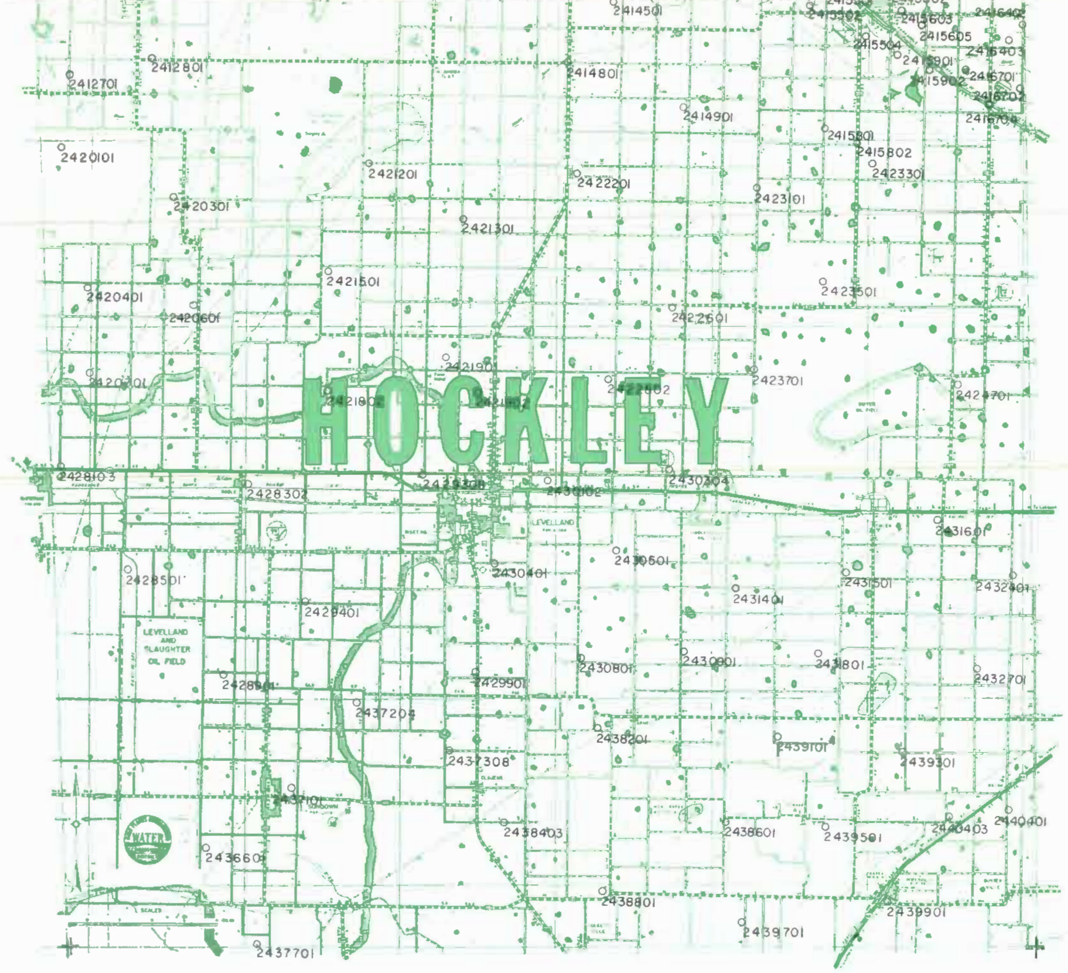
How can you become totally involved? Well first, we should discuss what we mean when we say get totally involved.

Total Involvement is curiosity, a restless mind, a compulsive need to know. It is a sense of or desire for relatedness. Total Involvement is active, seldom passive. It has a connotation of offense, not defense; of looking for opportunities, not waiting for problems.

We must all be aware of water conservation. We cannot sit around and wonder or think that water conservation is being accomplished—we must know for sure. We must know who is doing it and how. Every man, woman and child must know what is going on in their community to conserve what water we have.

So West Texan, if you plan to continue to prosper, no matter what your interests or occupation may be, "total involvement" in our water situation is a must for every individual.





LAMB COUNTY

Well No.	Depth To Water 1962	Depth To Water 1967	Total Decline	Avg Decline Per Year
10 44 401	103.42	127.06	23.64	4.72
10 44 501	109.54**	120.45	10.91	3.63
10 45 401	111.83**	121.71	9.88	3.29
10 45 501	132.03**	138.42	6.39	2.13
10 45 701	71.40*	83.86	12.46	3.11
10 45 901	132.22**	139.32	7.10	2.36
10 46 601	111.40*	161.30	49.90	12.47
10 46 703	135.79	153.83	18.04	3.60
10 47 401	119.08	134.76	17.92	3.58
10 47 501	119.68**	130.13	10.45	3.48
10 47 801	147.05	161.66	14.61	2.95
10 52 101	57.64	67.50	9.86	1.97
10 52 601	28.13	31.20	3.07	0.61
10 52 901	59.02	64.60	5.58	1.11
10 52 902	46.45	49.74	3.29	0.65
10 53 101	50.04**	56.14	6.10	2.03
10 53 302	63.51	74.61	8.90	1.78
10 53 602	42.02	48.60	6.58	1.31
10 54 202	112.52	125.84	13.32	2.66
10 54 301	132.28	146.82	14.54	2.90
10 54 502	87.61**	94.12	6.51	2.17
10 54 801	59.93	64.96	5.03	1.00
10 55 203	137.39*	151.93	14.54	3.63
10 55 301	153.34*	171.46	18.12	4.53
10 55 401	147.06**	154.05	6.99	2.33
10 55 701	72.63**	76.63	4.00	1.33
10 55 901	98.96*	113.36	14.40	3.60
10 55 902	115.10	132.93	17.83	3.56
10 55 904	110.66	128.21	17.55	3.51
10 56 102	153.12*	173.40	20.28	5.07
10 56 404	147.10	166.26	19.16	3.63
10 60 101	110.52	121.81	11.29	2.25
10 60 304	67.80*	71.08	3.28	0.82
10 60 401	122.57	131.27	8.70	1.72
10 60 601	109.83	99.99	+9.84	+1.98
10 60 904	137.50*	140.34	2.84	0.71
10 61 101	61.69*	72.57	10.88	2.72
10 61 201	48.76	55.07	6.31	1.26
10 61 501	106.14**	110.84	4.70	1.56
10 61 602	90.18**	92.28	2.10	0.70
10 61 701	106.23**	116.00	9.77	3.25
10 62 101	46.33*	51.84	5.51	1.37
10 62 201	92.79**	97.47	4.68	1.56
10 62 701	105.31	124.63	19.32	3.86
10 63 601	101.39**	100.46	+0.93	+0.31
10 64 701	105.79**	112.73	6.94	2.31
24 04 301	53.94**	58.63	4.69	1.56
24 04 401	155.09	181.41	26.32	5.26
24 04 601	64.79	73.63	8.54	1.70
24 05 101	37.60*	40.45	2.85	0.71
24 05 601	89.81**	98.50	8.69	2.89
24 06 201	117.79**	128.87	11.08	3.69
24 06 402	82.40	88.05	5.65	1.13
24 06 604	107.70*	117.62	9.92	2.48
24 06 902	79.77	94.95	15.18	3.03
24 07 202	131.51	144.37	12.86	2.57
24 07 301	113.61	127.09	13.48	2.69
24 07 601	130.56	143.10	12.54	2.50
24 07 701	123.05	135.40	12.35	2.47
24 07 901	102.63**	108.09	5.46	1.82
24 08 401	137.53**	145.00	7.47	2.49
24 08 701	114.98**	125.52	10.54	3.51
24 12 101	70.45	76.45	6.00	1.20
24 15 201	105.16**	111.63	6.47	2.15
24 15 506	67.92	79.20	11.28	2.23
24 15 609	115.40	127.87	12.47	2.49

* January 1963 Water Level.
** January 1964 Water Level.

HOCKLEY COUNTY

Well No.	Depth To Water 1962	Depth To Water 1967	Total Decline	Avg Decline Per Year
24 12 701	77.45	80.00	2.55	0.51
24 12 801	124.75	126.12	1.37	0.25
24 14 501	105.44*	109.05	3.61	0.90
24 14 801	50.27	54.48	4.21	0.84
24 14 901	95.93*	99.39	3.46	0.86
24 15 501	63.90	73.15	9.25	1.85
24 15 502	74.90*	79.86	4.96	1.24
24 15 504	61.90	68.16	6.26	1.25
24 15 601	90.02	102.53	12.51	2.50
24 15 602	103.03	115.61	14.01	2.80
24 15 603	98.32	112.94	14.62	2.92
24 15 605	84.26	93.95	9.69	1.93
24 15 801	129.00	132.58	3.58	0.71
24 15 802	173.30	179.27	6.97	1.39
24 15 901	41.20	45.03	3.83	0.76
24 15 902	34.64	48.85	14.21	2.84
24 16 402	124.29	130.15	5.86	1.17
24 16 403	93.55	104.65	11.10	2.22
24 16 701	58.38	65.88	7.50	1.50
24 16 702	85.47	95.33	9.86	1.97
24 16 704	85.60	107.21	21.61	4.32
24 20 101	129.37	152.34	22.97	4.59
24 20 301	115.21	131.66	12.67	2.53
24 20 401	111.08	121.22	10.14	2.02
24 20 601	133.24	147.80	14.56	2.91
24 20 701	142.00	145.45	3.45	0.69
24 21 201	38.55*	42.67	4.12	1.03
24 21 301	81.87	90.19	8.32	1.66
24 21 501	137.18	153.60	16.42	3.28
24 21 802	143.26*	153.75	10.49	2.62
24 21 901	141.77	152.28	10.51	2.10
24 21 902	150.52	167.94	17.42	3.48
24 22 201	74.53*	78.65	4.12	1.03
24 22 601	98.25*	100.19	1.94	0.48
24 22 802	114.94*	126.60	11.66	2.91
24 23 101	104.95*	108.95	4.00	1.00
24 23 301	178.60	191.79	12.19	2.43
24 23 501	100.87*	106.26	5.39	1.34
24 23 701	98.36*	103.63	5.27	1.31
24 24 701	124.23*	126.97	2.74	0.68
24 28 103	138.71*	145.75	7.04	1.76
24 28 302	127.90*	126.51	+1.39	+0.34
24 28 501	143.96*	148.75	4.79	1.19
24 28 901	150.92*	160.59	9.67	2.41
24 29 308	131.44*	144.25	12.81	3.20
24 29 401	139.07*	142.86	3.79	0.94
24 29 901	169.44	187.75	28.31	5.66
24 30 102	124.65*	138.10	13.45	3.36
24 30 304	96.08*	102.51	6.43	1.60
24 30 401	117.17	129.32	12.15	2.43
24 30 501	112.23*	123.05	10.82	2.70
24 30 801	162.71*	168.80	6.09	1.52
24 30 901	145.07*	154.99	9.92	2.48
24 31 401	117.51*	128.76	11.25	2.81
24 31 501	73.66*	80.14	6.48	1.62
24 31 601	113.81	120.08	6.27	1.25
24 31 801	141.39*	145.58	4.19	1.04
24 32 401	99.50	107.10	7.60	1.52
24 32 701	111.74*	117.10	5.36	1.34
24 36 601	143.90*	154.70	10.80	2.70
24 37 101	135.11*	141.82	6.71	1.67
24 37 204	137.36*	144.28	6.92	1.73
24 37 308	130.55*	145.02	14.47	3.61
24 37 701	151.00	151.05	0.05	0.01
24 38 201	154.46*	167.57	13.11	3.27
24 38 403	151.79*	160.13	8.34	2.08
24 38 601	119.80	131.42	11.62	2.32
24 38 801	154.91*	165.91	11.00	2.75
24 39 101	146.34*	154.24	7.90	1.97
24 39 301	142.30*	149.32	7.02	1.75
24 39 501	129.79*	137.22	7.43	1.85
24 39 701	107.07*	118.75	11.68	2.92
24 39 901	90.70	94.81	4.11	0.82
24 40 401	131.52	142.00	11.10	2.22
24 40 403	139.77*	148.95	9.18	2.29

* January 1963 Water Level.

PARMER COUNTY

Well No.	Depth To Water 1962	Depth To Water 1967	Total Decline	Avg Decline Per Year
09 24 601	286.05	314.61	28.56	5.71
09 40 901	226.64	263.91	37.27	7.45
09 40 903	206.38	224.55	18.17	3.63
09 48 301	191.54	205.28	13.74	2.74
10 17 301	191.74*	192.01	0.27	0.06
10 17 401	241.84	262.72	20.88	4.17
10 17 501	230.00	250.00	20.00	4.00
10 18 501	271.20***	283.82	12.62	6.31
10 18 701	203.35	229.83	26.48	5.29
10 18 901	207.68	223.02	15.34	3.06
10 19 101	232.00	255.64	23.64	4.72
10 19 301	239.90**	250.18	10.28	3.42
10 19 601	201.09	217.48	16.39	3.27
10 20 401	196.36**	209.10	12.74	4.24
10 20 502	151.34	160.40	9.06	1.81
10 25 101	304.22***	322.60	18.38	9.19
10 25 301	274.05	289.34	15.29	3.05
10 25 501	163.60*	167.09	3.49	0.87
10 25 701	212.68	239.50	26.82	5.36
10 26 101	289.22	309.90	20.68	4.13
10 26 301	272.40	288.00	15.60	3.12
10 26 701	181.40	193.35	11.95	2.39
10 26 801	198.05**	208.65	10.60	3.53
10 27 101	230.52*	246.67	16.15	4.03
10 27 301	252.15	274.78	22.63	4.52
10 27 401	245.37	264.34	18.97	3.79
10 27 501	296.85*	309.29	12.44	3.11
10 27 901	208.00	228.59	20.59	4.11
10 28 201	228.55*	249.38	20.83	5.20
10 28 501	222.86*	269.28	46.42	11.60

Well No.	Depth To Water 1962	Depth To Water 1967	Total Decline	Avg Decline Per Year
10 33 101	238.25	262.00	23.75	4.75
10 33 301	202.86	225.69	22.83	4.56
10 33 401	241.45	266.95	25.50	5.10
10 33 802	168.47	189.18	20.72	4.14
10 33 901	165.98	186.05	20.07	4.01
10 34 301	186.80	195.76	8.96	1.79
10 34 401	234.85	259.76	24.91	4.98
10 34 801	175.46	197.25	23.95	4.79
10 34 802	201.04	228.22	27.18	5.43
10 35 304	181.75**	193.44	11.69	3.89
10 35 401	204.15	223.51	19.36	3.87
10 35 501	194.50	218.48	23.98	4.79
10 35 601	169.60	187.96	18.36	3.67
10 35 701	182.78	202.93	20.15	4.03
10 35 901	206.05*	224.90	18.85	4.71
10 35 902	196.41	223.48	27.07	5.41
10 36 101	165.80	186.17	20.37	4.07
10 36 601	164.25**	181.87	17.62	5.87
10 36 801	156.82	179.62	22.80	4.56
10 41 201	137.28	146.34	9.06	1.81
10 41 202	123.35	141.31	17.96	3.59
10 42 101	138.20	155.08	16.88	3.37
10 42 202	163.80	185.85	22.05	4.41
10 42 501	124.23	141.67	17.44	3.48
10 43 201	163.85	187.16	23.31	4.66
10 44 101	152.60**	164.29	11.69	3.89

* January 1963 Water Level.
** January 1964 Water Level.
*** January 1965 Water Level.

CASTRO COUNTY

Well No.	Depth To Water 1962	Depth To Water 1967	Total Decline	Avg Decline Per Year
10 21 501	111.83	129.06	17.23	3.44
10 21 701	163.65	185.30	21.65	4.33
10 21 801	150.04*	170.89	20.85	5.21
10 21 901	126.22*	145.16	18.94	4.73
10 22 201	144.98*	146.84	1.86	0.46
10 22 401	106.57	127.06	20.49	4.09
10 22 801	121.76*	141.30	19.54	4.88
10 22 901	123.69	144.63	20.94	4.18
10 23 801	148.50	148.48	+0.02	0.00
10 24 201	168.84*	173.70	4.86	1.21
10 24 401	176.50	185.45	8.95	1.79
10 24 701	176.23*	179.58	3.35	0.83
10 24 801	158.86	175.69	16.83	3.36
10 28 301	224.41	256.15	31.74	6.34
10 29 302	216.29*	241.75	25.46	6.36
10 29 601	195.75	222.82	27.07	5.41
10 29 701	200.89	224.33	23.44	4.68
10 30 201	185.52	213.14	27.62	5.52
10 30 401	216.90*	228.89	11.99	2.99
10 30 505	194.98	210.37	15.39	3.07
10 30 601	185.25	203.57	18.32	3.66
10 30 801	172.18	193.08	20.90	4.18
10 30 901	194.43*	218.72.	24.29	6.07
10 31 201	139.18	157.12	17.94	3.58
10 31 301	163.54*	174.11	10.57	2.64
10 31 501	189.98*	191.89	1.91	0.47
10 31 601	135.24*	150.52	15.28	3.82
10 31 701	202.59	239.24	36.65	7.33
10 31 801	198.38	222.35	23.97	4.77
10 32 201	146.04*	155.20	9.16	2.29
10 32 501	125.64	130.81	5.17	1.03

Well No.	Depth To Water 1962	Depth To Water 1967	Total Decline	Avg Decline Per Year
10 32 701	180.03	200.28	20.25	4.05
10 32 801	166.10	185.00	13.35	2.67
10 37 201	155.45	175.47	20.02	4.00
10 37 401	128.85	146.77	17.92	3.15
10 37 601	113.03	127.22	14.19	2.83
10 37 901	118.24*	132.06	13.82	3.45
10 38 401	126.26	143.28	17.02	3.40
10 38 601	118.80*	130.29	11.49	2.87
10 38 701	123.24	139.86	16.62	3.32
10 38 801	125.10	141.09	15.99	3.19
10 38 901	113.50	130.26	16.76	3.35
10 39 101	153.30	175.78	22.48	4.49
10 39 401	134.00	150.50	16.50	3.30
10 39 501	129.54	153.90	24.36	4.87
10 39 701	117.90*	130.52	12.62	3.15
10 39 801	129.08*	140.86	11.78	2.94
10 40 401	138.31	162.26	23.95	4.79
10 40 501	170.20	190.76	20.56	4.11
10 40 801	146.92	166.39	19.47	3.89
10 45 101	134.44	149.56	15.12	3.02
10 45 301	140.91	156.16	15.25	3.05
10 46 301	52.64	69.40	16.76	3.35
10 46 405	136.66	152.01	15.35	3.07
10 47 201	108.55*	123.61	15.06	3.76
10 47 201	139.00*	157.31	18.31	4.57
10 47 302	121.76	140.29	18.53	3.70
10 48 301	112.77	136.35	23.58	4.71
10 48 501	116.03*	135.48	19.45	4.86

* January 1963 Water Level.

LYNN COUNTY

Well No.	Depth To Water 1962	Depth To Water 1967	Total Decline	Avg Decline Per Year
23 34 901	119.61	133.85	14.24	2.84
23 34 903	133.73	154.30	20.57	4.11
23 35 801	81.34	87.30	5.96	1.19
23 35 901	86.64	90.56	3.92	0.78
23 41 201	93.83	103.70	9.87	1.97
23 41 401	83.68	90.57	6.89	1.37
23 41 501	68.57	73.20	4.63	0.92
23 41 901	122.97	128.25	5.28	1.05
23 42 201	127.70	129.14	1.44	0.28
23 42 202	120.43	119.95	+0.48	+0.09
23 42 301	102.68	103.19	0.51	0.10
23 42 401	108.63	117.34	8.71	1.74
23 42 501	90.79	100.55	9.76	1.95
23 42 601	44.11	49.56	5.45	1.09
23 42 602	79.18	86.43	7.25	1.45

Well No.	Depth To Water 1962	Depth To Water 1967	Total Decline	Avg Decline Per Year
23 42 701	97.13*	102.60	5.47	1.36
23 42 801	64.79	69.10	4.31	0.86
23 43 301	25.89	37.55	11.66	2.33
23 43 501	69.95	76.59	6.64	1.32
23 43 502	74.20	68.35	+5.85	+1.17
23 43 503	81.94	85.65	3.71	0.74
23 43 504	75.68	79.00	16.68	3.33
23 43 901	64.74	65.47	0.73	0.14
23 44 101	58.14	67.55	9.41	1.88
23 44 401	56.19	60.85	4.66	0.93
23 44 701	50.74	78.58	27.84	5.56
23 44 702	37.58	40.70	3.12	0.62
24 48 201	91.70	101.30	9.60	1.92
24 48 302	99.06	111.07	12.01	2.40
24 48 601	83.72	93.59	9.87	1.97

* January 1963 Water Level.

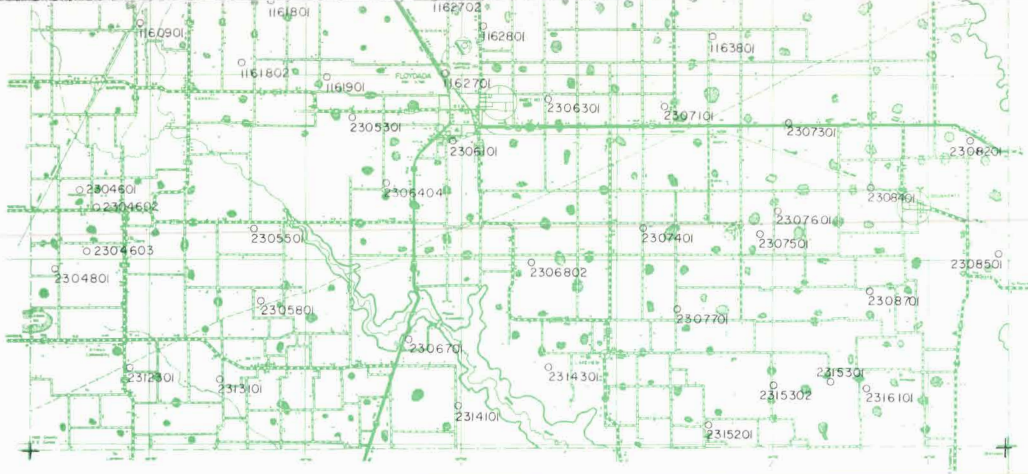
PUBLISHED BY

HIGH PLAINS UNDERGROUND WATER CONSERVATION DISTRICT

MARCH 1967

ARMSTRONG COUNTY

Well No.	Depth To Water 1962	Depth To Water 1967	Total Decline	Avg Decline Per Year
11 12 401	107.50	112.19	4.69	0.93
11 12 701	112.65	125.52	12.87	2.57
11 12 702	127.35	138.78	11.43	2.28
11 12 801	124.80	133.13	8.33	1.66
11 12 802	124.90	139.52	14.62	2.92
11 12 803	108.90	117.15	8.25	1.65
11 12 901	109.00	118.87	9.87	1.97
11 12 904	100.80	106.11	5.31	1.06
11 13 701	95.48	105.53	10.05	2.01



LUBBOCK COUNTY

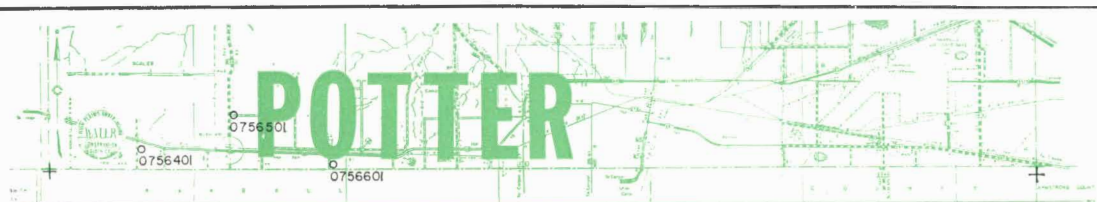
Well No.	Depth To Water 1962	Depth To Water 1967	Total Decline	Avg Decline Per Year
23 09 501	142.82	157.76	14.94	2.98
23 09 601	123.09	141.23	18.14	3.63
23 09 701	132.21	150.86	18.65	3.73
23 09 901	169.54	190.91	21.37	4.27
23 10 501	158.80	175.95	17.15	3.63
23 10 801	144.55	166.32	21.77	4.35
23 11 401	156.93	184.95	28.02	5.60
23 11 601	145.88	161.66	15.78	3.15
23 11 701	146.93	168.02	21.09	4.21
23 11 702	142.94	163.92	20.98	4.19
23 11 901	127.09	153.28	26.19	5.23
23 11 902	141.92	157.73	15.81	3.16
23 11 903	128.61	155.78	27.17	5.43
23 12 401	149.53	165.89	16.36	3.25
23 12 402	150.33	170.60	20.27	4.05
23 12 803	137.70	163.44	25.74	5.14
23 17 201	132.77	139.17	6.40	1.28
23 17 202	129.49	140.20	10.71	2.14
23 17 501	112.13	126.52	14.39	2.87
23 17 701	96.10	112.20	16.10	3.22
23 17 703	86.86	99.45	12.59	2.54
23 17 704	70.14	74.82	4.68	0.93
23 17 705	79.66*	88.63	8.97	2.24
23 17 706	83.22	103.22	20.00	4.00
23 17 801	75.13	85.13	10.00	2.00
23 17 802	54.34	78.85	24.51	4.90
23 17 804	52.53	65.22	12.69	2.53
23 18 201	128.97	151.71	22.92	4.58
23 18 301	145.56	171.46	25.90	5.18
23 18 402	112.27	133.11	20.84	4.16
23 18 403	113.12	121.32	8.20	1.64
23 18 404	118.57	135.51	16.94	3.38
23 18 502	110.83**	121.78	10.95	3.65
23 18 601	118.81	134.88	16.70	3.34
23 18 703	89.56*	94.42	4.86	1.21
23 18 704	79.80*	84.33	4.53	1.13
23 19 301	149.11	183.52	34.41	6.83
23 19 302	146.82	162.70	15.88	3.17
23 19 402	126.80	150.20	23.40	4.68
23 19 403	127.28	154.70	27.42	5.48
23 19 502	109.49	133.94	24.45	4.89
23 19 701	76.68	82.15	5.47	1.09
23 19 802	83.01	96.02	13.01	2.60
23 19 804	80.82*	92.58	11.76	2.94
23 19 901	108.29	148.31	40.02	8.00
23 20 401	139.18	173.96	34.78	6.95
23 20 701	125.12	141.69	16.57	3.31
23 20 802	158.69*	169.21	10.52	2.63
23 25 101	134.52	140.91	6.39	1.27
23 25 102	131.77	143.78	12.01	2.40
23 25 303	73.31	84.82	11.51	2.30
23 25 304	65.23	67.89	2.66	0.53
23 25 401	131.00	142.83	11.83	2.36
23 25 701	110.42	122.52	12.10	2.42
23 26 301	89.48	94.32	4.84	0.96
23 26 603	12.82	9.18	+3.64	+0.72
23 26 901	49.73	41.27	+8.46	+1.69
23 27 101	89.26	96.12	6.86	1.37
23 27 202	73.80	91.58	17.78	3.55
23 27 203	75.44	85.74	10.30	2.06
23 27 204	81.85	88.36	6.51	1.30
23 27 302	66.78	79.15	12.37	2.47
23 27 601	74.66	84.32	9.66	1.93
23 27 602	87.10	95.31	8.21	1.64
23 27 701	96.93**	87.86	+9.07	+3.02
23 28 701	59.62	67.75	8.13	1.62
23 33 201	125.11	130.87	5.76	1.15
23 33 401	100.13	105.22	5.09	1.01
23 33 501	106.22*	109.50	3.28	0.82
23 33 601	101.40	107.65	6.25	1.25
23 33 801	94.17	101.72	7.55	1.51
23 34 101	106.83	117.48	10.65	2.13
23 34 502	126.72	134.49	7.77	1.55
23 34 503	115.32	119.88	4.56	0.91
23 34 601	113.84	121.50	7.66	1.53
23 34 801	128.92	146.51	17.59	3.51
23 34 802	129.80	146.75	16.95	3.39
23 34 803	127.80	130.92	3.12	0.62
23 34 804	125.00	135.56	10.56	2.11
23 34 902	121.93	130.60	8.67	1.73
23 34 904	117.62	127.64	10.02	2.00
23 35 501	88.01**	92.35	4.34	1.44
23 35 701	114.86	133.14	18.28	3.61
23 35 703	116.67	129.57	12.90	2.58
23 35 802	104.86	112.35	7.49	1.49
23 36 501	194.70	194.01	+0.69	+0.13
24 16 501	108.19	118.61	10.42	2.08
24 16 601	122.16	125.25	3.09	0.61
24 16 901	162.33	163.25	0.92	0.18
24 16 902	144.46	152.41	7.95	1.59
24 24 201	61.36	71.98	10.62	2.12
24 24 302	128.50	145.78	17.28	3.45
24 24 501	116.32	136.19	19.87	3.97
24 24 601	71.04	80.71	9.67	1.93
24 24 901	130.28	141.82	11.54	2.30
24 32 301	128.52	139.16	20.64	4.12
24 32 501	114.20	124.90	10.70	2.14
24 32 601	120.61	128.50	7.89	1.57
24 32 602	121.21	139.47	18.26	3.65
24 40 201	114.01	130.90	16.89	3.37
24 40 601	116.62	119.31	2.69	0.53
24 40 901	66.03	69.39	3.36	0.67

* January 1963 Water Level.
** January 1964 Water Level.

FLOYD COUNTY

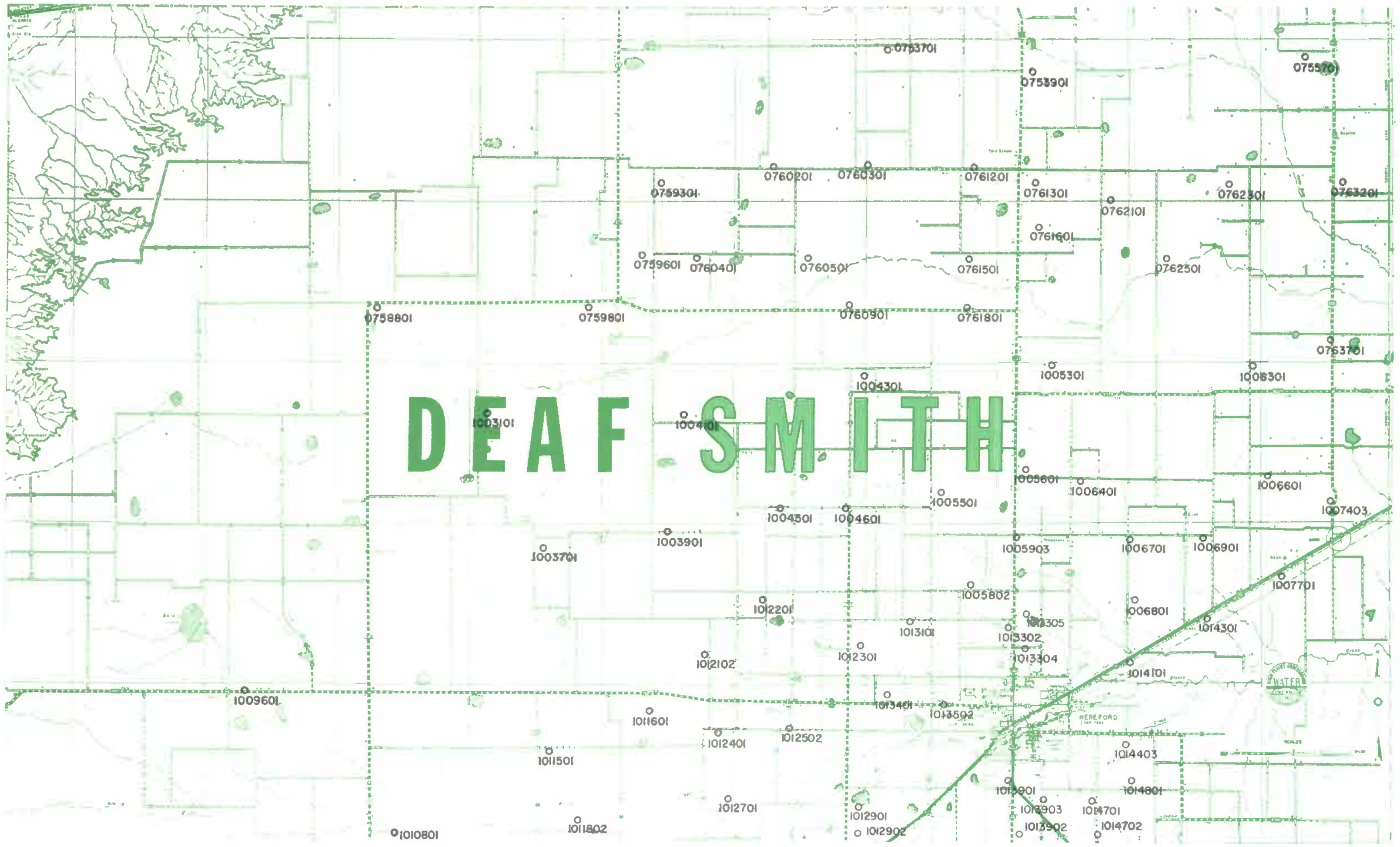
Well No.	Depth To Water 1962	Depth To Water 1967	Total Decline	Avg Decline Per Year
11 44 901	102.28	122.90	20.62	4.12
11 44 902	99.83*	123.85	24.02	6.00
11 45 802	129.68	143.20	13.52	2.70
11 46 701	158.40	181.15	22.75	4.55
11 52 301	109.13	136.81	27.68	5.53
11 52 302	115.80	142.71	26.91	5.38
11 52 303	135.33	169.37	34.04	6.80
11 52 304	127.07	151.50	24.43	4.88
11 52 602	142.30	163.70	21.40	4.28
11 52 603	138.93	158.67	19.74	3.94
11 52 801	127.65	161.79	34.14	6.82
11 52 901	143.38	164.47	21.09	4.21
11 52 902	142.30	157.90	15.60	3.12
11 52 903	148.40	157.65	9.25	1.85
11 52 905	146.40	161.28	14.88	2.97
11 52 906	145.20	164.69	19.49	3.89
11 53 101	127.75	157.20	29.45	5.89
11 53 201	126.38	142.60	16.22	3.24
11 53 202	126.98	144.08	17.10	3.42
11 53 203	130.69	141.97	11.28	2.25
11 53 402	143.79	163.10	19.31	3.86
11 53 501	159.74	182.96	23.22	4.64
11 53 701	146.10	162.07	15.97	3.19
11 53 702	134.38	155.20	20.82	4.16
11 53 703	144.38	166.59	22.21	4.44
11 54 301	209.24	231.71	22.47	4.49
11 54 401	165.32	174.19	8.87	1.77
11 55 701	214.70	232.90	18.20	3.64
11 55 901	264.96	283.95	18.99	3.79
11 60 302	138.73	158.10	19.37	3.87
11 60 303	136.41	155.42	19.01	3.80
11 60 501	122.13	146.29	24.16	4.83
11 60 602	134.70	155.08	19.38	3.87
11 60 901	121.36	147.73	26.37	5.27
11 61 101	147.91	171.90	23.99	4.79
11 61 104	139.57	163.14	23.57	4.71
11 61 105	143.73	171.60	27.87	5.57
11 61 203	159.73	182.54	22.81	4.56
11 61 204	150.42	177.42	27.00	5.40
11 61 301	37.29	41.51	4.22	0.84
11 61 401	145.89	178.88	32.99	6.59
11 61 403	138.14	173.75	35.61	7.12
11 61 404	143.79	177.52	33.73	6.74
11 61 601	44.64	50.93	6.29	1.25
11 61 801	153.40	191.92	38.52	7.70
11 61 802	140.83	187.82	46.99	9.39
11 61 901	146.36	181.73	35.37	7.07
11 62 201	102.86	142.01	39.15	7.83
11 62 401	58.44	59.70	1.26	0.25
11 62 601	147.06*	152.29	5.23	1.30
11 62 701	117.98	120.99	3.01	0.60
11 62 702	93.08	98.75	5.67	1.13
11 62 801	89.36	100.09	10.73	2.14
11 63 101	154.90	158.28	3.38	0.67
11 63 801	198.42	203.30	4.88	0.97
11 64 101	210.18	230.60	20.42	5.08
11 64 502	263.78**	264.28	0.50	0.16
23 04 601	138.78	167.14	28.36	5.67
23 04 602	148.89	177.40	28.51	5.70
23 04 603	141.68	180.62	38.94	7.78
23 04 801	126.24	159.10	32.86	6.57
23 05 301	153.44	182.18	28.74	5.74
23 05 501	171.78	198.50	26.72	5.34
23 05 801	183.10	210.20	27.10	5.42
23 06 101	148.24	162.13	13.89	2.77
23 06 301	155.41	161.07	5.66	1.13
23 06 404	161.47	200.59	39.12	7.82
23 06 701	179.82	204.70	24.88	4.97
23 06 802	183.42	216.77	33.35	6.67
23 07 101	203.97*	211.35	7.38	1.84
23 07 301	222.58**	222.58	0.00	0.00
23 07 401	233.45*	265.22	31.77	6.35
23 07 501	231.16	284.10	52.94	10.58
23 07 601	234.48	285.90	51.42	10.28
23 07 701	195.64***	200.00	4.36	1.45
23 08 201	261.73	266.15	4.42	0.88
23 08 401	265.53*	280.55	15.02	3.75
23 08 501	252.58	261.06	8.48	1.69
23 08 701	261.18*	274.40	13.22	3.30
23 12 301	138.97	183.35	44.38	8.87
23 13 101	154.76	180.62	25.86	5.17
23 14 101	194.25*	236.20	41.95	10.48
23 14 301	195.12	209.40	14.28	2.85
23 15 201	240.33	255.90	15.57	3.11
23 15 301	258.21	282.21	24.00	4.80
23 15 302	254.32	279.26	24.94	4.98
23 16 101	261.04	291.74	30.70	6.14

* January 1963 Water Level.
** January 1964 Water Level.
*** January 1965 Water Level.



POTTER COUNTY

Well No.	Depth To Water 1962	Depth To Water 1967	Total Decline	Avg Decline Per Year
07 56 401	206.71	216.34	9.63	1.92
07 56 501	201.20	214.89	13.69	2.73
07 56 601	184.53	205.32	20.79	4.15



Well No.	Depth To Water 1962	Depth To Water 1967	Total Decline	Avg Decline Per Year
10 05 501	135.27	170.18	34.91	6.98
10 05 601	117.04*	132.89	15.85	3.96
10 05 802	118.43	143.28	24.85	4.97
10 05 903	132.52**	145.12	12.60	4.20
10 06 301	129.80	154.02	24.22	4.84
10 06 401	126.96	147.81	20.85	4.17
10 06 601	120.35	136.27	15.92	3.18
10 06 701	52.25	67.42	15.17	3.03
10 06 801	66.14	88.79	22.65	4.53
10 06 901	104.05	118.26	14.21	2.84
10 07 403	96.70	116.44	19.74	3.94
10 07 701	98.46	120.00	21.54	4.30
10 09 601	64.98	65.96	0.98	0.19
10 10 801	185.90	194.49	8.59	1.71
10 11 501	171.99	187.99	16.00	3.20
10 11 601	151.10	174.61	23.51	4.70
10 11 802	166.60*	186.19	19.59	4.89
10 12 102	136.70	167.41	30.71	6.14
10 12 201	67.66	71.39	3.73	0.74
10 12 301	129.21	136.28	7.07	1.41
10 12 401	151.98*	170.15	18.17	4.54
10 12 502	112.37	132.26	19.89	3.97
10 12 701	120.23	137.17	16.94	3.38
10 12 901	112.21	131.36	19.15	3.83
10 12 902	148.25	165.45	17.20	5.44
10 13 101	132.68*	157.65	24.97	4.99
10 13 302	102.10	114.91	12.81	2.56
10 13 304	115.03	132.97	17.94	3.58
10 13 305	102.47*	118.65	16.18	4.04
10 13 401	117.12	135.60	18.48	3.69
10 13 502	134.72	149.68	14.96	2.99
10 13 901	122.07	134.10	12.03	2.40
10 13 902	125.06	143.32	18.26	3.65
10 13 903	126.62	146.49	19.87	3.97
10 14 101	74.54*	83.86	9.32	2.33
10 14 301	69.25	69.18	+0.07	+0.01
10 14 403	93.69	110.59	16.90	3.38
10 14 701	139.55	160.76	21.21	4.24
10 14 702	139.05	158.91	19.86	3.97
10 14 801	122.26	136.37	14.11	2.82

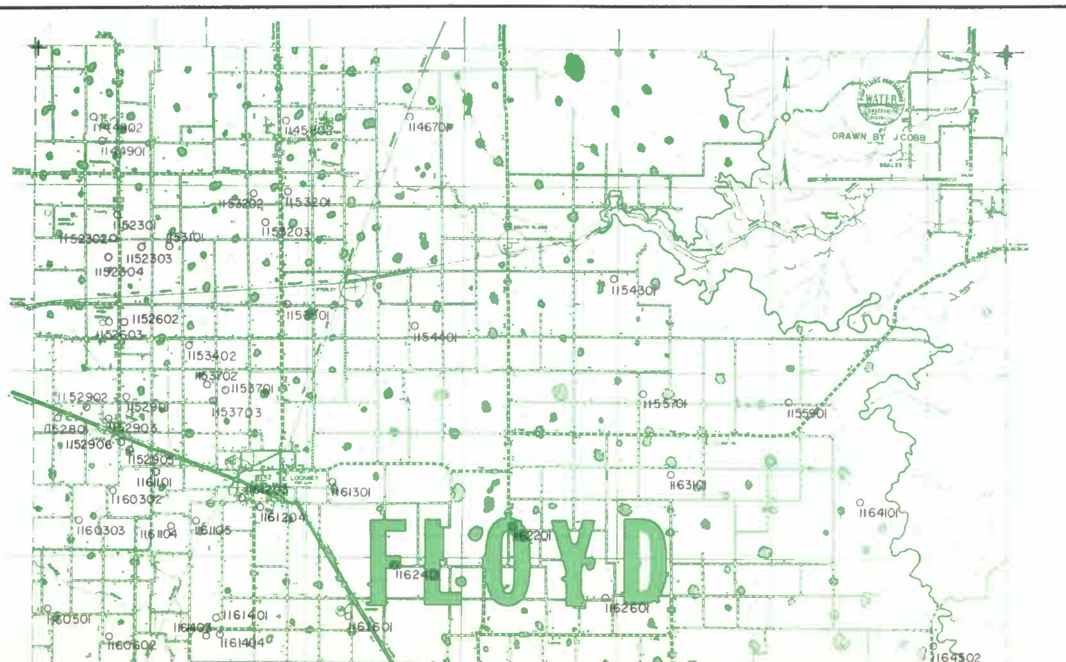
* January 1963 Water Level.
** January 1964 Water Level.

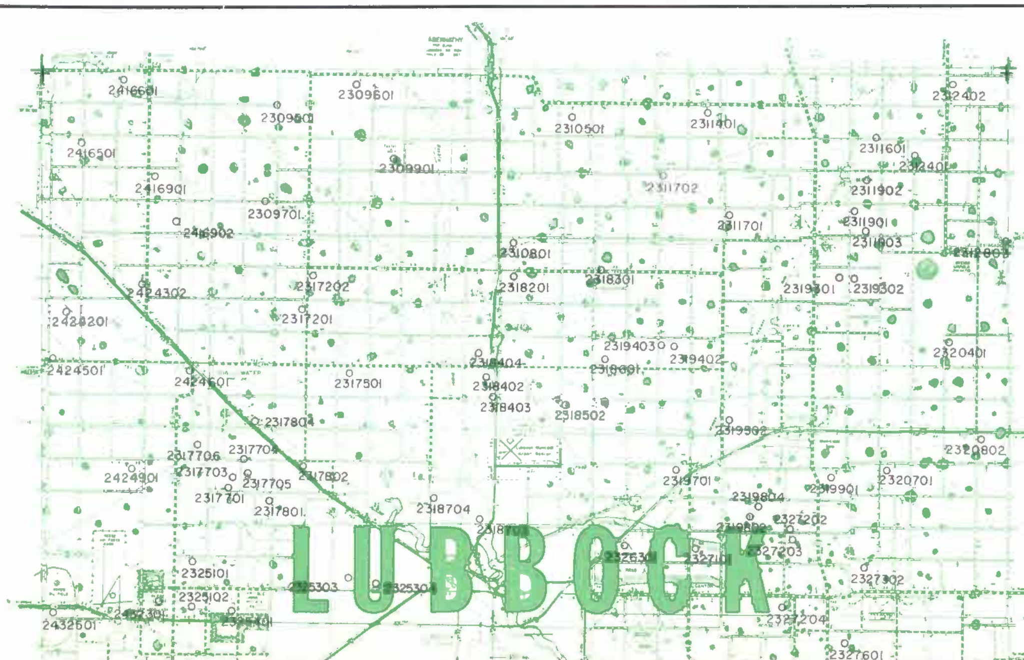
DEAF SMITH COUNTY

Well No.	Depth To Water 1962	Depth To Water 1967	Total Decline	Avg Decline Per Year
07 53 701	204.53	223.46	18.93	3.58
07 53 901	188.15	218.92	30.77	6.15
07 55 701	179.07	202.45	23.38	4.67
07 58 801	246.70	247.01	0.31	0.06
07 59 301	291.97*	302.60	10.63	2.12
07 59 601	297.24**	302.31	5.07	1.69
07 59 801	249.31	267.00	17.69	3.53
07 60 201	260.73*	272.99	12.26	3.06
07 60 301	226.40	245.68	19.28	3.85
07 60 401	280.97*	275.09	+5.88	+1.47

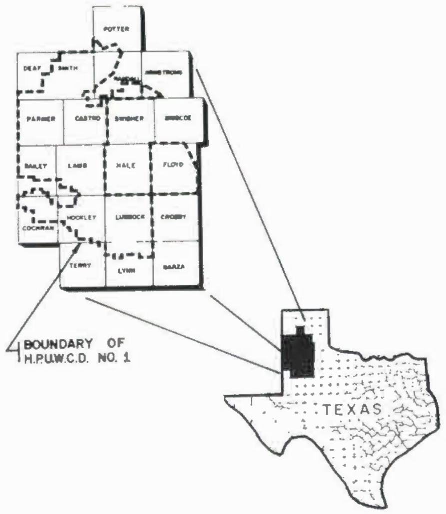
Well No.	Depth To Water 1962	Depth To Water 1967	Total Decline	Avg Decline Per Year
07 60 501	210.72	232.55	21.83	4.36
07 60 901	196.36**	202.17	5.81	1.93
07 61 201	205.48**	214.46	8.98	2.99
07 61 301	188.31*	204.51	16.20	4.05
07 61 501	163.91*	173.48	9.57	2.39
07 61 601	160.32*	173.84	13.52	3.38
07 61 801	163.98*	173.81	9.83	2.45
07 62 101	161.03	187.49	26.46	5.29
07 62 301	161.87	177.76	15.89	3.17
07 62 501	134.40	150.63	16.23	3.24

Well No.	Depth To Water 1962	Depth To Water 1967	Total Decline	Avg Decline Per Year
07 63 201	149.15	171.40	22.25	4.45
07 63 701	126.22	147.28	21.06	4.21
10 03 101	286.40	295.87	9.47	1.89
10 03 701	224.52	222.22	+2.30	+0.46
10 03 901	212.00	231.87	19.87	3.97
10 04 101	275.05	292.38	17.33	3.46
10 04 301	226.23	250.36	24.13	4.82
10 04 501	219.44	247.48	28.04	5.60
10 04 601	195.68*	217.38	21.70	5.42
10 05 301	134.90	146.81	11.91	2.38





Water Level Measurements In Observation Wells In High Plains Water District



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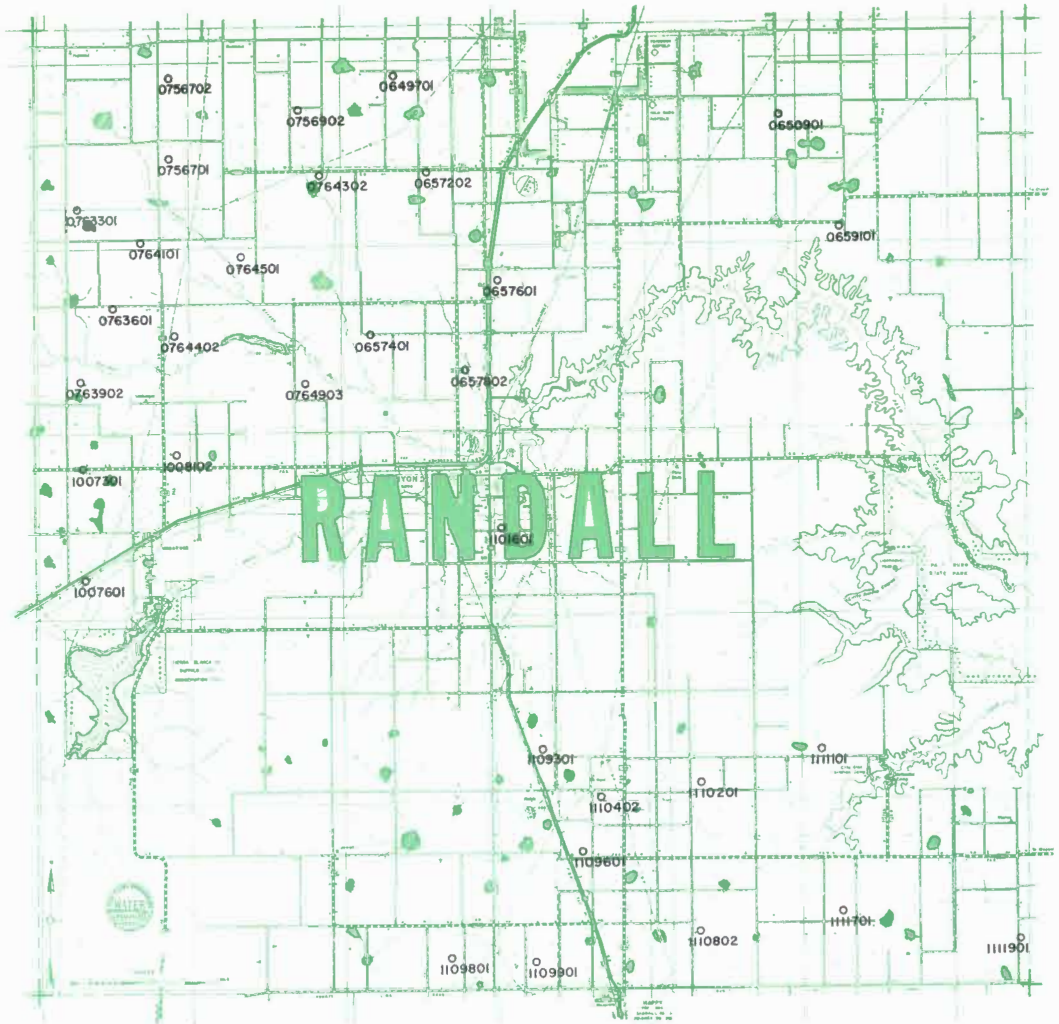
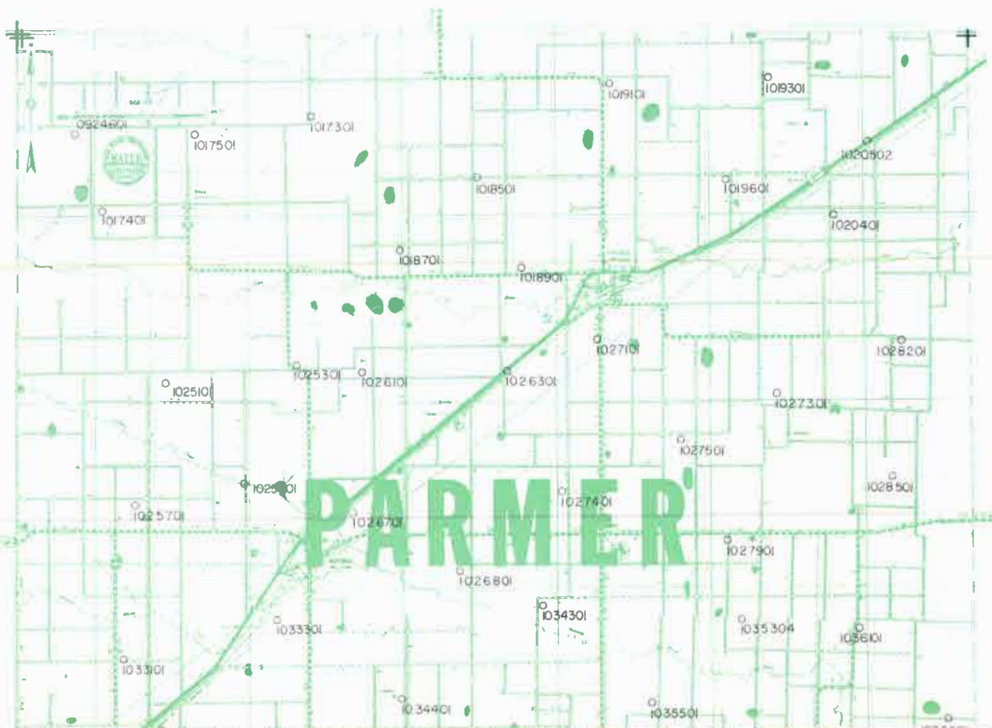
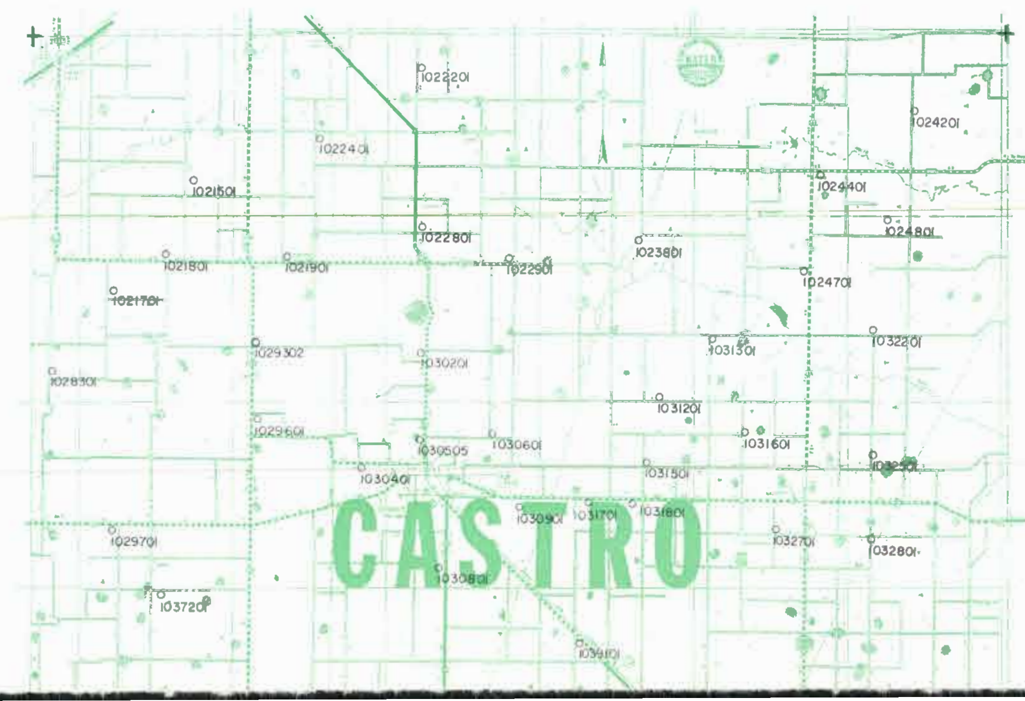


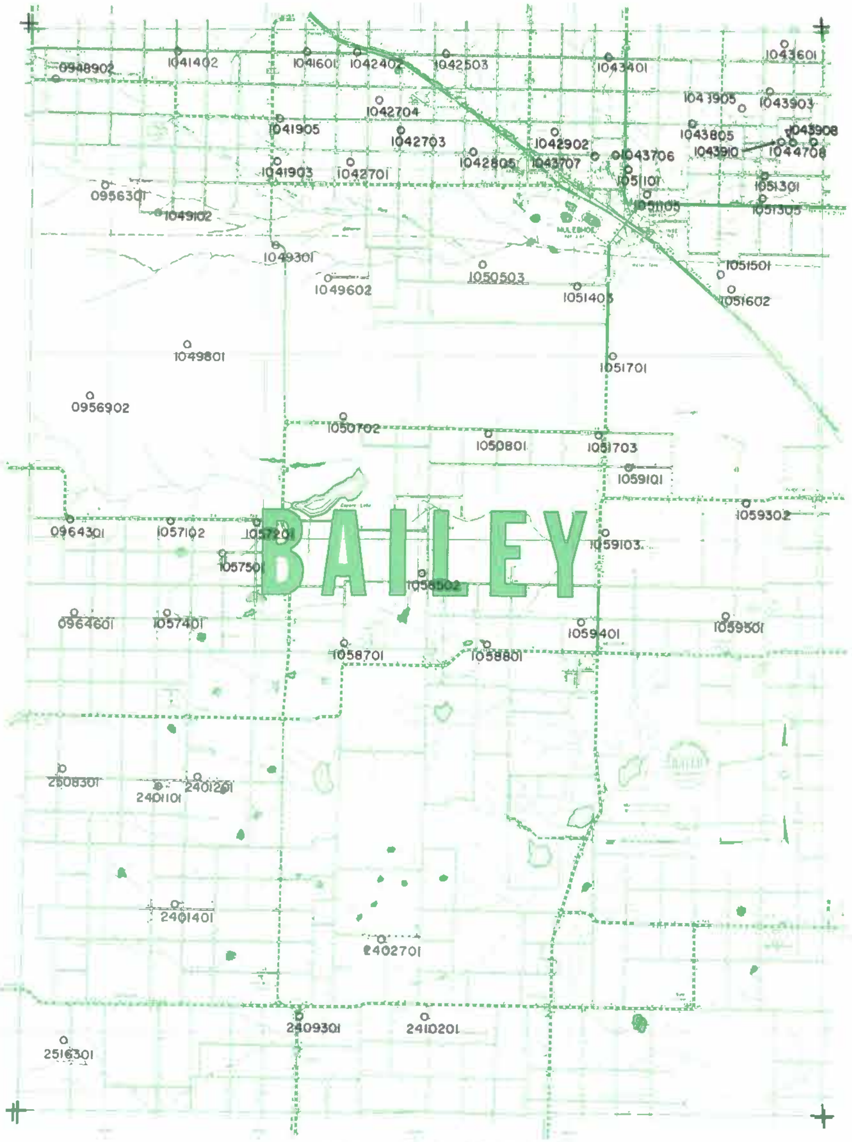
RANDALL COUNTY

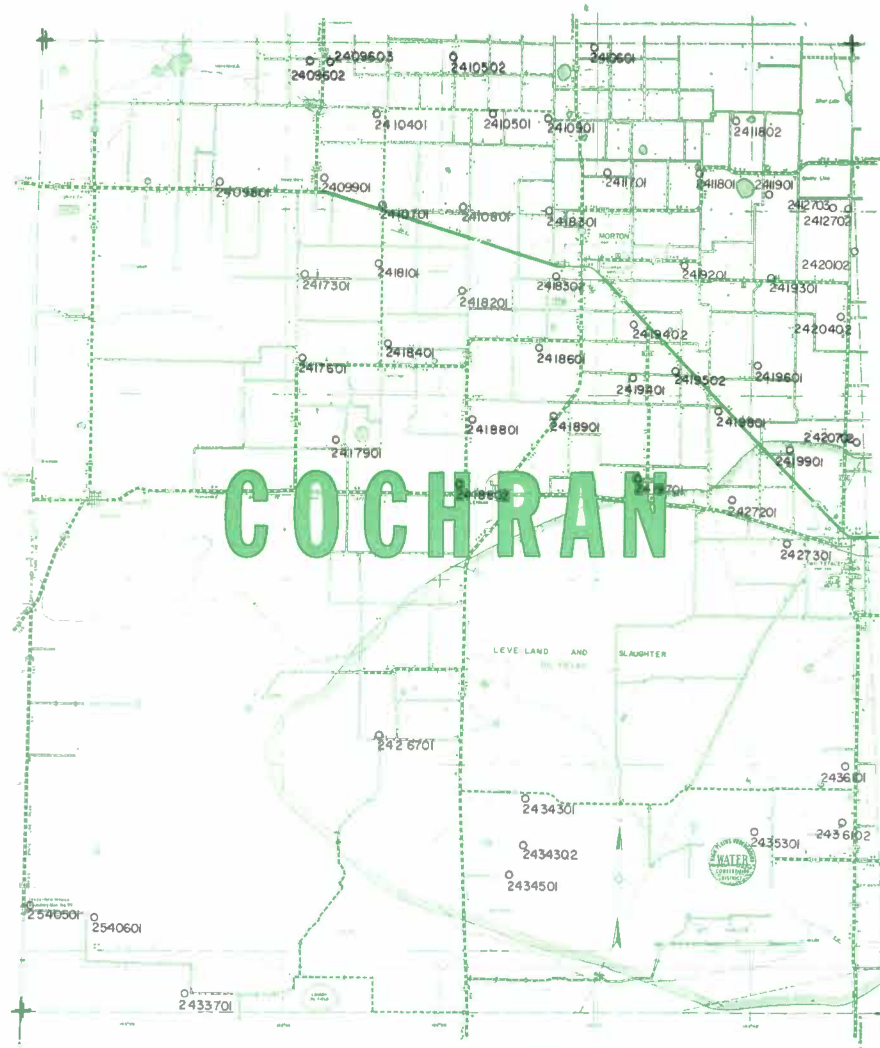
Well No.	Depth To Water 1962	Depth To Water 1967	Total Decline	Avg Decline Per Year
06 49 701	200.32*	222.61	22.99	5.74
06 50 901	199.39	204.12	4.73	0.94
06 57 202	176.52*	185.71	9.19	2.29
06 57 401	152.36	166.45	14.09	2.81
06 57 601	149.04	161.96	12.92	2.58
06 57 802	126.74*	148.58	21.84	5.46
06 59 101	197.58	197.48	+.10	+.02
07 56 701	165.89	190.45	24.56	4.91
07 56 702	187.97	198.12	10.15	2.03
07 56 902	169.94	177.72	7.78	1.55
07 63 301	178.75*	183.10	4.35	1.08
07 63 601	123.30	137.70	14.40	2.88
07 63 902	114.56*	118.90	4.34	1.08
07 64 101	171.86*	196.08	24.22	6.05
07 64 302	139.64	148.66	9.02	1.80
07 64 402	100.08*	103.11	3.03	0.75
07 64 501	132.87**	134.05	1.18	0.39
07 64 903	132.64	141.02	8.38	1.67
10 07 301	115.07*	124.54	9.47	2.36
10 07 601	90.37*	93.89	3.52	0.88
10 08 102	131.10	135.96	4.86	0.97
11 01 601	3.94	5.75	1.81	0.36
11 09 301	156.63*	159.08	2.45	0.61
11 09 601	187.11	194.71	7.60	1.52
11 09 801	173.41	186.81	13.40	2.68
11 09 901	166.44	181.45	15.01	3.00
11 10 201	151.32*	152.69	1.37	0.34
11 10 402	169.48	170.48	1.00	0.20
11 10 802	160.73*	170.57	9.84	2.46
11 11 101	130.03*	130.18	0.15	0.03
11 11 701	150.51*	162.20	11.69	2.92
11 11 901	101.99*	118.82	16.83	4.20

* January 1963 Water Level.
** January 1964 Water Level.









BAILEY COUNTY

Well No.	Depth To Water 1962	Depth To Water 1967	Total Decline	Avg Decline Per Year
09 48 902	117.15**	127.14	9.99	3.33
09 56 301	61.45	66.80	5.35	1.07
09 56 902	38.20	39.48	1.28	0.25
09 64 301	51.41**	56.96	5.55	1.85
09 64 601	126.07*	129.34	3.27	0.81
10 41 402	120.40	137.02	16.62	3.32
10 41 601	108.90	124.20	15.30	3.06
10 41 903	60.30	72.46	12.16	2.43
10 41 905	82.29	97.98	15.69	3.13
10 42 402	100.36	112.70	12.34	2.46
10 42 503	93.63	106.37	12.74	2.54
10 42 701	65.47	82.20	16.73	3.34
10 42 703	78.10**	90.82	12.72	2.54
10 42 704	92.64**	101.22	8.58	2.86
10 42 805	56.75	68.72	11.97	2.39
10 42 902	63.85	73.86	10.01	2.00
10 43 401	88.00	100.60	12.60	2.52
10 43 601	100.98**	111.24	10.26	3.42
10 43 706	67.80	76.88	9.08	1.81
10 43 707	68.97	83.21	14.24	2.84
10 43 805	63.66	78.02	14.36	2.87
10 43 903	78.69*	91.20	12.51	3.12
10 43 905	65.47	79.35	13.88	2.77
10 43 908	63.56	77.20	13.64	2.72
10 43 910	60.31	77.94	17.63	3.52
10 44 708	63.79	80.24	16.45	3.29
10 49 102	40.30	47.70	7.40	1.48
10 49 301	25.88	24.65	+1.23	+0.24
10 49 602	41.26	48.64	7.38	1.47
10 49 801	73.96	75.42	1.46	0.29
10 50 503	35.83	48.94	13.11	2.62
10 50 702	82.94**	86.00	3.06	1.02
10 50 801	69.34	73.90	4.56	0.91
10 51 101	59.59	64.80	5.21	1.04
10 51 105	44.58*	56.14	11.56	2.89
10 51 301	48.46	51.52	3.06	0.61
10 51 305	45.38	49.00	3.62	0.72
10 51 403	29.66	31.56	1.90	0.38
10 51 501	25.11	33.20	8.09	1.61
10 51 602	25.35	34.06	8.71	1.74
10 51 701	60.30	62.01	1.71	0.34
10 51 703	82.00	84.70	2.70	0.54
10 57 102	77.87**	78.32	0.45	0.15
10 57 201	26.29**	26.03	+0.26	+0.08
10 57 401	110.45	118.20	7.75	1.55
10 57 501	37.09	34.13	+2.96	+0.59
10 58 502	74.89*	73.49	+1.40	+0.35
10 58 701	46.49**	47.38	0.89	0.29
10 58 801	19.21**	23.48	4.27	1.42
10 59 101	116.18*	112.32	+3.86	+0.96
10 59 103	92.85	103.42	10.57	2.11
10 59 302	106.31**	110.06	3.75	1.25
10 59 401	103.59	115.37	11.78	2.35
10 59 501	102.39**	105.77	3.38	1.12
24 01 101	224.05	226.45	2.40	0.48
24 01 201	209.60	209.77	0.17	0.03
24 01 401	169.19	176.80	7.61	1.52
24 02 701	59.34**	59.42	0.08	0.02
24 09 301	89.23**	89.45	+0.22	+0.07
24 10 201	103.19**	126.89	23.70	7.90
25 08 301	80.54	80.55	0.01	0.00
25 16 301	116.55	123.55	7.00	1.40

* January 1963 Water Level.
** January 1964 Water Level.

COCHRAN COUNTY

Well No.	Depth To Water 1962	Depth To Water 1967	Total Decline	Avg Decline Per Year
24 09 602	103.68	118.56	14.88	2.97
24 09 603	99.31	114.39	15.08	3.01
24 09 801	120.76	124.53	3.77	0.75
24 09 901	93.53	103.31	9.78	1.95
24 10 401	106.30	110.70	4.40	0.88
24 10 501	92.96	94.85	1.89	0.37
24 10 502	86.49	87.92	1.43	0.28
24 10 601	88.90	93.89	4.99	0.99
24 10 701	148.16	160.85	12.69	2.53
24 10 801	123.98	135.10	11.12	2.22
24 10 901	91.72	94.14	2.42	0.48
24 11 701	122.22	127.82	5.60	1.12
24 11 801	103.43	108.99	5.56	1.11
24 11 802	98.24	109.99	11.75	2.35
24 11 901	115.09	124.56	9.47	1.89
24 12 702	120.11	143.15	23.04	4.60
24 12 703	117.23	138.48	21.25	4.25
24 17 301	127.16	139.15	11.99	2.39
24 17 601	136.43	148.01	11.58	2.31
24 17 901	159.78	166.93	7.15	1.43
24 18 101	143.30	149.59	6.29	1.25
24 18 201	157.34	172.10	14.76	2.95
24 18 301	125.82	131.95	6.13	1.22
24 18 302	142.73	160.77	18.04	3.60
24 18 401	138.06	147.53	9.47	1.89
24 18 601	156.47	167.97	11.50	2.30
24 18 801	173.95	194.54	20.59	4.11
24 18 802	161.67	170.01	8.34	1.66
24 18 901	115.37	114.96	+0.41	+0.08
24 19 201	134.12	145.82	11.70	2.34
24 19 301	150.37	164.86	14.49	2.89
24 19 401	140.57	154.28	13.71	2.74
24 19 402	133.03	145.75	12.72	2.54
24 19 502	152.18	169.78	17.60	3.52
24 19 601	144.57	154.30	9.73	1.94
24 19 701	144.07	162.97	18.90	3.78
24 19 801	144.35	160.00	15.65	3.13
24 19 901	124.93	125.89	0.96	0.19
24 20 102	120.04	141.98	21.94	4.38
24 20 402	134.61	147.40	12.79	2.55
24 20 702	143.28	154.00	10.72	2.14
24 26 701	181.04	181.90	0.86	0.17
24 27 201	168.70	177.35	8.65	1.73
24 27 301	176.66	180.47	3.81	0.76
24 33 701	130.82	134.07	3.25	0.65
24 34 301	179.57	182.72	3.15	0.63
24 34 302	157.76	164.42	6.66	1.33
24 34 501	163.70	169.59	5.89	1.17
24 35 301	170.15	172.69	2.54	0.50
24 36 101	173.03	181.63	8.60	1.72
24 36 102	167.38	177.08	9.70	1.94
25 40 501	136.84	144.34	7.50	1.50
25 40 601	143.25	151.03	7.78	1.55

Observation Wells—

(Continued from Page 1)

ing), observation wells were measured in February and March of each year. This early program provided a four to 6-month recovery period.

The water-levels within the District are now measured during the first two or three weeks in January. It is believed that this mid-winter measuring cycle provides:

1) A reasonable-recovery (rest) period after the summer, irrigation season (ending in September) and the early fall wheat irrigation (usually in October or November).

2) Ample time for the measurement of several hundred wells, within personnel capabilities, before the start of preplant watering (in February).

3) A routine for measuring the water levels in the same well near the same date each year — resulting in comparable water-level data, all other factors (pumping and rest cycles) assumed similar.

4) The longest, hydrologically-practical period for processing the water-level measurements before the income-tax, due-date deadlines.

Since January 1963, the number of observation wells has decreased—only 711 wells, of the 1963 total of 811 wells, were measured in January 1967.

The incidence of loss (dropped from the current program for various reasons) of observation wells is somewhat alarming. Since the early forties, about 491 wells have been dropped from the program in the 13-county District area—the water level records therefore becoming "historical" data, not currently usable. This represents nearly 38 percent of all of the wells that have ever been a part of the program in this same 13-county area. Such interruptions in water-level records are particularly burdensome to the District's cost-in water, income-tax-allowance mapping and data processing programs.

It is not physically or economically possible to annually measure the static, water level in every irrigation well within the District (or for that matter, even the measurements requested by the well owners, or their representatives). Therefore, it is imperative that the selective, observation-well program be upgraded, maintained, and revised as necessary—in order to be adequately representative of the reservoir system.

OBSERVATION WELLS

All observation wells are privately owned—none of the wells in this program are owned by the District or the State.

Most of the observation wells are farmer-owned, equipped and operational, irrigation wells. The majority of these wells are equipped with large-capacity, turbine pumps. However, in recent years a large number of the observation (and other) wells in the District have been reequipped with (smaller capacity) submersible pumps—the direct physical and economic indications of adjustment to a declining water supply, first evidenced by the water-level records.

Permission to measure the water level in wells is secured from the land owner and/or operator, before the well is added to the program.

In the early years, prior to the mid 1950's, the well owners—although not openly reluctant to permit the use of their wells—often questioned the necessity for such a program. More recently, the general public has become somewhat cognizant of the water-supply situation in this area, and the well owners are increasingly solicitous of having their wells added to the observation-well program.

Since the majority of the observation wells are operational wells, these installations are periodically subject to alteration. Equipment is replaced, because of obsolescence or inefficiency; partially-penetrating wells are redrilled (and cased), as the water levels decline; water distribution and supporting structures are often repaired or replaced; the well is abondoned (and often destroyed) because of sanding, collapsed casing, contamination, pollution, or a decrease in capacity—all of these conditions complicate the location (finding), access to, or entry into such wells, These conditions often result in the well being removed from the program, with the resultant loss of current, water-level data—the loss of a much-needed, reservoir data-point.

METHOD OF MEASURING

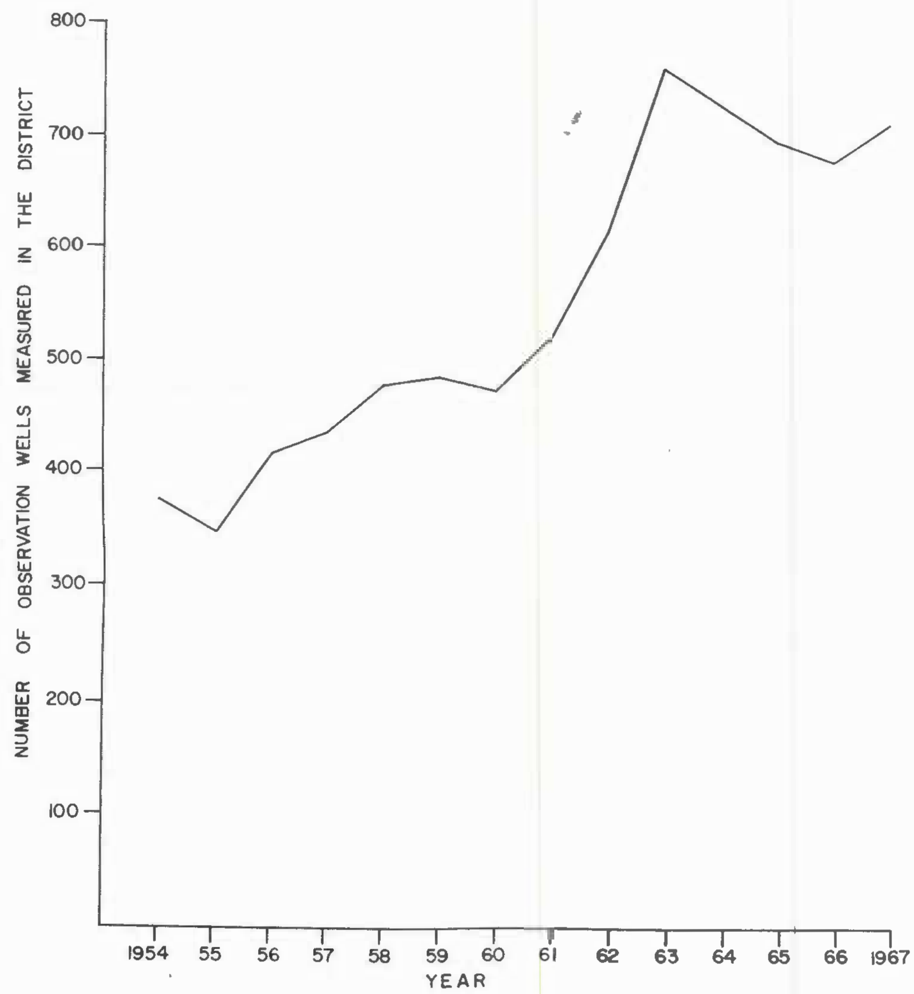
Most of the depth-to-water measurements are made with steel tapes. These tapes—in widths of 1/4-inch and 3/8-inch, and only thousandths of an inch thick—are spooled in 300 and 500 foot lengths. Each tape is graduated in feet throughout its entire length, with each foot of the first (free-end) 30-feet graduated in tenths and hundredths of a foot.

After consulting the water-level records, the individual measuring the well applies "carpenter's" chalk (which turns dark blue in color upon contact with water) to the graduated tape, and enters enough tape into the well annulus — between the pump column and the well casing—to insure immersion of a part of the chalked tape. The depth-to-water is determined by subtracting the amount (in feet, tenths and hundreths of a foot) of the wetted tape from the value of the footmark held at the M. P. (the measuring point at the well-head). An attempt is made to use the same M. P. for each annual measurement, in order to provide comparable depth-to-water records. The depth to water below the M. P. is then adjusted to a common land-surface-datum, by subtracting the height of the M. P. above land surface—usually one to two feet—from the depth-to-water measurement made therefrom.

THE VALUE OF RECORDS

Those responsible for the inception, and the continuation—through trying years — of the observation-well program in the Southern High Plains can now point with pride to the wisdom of their efforts and convictions. It is unlikely that all of these "pioneers" fully realized, in 1936, just how wise time would prove them to be. It would indeed take a wise man to predict, in 1936, that in less than 30 years the Southern High Plains would develop a multi-billion dollar agricultural complex containing over 50,000 irrigation wells pumping over 6 million acre-feet annually. A complex dependent on the ground-water-reservoir system, first monitered by the observation-well program they helped to establish and maintain. Even less perceptible, in 1936, would be the prediction that the water-level decline (depletion) records, provided by the observation-well program, would in themselves be responsible for establishing a precedent — the cost-in-water, income-tax allowance—that would return several million dollars to the Plains economy.

The observation well records provide the basis for nearly every ground - water investigation in this area. The necessity for, and the value of, these records can be expected to increase several-fold in the near future. The importation of a surface-water supply hinges, in part, on these records.



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THE Cross SECTION

A Monthly Publication of the High Plains Underground Water Conservation District No. 1

Volume 13—No. 11 "THERE IS NO SUBSTITUTE FOR WATER" *April 1967*

Potential For Storage Of Water In Southern High Plains Of Texas

By F. A. RAYNER

Continued from the February 1967 issue of The Cross Section.

It is now popularly accepted that it is engineeringly feasible to transport large quantities of water to the Southern High Plains of Texas. (Castro, Deaf Smith, Randall, Parmer, Swisher, Briscoe, Bailey, Lamb, Hale, Floyd, Cochran, Hockley, Lubbock, Crosby, Yoakum, Terry, Lynn, Gaines, Dawson, Andrews, and Martin Counties). If it is engineeringly possible to annually impound millions of acre feet of water in surface reservoirs located hundreds of miles from the Plains; transport this mass of water through elaborate conveyance (canals and pipelines) facilities; lifting it some 3000 feet; then the only other apparent obstacles—political and economic—will be solved by the only reason for undertaking such a mammoth task—a need for the water.

Declining water levels — with the resultant declines in well yields—in the areas only large ground-water reservoir system, the Ogallala formation, attest to this approaching need.

The Texas Water Development Board (Gillett) reports that by the year 2020 it will be necessary to import about 12 million acre-feet of water annually, in order to develop the Southern High Plains' full agricultural potential.

Agricultural water use, and water needs, are almost always expressed in terms of acre feet per year. However, it should be noted that in the Southern High Plains over 80 percent of this use occurs during the six months of March, April, May, July, August, and September, with over 21 percent of the annual demand occuring in the month of August.

If the total annual irrigation-water demand was supplied at a constant rate, 8.33 percent per month, this amount of water would more than supply all of the irrigation demand for the months of January, February, June, October, November, and December. Supplied at the 8.33 percent per month rate, 82 percent of the water supplied in January (the minimum, irrigation-water-demand month) would be surplus to present irrigation needs. Storage will have to be provided for this water, and the surplus that will exist in February, October, November and December, and all or a part of other months of the year — depending on weather conditions, and cropping patterns. This seasonal demand presents several engineering and economic problems.

Engineering and economic limitations dictate that large scale conveyance facilities be operated continuously at near peak design capacity. However, since almost all of this areas water needs occur in two separate 3-month periods, "terminal storage" will have to be provided as "near as possible" to the water demand areas—the individual farms, which collectively comprise nearly all of the 20,679 square-mile Southern High Plains.

There are only a limited number of intra-planal, terminal-storage sites; such as Bull and Illusion Lakes, in Lamb and Hockley Counties, and other basin areas in Andrews, Bailey, Deaf Smith, Gaines and Terry Counties. Most of the "efficient" (capable of storing large volumes of water within a reasonably small surface area) terminal-storage sites are associated with the reentrant canyons near the eastern Plains escarpment, in Randall, Swisher, Floyd, Crosby, Lubbock and Dawson Counties. These "off Plains" terminal-storage sites are somewhat removed and at a considerably lower elevation than the water demand areas.

Thousands of playas are strategically located (on the farms within the Plains), however, an elaborate distributary system (the facilities conveying water away from the primary conveyance or terminal storage areas) would be needed to connect the playas. Playas provide *very* inefficient storage.

The most efficient and economic distributary system would be one operating continuously at peak capacity. In order to take advantage of such a system, on-farm water storage would have to be developed to meet peak irrigation requirements. Ample "beneath-farm" storage is available—in the Ogallala formation.

THE STORAGE AREA

The Ogallala formation covers nearly all of the area within the 21 county, Southern High Plains area. These Tertiary age rocks generally consist of a heterogenous series of sand, gravel, silt, clay and caliche horizons—progressively thinning in a southern direction, from a maximum thickness of over 500 feet in Parmer County, to less than 50 feet in Martin County.

Depths to water in the Ogallala formation also decrease to the south—from over 300 feet in Parmer County, to less than 50 feet in the southern part of the Southern High Plains.

The better quality water in the Ogallala formation is located in the deeper-depths to water areas—in the northern part of the Southern High Plains. This same area is also covered by the hardlands (clay) soil—a factor, coupled with the deeper depths to water, that probably accounts for the occurrence of the better quality water.

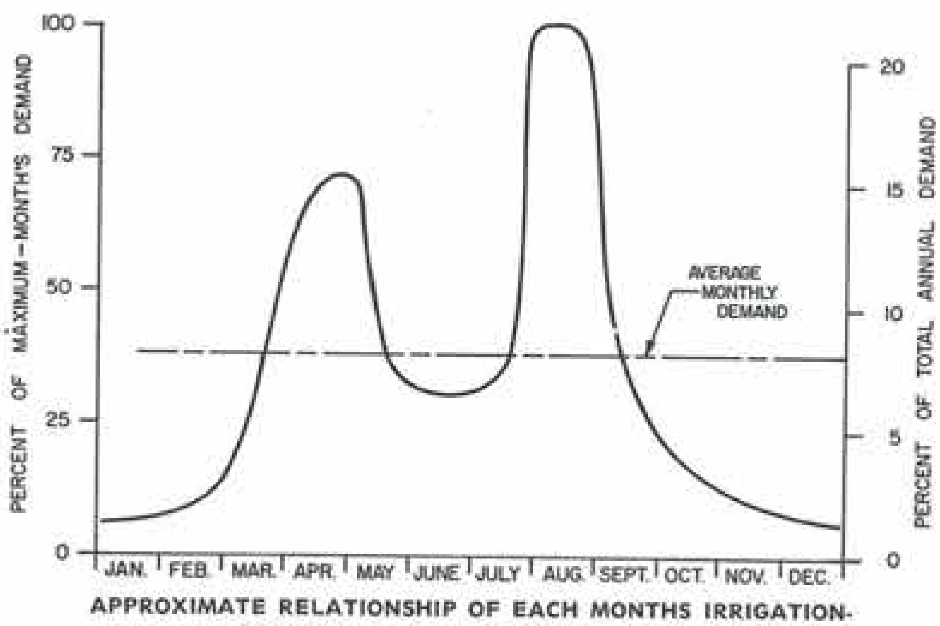
The ancient, eroded land surface consisting primarily of the red and blue shale of Triassic age, and yellow and blue shale of Cretaceous age, forms most of the base of the Ogallala formation—and constitutes the basal aquiclude of the saturated interval in this Formation.

The interval of interest to this writing is that zone in the Ogallala formation extending upward from the top of the aquifer (the water table) to within 50 feet of the land surface. This zone, consisting of almost 200 cubic miles of sand, gravel, silt, clay and caliche, could store more than 134 million acre-feet of water.

Each of the twenty-one Southern High Plains counties' approximate, dry-volume storage potential is listed in Table 1.

Water stored in the subsurface would be subject to contamination

(Continued on Page 4)



APPROXIMATE RELATIONSHIP OF EACH MONTHS IRRIGATION-WATER DEMAND, 1955 THROUGH 1966

TABLE 1—Potential, buffered, dry-volume storage in the Ogallala formation, 1958.

COUNTY	Col. 1	Col. 2	Col. 3
Parmer	16,054,225	1	12
Castro	10,431,450	2	8
Floyd	10,278,750	2	8
Cochran	9,733,600	2	7
Deaf Smith	9,324,350	2	7
Hale	8,209,200	2	6
Hockley	7,719,600	2	6
Lubbock	6,469,750	3	5
Randall	6,350,600	3	5
Bailey	5,810,550	3	4
Swisher	5,803,850	3	4
Yoakum	5,444,000	3	4
Andrews	5,359,900	5	4
Gaines	5,090,800	5	4
Martin	4,304,625	4	3
Terry	4,292,050	4	3
Lamb	3,912,050	5	3
Crosby	3,568,050	5	3
Dawson	3,139,750	5	2
Briscoe	1,665,100	10	1
Lynn	1,373,950	12	1
TOTAL	134,336,200		

Column 1—Dry-volume storage potential, in acre feet, at 20 percent of bulk dry volume, excluding the first 50 foot buffer zone.
Column 2—Ratio of Parmer County's buffered, dry-volume storage potential to each county's buffered, dry-volume storage, after adjustment to buffered, dry-volume storage per acre.
Column 3—Each county's percentage of the 21 counties' total buffered, dry-volume storage.

Decline Of Water Level 1966

By F. A. RAYNER & A. W. WYATT

The decline of the water level in the Ogallala formation, from January 1966 to January 1967, is shown by the map on pages two and three. This map represents a composite of the individual county, depletion-guideline maps prepared by the District.

This composite map cannot be used as a guideline for calculating cost-in-water-depletion, income-tax allowances. The county maps, prepared on a land-grid base to the scale of one inch equals two miles, are the only depletion-guideline maps acceptable to the Internal Revenue Service. (The *Cross Section*, February 1967)

The depletion-guideline maps are prepared from water-level records collected as the result of the annual measurement of the depth to water in over 700 observation wells within the District. (For an explanation of the observation well program, the reader is referred to the March 1967 issue of the *Cross Section.*)

(Turn to Next Page)

Decline of the Water Level in the Ogallala Formation, High Plains Underground Water Conservation District No. 1, 1966

(Continued from Page 1)

Only decline or zero values are used in preparing the depletion-guideline maps, hence this composite map is contoured only in those areas where the change in depth to water was a decline, or remained unchanged (zero). During 1966, a limited number of observation wells experienced a rise in water level. All of these wells are located within the zero contours, primarily in Lamb and Hockley Counties.

PREPARING DECLINE MAPS

The annual depth-to-water records are thoroughly perused before they are accepted as being representative (valid) of the "static" depths to water. Several types of checks are performed on apparently anomalous, water-level records.

In the event the change in the valid, depth-to-water measurement for the current year (1967) is less than in the valid, depth-to-water measurement for the map year (1966) — a rise in water level—the data point (observation well) is assigned a zero decline value.

If the water level in an observation well could not be measured, for various reasons, an assumed decline (a whole number, or zero) is assigned the data point.

Each decline value—in this case the January 1966 measurement subtracted from the January 1967 measurement—is "rounded off" to the nearest whole number.

These data adjustments are necessary in order to prepare "equitable" maps that reflect only the annual extent of aquifer depletion.

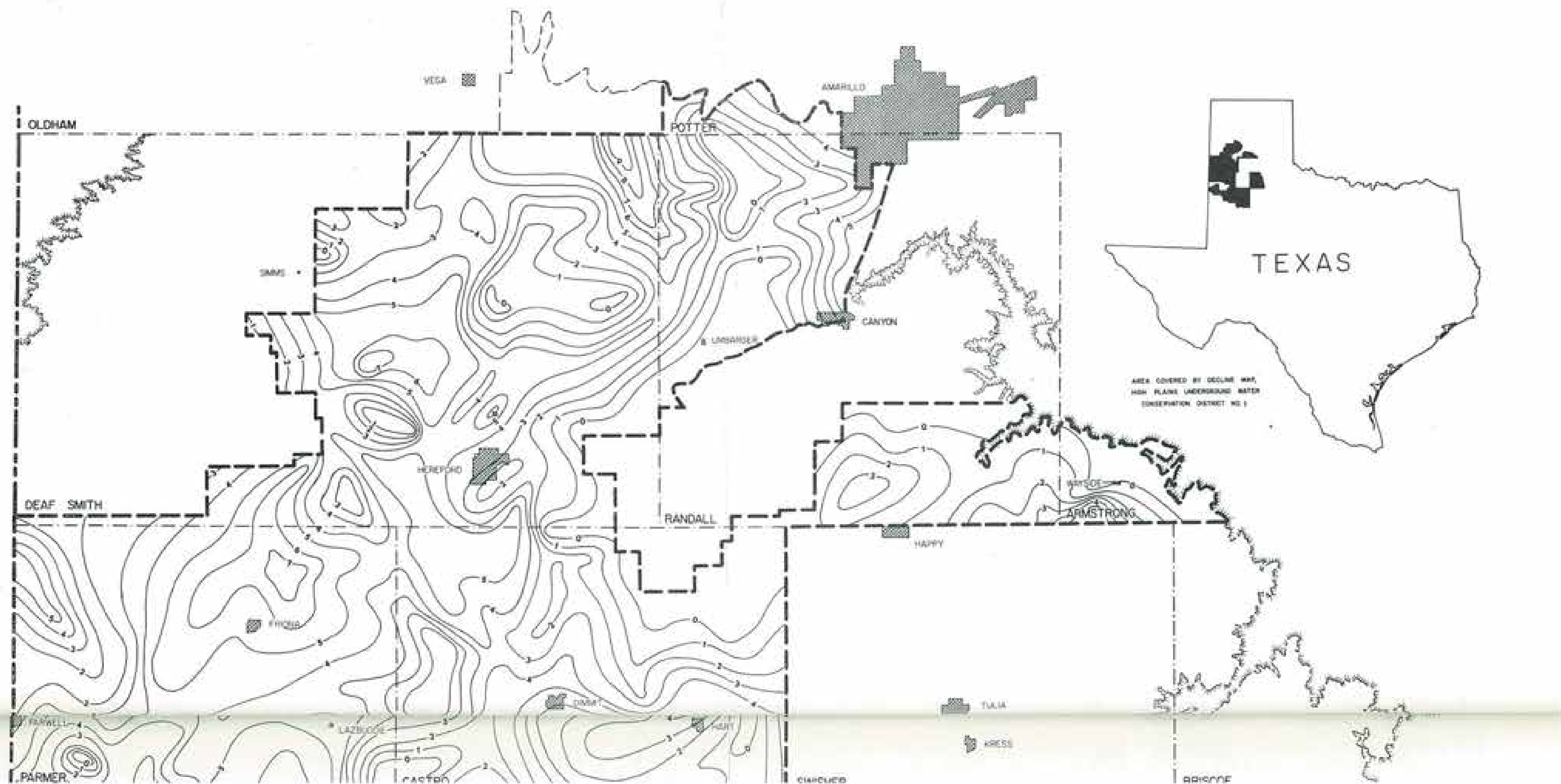
These data treatment annually involves several thousand, simple, arithmetical operations. Since the first depletion-guideline map was constructed, for the year 1962, these records have become very cumbersome. The District has now established a digital-computer program that will perform the eight operations associated with the annual, depth-to-water measurement. This program will also provide a "printout" of the water-level records for each observation well, and the calculations made in regard thereto. This printout will indicate the cumulative "excess" (water-level decline assigned to a well in excess of the actual decline experienced by the well) or "deficit" (the amount of water-level decline actually experienced by the well in excess of the decline that has been assigned thereto) for each observation well.

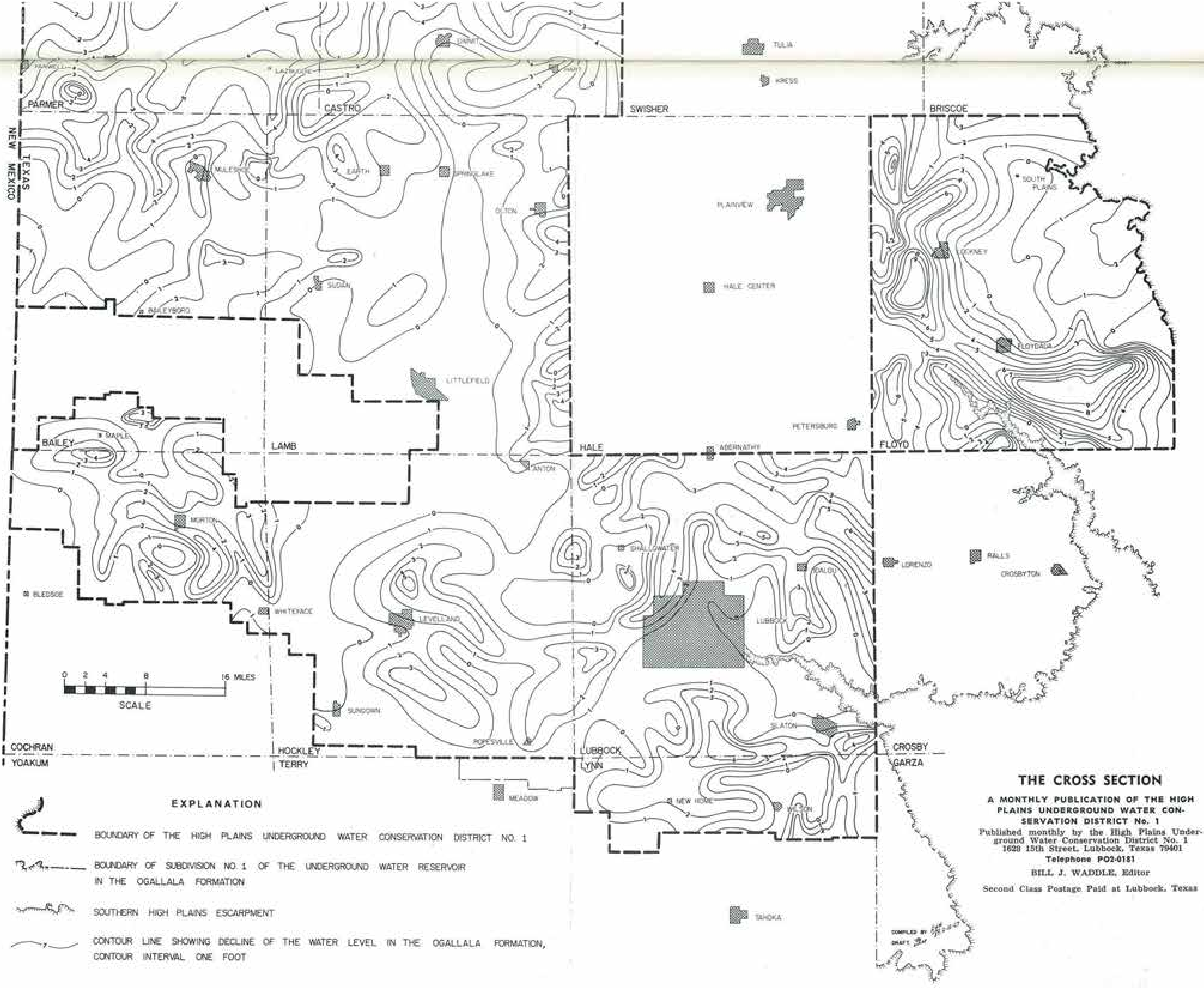
A second digital-computer program is now in preparation. This program is designed to perform the inspection of the water-level records—now done by the person preparing the decline-guideline maps—and eliminate or adjust erroneous data.

The following table lists the percentage of the land area in each county that is within the respective contours (decline intervals) shown on the 1966 decline map. The entries in the "Approximate Square Miles In District" column can be multiplied by the percent of the area in each county, as listed in the decline-interval columns, to determine the area (within each county and the entire District) experiencing the respective order of magnitude of decline.

The average annual decline for all observation-wells, during the five year interval from January 1962 to January 1967, was greater for nine counties, slightly less for two counties (Armstrong and Bailey), and more than one foot less for Potter and Randall Counties, than was the average (per county) decline during 1966 (January 1966 to January 1967).

County	Approx. Sq. Miles in District	No Decline	PERCENT OF EACH COUNTY WITHIN EACH DECLINE INTERVAL, FROM ZERO TO MORE THAN NINE FEET									
			0 to 1	1 to 2	2 to 3	3 to 4	4 to 5	5 to 6	6 to 7	7 to 8	8 to 9	More than 9
Armstrong	50	50	21	9	6	4	6	4				
Bailey	680	18	29	37	8	5	3					
Castro	845	11	14	18	20	13	14	8	2			
Cochran	268	13	23	23	30	9	2					
Deaf Smith	750	4	8	11	16	20	17	17	4	2	1	
Floyd	938	13	16	16	14	14	10	5	5	2	2	3
Hockley	842	32	32	20	11	4	1					
Lamb	972	28	35	25	10	1	1					
Lubbock	892	18	28	17	18	12	4	2	1			
Lynn	238	18	22	31	23	4	2					
Parmer	859	2	1	7	7	20	45	10	6	2		
Potter	40	2	2	19	29	29	19					
Randall	450	20	18	23	17	12	8	2				





THE CROSS SECTION

A MONTHLY PUBLICATION OF THE HIGH PLAINS UNDERGROUND WATER CONSERVATION DISTRICT No. 1

Published monthly by the High Plains Underground Water Conservation District No. 1
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Telephone PO2-0181

BILL J. WADDLE, Editor

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Potential— (from Page 1)

and pollution, as a result of mans activities at the land surface—on top of the reservoir. Therefore a "buffer zone"—from the land surface to a depth of 50 feet—was reserved as a filtering (purifying) medium, and is not included in the potential storage values listed in Table 1. This 50 foot section was also excluded from consideration, because water stored near the land surface would be subject to degradation in quality by natural processes.

Storing water in the shallow subsurface would interfere with other surface or near surface activities—such as certain highway and railroad installation, municipal and domestic waste disposal facilities, subsurface buildings (basements), silage and other on-farm subsurface storage, etc., and would inundate or waterlog land in low areas—in large playa basins, and in the "draws".

ECONOMICS OF RECHARGE

Water imported to this area will be somewhat expensive — measured by todays economic parameters — therefore it will be necessary to make maximum beneficial use of such "purchased" water.

The most economic agricultural use would be to apply all imported water directly to the land as preplant or summer irrigation. However this would require an importation and distribution system designed to meet peak irrigation demands; a system that would be inoperative or operating at only a fraction of its design capacity at least 11 months of every year; and for possibly longer time intervals, depending on climatic conditions. Such a system is impractical —it is not needed.

It is just as impractical to pay the costs of importing water to this area just to store it underground—to fill up the reservoir — unless it can be demonstrated that the cost of the water used to "build up" the water level in the aquifer is offset by the reduced lifting (pumping) costs, during recovery cycles. Subsurface storage, as well as surface storage, should only be used on an interim or emergency basis. It should be intended that all water that is artifically induced to the Ogallala formation should be withdrawn, and put to beneficial use.

The unintentional, long term, continued rise of water levels in the Ogallala formation, as a result of recharge by imported water, should be viewed with alarm—such a condition is physically and economically undesirable.

RECHARGE CANALS

The use of large unlined (porous bottom and sides) canals, as the primary element of the distribution system, would afford a means of recharging the Ogallala formation.

Some of the advantages of using unlined canals are:

1) They are the least expensive type of conveyance facility.

2) They are readily accessible for most types of maintenance.

3) They afford a large surface area for infiltration. The cost per unit of infilterating area is much less than that of a recharge well.

4) They do not require as much skill to operate and maintain as do recharge wells.

5) They provide a means of transporting water as well as a means of recharging the ground-water reservoir.

Some of the disadvantages of using unlined canals are:

1) They would require a considerable amount of land to construct and maintain.

2) Their tortuous paths, necessary to maintain optimum grade, would interfere with the advanced mechanization necessary to the economic operation of a Plains farm.

3) They would expose the water carried therein to organic and inorganic pollutants, some of which could be induced to the aquifer, and/or carried to other farms—damaging the crops thereon.

4) Wind and wind induced wave action would scour their banks, facilitating the suspension of solids in the water carried therein—with the resultant loss of some infiltrating capacity, and the associated maintenance cost to reclaim same.

5) They would have to be over designed ,or alternate (back-up) canals would have to be constructed to carry water while the primary canal is being dried out. A condition necessary for the remedial work to maintain their infiltration efficiency.

6) They would permit the continued loss of water to the subsurface, during periods when all the water the distributary system could carry should be benefically applied to crops. Infiltration rates *can not* be controlled.

7) They could completely fill (overfill) the reservoir medium in their immediate proximity, while their effect on the water level in the majority of the remaining reservoir system would be negligible.

8) Special well networks, in the immediate vicinity of the canals, would be needed to efficiently and beneficially utilize the water recharged to the ground-water reservoir (pump back into canal).

9) They would probably permit excessive loss of water in the sandhills and sandy soils area of Andrews, Bailey, Cochran, Dawson, Gaines, Lamb, Terry, and Yoakum Counties.

10) They would lose a considerable amount of water by evaporation and by transpiration through undesirable vegetation. Such vegetation would have to be controlled by a continuous eradication program.

11) Water percolating down through the extensive, dry matrix (particularly in the northern part of the Southern High Plains) would undergo a degradation in quality as the result of ion exchange, and the solution of some of the matrix material.

12) Some highways, railroads and other cultural features would have to be relocated or modified.

13) Some water would be lost to "perched" zones.

14) Some water would be wasted, by contamination, where unlined canals crossed areas containing poor quality water.

Water spreading, in the sandhills and sandy soils areas, appears to be a promising method of recharging the Ogallala formation — particularly in areas of heavy demand, such as municipal and industrial well fields. Efficient recovery of water recharged by spreading would, in most cases, require a network of special purpose wells.

RECHARGE WELLS

The ability of the Ogallala formation to produce water is amply demonstrated by the production of about 6 million acre feet annually, from possibly 50 thousand irrigation wells located throughout the Southern High Plains.

In theory an aquifers ability to produce water is a direct indication of its ability to accept water; and a well that can produce water at a high rate, should, if properly equipped, accept water at a high rate. There does not appear to be any insurmountable obstacles to large-scale artificial recharge of the Ogallala formation through wells, *provided;* water of adaptable quality is to be injected under controlled conditions, into proper equipped wells. In short, the theory has been perfected, it is the practice that needs considerable work.

In the Southern High Plains, the long-term results of most of the attempts to inject turbid, playa water into the Ogallala formation have been disappointing. However, the results of two, short-term recharge tests, and two continuing recharge projects—using potable or near potable water —are very encouraging. (*The Cross Section,* January 1967). These projects tend to substantiate the assumption that the practice of using properly designed, properly operated and properly maintained wells—to inject compatable (to the ground-water, reservoir system) quality water into the Ogallala formation—is both a feasible and economically acceptable practice.

Some of the advantages of using wells to inject surplus, imported water into the Ogallala formation are:

1) They require the least possible amount of land.

2) They do not permit evaporation or transpiration losses.

3) Approximately 50,000 wells that could be modified to function as recharge wells, are presently strategically located (on farms) throughout the Southern High Plains. These wells are equipped and can be pumped as needed—a maintenance requirement for all injection wells.

4) they are aesthetically more acceptable, than are canals and they do not present a safety or health hazard.

5) They can inject water directly into the aquifer, or into the dewatered zone immediately above the aquifer, thereby avoiding some of the quality of water changes that will occur in water induced from the land surface.

6) They could be operated continuously, thereby reducing the size of the distributary system.

7) Several thousand of the existing irrigation wells are tied into on-farm distribution systems (underground pipeplines), which could function with some minor modification, as the terminal part of the distributary system. This would facilitate the use of one or more standby wells, that could inject emergency spillage in the event of injection well failure, or during "down time" for workover.

8) They would provide the most efficient means of subsurface storage and retrieval, if properly operated as both an injection well and as a producing well.

9) Injection rates are easily controlled.

10) They provide the maximum rate of injection per unit area, because of direct exposure to the most permeable zone of the reservoir matrix — the horizontal permeability of the aquifer—and the ability to develop high injection pressures.

There are several apparent disadvantages of using injection wells to provide terminal storage in the Ogallala formation.

(To be Continued)

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High Plains Underground Water
Conservation District No. 1
1628 Fifteenth Street
Lubbock, Texas 79401

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THE Cross SECTION

A Monthly Publication of the High Plains Underground Water Conservation District No. 1

Volume 13—No. 12 "THERE IS NO SUBSTITUTE FOR WATER" May 1967

MOVING WATER WEST

Imagineering is how many describe it, others say it's not feasible, and many are convinced it will become a reality.—Importing surface water to West Texas.

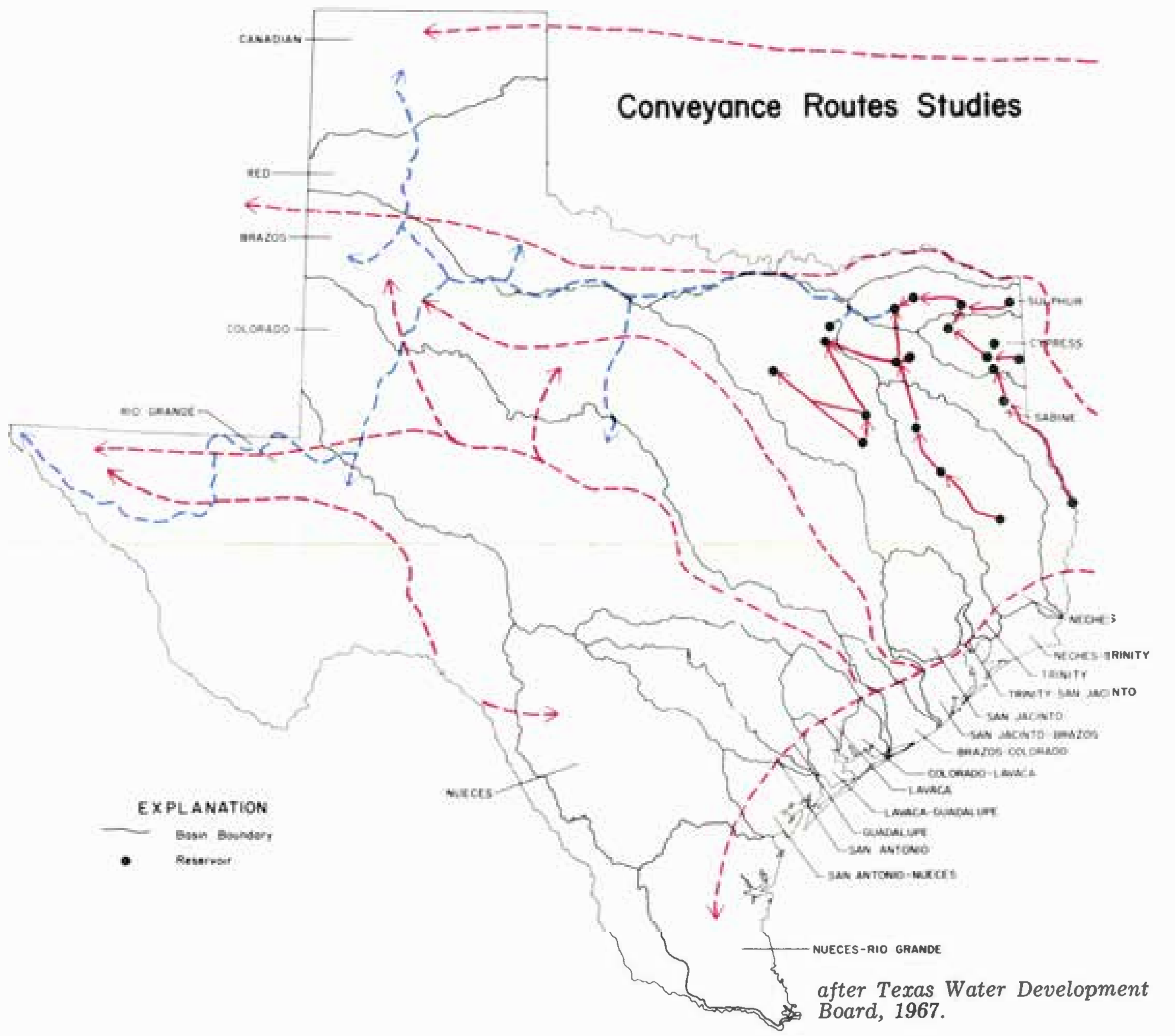
Through the Texas Water Development Board, three detailed studies are being made to explore the possibilities of importing surface water to West Texas. →

The accompanying map shows the alternative conveyance facilities being studied. The broken red line represents studies being made by the Bureau of Reclamation. These studies encompass the conveyance of 16 million acre-feet of water per year from the Mississippi River through canals and the Red, Brazos, and Colorado River channels to the western regions of Texas; the conveyance of 200 thousand acre-feet of water per year from the Amistad Reservoir location to the El Paso area; and the conveyance of 200 thousand acre-feet of water from the Amistad Reservoir location to the upper Nueces River Basin, and a like amount of water to the El Paso area.

The solid red line represents studies being made by the firm of Forrest and Cotton. This firm is studying the collection of two to five million acre-feet of water per year in the eastern regions of Texas, utilizing Cooper Reservoir as a terminal storage facility.

The broken blue line represents studies being made by the firm of Freese, Nichols, and Endress. This firm is investigating the possibility of transporting two to six million acre-feet of water per year from Cooper Reservoir, to the western regions of Texas.

All of these studies are scheduled for completion late this summer.



after Texas Water Development Board, 1967.

HALE COUNTY ELECTION

On May 22, 1967, voters in precinct 2 of Hale County, Texas, chose to become a part of the High Plains Underground Water Conservation District No. 1. Voters within the District also chose to accept the precinct as a part of the District.

Unofficial returns showed that 283 voters cast ballots; 233 voting for annexation and 50 voting against. The returns also revealed that 229 voters voted for the tax proposal and 50 voted against it.

Precinct 2 is located in the southeastern part of Hale County. The city of Petersburg is located within this precinct.

WATER, Incorporated

Independent people with independent ways built West Texas.

In fact, people have criticized West Texans of being so independent that they seldom ever agree on anything.

On May 24, the people of West Texas and Eastern New Mexico agreed. *Water, Incorporated* was formed and has become a reality.

The Organization is a nonprofit association founded to work for the vast importation of water to the High Plains and adjacent areas.

A crowd of 1300 persons from a wide region of the Southwest attended the organizational meeting in Lubbock to launch a united effort to import water to the High Plains.

Election of officers for the organization climaxed the meeting which featured five addresses by water authorities, one of whom declared, "without reservation, importation is engineeringly feasible and ways will be found to finance it."

John J. Kendrick, a banker from Brownfield was elected president of the association. K. B. Watson, of Amarillo, who has been serving as temporary chairman of the founders' committee was elected first vice president.

Other officers elected were: Gaston Wells, Dumas, second vice president; J. M. Collins, Plainview, secretary; and Jim Ed Waller, Lubbock, treasurer. The officers were elected by a 33 member board of directors named at the membership meeting.

The directors were elected from 23 districts, with five additional West Texas districts outside the High Plains area to be established later. Also included on the board are 10 "at-large" directors.

Joe G. Moore, Jr., executive director of the Texas Water Development Board, Austin, told the membership meeting that some of the studies on the importation of water into the West Texas area should be completed this summer. Moore said, "some of the studies contracted by the TWDB

(Continued on Page 4)

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Ernestine Cox .... Bookkeeper
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Jo Ann Chilton .... Secretary

BOARD OF DIRECTORS

Precinct 1
(LUBBOCK and LYNN COUNTIES)
Russell Bean, President .... 2806 21st St. Lubbock, Texas

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Weldon Newsom, Secretary-Treasurer .... Morton

Precinct 3
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(ARMSTRONG, DEAF SMITH, POTTER and RANDALL COUNTIES)
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Precinct 5
(FLOYD COUNTY)
Chester Mitchell, Vice President....Lockney. Tex.

Field Office, Hereford
Mrs Mattie K. Robinson .... Secretary

Field Office, Muleshoe
Mrs. Billie Downing .... Secretary

COUNTY COMMITTEEMEN

Armstrong County
Cordell Mahler, 1968 .... Wayside, Texas
Foster Parker, 1970 .... Rt 1 Happy, Texas
George Denny, 1969 .... Rt 1, Happy, Texas
Guy Watson, 1968 .... Wayside, Texas
James Bible. 1970 .... Wayside, Texas

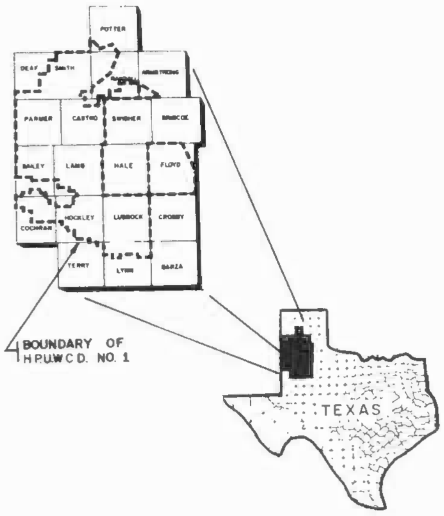
Bailey County
Mrs. Billie Downing
High Plains Water District
Box 594, Muleshoe, Texas
Marvin Nieman, 1968 .... Rt 1, Box 107, Muleshoe
Ernest Ramm, 1970 .... Rt 2, Muleshoe
Homer W. Richardson, 1968 .... Box 56, Maple
W. L. Welch, 1970 .... Star Rt, Maple
J. M. Witherspoon, 1969 .... Box 261, Muleshoe
Committee meets last Friday of each month at 2:30 p. m., 217 Avenue B, Muleshoe, Texas.

Castro County
E. B. Noble
City Hall, Dimmitt, Texas
Calvin Petty, 1969 .... Box 605, Dimmitt, Texas
Dale Maxwell, 1970 .... Hiway 385, Dimmitt, Tex
Frank Wise, 1970 .... 716 W. Grant, Dimmitt
Donald Wright, 1968 .... Box 65. Dimmitt
Morgan Dennis, 1968 .... Star Rt, Hereford
Committee meets on the last Saturday of each month at 10:00 a. m., City Hall, Dimmitt, Texas.

Cochran County
W. M. Butler, Jr.
Western Abstract Co., Morton, Texas
D. A. Ramsey, 1970 .... Star Rt 2, Morton
Ira Brown, 1968 .... Box 774, Morton
Willard Henry, 1969 .... Rt 1, Morton
Hugh Hansen, 1970 .... Rt 2, Morton
E. J. French, Sr., 1968 .... Rt 3, Levelland
Committee meets on the second Wednesday of each month at 8:00 p. m., Western Abstract Co., Morton, Texas.

Deaf Smith County
Mrs. Mattie K. Robinson
High Plains Water District
317 N. Sampson, Hereford, Texas
W. H. Gentry, 1969 .... 400 Sunset, Hereford
Billy Wayne Sisson, 1968 .... Rt 5, Hereford
Frank Zinser, 1970 .... Rt 5, Hereford
Billy B. Moore, 1968 .... Wildorado, Texas
L. B. Wortham, 1970 .... Rt 3, Hereford
Committee meets the first Monday of each month at 7:30 p. m., High Plains Water District office, Hereford, Texas.

Floyd County
Sam Puckett
325 E. Houston St., Floydada, Texas
Pat Frizzell, 1970 .... Box 1046, Lockney
J. S. Hale, Jr., 1969 .... Rt 1, Floydada
Tate Jones, 1970 .... Rt 4, Floydada
M. M. Julian, 1968 .... Box 65, South Plains
M. J. McNeill, 1968 .... 833 W. Tenn., Floydada
Committee meets on the first Tuesday of each month at 10:00 a. m., Farm Bureau Office, Floydada, Texas.



Hockley County
Murray C. Stewart
208 College, Levelland, Texas
J. E. Wade, 1970 .... Rt 2, Littlefield
Preston L. Darby, 1968 .... Rt 1, Ropesville
Jimmy Price , 1970 .... Rt 3, Levelland
H. R. Phillips, 1968 .... Rt 4, Levelland
S. H. Schoenrock, 1969 .... Rt 2, Levelland
Committee meets first and third Fridays of each month at 1:30 p. m., 917 Austin St., Levelland, Texas.

Lamb County
Calvin Price
620 Hall Avenue, Littlefield, Texas
Jack Thomas, 1970 .... Box 13, Olton
Roger Haberer, 1968 .... Earth
W. B. Jones, 1969 .... Rt 1, Anton
Troy Moss, 1968 .... Rt 1, Littlefield
Lee Roy Fisher, 1970 .... Box 344, Sudan
Committee meets the first Thursday of each month at 8:00 p. m., Crescent House Restaurant, Littlefield, Texas.

Lubbock County
Mrs. Doris Hagens
1628 15th Street, Lubbock, Texas
R. F. (Bob) Cook, 1970 .... 804 6th Pl, Idalou
Bill Hardy, 1968 .... Rt 1, Shallowater
Bill Dorman, 1970 .... 1910 Ave E, Lubbock
Edward Moseley, 1969 .... Rt 2, Slaton
W. O. Roberts, 1968 .... Rt 4, Lubbock
Committee meets on the first and third Mondays of each month at 1:30 p. m., 1628 15th St., Lubbock, Texas.

Lynn County
Mrs. Doris Hagens
1628 15th Street, Lubbock Texas
Don Smith, 1969 .... Box 236, New Home
Harold G. Franklin, 1968 .... Rt 4, Tahoka
Roy Lynn Kahlich, 1970 .... Wilson
Roger Blakney, 1970 .... Rt 1, Wilson
Reuben Sander, 1968 .... Rt 1, Slaton
Committee meets the third Tuesday of each month at 10:00 a. m., 1628 15th Street, Lubbock, Texas.

Parmer County
Aubrey Brock
Wilson & Brock Insurance Co., Bovina, Texas
Webb Gober, 1969 .... RFD, Farwell
Henry Ivy, 1970 .... Rt 1, Friona
Jim Ray Daniel, 1970 .... Friona
Carl Rea, 1968 .... Bovina
Ralph Shelton, 1968 .... Friona
Committee meets on the first Thursday of each month at 8:00 p. m., Wilson & Brock Insurance Agency, Bovina, Texas.

Potter County
Fritz Meneke, 1970 .... Rt 1, Box 538, Amarillo
W. J. Hill, Jr., 1969 .... Bushland
L. C. Moore, 1968 .... Bushland
Jim Line, 1968 .... Bushland
Vic Plunk, 1970 .... Rt 1, Amarillo

Randall County
Mrs. Louise Knox
Randal County Farm Bureau Office, Canyon
R. B. Gist, Jr., 1968 .... Rt 3, Box 43, Canyon
Ralph Ruthart, 1969 .... Rt 1, Canyon
Carl Hartman, Jr., 1968 .... Rt 1, Canyon
Marshall Rockwell, 1970 .... Canyon
Richard Friemel, 1970 .... Rt 1, Canyon
Committe meets on the first Monday of each month at 8:00 p. m., 1710 5th Ave., Canyon, Tex.

Animals can adapt to environments where fresh water is not available. Whales have kidneys which allow them to drink and dispose of sea water; the sea gull has special apparatus in its skull for distilling sea water to obtain a fresh water supply.

POTENTIAL FOR STORAGE OF WATER IN SOUTHERN HIGH PLAINS OF TEXAS

By F. A. RAYNER

Continued from the April 1967 issue of the Cross Section.

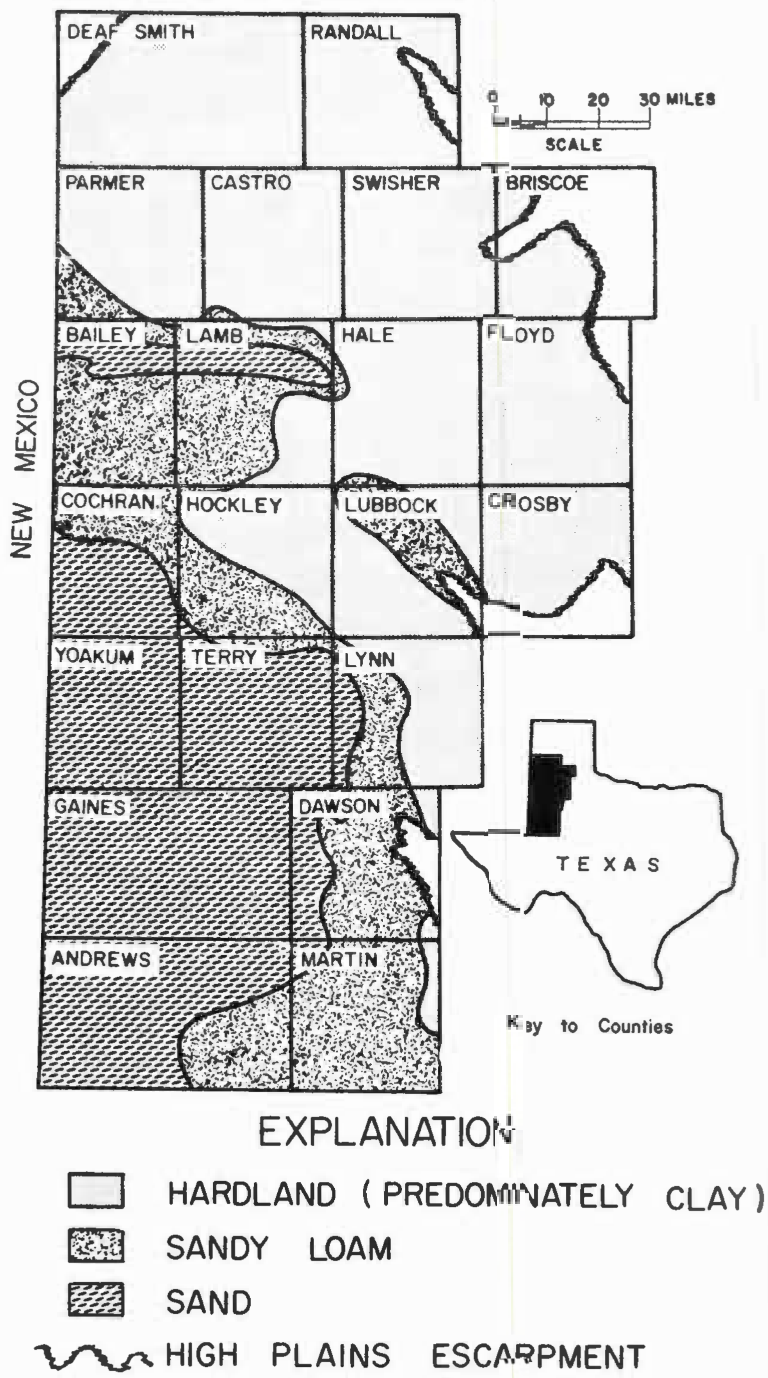
The advanced state of irrigation development—consisting of an estimated 50,000 wells, pumping an estimated 6 million acre-feet of water annually—in the Southern High Plains of Texas, has initiated a trend to depletion of the areas vast, ground-water reservoir in the Ogallala formation. This ground-water system, the Ogallala aquifer, constitutes the areas only major water supply.

Exploratory drilling has shown that deeper-lying aquifers, capable of appreciably abating the drain on the Ogallala aquifer, do not exist.

There are no major river systems in these High Plains that are even capable of supplying the areas municipal and industrial water needs—which represents less than two percent of the areas total water demand.

If the trend to depletion of the Ogallala aquifer continues—and there is no reason to reverse such a wealth-producing practice—it is apparent that it will be necessary for man to construct an uphill-flowing river(s) to supply the areas annual multi-million-acre-feet water demand; water needs that vary from season to season and day to day—depending upon weather conditions, and agricultural practices. If man is to construct such a river system, it must have a terminus that can accept the water so transported—some of which will probably be surplus to needs, at any given time. The absence of efficient, surface storage at or near the water demand centers (the thousands of individual farms) focuses attention on the problem of terminal storage for large volumes of imported, surface water.

Within the 21-county Southern High Plains there is more than ample on-farm storage—in actuality below-farm storage, since this storage space is contained in the Ogallala formation. Subsurface storage space is available, and so are numerous prob-



GENERALIZED SOILS MAP OF THE SOUTHERN HIGH PLAINS OF TEXAS (*after Carter*) lems associated with its use. The problem, simply stated, is, can this mammoth storage space be efficiently and economically utilized to enhance the workability of importing water to this area. The answer *must* be in the affirmative.

THE STORAGE ZONE

Within the "dry" matrix of the Ogallala formation—extending downward from the land surface to the top of the water saturated part of these rocks—there is an estimated 254,453,000 acre-feet of "air-filled" void (at 20 percent of the total bulk, dry-volume of the Ogallala formation). Excluding a 50 foot, near-surface section—the storage protecting, or buffer zone—there remains an estimated 134,336,200 acre feet of "safe" storage potential in the Ogallala formation.

About 38 million acre-feet of this water-yielding void constituted a part of the Ogallala aquifer before being depleted by large-scale, irrigation pumpage.

Water injected (by wells) into this former aquifer zone could be expected to be least affected by a change in quality—resulting from solution of the matrix, or as a result of ion exchange—and the recoverable volume of water so stored would probably be considerably higher than the recovery of the water initially stored in the historically dry matrix of this same Formation.

Whenever and wherever practicable, water stored in the Ogallala formation should be confined to the former aquifer zone.

METHODS OF RECHARGE

The advantages and disadvantages of the use of unlined canals—as an integral part of the intra-Planes, distribution system—to induce water to the subsurface, were presented in the April, 1967, issue of the *Cross Section.*

Although (water) "spreading basins" can not be grouped with conveyance facilities, the hydrologic problems associated with the use of such installations are similar, in most respect, to those of the unlined canal.

The use of spreading basins—in conjunction with a network of production wells—appears favorable (and even desirable, depending upon the quality of the water being spread) in the sandhills, and in the shallow, depth-to-water areas in the sandy soils of the southern part of the Southern High Plains.

The long-term use of recharge shafts, to induce even "clear" water to the subsurface, does not appear logical, workable, or adaptable as a part of the terminal storage facilities associated with a large-scale. water-importation program.

Attempts to use shafts to recharge playa catchment to the subsurface, by the High Plains Underground Water Conservation District No. 1; the Agricultural Research Service, U. S. Department of Agriculture, Bushland Station; and by several individual landowners, have not been considered successful.

A recharge shafts inability of "self-reclamation" (here referring to its inability to produce water) prevents inexpensive, downhole maintenance.

Dual-purpose wells—injection wells that are equipped to produce relatively large volumes of water—appear to be the only workable type of injection well.

The use of recharge canals and spreading basins appears to be limited to specific parts of the Southern High Plains. However, dual-purpose wells appear to be adaptable throughout the Ogallala formation—provided such wells are properly equipped, and operated in conformance with several limiting criteria.

It is not intended to suggest that the use of dual-purpose wells are the only, or ultimate, answer to using the Ogallala formation as an interim, or seasonal, water-storage reservoir. However, it should be noted that the numerous, apparent advantages (see the *Cross Section,* April 1967) of using such wells as terminal storage hardware prevents abnegation of their worth, without qualifying study.

Although I believe that dual-purpose wells will be required to maintain a long-term, large-volume, water-importation program in the Southern High Plains, it would be prejudicial not to also list the apparent disadvantages of using such installations—some of which are:

1) No precedent has been established to indicate the workability of integrating injection wells with a mammoth distributary system, as is invisioned for the Southern High Plains. The legal and managerial complexities of using privately owned wells to provide terminal storage points have not been approached, or surmounted.

2) Injection wells require considerable technical knowledge to operate and maintain. The operation of such wells, although privately owned, would have to be coordinated with the activities of the water supply agency, or other appropriate organization, during major recharge cycles.

3) The legal ramifications of ownership of injected water, and of subsurface trespass, have not been defined.

4) Water to be injected may require "dose" or continuous, expensive, pre-treatment; such as, filtration, deoxygenation, p^H adjustment, addition of algicides, biocides, etc.

5) Contaminants or pollutants would be injected directly into the aquifer, without the benefit of the soil purification provided for water induced from the land surface.

6) Maximum cost per unit area of injection surface.

7) Water delivered to injection wells would probably have to be conveyed through closed systems, or at least lined canals. This apparent disadvantage—the necessity of a closed system—may prove to be a long-term advantage. Although unlined canals may be the least expensive conveyance facility, in respect to initial-cost; their long-term maintenance costs, safety and health hazards, and "inconvenience" potential (unsuitability, in respect to aesthetics; transportation; the areas on-the-square, mechanized-farming practices; etc.) may make them more expensive than the more direct-route, pipeline-distributary system.

PREFERRED RECHARGE AREAS

The criteria determining those areas in the Southern High Plains adaptable to recharging by the use of unlined canals, or spreading basins, are sometimes in direct conflict with those criteria describing the areas adaptable to recharging by the use of wells.

Recharge canals and spreading basins should:

1) Be strategically located in reference to areas of large scale development; such as near or in the well fields of large cities, industries or concentrated irrigation-development.

2) Be outside of the boundries of large oil fields.

3) Be located in areas overlain by pervious soils.

4) Be developed in conjunction with dewatering wells, located in the immediate proximity of the canal, that could pump into the canal during peak demand periods.

5) Be lined in areas of naturally, poor-quality water.

6) Be within areas where the depth to water, or the base of the Formation, does not exceed 100 feet.

7) Be outside, preferably north or west, of metropolitan areas.

8) Be located several miles west and/or northwest of the eastern escarpment, and some of the reentrant canyons associated therewith, as dictated by the hydrologic conditions that would result by the filling of the Formation in the proximity of the canals, or spreading basins. Care would have to be taken to prevent, or avoid increasing the natural loss of water from the aquifer through springs, seeps and transpiration.

9) Not be located in areas of porous percipitate rocks, unless overlain by at least 50 feet of Ogallala formation.

The southern part of the Southern High Plains satisfies most of these criteria.

Large areas selected for artificial recharge through wells should:

1) Be strategically located in reference to areas of large scale development; such as near or in the well fields of large cities, industries or concentrated irrigation-developments.

2) Be outside of the boundries of large oil fields.

3) Be overlain by relatively impervious soils.

4) Contain a considerable dewatered, but preferably not depleted section, in addition to the recommended 50-foot buffer zone.

5) Be outside of areas of naturally, poor-quality water.

6) Be within areas where the depth to water exceeds 100 feet.

7) Be within areas where the depths to water do not exceed 400 feet.

8) Be outside, preferably north or west, of metropolitan areas.

9) Be located a few miles west and/or northwest of the eastern escarpment, and some of the reentrant canyons associated therewith, as dictated by the hydrologic conditions that would result from the partial or complete filling of the now, dewatered zone. Care would have to be taken to prevent augmenting, inducing or reinducing spring flow, and other natural water losses. Properly operated recharge wells could be located nearer the boundaries of the Formation than can recharge canals and spreading basins.

10) Not be in areas of porous percipitate rocks, unless overlain by at least 50 feet of Ogallala formation.

The northern part of the Southern High Plains satisfies most of these criteria.

Within the preferred recharge areas, recharge wells should:

1) Be strategically located in respect to producing wells, as aquifer characteristics dictate. The most efficient well would be both a recharging and producing well (dual-purpose well).

2) Be outside of areas of local contamination.

3) Be located in areas of relatively high permeability, such as buried channels, and areas containing porous, percipitate rocks — adequately protected by Ogallala "cover".

It is probable that both recharge canals and recharge wells will be employed in any mass importation system serving the Southern High Plains. The surface-water supply and groundwater reservoir system *will have to be* coordinated, in order to make long-term importation of water to this area possible.

If this area is to continue to expand or even maintain its agricultural production, in order to help supply the Nations—and indeed the Worlds—need for food and fiber; it must strive for the mass importation of water in heretofore unheard of quantities. Seasonal storage will have to be provided for some of this water—the storage space is available, and so must be the solutions to the problems obstructing the use of same.

SELECTED REFERENCE

Carter, W. T., The Soils of Texas, Texas Agricultural Experiment Station Bull. 431, July 1931.

WATER, Incorporated Officers, from left to right, Gaston Wells, Dumas, second vice president; K. B. Watson, Amarillo, first vice president; John J. Kendrick, Brownfield, president; J. M. Collins, Plainview, secretary; and Jim Ed Waller, Lubbock, treasurer. (See Story Page 1).

Please Close Those Abandoned Wells!!!

Water, Incorporated—

(Continued from Page 3)

with private engineering firms have been completed on the cost aspects of various plans and the board is attempting to determine which one of the cost estimates appears most reasonable."

John Thompson, assistant director of the Region 5 office of the U. S. Bureau of Reclamation at Amarillo, told the group that to import water to the High Plains area it would have to be lifted 3,800 to 4,000 feet under any of the proposals now being considered.

Thompson also said, "the interest-free component under the Reclamation Act for the irrigation phases would, in my opinion, be an absolute necessity to help finance the project." He further stated that "the cities and towns should be prepared to assist in financing the irrigation costs, in addition to paying the entire municipal and industrial cost."

A. C. Verner, president of the First National Bank of Lubbock urged residents to unite behind Water, Incorporated, to "persue every possibility and search out every corner until what was once a dream becomes a reality."

Brig. Gen. W. T. Bradley, Southwest division engineer with the U. S. Corps of Engineers, Dallas, emphasized that "only through cooperation of the principal echelons of government—federal, state and local—will we ever be able to meet basic water needs."

Marvin Nichols of the Fort Worth engineering firm of Freese, Nichols and Endress said, "imported water will come to West Texas if the region's residents display the kind of wisdom, fortitude and stick-togetherness its going to take to get the job done."

At the conclusion of the membership meeting, the board of directors named a seven member executive committee composed of Homer Garrison, Plainview; J. D. Smith, Littlefield; A. L. Black, Friona; J. W. Buchanan, Dumas; and Kendrick, Watson and Verner.

The association will headquarter in Lubbock and will be financed by voluntary dues, the exact level of which will be determined by a study by a special committee. There will be several classifications of dues.

With the formation of Water, Incorporated the people of this area have taken a giant step in the direction of assuring an adequate long-range supply of water for the High Plains and adjacent areas for use in agriculture, industries, and cities.

Directors elected by districts include:

DISTRICT NO. 1—
Dallam, Hartley, Sherman, and Moore Counties, Texas;
Gaston Wells, Dumas, Texas

DISTRICT NO. 2—
Hansford and Hutchinson Counties, Texas;
N. F. Renner, Spearman, Texas

DISTRICT NO. 3—
Ochiltree, Lipscomb and Hemphill Counties, Texas;
R. D. Lemon, Perryton, Texas

DISTRICT NO. 4—
Carson, Gray, Wheeler, Collingsworth, Roberts and Donley Counties, Texas;
Fred S. Vanderburg, Pampa, Texas

DISTRICT NO. 5—
Armstrong, Randall and Potter Counties, Texas;
Jerome W. Johnson, Amarllo, Texas

DISTRICT NO. 6—
Oldham and Deaf Smith Counties, Texas;
R. C. Godwin, Hereford, Texas

DISTRICT NO. 7—
Parmer and Bailey Counties, Texas;
A. L. Black, Friona, Texas

DISTRICT NO. 8—
Castro and Lamb Counties, Texas;
Ray Joe Riley, Dimmitt, Texas

DISTRICT NO. 9—
Swisher and Hale Counties, Texas;
Homer Garrison, Plainview, Texas

DISTRICT NO. 10—
Briscoe and Floyd Counties, Texas;
Chester Mitchell, Lockney, Texas

DISTRICT NO. 11—
Lubbock and Crosby Counties, Texas;
Russell Bean, Lubbock, Texas

DISTRICT NO. 12—
Cochran and Hockley Counties, Texas;
Gene Benham, Morton, Texas
Yoakum and Terry Counties, Texas;
John Kendrick, Brownfield, Texas

DISTRICT NO. 14—
Lynn and Garza Counties, Texas;
Wilmer Smith, Wilson, Texas

DISTRICT NO. 15—
Gaines and Dawson Counties, Texas;
Donnell Echols, Lamesa, Texas

DISTRICT NO. 21—
Roosevelt, Lea, Eddy and Chaves Counties, New Mexico;
A. T. Ford, Portales, New Mexico

DISTRICT NO. 22—
Curry, DeBaca, Quay, Harding and Union Counties, New Mexico;
Hoyt Pattison, Clovis, New Mexico

DISTRICT NO 23—
Panhandle of Oklahoma;
Billy Ray Gowdy, Boise City, Okla.

DIRECTORS AT LARGE—
A. C. Verner, Lubbock, Texas
J. W. Buchanan, Dumas, Texas
K. B. Watson, Amarillo, Texas
Bruce Spencer, Lubbock, Texas
Jim Nation, Pampa, Texas
Geo. W. McCleskey, Lubbock, Texas
J. M. Collins, Plainview, Texas
Jim Ed Waller, Lubbock, Texas
D. G. (Bill) Nelson, Amarillo, Texas
J. D. Smith, Littlefield, Texas

ADVISORY DIRECTORS—
Don Johnson, Lubbock, Texas
Michael Garrett, Clovis, New Mex.
Marvin Nichols, Ft. Worth, Texas
Melvin Semrad, Amarillo, Texas
Berwin Tilson, Plainview, Texas
Marvin Shubert, Petersburg, Texas

WATER WONT WEAR OUT

What is the best investment a High Plains farmer can make today? No doubt about it—WATER.

Tractors, trucks, irrigation engines, most farm equipment, clothes, shoes, or just about anything a farmer owns today, eventually will deteriorate because of use or wear. The District has yet to hear a high plains farmer say his water is "worn out". He may deplete it, but it just can't be "worn out" by using it.

Not many farmers can be found who pay good hard earned money for a piece of farm machinery, use it once and then give it away. They should, and many do, treat their water the same way. Chances are they paid a "handsome" price for the water, so they should get their moneys worth every time they turn on an irrigation well. However, there are still many farmers in the Water District and in the High Plains area who are getting "took" every time they irrigate, because they won't use the irrigation water to its fullest extent. Many farmers use the water one time and then allow it to escape from their land and be wasted.

The waste of underground water is prohibited by laws of the State of Texas. The law reads, in part:

"Wilfully causing, suffering, or permitting underground water produced for irrigation or agricultural purposes to escape into any river, creek or other natural watercourse, depression or lake reservoir, drain or into any sewer, street, highway, road, road ditch or upon the land of any other person than the owner of such well or upon public land is prohibited."

Farmers who allow their water to escape, are violating the law and robbing themselves.

For a small investment a farmer can correct both violations, and really get some use and wear out of his most precious farm possession—his water.

In early 1956, the Water District initiated experimental projects to capture "tail water" that was escaping from hundreds of farms. The District studied what was called "tail water return systems". These systems consisted of a depression or pit constructed at the low end of a field, to capture water that was escaping from the farm. The depression or pit was equipped with a pump and the water was pumped back to the high end of the field, and was re-applied to the crop.

In 1962, the District installed its first experimental tailwater pit. The pit was installed on the James Mabry farm near Friona, Texas. Mr. Mabry installed a six inch underground plastic pipe line from the pit up to the existing concrete underground pipe line on his farm.

Since this first installation the District has made use of various types of installations to thoroughly study tailwater return systems. In past years the District has made the following observations, on a group of pits in Parmer County, Texas:

The average capital investment in pits has been about $3,500.00, for the pit, pump, motor and underground return line. Many pits, however, have cost much less.

Studies have also revealed that an average of 78 acre feet of water is recovered annually by these installations.

The District has no official record of the number of tailwater pits in the High Plains area, but Deaf Smith County is known to have well over 300.

Many farmers and land owners get good use out of their water. If you are one that is not, then you can well afford to examine the possibility of installing a return system on your farm. Returned water aids in additional crop yields and insures more profit.

Now is the time to install such a system. Contact the High Plains Underground Water Conservation District and we will be glad to assist you with planning your installation.

Every gallon of water wasted is lost forever. Act now to protect the investment you have made in water.

WHEN YOU MOVE—

Please notify the High Plains Underground Water Conservation District, Lubbock, Texas on Post Office Form 22S obtainable from your local postmaster, giving old as well as new address, to insure no interruption in the delivery of "The Cross Section."

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Conservation District No. 1
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Second Class Permit

THE Cross SECTION

A Monthly Publication of the High Plains Underground Water Conservation District No. 1

Vol. 14—No. 1 "THERE IS NO SUBSTITUTE FOR WATER" June 1967

Committee Appointed For Hale County

Precinct 2 of Hale County, now a part of the High Plains Underground Water Conservation District No. 1, has its first County Committee.

Hale County Judge, C. L. Abernathy, recently appointed five men in Precinct 2 of Hale County to serve on the Committee.

Individuals appointed to serve are J. C. Alford, Box 28, Petersburg; Don Hegi, Box 160-A, Petersburg; Harold D. Rhodes, Box 100, Petersburg; W. D. (Dub) Scarborough, Box 147, Petersburg; and Charley Schuler, Petersburg.

The terms of office for these men will be determined by a drawing at their first meeting.

Duties of the County Committee will be to approve drilling permits and counsel and guide the District Directors in the operation of the Water District.

Who Owns The Water In "Playa Lakes"

If you own a farm that has a large "playa lake" on it, you are indeed fortunate. The water captured in these numerous lakes, that are scattered over the area, can and is being used as an alternate supply of irrigation water for many farmers.

During the past five years the practice of pumping "playa lakes" has become quite popular. The popularity of this practice has also led to some problems, one of which is, who owns the water in "playa lakes".

Lakes that are located on land that is under one ownership have caused no problems and none are expected. Lakes that are located on property owned by one or more individuals, have in some instances, created problems, especially when one or more parties were pumping water from the lake.

Disputes have arisen over who owned the water and how much each individual could pump.

With the use of "playa lakes" for supplemental sources of irrigation water increasing, we should take a close look at *who does* own the water in these lakes.

When we speak of "playa lakes" we are referring to the intermittent lakes found in the High Plains Region of the State, created by the interior drainage of diffused surface waters into natural depressions in the earth. The beds of these lakes are privately owned and the waters collected are dissipated rather rapidly by pumping,

(Continued on Page 2)

Texas Ground Water Law

By GEORGE W. McCLESKEY

Unlike many other states, ground water in Texas is privately owned in fee simple by the owner of the surface of the land unless such ownership has been lost by severance or sale.

In the case of surface waters, the legislature has declared that both the regular or ordinary flow and the flood waters in streams and lakes are the property of the State of Texas. This public ownership does not encompass diffused surface waters such as that intermittently flowing in sheets outside of defined channels. On the other hand, ground water has been recognized as privately owned, both by the Courts of Texas and by such legislative proclamations as that found in the statute authorizing the creation of and specifying the authority granted to Underground Water Conservation Districts. There it is said:

"The ownership and rights of the owner of the land, his lessees and assigns, in underground water are hereby recognized, and nothing in this Section 3(c) shall be construed as depriving or divesting such owner, his assigns or lessees, of such ownership or rights, subject, however, to the rules and regulations promulgated pursuant to this Section 3(c)."

Having made this general point, certain words of explanation are in order.

(1) Ground water is defined generally as water percolating beneath the surface of the ground other than water in a defined underground stream or in the underflow of a surface stream.

(2) Percolating water beneath the surface of the ground is presumed to be not in an underground stream or in the underflow of a surface stream. This means, of course, that the party seeking to defeat private ownership of water beneath the ground has the burden of proving that the water is in a defined underground stream or in the underflow of a surface stream. To my knowledge there is no recorded Texas Appellate Court decision wherein proof of such matter was deemed sufficient. An interesting case in this respect arose at Ft. Stockton, Texas. There, flowing Commanche Springs has afforded down stream property owners enjoyment of the surface waters therefrom for a period of some ninety years. Other land owners up-dip from the springs, developed their land by drilling various water wells and began pumping them with mechanical pumps. As a result, Commanche Springs ceased flowing. The down-stream owners, among other things, alleged that the waters produced at Commanche Springs reached the Springs in well defined channels. Both the District Court and the Court of Civil Appeals rejected the allegations of the down-stream owners, holding that the ownership of the surface includes the percolating ground water, and the owner may use such water in any non-wasteful manner he chooses. Both Courts further held that the general allegation that such waters reached the Springs through well defined channels was merely a conclusion of the pleader and that such pleadings were insufficient unless they stated further the identity of the well defined channel, either as to surface indications, probable route, source, or destination, or alleged some facts affording some clue as to such identity. The Court affirmed the rule that all underground waters are presumed to be percolating, and in effect held that the mere fact that pumping at an up-dip location dried up the Springs was not proof of well defined underground channels.

Many of you will recall with me that in the past, and possibly there are some present instances, claims have been and are made that there are underground streams in the High Plains areas. Generally, these claims are based upon the assumption that since producing irrigation wells in some areas seem to follow a meandering design or pattern as they are located upon the land surface, then this meandering pattern must have some similiarity to the meanderings of a sub-surface stream. In conversations with hydrologists, I have heard it suggested that such irregularities in the locations of producing wells is more likely caused by variations in permeability and rather radical rises and declines of the red beds.

RIGHTS OF OWNERSHIP

Generally, the right of ownership in any property includes the right to sell, lease, grant the use of, and fully enjoy and utilize, even to the point of exhaustion. These rights are included in the bundle of ownership rights that apply to ground water in Texas. One peculiarity of this ownership in Texas, is that if a neighbor drains the ground water from underneath an owner's land by pumping a lawful well, that owner has no remedy against his neighbor for such drainage. This has been considered by many as a logical limitation upon such ownership because of the very nature of ground water aquifers. The ground water is capable of moving in the formation and generally "flows" —some times very sluggishly—in the direction of the down-dip of the hydraulic gradient. To those of us who are not hydrologists, this simply means that water flows down the slope of the water table. When water is withdrawn from one area, it has a tendency to lower the level of the water in that area, and thus, causes the water table to slope in that direction. We then see that by the very nature of the aquifer it would be difficult to impose upon one land owner damages for draining water from his neighbor's land, when as a matter of fact, all he has done is to take water from his own land and in the process lowered his water table and caused neighboring water to drain down-dip into his area.

Generally, the owner of ground water may use that water at any place he chooses in any quantities that are available so long as such use is non-wasteful. Again, referring to the statute authorizing the creation of and granting authority to underground water conservation districts, the term "beneficial purpose" is there defined as including a number of specific things, and then concludes by providing that the term includes "any other purpose that is useful and beneficial to the user thereof". It would appear, therefore, that the term "beneficial" as applied to the use of ground water is given a very broad meaning.

The water may be used on or off the premises from which it is produced. A Texas Supreme Court case recognized the right of the City of Corpus Christi to pump percolating ground water to the surface in the area of Pleasanton, Texas, and thereafter, to flow that water down a natural stream for storage, treatment, and use at Corpus Christi. Private ownership of ground water and the right to make use of one's own property was the basis upon which the Court recognized Corpus Christi's right to use that water at such place as it saw fit.

Recently, a three-judge Federal Court declared unconstitutional a Texas Statute which generally prohibited the removal of ground water from the State of Texas after it has been brought to the surface. The facts in that case were that the City Council of Altus, Oklahoma, came across

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THE Cross SECTION

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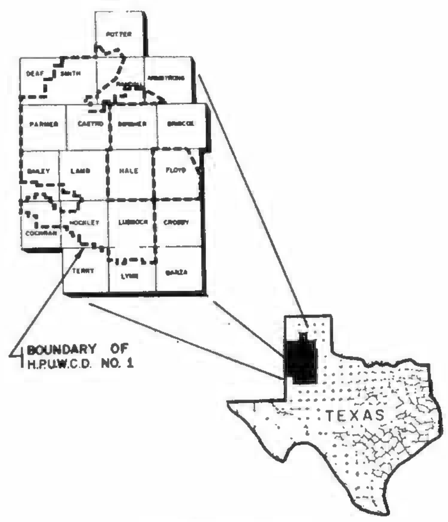

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Playa Lakes—

(Continued from Page 1)

evaporation and seepage.

Apparently, the waters of "playa lakes" have not been the subject of litigation in this State, as no Texas court decision involving these lakes has been found.

There have been some cases tried in Texas that could be considered similar to litigation of "playa lake" waters. In one of these cases, *Turner v. Big Lake Oil Co.*, 128 Texas 155, 96 S. W. 2nd 221 (1936), the Court held that in the light of the Constitution and of the Common Law and Mexican Civil Law under which lands have been granted in Texas, the owners of the soil on which rains may fall *and surface waters gather* are the proprietors of the water so long as it remains on their land, and *prior to its passage into a natural water course to which riparian rights may attach.*

The Court expressed no opinion as to the effect of Article 7476 Civil Statutes of the State of Texas. (This statute provides certain surface waters to be the property of the State). However, it is believed by many that the Courts will still hold that the owner of the land has the absolute right to capture and use all diffused surface waters which appear upon his land.

There are several other cases that can be reviewed, but as stated earlier, none deal directly with "playa lakes".

Extensive research has led to the accepted doctrine that the waters of "playa lakes" are surface waters, owned by the owners of the lands upon which they appear, to which no riparian rights are attached and to which the appropriation statutes are not applicable.

This has partially answered our question, but there still remains the problem of lakes that are situated on lands owned by more than on individual.

One answer to this problem has been to construct a dam in the center of the lake dividing it in half. This allows two parties to pump from the lake and neither feels that his neighbor is using his water.

Another possible solution could be a simple contract between the owners of the lake. The contract could state how the lake would be used by each party and to what extent.

With a constant need for more water, facing all West Texans, it is evident that all "playa lakes" will eventually be put to good use.

The waters in the lakes belong to the owners of the lakes, no doubt about it. Let's get to work and get the most out of what we own.

"CHIEF RUNNING WATER," SAYS—

Water Organization Sets Membership Dues

Membership dues to Water, Inc., designed to support a first-year budget of at least $200,000, were set at the initial meeting of the new organizations executive committee.

General minimum annual membership dues will be $25.00. Other dues have been established to reflect the size of individual or company operations.

Dues for landowners, farmers and ranchers were fixed on a per-acre basis, with allowances for differences in land values.

Irrigated farms will have yearly dues of 10 cents per acre. Non-irrigated farm dues will be five cents per acre. Ranch owners and operators will be asked to pay two cents per acre.

Dues for commercial businesses were set at 50 cents per $1,000 of capitalization and surplus, up to $250. in dues or $500,000 capitalization. These are "Commercial Memberships".

Special membership fees above $250.00 will be set from time to time for individual enterprises, companies, banks and others, whose capitalization amounts to more than $500,000.

Membership classifications will include a "sustaining" category for those paying dues between $250.00 and $1,000; a "sponsoring" member for $1,000 to $5,000; and a "leadership" division for contributions above $5,000.

Applications for membership will be made available by mail, through Chamber of Commerce offices, banks, and other places.

Membership in Water, Inc., is open to anyone interested in securing an adequate supply of imported water for irrigation, industry and municipalities in the High Plains and adjacent areas.

The Organization's mailing address is P. O. Box 367, Lubbock, Texas 79401. Subscriptions for membership may be sent to the above address.

Water, Inc., was organized in Lubbock on May 24, and is incorporated under the laws of the State of Texas.

Objectives of the organization are to work with existing agencies, both State and Federal, conduct studies and do all other things necessary to import surplus surface water to West Texas and adjacent areas.

John J. Kendrick, Brownfield, president of the non-profit Corporation said, "the engineering feasibility of transporting water to the West from both in-state and out-of-state sources has been firmly established." He further stated, "most observers are convinced it is economically feasible as well."

A project of this magnitude requires a great deal of money to move it through the necessary engineering and political phases. Both state and federal money will be necessary, and the cooperation of many agencies in Austin and Washington will be indispensable.

Water, Inc., was formed to aid and encourage the importation of water to West Texas. The High Plains Underground Water Conservation District urges everyone, with a "stake" in West Texas to become a member and support the organization and its endeavors.

Dreams Do Come True

Men of vision who tackled a "far-fetched" dream in the face of many obstacles and criticisms were praised this month in Lubbock at the dedication of the Lubbock water treatment plant and Canadian River Municipal Water Authority Aqueduct System.

More than 250 people attended the program, which featured addresses by Lubbock Mayor W. D. (Dub) Rodgers, Jr., Lt. Governor, Preston Smith and U. S. Representative, George Mahon, who spoke from his office in Washington via telephone.

Honored guests included representatives from all 11 member cities, the U. S. Bureau of Reclamation, Contractors, current and past directors of the Authority, and Mrs. A. A. Meredith, widow of the project leader for whom Lake Meredith, project reservoir near Sanford, Texas, was named.

In 1936, a group of men who thought a dream could become a reality gathered under a shade tree near Sanford and began to seriously discuss the possibility of a dam and the gigantic water system.

From this first meeting, spanning many years, the Canadian River Municipal Water Authority was born.

In cooperation with the Bureau of Reclamation, the plan consisted of impoundment of water on the Canadian River by an earthen dam near Sanford, and raw water delivery to the participating cities by means of pipeline tributaries to a main aqueduct, with flow in the lines maintained by a series of pumping stations located along the main aqueduct.

In 1960, voters of Amarillo, Pampa, Borger, Plainview, Lubbock, Slaton, O'Donnell, Tahoka, Brownfield, and Lamesa approved the project by a 30-1 margin, largest ever polled by such a program.

Sanford Dam and Lake Meredith were dedicated last year.

Costs of the project will be paid by the member cities in water use fees.

The new treatment plant, owned by the City of Lubbock, treats water for the city, as well as, Slaton, Levelland, Brownfield, Tahoka, O'Donnell and Lamesa on a fee and fixed charge basis. The plant was constructed in two years.

A 500-acre-foot regulating reservoir is located north of the treatment plant. It is currently holding 460 acre feet of water in the reservoir. Inflow into the reservoir is 85 cubic feet per second or 38,100 gallons per minute. The water travels 146 miles from Lake Meredith to the reservoir.

The aqueduct was constructed in record breaking time. In fact, the entire project was completed one year ahead of the completion date at a savings of approximately 12 million dollars.

Maximum size of the pipe used in the aqueduct is 96 inches in diameter.

Lubbock became the first member to use a daily supply of project water. The City is currently using 8.6 million gallons daily.

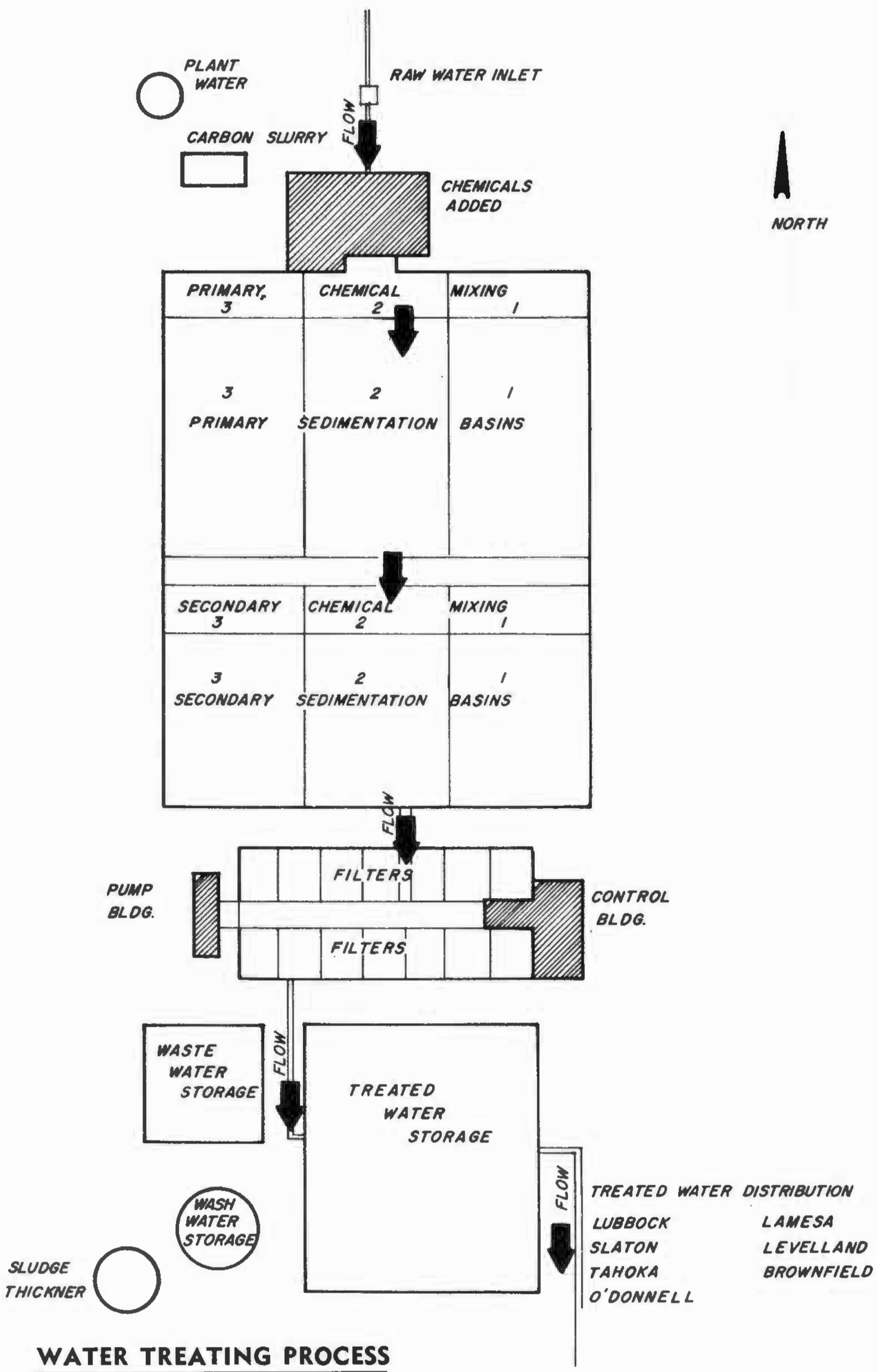
Brownfield is due to start taking water very soon. It was the second city to receive permission to draw an emergency summer supply.

Plant laboratory technicians say the water is well within minimum standards prescribed by the State Health Department.

Minerals, causing hardness of the water, have been reported at 204 parts per million, compared to the 230 parts per million rating of the water that the City of Lubbock produces from the sand hill area in Bailey County.

Dreams can come true, the Canadian River Municipal Water Authority is a prime example.

Guests who attended the dedication of the Lubbock water treatment plant and The Canadian River Aqueduct System included: from left to right Tom McFarland, Manager, High Plains Underground Water District; Mills Cox, Chairman, Texas Water Development Board; Lt. Governor Preston Smith; Mrs. Jean Williams, Texas Water Development Board; and Marvin Shurbet, Vice Chairman, Texas Water Development Board.



WATER TREATING PROCESS

The untreated water entering the plant is first chlorinated, then chemicals are added and mixed to facilitate the removing of silt and color. The mixing is accomplished by first mixing in rapid mixers for a short period of time, then in a slower motion by large paddles called flocculators. When the mixing has been completed the silt particles are settled out in the sedimentation basins. In the secondary treatment more chemicals are added and the same procedure is continued. The water receives its final treatment by filtering through sand and gravel. The filtered water then drains into a line that takes it to the treated water storage. The water is chlorinated again before it is released into the distribution system.

Water Law—

(Continued from Page 1)

into Texas, just north of Vernon, and there acquired water rights from the surface owner. Being confronted with the Texas Statute, the City of Altus brought suit against the then Attorney General, Waggoner Carr, to have that statute declared unconstitutional. The Court held with the City of Altus, basing its opinion primarily on unreasonable interference with interstate commerce.

One of the recognized ownership rights in ground water is that artificial pollution thereof by others can be the basis for recovery of damages. This has been held by a number of Texas Courts, including the Supreme Court, in cases wherein recovery was allowed against the operators of oil and gas leases for pollution that resulted from disposal of salt water through placing the salt water in open earthen pits. Findings were involved which established that the salt water percolated downward to the fresh water formation and did so in such amounts that the fresh water was polluted.

The significance of protection from pollution is also recognized in administrative law. Underground Water Conservation Districts are specifically granted the right to make and enforce rules against pollution and other wastes. Both the Texas Railroad Commission and the Water Pollution Control Board are empowered by Statute to concern themselves with prevention of pollution of ground water and each has issued and enforced orders preventing pollution.

(Continued on Page 4)

Water Law—

(Continued from Page 3)

Another incident of ownership is that water rights may be carved out of the over-all fee simple estate in the land and may be conveyed separately or may be reserved by the owner when the property is conveyed. There have been instances where water rights have been sold separate and apart from the surface, such as the sale of water rights to municipalities and the sale of water rights to oil companies for use in water flooding operations. Reservations of water rights are illustrated in that occasionally easements or rights-of-way on the surface are granted, but the water rights thereunder are reserved.

It can be generally concluded that in Texas, ground water is owned by the surface owner. The incidents thereof are generally those of full ownership, the major exception being that there is no remedy for taking of such private property through drainage occasioned by lawful neighboring pumping activities. There is, however, another limitation which deserves attention in this discussion. It arises by reason of the public's interest in ground water.

THE PUBLIC'S INTEREST IN GROUND WATER

Available potable ground water has long been recognized as a major factor in determining the value of land and in the promotion of economic well being and human happiness. This coupled with the fact that ground water aquifers do not conform to surface boundary lines has resulted in the recognition that the government is interested and has the right to take an interest in such waters.

A limitation upon exercise of ownership rights is found in the fact that wasteful uses or non-beneficial uses of ground water may be enjoined. Underground Water Conservation Districts are specificially authorized "to formulate, promulgate and enforce rules and regulations to prevent the waste, . . . of the underground water of the underground water reservoir or subdivision thereof." By statute pertaining to these water districts, waste is specifically defined in Art. 7880-3(c).

In addition to restrictions on waste, underground water districts are empowered to require spacing of wells and to forbid installation of wells until a permit has been obtained Language of the Supreme Court indicated the Legislature has authority to grant even broader powers to governmental agencies for management of ground waters. In the Corpus Christi vs. City of Pleasanton Case, the Court said:

"Undoubtedly the Legislature could prohibit the use of any means of transportation of percolating or artesian water which permitted the escape of excessive amounts, but it has not seen fit to do so."

This brings us to the place of considering what the future may hold with respect to management and regulation of ground water. Some concepts have already evolved and have been used in other areas of America, but are still novel to us, and some are objectionable now in our thinking for our area. Without in any way advocating any particular program, let me think with you about some of these concepts.

We live in an area where the supply of ground water is being depleted. We know it can be exhausted so far as agricultural needs are concerned; the only alternative which now seems possible is importation of water from other areas. This is not impossible. We are not the first civilization or economic segment of our nation to face this alternative. Others have successfully dealt with such a situation, but their experiences foretell that the physical movement of the water may well be the more easily solved phase of the problem. Financing, human relationships, and claims between people may be more difficult of solution. For this discussion let us assume that river compacts between states or even nations are already worked out and, therefore, water is available for importation. We still have the problem of financing and managing the water after it reaches our area.

It is obvious that we shall not individually import water. In the absence of individual importation there cannot be complete individual freedom in the management and use of imported water. The functions of importing water and managing such water must be conducted by some agency with authority to act for the whole group of users.

Without in any way here advocating such a program and knowing that we are talking about a time considerably in the future, we may do well now to at least consider some alternatives. We may not be willing to make the changes necessary for water importation, but let us at least examine the price tag and then make the decision.

Assistance in financing a water import program is available, but this does not mean that we are to avoid any participation in such costs. Our area participation will not and should not be limited solely to the one who uses or applies the water. Others will properly contribute because the continued prosperity of our agricultural water dependent area is important to them as well as the user of the water. In more blunt language, the importation into and distribution of water in our area would probably result in additional taxes or other forced contributions to the program. We have stated firmly that any Texas Water Plan must include our area; we shall be expected to help bear some of the cost. At this time, no one can say what system will be adopted in prorating our part of the cost, but it is not too early to start serious consideration of this. It is a new problem in the field of ground water and may well demand new concepts yet unknown to us.

Water brought into this area must be first stored and then distributed. Surface storage could avoid many problems that would arise if we were to store imported water in the underground aquifer. Yet, so much has been said about underground storage that at least some of the problems should be mentioned. Aside from the physical and engineering questions that would have to be answered, there is at least one major legal question. We treat ground water as private property; but what agency or group could possibly afford to finance the program if it were to lose both ownership and control as soon as it places water in storage beneath the surface of the ground?

Already, there has been one Texas example of this impasse. In 1957, the legislature authorized recharging of the Edwards Limestone formation. The same legislature, however, specifically preserved the private ownership of the injected water, once it was put underground. As a result, there has been no massive recharge program under this enabling act, even though surface water is readily available. Knowledgeable people in that area assure me it is impossible to arrange financing unless the agency which pays the bills also retains some authority over the injected water. I can believe that the same difficulties would be encountered elsewhere. I doubt that I would have enthusiasm to help pay for water to be imported and injected beneath the surface of your land if you become the owner of it the minute it is so injected, and I and those representing me thereupon lose all control over it. Neither would I have enthusiasm for granting authority to your and my agency to arbitrarily decide to take over storage space in the aquifer beneath my land for the benefit of the area generally. There may be some way to write the law so as to preserve private ownership and yet permit wide fair distribution of imported water from the underground storage. Until that way is found, I can believe that we shall have to move nearer to exhaustion of present ground water supplies before encountering widespread willingness to surrender private rights. Possibly, it is repulsive for you to even consider such possibilities, but it is time that we face our problems openly and honestly. This is possibly one of them.

I hope we can go the route of surface storage and avoid the complexities of disturbing ground water ownership law.

But regardless of storage systems, we have distribution problems to face. Are you willing for some agency to be granted the power of eminent domain to run either surface ditches or underground pipe across your land in order to transport water to mine? Yet the distribution of large quantities of imported water will inevitably require such authority. The distribution lines would have to go somewhere and costs will probably require that such lines follow the most direct route.

That some agency must also have proration authority. So far, ground water users are unaccustomed to being told how much water they can use and when they can use it Yet this experience is in prospect when we start irrigating with water from the Mississippi, San Juan, Missouri, or Columbia rivers.

The agency we have been somewhat contemplating may be the Federal, State, or Local government or some arm of one or more of them. I believe that most of us are more willing to accept regulations from local government than from government at a more remote level. At this time, we do not have any local government with the authority or scope that would be needed. Thoughtful contemplation of just what agency or agencies should handle these responsibilities are now in order. The sound thinking of many people knowledgeable in these fields is needed.

We shall move forward. We shall deal successfully with our problems. In doing so, let us carefully preserve those good things of the past and make certain that freedom from control is relinquished only with full safe guards and only where necessary for the purpose of providing benefits that are more important to our being than the rights we may relinquish. But at the same time, let us recognize the realities of life and not refuse to consider good things of the future merely because there are problems to solve

Second Class Permit

High Plains Underground Water
Conservation District No. 1
1628 Fifteenth Street
Lubbock, Texas 79401

THE Cross SECTION

A Monthly Publication of the High Plains Underground Water Conservation District No. 1

Vol. 14—No. 2 "THERE IS NO SUBSTITUTE FOR WATER" July 1967

Hale County Office To Open August 1

The Hale County office of the High Plains Underground Water Conservation District No. 1 will open Aug. 1.

The office is located at 1617 Main Steet in Petersburg, and a copy of all Hale County Water District records will be kept there.

Joe B. Mayo is the County Secretary for Hale County and will be conducting business for the District.

Landowners and farmers in Precinct 2 of Hale County will have the opportunity to register their existing well locations with the County office from August 1st to the 11th if they so desire. The County office will also receive applications for well permits on August 1st.

Beginning August 1, 1967, any well drilled in Precinct 2 of Hale County, producing in excess of 70 gallons per minute will be required to have a permit.

The Water District is very happy to have a new office opening in Hale County and looks forward to serving the people in Precinct 2.

Abandoned Wells Serious Problem

No one would knowingly endanger a small childs life. Yet, many landowners in Texas and the United States are doing it this very moment—endangering human lives by neglecting to close or plug abandoned wells that are no longer being used.

Open abandoned irrigation, domestic and industrial wells lurking as a menace to life (that have been abandoned for some reason) can be found in any county you choose to look.

Landowners who are in the High Plains Underground Water Conservation District No. 1 have made great progress in plugging abandoned wells, but, there are still many wells in the District that are not plugged.

Wells that are within the District and are not plugged are in violation of Rule 16 of the High Plains Underground Water Conservation District No. 1.

The rule reads as follows:

Every owner or operator of any land within the District upon which is located any open or uncovered well is, and shall be, required to close or cap the same permanently with a covering capable of sustaining weight of not less than four hundred (400) pounds, except when said well is in actual use by the owner or operator thereof; and

(Continued on Page 2)

TEXAS SUPREME COURT

Water Case Goes To Court

The Texas Supreme Court has set an October 25 hearing on the Sun Oil Company vs. Earnest Whitaker, et al., water case from Hockley County, Texas. The case, involving a question not yet decided by the Texas Supreme Court, deals with the free use of Ogallala water in secondary oil recovery operations.

The suit was brought by Sun Oil Company for an injunction against alleged efforts by Whitaker to prevent Sun from using his water, without due compensation, for water flooding purposes. Sun Oil Company contended they had the free use of the water under a mineral lease arrangement with Mr. L. D. Gann, owner of the mineral rights to the land.

The 121st District Court in Hockley County denied the injunction and the 7th Court of Civil Appeals at Amarillo upheld the denial.

HISTORY OF CASE

Sun Oil Company obtained an oil, gas and mineral lease April 5, 1946 from Mr. L. D. Gann on a 267 acre farm in Hockley County.

Gann deeded the land to Earnest Whitaker on January 2, 1948. Whitaker is now cultivating the land as an irrigated farm.

Gann deeded the land to Whitaker, reserving all minerals, and made the conveyance of the land subject to the terms of the oil and gas lease. The lease is still in affect by virtue of eight producing oil wells on the land.

During the past few years, production from the wells diminished greatly and Sun decided to water flood the lease. The Texas Railroad Commission issued approval to Sun Oil Company to water flood the lease by injecting fresh water into the oil bearing formation beneath the farm land. To accomplish the flooding operation, Sun drilled a water supply well on the farm.

The Company alleged, however, that Whitaker threatened repeatedly to prevent them from using the water for the water flooding operation.

The crucial question in the suit is the portion of the lease agreement which says, "lessee shall have free use of oil, gas, coal and water from said land except water from lessor's wells for all operations hereunder."

The critical phrase the Courts said was, "all operations hereunder."

"As far as we have been able to determine, this question has not been previously raised in this State," said the Civil Appeals Court opinion.

WATER FLOODING NEW

The High Plains Underground Water Conservation District No. 1 intervened in the suit with Whitaker, contending that at the time of the lease in 1946, secondary recovery by water flooding was unknown in the area. Both parties further alleged that Sun was limited to operations of a general nature which would not destroy the estate of the surface owner. Whitaker and the Water District also allege that it was not the intention of the parties who made the lease to permit Sun free use of any amount of water for a water-flooding project.

In the lower courts it was determined that secondary recovery by water flooding was not known in the Hockley County area until the 1950's. It was also established by the lower courts that the Ogallala is the only source for domestic and irrigation water in the area and that the source is only replenished by rainfall which is irregular and relatively insignificant.

Sun Oil Company, in the lower courts, has argued that it has authority under its oil and gas lease to water flood and that Whitaker and the Water District seek to stand in the way of progress.

FINAL VERDICT IMPORTANT TO THE AREA

The findings and decision of the Texas Supreme Court will be particularly important to the High Plains area.

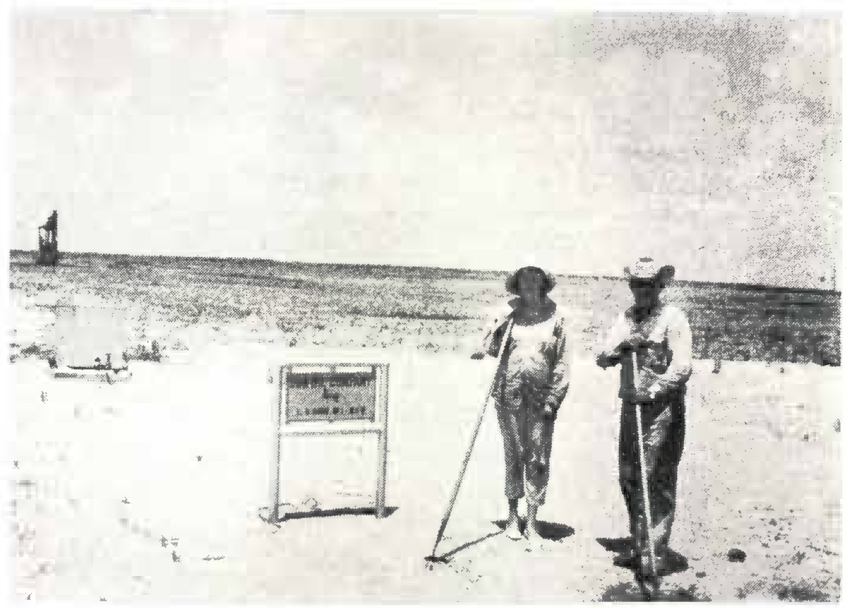
Sun Oil Company claims they will use only 65% of the water beneath Whitaker's land for their flooding operations.

If the court holds that Sun has the right to the free use of any water under Whitaker's land for water-flooding purposes, what will prevent it from using all the water if it is later found to be needed?

Further, should the court hold in favor of Sun Oil Company, land values in the High Plains area will suffer a tremendous decline in value.

Would a knowledgeable buyer purchase any farm as an irrigated farm if Sun's contention is correct? Many farmers have purchased farms at irrigated farm prices completely relying upon the fact that the surface owner has the right to use the water in storage under his land.

People have to have fresh water to live—oil can be recovered without using FRESH water.



Mr. and Mrs. Earnest Whitaker of Route 4, Levelland, pause near the water supply well that Sun Oil Company has drilled on their farm. Water is being produced from the well to water flood Sun's oil lease. Sun contends they have the free use of the water beneath Whitaker's farm to use in water flooding their lease. Whitaker contends that Sun has no right to the free use of his water for water flooding purposes. The State Supreme Court will soon decide if Sun Oil Company has the right to the free use of the water beneath Whitaker's farm.

THE Cross SECTION

A MONTHLY PUBLICATION OF THE HIGH PLAINS UNDERGROUND WATER CONSERVATION DISTRICT No. 1

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Committee meets last Friday of each month at 2:30 p. m., 217 Avenue B, Muleshoe, Texas.

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Committee meets on the last Saturday of each month at 10:00 a. m., City Hall, Dimmitt, Texas.

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Western Abstract Co., Morton, Texas
D. A. Ramsey, 1970 .... Star Rt 2, Morton
Ira Brown, 1968 .... Box 774, Morton
Williard Henry, 1969 .... Rt. 1, Morton
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E. J. French, Sr., 1968 .... Rt. 3 Levelland
Committee meets on the second Wednesday of each month at 8:00 p. m., Western Abstract Co., Morton, Texas.

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High Plains Water District
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Frank Zinser, 1970 .... Rt 5, Hereford
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L. B. Wortham, 1970 .... Rt 3, Hereford
Committee meets the first Monday of each month at 7:30 p. m., High Plains Water District office, Hereford, Texas.

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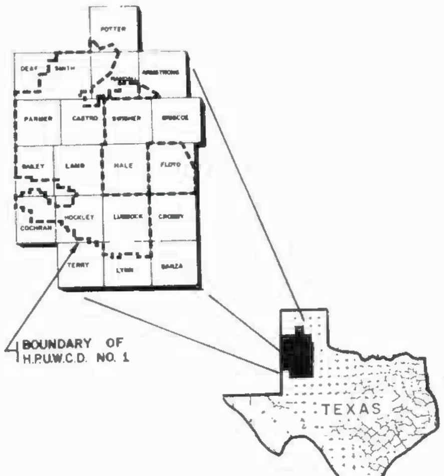
Sam Puckett
325 E. Houston St., Floydada, Texas
Pat Frizzell, 1970 .... Box 1046, Lockney
J. S. Hale, Jr., 1969 .... Rt 1, Floydada
Tate Jones, 1970 .... Rt 4, Floydada
M. M. Julian, 1968 .... Box 65, South Plains
M. J. McNeill, 1968 .... 833 W. Tenn., Floydada
Committee meets on the first Tuesday of each month at 10:00 a. m., Farm Bureau Office, Floydada, Texas.



Hale County
J. B. Mayo
1617 Main, Petersburg, Texas
Charles Schuler, 1970 .... Petersburg
Don Hegi, 1970, ... Box 160 A, Petersburg
W. D. (Dub) Scarborough, 1969 .... Box 147, Petersburg
Harold D. Rhodes, 1968 .... Box 100, Petersburg
J. C. Alford, 1968 .... Box 28, Petersburg

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Murray C. Stewart
208 College, Levelland, Texas
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H. R. Phillips, 1968 .... Rt 4, Levelland
S. H. Schoenrock, 1969 .... Rt 2, Levelland
Committee meets first and third Fridays of each month at 1:30 p. m., 917 Austin St., Levelland, Texas.

Lamb County
Calvin Price
620 Hall Avenue, Littlefield, Texas
Jack Thomas, 1970 .... Box 13, Olton
Roger Haberer, 1968 .... Earth
W. B. Jones, 1969 .... Rt 1, Anton
Troy Moss, 1968 .... Rt 1, Littlefield
Lee Roy Fisher, 1970 .... Box 344, Sudan
Committee meets the first Thursday of each month at 8:00 p. m., Crescent House Restaurant, Littlefield, Texas.

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Mrs. Doris Hagens
1628 15th Street, Lubbock, Texas
R. F. (Bob) Cook, 1970 .... 804 6th Pl, Idalou
Bill Hardy, 1968 .... Rt 1, Shallowater
Bill Dorman, 1970 .... 1910 Ave E, Lubbock
Edward Moseley, 1969 .... Rt 2, Slaton
W. O. Roberts, 1968 .... Rt 4, Lubbock
Committee meets on the first and third Mondays of each month at 1:30 p. m., 1628 15th St., Lubbock, Texas.

Lynn County
Mrs. Doris Hagens
1628 15th Street, Lubbock Texas
Don Smith, 1969 .... Box 236, New Home
Harold G. Franklin, 1968 .... Rt 4, Tahoka
Roy Lynn Kahlich, 1970 .... Wilson
Roger Blakney, 1970 .... Rt 1, Wilson
Reuben Sander, 1968 .... Rt 1, Slaton
Committee meets the third Tuesday of each month at 10:00 a. m., 1628 15th Street, Lubbock, Texas.

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Aubrey Brock
Wilson & Brock Insurance Co., Bovina, Texas
Webb Gober, 1969 .... RFD, Farwell
Henry Ivy, 1970 .... Rt 1, Friona
Jim Ray Daniel, 1970 .... Friona
Carl Rea, 1968 .... Bovina
Ralph Shelton, 1968 .... Friona
Committee meets on the first Thursday of each month at 8:00 p. m., Wilson & Brock Insurance Agency, Bovina, Texas.

Potter County
Fritz Meneke, 1970 .... Rt 1, Box 538, Amarillo
W. J. Hill, Jr., 1969 .... Bushland
L. C. Moore, 1968 .... Bushland
Jim Line, 1968 .... Bushland
Vic Plunk, 1970 .... Rt 1, Amarillo

Randall County
Mrs. Louise Knox
Randal County Farm Bureau Office, Canyon
R. B. Gist, Jr., 1968 .... Rt 3, Box 43, Canyon
Ralph Ruthart, 1969 .... Rt 1, Canyon
Carl Hartman, Jr., 1968 .... Rt 1, Canyon
Marshall Rockwell, 1970 .... Canyon
Richard Friemel, 1970 .... Rt 1, Canyon
Committe meets on the first Monday of each month at 8:00 p. m., 1710 5th Ave., Canyon, Tex.

Abandoned Wells—

(Continued from Page 1)

Children are curious, these boards are easily moved.

no such owner or operator shall permit or allow any open or uncovered well to exist in violation of this requirement. Officers, agents and employees of the District are authorized to serve or cause to be served written notice upon any owner or operator of a well in violation of this rule, thereby requesting such owner and/or operator to close or cap such well permanently with a covering in compliance herewith. In the event any owner or operator fails to comply with such request with in (10) days after such written notice, any officer, agent, or employee of the District may go upon said land and close or cap said well in a manner complying with this rule and all expenditures thereby incurred, shall constitute a lien upon the land where such well is located, provided, however, no such lien shall exceed the sum of One Hundred Dollars ($100.00) for any single closing. Any officer, agent, or employee of the District, is authorized to perfect said lien by the filing of the affidavit authorized by Article 7880—3c B (11) as amended by acts of the 75th Legislature 1961, Chapter 493, pages 1095 and 1096, House Bill No. 692. All of the powers and authority granted in such 1961 amendment are hereby adopted by the District, and its officers, agents, and employees are hereby bestowed with all of such powers and authority. (Effective March 28, 9162.)

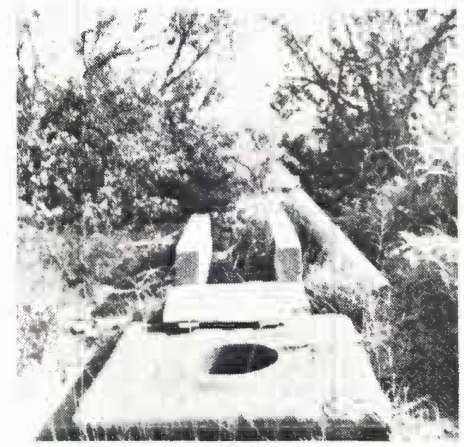
During the past few weeks representatives of the District have found several wells that have been abandoned and not properly plugged. On one occasion there were farm workers in a near-by field working while their small children played near an open well.

It's awful easy to throw a few boards over an abandoned well and say its plugged, but who is responsible if the boards rot and some child or adult falls through.

With the area receiving large amounts of rain lately, some of these abandoned wells could have caved in or sunken, causing added danger.

The High Plains areas have been very lucky to date, having lost no lives to abandoned and unplugged wells. Our luck can't hold forever.

If you have an abandoned well that is not properly plugged, today is the time to plug it. Let's not have a similar accurence on the High Plains or in the State, such as was experienced near Houston earlier this year, when a child was almost lost, due to an old well that was improperly covered.



A child's life could be lost here.

Microscopic quantities of water can produce gigantic effects. Single drops of rain exert many pounds per square inch of pressure on surfaces they contact, and single drops of water freezing in narrow crevices can split the strongest rocks. Such micro-effects, including solution by dissolved carbon dioxide, are responsible for major changes in our weathering landscapes.

Water serves other than physical needs of man. To millions of devout Indians the Great Ganga (formerly the Ganges) is sacred, so sacred in fact that they consider it to be beyond any adverse effect (pollution) of the millions who populate its banks.

DRILLING STATISTICS FOR JULY

During the month of July permits were closed on 112 new wells within the High Plains Underground Water District; 7 replacement wells were drilled and 6 wells were drilled that were either dry or non-productive for some other reason. The County Committees issued 85 drilling permits.

County	Permits Issued	New Wells Completed	Replacement Wells Drilled	Dry Holes
Armstrong	0	0	0	0
Bailey	6	3	1	1
Castro	18	21	0	1
Cochran	3	4	0	0
Deaf Smith	14	17	1	0
Floyd	4	12	0	0
Hale	0	0	0	0
Hockley	3	11	0	2
Lamb	8	12	1	1
Lubbock	10	7	1	0
Lynn	0	0	0	0
Parmer	5	22	3	1
Potter	0	0	0	0
Randall	14	3	0	0
TOTAL	85	112	7	6

Attorney General Acts On Well Driller

Attorney General Crawford C. Martin recently announced that his office has just concluded the first law suit brought to enforce the Texas Water Well Drillers Act.

This first court case brought under the Act was tried in the 67th Judicial District Court of Tarrant County in Fort Worth. Final judgment was entered by Judge Harris Brewster on Monday, June 5, 1967, permanently enjoining the defendant from conducting water well drilling activities in Texas in violation of Article 7621e and the Drillers Rules and Regulations.

While numerous other unlicensed drillers have applied for license to the Water Drillers Board, Sam Houston Building, Austin, Texas, this is the first case where enforcement of the law was accomplished through court action.

The Drillers Act, Article 7621e Vernon's Civil Statutes, was enacted by the 59th Legislature and became effective September 1, 1965. The stated purpose of the Act is " . . . the prevention of pollution of the State's underground water by providing minimum water well driller qualifications and standards of conduct."

Martin said that under the provisions of the Act, any person now desiring to drill water wells in Texas for compensation must pass an examination given by the Texas Water Well Drillers Board, provide the Board with a $2,000 indemnity bond for the benefit and protection of the general public, submit drilling logs for each completed well, and comply with the rules and regulations of the Board.

The Texas Water Well Drillers Board is composed of nine members. The six voting members appointed by the Governor are J. D. Kirkland of Hereford, Texas; Owen F. Jensen, Jr., Houston, Texas;V. E. West, Athens, Texas; W. D. Jones, Dumas, Texas; C. F. Gill, El Paso, Texas; and Murray Don McKinley, Pearsall, Texas. Three of the members are ex officio nonvoting members: Joe G. Moore, the Executive Director of the Texas Water Development Board; Hugh Yantis, the Executive Secretary of the Texas Water Pollution Control Board; and Hampton C. Robinson, M. D., who is Chairman of the Board of Health.

Enforcement of Water Well Drillers License Law continues by the Attorney General's Office.

Unregistered Drillers served by the Attorney General's Office are restricted from continuing water well drilling operations until they obtain registration.

Reporting of unregistered drillers who are drilling water wells without a license, has and continues to be effective, in obtaining compliance with the Driller's Act.

Water-lifting devices—pumps of a sort—have been used for at least 5,000 years. The Egyptian Shaduf and Archimedes screw are well-known examples.

Water first was used for telling time in 250 B. C. and a water clock called a clepsydra involving a relatively elaborate gear train was described by a Roman engineer in 95 B. C.

Acreage Limitations

By BILL J. WADDLE

During the past year the State of Texas and especially West Texas has constantly talked of importing surplus surface water to the High Plains area.

Planners have long been aware that there are many problems associated with moving water—political and engineering. Other problems are also present that affect the water user.

In areas where projects have been developed under Federal Reclamation Law, the controversial land limitation provisions of the 1902 Reclamation Law has been, and still is, a great problem for the water user.

The Federal Reclamation Law, as presently interpreted, limits irrigation water deliveries from federal projects to 160 irrigable acres of farm land in individual ownership, 320 irrigable acres jointly for man and wife.

Two objectives are reflected in this provision in federal law. First, it is desired that the greatest number of direct beneficiaries result from federal investments in irrigation projects or so-called "family size" farms. Secondly, it is designed to discourage speculation in farm land values in anticipation of project construction.

Speculation in farm land has been a detriment to federal irrigation development. To the extent that the acreage limitation controls such speculation, a worthwhile purpose is served.

However, "family size" farm concept is an indefinite variable depending upon climate, soils, cost of water service, type of farm enterprise, management ability, availability of labor, cost of equipment versus degree of utilization, prices for farm products and other factors. The acreage limitation as presently imposed is not in harmony with the presently accepted standard of living for a farm family.

18th Century Concept

The 160-acre limitation provisions in the Reclamation Act had their origin in the 105-year-old Homestead Act—a measure passed by Congress in 1862 to stimulate settlement of the West.

Under the Homestead Act, any person who had filed his first papers or was a citizen at least 21 years old and head of a family could enter upon a quarter section—160 acres—of public land. After residing on and farming the land for a stipulated number of years he was issued a patent to the land by the Federal Government.

Somehow this 160-acre concept became associated with the supplying of water by the government to developed farms as well as undeveloped arid public lands.

The late U. S. Senator Sheridan Downey, a leading authority on the land limitation issue, said in his book, *"They Would Rule the Valley"*: "The 160-acre figures have no particular revelance to any agricultural theory of what an economic unit should be under varying soil, crop and terrain conditions; it was used because it was traditionally associated with the homestead laws in opening up the public domain."

Modified Concept

The Secretary of the Interior has advanced a modified concept of the acreage limitation to the effect that 160 acres of a "Class 1 land equivalent" be the basis for water service from federal irrigation facilities.

Generally speaking, irrigable lands on federal projects are divided into Class 1, Class 2, and Class 3, depending upon their relative ability to produce crops. (Other factors involved in the classification of these lands are soil type, topography, and drainage of the soil below the root zone.)

Class 2 lands have the capability to produce 80 percent of the amount of crops that Class 1 lands can be expected to produce. Class 3 lands have capability of perhaps 65 percent as compared to Class 1. This concept advanced by the Secretary of the Interior would allow delivery of project water to a sufficient number of Class 2 or Class 3 acres to provide the same capability as 160 acres of Class 1 land.

The "Class 1 land equivalent" is a meaningful modification of the strict 160-acre limitation. It should be recognized, however, that this is a partial answer only. It covers the relative ability of different lands to produce farm crops in a given climate. It does not adequately cover differences in productive capacity caused by climatic conditions. The latter variable influences dollars earned—a measure of an acceptable standard of living for the farm family or any other family.

Affects Of Limitations

California farmers have been living with the acreage limitation problem for several years. Most farmers agree it is near impossible to make a living farming land under the land limitation provisions of the 1902 Reclamation Law.

In an attempt to "update" the land limitation provisions of the Reclamation Law, Governor Reagan of California was the first State Administrator to act. He recently appointed a five-man task force to draft amendments which could be offered Congress to "afford rational approaches to the different situations which face California agriculturalists."

These approaches could also affect High Plains farmers if surplus surface water is imported to West Texas.

Officials of the Irrigation Districts Association of California and the National Reclamation Association have pointed out that while the "original Reclamation Act has been amended to permit supplemental water deliveries to lands already irrigated, Federal Administrative Agencies have proposed to impose acreage limitations in areas which would be in conflict with the local reliance upon contracts with the Federal Government and the long-standing announced policies of the Administrative Agencies." (An instance of this nature is the suit brought by the U. S. against the Imperial Irrigation District in California to upset a 30-year-old Federal ruling and apply acreage limitations within the District.)

Another announced intention of the Department of Interior that would affect West Texas farmers is the attempt to apply land limitation policies in ground-water basin areas, such as the Ogallala, that would be receiving only supplemental project water. (A classic example here is that of the U. S. proposing to apply acreage limitations to all acres in Santa Clara and neighboring counties in California receiving water from the Bureau of Reclamation's San Felipe Division of the Central Valley Project. Only a small percentage of water to be used in the area will be supplied by the project, but by following the water into the underground reservoir, the U. S. would apply land limitations to anyone who pumps any water in the service area for more than 160 acres). This would apply directly to High Plains farmers when surface water is imported to West Texas. Unless of course, the 160-acre law can be changed.

It has also been declared that "the Department now asserts the continuing applicability of acreage limitation in a Reclamation project where the agency contracting to pay the reimbursable costs thereof has fully repaid all such reimbursable costs, thus controverting a basic concept and interpretation of Reclamation law which has been repeatedly recognized and ratified by Congress and has existed and been uniformly applied and relied upon since the passage of the Reclamation Act of 1902." (An illustration of this situation is that of Isabella Dam on the Kern River in California — a Federal project—where the entire Federal contribution to water conservation benefit has been repaid to the government by the farmers owning rights to the water, but the U. S. has told the landowners that land limitations will nevertheless be enforced.) The above quoted examples of impractical application of the old land limitation law which creates inequity with other Federal programs on the farm bears every West Texas landowner's keen interest.

The High Plains area will have surplus water imported for agricultural use! When the engineering and construction is completed, we will still have the "out dated" land limitation provision of the 1902 Reclamation Law to "live" with, unless we start today working for a change in the law that will allow a farmer to farm and irrigate enough land to make a living. It is evident, many politicians haven't tried to produce 17 cent cotton, buy farm equipment, raise a family, and make a living on 160 acres of farm land.

The High Plains Underground Water Conservation District No. 1 urges everyone to lend a hand and help get the land limitation provisions of the Reclamation Law changed. Write your representatives in Congress and express your views.

Imported water will be good for West Texas—So will a change in the acreage limitations of the Reclamation Law.

This abandoned well could cost someone his life.

High Plains Underground Water
Conservation District No. 1
1628 Fifteenth Street
Lubbock, Texas 79401

Second Class Permit

THE Cross SECTION

A Monthly Publication of the High Plains Underground Water Conservation District No. 1

Vol. 14—No. 3 "THERE IS NO SUBSTITUTE FOR WATER" August 1967

PLAN AHEAD TO SAVE WATER

Irrigation is now in its last stages, grain sorghum, soy beans, vegetables and other crops dot the High Plains area with beautiful picturesque scenes, while farmers are looking forward to a bountiful harvest—that is the situation in the High Plains of Texas today.

During the time period between the irrigation season and harvest season is the time farmers should make plans for the conservation of water on their farms next year. Decisions should be made now while the water problems they faced this year are still on their minds. Some of these problems being; rainfall run off, small wells, lack of sub surface moisture, evaporation losses and all the other problems farmers face when raising crops under irrigation.

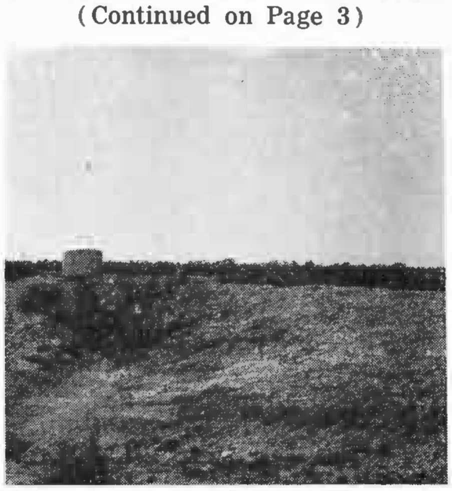
One of the most prevalent and probably the least observed problem is the loss of irrigation and rainfall runoff from the farm. Far too many farmers have been neglecting the fact that they can lose up to 44.8% of their rainfall as runoff from dry land farms in the Lubbock area.

Studies being conducted by the Texas Agricultural Experiment Station at Lubbock, Texas reveal that different percentages of rainfall are lost from farms depending on the slope of the land surface.

In these studies, which are partially financed by the High Plains Underground Water Conservation District No. 1, five different plots of land with different degrees of slopes are being observed. The slope of the plots varies from level land to land with 1.2% slope.

Rainfall that is subject to run off is being recorded and the actual run-

(Continued on Page 3)



Runoff recording flume used to record runoff at the Lubbock Station.

BUREAU OF RECLAMATION

Water Import Studies

In January of 1967 the Bureau of Reclamation initiated water importation studies for West Texas and Eastern New Mexico. These studies were funded by the 1967 Public Works Appropriation Act.

The purpose of the studies is to formulate and evaluate on a reconnaissance basis alternative, plans for importing water from the Mississippi River system to the portion of Texas west of a line from Wichita Falls through Abilene to Del Rio and the portion of Eastern New Mexico, including the High Plains, the Pecos River Basin, and the Canadian River.

The study area includes the High Plains of Texas and New Mexico, where virtually all municipal, industrial, and irrigation water requirements are supplied from ground water stored in the Ogallala formation.

An inventory of irrigation by the Texas Water Development board and the Soil Conservation Service shows that about 7¾ million acre feet of ground water from the Ogallala were used to irrigate about 5 million acres on the Texas High Plains in 1964.

Similar studies by the State of New Mexico indicate an annual depletion of 1,107,000 acre feet per year for the irrigation of 492,000 acres of land on Curry, Lea and Roosevelt Counties of New Mexico.

Recharge to the Ogallala aquifer is only a minor fraction of current withdrawals, which are expected to increase as additional lands are placed under irrigation. As a result, the large volume of water stored in the Ogallala formation eventually will be depleted, and most of the present irrigation will disappear, with resulting major damage to the area's economy, unless water is imported into the area to replace the depleted ground water.

The process of ground water depletion and declines in ground water levels is well advanced in the Southern Texas High Plains, in the general vicinity of Lubbock, where large-scale irrigation development first occurred and where total ground water withdrawals have been the largest. In this area, most of the irrigation must cease within the foreseeable future unless imported water supplies are made available to the irrigators. There has been a critical decline in the ground water levels in the Portales Valley of New Mexico and irrigation has already essentially ceased in part of the valley.

The accompanying table shows Texas Water Development Board projections of West Texas requirements for importation of water for irrigation by decades from 1980 through 2020. As shown in the table, the Texas High Plains accounts for 6,375,000 acres of a total of 7,276,000 acres in 2020 and annual irrigation requirements of 12,750,000 acre-feet of a total of 15,086,000 acre-feet in 2020. The tabulation on the map defining the New Mexico service area shows an annual requirement of 3,128,000 acre-feet in 2020, and an ultimate annual requirement of 20,455,000 acre-feet. The annual requirement of the service area in the year 2020 totals 18,214,000 acre-feet. The magnitude of the estimated requirements, now available, establishes that it will be necessary to evaluate all major possible import routes to

(Continued on Page 2)

TEXAS WATER DEVELOPMENT BOARD ESTIMATES OF WEST TEXAS IRRIGATION IMPORT REQUIREMENTS

	1980		1990		2000		2010		2020	
	Acres (thousands)	Ac.-Ft.	Acres (thousands)	Ac.-Ft.	Acres (thousands)	Ac.-Ft.	Acres (thousands)	Ac.-Ft.	Acres (thousands)	Ac.-Ft.
UNIT NO. 1										
High Plains 1/	870	1,740	1,859	3,718	2,622	5,244	3,351	6,702	3,812	7,624
North-Central Tex. 2/	20	42	60	128	95	202	95	202	95	202
Total Unit No. 1	890	1,782	1,919	3,846	2,717	5,446	3,446	6,904	3,907	7,826
UNIT NO. 2										
High Plains 3/	......	....	862	1,724	1,350	2,700	1,722	3,444	2,025	4,050
North-Central Tex. 4/	......	....	90	192	125	267	165	352	205	437
Trans-Pecos 5	......	....	142	492	198	686	254	881	311	1,078
Total Unit No. 2	......	....	1,094	2,408	1,673	3,653	2,141	4,677	2,541	5,565
UNIT NO. 3										
High Plains 6/	......	....	....	....	261	522	389	778	538	1,076
North-Central Tex. 7/	......	....	....	....	90	192	190	405	290	619
Total Unit No. 3	......	....	....	....	351	714	579	1,183	828	1,695
TOTAL-WEST TEX.	890	1,782	3,013	6,254	4,741	9,813	6,166	12,764	7,276	15,086

1/ Area south of sandhills, in Bailey and Lamb Counties to the southern edge of High Plains.

2/ 70,000, Haskell and Knox Counties; 10,000, northern Knox County; 15,000, Knox and Baylor Counties.

3/ Area north of sand hills to Canadian Breaks.

4/ 40,000, Cottle County, 70,000, Hardeman and Wilbarger Counties; 70,000, Foard and Wilbarger Counties; and 25,000, Glasscock and Reagan Counties.

5/ Reeves, Pecos and Ward Counties only.

6/ North of the Canadian Breaks.

7/ 30,000, Collingsworth County; 20,000, northern Hall County; 12,000, southern Hall; 12,000, Motley County; 40,000, Stonewall County; 60,000, Mitchell and Nolan Cuonties; 50,000, Haskell County; 50,000, northern Jones County; 50,000 Jones and Taylor Counties; 21,000, Callahan County; 17,000, southern Toylar County; 15,000, southern Callahan County; 15,000, Runnels County; 60,000, Tom Green and Concho Counties; 10,000, McCulloch County; 15,000, San Saba County. Total 477,000.

THE Cross SECTION

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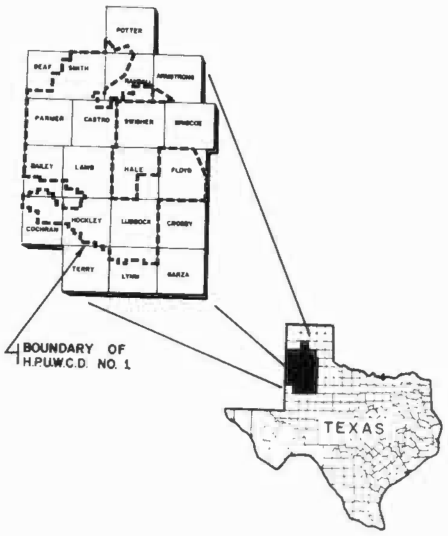

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Ralph Shelton, 1968 .... Friona
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Richard Friemel, 1970 .... Rt 1, Canyon
Committe meets on the first Monday of each month at 8:00 p. m., 1710 5th Ave., Canyon, Tex.

Import Studies—

(Continued from Page 1)

the full extent of their physical capabilities.

Irrigation requirements on the High Plains are largely concentrated in the summer months, with at least 25 percent of annual requirements occurring in August. In order to minimize construction costs for import facilities, plans for those facilities will be based on uniform deliveries for 11 months of the year, with deliveries in excess requirements being stored in terminal reservoirs for release to irrigators in months when requirements exceed import capacities. Several large depressions on the High Plains and reservoir sites on streams traversing, or disecting the area, afford favorable opportunities for creating reservoirs, and geologic and engineering studies of these sites are now in progress.

Import Routes

As shown on the map, nine possible routes for importing water from the Mississippi River system to West Texas and Eastern New Mexico are now being studied. Four possible diversion points are involved, as follows:

A. Mississippi River at the mouth of the St. Francis River.

B. Mississippi River at the mouth of the White River.

C. The Old River control structure at the confluence of the Red and Mississippi Rivers, where the Atchafalaya River begins.

D. The Atchafalaya River downstream from the control structure.

The alternative import routes being studied are as follows:

1. From Diversion B up the navigation channel being constructed by the Corps of Engineers on the White and Arkansas Rivers to Robert S. Kerr Reservoir; then by canal to Eufaula Reservoir; and then by canal along the divide south of the Canadian River to the Texas High Plains.

2. From Diversion B up the above navigation channel to Webbers Falls Reservoir; then by canal between the Deep Fork and Cimarron Rivers Basins to central Oklahoma; and then by canal between the Canadian and North Canadian River Basins to the Texas High Plains.

3. From Diversion A westward by canal via De Valls Bluff, Conway, Danville, Hartford, and Wilburton to Eufaula Reservoir, and then by canal via either route 1 or 2 to the Texas High Plains.

4. From Diversion B up the navigation channel on the White and Arkansas Rivers to Lock and Dam No. 5; then westward by canal via Malvern and Mena, Arkansas, and Kiowa, Oklahoma, to the divide south of the Canadian River; then by canal up that divide to the Texas High Plains.

5. From Diversion C up the Red River to the mouth of the Sulphur River; then up the Sulphur River to Cooper Reservoir; and then by canal generally along the divide between the Red River Basin and adjoining basins on the south to the Texas High Plains.

6. From Diversion D by canal to the Sabine River; then up the Sabine River to Lake Tawakoni; then by canal across the upper end of the Sulphur River Basin to join Route 5; and then by Route 5 to the High Plains.

7. From Diversion D by canal to the Sabine River, as in Route 5; then by canal to the Brazos River; then up the Brazos River to Possum Kingdom Reservoir; then up the Clear Fork of the Brazos River to the vicinity of Rotan; and then by canal to the High Plains.

8. From Diversion D by canal to the Brazos River, as in Route 7; then by canal to the Colorado River; then up the Colorado and Concho Rivers; and then either by canal or by San Angelo Reservoir and canal to the High Plains.

9. From Diversion D by canal to a point east of Galveston Bay as in Route 7; then up the Trinity River to join Route 5; and then by Route 5 to the High Plains.

The imported water would be pumped upstream along the various routes through existing, authorized, and potential reservoirs whose construction would be required. Pumping plants would be required at intervals along canal sections of these routes.

Many problems will still be present when these studies are completed—These problems will have to be resolved by the people of West Texas and Eastern New Mexico.

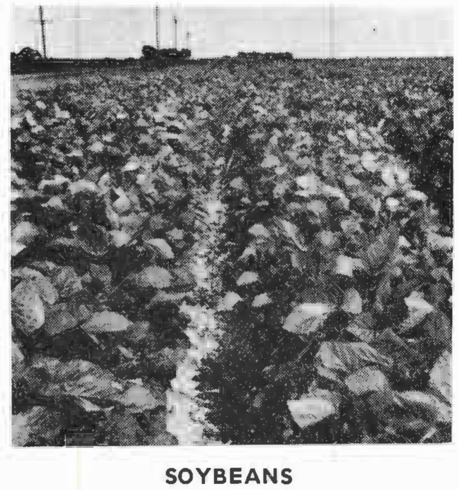
Paying for the water, a delivery system, and land are just a few of the problems.

It's not too early for the local people to begin to resolve these problems—*Let's get to work!*

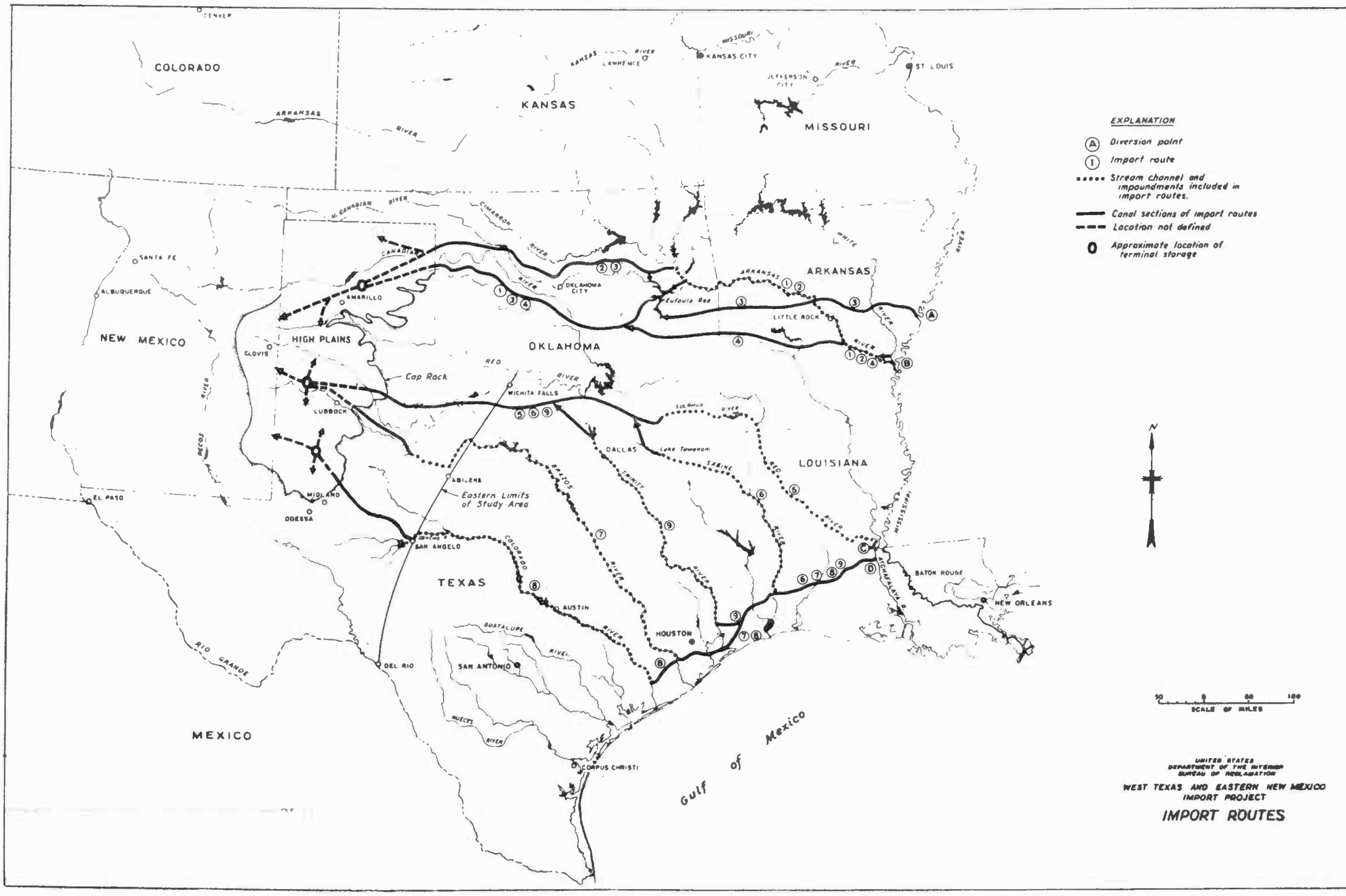
Feast or famine are close neighbors in many monsoon climates such as in India. People in the Ganga Plain depend primarily on effective utilization of water provided by the brief rainy season. However, beneath the Ganga Plain is more than enough ground water to sustain a continuous effective agriculture.

SOME CROPS OF THE HIGH PLAINS

COTTON



SOYBEANS



Plan Ahead—

(Continued from Page 1)

off is being measured by runoff recording devices installed on each individual plot.

The land plots being studied are also being observed under different moisture levels.

See Table I.

You will notice in this table that land with no slope had no runoff under any moisture level. Land with a slope of 1.2% that had no irrigation water applied, lost 44.8% of the rainfall.

Land leveling can, and in many instances, will eliminate the problem of rainfall runoff. This practice is very simple. All you do is go in and completely level the land so it has no slope at all.

In areas of permeable soil, run off is eliminated and the water gets into the soil where it can be stored or put to instant use.

Research at the Lubbock Station shows just how expensive runoff can be. See Table II.

In Table II you can see for yourself what the difference in yields are on land with different slopes.

Leveling can be just as effective on irrigated land. You save both runoff and tailwater losses. You can run your water down the furrow. It just takes a larger head of water.

Researchers at the Lubbock Station figure that completely level land saves about one summer irrigation per year. This amounts to about four acre inches of water — enough to make a difference of 100 pounds of lint per acre. At $20. to $40. an acre for leveling it wouldn't take long to pay for itself, and this is adapted to about 5 million acres in the Southern High Plains.

Land-leveling practices can also be used on lands with a great degree of slope. This calls for benching, which involves building a series of level shelves, similar to broad flat steps. Cost of building level benches usually runs from $30. to $90. per acre, depending on the degree of slope. You can usually recover this in less than ten years by storing irrigation and rainfall water once lost as runoff.

Level terracing is another system you can use on moderately sloping land, especially where the soil is deep and highly permeable. Level terraces are built with no grade in the terrace channel. Ridgetop and channels are constructed level so that runoff is stored along the terrace. Ends of terraces are usually closed, so that the soil is the only terrace outlet. The principle here, again is to hold the water on the land long enough to infiltrate into the soil.

Level terraces are well suited in our area where we have a low rainfall of 18 to 22 inches per year.

Vegetative practices work good in holding the rainfall where it falls. A good cropping system that maintains the organic matter at a high level in the soil will improve the intake rate for both rainfall and irrigation water. Leaving as much residue as possible on the soil surface for as long a period as possible reduces soil evaporation losses.

Leveling land to eliminate rainfall runoff will make you profits today and also in the future.

When water is imported to our area, and farmers pay for it by the acre foot, every drop saved will be profit made.

Make plans today to install some conservation practice on your farm to save the water you have.

TABLE I PERCENT OF WATER LOST FROM RAINS CAUSING RUNOFF.

Texas Agricultural Experiment Station, Lubbock, Texas—1964, '65, and '66. 1/

Moisture Level	Percentage Slope 0.0%	0.2%	0.5%	0.9%	1.2%
Dryland	0	23.6	32.4	39.7	44.8
PP Only	0	20.0	18.0	29.2	26.8
Preplant Plus 1 Irrigation	0	18.6	21.3	29.2	27.4

1/ Total rainfall subject to runoff was 4.04 inches in 1964, 8.66 inches in 1965 and 11.28 inches in 1966. Totals were from 4 rains in 1964, 7 rains in 1965 and 7 rains in 1966. Total annual rainfall was 12.81 inches in 1964, 12.61 inches in 1965, and 18.13 inches thru September 1966.

TABLE II—COTTON YIELD IN POUNDS OF LINT PER ACRE FOR 5 SLOPES AND 3 MOISTURE LEVELS ON LOAM SOIL.

Texas Agricultural Experiment Station, Lubbock, Texas — 1963-66

Percent	DRYLAND 1/					PREPLANT ONLY 2/					PP PLUS 1 IRR. 3/					Slope
Average	63	64	65	66	Avg	63	64	65	66	Avg	63	64	65	66	Avg	Average
0.0%	636	184	35	232	272	527	284	332	275	354	657	319	515	244	434	353
0.2%	326	78	0	211	154	426	200	249	250	281	547	222	505	208	370	268
0.5%	397	60	0	157	154	397	216	260	216	272	403	259	289	201	288	238
0.9%	250	49	0	93	98	339	259	116	186	225	613	380	308	192	373	232
1.2%	211	37	0	98	86	432	226	207	148	253	454	368	282	164	317	219
Moisture Level Average			153					277					357			

1/ 1963 crop followng heavy rainfall in September 1962. Water stored in level borders produced favorable yield in 1963. Rainfall for 1963, '64, '65, and '66 were 16.46, 12.81, 12.61, and 18.13 respectively.

2/ Preplant only borders received a 4-acre-inch irrigation before planting.

3/ These borders received a 4-inch preplant plus 1 summer irrigation at the peak bloom stage of cotton growth.

GEOLOGY OF WATER IMPORTATION

By C. C. REEVES, Jr. and W. T. PARRY
Assistant and Associate Professors of Geosciences Respectively, Texas Technological College

During the last year or so considerable attention has been devoted to various ideas of water importation to the Southern High Plains of West Texas, yet surprisingly little has been said about just what will be done with the water once it arrives. Obviously the amount of imported water, if and when realized ,will be of such magnitude that it will have to be gathered in suitable large capacity, strategically located storage reservoirs for distribution or it will have to be immediately transferred into the Ogallala aquifer.

The professional concerned with the many facets of water importation. as well as the man-in-the-street, well knows that the tremendous cost of this project leaves little financial room for the added cost-burden of constructing a great complex of artificial storage reservoirs. Thus, one practical solution concerns the possible utilization of existing storage facilities such as the Yellow-Illusion Lake basin, Tule and Palo Duro Canyons, and even Yellowhouse Canyon in the Lubbock area. Initially this seems an excellent idea, for who in West Texas wouldn't be pleased with a vast lake-reservoir complex resembling the TVA chain of Kentucky, Alabama, and Tennessee, but irrigation water in Tule or Palo Duro Canyons isn't much good to Hockley or Lynn County farmers. However, using lake basins on the Plains, though geographically better suited, is a proposal fraught with complex geologic difficulties . . . Let's examine some of these:

The first of the natural basins in the West Texas area which come to mind as possible storage reservoirs are the so-called "playa lakes". The number of these shallow, small deflation basins supposedly ranges as high as 37,000 but we have personally never counted more than about 900 to 1,000 per normal county area (about 900 square miles), and generally density is much less. Although these small basins exist in admirable numbers and exhibit a wide geopraphic distribution, they are woefully deficient in the size, storage capacity, and depth necessary for good reservoirs. Secondly, although the regional geographic occurance would help immeasurably in final distribution of water to individual users, how in the world could each individual basin be filled except by rain or snow?

Also scattered across the West Texas plains are many large, deep and generally interconnected basins, all that remains of large ice age lakes that last existed about 11,000-14,000 years ago. These basins, formed by the unlikely alliance of ice age rivers and characteristically high winds are today known as "salt lakes," typified by Yellow and Illusion in Lamb and Hockley Counties; Coyote, Baileyboro, and Muleshoe in Bailey County, and Rich and Mound in Terry County. Some of these basins, like Yellow, Illusion, Cedar, and Bull have already been picked for preliminary studies, and drilling and coring by the U. S. Bureau of Reclamation has been completed.

Even though the large "salt lakes" and their immediately surrounding basins have inherent advantages as possible storage reservoir sites such as large size, depth, connecting drainage channels, there are several disadvantages. For instance, virtually every central playa is saturated in the upper several feet (The uppermost modern fill is recognized from basin to basin by high gypsum and saline water content. Pre-modern sediments contain less gypsum, less water, and are considerably denser) by gypsum and often sodium sulfate, and the surrounding basins always contain selenite gypsum. Fresh water put into such a basin will immediately become "gyppy".

Nearly all of the deep lake basins contain sporadic Cretaceous outcrops, usually of the Duck Creek and Kiamichi, which more often than not have associated springs yielding typical saline Cretaceous water to the playas. Water analyses from several of these springs shows a chloride content of 2000 PPM and a sulfate content of 6300 PPM, not tremendously high but enough to slowly contaminate reservoir waters. Therefore, it seems that in order to utilize our large basins as fresh water reservoirs we'll first have to remove or seal off the saliferous lacustrine sediments, or flush the reservoirs, and hopefully expect reservoir water pressure to hold the saliferous Cretaceous interface below the reservoir floor.

The third problem, that of the unusually high evaporation rate to runoff ratio, is undoubtedly the most difficult of all to combat, for there is presently little we can do to decrease the evaporation rate or to increase natural runoff. As we are all aware the average 19 inches annual precipitation over the Southern High Plains is far exceeded by the yearly evaporation, probably by at least 200 percent. Our preliminary studies show a yearly *net* lake evaporation of about 60 inches, but studies now in progress and the Weather Bureau Class A pan show a lake surface evaporation of perhaps up to 110 inches, over nine feet, per year! No one as yet knows just what an acre-foot of imported water will cost, in fact, no one will say, so let's assume costs of $30.00, $60.00 and $100 per acre foot. This means that a reservoir of about 30 square miles (about the size of the Yellowhouse complex without the large proposed dike) will lose at least $3,500,000 and perhaps as much as $16,500,000 of water per year by evaporation if we attempt to sustain a static-level, year-round lake, and even a small canyon-confined reservoir as proposed for the Lubbock area will lose at least $540,000 worth of water per year. Of course, if we get up to a lake of about 44,000 acres, as proposed for the Yellowhouse area by the construction of a large 15-mile dike, then our loss rises astronomically

TABLE 1

Illustrating approximate various dollar amounts of imported water lost due to lake evaporation only for reservoir areas of 30 and 65 square miles.

	30°°/A/Ft.	60°°/A/Ft.	100°°/A/Ft.
LAKE OF 30 SQUARE MILES			
Class A Pan no coefficient	$ 5,020,000	$10,040,000	$16,800,000
Class A Pan no coefficient	$ 3,456,000	$ 6,912,000	$11,520,000
LAKE OF 65 SQUARE MILES			
Class A Pan no coefficient	$11,546,000	$23,092,000	$38,640,000
Class A Pan .68 coefficient	$ 7,948,800	$15,897,600	$26,400,000

Brief as this discussion is, we think its obvious that the solution to the question of what to do with imported water and how to distribute the water is not one of simply filling all of the large lake basins in West Texas and providing each rancher and farmer with a long garden hose. Rather, the economics of water importation, the local environmental parameters, and the problems of effective distribution leave little choice but to recharge the Ogallala. We will have to get any imported water underground as fast as possible to defeat evaporation and to take advantage of natural distribution by the Ogallala aquifer. Unfortunately this seems to preclude those permanent static-level recreational lakes.

The economics of water loss from the potential Bull Lake Reservoir complex have recently been computed by the Bureau of Reclamation in Austin. The Bureau assumes that only 33½ percent of the water will require seasonal storage and furthermore that there would be no storage from year to year. These assumptions then reduce average yearly evaporation to about three to four percent (figured on about five feet per year at $30.00 an acre-foot and 30,700 acre-feet of annual import) or about $921,000 worth of water. Our figures on the Bull Lake complex, at an evaporation rate of only five feet per year, would indicate a monetary loss of $2.8 million worth of water (at $30.00 per acre-foot); however, this discrepancy is not important. What is important is that the figures, one based on a fluctuating reservoir and one on a static level reservoir (both using a minimum evaporation rate) along with the figures in Table 1 (utilizing a static reservoir at a maximum evaporation rate) show that it will be to our decided advantage to get any imported water underground.

Recharging the Ogallala by wells is generally fraught with difficulty when silt-laden water is used; however, recent studies indicate that Ogallala recharge is feasible with clear water. Recharge by unlined canals as has recently been proposed, would work only if the canals were cut below the well-known "cap rock" caliche which now so effectively seals the Ogallala to natural infiltration. Unfortunately depth to the "cap rock" caliche varies tremendously, thus any so-called recharge canals would have to be cut with a roller-coaster grade or at a set grade at a deep depth which would necessitate the movement of a much greater volume of material. Either method would naturally be far more costly in both time and money, and yet probably far less effective than recharge by wells.

Of course there are other geologic problems associated with water importation to the West Texas area which must soon be resolved. For instance, what is the rate (minimum, maximum, average) of water movement through the Ogallala? Where are the ancient drainage channels in the Ogallala? What is the distribution of the underlying Cretaceous? All of these are problems which will soon require examination: The sooner the better!

The fact that our reservoirs will lose an unordinary amount of water due to evaporation, or that we are faced with a water quality problem because of saliferous lake sediments, should not discourage us. The problems can be solved, but only if we are well aware of their potential impact on the overall water importation program. The time is long past when we can afford to simply ignore the Pleistocene ("Ice Age") geology of the West Texas plains. Its time for the engineers and geologists to not only get together but to get to work!

High Plains Underground Water
Conservation District No. 1
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THE Cross SECTION

A Monthly Publication of the High Plains Underground Water Conservation District No. 1

Vol. 14—No. 4 "THERE IS NO SUBSTITUTE FOR WATER" September 1967

SPRINKLER IRRIGATION

Declining water, small producing wells, a decrease in net profits, and high costs of labor are factors that all High Plains farmers must live with in today's agricultural trend.

What's the answer?—Many agree, a more efficient way to irrigate.

For some farmers sprinkler irrigation has solved the above mentioned problems associated with farming.

Automatic sprinkler irrigation has improved vastly since its early conception. The first sprinkler systems that were put in use were very simple, usually being sections of aluminum flow line with sprinkler heads attached. These systems were effective but required a great deal of labor and time to move from one set to another. Frequently the lines accumulated sand in them and made them very difficult to move.

Realizing the great potential for a water and labor saving device, the manufacturers of sprinkler irrigation systems designed and built in the early 40's the automatic sprinkler systems now being used in the High Plains of Texas.

Many areas are using sprinkler systems exclusively to irrigate farm land. Other areas are beginning to use them and in future years it is predicted that almost all irrigating of farm land on the High Plains will be done

(Continued on Page 4)

Approximate Depth To Water Map

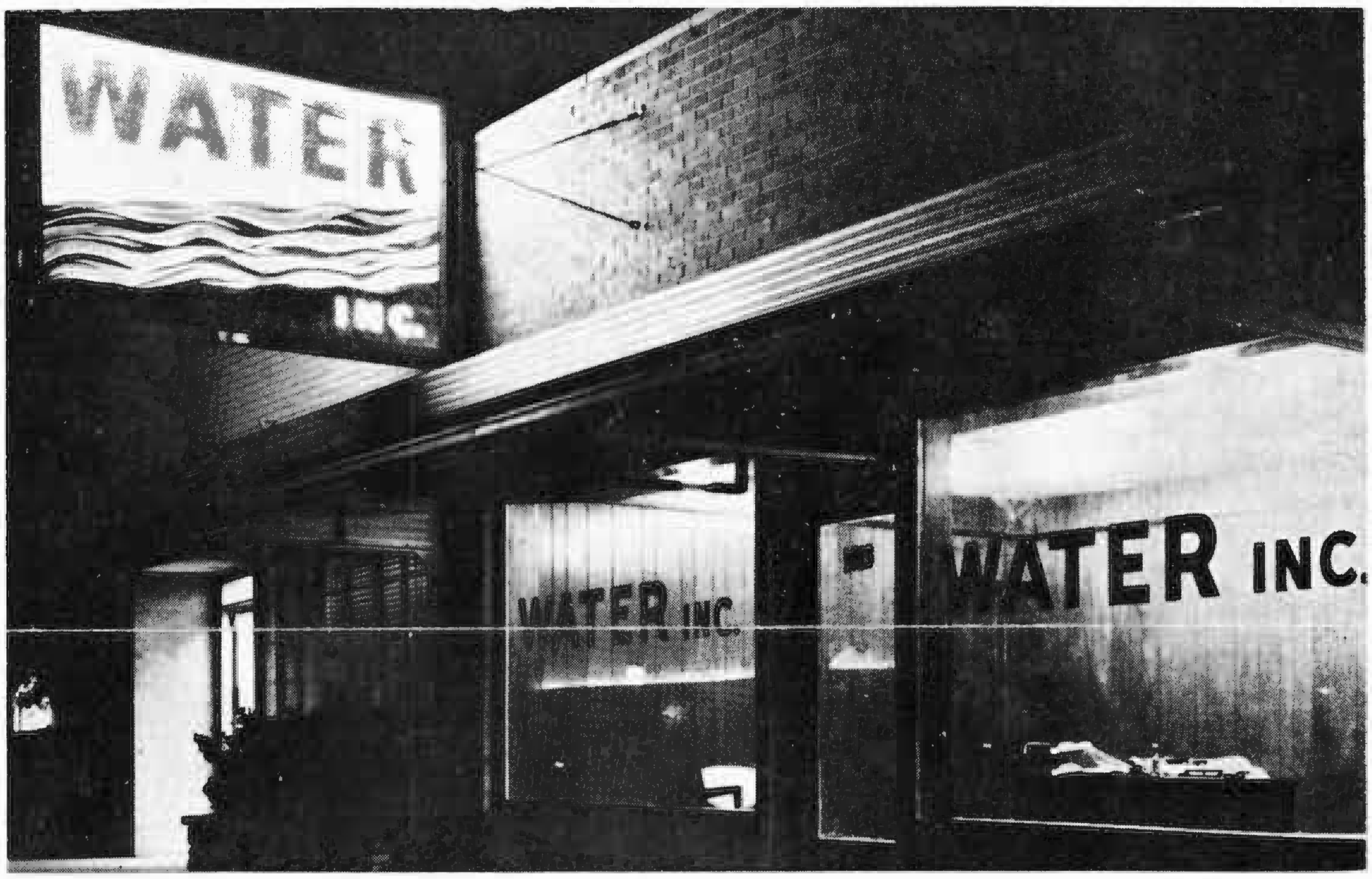
The map on Pages 2 and 3 of this issue shows the approximate depth to water below the land surface in the High Plains Underground Water Conservation District No. 1.

The map was constructed from data assembled by the District from the 1967 measurements of more than 800 observation wells within the bounds of the Water District.

The map is contoured on 20 ft. intervals with consideration given to the general geological and hydrological conditions as known by the District.

The water level measurements were not corrected to a standard elevation, therefore local surface relief in a particular area should be considered when using this map as a guide for local depths to water.

We hope this map will give our readers a general knowledge of the depths to water in various areas of the Water District.



WHY WATER, Incorporated?

Winding and twisting for 455 miles up the vast central valley of California stretches a man-made river. A river two hundred and fifty feet wide, fifty feet deep and concreted sides and bottom. Like a golden arm, it threads its way through the Sierra Nevada mountains to the town of Oroville, California, some seventy-five miles northeast of the City of San Francisco and on until its gaping head gates intercept the surging, turbulence of the Feather River below the mighty Oroville dam. Spectators stand high in the overlook area, awe stricken by the massive magnificence of this mighty dam—more like than not fail to give as much as a single thought to the days on end of planning and study and work necessary to transmitting a dream, like the "Big O", into the reality it has become today. A dream that will go for generations with its true value still undetermined, for it was this dream that will shape the entire future of the California Central Valley, as well as much of the southern part of the State.

Sometime in the early stages of thinking about a water supply that would divert desert lands to dollar lands and fill the drinking cups of millions of citizens, a perceptive Californian coined the word "Imagineering", and with it sold an idea to a thought-minded core of California citizens—a core of men with distance in their vision who refused to bow before the immensity of the task of harnessing the ravaging, turbulent river, and moving its water through lifts and a canal for hundreds of miles to the thirsty areas of greater California.

While this has been going on in the West, most Texans have been prone to continue resting under their laurels satisfied by just keeping on skinning their sheep. Smug in our ideas that Texas has no problem of water for sky-rocketing populations, expanding industry, and an agricultural potential far greater than that of California, is a fault of our natives. Surely there will come a day, and when it does, the natural conclusion can only be either—we are not too bright—or, we think we have become too SMART to DREAM.

Population bulletins tell us that by 1975, Texas will have become the third largest state in the Nation. Still, a century ago, a wise old Chinese warned mankind:

"WOE IS HE WHO WAITS TO BEGIN DIGGING A WELL UNTIL HE HAS BECOME THIRSTY."

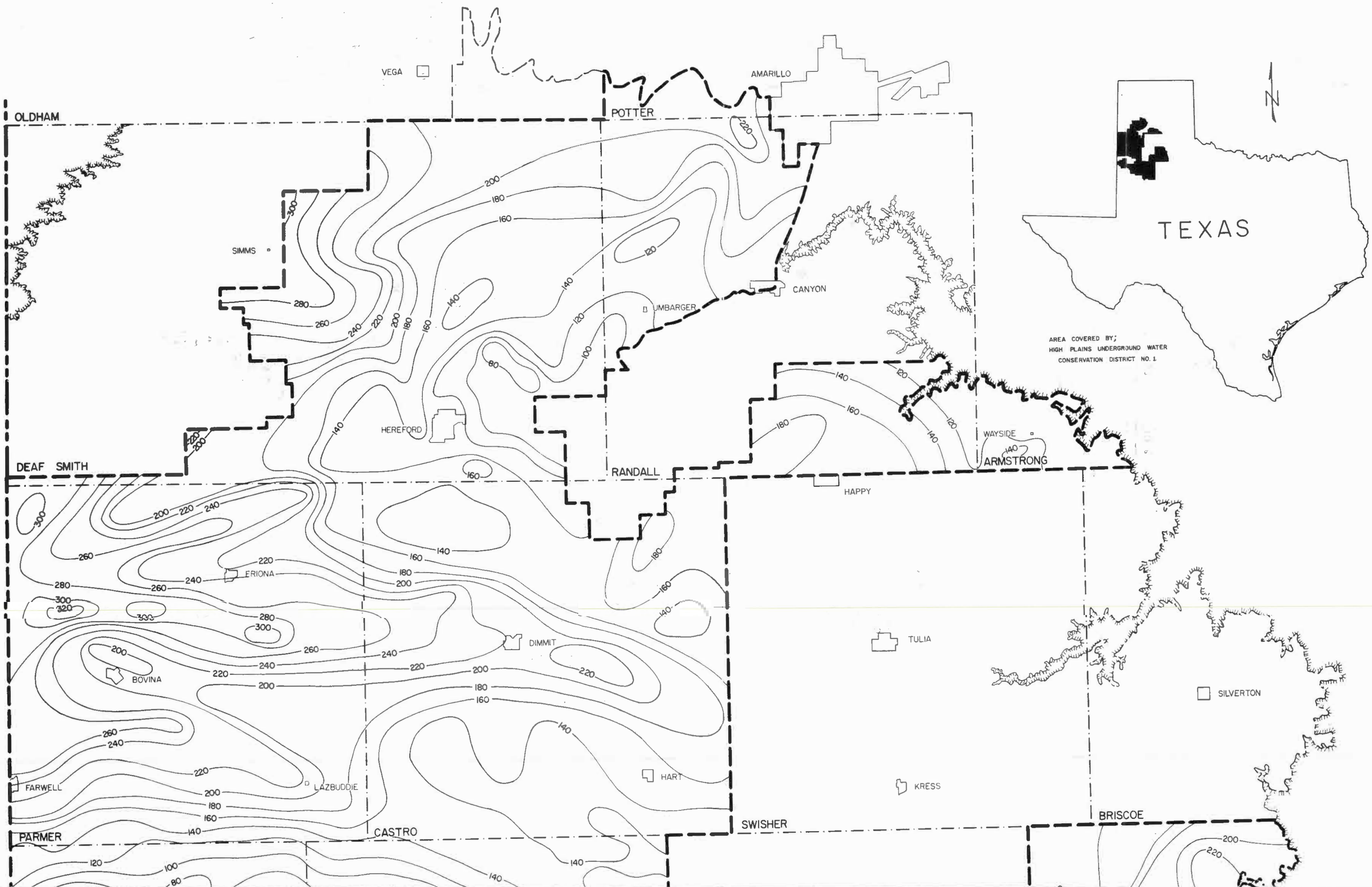
Californians have not waited to begin digging, and they have kept digging. The tough minded core of individuals with distance in their vision banded themselves together into an organization and called the organization "The Feather River Association,"—nonprofit, nonpolitical and with a single purpose—to develop a water supply for the central valley of California. Across the entire State, WATER became a PEOPLE PROBLEM, and the people pitched in to help.

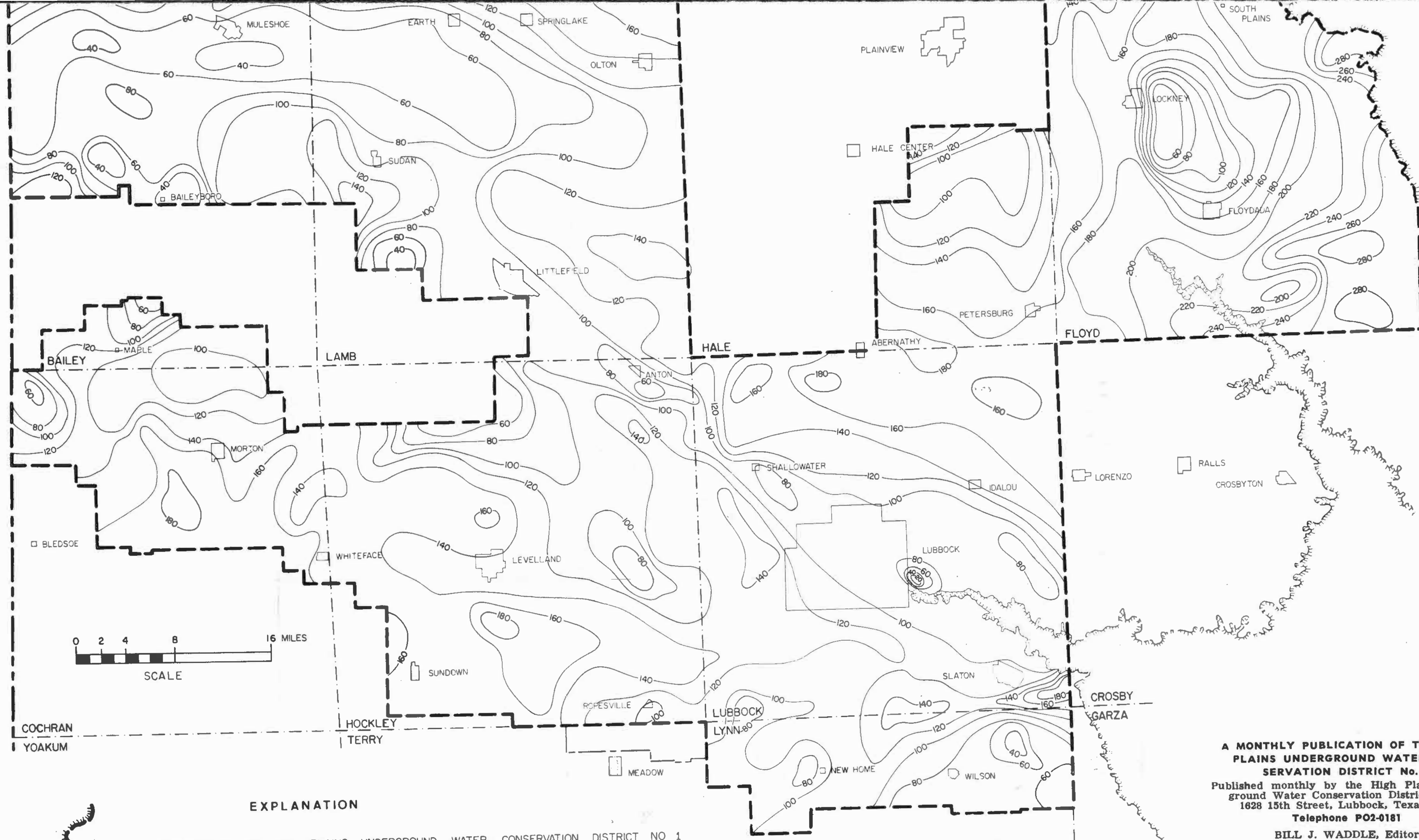
And that is why Water, Incorporated has been nutured into existence in West Texas.

Water for West Texas is a people problem. It is not a Sam problem, or a Henry problem, or a George problem, or a problem for High Plains Water District. It is everybodies problem. And a problem that could slowly evolve into disaster, if every businessman, landowner, professional man, preacher, teacher, service station operator, TV repairman, barber, rabbi, or housewife does not become fully educated to its importance. The apathy that exists, and the great danger of letting that apathy blank our minds is frightening in itself. The popular attitude seems to be that an abundance of good water is something that God owes us because we are West Texans.

(Continued on Page 4)

Approximate Depth To Water Below Land Surface In The Ogallala Formation 1967





EXPLANATION

BOUNDARY OF THE HIGH PLAINS UNDERGROUND WATER CONSERVATION DISTRICT NO 1

BOUNDARY OF SUBDIVISION NO 1 OF THE UNDERGROUND WATER RESERVOIR IN THE OGALLALA FORMATION

SOUTHERN HIGH PLAINS ESCARPMENT

120 CONTOUR LINE SHOWING APPROXIMATE DEPTH TO WATER BELOW LAND SURFACE IN THE OGALLALA FORMATION, CONTOUR INTERVAL 20 FEET

A MONTHLY PUBLICATION OF THE HIGH PLAINS UNDERGROUND WATER CONSERVATION DISTRICT No. 1

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Sprinkler Irrigation—

(Continued from Page 1)

by automatic sprinkler systems.

Let's try to answer a few questions irrigators commonly ask when exploring. the possibility of buying a Self-Propelled Sprinkler System.

WHAT ABOUT CROP DAMAGE?

Crop damage by the wheels of a self-propelled system is less than 1%. This loss is almost insignificant. The system usually tracks perfectly and the wheel damage is limited to the first time the system is used.

HOW DOES THE SYSTEM OPERATE IN ROW CROPS?

When using a self-propelled sprinkler system on row crops you do not have to make any changes. You do not need to change the direction of the rows or the length. Systems usually operate with ease under any planting method.

WHAT ABOUT UNEVEN LAND?

Automatic springler systems will operate on rolling land and most of them will handle slopes up to 5%. Slopes greater than 5% may require a small amount of levelling, but not as much as would be required to furrow water.

INSTALLATION PROBLEMS?

Automatic sprinkler systems are usually designed to the exact needs of each individual farm. They are engineered to get the best results possible from each individual water supply. Most manufactures have technicians to set the system up and make all necessary adjustments.

WILL I BE ABLE TO MOVE MY SPRINKLER FROM FIELD TO FIELD

Most systems, depending on their size, are easily moved. The wheels are usually rotated 90° and the system is pulled from one location to another by a tractor. The entire operation can usually be accomplished in a few hours.

HOW BIG A SYSTEM CAN I BUY?

Automatic sprinkler systems can usually be obtained in any size, however, most of them are never over 1,500 feet long. The size of any system depends on how the land is laid out, water supply, soil and other factors.

HOW MUCH WATER IS REQUIRED?

Water requirements will vary depending on the size of the system and the type of crops grown. The system could operate on as little as 300 gallons per minute or require in excess of 1,000 gallons per minute.

WHAT ABOUT MAINTENANCE?

Maintenance is determined by use. A good thumb rule is that yearly maintenance costs are about 1% of the systems total cost. Lubrication and preventaive maintenance can cut down annual maintenance costs immensely.

HOW LONG WILL IT TAKE TO WATER MY CROP?

Speed is determined by the size of the system and the water application rate. It also depends on the type of system being used. A circular system can apply 1 inch of water to 160 acres in 64.3 hours. Automatic sprinkler systems can be set at a variety of application rates and speeds.

CAN I APPLY FERTILIZER WITH AN AUTOMATIC SPRINKLER SYSTEM?

Fertilizers, herbicides and insecticides can be applied. The uniform application of the chemicals through the system gives uniform coverage over the entire field.

How can a farmer tell when his automatic sprinkler system makes him a profit? To determine this he must look at three expenses. These are initial costs (spread over some reasonable life); annual operating and maintenance costs; and labor costs.

An average automatic sprinkler system that would water 140 acres would cost $17,000 installed. Reasonable life of the system is fifteen years. This means that the annual cost would be $1,133 or $8.09 per acre per year.

None of the above illustrations use shorter allowable depreciation or investment credit which would be to a farmers advantage. If fertilizer or weed control herbicides are used through the system, large savings on fuel and labor are obvious.

The figures do not reflect difference in capital investment for different power units; electric diesel, or natural gas. They do not reflect additional efficiency that occurs if you have more than one system. They do give a fairly accurate view of the costs involved in an automatic sprinkler system.

ARE FARMERS WHO HAVE AUTOMATIC SPRINKLER SYSTEMS SATISFIED WITH THEM?

Farmers now using sprinkler systems all seem to be satisfied. They all agree that increase yields and less labor will easily pay for an automatic system in five to seven years.

You might be missing a good chance to use less water and increase your yields and profit with the use of an automatic sprinkler system. All you can lose is a little time—It might pay you to check on an automatic sprinkler system for your farm.

Water, Incorporated—

(Continued from Page 1)

Every citizen living in West Texas, or those who expect to keep accumulating dollars from West Texas, should make an application to offer his talents, as well as a part of those dollars to help MOVE WATER WEST.

Water from the flood plains of the Mississippi to the High Plains of West Texas requires very little "imagineering" and certainly presents no greater problem than that of moving the water from the "Big O" across the central valley, over the Tehachapi Mountains and into Southern California.

Don't ask WHY, Water, Incorporated—instead, ask—how can I fit in and help?—For it has been said, man's frontiers are bounded only by his imagination, and an unwillingness to work with others.

LABOR COSTS

If you operate the farm yourself without outside labor, you might neglect this cost.
If you hire labor specifically for irrigation, the cost is between $1.00 and $2.00 per hour.
Using $1.50 per hour as an average, 3 hours per round is a reasonable estimate of the labor time to operate a system. This includes checking, adjustment, routine maintenance, tuneup, repairs, etc.

	PER YEAR	PER ACRE PER YEAR
For 10 rounds per year	$ 45.00	$ .32
For 20 rounds per year	90.00	.64
For 30 rounds per year	135.00	.96
For 40 rounds per year	180.00	1.28

WELL PUMP AND ENGINE COSTS

Although pump, engine and well are costs common to all irrigation, we include these in order to estimate ALL costs.
The costs can vary enormously depending on depth of well and area or region.
A lower cost well, pump and power unit would run $5,000.00; a medium cost might be $12,000.00, and higher cost one might be $20,000.00 or more.

TOTAL COST (and a life of 10 years)	PER YEAR	PER ACRE PER YEAR
at $ 5,000.00	$ 500.00	$ 3.56
at $12,000.00	1,200.00	8.58
at $20,000.00	2,000.00	14.30

Notes: $ 5,000.00 = 100' well, 50' lift
$12,000.00 = 300' well, 150' lift
$20,000.00 = 600' well, 400' lift

You would deduct
$1,000.00 for electric power unit at $ 5,000.00
$1,500.00 for electric power unit at $12,000.00
$2,000.00 for electric power unit at $20,000.00

OPERATING COSTS

(FOR A LOW LIFT SYSTEM IRRIGATING 140 ACRES)

Costs are figured without labor, but include fuel ,grease, oil, repairs, etc., and are based on $1.00 per hour of use.

	PER YEAR	PER ACRE PER YEAR
*10 rounds per year (66 hour cycle) applying 1" per round @ $1.00 per hour	$ 660.00	$ 4.70
*20 rounds per year (66 hour cycle) applying 1" per round @ $1.00 per hour	1,320.00	9.40
*30 rounds per year (66 hour cycle) applying 1" per round @ 1.00 per hour	1,980.00	14.10
*40 rounds per year (66 hour cycle) applying 1" per round @ $1.00 per hour	2,640.00	18.80

*Since heavier applications assume a greater water holding capacity for the soil, cost would be approximately the same. In other words, five rounds applying 2" is equal to 10 rounds applying 1".
Note: Figures are based on using diesel fuel and a low cost well installation. Add 25% for electricity or $1.25 per hour. Deduct 25% for natural gas or .75 per hour.

ADDING IT UP ON A PER ACRE—PER YEAR BASIS

	Per Acre/Per Year
Cost of system irrigating 140 acres	$ 8.09
Operating-Maintenance 10 rounds per year	4.70
Labor Costs	.32
Total	13.11
Plus lower cost well, pump and engine	3.56
TOTAL	$16.67 Per Acre/ Per Year

This means that you need to increase your non-irrigated crop value only $16.67 per acre to break even, about 16 bushels of milo.

1. With a medium cost well, pump and power installation, the break even is $21.69 Per Acre/Per Year
2. With a higher cost pump, well and pewer installation, it's about $27.41 Per Acre/Per Year
3. If you need 20 rounds for each crop or cutting add $ 5.02 to the above figures
4. If you need 30 rounds, add $10.36 to the above figures
5. If you need 40 rounds, add $16.34 to the above figures

MR. MURRY H. STEWART
LEVELLAND, TEXAS
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THE Cross SECTION

A Monthly Publication of the High Plains Underground Water Conservation District No. 1

Vol. 14—No. 5 "THERE IS NO SUBSTITUTE FOR WATER" October 1967

A fact of life is that you can't separate Local Control from Local Responsibility . . . Are you doing your part to help conserve our Greatest Natural Resource—WATER?

Supreme Court Hears Water Case

On October 25th the Supreme Court of Texas heard oral argument in the Sun Oil Company vs Earnest Whitaker, et al., water case from Hockley County, Texas. The case, involved a question never heard previously by the Texas Supreme Court, the free use of Ogallala water in secondary oil recovery operations.

This suit was brought by Sun Oil Company for an injunction against alleged efforts by Whitaker to prevent Sun from using his water, without due compensation, for water flooding purposes. Sun Oil Company contended they had the free use of the water under a mineral lease arrangement with Mr. L. D. Gann, owner of the mineral rights to the land.

The 121st District Court in Hockley County denied the injuction and the 7th Court of Civil Appeals at Amarillo upheld the denial.

HISTORY OF CASE

Sun Oil Company obtained an oil, gas and mineral lease April 5, 1946 from Mr. L. D. Gann on a 267 acre farm in Hockley County.

Gann deeded the land to Earnest Whitaker on January 2, 1948. Whitaker is now cultivating the land as an irrigated farm.

Gann deeded the land to Whitaker, reserving all minerals, and made the conveyance of the land subject to the terms of the oil and gas lease. The lease is still in effect by virtue of eight producing oil wells on the land.

During the past few years production from the wells diminished greatly and Sun decided to water flood the lease. The Texas Railroad Commission issued approval to Sun Oil Company to water flood the lease by injecting fresh water into the oil bearing formation beneath the farm land. To accomplish the flooding operation, Sun drilled a water supply well on the farm.

The Company alleged, however, that Whitaker threatened repeatedly to prevent them from using the water for the water flooding operation.

The crucial question in the suit is

(Continued on Page 2)

Annexation Petitions Filed By Crosby County

Petitions have been presented to the Board of Directors of the High Plains Underground Water Conservation District No. 1 by land owners in Crosby County asking that their County be made a part of the High Plains Underground Water Conservation District No. 1.

The Board, at a recent meeting, accepted the petitions, and will hold a hearing in Crosby County in the near future to determine if there is sufficient interest in the County to call an annexation election.

Should the Board call such an election and the County votes to become a part of the District the County will become a part of the largest underground water district in the world.

Services that the residents of Crosby County will receive are, cost-in-water depletion maps, an extensive and vast amount of technical data on water conservation, tailwater return systems, artificial recharge, lake modification data, and numerous other services offered by the District.

Land owners in Crosby County will also profit from future studies on water conservation that will be done by the District.

Open For Business

The High Plains Underground Water Conservation District No. 1 opened it's office in Petersburg, Texas on August 1, 1967. The office is located in the Mayo Insurance Agency and is staffed by Joe Mayo and Mrs. Lois Markham.

Well drilling applications are being received and processed. Farmers in the Petersburg area are invited to come by your High Plains Water District Office to attend to Water business and get acquainted with the operation and personnel.

Please Close Those Abandoned Wells!!!

We Pass This Way But Once

By HON. BILL CLAYTON

EDITOR'E NOTE: From time to time conservationists get so wrapped up conserving natural resources that they often forget the most important resource of all—Our National Heritage. The following is a speech that was delivered by the Hon. Bill Clayton of Springlake, Texas, at the recent Annual State Meeting of the District Supervisors of the Texas Soil and Water Conservation Districts.

We think you will find Clayton's remarks quite inspirational.

It's certainly a pleasure to meet with you again. I know of no group that is working harder to conserve our soil and water than you. Being a farmer, I'm interested in your work and the progress you have made during the past years.

It has been my pleasure to work with you and your representatives in the Texas Legislature. I feel we have made great progress in the past and I look forward to greater progress in the future.

This being a conservation meeting, I would like to share a few of my thoughts with you, concerning conservation.

Conservation is more than saving and protecting our soil and water—it is also preserving our national heritage—respect for law and order—uplifting human morality and dignity—passing on to future generations the many freedoms we enjoy.

It is this broadest scope of conservation that we'll speak of this morning when we say, —"WE PASS THIS WAY BUT ONCE"—

To bring our subject into focus, we'll use the negative approach. Let's think about some mistakes we all need to avoid in life. I have ten of them I would like to discuss. They are:

1) Remorse over yesterday's failure.

2) Anxiety over today's problems.

3) Worry over tomorrow's uncertainty.

4) Waste of the moment's opportunity.

5) Procrastination with one's present duty.

6)Resentment of another's success.

7) Criticism of a neighbor's imperfection.

8) Impatience with youth's immaturity.

(Continued on Page 4)

Mr. and Mrs. Bill Clayton admire the award recently presented to Clayton by the District Supervisors of the Texas Soil and Water Conservation Districts for his distinguished service to the people of Texas.

THE Cross SECTION

A MONTHLY PUBLICATION OF THE HIGH PLAINS UNDERGROUND WATER CONSERVATION DISTRICT No. 1

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Dale Maxwell, 1970 ... Hiway 385, Dimmitt, Tex
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Morgan Dennis, 1968 .... Star Rt, Hereford
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Western Abstract Co., Morton, Texas

D. A. Ramsey, 1970 .... Star Rt 2, Morton
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Frank Zinser, 1970 .... Rt 5, Hereford
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L. B. Wortham, 1970 .... Rt 3, Hereford
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325 E. Houston St., Floydada, Texas

Pat Frizzell, 1970 .... Box 1046, Lockney
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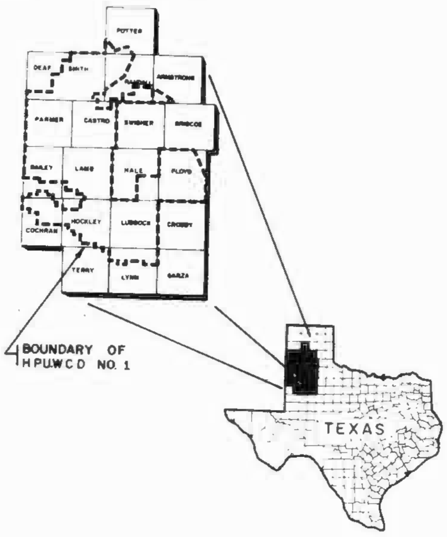
Tate Jones, 1970 .... Rt 4, Floydada
M. M. Julian, 1968 .... Box 65, South Plains
M. J. McNeill, 1968 .... 833 W. Tenn., Floydada
Committee meets on the first Tuesday of each month at 10:00 a. m., Farm Bureau Office, Floydada, Texas.



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J. B. Mayo
1617 Main, Petersburg, Texas

Charles Schuler, 1970 .... Petersburg
Don Hegi, 1970, ... Box 160 A, Petersburg
W. D. (Dub) Scarborough, 1969 .... Box 147, Petersburg
Harold D. Rhodes, 1968 ... Box 100, Petersburg
J. C. Alford, 1968 .... Box 28, Petersburg
Committee meets first Monday each month at Water District office in Petersburg.

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208 College, Levelland, Texas

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Jimmy Price , 1970 .... Rt 3, Levelland
H. R. Phillips, 1968 .... Rt 4, Levelland
S. H. Schoenrock, 1969 .... Rt 2, Levelland
Committee meets first and third Fridays of each month at 1:30 p. m., 917 Austin St., Levelland, Texas.

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Calvin Price
620 Hall Avenue, Littlefield, Texas

Jack Thomas, 1970 .... Box 13, Olton
Roger Haberer, 1968 .... Earth
W. B. Jones, 1969 .... Rt 1, Anton
Troy Moss, 1968 .... Rt 1, Littlefield
Lee Roy Fisher, 1970 .... Box 344, Sudan
Committee meets the first Thursday of each month at 8:00 p. m., Crescent House Restaurant, Littlefield, Texas.

Lubbock County

Mrs. Doris Hagens
1628 15th Street, Lubbock, Texas

R. F. (Bob) Cook, 1970 .... 804 6th Pl, Idalou
Bill Hardy, 1968 .... Rt 1, Shallowater
Bill Dorman, 1970 .... 1910 Ave E, Lubbock
Edward Moseley, 1969 .... Rt 2, Slaton
W. O. Roberts, 1968 .... Rt 4, Lubbock
Committee meets on the first and third Mondays of each month at 1:30 p. m., 1628 15th St., Lubbock, Texas.

Lynn County

Mrs. Doris Hagens
1628 15th Street, Lubbock Texas

Don Smith, 1969 .... Box 236, New Home
Harold G. Franklin, 1968 .... Rt 4, Tahoka
Roy Lynn Kahlich, 1970 .... Wilson
Roger Blakney, 1970 .... Rt 1, Wilson
Reuben Sander, 1968 .... Rt 1, Slaton
Committee meets the third Tuesday of each month at 10:00 a. m., 1628 15th Street, Lubbock, Texas.

Parmer County

Aubrey Brock
Wilson & Brock Insurance Co., Bovina, Texas

Webb Gober, 1969 .... RFD, Farwell
Henry Ivy, 1970 .... Rt 1, Friona
Jim Ray Daniel, 1970 .... Friona
Carl Rea, 1968 .... Bovina
Ralph Shelton, 1968 .... Friona
Committee meets on the first Thursday of each month at 8:00 p. m., Wilson & Brock Insurance Agency, Bovina, Texas.

Potter County

Fritz Meneke, 1970 .... Rt 1, Box 538, Amarillo
W. J. Hill, Jr., 1969 .... Bushland
L. C. Moore, 1968 .... Bushland
Jim Line, 1968 .... Bushland
Vic Plunk, 1970 .... Rt 1, Amarillo

Randall County

Mrs. Louise Knox
Randal County Farm Bureau Office, Canyon

R. B. Gist, Jr., 1968 .... Rt 3, Box 43, Canyon
Ralph Ruthart, 1969 .... Rt 1, Canyon
Carl Hartman, Jr., 1968 .... Rt 1, Canyon
Marshall Rockwell, 1970 .... Canyon
Richard Friemel, 1970 .... Rt 1, Canyon
Committe meets on the first Monday of each month at 8:00 p. m., 1710 5th Ave., Canyon, Tex.

Storage Of Water

Water, petroleum and natural gas, three of the worlds most important resources have many things in common. Because two of them are liquids and the third is a gas, they can be pumped through pipelines, stored in tanks, and delivered to points of use with a minimum of effort. As a consequence, the problems that arise in developing and distributing these resources are somewhat similar, and it will be a necessity, in the near future, for water supply specialists to familiarize themselves with the practices used by the oil and gas industry to see whether some of them might be applied to water.

A major problem we should examine is that of storage which will pose a major problem for the High Plains when water is imported to the area.

Natural gas and petroleum occur in natural underground pools or reservoirs, whereas water may occur either in the ground or in rivers and lakes. The petroleum or gas utility cannot store its products in open pools on the land surface, although the water utility can. All three utilities may construct tanks to store their output.

The natural gas industry, faced with the mounting cost of building more and more tanks in areas of high demand, has come to recognize that the earth itself may provide free storage space, and in recent years has developed many natural underground storage reservoirs in various parts of the country. In those localities, gas is led through pipelines to injection wells, and then is forced deep underground to be held in reserve until needed. The openings and pore spaces in the rocks and sediments constitute the reservoir, whose capacity is limited only by the thickness and extent of the porous geologic formations.

In a sense, it was only logical that the gas utilities should turn to the earth for storage purposes, because they were already familiar with the fact that the earth is really a kind of tank in which gas is found.

But in most instances water planners have always had their attention diverted away from the high storage capabilities of the formations beneath their feet—partly because these reservoirs are hidden, and partly because the excellent recreational features of surface storage.

The fact remains that nature's ground-water reservoirs, located in almost every region of the world, are of infinitely greater capactiy than all the costly engineering works that man has constructed or will ever construct for the storage of water. In most instances, ground-water basins are already nearly full, and have only to be tapped by efficient modern wells to deliver an abundance of fresh water.

There are in some isolated areas, ground-water reservoirs that have been tapped, and unused storage space is available for the storage of surplus surface waters. The Ogallala reservoir is a fine example of such a storage facility.

In Israel, California, and elsewhere, the storage value of ground-water reservoirs is highly appreciated, and substantial improvements in water management have been achieved by using them to balance out periods of surplus and shortage. However, the technique can and must be applied to the High Plains area and the Ogallala formation. A unified and concerted effort must be made to study and develop good efficient ways to store surplus water in the Ogallala formation.

The task is before us, and all that is needed is to take the first step.

Supreme Court—

(Continued from Page 1)

the portion of the lease agreement which says, "lessee shall have free use of oil, gas, coal and water from said land except water from lessor's wells for all operations hereunder."

The critical phrase the Court said was, "all operations hereunder."

The High Plains Underground Water Conservation District No. 1 intervened in the suit with Whitaker, contending that at the time of the lease in 1946, secondary recovery by water flooding was unknown in the area. Both parties further alleged that Sun was limited to operations of a general nature which would not destroy the estate of the surface owner. Whitaker and the Water District also allege that it was not the intention of the parties who made the lease to permit Sun free use of any amount of water for a water-flooding project.

The findings and the decision of the Texas Supreme Court are anxiously being awaited.

The decision of the Supreme Court will have a great impact on all landowners in Texas.

This case and its final decision merits everyone's close interest.

Include A Tailwater System In Your 1968 Budget

Drilling Statistics For September 1967

County	Permits Issued	New Wells Completed	Replacement Wells Drilled	Dry Holes
Amstrong	0	0	0	0
Bailey	0	0	0	0
Castor	4	6	0	0
Cochran	2	4	1	0
Deaf Smith	12	17	0	0
Floyd	2	5	0	0
Hale	2	0	0	0
Hockley	4	3	0	0
Lamb	3	4	1	1
Lubbock	4	2	0	0
Lynn	0	1	0	0
Parmer	12	17	0	0
Potter	0	0	0	0
Randall	0	3	0	0
TOTALS	45	62	2	1

A POPULAR PRACTICE TODAY

Using and re-using tailwater by hundreds of farmers on the High Plains of Texas is no accident. It's a common and popular practice in areas where any amount of extensive irrigation is being practiced.

Not many years ago, the popular practice that was acceptable to most farmers was to waste water and not worry about the future. Today, wasting water is unpopular in every community on the High Plains.

The numerous tailwater return systems that dot the Plains area today are the final results of long hours of study and evaluation of new ideas, methods and equipment that were used in a few experimental systems installed by the District in Parmer County.

The experimental installations have proven the following advantages for the Texas High Plains farmer.

1) Prevents the ponding of water at the lower end of the field which interferes with plant development and causes reduced crop yields.

2) Prevents the flooding of adjoining neighbors farmland, thereby reducing the threat of legal action.

3) Prevents the flooding of public roads and eliminates sources of automobile accidents.

4) Prevents the flooding of public road drainage ditches and reduces county expense for road maintenance and repairs.

5) Prevents mosquito breeding by eliminating the shallow, tepid waters necessary for mosquito breeding.

6) Provides an additional source of irrigation water, in some cases increasing it by as much as 20 to 25 percent.

7) Improves the efficiency of water distribution by allowing the farmer to use a larger head of water to get the water to the end of the rows quicker. This provides for a more uniform moisture penetration by eliminating deep moisture penetration in the upper portion of the field, not enough moisture in the middle of the field and deep penetration at the lower portion of the field where ponding occurs.

8) Reduces the amount of irrigation labor necessary. Many farmers using recirculation systems state that one man can now irrigate as much as two or three men before the recirculation system was installed.

9) Recovers and reapplies nutrients carried from the farm in tailwater. Water District tests show that about 30 pounds of nitrogen in the form of nitrates were being lost per acre-foot of tailwater. The recirculation system salvages these nutrients as well as the tailwater.

10) Recovers and reapplies rich top soil carried from the farm in tailwater. Water District tests show that on the average 9 to 10 tons of soil are carried off the farm in each acre-foot of tailwater. Recirculation systems are reclaiming approximately 50 percent of this top soil and returning it to the farm.

11) Improves plant growth rate because tailwater is much warmer than ground water. Cold ground water causes a temporary cooling of the soil and reduces the rate of plant growth for a few days. The warm tailwater does not lower the soil temperature appreciably, and allows the plant to continue its normal growth rate.

One farmer who has taken advantage of benefits provided by his return system is Hershel Johnson of Friona, Texas.

Johnson's system irrigates a total of 80 acres of land without the aid of additional water except in extreme emergencies. Part of this land is in cultivation, the other is planted in bermuda grass. Cows dot the pasture land in large numbers and provide a nice added income to accompany the profits of Johnson's farming operation.

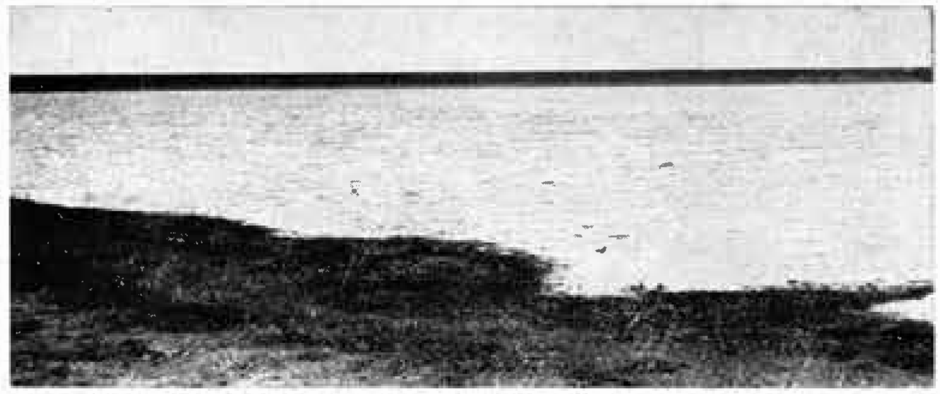
Johnson said, "Before I installed my return system, I used one of my wells to irrigate this 80 acres. Now that I have the system the District helped me install, I seldom ever pump this well. By using my tailwater over and over again, my water beneath the ground is being conserved and it's just like having a big balance in my bank account. It makes a farmer feel good."

You too, can probably maintain a big balance in your "water account" by installing a tailwater return system.

Now is the time to install one for next year.

Water Is Your Future, Conserve It!

Why not modify your spare irrigation equipment for a tailwater return system?



Hundreds of lakes such as this one dot the High Plains. They serve as an excellent source of irrigation water. If you have such a lake you are missing a bet if you are not utilizing it.

Something Worth Thinking About

Thinking about pumping water from your playa lake?

Then you likely are noting the experience of others in the program that has a double-barrel advantage of land reclamation and cheaper source of ready water.

The experience of Richard Drachenberg, farming in eastern Hockley County, graphically illustrates a practical approach to lake use, year in and year out, in farming operations.

Drachenberg is no engineer and he disclaims a scientific approach to his comprehensive system, but he is very conscious of the costs involved, the equipment he can use from his own farming operations, and the profits to be earned in lake utilization.

He consistently has harvested bumper cotton crops from land that slopes drastically in just about every direction, land on which four playa lakes cover as much as 100 acres in some years.

Drachenberg has six irrigation wells on the 770 acres he farms, but four-inch wells pumping at 150 feet depths hardly provide the needed irrigation at strategic watering times.

He has found the readily available lake water, in about three out of four years, to be his salvation.

Also, in draining the lakes onto his cropland, he has salvaged valuable acreage on which he is making full use, with rye or wheat.

He first started pumping from his lakes in 1959 when he experimented with one to his satisfaction and immediate profit.

The history of his lake utilization is marked with "common sense," he professes, rather than elaborate or expensive engineering and dirt moving.

"I do my own work in cleaning the lake beds and shaping them for convenient pumping," he reports. In fact, he spent only 28 hours in initial "working" of the big lake on his land, using a three-bottom breaking plow followed by a blade for short-haul dirt jobs.

He annually goes into the lakes with his farm machinery and in a few hours gets them in good shape for the season ahead.

Utilization of the lakes is currently evident, with rye flourishing (for spring grazing) on lake beds from which water was pumped for the present cotton crop.

During the past season, Drachenberg used only one of his irrigation wells, a five-inch well pumping about one-half pipe, for pre-planting moisture, and all other watering has been from the playa lakes. Of course natural rainfall this season aided a great extent.

An elaborate underground pipe system on the highly contoured land has augmented his other farming practices. He has about 6,000 feet of concrete pipe, plus a lesser amount of transite pipe, into which the wells or lakes can be connected. Presently, four 6-inch pumps on the lakes are fed into the system.

"One week of watering from my lakes gets the job done that would require a month from the wells," Drachenberg reports, adding that "a man would be a fool not to use the water from his lakes."

Using his farm equipment at hand, the Hockley County farmer has built rises jutting into the lake from pump sites, aiding appreciably in preventing silt fill at pump location. A little work annually both improves the layout and keeps the basin from silt and sand filling, he said.

He has not kept accurate figures on costs (lake use as against well use) but he doesn't hesitate to point out that initial cost via the lake route is cheaper and that annual costs are considerably less.

"The cotton I have this year appears to be the best I've ever had," Drachenberg reports, "and I have had some good one and one-half-bale-per-acre yields."

The High Plains Underground Water Conservation District No. 1 in its studies has come up with a six-point list of considerations in playa lake utilization, and its findings are outlined in special booklets available at the District Office, 1628 15th Street, in Lubbock.

Tables for computing acre feet of water in various size lakes, pipe friction losses, pumping rates, evaporation losses, etc., are available for the asking.

Economics of lake use also are outlined in depth by hydrologists and engineers who are staff members of the District organization.

All rivers flood according to patterns that can be described in statistical terms, but the exact time and severity of a particular flood can not be predicted accurately. Much flood damage results from building on flood plains which are well identified.

WATER, Inc. Needs Your Support— JOIN TODAY!

We Pass This Way—

(Continued from Page 1)

9) Skepticism of our nation's future.

10) Unbelief in God's Providence.

Now let's take these mistakes one at a time and discuss them.

The first mistake is remorse over yesterday's failure. Experience is the best teacher. We must realize our failures and strive to do something about them . . . Failures admonish change—A man may get blistered a few times to ever achieve his place in the sun. Don't be remorseful over yesterday's failure—If you get into hot water—just take a bath in it.—Stick out your neck—if you lose your shirt don't give up but brag about your suntan. A man may make a mistake, but he isn't a failure until he starts blaming someone else.

The second mistake to avoid is anxiety over today's problems. Meet the day with determination but practice patience and forebearing. Anxiety causes us to forget the important things of life. If we have the right goals set for our lives we overcome anxiety. We can only do so much or it can be expressed in this creed—"God grant me the serenity to accept things I cannot change, the courage to change the things I can, and the wisdom to know the difference." So, let's avoid anxiety over today's problems.

The third mistake to avoid is worry over tomorrow's uncertainty. Worry is a lack of faith. The Bible tells us to "take therefore no thought for the morrow, for the morrow shall take thought for things of itself". Our hospitals are full of mental cases—all because of worry—. We should make up our mind that we will do something that will be lasting—do something for some one—keep self in the background—Franklin said "He that loveth himself will have no competition". With this type of an attitude of doing something, we can avoid—worrying over tomorrow's uncertainty.

The fourth mistake to avoid is—waste of the moment's opportunity. Here again, we can strive for that which is right—and just—and moral because someone will be following in our steps—. E. L. Sharpe stated it pretty plain in these words—

"To each is given a bag of tools,
A shapeless mass and a book of rules,
And each must make, ere life is flown,
A stumbling block or a stepping-stone".

We must not waste opportunities.

The fifth mistake to avoid is procrastination with one's present duties. Why do we put off doing what needs to be done so much of the time—or why do we say, let Joe do it—We all have a job to do in conservation of soil—water—country—human race—what would result if we all procrastinated our duty?—An excellent example of what I'm talking about is the story about the scientists who set out to study a certain breed of monkeys. The scientists went into the jungle where these monkeys lived; cleared out a place and built a large fire. Soon the monkeys came and sat around the large fire. As the night wore on the younger monkeys paired up and slipped to the edges of the clearing. The older monkeys sat around the fire and watched it grow dim. Not one made a move to put wood on the fire to keep it going. It appeared that each monkey was waiting for the other one to do what had to be done to keep the fire going. We must exert an effort to ever accomplish anything. We cannot afford to make the mistake of putting off our present duty.

The sixth mistake to avoid is resentment of another's success. I believe almost anything is possible if we really work at it. If someone else is a success, it is because he worked hard at it. Resentment on our part would show littleness of our own character. Ella Wilcox wrote—"One ship drives east and another drives west with the selfsame winds that blow Tis the set of the sails and not the gales which tells us the way to go." In other words, the course one sets for his life and how hard he works at keeping it on that course is what makes success. Let's not resent another's success.

The seventh mistake to avoid is criticism of a neighbor's imperfection. You know most people are better than they appear and most people are potentially more capable than we judge. The Bible teaches us, when we find fault of imperfection with our neighbors, it's because we're trying to hide or cover up our own faults — We should look for the good in people, not the bad—we don't need to be guilty of making the mistake of criticism of a neighbor's imperfection.

The eighth mistake to avoid in life is impatience with youth's immaturity. As parents, we are all probably guilty of this and we think rightly, so as we read the headlines about hippies—teenage sex parties—draft card burning—etc. — Let me read you a quote—"Our youth now loves luxury—they have bad manners, contempt for authority. They show disrespect for elders—they love to chatter instead of exercising. Children are now tyrants — they no longer rise when elders enter the room. They contradict their parents, chatter before company, gobble up food, and terrorize their teachers." Is that a modern picture—? No — these words were written by Socrates, 400 years before Christ. We can conserve the morality and dignity of our youth with good programs—we should have faith in our youth and not make the mistake of being impatient with their immaturity.

The ninth mistake to avoid is skepticism of our nation's future. We could talk all morning on this one mistake that so many make today—however, we'll cover it briefly. Did you know the communists say that victory is certain over the United States because the average people are—

1) Intellectually lazy
2) Intoxicated with entertainment
3) Limited in his horizon
4) Inherently selfish

If we examine these thoughts carefully, we find a lot of truth in them. Did you know that last year in the United States, we spent three times as much for alcoholic beverages — five times as much for recreation, and seven times as much for gambling as all the money spent for religious and charitable organizations put together. The thing that encourages us is the fact that in America, we are not all average — and with God's continued help, we never will be. It was once said by a West Texan that—

"To be born a free man is an accident—To live a free man is a responsibility—To die a free man is an obligation—"

If we will not forget our responsibility and our obligation, we will never show skepticism of our nation's future.

The last mistake to avoid, and I think the most important is unbelief in God's Providence. If we avoid this great mistake of life, then the others are automatically avoided. On this hinges the conservation of human nature. There is a poem that expresses this much better than I can. It is entitled—

"YOUR HERITAGE"

God gave you a brain to do your part,
Make it lead a nation or draw a cart,
You can fill it with gems, or stuff it with slime,
Make it live for a day or live for all time.

American today needs to avoid this last mistake of unbelief in God's Providence.

If we each day would try to avoid all ten of these mistakes, what a different person we would be—we would be practicing conservation of the top rank—and did you know, that in so doing, many round about would be watching and following our example. We would be leaving a mark for someone to match, or a stepping stone instead of a stumbling block . . . or a bridge for someone to cross. Like the:

Old man going on a lone highway
Who come in the evening cold and gray
To a chasm deep and dark and wide
The old man crossed in the twilight dim.
The sullen stream had no fears for him.
But he paused when safe on the other side
And build a bridge to span the tide.
"Old man," said a fellow pilgrim near,
"You're wasting your time in building here.
Your journey will end with the ending day.
You will never again pass this way.
You've crossed the chasm dark and wide.
Why build you this bridge at eventide?"
The old man raised his old gray head.
"Good friend, in the path I have come," he said.
"There followeth after me today
A youth who, too, must pass this way.
The sullen stream which had no fears for me
To that fair-haired youth may a pitfall be.
He, too, must cross in the twilight dim.
Good friend, I'm building this bridge for him."

This is our challenge because—"WE PASS THIS WAY BUT ONCE."

South Plains Water District Ruled Valid

The El Paso Court of Civil Appeals has ruled that the South Plains Underground Water Conservation District No. 4 is valid. The District includes parts of Cochran, Terry, Yoakum and Gaines Counties.

The ruling by the Appeal Court reversed a lower court ruling stating the District was invalid.

The case is not settled as of yet though, as the Directors of the District have been notified that the case will be appealed to the Supreme Court.

The *Cross Section*, in future issues, will keep you informed on the progress of this important water case.

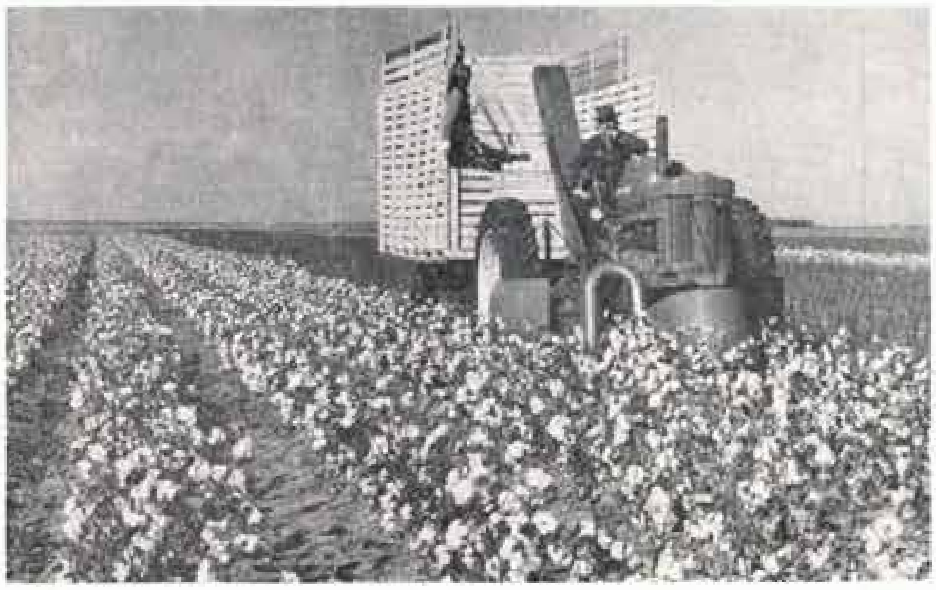
Second Class Permit

High Plains Underground Water
Conservation District No. 1
1628 Fifteenth Street
Lubbock, Texas 79401

THE Cross SECTION

A Monthly Publication of the High Plains Underground Water Conservation District No. 1

Vol. 14—No. 6 **"THERE IS NO SUBSTITUTE FOR WATER"** *November 1967*



Harvest Time On The Texas High Plains!!!

WAYNE WYATT

Wayne Wyatt resigned from his position as a member of the staff of the High Plains Underground Water Conservation District No. 1 to assume the position as District Manager of the South Plains Underground Water Conservation District No. 4 with its office at Brownfield, Texas.

For ten years Wyatt has served the High Plains District as a very dedicated associate and has played an important role in many of the Districts undertakings.

Wyatt's knowledge of the Southern High Plains in general and its many problems of water supply will no doubt prove to be an invaluable asset to the people of the South Plains District.

His many friends in District No. 1 wish Wayne the best of luck in his new position.

Why We Were There

Last month the Texas Supreme Court heard oral arguments on the Sun Oil Co. vs. Earnest Whitaker water case from Hockley County. The High Plains Underground Water Conservation District No. 1 was an intervenor in this case.

Why did the Water District enter into the case and become involved? The District entered the case because the main reason for the existence of the District was involved—the private ownership of the water beneath a man's land.

Some journalists have reported that the District entered the case to prevent the oil company from establishing and operating a water-flood operation on Whitaker's land. This is not the reason at all.

The Water District has long recognized that the oil industry has done an excellent job of conservation by using secondary recovery operations in oil fields to produce all the oil possible. We have issued well permits to several companies who owned the water rights or had them specifically assigned to them. We shall continue to do so in the future.

The District does, however, feel that a land owner under State law owns the water beneath his land and may sell, lease or use it as he sees fit. We don't believe he should have to

(Continued on Page 3)

Importance Of Major Irrigated Crops To Agricultural Input Suppliers Of The High Plains

*By JAMES E. OSBORN**

The Texas High Plains, as an agricultural producing area, is a very productive area, but a unique area in many ways. The geographical location and isolation from major consumption areas is not typical of productive agricultural areas. Transportation facilities including truck, rail, and air provide excellent means of transporting the products to markets throughout the United States and foreign countries. However, efficiency of the region in production, processing, and marketing, as well as location, will determine the ability of High Plains farmers and ranchers to compete with those in other regions for the available foreign and domestic markets.

Farm production of the High Plains is organized around three agricultural products: (1) cotton, (2) wheat, and (3) grain sorghum. Production of each of these commodities is limited by compliance rates established by government programs. These programs generally have provided incentives to participate at various compliance rates that in the absence of such programs would not be consistent with goals of farm managers. Likewise, many farm management decisions based on capital growth, water conservation, efficient utilization of equipment inventories and others have degenerated to short-term, usually determined by length of the program, program participation decisions. To a certain extent, incentives are not present to make decisions for long-term planning horizons.

Agricultural products produced on

(Continued on Page 2)

**Assistant Professor, Department of Agricultural Economics, Texas Technological College and Texas Agricultural Experiment Station, Lubbock, Texas.*

Crosby County Hearing

A hearing, pertaining to the annexation of Crosby County to the High Plains Underground Water Conservation District No. 1, was held in Crosbyton, November 10.

Purpose of the hearing was to gather facts and opinions from land owners of the County to determine if they are interested in joining the District.

The hearing was called as a result of a petition presented to the Water District asking for such a hearing.

The Board of Directors of the District is now studying the testimony presented at the hearing to determine if it would be to the advantage of Crosby County, as well as the Water District, for the county to become a member of the organization.

If the Board decides to annex Crosby County to the District, a confirmation election will be called allowing all tax-paying property owners in Crosby County to vote on the annexation.

The Board should make its decision in the near future.

THE Cross SECTION

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Foster Parker, 1970 .... Rt. 1, Happy, Texas
George Denny, 1969 .... Rt. 1, Happy, Texas
Guy Watson, 1968 .... Wayside, Texas
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High Plains Water District
Box 594, Muleshoe, Texas

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Ernest Ramm, 1970 .... Rt 2, Muleshoe
Homer W. Richardson, 1968 .... Box 56, Maple
W. L. Welch, 1970 .... Star Rt, Maple
J. M. Witherspoon, 1969 .... Box 261, Muleshoe

Committee meets last Friday of each month at 2:30 p. m., 217 Avenue B, Muleshoe, Texas.

Castro County

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City Hall, Dimmitt, Texas

Calvin Petty, 1969 .... Box 605, Dimmitt, Texas
Dale Maxwell, 1970 .... Hiway 385, Dimmitt, Tex
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Donald Wright, 1968 .... Box 65. Dimmitt
Morgan Dennis, 1968 .... Star Rt, Hereford

Committee meets on the last Saturday of each month at 10:00 a. m., City Hall, Dimmitt, Texas.

Cochran County

W. M. Butler, Jr.
Western Abstract Co., Morton, Texas

D. A. Ramsey, 1970 .... Star Rt 2, Morton
Ira Brown, 1968 .... Box 774, Morton
Willard Henry, 1969 .... Rt. 1, Morton
Hugh Hansen, 1970 .... Rt. 2, Morton
E. J. French, Sr., 1968 .... Rt. 3 Levelland

Committee meets on the second Wednesday of each month at 8:00 p. m., Western Abstract Co., Morton, Texas.

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Mrs. Mattie K. Robinson
High Plains Water District
317 N. Sampson, Hereford, Texas

W. H. Gentry, 1969 .... 400 Sunset, Hereford
Billy Wayne Sisson, 1968 .... Rt 5, Hereford
Frank Zinser, 1970 .... Rt 5, Hereford
Billy B. Moore, 1968 .... Wildorado, Texas
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Committee meets the first Monday of each month at 7:30 p. m., High Plains Water District office, Hereford, Texas.

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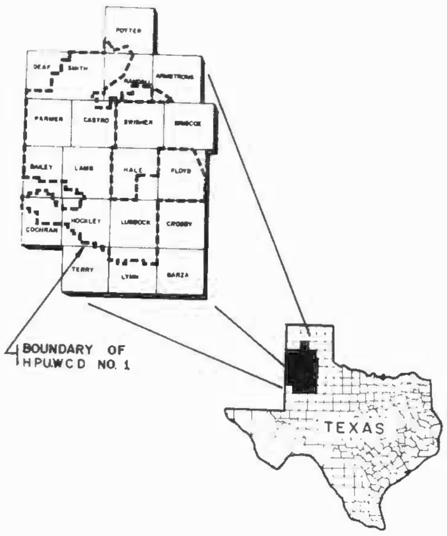
Sam Puckett
325 E. Houston St., Floydada, Texas

Pat Frizzell, 1970 .... Box 1046, Lockney
J. S. Hale, Jr., 1969 .... Rt 1, Floydada
Tate Jones, 1970 .... Rt 4, Floydada
M. M. Julian, 1968 .... Box 65, South Plains
M. J. McNeill, 1968 .... 833 W. Tenn., Floydada

Committee meets on the first Tuesday of each month at 10:00 a. m., Farm Bureau Office, Floydada, Texas.



Hale County

J. B. Mayo
1617 Main, Petersburg, Texas

Charles Schuler, 1970 .... Petersburg
Don Hegi, 1970, ... Box 160 A, Petersburg
W. D. (Dub) Scarborough, 1969 .... Box 147, Petersburg
Harold D. Rhodes, 1968 .... Box 100, Petersburg
J. C. Alford, 1968 .... Box 28, Petersburg

Committee meets first Monday each month at Water District office in Petersburg.

Hockley County

Murray C. Stewart
208 College, Levelland, Texas

J. E. Wade, 1970 .... Rt 2, Littlefield
Preston L. Darby, 1968 .... Rt 1, Ropesville
Jimmy Price, 1970 .... Rt 3, Levelland
H. R. Phillips, 1968 .... Rt 4, Levelland
S. H. Schoenrock, 1969 .... Rt 2, Levelland

Committee meets first and third Fridays of each month at 1:30 p. m., 917 Austin St., Levelland, Texas.

Lamb County

Calvin Price
620 Hall Avenue, Littlefield, Texas

Jack Thomas, 1970 .... Box 13, Olton
Roger Haberer, 1968 .... Earth
W. B. Jones, 1969 .... Rt 1, Anton
Troy Moss, 1968 .... Rt 1, Littlefield
Lee Roy Fisher, 1970 .... Box 344, Sudan

Committee meets the first Thursday of each month at 8:00 p. m., Crescent House Restaurant, Littlefield, Texas.

Lubbock County

Mrs. Doris Hagens
1628 15th Street, Lubbock, Texas

R. F. (Bob) Cook, 1970 .... 804 6th Pl, Idalou
Bill Hardy, 1968 .... Rt 1, Shallowater
Bill Dorman, 1970 .... 1910 Ave E, Lubbock
Edward Moseley, 1969 .... Rt 2, Slaton
W. O. Roberts, 1968 .... Rt 4, Lubbock

Committee meets on the first and third Mondays of each month at 1:30 p. m., 1628 15th St., Lubbock, Texas.

Lynn County

Mrs. Doris Hagens
1628 15th Street, Lubbock Texas

Don Smith, 1969 .... Box 236, New Home
Harold G. Franklin, 1968 .... Rt 4, Tahoka
Roy Lynn Kahlich, 1970 .... Wilson
Roger [illegible], 1970 .... Rt 1, Wilson
Reuben Sander, 1968 .... Rt 1, Slaton

Committee meets the third Tuesday of each month at 10:00 a. m., 1628 15th Street, Lubbock, Texas.

Parmer County

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Wilson & Brock Insurance Co., Bovina, Texas

Webb Gober, 1969 .... RFD, Farwell
Henry Ivy, 1970 .... Rt 1, Friona
Jim Ray Daniel, 1970 .... Friona
Carl Rea, 1968 .... Bovina
Ralph Shelton, 1968 .... Friona

Committee meets on the first Thursday of each month at 8:00 p. m., Wilson & Brock Insurance Agency, Bovina, Texas.

Potter County

Fritz Meneke, 1970 .... Rt 1, Box 538, Amarillo
W. J. Hill, Jr., 1969 .... Bushland
L. C. Moore, 1968 .... Bushland
Jim Line, 1968 .... Bushland
Vic Plunk, 1970 .... Rt 1, Amarillo

Randall County

Mrs. Louise Knox
Randal County Farm Bureau Office, Canyon

R. B. Gist, Jr., 1968 .... Rt 3, Box 43, Canyon
Ralph Ruthart, 1969 .... Rt 1, Canyon
Carl Hartman, Jr., 1968 .... Rt 1, Canyon
Marshall Rockwell, 1970 .... Canyon
Richard Friemel, 1970 .... Rt 1, Canyon

Committee meets on the first Monday of each month at 8:00 p. m., 1710 5th Ave., Canyon, Tex.

A System Like This Can Make You Money

(Continued from Page 1)

the Texas High Plains require major transformations in the marketing process before they are in a form for the ultimate consumer. For example, lint cotton requires blending, spinning, weaving or yarning, dying, tailoring, merchandising, and other processing before the consumer receives a finished product. Few of these processes are present in the Texas High Plains in comparison to the quantity of cotton produced. In general, few agricultural processing facilities are located in the area. For a regional economy such as this area, processing firms can provide additional employment of capital and labor resources that will allow increased multiplier effects from the agricultural products.

The natural resources in the area are highly productive resources when combined in the optimum combination. Soils in the area are capable of high levels of production with the proper combination of water and variable resources. Annual precipitation in the area is 18 inches which is below moisture requirements for normal cropping practices for cotton, grain sorghum and other crops. To supplement this condition, ground-water has been used as a major source of water. Of the eight million acres of cropland in the area, over five million are irrigated at the present time from the Ogallala Formation.

Irrigation by farmers in the area was initiated to supplement rainfall that is characterized by erratic timing and quantity of precipitation. Significantly large output responses produced by the application of groundwater were evident and provided incentives for advanced development of the water resources. Since the initial development, irrigation has changed from a resource that was used as a supplemental water source. Now, it is applied in varying quantities depending upon prices and production restrictions. As commercial fertilizers were developed, interactions were observed between water and fertilizer applications, as well as between water and other variable resources such as labor and equipment. That is, higher yields were possible by using less water combined with increases in other variable resources. This increased productivity, combined with increased profits, provided incentives for agricultural producers to combine and increase the use of agricultural inputs.

The increased demand for agricultural inputs is directly associated with the quantity of ground-water which the farmers control. Government programs, improved technologies, increasing population and higher incomes are important economic factors that have provided an environment for development of irrigation facilities. Increased profits and reduction of risk through increased and stable production have induced farmers to increase their demand for variable resources to be used in production.

Study Area

Of the eight million acres of cropland in the Texas High Plains, over four million acres are included in a 17-county area bounded on the north by Randall and Deaf Smith Counties, on the east by Briscoe, Floyd, Crosby, and Lynn Counties, on the south by Lynn, Terry, and Yoakum Counties, and in the west by the New Mexico State line. An estimated 57 percent of 2.7 million of the irrigated acres are included in the area. The following discussion will be based on this area.

The estimates of importance of irrigated cotton and grain sorghum to agricultural input suppliers are based on 1964 data since the most complete production records are available for that year. Most of the 1964 data is aggregated with respect to yields and acres of dryland and irrigated crops. The 1964 average irrigated and dryland yields were estimated since the available data were aggregated with respect to dryland and irrigated farming. The average yield of cotton was 0.97 bales. Cotton acres accounted for 38 percent of planted cropland acres while grain sorghum was planted on 44.2 percent of the acres (See Table 1). Cotton and grain sorghum were planted on 3.4 million of the 4.2 million acres of cropland in the area. Of the cotton acres, 75 percent were irrigated while 56 percent of the grain sorghum acres were irrigated.

Levels of pumping were determined for saturated thicknesses in each county by using records from the High Plains Undeground Water District. After the saturated thicknesses were determined in each county, the pumping rates were determined for the area. The pumping rate was 12.71 acre inches (1.06 acre feet) for cotton and 12.68 acre inches (1.06 acre feet) for grain sorghum. Nearly 2.3 million acre feet were pumped for grain sorghum and cotton in the 17-county area.

Cotton

The value of cotton was $223 million for the area in 1964 (See Table

Water Conservation Experience On A Texas High Plains Farm

By DON ANDERSON

Water and cotton allotments seem to be the favorite subjects on the Plains today and we seem to have a shortage of both. I have been keeping records on my wells closely since 1962 and a decline from 8 feet to 43 feet, or an average of 18 feet amount of underground water has occurred. Since we do not know how low we can pull the water table down and still pump economically, we are not sure how much longer it will last. But regardless of the time, the need for conserving rainfall is great and before long may be an absolute must. To give an idea of the quantity of our rainfall, I would like to quote the following figures. Average rainfall for Crosby County is 20 inches. This is 1.6 acre feet over the crop land of Crosby County which is 327,000 acres. This 1.6 times 327,000 equals 523,200 acre feet of water. We have approximately 2,200 irrigation wells in Crosby County and if the average of these wells pump 300 gallons per minute, it would take 157 days to pump that much water.

Some say let the runoff go to the lake, I will pump it back. Well this is good, but generally when the lake is full the field is wet or crops are not in need of water. There is a considerable loss due to evaporation, particularly when it is one to two months later when the lake water is used. The time is most urgent for carrying out good water management on every farm on the plains. In talking about water management on my farm I would like to begin when I was utilizing contoured rows and terraces on dryland. These practices were a great help in conserving rainfall and repaid in production much more than the cost of the installation or the inconvenience. When I began to drill wells, realizing that watering on the contoured and terraced land was extremely difficult, I took a maintainer and tore down the terraces and headed my rows straight down the hill. Certainly the increased yield was much more even with the loss of rainfall runoff. But the reduced production on the steep slope due to the loss of rainfall and uniform penetration of irrigation water certainly made that land less desirable. I had considerable washes occurring during heavy rains with a loss of the rainfall and the topsoil. When I irrigated, my rows washed out on the hillside and extremely irregular water penetration caused planting difficulties and other farming problems.

I decided to bench level a part of the slope around my lake that I had been unable to irrigate. I did this work under supervision of the Soil Conservation Service and a commercial operator using a carryall and a maintainer and somewhat to my surprise it came out pretty level. A rain immediately after completition filled my benches completely full, but not a drop went into the lake. The first year I planted red top cane on the bench leveled land and harvested the seed, then turned under the stalk for humus matter. This was to rebuild the topsoil in the upper portions of the benches where the top soil had been moved to fill the low places. With 100 pounds of nitrogen, I harvested two bales per acre the second year with much less water than I had been using previously. I had some problems with weeds on the borders the first and second years. This did not bother me too much the first year in the cane, because I could not see them, but in the second year in the cotton the careless weeds must have been some exotic hybrid variety because of the exceptional seedling vigor and rapid plant develpment. This I believe is a technical term for fast growing careless weeds. After playing catchup all summer on the weeds on my borders *I concluded that I should pay as close attention to the weeds on the borders as those in the rows.* With this approach, I now have a minimum amount of trouble. Getting the little weeds early with flame or chemical is relatively easy.

The next year I benched the second section and completed the slope last year. Between the three sections of my benches I made roadways leading toward the lake to reduce the amount of dirt movement necessary to make my benches 12, 18 or 24 rows wide. These benches are all parallel and work very satisfactorily with six row equipment. The elevated road acts as a divider and holds the rainfall in each of the sections.

The second year I drilled a new well on the edge of the lake on a dump built from the dirt taken from a pit that sumps the lake. My underground water line runs parallel with the roads through the benches to this well, then out another direction to connect with another well which provides a transport connection between my three irrigation wells on this farm. At the same time I have risers at alternating borders in order to irrigate the benches. I installed a connection at my new well to hook up a lake pump, however, the lake has been dry ever since I benched the land. The rainfall that has fallen on the slope has simply not reached the lake.

I have increased yields enough to return my capital outlay in three years counting the reduced first year production as one of these years. Of course bench land gets better the second and third year when good cropping practices that return humus to the soil is carried out. I would like to show you what the values look like on my farm before this work was done and after in order to get an idea of the amount of capital increase in the farm value. I paid $325 per acre for this 320 acres of land and in order to evaluate my expenditure I assessed values to each of the fields and by multiplying out this value times the acres I arrived at the average of $325 per acre for the entire farm. I assessed these values in relation to the size of the fields in accordance with what I thought was reasonable in considering the market at that time. These various fields on the farm are listed as follows with the porporionate price per acre.

75.5 acres	$500.00
70.0 acres	$450.00
31.7 acres	$400.00
16.0 acres	$300.00
10.0 acres	$150.00
11.0 acres	$125.00
22.0 acres	$150.00
54.0 acres	$200.00
34.0 acres (lake)	$ 50.00

After completing the three sections of bench leveling around my lake and reassessing values to the acreage, I come out with the following:

72.5 acres	$500.00
70.0 acres	$450.00
27.3 acres	$550.00
13.9 acres	$450.00
22.0 acres	$350.00
11.0 acres	$125.00
20.9 acres	$350.00
44.0 acres	$350.00
38.0 acres (lake)	$ 50.00

The farm values before and after are as follows:

Farm value average $383.50 per acre	$122,710.00
Original cost a average $325.0 per acre	104.000.00
Increase	18,710.00
Less benching cost on 114 acres at $50 per acre	3,700.00
Net capital gain	13,010.00

This gives a clear illustration as to the amount of capital gains on the farm as a result of the expenditures for bench levelling. In view of this amount on capital outlay plus the additional benefits of increased crop yields and tax benefits from being able to charge off bench leveling costs, this certainly proves to be a wise investment for any farmer who has sloping land that will qualify for bench leveling practices. The combination of increased values, increased yields, coupled with conservation of rainfall certainly makes this an attractive practice for every farmer.

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2). Distribution of the estimated $223 million of income will be discussed for dryland, irrigated, and additions to income from irrigation.

Dryland

The value of the dryland cotton was $25 million. Of this amount, the manager received 58.9 percent for returns to management, land, and taxes (See Table 4). Harvesting accounted for 22.8 percent of the gross income. For additional acres of dryland cotton, 18 percent of the gross value of sales would go to implement, fuel, oil, fertilizer, seed, and chemical suppliers.

Irrigated

Irrigated cotton was estimated to

(Continued on Page 4)

Drilling Statistics For October 1967

County	Permits Issued	New Wells Completed	Replacement Wells Drilled	Dry Holes
Armstrong	0	0	0	0
Bailey	5	7	2	0
Castro	9	12	0	0
Cochran	5	4	0	0
Deaf Smith	32	13	0	0
Floyd	8	7	1	0
Hale	1	0	0	0
Hockley	7	7	0	0
Lamb	4	2	0	0
Lubbock	11	7	0	0
Lynn	0	0	0	0
Parmer	13	10	2	2
Potter	0	0	0	0
Randall	3	6	0	0
TOTAL	98	75	3	2

Why We Were There—

(Continued from Page 1)

stand by and see it taken without just compensation.

The Sun Oil-Whitaker case is not a case to stop water flooding, but a case to determine if the surface owner still has the right to control his private property — his underground water.

Irrigation Importance—

(Continued from Page 3)

be worth $195 million. The largest portion of the value (49.6 percent) was left for management, land, water, and taxes. The same percentage was required for harvesting irrigated cotton as for dryland (22.8 percent). Farmers, realizing the response from additional quantities of variable resources, including ground-water. increased the percentage of expenditure from 3.8 for dryland to 10 percent for irrigated cotton. Fuel, oil, depreciation and repairs on tractor and equipment received a reduced percentage from irrigation than for dryland. Irrigation suppliers receive 3.2 percent of the gross value. If farmers are making plans that approximate optimum farm plans with respect to profit, agricultural input suppliers can expect 50.4 percent of income from increases in cropland acres planted to irrigated cotton.

Increased Income From Irrigation

In the Texas High Plains, farmers increase their water supply by adding new wells when possible. Decisions such as this change the technique of producing cotton from dryland to irrigation. In this situation, income added by applying water and other resources is important to the agricultural resource owners. Irrigated cotton increased income over dryland cotton by $97.78 per acre or $119 million. The largest share, which was 43.5 percent, was received by farmers for added management, taxes, and water. Fertilizer, seed, and chemical suppliers received 14 percent of the total added value. Suppliers of irrigation equipment received 5.4 percent of the added income. Other supply sectors received the same percentage as for dryland conditions.

Grain Sorghum

The total value of grain sorghum production for the area in 1964 was $105 million (See Table 3). Distribution of the estimated $105 million will be discussed for dryland, irrigated, and additions to income from irrigation.

Dryland

The value of dryland grain sorghum was $21 million compared to $25 million for dryland cotton. Of the $21 million, 60.4 percent was received by farmers for unspecified resources and taxes. Owners of harvesting equipment received 13.2 percent of the dryland value. Fertilizer, seed, and chemical suppliers received 9.4 percent. Other suppliers of resources such as fuel, oil, repairs, depreciation, and labor received lower percentages.

Irrigated

Irrigated grain sorghum producer's income was estimated to be $83 million in 1964. The producers of irrigated grain sorghum production was less than dryland producer's share. Fertilizer, seed, and chemical suppliers received 14 percent of gross income. Additional cropland transferred into irrigated grain sorghum will allocate 5.7 percent of the increased income from the added acres to suppliers of irrigation equipment. In general, the major resource owners received increased shares of the income from irrigated compared to dryland grain sorghum except the farm manager.

Increased Income From Irrigation

Irrigated grain sorghum increased income over dryland production by $55.11 per acre of $55 million. Farmer's share of the increased income for increased quantities of unspecified resources such as management, water, and taxes decreased when compared to dryland. The share to management (44.4 percent) was 2 percent lower than the portion that was allocated for irrigated cotton. The allocation to fertilizer, seed, and chemical suppliers increased to 16.2 percent which is higher than that for irrigated cotton. In summary, of the allocation of the increased income from irrigated grain sorghum, agricultural input suppliers received 55.6 percent of the total increased value.

Summary And Limitations

Agricultural input suppliers do receive a significant amount of income from irrigated cotton and grain sorghum in the 17-county area. Of the $160 million allocated to the agricultural input suppliers from dryland and irrigated production of cotton and grain sorghum, 61 percent or $98 million was produced by the development and use of irrigation. Farmers received 39 percent of the increased income to provide incentives to utilize the resources.

Government payments were not included in the total value of the two crops. The effect of inclusion would be an increase in farmer's share with a reduction in the agricultural input supplier's share.

The absolute income values may not be applicable to current production organizations. Relationships of the magnitude expressed in the summary should be applicable to current production patterns to provide estimates of shares of income added from irrigation.

Although the yields and acres of irrigated and dryland crops were estimated and based on 1964 data, the results will provide a basis for projecting future shares for expanded and decreasing levels and acres of irrigation. Continued refinement in the data through research will provide guides for expansion and contraction of individual supply firms.

TABLE 1. Characteristics of Cotton and Grain Sorghum in the 17-County Area, 1964.

Item	Cotton	Grain Sorghum
Acres Harvested (a)	1,612,702	1,785,514
Estimated Irrigated Acres (b)	1,213,127	1,005,912
Estimated Dryland Acres (b)	391.540	779,602
Added Revenue/Acre from Irrigation	$42.58	$24.59
Average Yield (a)	0.97 bales	2957.7 lbs.
Average Irrigated Yield (b)	1.15 bales	3761.8 lbs.
Average Dryland Yield (b)	0.46 bales	1934.4 lbs.
Acre Inches Pumped (c)	12.71	12.68
Percent of Cropland Acre (a)	38.0	44.2

(a) Preliminary Census of Agriculture, 1964.
(b) Estimates are based on a linear projection from 1959 to 1964, with aggregate data as the basis for projecting.
(c) Based on pumping records from High Plains Underground Water District and hydrologic subareas of the Ogallala.

TABLE 2. Purchases of Agricultural Input for Dryland and Irrigated Cotton for the 17 Counties, 1964.

Item	Dryland	Irrigated	Added by Irr.
		(Thousand Dollars)	
Fertilizer			
Seed and Chemicals (a)	970	19,608	16,596
Fuel, Oil and Repairs:			
Tractor and Equipment (b)	939	5,654	2,742
Irrigation Equipment (c)		3,141	3,141
Depreciation:			
Tractor and Equipment (b)	516	2,914	1,310
Irrigation Equipment (c)	----	6,426	6,426
Harvesting:			
Hauling and Stripping (b)	2,574	20,016	12,046
Ginning (d)	3,198	24,999	15,091
Labor (b)	2,236	16,539	9,608
Farmer's Return	14,957	92,994	51,657
TOTAL	25,390	197,291	118,617

(a) Fertilizer values were estimated using the Preliminary Census of Agriculture, 1964. Seed and chemicals were published in Texas Agriculture Experiment Station Bulletins MP-601 and MP-695, entitled "Production and Production Requirements, Costs and Expected Returns for Crop Enterprises".
(b) Texas Agricultural Experiment Station, "Production and Production Requirements, Costs and and Expected Returns for Crop Enterprises", MP-601 and MP-695.
(c) Based on interviews with irrigation dealers and farmers.
(d) Agricultural Statistics, USDA, 1965.

TABLE 3. Purchases of Agricultural Inputs for Dryland and Irrigated Grain Sorghum for the 17 Counties, 1964.

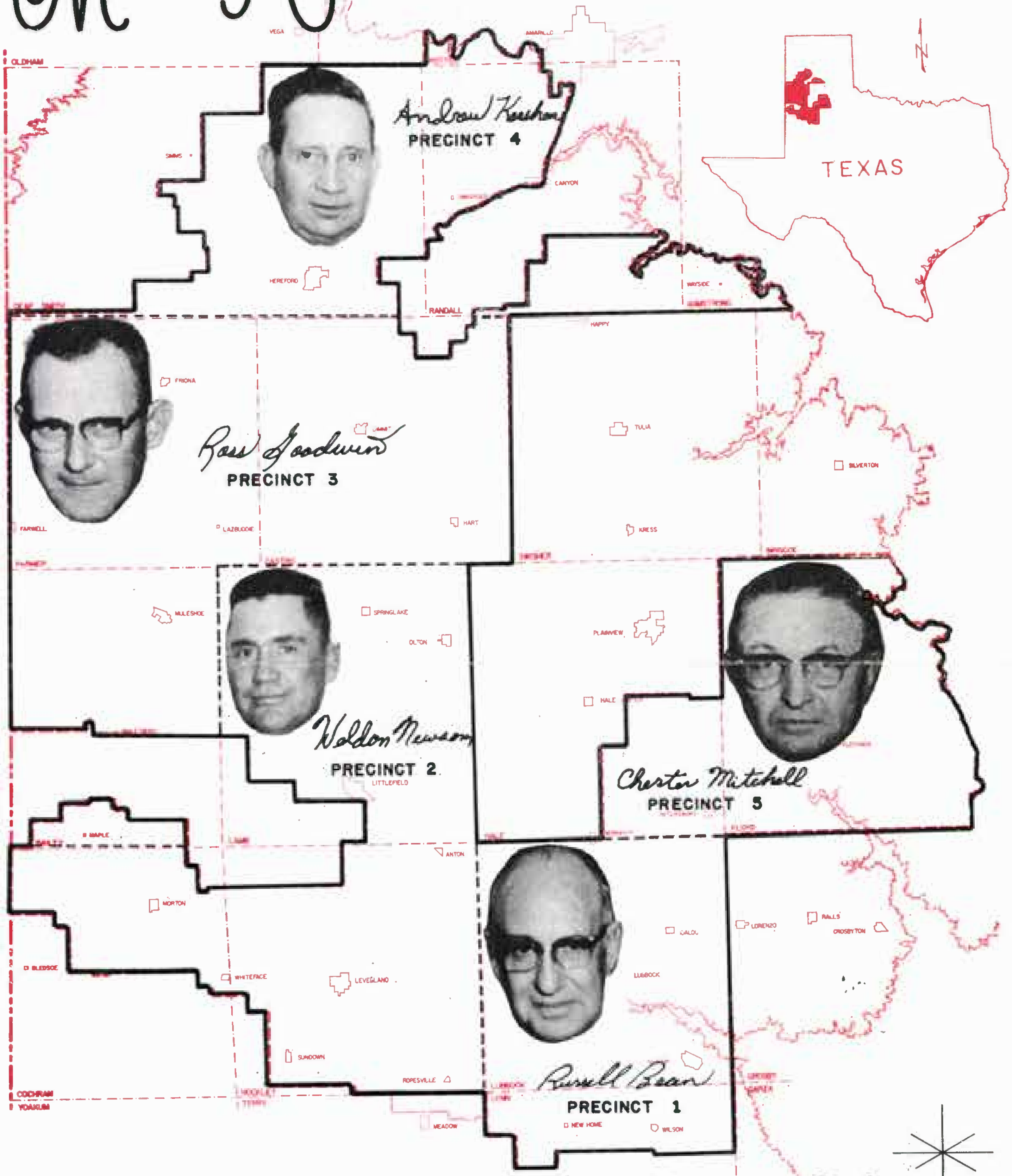
Item	Dryland	Irrigated	Added by Irr.
Fertilizer, Seed and Chemicals (a)	2,031	11,648	8,983
Fuel, Oil and Repairs:			
Tractor and Equipment (b)	1,442	3,950	2,092
Irrigation Equipment (c)	----	2,719	2,719
Depreciation:			
Tractor and Equipment (b)	790	2,040	1,026
Irrigation Equipment (c)	----	4,742	4,742
Harvesting	2,861	10,986	7,293
Labor (b)	1,456	5,732	3,853
Return to Farmer	13,133	41,676	24,732
TOTAL	21,733	83,493	55,440

(a) Fertilizer values were estimated using the Preliminary Census of Agriculture, 1964. Seed and chemicals were published in Texas Agricultural Experiment Station Bulletins MP-601 and MP-695, entitled "Production and Production Requirements, Costs and Expected Returns for Crop Enterprises".
(b) Texas Agricultural Experiment Station. "Production and Production Requirements, Costs and Expected Returns for Crop Enterprises", MP-601 and MP-695.
(c) Based on interviews with irrigation dealers and farmers.

TABLE 4. Comparisons of the Major Agricultural Inputs for the 17 Counties, 1964.

Item	Cotton			Grain Sorghum		
	Dryland	Irrigated	Added Income from Irr.	Dryland	Irrigated	Added Income from Irr.
			(Percent)			
Fertilizer, Seed, and Chemicals	3.8	10.0	14.0	9.4	14.0	16.2
Fuel, Oil & Repairs:						
Tractor & Equip.	3.7	2.9	2.3	6.6	4.7	3.8
Irrigation Equip.	----	1.6	2.6	-	3.3	4.9
Depreciation:						
Tractor & Equip.	2.0	1.5	1.2	3.7	2.4	1.8
Irrigation Equip	----	3.2	5.4	----	5.7	8.6
Harvesting	22.8	22.8	22.8	13.2	13.2	13.2
Labor	8.8	8.4	8.2	6.7	6.8	7.1
Farmer's Return	58.9	49.6	43.5	60.4	49.9	44.4
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0

Merry Christmas



Happy New Year

Board of Directors

High Plains Underground Water Conservation District No. 1

THE Cross SECTION

A MONTHLY PUBLICATION OF THE HIGH PLAINS UNDERGROUND WATER CONSERVATION DISTRICT No. 1

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W. O. FORTENBERRY
1894 - 1967

To many of his Friends, he was always, "Mr. Bill".

He first came to West Texas shoveling coal on a Santa Fe freight train. Using his coal shovel for a skillet, he fried bacon and eggs in the fire-box of the engine for himself and the engineer, because eating places were scarce up and down the line in those days.

He was a young man then, but he could see even then that the High Plains could be a great country someday and he was determined to be a part of it.

He accomplished that goal.

Agriculture, Industry, Business, Education, Conservation — he helped with the problems involved in all of them with an endless enthusiasm.

Mr. Bill was a man with distance in his vision .For years, he worked for the wise use and the conservation of the water supply of the Texas High Plains.

He served as Chairman of an organization encompassing all of West Texas that worked through three sessions of the Legislature to pass a statewide bill that would further aid in the protection of the individual to the water beneath his property. He saw to it that enabling legislation was included in the same act providing the tools for the creation of Underground Water Conservation Districts wherever they might be needed in the State.

Three Texas Governors called upon him many times to apply his practical wisdom in the planning for the future of water supplies for the State.

Six years, he served as Chairman of the Board of Directors of the High Plains Water District. His love for the Plains, and his interest in perpetuating its economy far into the future was responsible for many of the decisions being followed today by several Ground Water Districts in the preservation and protection of their underground supplies. At his own expense, he made numerous trips to the State Capitol for conferences with the Texas Board of Water Engineers (now the Texas Water Development Board) and the Texas Railroad Commission, fighting for more and better control from pollution of the underground reservoirs.

The idea of applying for tax relief on the use of a natural resource in the production of farm commodities had never been applied to irrigation water until he and the other members of the Board of Directors of the District, the District's Hydrologist, Accountants, and Legal Counsel began toying with a plan. It was from these conferences that the Tax Depletion case was conceived. As a result of that case, over two and a half million dollars have been pumped into the High Plains economy in the two years since the court's decision.

Through his efforts to write water law to protect the underground water supplies of Texas, as well as the individual's rights in that water, he became known across the State as a "Water Man". This was in addition to the many other titles and distinctions he bore.

Where Do Men Like Mr. Bill Come From—

For what he meant to those who had the honor and pleasure of working with him, his living presence will forever remain.

WATER LEVELS TO BE MEASURED

During January, District and Texas Water Development Board personnel will measure the static water levels in nearly 800 observation wells within the District. These measurements will constitute the continuation of the annual, water-level-measuring program, vestigia of which extend back over 30 years.

Within the District, Board personnel will measure the observation wells in Armstrong, Bailey, Cochran, Floyd, Lamb, Lynn and Parmer Counties; while District personnel will measure wells in Castro, Deaf Smith, Hockley, Lubbock, Potter, and Randall Counties, and in Precinct 2 (southeast one-fourth) of Hale County.

These measurements provide the water-level data for the cost-in-water-depletion, water-level decline, income tax allowance, guideline maps, compiled annually by the District.

Most of the observation wells are privately owned irrigation wells—for which permission to measure was obtained from the respective owners, at the time each well was added to the program.

In order to supply well owners with this January's water-level measurements, a yellow, vinyl, stick-on tag will be placed on or near the well head equipment. An example tag, (reduced in size) shown below.

THE DEPTH TO WATER IN THIS
WELL, NO. 24-36-302
WAS 124.37 FEET
BELOW THE LAND SURFACE, ON
JANUARY 5, 1968
BY ______ T.W.D.B.
BY [initials] H.P.U.W.C.D. NO. 1

(Continued on Page 4)

WELL DEVELOPMENT WITHIN THE DISTRICT

By F. A. RAYNER

From May 1953 to January 1, 1967, a total of 26,138 new wells were drilled within the District*. The accompanying table, compiled by A. Wayne Wyatt, summarizes well development during these 13 years and 9 months.

The influence of antecedent precipitation on the magnitude of well development, is illustrated by the histogram of well development and precipitation. The unprecedented rate of well development during the early and middle 50's was perpetrated, in part, by the below-normal precipitation during these years. The apparent paradox of well development in 1957 (an abundant rainfall year) can be explained by an understanding of this areas precipitation pattern**.

Practically all of this areas total annual precipitation accurs as rainfall during May, June, July, August, September, and October; while November, December, January, February, and March are usually very dry months. These months, with April and part of May, constitute—for all practical purposes—the well-drilling season. Therefore, the predominance of the drilling activity, during any given year, precedes the occurance of the major part of that years precipitation. It is this well development-precipitation cycle that prompted the plotting of each years well development graph to the left of that years graph of precipitation.

The above-average rainfall, during 1957 through 1962, is primarily responsible for the relatively small number of wells completed during these years.

The influence of climatic conditions on well development is further illustrated by the cumulative curve *("Cumulative Number of Wells Completed In The . . . ")*; by the steepening of its slope during drought years, and a flattening (reduction) of its slope during wet years.

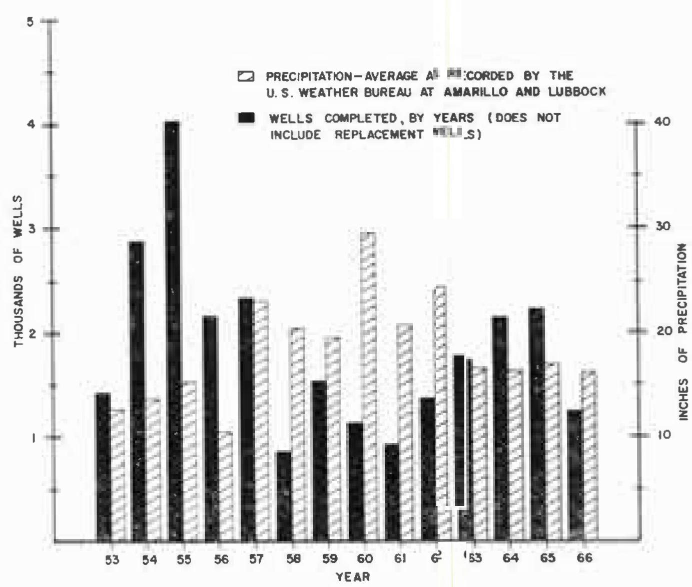
The incremental annual increase in well development, during 1961 through 1965, may have been caused, in part, by the irrigators need to complete additional wells, in order to maintain a desired pumping capacity. A condition created by the decline in well yields, as a result of the trend to depletion of the aquifer. By this analogy—all other factors being equal—the rate of well development in 1966 (a near normal rainfall year) should have continued this numerical acceleration. However, it is suspected that another more powerful influence may be reflected by this reduced well development—"tight" money, and high interest rates.

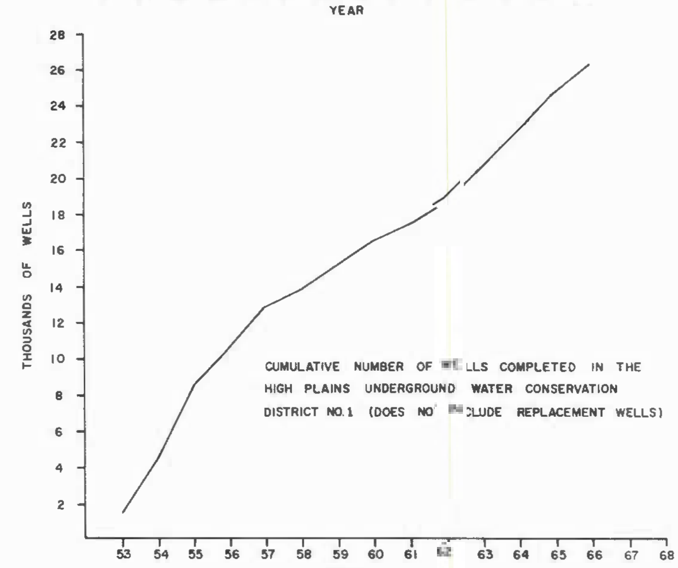
Limit to Well Development

In theory, the cumulative curve should, in time, become asymptotic to some maximum permissible well density. The influence of the reduced well development in 1966, on the slope of the cumulative curve, would tend to suggest the approaching of this presumed point of well saturation.

There are numerous factors that will determine the ultimate well density; foremost are economic limitations, second are geohydrologic limitations, and thirdly — and the least probable, because of the limiting con-...

(Continued on Page 4)





Water District Election Time

The annual election for the High Plains Underground Water Conservation District No. 1 will be held January 9, 1968. Voters will have several issues on which to make decisions.

At the end of this year three of the five men who serve as members of the Board of Directors will conclude their present terms of office. These three are Russell Bean, who represents Lubbock and Lynn Counties, Chester Mitchell of Lockney, who represents Floyd and Hale Counties, and Weldon Newsom of Morton, who represents Hockley, Cochran and Lamb Counties.

The ballot will also include the nominees to fill places for each five-man County Committee in the District. Each county in the District has a "County Committee" that approves well drilling permits and makes recommendations on various matters to the District Board.

The other issue on the ballot will be the annexation of Crosby County into the High Plains Underground Water Conservation District No. 1.

Residents of the county are applying for membership and the residents of the District will vote to accept or reject this county.

Residents living within the County of Crosby will vote to either join the District or remain separated from it. To vote on this proposal, one must be a qualified voter and must live in the area effected. A person who owns property in the area under consideration, but does not reside in the area is not eligible to vote on this proposal.

All qualified voters living within the District are eligible to vote for the District Directors, County Committeemen, and to accept or reject the county that desires to become a part of the District.

A qualified voter is one who has a valid Voter Registration Certificate for 1967, and owns property within the District. This property can be a house and lot, farm, business property or land of any type. You do not have to be a farmer or own an irrigation well. School teachers, bankers, mechanics, grocers, or anyone who owns property that is taxed by the Water District is eligible to vote.

Nominations of qualified persons for District Directors and County Committeemen are made by the respective County Committees or they are made by a petition signed by twenty-five qualified voters in the area involved.

Voters must cast their ballots in their home counties; however, they may vote at any one of the voting places in that county.

Nominees for Directors and Committeemens' places are as follows:

NOMINEES FOR DISTRICT DIRECTOR

(One to be elected for each precinct)

PRECINCT ONE (1) Lubbock and Lynn Counties

Russell Bean, 2806 21st Street, Lubbock, Texas

PRECINCT TWO (2) Cochran, Hockley and Lamb Counties

Weldon Newsom, Rt. 2, Morton, Texas

PRECINCT FIVE (5) Floyd and Hale Counties

Chester Mitchell, Lockney, Texas

NOMINEES FOR COUNTY COMMITTEEMEN

Two (2) to be elected for each County.

ARMSTRONG COUNTY

PRECINCT 3

Residents of Commissioner's Precinct No. 3 vote for Two (2)

Bill Heisler, Box 118, Wayside, Texas
C. D. Rogers, Wayside, Texas
Guy Watson, Wayside, Texas
Cordy Mahler, Wayside, Texas
John Patterson, Wayside, Texas
Jack McGehee, Wayside, Texas

BAILEY COUNTY

PRECINCT 1

Residents of Commissioner's Precinct No. 1 vote for one (1)

R. O. Gregory, Rt. 1, Box 194 Muleshoe, Texas
Lloyd D. Throckmorton, Rt. 1, Box 115, Muleshoe, Texas

PRECINCT 3

Residents of Commissioner's Precinct No. 3 vote for one (1)

Morgan Dennis, Star Rt., Hereford, Texas

PRECINCT 4

Residents of Commissioner's Precinct No. 4 vote for one (1)

Donald Wright, Box 65, Dimmitt, Texas

COCHRAN COUNTY

DISTRICT DIRECTOR

Residents of Cochran County vote for one (1)

Weldon Newsom, Morton, Texas

COUNTY COMMITTEEMEN

Residents of Commissioner's Precinct No. 2 vote for one (1)

E. J. French, Jr., Rt. 3, Levelland, Texas
Don Keith, Rt. 1, Morton, Texas

COMMITTEEMEN-AT-LARGE

Residents of Cochran County vote for one (1)

W. D. (Bill) Ford, Jr., Star Rt. 2, Morton, Texas
Ronald Coleman, Rt. 1, Morton ,Texas

DEAF SMITH COUNTY

PRECINCT 3

Residents of Commissioner's Precinct No. 3 vote for one (1)

Billy Wayne Sisson, Rt. 5, Hereford Texas
George Ritter, Rt. 5, Hereford, Texas

PRECINCT 4

Residents of Commissioner's Precinct No. 4 vote for one (1)

Harold Martin, Box 13, Wildorado, Texas
Harvey Fuqua, Rt. 1, Hereford, Texas

FLOYD COUNTY

DISTRICT DIRECTOR

Residents of Floyd County vote for one (1)

Chester Mitchell, Lockney, Texas

COUNTY COMMITTEEMEN

PRECINCT 1

Residents of Commissioner's Precinct No. 1 vote for one (1)

M. J. McNeill, 833 W. Tenn., Floydada, Texas

PRECINCT 3

Residents of Commissioner's Precinct No. 3 vote for one (1)

M. M. Julian, Box 65, South Plains, Texas

HALE COUNTY

DISTRICT DIRECTOR

PRECINCT 2

Residents of Commissioner's Precinct No. 2 vote for one (1)

Chester Mitchell, Lockney, Texas

COUNTY COMMITTEEMEN

PRECINCT 2

Residents of Commissioner's Precinct No. 2 vote for two (2)

Henry Scarborough, Petersburg, Texas
Harold Rhodes, Box 100, Petersburg, Texas
John C. Alford, Box 28, Petersburg, Texas
Kenneth Roberson, Petersburg, Texas

HOCKLEY COUNTY

DISTRICT DIRECTOR

Residents of Hockley County vote for one (1)

Weldon Newsom, Morton, Texas

COUNTY COMMITTEEMEN

PRECINCT 1

Residents of Commissioner's Precinct No. 1 vote for one (1)

Harold Ray Phillips, Rt. 5, Levelland, Texas
T. H. Kimbrough, Rt. 5, Levelland, Texas

PRECINCT 2

Residents of Commissioner's Precinct No. 2 vote for one (1)

Erlan Gresham, Rt. 1, Levelland, Texas
Ewel Exum, Rt. 1, Ropesville, Texas

LAMB COUNTY

DISTRICT DIRECTOR

Residents of Lamb County vote for one (1)

Weldon Newsom, Morton, Texas

COUNTY COMMITTEEMEN

PRECINCT 2

Residents of Commissioner's Precinct No. 2 vote for one (1)

Gene Templeton, Star Rt. 1, Earth, Texas
Kenneth Henson, Springlake, Texas

Residents of Lamb County vote for one (1)

E. D. Bingham, 501 E. 9th, Littlefield, Texas
Billy Chester, 410 Smith, Sudan, Texas
Artis Barton, Hwy 70, Earth, Texas
Bob Mills, West 8th, Olton Texas

LUBBOCK COUNTY

DISTRICT DIRECTOR

Residents of Lubbock County vote for one (1)

Russell Bean, 2806 21st St., Lubbock, Texas

COUNTY COMMITTEEMEN

Residents of Commissioner's Precinct No. 1 vote for one (1)

Glen Blackmon, Rt. 1, Shallowater, Texas
Benny James, Rt. 1, Anton, Texas

PRECINCT 4

Residents of Commissioner's Precinct No. 4 vote for one (1)

Andrew (Buddy) Turnbow, Rt. 5, Lubbock, Texas
W. O. Roberts, Rt. 4, Lubbock, Texas

LYNN COUNTY

DISTRICT DIRECTOR

PRECINCTS 1 and 4

Residents of Commissioner's Precincts No. 1 and 4 vote for one (1)

Russell Bean, 2806 21st St., Lubbock, Texas

COUNTY COMMITTEEMEN

PRECINCT 1

Residents of Commissioner's Precinct No. 1 vote for one (1)

Reuben Sander, Rt. 1, Slaton, Texas
Orville Maeker, Rt. Slaton, Texas

PRECINCT 4

Residents of Commissioner's Precinct No. 4 vote for one (1)

O. R. Phifer, Jr., New Home, Texas
LeRoy Nettles ,New Home, Texas

PARMER COUNTY

COUNTY COMMITTEEMEN

PRECINCT 1

Residents of Commissioner's Precinct No. 1 vote for one (1)

Edmund Schlab, Rt| 3, Friona, Texas
George Frye, Rt. 3, Friona, Texas
Guy Latta, Friona, Texas

PRECINCT 2

Residents of Commissioner's Precinct No. 2 vote for one (1)

Edwin Lide, Rt. D, Bovina, Texas
A. E. Steelman, Rt. D, Bovina, Texas

POTTER COUNTY

PRECINCT 4

Residents of Commissioner's Precinct No. 4 vote for two (2)

Jim Line, Bushland, Texas
Temple Rodgers, Rt. 1, Amarillo, Texas

RANDALL COUNTY

COUNTY COMMITTEEMEN

PRECINCT 3

Residents of Commissioner's Precinct No. 3 vote for one (1)

R. B. Gist Jr., Rt. 2, Box 43, Canyon, Texas
Melvin Schaeffer, Rt. 1, Happy, Texas

PRECINCT 4

Residents of Commissioner's Precinct No. 4 vote for one (1)

Carl Hartman, Rt. 1, Canyon, Texas
Frank Begert, Rt. 1, Canyon, Texas

FOR The confirmation of the annexation of certain eligible lands in Crosby County to the High Plains Underground Water Conservation District No. 1.

AGAINST The confirmation of the annexation of certain eligible lands in Crosby County to the High Plains Underground Water Conservation District No. 1.

POLLING PLACES:

ARMSTRONG COUNTY
1) School House, Wayside

BAILEY COUNTY
1) Enochs Gin, Enochs
2) State Bank, Muleshoe

CASTRO COUNTY
1) Brockman Hardware Co., Nazareth
2)County Court House, Dimmitt
3) Easter Community Center, Easter
4) City Hall, Hart

COCHRAN COUNTY
1) County Activities Bldg., Morton
2) Star Route Co-op Gin, 5 miles West of Morton
3) Alamo Gin, 2 miles East of Morton

DEAF SMITH COUNTY
1) County Court House, Hereford

FLOYD COUNTY
1) County Court House, Floydada
2) City Hall, Lockney

HOCKLEY COUNTY
1) City Hall, Anton
2) Farm Center Gin, Ropesville
3) County Court House, Levelland
4) Whitharral Lions Club Bldg., Whitharral
5) City Hall, Sundown

LAMB COUNTY
1) City Hall, Olton
2) City Hall, Sudan
3) Community Bldg., Earth
4) County Court House, Littlefield
5) Farmers Coop Gin, Spade

HALE COUNTY
1) Community Center, Petersburg

LUBBOCK COUNTY
1) Community Club House, Shallowater
2) City Hall, Wolfforth
3) Old County Court House, Lubbock
4) City Hall, Idalou
5) Community Club House, Slaton

LYNN COUNTY
1) Community Center, New Home
2) Wilson State Bank, Wilson

PARMER COUNTY
1) City Hall, Friona
2) Wilson & Brock Insurance Agency, Bovina

POTTER COUNTY
1) School House, Bushland

RANDALL COUNTY
1) Consumer's Fuel Assoc. Elevator, Ralph Switch
2) V. F. W. Hall, 1 mile North Canyon
3) Columbus Club Hall, Umbarger

CROSBY COUNTY
1) Pioneer Memorial Bldg., Crosbyton
2) V. F. W. Hall, Ralls
3) Community Center, Lorenzo

ABSENTEE BALLOTING

Absentee balloting for the annual election of the High Plains Underground Water Conservation District No. 1 will be held December 20, 1967 through January 5, 1968. Absentee balloting will be conducted by the secretaries of the County Water District Offices except in Potter County ,where residents may cast their ballots at the County Clerk's Office.

Eligible voters of the Water District are urged to vote absentee if they are going to be absent from the County on January 9th .

Proposals on the ballot will be three (3) District Directors positions, twenty-eight (28) County Committeemen, and the acceptance or rejection of Crosby County.

Be sure to vote, either absentee or on January 9, 1968.

Well Development—

(Continued from Page 2)

ditions dictated by those physical parameters listed as the second most probable limitation — are well-spacing regulations.

The District's rules do not impose spacing, or other requirements, on wells equipped to produce less than 100,000 gpd (69.5 gpm). However, most well owners have come to recognize the economic advantages of sufficient spacing between even small capacity wells; therefore, they continue to observe the District's minimum-spacing regulations. Assuming that this trend to spacing wells 200 yards on centers will continue; and assuming an optimum configuration for the 8,056 square miles within the District; and assuming a square, well-spacing pattern; and further assuming that all other limiting factors are satisfied; then approximately 625,000 wells could (theoretically) be completed within the District.

At the historical annual rate of new well development within the District —approximately 1900 wells per year —it would require about 330 years to reach the ultimate well density permissible under the District's present well-spacing rules. Although very little justification can be accredited the assumptions used to arrive at this time estimate, it is apparent that the presently existing well-spacing regulations are inconsequential in respect to determining the areas ultimate well density.

Lubbock County has an average well density of approximately nine wells per square mile. Within the District, only Lynn County has a greater well density—with approximately 10 wells per square mile.

A review of the well development table shows that only in 1958 and 1959 were there more wells developed in another District county (Hockley), than were developed in Lubbock County. This is to say, that even with Lubbock County's relatively heavy well density, it continues to lead all other areas in new well development. This is a strong indication that the change in slope of the cumulative curve, in 1966, is not an indication of well saturation.

However, the well development records for Lynn County (that portion within the District) suggests a trend to well saturation. This condition is probably perpetrated by economic conditions, that are, in turn, dictated by geohydrologic parameters. An in-depth economic analysis, now being completed by Messers. Hughes and Harman, of Texas A & M University, supports this evaluation.

It is probable that the long-term, upward trend to well development will continue, with periodic reversals (such as in 1966), but with a lessening of the climatic influence thereon.

The present well-spacing regulations do not appear to inhibit the rate of well development, and there does not appear to be any need for otherwise restricting, at this time, the drilling of additional wells.

*This statement applies to the original 13-county District area: this does not include Precinct 2, Hale County; or other lands in Bailey, Cochran and Hockley Counties, that was added to the District in 1966.

**A discussion of this area's precipitation history is presented in the February 1967 issue of the Cross Section.

NOTICE TO LANDOWNERS—

The 1967 Water Level Decline Maps will be available about February 15, 1968. Landowners will find it advantageous to file an estimate of tax by January 15, 1968; in order to delay the filing of the final (1967) income tax return until after these maps become available. In this regard, you may wish to consult with your tax advisor prior to January 15.

New Wells Completed In The District, May 1953 to January 1, 1967

County	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	Cnty Ttl
Armstrong	1	10	12	1	4	4	6	3	9	0	4	20	21	7	102
Bailey	43	151	254	198	234	59	91	68	48	65	107	112	112	59	1601
Castro	142	264	371	138	196	86	106	72	100	117	134	232	238	126	2322
Cochran	36	109	196	89	86	33	64	38	33	53	78	76	56	34	981
Deaf Smith	61	236	285	185	165	106	128	97	72	109	206	303	260	192	2405
Floyd	152	241	358	174	185	70	144	94	54	113	131	275	228	124	2343
Hockley	194	325	547	310	358	139	263	182	131	252	246	218	249	114	3528
Lamb	178	320	456	194	241	81	176	123	102	115	215	200	228	95	2724
Lubbock	344	518	606	452	473	121	252	249	178	266	314	289	429	200	4691
Lynn	97	194	268	212	148	29	101	87	82	104	46	86	115	59	1638
Parmer	190	484	494	161	171	109	143	88	83	142	183	239	213	164	2864
Potter	4	1	4	0	2	2	2	0	2	1	7	2	2	7	36
Randall	52	80	147	56	56	30	42	32	15	51	75	101	92	74	903
TOTAL	1494	2933	3998	2170	2319	879	1518	1133	909	1388	1746	2153	2243	1255	26138

Irrigation Study Released

The Texas Agricultural Extension Service has recently released the 1967 High Plains Irrigation Survey.

The survey covers the 42 - county area of the High Plains of Texas.

Included in the survey are items such as: total number of acres irrigated in each county, water lift, types of fuels used, sprinkler and surface irrigation, playa lakes used, crops grown, recharge wells, and return systems.

The report is very interesting and is well worth reading.

Copies may be obtained through your local county agricultural agents office.

REMINDER—

West Texas Water Conference— Student Union Building—Texas Tech—February 2, 1968.

Water Levels—

(Continued from Page 2)

These tags will also identify the wells measured, which will provide for the checking of the apparently anomalous, water-level measurements that sometimes "crop up", as a result of the use of these data in the preparation of the tax-allowance, guideline maps. These tags will also facilitate the District's observation-well, upgrading program.

Well owners, and/or operators, are requested to remove these tags from any equipment that is removed from an observation well; particularly so if such equipment is to be installed in another well.

Complete water-level records for each observavtion well can be obtained from the District, or the Texas Water Development Board.

The 1968 water-level measurements will be published in the March issue of the *Cross Section.*

Water Is Your Future—Conserve It!

10 EASY WAYS TO BE MISERABLE

1. Forget the many good things you have and over-emphasize the few you lack.
2. Convince yourself that money is more important than it really is.
3. Think of yourself as indispensible.
4. Think that you always have too much to do.
5. Be convinced that you are exceptional and entitled to special privileges.
6. Forget that a sense of responsibility is essential to a democratic society.
7. Forget other people.
8. Cultivate a pessimistic outlook.
9. Always feel sorry for yourself.
10. Associate only with unhappy people.

—Copied from "GO", Transport Times of the West

High Plains Underground Water
Conservation District No. 1
1628 Fifteenth Street
Lubbock, Texas 79401

Second Class Permit