THE Cross SECTION

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DIRECTORS/COMMITTEEMEN ELECTED

District Voters Called To Polls

Members of a grassroots network of elected officials, charged with representing the interests of the residents they serve in all facets of the programs and activities of the High Plains Underground Water Conservation District No. 1, are to be elected Saturday, January 18, 1986. Registered voters residing within the boundaries of Water District Directors' Precincts One, Two and Five will be called upon to elect one person to the Board of Directors from each of the three Directors' Precincts and to fill two places on the five-man county committee for each county within these Directors' Precincts.

The counties comprising District Directors' Precinct One are Crosby, Lubbock and Lynn. Cochran, Hockley and Lamb Counties make up Director's Precinct Two, and Precinct Five includes Floyd and Hale Counties.

Becca Williams, election chairman, notes that District Directors and county committeemen form the base of a network of neighbors serving neighbors. "These committeemen know the programs and activities of the District, and in many instances participate as volunteers in on-farm field testing of new water conservation techniques. They can then pass along their own hands-on experiences to the people in their local community. Our committeemen can assist their neighbors in anything from explaining the simple procedures which need to be followed to take out a water well permit to passing along information about new water conservation techniques and legislative matters that the District is involved in."

Director's Precinct One

Residents of Water District Director's Precinct One, consisting of Crosby, Lubbock and Lynn Counties, are currently represented on the District's Board of Directors by James P. Mitchell of Wolfforth. Mitchell was elected to his first term on the Board of Directors in January of 1976, and he has agreed to place his name on the ballot for re-election.

Two positions on the county committees in Crosby, Lubbock and Lynn Counties will also be filled during this election. In Crosby County, Bobby Brown, representative at-large, has expressed his desire to serve a second four-year term in office. Tracy Don Hancock, county committeeman-at-large, is seeking his first term in office to fill the vacancy left by Tom McGee.

Lubbock County residents residing in County Commissioner's Precinct Three have been represented on the five-man county committee by Pierce Truett for

continued on page 4 . . . VOTERS

election

JANUARY 18, 1986

Audit Designed To Evaluate Municipal Water Resources

With the passage of Proposition Number 2 on the November 5, 1985, general election ballot, which provides for municipal water financing, many small cities and towns in the High Plains may be taking a closer look at their water resources and at planning for their future water needs. Kate Trauth, graduate student and research assistant for the Water Resources Center at Texas Tech University, may have just the tool that cities and towns in this area need to help them evaluate their current water resources and the ability of those resources to meet future demands.

Called a "Municipal Water Resources Audit," Trauth has designed a do-it-yourself guide to assist cities in evaluation of their current water situations. By providing a series of questions, the audit will help a community that is interested in assessing its water resources, but that may not know where to begin or exactly what questions to ask. The guide was designed with a three-fold purpose as follows:

- To help a city get an overview of the water resources of the community,
- To identify problem areas, and
- To assist in setting goals and structuring planning and management strategies to meet these goals.

Trauth explains, "The water resources audit is geared for the people who actually operate the water supply, wastewater, and stormwater systems of a municipality. We tried to design the audit to utilize existing people and resources. Through this process, information is gathered on a city's individual water resources, uses and needs, and the information is put into a format that hopefully will make the problems and potential solutions to problems obvious to those people it affects. For example, some of the questions asked in the audit and the answers to those questions may help the city management look ahead and take care of potential problems before they appear.

"Additionally," Trauth notes, "once the information is compiled to complete the questions asked in the audit, this information may be useful in the actual planning, design and engineering stages of any projects that are needed."

Basically, the audit is comprised of questions relating to four specific areas regarding a city's water resources system:

- Water supply,
- Wastewater components,
- Stormwater management, and
- Conservation.

Utilizing these four major components, there are then five specific goals to be accomplished through the implementation of the audit:

- To identify conservation potential, both in the operation of the water system and in the habits of the customers,

continued on page 4 . . . WATER AUDIT

Cities Get Good News From EPA

According to recent reports from Washington, D.C., the Environmental Protection Agency is considering increasing the maximum allowable fluoride level permitted in public drinking water supplies. This move spells good news for many towns and cities in the Texas High Plains.

Currently, the maximum allowable fluoride content permitted in public drinking water supplies ranges from 1.4 milligrams per liter to 2.4 milligrams per liter. The new proposed contaminant level would increase the maximum allowable fluoride content to four milligrams per liter.

The normal fluoride content of ground water in the Ogallala Formation ranges from a low of less than one milligram per liter to a high of about six milligrams per liter. However, approximately 75 percent of the area served by the High Plains Water District has fluoride concentrations of four milligrams per liter or less.

Most medical experts consider four milligrams per liter of fluoride in public drinking water supplies as a safe level. In fact, no health hazards have been listed for fluoride in public water supplies, except for the possible staining of teeth if large amounts of water containing high fluoride levels are consumed by children in their formative years.

There are, in fact, benefits associated with low concentrations of fluoride contained in drinking water. One positive benefit includes improved tooth development, resulting in fewer cavities if good dental hygiene is observed.

If these new fluoride concentration levels are approved, most of the cities and towns in this area will be able to meet the new standard without the expense of water treatment or without having to fulfill a notification requirement.

Stored Soil Moisture Important In Pre-Plant Planning

Now that the crop harvest has wound to a close and producers have hauled their harvest to market, thoughts naturally turn to preparations for next spring's planting. One important aspect many producers will be looking at in preparing for their next crop is the condition of their soil moisture profile.

Crews from the High Plains Underground Water Conservation District No. 1 are nearing completion in the collection of field readings in approximately 150 soil moisture monitoring sites scattered throughout the District's service area.

Staff members Ken Carver, Mike Risinger, Jerry Funck, David Swaringen, Keith Whitworth and Obbie Goolsby spent most of the month of December

DETECTIVE WORK—Metal detectors are used to locate the buried neutron access tubes. Once located, the tubes are uncovered for readings.

in the field taking soil moisture readings. Soil moisture readings are taken by lowering the probe from a neutron moisture meter into two seven-foot aluminum tubes, which were previously located at each monitoring site, to observe the soil moisture conditions at each one-foot depth in the plant root zone soil profile.

Additionally, observations as to the type of crop grown, precipitation received, and other field conditions which might contribute to abnormal soil moisture conditions are also noted at each site as readings are taken.

Early Observations

Initial observations regarding the soil moisture conditions throughout the District's service area indicate that the northern counties of the District seem to be somewhat drier than the southern portions. Some explanation for this may be seen in the incidence of hardpans. Staff members making the readings frequently return with examples of plants with a shallow root system. Root growth seems to have been restricted in downward growth patterns by a hardpan.

Results To Be Published

Upon completion of the soil moisture readings, the data from each site will be analyzed, computer processed, and plotted on maps. The data will then be contoured, which will yield county and regional pre-plant soil moisture survey maps. These maps will be distributed to the local print media upon completion.

When published, the pre-plant soil moisture survey maps can be used by irrigators to estimate the amount of water in storage in the plant root zone soil profile, to estimate the amount of water needed to fill the root zone soil profile to field capacity, and to help in determining where in the plant root zone the moisture is stored.

Pre-Plant Irrigation Options

Irrigators who check the maps may find that their soil is wet to field capacity throughout the root zone profile and determine that they will not need to pre-irrigate. If this is not the case, irrigators can determine how much water would need to be applied as a pre-plant irrigation to wet the root zone soil profile to field capacity.

Another possibility is that the maps may show that the moisture profile needs only a small amount of water to bring it to field capacity. With this knowledge the irrigator may decide to gamble on receiving adequate precipitation before planting season to wet the soil profile.

Conversely, the maps may illustrate that the root zone soil profile is dry

PROBING FOR WATER—A probe inside the neutron moisture meter is lowered down aluminum access tubes then neutron particles are emitted. The displayed figures translate to readings of soil moisture content.

from top to bottom, and the irrigator may need to add a large irrigation to bring his moisture profile to field capacity prior to planting.

Savings Significant

High Plains irrigators have historically applied pre-plant irrigations of four to 12 inches. Recent pre-plant soil moisture surveys indicate normal deficits of two to eight inches. Use of the soil moisture data from the pre-plant survey indicates that the historic pre-plant irrigation application rate may be reduced by one-fourth to one-half.

Approximately 3.5 million acres are irrigated in the Water District's service area. If pumpage is reduced by an average of three inches per acre over one-half of the 3.5 million acres, 437.5 thousand acre-feet of water could be saved annually for future use.

Additionally, the cost of fuel to pump water in the District's service area ranges from $36 to $48 per acre-foot. The potential annual savings in fuel cost would be more than $15 million if the larger pre-plant irrigations are not needed or applied.

The Pre-Plant Soil Moisture Survey maps are planned for distribution in early February, 1986. One map will illustrate the estimated available soil moisture. The second will provide estimates of the soil moisture deficit, which is the amount of moisture that would need to be added, either through precipitation or irrigation, to bring the root zone soil profile to field capacity prior to planting. Each map also contains a graphic illustrating the distribution of soil moisture in the root zone.

THE CROSS SECTION

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Complex Programs Evolve To Simple Tax Deductions

"You can't just walk in and sue the Internal Revenue," stated Marvin Shurbet in a 1980 interview regarding the suit he filed against the Internal Revenue Service for a cost-in-water income tax depletion allowance for the water he used in his business of irrigation farming (*The Cross Section*, January, 1980). However, Shurbet did sue and won the suit on November 19, 1965, with the issuance of IRS ruling 25-296.

The Water District sponsored Shurbet in his suit, which was actually against the U. S. Department of Treasury, under an agreement with the Treasury Department that the final ruling would apply to all eligible landowners in the southern High Plains of Texas.

Since that ruling, landowners throughout the Water District's service area who use their underground water resources in the business of irrigation farming have saved millions of dollars on their federal income tax returns by claiming a cost-in-water income tax depletion allowance. And, tax year 1985 will be no different than any other year.

Currently, cost-in-water income tax depletion information for tax year 1985 is being made available, upon request, to landowners or accountants to help in preparation of their federal income tax returns.

The Basis Of A Claim

The calculation of a cost-in-water income tax depletion allowance is based on the landowner's cost in his ground-water resources at the time of acquisition. Cost guidelines are updated each year when a study is made of actual land sales on a county-by-county basis by qualified real estate appraisers hired by the Water District. Each tract of land sold during the year is visited to evaluate the value of any improvements that may have affected the sales price. The value of the improvements is then subtracted from the sales price to obtain a sales price for the raw land and water resources. Additionally, this visit helps identify any special circumstances of a sale, and if such is the case, the sale is eliminated from consideration in the determination of average sales values.

After all land sales have been reduced for the value of improvements, an average sales price is calculated for all dryland and irrigated land that is sold during the year. Basically, the difference in the average sales price for dryland and the average sales price for irrigated land is assumed to be the cost involved in the purchase of the underground water resources.

Who's Eligible

Any landowner who purchased, inherited or otherwise attained interest in land in the District's service area after 1948 is entitled to a depletion deduction. Prior to 1948, land sales data indicated no appreciable difference in the price paid for land with underground water resources as compared to that paid for dryland. Therefore, at the program's inception, 1948 was established as the earliest possible time at which a percentage of the price paid for land could have been attributed to the purchase of ground-water resources. Cost-in-water land sales values acceptable to the IRS for each county served by the Water District for each year from 1948 to date are available free of charge from the District.

Once the cost-in-water is established, the amount of water in storage under a particular tract of land at the time of acquisition, referred to as the saturated thickness, must be established.

"LANDOWNERS . . . HAVE SAVED MILLIONS OF DOLLARS ON THEIR FEDERAL INCOME TAX RETURNS."

Documentation Required

The IRS requires that each landowner document the average saturated thickness of the water table under his tract of land at the date of acquisition. This documentation is normally supplied by the Water District through the use of a set of maps, which the Water District staff constructs. This map series consists of individual county maps illustrating: 1) the land surface elevation (in recent years only), 2) the depth to the base of the Ogallala Formation, 3) the depth to water below land surface, and 4) the saturated thickness of the water bearing formation. The saturated thickness maps in essence reflect the depth from the top of water table to the base of the Ogallala Formation. Maps illustrating the depth-to-water below land surface were constructed at 10-year intervals from 1938 to 1958, and thereafter, at selected time periods, generally three- to five-year intervals for each county.

The depth below land surface to the base of the Ogallala Formation is determined from actual water well drillers' logs. The Water District maintains files of approximately 46,000 water well drillers' logs. The depth to the base of the Ogallala Formation taken from these drillers' logs is corrected to reflect the elevation above sea level where the base of the Ogallala is found. The elevation of the base of the formation is then plotted for each well at its location on county maps, and the maps are contoured.

The elevation of the water table is determined for each year that saturated thickness maps are made by measuring water levels in a large number of wells in each county where the maps are to be made. This extra group of water-level measurements supplement the wells measured annually by the District staff. The expanded water-level measuring data and yearly water-level measurements are combined to construct the elevation of the water table maps for the year of interest. The difference in the elevation of the water table and the elevation of the base of the Ogallala Formation is calculated, plotted and contoured. The resulting maps illustrate the saturated thickness of the Ogallala Formation. The data used to construct the two sets of base maps, plus the resulting saturated thickness maps, are examined by IRS engineers. Once approved, the saturated thickness maps are used by the Water District staff to provide each taxpayer with the average saturated thickness of the Ogallala under his tract of land at the date of acquisition.

Annual Water-Level Measurements

The annual water-level measuring program involves the monitoring of the depth-to-water level in a network of approximately 950 water-level observation wells throughout the District. With this program the District maintains an accurate accounting of the yearly changes in the depth-to-water.

Each January District staff personnel head into the field, armed with E-lines and steel measuring tapes, to measure the depth-to-water in all the established water-level observation wells. When these measurements are completed, the actual one-year change in the depth-to-water, along with the computed five-year and ten-year average annual changes for each water-level observation well are plotted on work maps. Hydrographs of measured changes in water levels are compared with hydrographs of the assigned declines so that a determination can be made as to whether or not the assigned declines reflect the true changes in water levels. Water District Geologists Don McReynolds and Cindy Gestes then evaluate any bookkeeping excess or deficit and assign the current year's water depletion values.

The IRS Check

Internal Revenue Service engineers are asked to review the data. The 1985 data was reviewed and approved in mid-December of 1985 for use in completing individual parcel claims.


CHECKING IT TWICE—IRS engineers check over the Water District's maps used in assigning depletion information, while at the same time reviewing the cost guidelines for 1985 developed by B. L. Jones and Sons appraisers.

Get Out The Pencils And Calculator

All that remains at this point is the actual paperwork. Landowners and/or tax accountants who are interested in claiming a cost-in-water income tax depletion allowance are encouraged to contact Water District Depletion Coordinator Rosie Risinger to make a request for the information which will be needed to claim the tax deduction.

A check with Rosie reveals that landowners or accountants will need to supply the following information to establish a water depletion claim: the landowner's name, address and social security number or federal I.D. number; a complete legal description of the land on which the claim is to be filed; and the year in which the land was acquired. Upon submission of this information, Rosie will establish a permanent set of records on the individual parcel claim. Permanent re-order numbers are assigned to each claim, and these numbers are then used in succeeding years to request the current decline information.

Accountants or landowners who have already established their parcel claims with the District need only submit the permanent re-order number to get the 1985 decline information.

Making Sense Of It All

To put it all together, the landowner's cost per acre in water is divided by the saturated thickness of the aquifer beneath his land to arrive at a cost per acre per foot. As an example, if a landowner purchased a 320 acre tract with a saturated thickness of 100 feet at the date of purchase and paid $750 per acre for the land with the average price of dryland at $250 in the year of purchase, he would then have a cost of $500 per acre for the water or $5.00 per foot of saturated material.

Each year as he receives an assignment of "feet of decline" from the Water District, the landowner can calculate the cost of depleting his ground water. This is done by multiplying the feet of decline times the cost per foot times the total acres, to arrive at a dollar value for his tax deduction.

Using the example above, if he had three feet of decline, he would multiply this by the $5.00 per foot value for a resultant tax deduction of $15 per surface acre, or a deduction of $4,800 for the 320 acre tract.

The Water District's Board of Directors has established a nominal fee for obtaining the decline and saturated thickness information needed to claim the depletion deduction. This fee is used to make the cost-in-water income tax depletion program self-supporting so that taxpayers who are not eligible to take advantage of the service do not support the service. The current cost, which is indeed the same cost that has been charged for the information since 1975, is $5.00 for the yearly decline and $25.00 for the saturated thickness information.

VOTERS . . . continued from page 1

the past four years. Truett has placed his name on the ballot for re-election to this position. Additionally, one committeeman at-large will be elected during the January election to fill the space left on the Lubbock County Committee by J. O. Gilbreath who has completed two consecutive four-years terms in office. G. V. "Jerry" Fulton has expressed his desire to seek this position.

In Lynn County, Danny Nettles, representing County Commissioner's Precinct Four, is seeking re-election to his second term in office on the county committee, while residents in Precinct One will be looking for a new representative to round out the county committee. Precinct One residents have been represented by Gary Houchin who has completed two consecutive four-year terms of service to these residents.

District Director's Precinct Two

Cochran, Hockley and Lamb Counties comprise District Director's Precinct Two. Mack Hicks of Levelland is currently representing the interests of persons who reside in these counties on the District's Board of Directors. Hicks began his service to these residents with his election to his first term in office in January of 1980. Hicks has placed his name on the ballot, seeking his fourth term in office.

Cochran County residents will need to elect two members to their five-man county committee. Residents in this county have previously been represented by Keith Kennedy, Committeeman-at-large, and L. T. Lemons from the County Committeeman's Precinct East of Highway 214. Kennedy will be vacating his seat on the committee, and Kenneth G. Watts has agreed to run at-large to fulfill this vacancy. Lemons has agreed to run for re-election.

Residents in Hockley County Commissioner's Precinct Four have been represented on the county committee by Marion Polk for the preceding four years. Polk is eligible to seek re-election to his second term in office. Jack Earl French has served the residents of Hockley County Commissioner's Precinct Three for the past eight years and will be vacating his position.

In Lamb County, residents of County Commissioner's Precincts One and Four are currently being represented by Jim Brown and Haldon Messamore, respectively. Brown is eligible to seek re-election to his second term in office, and Stanley Miller is seeking the position on the county committee vacated by Messamore.

District Director's Precinct Five

Gilbert Fawver of Floydada currently represents the residents of District Director's Precinct Five, consisting of Floyd and Hale Counties. Fawver was originally elected to the Board of Directors by residents residing in these counties in January of 1982. Joining Mitchell and Hicks, Fawver has also entered the race for re-election.

Floyd County residents living in County Commissioner's Precinct Two have previously been represented by Charles Huffman who has just completed his second term in office on the Floyd County Committee. Bill Glasscock has submitted his name as a candidate to fill this vacancy on the county committee, while Kenneth Willis, representing County Commissioner's Precinct Four, is seeking re-election.

Larry B. Martin and W. T. Leon, Hale County Committeemen-at-Large, have each completed their first four-year terms in office and are currently seeking re-election to the Hale County Committee.

With the 1986 election, members elected to the Board of Directors of the Water District will serve four-year terms. The terms in office for District Directors were recently changed from two to four years by the passage of House Bill 332 during the 1985 legislative session. Directors elected on January 18, 1986, will serve the residents of the counties they represent until January of 1990.

District Manager A. Wayne Wyatt encourages all residents of District Directors' Precincts One, Two and Five to take the time to drop by the polls on Saturday, January 18, 1986, to cast their ballots. "As in any election, residents who want their voices heard on matters concerning the ground-water resources of the area in which they live should take the time to elect qualified people to represent their interests to the High Plains Water District. The District's County Committees form the base of a network of citizens concerned about the ground-water resources of the High Plains, and these elected officials are consulted throughout the year for input on important water issues affecting us all."

Any registered voter having a valid voter registration, who resides within the boundaries of the Water District and within the county wherein the balloting is being conducted, is encouraged to participate and cast his ballot in the election.

WATER AUDIT . . . continued from page 1

- To reduce the volumetric demand,
- To reduce the peak demand in order to delay expansion of the water supply system,
- To realize the potential of wastewater and stormwater as new sources, and to use them as a particular situation dictates, and
- To promote the responsible management of water resources.

The audit, which was prepared by Trauth as partial fulfillment of her master's degree requirements at Texas Tech, was designed with assistance from the City of Levelland, and thus far has been field tested by the City of Wolfforth in a cooperative program with the Water Resources Center at Texas Tech.

According to Dr. Lloyd Urban, Director of the Water Resources Center, there are additional plans for the audit. "What we would like to do at this point in time is get the cooperation of other communities in the High Plains who will agree to perform the audit in a field test situation. We would then like to have these cities evaluate the audit and make suggestions for additions, alterations and improvements to the audit based on their use.

"Ideally, we would like to have the cooperation of approximately three municipalities that vary in size and water resource systems. For instance, we would like cities ranging in population from 1,000 to 2,000, from 5,000 to 10,000, and possibly one over 10,000. This will give us a good variety of circumstances under which to test the audit." Trauth also notes that ideally they would like to work with a city or town who is doing some work toward conservation and reuse.

"Following these additional trial runs," states Urban, "we would like to see cities and towns throughout the High Plains, and possibly even throughout the State of Texas, adopt the use of the Municipal Water Resources Audit.

Trauth indicates that the audit could be used by any small city or town in the High Plains who does not have a municipal staff dedicated to planning and development. In actuality, the audit could be used every five years or so to re-evaluate a city's water resources and the capability of those resources and systems to meet future demands.

Based on the experience with the Wolfforth field test, the audit itself takes approximately 80 hours to complete. Urban notes that this figure is highly dependent upon the complexity of the city's water resources systems and the availability of documentation on various aspects of the water system on which answers to the questions posed in the audit are based.

The Municipal Water Resources Audit was designed to take in all possible aspects of a municipal water resources system. However, Trauth notes, "A municipality may not be involved with all the areas discussed. Answers to all of the questions are not required. Each city may take the basic audit and, through the do-it-yourself audit approach, respond to only those questions which apply."

Cities or towns in the High Plains area that might be interested in cooperating with the Water Resources Center to field test the Municipal Water Resources Audit are encouraged to contact Dr. Lloyd Urban, director of the Water Resources Center, Texas Tech University, P.O. Box 4630, Lubbock, Texas 79409, or telephone 806-742-3597.

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Remember To Cast Your Ballot On January 18!

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PRECIPITATION TOTALS AFFECT SOIL MOISTURE

Pre-Plant Moisture Conditions Highly Variable

Highly variable 1985 precipitation totals, ranging from near normal at 20 inches to almost twice the norm at 40 inches, are contributing factors to highly variable stored soil moisture conditions throughout the Water District's service area.

Water District soil moisture monitoring crews have been taking readings in the neutron access tubes scattered across the District's service area since early December. According to Soil Scientist Mike Risinger of the USDA Soil Conservation Service, "We have more variation in current soil moisture conditions this year than we have had since we began making annual soil moisture measurements in 1982."

Speaking In General Terms

Generally speaking, however, the amount of water available for plant use, as producers head into the 1986 planting season, ranges from two to six inches. Plant available water is that amount of moisture held in the root zone soil profile which plants can extract from the soil for use. Speaking in terms of the percent of field capacity, plant available water stored in the soil profile throughout the District ranges from 25 percent of field capacity to 75 percent of field capacity.

Soils in the High Plains Water District's service area hold a total of 7.8 to 9.8 inches of plant available water in the five-foot root zone soil profile.

In other words, as producers consider their pre-plant irrigation decisions, they are looking at soil moisture deficits ranging from two to six inches. The soils in the area need from two to six inches of moisture to bring them to field capacity before planting time.

Maps Show Moisture Availability And Deficits

The maps on pages 2 and 3 show the regional trends in stored soil moisture conditions. On page 2, the map illustrates the amount of plant available water that is currently stored in the top five feet of the soil profile. The map on page 3 reveals the amount of moisture deficit which currently exists. The deficit is an indication of the amount of moisture that needs to be added to the five-foot crop root zone to bring the soil profile to field capacity prior to planting.

Site-Specific Checking Encouraged

"Usually our pre-plant soil moisture conditions run in trends in large areas," notes Risinger. "This year, however, in any one county we have found big differences in the amount of stored moisture present. We've got some moisture conditions that are running in the neighborhood of seven inches of plant available water, or better than 90 percent of field capacity. Conversely, we've also got some moisture conditions that are running in the vicinity of less than one inch of plant available water, or less than 10 percent of field capacity."

This variability in moisture trends builds a good case for the individual producer to do some checking on his own. One way individuals may monitor their soil moisture conditions is through the feel and appearance method of soil moisture monitoring. The Water District has a Water Management Note available entitled, "Monitoring Soil Moisture By Feel and Appearance," that is free of charge. This Water Management Note provides step-by-step procedures that producers might follow to determine their soil moisture conditions. It takes a little work, but considering the cost of applying that pre-plant irrigation it could prove to be a very worthwhile exercise.

Pinning It Down

"If I had to pick a general trend," Risinger explains, "I'd say that the central part of the District is in better shape moisture-wise than either the northern or southern areas of the District. Overall though, we are probably in a little better shape this year than we were last year. Last year we had some deficits of eight inches. Generally speaking, this year we don't have deficits much above six inches."

Jerry Funck, Water District agricultural engineer, has been running the soil moisture readings taken by the field crews through the computer processing stage of the program. Funck

continued on page 2 . . . MOISTURE

Rainfall Probabilities Can Help In Making Irrigation Decisions

In today's agricultural climate of high input production costs and low commodity prices, saving money has become the name of the game. One option available to all producers to help them reduce their input costs and become more efficient in their farming operations is the use of precipitation probability charts in conjunction with their pre-plant and summer irrigations.

The precipitation probability charts shown on page 4 provide the producer with the percent probability of receiving a measured amount of rainfall in any given month.

Playing The Odds

To use the rainfall probability data, the producer first needs to know the amount of moisture his soil will hold and the amount of water he currently has stored in the soil. In essence, the difference is the amount of water needed to fill the soil profile to field capacity. The soil moisture deficit map shown on page 3 provides this data. It is also helpful to know where in the root zone soil profile the moisture deficit is located.

After the farmer has determined these things, he may wish to check the rainfall probability charts to determine his chances of receiving the needed moisture prior to crop needs. If the

continued on page 2 . . . DECISIONS

Incumbents Elected To Board

Elections for Water District Directors and county committeemen that were held in District Directors' Precincts One, Two and Five of the High Plains Underground Water Conservation District No. 1 on Saturday, January 18, 1986, resulted in three returning Board Members, eight re-elected county committeemen and the election of eight new county committeemen.

Official results of the election reveal that James P. Mitchell, Mack Hicks and Gilbert Fawver were each re-elected to positions on the Water District's Board of Directors.

District Director's Precinct One

James Mitchell, who resides in the Wolfforth area, returns to the Board to serve the residents of District Director's Precinct One, which includes Crosby, Lubbock and Lynn Counties. This is Mitchell's sixth term in office, having first been elected to the Board in 1978.

Residents of each county included in Director's Precinct One also elected one new representative and a second-term representative to their respective county committees.

In Crosby County, Tracy Don Hancock of Lorenzo was elected to replace outgoing committeeman Tom McGee. Bobby Brown, also of Lorenzo, is returning for a second four-year term in office. Both of these gentlemen serve the residents of Crosby County as committeemen-at-large.

Lubbock County voters who reside in Lubbock County Commissioner's Precinct Three re-elected Pierce Truett of Idalou to represent their interests on the county committee. G. V. "Jerry" Fulton of Lubbock was elected by county voters as a committeeman-at-large to replace committeeman J. O. Gilbreath, who leaves the county committee after two consecutive four-year terms in office.

Lynn County residents residing in County Commissioner's Precinct Four voted for Danny Nettles, who resides near Tahoka, in his bid for a second term in office. Lonnie Paul Donald of Wilson was elected by residents of County Commissioner's Precinct One to his first term in office. Donald fills the vacancy left by outgoing committeeman Gary Houchin.

District Director's Precinct Two

Voters of Director's Precinct Two voted in favor of Mack Hicks of Levelland in his bid for a fourth term in office. Director's Precinct Two is comprised of Cochran, Hockley and Lamb Counties. Hicks was first elected to the Board by the people of these counties in January of 1980.

The six county committee positions available in Director's Precinct Two were also divided between four newly elected committeemen and two returning committee members.

In Cochran County, Kenneth G. Watts and L. T. Lemons, both of Morton, were elected to the Cochran Coun-

continued on page 3 . . . INCUMBENTS

MOISTURE CONDITIONS . . .

continued from page 1

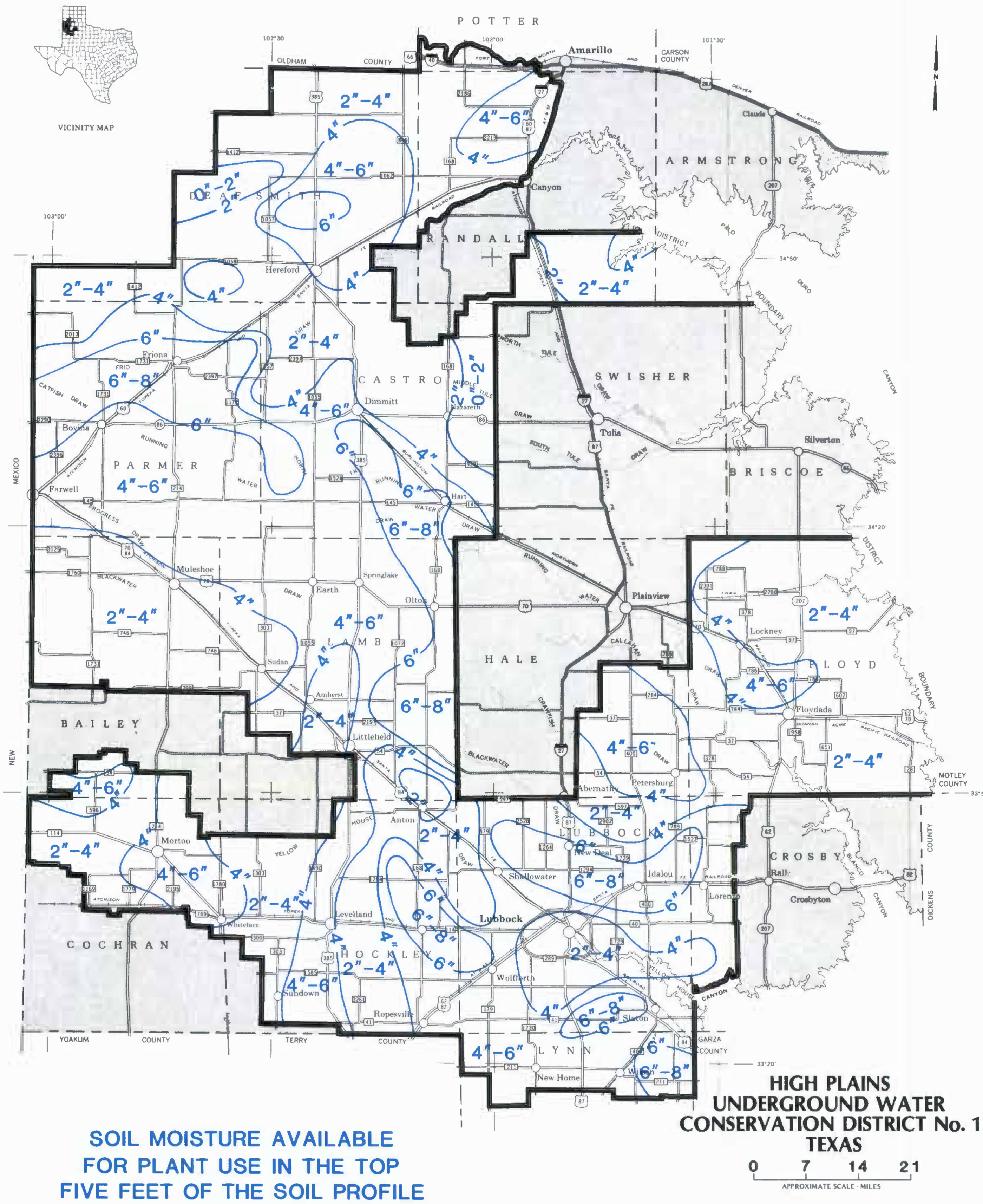
notes that moisture conditions seem to be better in the major irrigated portions of the Water District than they have been in recent years. "The dry-land areas are the ones that really need moisture."

Both Funck and Risinger see the past year's spotty rainfall as a primary contributing factor to the current moisture conditions. "We had rainfall in some parts of the District of two to three times the normal average. Many of the 1985 precipitation events came in very short high-intensity storms. In these areas, there was a lot of runoff, and only a small amount of the rain soaked into the soil. Therefore, some of these areas have low soil moisture levels."

Risinger notes that the late freeze also contributed to lower soil moisture conditions. "The lateness of the first freeze allowed plants to deplete soil moisture after they had actually quit producing fruit. This is true especially in the cotton producing areas. In other areas where crops were harvested earlier, moisture conditions are running a little better, particularly in the top two feet of the profile."

Risinger suggests that it is also a good idea for farmers to check for hardpans in their fields. If present, they should be destroyed to make the most of any rainfall received or irrigation water applied between now and planting season.

There are approximately 3.5 million irrigated acres in the District's service area, and historical pre-plant irrigations have ranged from 4 to 12 inches. By only adding that amount of water needed, as shown on the soil moisture survey map, the historical pre-plant water use could be reduced by one-fourth to one-half. In dollars and cents, that amounts to a potential annual savings in the fuel cost alone of more than $15 million. Additionally, it is estimated that if irrigators applied only the amount of moisture needed (as shown on the soil moisture deficit map) to bring the soil profile up to field capacity, 437.5 thousand acre-feet of water could be saved annually for future use.



SOIL MOISTURE AVAILABLE FOR PLANT USE IN THE TOP FIVE FEET OF THE SOIL PROFILE

SURVEY CONDUCTED NOV. 18, 1985–JAN. 24, 1986

F.Y.I...

Water Management Notes explaining the Pre-Plant Soil Moisture Survey and various Soil Moisture Monitoring techniques are available **free of charge** by contacting the Water District's Lubbock office at 2930 Avenue Q, Lubbock, Texas 79405 or calling 806-762-0181.

DECISIONS . . . **continued from page 1**

rainfall probabilities are good, about 70 percent or better, for receiving all of the needed moisture, the farmer may wish to delay irrigating in the hope of utilizing the free rainfall instead of pumping water from the aquifer.

If, however, the probabilities are better than 70 percent for receiving only a portion of the needed moisture, the irrigator may choose to apply a light irrigation and gamble on rainfall to make up the difference.

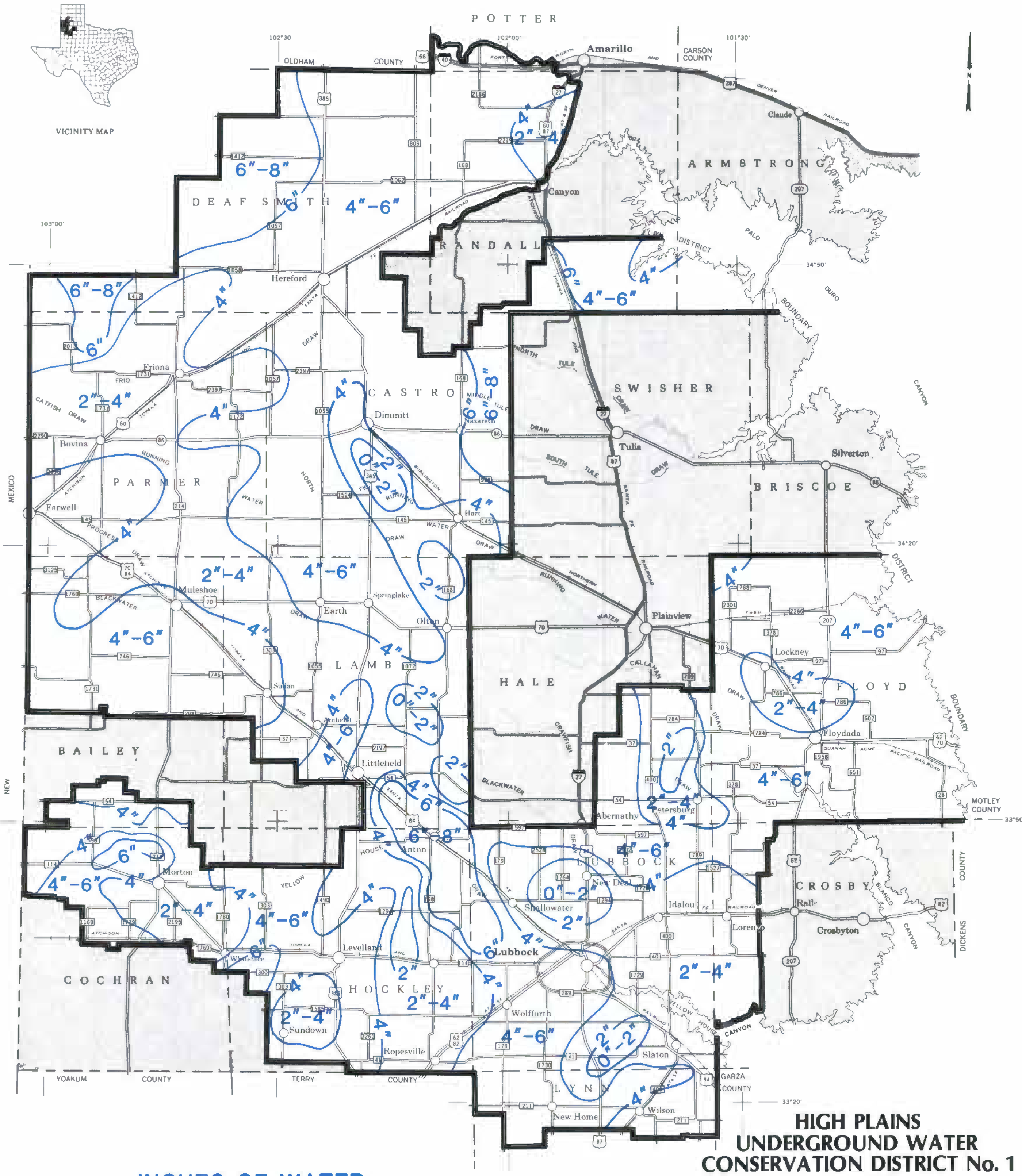
Conversely, if the chances are 20 percent or less for receiving rainfall in sufficient quantities to fill the moisture deficit, then the irrigator may wish to irrigate.

James Mitchell, a farmer in Lubbock and Lynn Counties, routinely checks the rainfall probability charts. Mitchell determines his soil moisture conditions by checking the regional survey maps and then checking his soil moisture blocks. The soil moisture blocks give Mitchell a more site-specific indication of his moisture conditions in comparison to regional conditions. Additionally, Mitchell gets a more specific reading as to where in his soil profile his moisture is stored.

Mitchell notes that much of his decision as to whether or not to irrigate prior to planting depends on the amount of moisture deficit in his soil and where in the root zone the moisture is needed. "For instance," he says, "if my soil moisture deficit were one to two inches and the moisture was needed in the top of the soil profile, then I would check the rainfall probability charts to see what the chances were of my receiving two or more inches of rain prior to my planting date. If the chances are good, then I'd gamble on the rainfall." Mitchell qualified his gamble just slightly by stipulating that he would be sure he could apply the water he needed through his irrigation system quickly and evenly if the rain didn't materialize.

Mitchell believes that the later in the season you can wait to pre-irrigate, the greater the probability of receiving rain. "Saving just one watering can save water, fuel costs, labor costs and any-

continued on page 4 . . . DECISIONS



INCHES OF WATER NEEDED TO WET THE TOP FIVE FEET OF SOIL TO FIELD CAPACITY

SURVEY CONDUCTED NOV. 18, 1985–JAN. 24, 1986

INCUMBENTS . . .

continued from page 1

ty Committee. Watts fills the committeeman-at-large position vacated by Keith Kennedy, and Lemons will serve his second term representing the people of the County Committeeman's Precinct East of Highway 214.

Hockley County residents voted for Marion Polk and Hershell Hill in their bids for positions on the Hockley County Committee. Polk of Whitharral begins his second term representing the voters of Hockley County Commissioner's Precinct Four; and Hill begins his first term in office representing the interests of the residents of Hockley County Commissioner's Precinct Three. Hill replaces retiring committeeman Jack Earl French.

Lamb County voters who reside in County Commissioner's Precinct One elected Harold Mills of Olton to represent their interests on the Lamb County Committee. Mills replaces outgoing committeeman Jim Brown. Stanley Miller of Amherst was elected to his first term representing the voters of County Commissioner's Precinct Four. Miller replaces outgoing committeeman Haldon Messamore.

District Director's Precinct Five

Voters in District Director's Precinct Five re-elected Gilbert Fawver, a resident of the Floydada area, to his third term in office. Fawver began his service as Director to the residents of Precinct Five in January of 1982 when he was first elected to the Board.

Additionally, Precinct Five voters elected three incumbent county committeemen and one new committeeman to their county committees. Director's Precinct Five includes Floyd and Hale Counties.

Hale County residents re-elected Larry B. Martin and W. T. Leon, both of Petersburg, to committeemen-at-large positions on the Hale County Committee.

Kenneth Willis of Floydada was re-elected to the Floyd County Committee by the voters of Floyd County Commissioner's Precinct Four. Bill Glasscock of Lockney will begin his first term of service filling the Floyd County Committee position left vacant by Charles Huffman. Glasscock represents the interests of the voters in Floyd County Commissioner's Precinct Two.

Results of the January 18, 1986 election were canvassed by the Board of Directors of the Water District at a special meeting held on Thursday, January 23, 1985 and declared official.

Annual Precipitation Measurements And Averages 1975-1985

AMARILLO PRECIPITATION—National Weather Service

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1975	.28	1.33	.51	1.02	2.47	4.15	5.19	3.97	.76	.33	.92	.15	21.08
1976	*	.10	.79	1.65	1.36	2.94	1.77	1.78	4.28	1.14	.43	*	16.24
1977	.64	.53	.24	2.74	4.01	2.06	3.14	4.94	.03	.26	.32	.27	19.18
1978	.63	.80	.21	.55	5.76	6.50	1.82	1.61	2.42	.97	.47	.27	22.01
1979	.92	.28	1.46	1.29	3.94	3.19	2.03	5.08	.52	1.28	.40	.07	20.46
1980	.85	.55	1.38	.82	2.88	1.30	.65	1.80	1.55	.42	.84	.35	13.39
1981	.11	.23	1.87	.90	2.11	1.04	2.73	5.22	3.47	1.79	1.50	.03	21.00
1982	.15	.39	.52	.43	1.96	4.75	6.23	.55	1.37	.71	.75	.79	18.60
1983	1.78	1.19	.98	.83	2.85	1.76	.74	.28	.37	3.23	.33	.64	14.98
1984	.56	.37	.98	1.18	.04	6.76	.83	2.28	.95	3.19	1.09	1.00	19.23
1985	.99	.77	1.49	2.79	.86	3.08	2.07	1.67	4.96	3.07	.39	.26	22.40
Average (1975-1985)	.63	.59	.95	1.29	2.57	3.41	2.47	2.65	1.88	1.49	.68	.35	18.96

*Trace

LUBBOCK PRECIPITATION—National Weather Service

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1975	.41	1.53	.04	.45	2.74	1.80	4.32	2.21	2.61	.06	1.18	.34	17.69
1976	*	.03	.24	1.76	1.19	2.46	7.20	1.99	3.28	1.39	.56	.01	20.11
1977	.24	.38	.82	2.90	2.46	2.28	1.13	4.31	.49	1.11	.02	.01	16.15
1978	.59	1.39	.23	.21	3.20	1.93	.15	.34	3.29	1.06	1.11	.17	13.67
1979	.33	.85	2.95	1.17	4.00	3.69	1.84	3.81	.21	.59	.09	1.29	20.82
1980	.54	.38	.19	1.13	3.46	1.78	.20	1.64	3.55	.19	2.29	.51	15.86
1981	.32	.67	1.19	2.05	1.25	.79	3.35	5.41	1.78	5.34	.64	.20	22.99
1982	.05	.39	.44	2.53	4.54	4.99	2.08	1.08	1.29	.48	1.18	1.95	21.00
1983	2.75	.32	.55	.77	1.23	1.79	.41	.32	.39	10.80	.54	.36	20.23
1984	.03	.17	.23	.23	.45	4.32	.53	3.72	.15	1.74	1.87	1.18	14.62
1985	.38	.27	1.19	.48	2.97	4.51	3.94	.63	4.73	3.60	.27	.18	23.15
Average (1975-1985)	.51	.58	.73	1.24	2.50	2.76	2.29	2.31	1.98	2.40	.89	.56	18.75

*Trace

Charts Reveal Rainfall Probabilities

LUBBOCK WB.A.P. INDEX NO. 5411

Probability (in percent) of receiving rainfall during various months that is equal to or more than the amount stated.

Rainfall (inches)	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
0.25	61	55	59	82	98	96	88	90	84	88	57	61
0.50	41	43	53	65	92	88	86	78	80	78	45	43
0.75	24	31	41	57	90	82	78	75	65	71	35	27
1.00	14	24	29	47	90	78	75	73	57	55	24	22
1.25	10	18	25	33	84	76	67	67	55	47	18	18
1.50	4	10	25	27	73	71	57	63	53	37	10	8
1.75	4	6	20	27	67	65	53	55	53	33	8	6
2.00	4	2	12	14	61	53	47	47	49	29	8	4
2.25	4	2	8	10	55	49	39	35	45	29	6	4
2.50	2	2	8	8	49	35	37	27	43	27	2	2
2.75	2		8	8	43	29	35	22	41	25		2
3.00	2		4	6	35	29	31	18	35	24		
3.25	2		2	4	29	27	20	16	33	22		
3.50	2		2		24	25	18	16	29	18		
3.75	2				24	24	16	14	20	18		
4.00	2				20	24	16	12	18	14		
4.25					16	18	10	10	16	10		
4.50					12	18	4	8	14	10		
4.75					12	16	4	8	14	6		
5.00					12	14	2	6	10	6		
5.25					12	12	2	4	8	6		
5.50					12	10	2	2	8	6		
5.75					12	6	2	2	6	6		
6.00					10	4	2	2	6	2		
6.25					10	4	2	2	6	2		
6.50					6	4	2	2	6	2		
6.75					6	4	2	2	4	2		
7.00					4	4	2	2	4	2		
7.25					4	4		2	4	2		
7.50					4	2		2	4	2		
7.75					4	2		2	2	2		
8.00					2			2	2			
8.25					2			2	2			
8.50					2			2	2			
8.75					2			2	2			
9.00					2				2			
9.25					2				2			
9.50					2				2			
9.75					2				2			
10.00					2				2			

PLAINVIEW WB.A.P. INDEX NO. 5411

Probability (in percent) of receiving rainfall during various months that is equal to or more than the amount stated.

Rainfall (inches)	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
0.25	67	65	67	90	98	96	90	92	86	84	57	71
0.50	47	53	53	76	98	90	82	90	84	80	43	37
0.75	33	39	42	65	92	82	76	84	80	61	37	29
1.00	22	29	36	49	88	80	64	75	75	53	29	24
1.25	16	14	26	39	76	80	64	69	59	49	20	20
1.50	12	6	18	33	69	74	58	59	57	39	18	18
1.75	8	4	16	25	67	64	58	51	49	35	10	12
2.00	6	2	10	24	59	64	50	43	45	25	4	10
2.25	4	2	8	20	59	54	38	39	41	24	2	8
2.50	2		2	16	53	50	38	35	33	20	2	6
2.75	2		2	10	51	48	34	29	31	20	2	2
3.00	2		2	8	47	46	30	22	31	18	2	
3.25	2			6	35	40	30	14	31	14		
3.50	2			6	33	34	26	14	22	14		
3.75	2			4	29	34	20	10	16	14		
4.00				4	27	34	20	10	14	14		
4.25				2	25	32	16	8	14	12		
4.50				2	22	28	14	6	14	12		
4.75				2	20	20	14	6	12	10		
5.00				2	20	14	12	6	6	8		
5.25				2	16	10	10	6	6	8		
5.50					16	10	6	6	4	6		
5.75					14	6	6	6	2	6		
6.00					12	6	6	6	2	2		
6.25					10	4	6	4	2	2		
6.50					10	2	6	2	2			
6.75					10	2	2	2	2			
7.00					8	2	2	2	2			
7.25					4		2	2				
7.50					4		2	2				
7.75					4		2	2				
8.00					4		2	2				
8.25					4		2					
8.50					4		2					
8.75					2		2					
9.00					2		2					
9.25					2		2					
9.50					2		2					
9.75					2		2					
10.00					2		2					

AMARILLO WB.A.P. INDEX NO. 5411

Probability (in percent) of receiving rainfall during various months that is equal to or more than the amount stated.

Rainfall (inches)	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
0.25	67	67	73	86	96	96	94	98	94	86	67	69
0.50	45	47	53	73	94	94	94	96	80	73	41	37
0.75	25	25	35	63	92	90	84	90	71	65	33	27
1.00	18	18	31	53	84	86	76	86	59	49	20	14
1.25	12	12	24	43	80	84	75	86	57	37	16	6
1.50	10	8	18	35	75	80	63	78	53	33	12	4
1.75	6	6	14	25	75	73	55	67	43	27	10	4
2.00	6	2	14	18	61	65	45	61	41	27	10	4
2.25	4	2	12	12	57	55	39	51	35	27	8	4
2.50	2	2	10	6	53	53	37	49	27	24	4	4
2.75		2	6	2	49	51	37	49	24	14	4	4
3.00			2	2	39	45	27	47	20	14	2	4
3.25			2	2	33	41	25	41	18	12	2	4
3.50			2	2	31	35	22	33	16	10	2	4
3.75			2		27	33	20	33	16	10	2	4
4.00					25	31	18	22	14	10		2
4.25					20	22	14	22	10	10		2
4.50					16	16	14	22	6	10		2
4.75					14	14	14	18	2	8		
5.00					12	12	14	14	2	6		
5.25					12	10	10	8		6		
5.50					12	10	10	6		6		
5.75					12	10	10	4		4		
6.00					10	10	10	4		4		
6.25					10	10	8	2		2		
6.50					8	10	8	2		2		
6.75					8	8	6	2		2		
7.00					6	8	6	2		2		
7.25					6	8	6	2		2		
7.50					6	8	4	2		2		
7.75					4	6						
8.00					4	6						
8.25					4	6						
8.50					4	6						
8.75					4	6						
9.00					4	6						
9.25					2	4						
9.50					2	4						
9.75					2	4						
10.00						4						

MULESHOE WB.A.P. INDEX NO. 5411

Probability (in percent) of receiving rainfall during various months that is equal to or more than the amount stated.

Rainfall (inches)	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
0.25	61	65	56	74	96	94	96	94	88	74	62	56
0.50	49	45	37	58	82	86	90	88	80	70	45	35
0.75	25	21	23	50	76	80	86	80	74	58	35	21
1.00	16	14	18	43	69	78	75	76	67	49	24	18
1.25	10	8	14	33	61	69	69	73	61	37	18	14
1.50	10	4	10	25	55	67	65	71	59	31	14	6
1.75	8	2	6	22	43	63	61	55	51	25	8	4
2.00	2		4	12	37	49	51	43	39	24	8	2
2.25	2		4	10	33	47	41	37	39	20	2	2
2.50			4	6	29	41	33	37	33	16	2	2
2.75			2	6	27	35	29	33	29	16	2	2
3.00			2	4	24	29	24	27	25	14		2
3.25				4	18	27	20	25	20	12		2
3.50				2	16	24	14	22	10	12		
3.75					14	24	12	18	10	12		
4.00					10	22	12	16	8	12		
4.25					10	18	10	16	6	12		
4.50					8	12	10	16	6	12		
4.75					8	10	10	10	4	10		
5.00					8	10	10	10		4		
5.25					8	10	10	8		4		
5.50					8	6	10	8		2		
5.75					6	6	10	8		2		
6.00					6	4	8	8		2		
6.25					6	4	6	6				
6.50					6	4	4	6				
6.75					6	4	4	4				
7.00					4	4	2	4				
7.25					4	2	2	2				
7.50					2	2	2	2				
7.75					2		2	2				
8.00					2		2					
8.25					2		2					
8.50					2		2					
8.75					2							
9.00					2							
9.25					2							
9.50					2							
9.75					2							
10.00					2							

DECISIONS . . .

continued from page 2

thing else associated with applying irrigation water."

Mitchell also explains that it is important to him to have his soil moisture profile at field capacity going into the growing season, especially if his moisture deficits are in the lower areas of his root zone profile. "Although the water in the lower zones is not needed until later in the growing season, if my profile is not full at planting and there is not enough rain to meet the crop needs, then with my limited water, I could never catch up."

Dr. Bill Lyle of the Texas Agricultural Experiment Station echoes Mitchell's belief that the later in the season a farmer can wait for moisture the better his chances are for getting at least a portion of the needed moisture in the form of precipitation. Lyle also believes that with good water and the right irrigation equipment for applying lighter water applications at even distribution rates, it is possible for irrigators to hedge even further on precipitation probabilities. Lyle explains that irrigation decisions may also take into account not only how much soil moisture is present in the profile and where it is located, but should consider when the crop will be using the water from each soil depth.

According to Lyle, two periods are important for stored moisture. First, good quantities of water are necessary in the top portion of the root zone, which is about the upper two feet of the soil profile, when the crop is planted to carry it through to the next stage of growth. Secondly, moisture in the lower root zones is important when the crop goes into rapid leaf expansion and high evapotranspiration rates from the leaves.

Thus, Lyle notes that if the right irrigation equipment is available with sufficient quantities of water present in the upper root zone, then pre-plant irrigation may be avoided in the hope that rain later in the season will help to fill the lower zones.

Irrigators using rainfall probabilities to hedge against the odds, should take into account that only about 50 percent of the rainfall received is capable of being stored in the soil and utilized due to evaporation and runoff. Farmers who harvest rainfall with tillage methods such as furrow dikes, minimum tillage or terraces, can maximize rain infiltration rates and minimize evaporation losses to increase these percentages.

THE CROSS SECTION (USPS 564-920)
HIGH PLAINS UNDERGROUND WATER CONSERVATION DISTRICT NO. 1
2930 AVENUE Q
LUBBOCK, TEXAS 79405

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FUNDS AVAILABLE MID-APRIL

Ag Water Conservation Loans Within Reach

Farmers who would like to upgrade the efficiency of their irrigation system, may soon be eligible to take advantage of a new state-backed low interest loan program for agricultural water conservation. The rules and regulations for implementation of the Agricultural Water Conservation Program are down to the final polish stage.

Rules governing loan applications to the Texas Water Development Board, the administering agency for the program, have recently been submitted to the Texas Register for publication and public review. Following a 30-day review period, the rules will be submitted to the Texas Water Development Board for final consideration and adoption at their regular March Board of Directors meeting. If adopted by the Board, the rules will take effect 20 days after adoption, and funds should be available for loan by mid-April.

Applications for loans under the Agricultural Water Conservation Program may be submitted to the Water Development Board by soil and water conservation districts and underground water conservation districts throughout the state.

Water District Ready And Waiting

The High Plains Underground Water Conservation District No. 1 has submitted an application to the Water Development Board for a loan of $1 million under this new program. When the Water District obtains its loan funds from the Board, the money will be available for low interest loans to qualified irrigators.

The Board of Directors of the High Plains Water District has submitted a draft set of rules governing the administration of the loan program from the District to individual irrigators to the Water Development Board for their review and approval.

The District is responsible for setting its own policies and procedures regarding its loan program, eligibility of applicants and terms of repayment of its loans. However, these rules must coincide with the Water Development Board's rules. Therefore, District requirements cannot be finalized until the Water Development Board rules are adopted.

Pilot Loan Program

Currently, a two-year $5 million pilot program is being implemented statewide to ascertain the success of a low interest loan program. In 1987, a report will be presented to the Texas Legislature discussing borrower interest and the success of administering the program. The Texas House and Senate

continued on page 2 . . . LOANS

Are You Ready For Rain?

During 1985 playa basins in the Texas High Plains collected more water than they have in several years. One of the reasons for this, obviously, is that the area received abnormally high rainfall.

Many of the rainfall events last year, as is normal in the High Plains, came in short, high-intensity showers, which provided moisture in excess of the soil's ability to take water.

Rainfall runoff which collects in playa basins is a valuable asset when it is pumped back to the field and used for irrigation. Pumping water from a playa basin costs about one-third to one-fourth as much as it does to pump water from the aquifer in fuel cost alone.

However, the irrigator who plans ahead and prepares his land in advance of these high-intensity rains by installing furrow dikes or terraces to hold the water in place until it has time to soak into the soil may come out dollars ahead at the end of the season.

Determining whether or not the installation of furrow dikes will provide an opportunity to trap precipitation requires a look at rainfall probabilities.

Checking The Chances

Checking precipitation probabilities for March reveals that there is a 36 percent chance of receiving one-inch of precipitation, and a ten percent chance of getting as much as two inches of rainfall.

Rainfall probabilities increase in April to a 49 percent probability of receiving one inch, and a 24 percent probability of receiving two inches.

In May the probabilities increase even further. In May, there is an 88 percent chance for one inch of precipitation, a 59 percent chance for two inches and a 47 percent chance of receiving up to three inches of rainfall during the month. There is even a 20 percent chance of receiving up to five inches of rainfall during the month of May.

Precipitation probabilities for June indicate that there is an 80 percent probability of receiving one inch, a 64 percent probability of two inches, a 46

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Slide Show Welcomes Committeemen

The Board of Directors and staff of the High Plains Underground Water Conservation District are warmly welcoming recently elected county committeemen into the District's family this year with something new—a narrated slide presentation and special notebooks that were both developed to assist the committeemen in their service to the people of their communities. Both of these tools serve to introduce the committeemen to the internal workings of the District, from its organization to the development of programs and activities, as well as refresh the committeemen's insights into many of the services the District offers to the residents of its service area.

TAKING THE OATH—Judge Melvin Powers, Justice of the Peace for Precinct 5 of Lubbock County, gives the Oath of Office to newly elected Crosby, Lubbock and Lynn County Committeemen. From left to right are Lonnie Paul Donald of Wilson, G. V. (Jerry) Fulton of Lubbock, Pierce Truett of Idalou, and Bobby Brown of Lorenzo.

The 20-minute slide presentation and the accompanying notebooks are being presented to the newly elected county committee members and second-term committeemen at special meetings held throughout the District in honor of all the District's county committeemen and county secretaries. These special meetings are being held to bring the committeemen of each of the District's Directors' Precincts together with their Director and the District's staff.

Adding to the festivities at each of these meetings is the ceremony during which newly elected county committeemen and returning committee members take their oaths of office. The oaths are administered to the committeemen by local judges residing within the area the committeemen serve. Special certificates are presented to outgoing committee members to recognize their contributions in service to the District.

The recently completed slide presentation introduces the High Plains Water District to all those in attendance with a montage of sights and sounds. Background music sets the mood as a narrator relates the story of the District and colorful slides illustrate

continued on page 3 . . . SLIDE SHOW

Loans Within Reach . . .

continued from page 1

must both vote in favor of the program by a two-thirds majority for the $200 million in state bonds authorized by the new amendment to be released for continuation of the low interest loan program.

TWDB Proposed Rules

Water Development Board requirements for the pilot loan program stipulate that loans may be made for irrigation application and distribution systems only. Equipment, materials, contractor services and installation costs for irrigation water delivery and application systems such as the low energy precision application (LEPA) sprinkler systems, low pressure drip irrigation systems, or pipelines are eligible. Moisture retention devices such as furrow dikers are also eligible. Additionally, Water Development Board rules allow loans to be made for flow meters and other flow measuring devices, soil moisture monitoring equipment such as tensiometers and gypsum blocks, and computer software when it is used to monitor irrigation applications.

Water Development Board rules also stipulate that a district loan to an irrigator shall be limited to 80 percent of the purchase price of capital items and 50 percent of labor costs for installation or for purchase of other nonrecoverable items.

Water Development Board rules also require that funds from the loan program may only be used for equipment which will be operated on land that has been irrigated at least two of the previous six years.

District loan applications made to the Water Development Board in areas with critical needs will receive priority funding from the Water Development Board if there is a shortage of funds.

Under Water Development Board rules, districts will have to disburse their loan funds to individual irrigators within 120 days or the funds will have to be returned to the Water Development Board.

Multiple county districts, such as the High Plains Water District, may receive initial loans of up to $1 million from the Water Development Board, and may re-apply for an additional one million dollars after 120 days, provided previously loaned funds are fully committed. Single-county districts may borrow up to $300,000 from the Board at one time.

Loans made to districts will be under fixed interest rates. The interest rate charged will be set on the lowest amount listed on the bond buyer index, a tax exempt bond market, during the six months prior to the month the loan is made. However, interest rates will not exceed 12 percent. It is expected that loan interest rates will be about 9 to 10 percent. Districts must repay their loans to the Water Development Board within ten years.

Loans made under the pilot loan program are backed by the state. If any default is experienced on a loan made under this program, 50 percent of any unrecoverable loss is absorbed by the state. The remaining 50 percent of unrecoverable losses is absorbed by the agency responsible for the loan.

High Plains Water District Proposed Rules

Under the draft provisions of the High Plains Water District's rules for implementation of the District's loan program, eligible applicants consist primarily of individual producers. However, partnerships and corporations are also eligible to apply for loans from the District.

Loan requests to the High Plains Water District will be processed on a first come, first-served basis. District county committeemen residing within the county where the loan is to be made will make recommendations to the Board of Directors concerning each loan application. The Board is responsible for final approval or denial of all loans.

If a loan is made for the purchase of permanent equipment, such as center pivot sprinkler systems, then all of the land whereon the equipment will be operated must be within the District's boundaries.

If a loan is made for portable equipment, such as gated pipeline and soil moisture monitoring devices, then at least 50 percent of the land the equipment will be operated on must be within District boundaries.

Under Water District rules as proposed at press time, eligible equipment includes:

- Irrigation water delivery equipment including underground pipeline, above-ground pipeline, in-line flow meters and other flow measuring devices;
- Irrigation application systems including LEPA sprinkler systems, low pressure sprinkler systems, low pressure drip irrigation systems, surge flow valves, modification equipment for converting high pressure sprinkler systems to low pressure dropline systems, and soil moisture monitoring equipment; and
- Moisture retention equipment such as furrow dikers.

The Water District will charge its borrowers the same interest rate it pays to the Water Development Board. Additionally, a one-time service fee of 2.5 percent of the amount of the loan will be required. It has not yet been decided whether the fee will be charged up front through a point system, or if it will be paid annually over the term of the loan.

For instance, if an irrigator borrowed $100,000 from the District, he would then pay $2,500 as a one-time service fee either at the time of the loan or in installments throughout the term of his loan. This fee covers the District's administrative costs for the loan program.

Ag Water Conservation Program Grants

Basically the Agricultural Water Conservation Program is intended to encourage conservation of water in irrigated agriculture, since agricultural use accounts for about 72 percent of the water used in Texas.

The Agricultural Water Conservation Grant Program provides that the Water Development Board may assist public agencies such as soil and water conservation districts, underground water conservation districts, the Soil Conservation Service, and the Texas Agricultural Extension Service with programs designed for information and education exchange. Such programs include the development of literature on conservation practices and equipment, workshops, field days, and conferences which are designed to pass information on agricultural water conservation practices to the producer.

Additionally, grants may be made to these and other public agencies for the purchase of new equipment or to replace worn equipment that is used by these agencies in measuring on-farm irrigation application efficiencies.

Under the grant program agencies will be able to apply to the Water Development Board for grants for the purchase of equipment to measure on-farm irrigation application efficiencies. Grants for matching funds up to 75 percent of the equipment costs can be made.

The High Plains Water District is compiling a list of interested irrigators. To add your name to this list call or write the District at (806) 762-0181 or 2930 Avenue Q, Lubbock, Texas 79405.

—KES/KR

THE Cross SECTION

THE CROSS SECTION (USPS 564-920)

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NOTICE: Information regarding times and places of the monthly County Committee meeting can be secured from the respective County Secretaries.
Applications for well permits can be secured at the address shown below the respective County Secretary's name, except for Potter County; in this county contact Sam Line.

Gypsum Blocks Prove Valuable In Growing Wheat, Corn

"Not knowing the condition of the soil moisture in our crop root zone during the growing season cost us a lot of money," states Stephen Smith, a Lamb County farmer. Smith irrigates 2,300 acres of wheat, corn, soybeans and cotton with ten center pivot sprinklers near Olton, Texas.

"Our operation's highest cost is irrigation water." Applying more water than the soil will hold in the root zone, wastes water, requires unnecessary labor and energy costs, as well as wears out irrigation equipment. "But, when we don't apply enough water," notes Smith, "we hurt our yields."

Smith tried using soil moisture gypsum blocks to monitor his soil moisture conditions about four years ago, with the assistance and encouragement of the Lamb County Soil Conservation Service. "It is usually very hard to get me to try anything new," Smith admits, "but now that I've tried soil moisture monitoring, I'm convinced that it works. I think that an ignorance of what was happening in our soil moisture profile during the growing season created a lot of problems for us. Without some type of soil moisture monitoring program it's strictly a hit or miss situation."

When Smith began using gypsum blocks to monitor his soil moisture conditions, he had one tract of 123 acres of corn that he was irrigating with a center pivot from one 800 gallon per minute well.

"When we began running full pivots of corn, we were trying to keep the top of the soil wet on 123 acres of corn under the pivot, but we were making poorer yields than we had experienced with row water. We couldn't figure out why," Smith says.

With gypsum blocks, "we learned a lot about irrigation that first year," notes Smith. "We found out that we were trying to stretch our water too far. We had moisture in the top foot, but the bottom two feet dried out. With little or no moisture stored in the two and three foot soil levels, we couldn't apply enough water fast enough to meet the corn's water needs for optimum production.

"After that discovery we decided to alter our cropping pattern to one-half corn and one-half wheat for each pivot. Now we monitor our soil moisture conditions and apply irrigation water as it is needed by the crop."

Monitoring Soil Moisture In Wheat

Before Smith started monitoring his soil moisture conditions, he always thought he had to have good stored soil moisture all the way to the three foot level to make a good wheat crop. However, he found out that he can make good yields on wheat with shallow moisture. "We found out about that when we had a pump go out."

Smith explains that the wheat used almost all of the soil moisture before he could get the pump repaired. Then when he started back with his irrigation, he could not add enough water fast enough to rewet the top three feet of the soil profile as well as supply the amount of water being used by the wheat. In order to get across the field before it all burned up, Smith increased his pivot speed and was only able to wet the top foot.

Smith says the results were surprising. "In one of our other fields where we had a high moisture profile, the wheat lodged on us. In the field that we thought we had stressed by just watering the top foot, the wheat did not give us any lodging problems and we still made 107 bushels to the acre."

The next year Smith let his deep moisture on his wheat land slide, and he notes that the yields did not suffer at all. "In my opinion, if you can get good stored soil moisture in the top 18 inches and apply irrigation water when you need to, you can still get good yields. We are now obtaining far better yields from our wheat with less water and we are having less lodging problems."

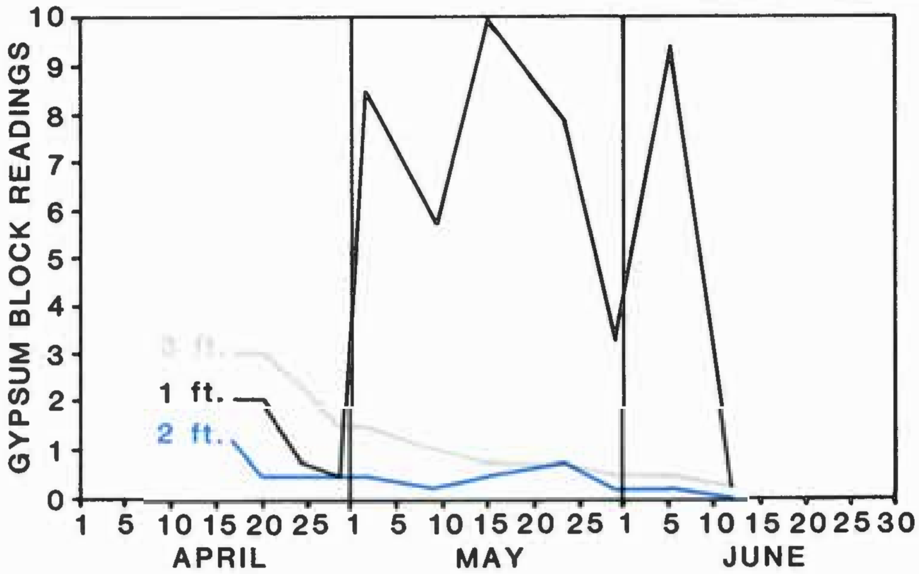
But Corn's A Different Story

"Now with corn, I just can't stress the importance of deep moisture." Smith explains that his well yields are not large enough to supply the amount of moisture his corn needs during its peak growing period. However, Smith notes that the corn can pick up the remainder of its water needs from the deep moisture stored in the soil.

Smith starts reading his gypsum blocks after his corn crop is established. "We run our pivots until the gypsum blocks show us that the soil moisture profile is at field capacity in the one, two and three foot levels." Smith checks his moisture blocks at least once a week thereafter, and says that since he started monitoring his soil moisture conditions and applying the moisture the crop needs on a timely basis, his yields have improved and stabilized.

Knowing the soil moisture conditions at each one-foot depth in the root zone soil profile can alleviate starting to irrigate too quickly as well as applying too much water during the first irrigations. Additionally, knowing the soil moisture conditions may alleviate starting your irrigation too late.

continued on page 4 . . . BLOCKS



GYPSUM BLOCK READINGS in the top foot of the soil profile show significant variation in moisture content throughout the growing season, while the two and three foot readings remain fairly stable. This chart of moisture readings seems to indicated that the moisture content of the top 18 inches of the soil profile is very important to wheat production.

Lubbock County Committeemen (from left to right) Danny Stanton of Shallowater, Pierce Truett of Idalou, Billy Walker of Lubbock, Richard Bednarz of Slaton, and Jerry Fulton of Lubbock join to serve the residents of Lubbock County in matters related to the Water District.

Ronald Smith, Bobby Brown and Loyd Gregory, all of Lorenzo, join with Marvin Schoepf of Ralls and Tracy Don Hancock of Lorenzo (not pictured) to serve as County Committeemen for the residents of Crosby County.

SLIDE SHOW . . . continued from page 1

the activities and programs of the District. Information in the presentation includes a brief history of the District and highlights some of the District's services such as the dissemination of information, soil moisture monitoring, water level measurements, water quality testing, and field demonstration days.

The show, which is also available for service, social and professional organization meetings, explains the District's "chain of command" from the Board of Directors, to the county committeemen and county secretaries, to the staff who carries out the daily functions and activities of the District.

The three-ring notebook provides more details on the information presented in the slide presentation. County committeemen can take these notebooks home and rely on the material contained in the notebook to assist them in responding to questions from their neighbors regarding the District's programs and services.

An orientation meeting for the County Committeemen in District Director's Precinct One, comprised of Lubbock, Lynn and Crosby Counties, was held on Thursday, February 6, 1986. Meetings for the committeemen in other District Directors' Precincts are scheduled for March.

Each meeting affords the Directors, committeemen and staff an opportunity to discuss the current activities of the District, including guidelines for the agricultural loan program, changes in water levels and the current status of soil moisture conditions taken from recent measurements made throughout the District's service area. Committeemen also provide information on the special concerns and interests of the communities they represent regarding water related issues. —*KES*

Chemicals Important To Success Of Conservation Tillage

Making conservation tillage a winning proposition takes a thorough knowledge of the chemicals used to control weeds and attention to detail. No one knows this better than Coy Franks, a Motley and Floyd County farmer who raises cotton and grain sorghum.

"In the spring of 1985 we had stalks from our 1984 grain sorghum that we used to plant cotton into. Prior to planting the grain sorghum we had applied one pound of Miloguard which was less than the label rate. Then before we planted the cotton, we applied eight ounces of Roundup and one-half pound of Carmex per acre. We planted about 40,000 cotton seed per acre on a 40-inch row spacing and then added another one-half pound of Carmex and one pint of Prowel per acre.

"Well, that summer we ended up spending $4.50 per acre for hoeing, and $3.50 per acre for purple nightshade spot spraying," states Franks, believing that the hoeing expense could have been avoided had he applied the recommended label rates of his chemicals.

"We also had problems with seedling disease and stress because of an abnormally wet spring. But, eventually the cotton began to grow out of the stress and seedling disease problems. We had 36-acres that yielded 347 pounds of cotton per acre at an out-of-pocket expense of $37.50 per acre including a $15 per acre harvesting cost."

Franks states that prior to his conservation tillage work, he spent up to $100 per acre to grow cotton. "I saved $40 per acre this year in production costs by using conservation tillage."

Franks also thinks he has learned something over the years trying conservation tillage. "If I was going to do it again, and I am, I would use the label rates on the chemicals I apply. Additionally, I would avoid moving any soil. Every time I moved soil, I germinated some of the sorghum that I had planted my cotton into."

One of the advantages Franks sees in conservation tillage is that its easy to grow a crop with low overhead. Franks also says that it saves soil moisture. "I pre-watered just this week thanks to the snow," states Franks.

Three passes through the field is all it takes for Franks to make a crop under his conservation tillage system. "I sprayed, planted and harvested. And, I didn't worry about sand blowing one time."

Franks says he could have sold his rotary hoe and his cultivator and blown the money on a vacation.

Breaking tradition is the hardest thing for a man to do in changing to conservation tillage, according to Franks. "But, I hope that somebody tries this deal with me, because it's so easy to do, it was even fun." —KR

BLOCKS . . . continued from page 3

Rains can provide a source of trouble for irrigators who do not know their soil moisture conditions. A rain may not wet the soil profile down to a level that the added moisture meets the moisture that was previously stored in the root zone, leaving a dry pocket. If this happens, irrigators may delay their next irrigation thinking that the full soil profile is wet. Consequently, playing catch-up the rest of the year becomes a distinct possibility.

"I highly recommend that every irrigator look into some type of soil moisture monitoring program," states Smith. "The expense is minimal, at least for the gypsum blocks, and by using the tools that we have available today, we can maximize our profits and conserve our resources." —KR

Rain . . .

continued from page 1

percent probability of three inches, a 34 percent probability of four inches, and a 14 percent chance of getting up to five inches of precipitation.

Chances of receiving precipitation in July are 64 percent for one inch, 50 percent for two inches, 30 percent for three inches, and 20 percent for four inches.

In August, probabilities show the chance of one inch of precipitation is 75 percent, two inches is 43 percent and three inches is 22 percent.

In summary, the rainfall probabilities for the spring and summer months provide good odds for having precipitation to harvest.

Rainfall Runoff

Soil infiltration rates in the Texas High Plains area range from two inches per hour in sandy soils to one-tenth of an inch per hour in tight clay soils. Therefore, the likelihood of receiving precipitation in excess of the soil's infiltration rate seems pretty high.

Rainfall runoff studies conducted at the Texas Agricultural Experiment Station at Lubbock reveal that on loam soils no runoff occurred on level land and that the average annual runoff was 1.74 inches for land with a 0.2 percent slope (two inches per 100 feet). Runoff was 2.51 inches from soils with a 0.5 percent slope, 3.08 inches from soils with a 0.9 percent slope, and 3.61 inches from soils with a 1.2 percent slope. The average annual precipitation runoff during the three-year study for the four graded tracts was 2.73 inches per acre.

Rainfall runoff usually is very marginal in rainfall events of one-half inch or less. The probabilities of runoff increase with larger amounts of precipitation.

Harvesting Precipitation

The use of furrow dikes is one method of maximizing the benefits of rainfall not only prior to planting, but also during the entire growing season. In fact, they may be the single most cost effective conservation practice that can be implemented to increase crop yields and profits.

In some years furrow dikes have been installed and plowed out without catching a single drop of water. Obviously, during these years furrow dikes proved to be of little or no benefit.

However, over the long haul furrow dikes have demonstrated their value to farmers and researchers alike. Their experiences show that on a 10-year average, two to four inches of additional rainfall can be saved through the use of furrow dikes. What makes the dikes so effective is that they help to eliminate rainfall runoff by keeping the rainfall in place, allowing for the maximum potential amount of water to soak into the soil.

Research also shows that for every inch of water made available to the cotton plant over that which is required for plant production, the cotton plant will produce 30-40 pounds more lint per acre. Likewise, grain sorghum yields will increase by 300 to 400 pounds of grain per acre, and wheat will produce two to three more bushels per acre.

Therefore, the two to three inches of runoff water saved by furrow dikes translates to an increased cotton production of 80 to 120 pounds of lint per acre and 600 to 1,000 pounds of grain sorghum per acre.

Pumping water from the Ogallala aquifer in an amount equal to the average runoff would cost producers from $8 to $12 per acre, assuming 2.73 inches of runoff per acre as indicated by the Texas Agricultural Experiment Station study. Under most conditions, the increased yields as a result of the water harvested by furrow dikes may pay for the cost of the diking equipment within one year.

Furrow dikes are also effective when used in conjunction with irrigation, especially with sprinkler systems or alternate row watering patterns.

Because rainfall and rainfall amounts are not always consistent, it is important to keep furrow dikes in place as much as possible to maximize the benefits of rain. —KR

A New Idea:

An alternative to using furrow dikes for harvesting precipitation, which is used mostly by corn producers, is plowing a chisel furrow two to three inches wide and four to six inches deep in the center of the furrow between the rows of corn.

The chisel furrow must be installed before the corn extends its roots out to the center of the furrow or root damage will occur. The chisel furrows are generally installed before the corn is one foot tall.

The chisel furrow provides a storage basin for water, increases the area for infiltration to occur and, by confining the water in small deep basins, reduces the potential evaporation rate.

Chisel furrows are reported to work well on land being irrigated with center pivot irrigation systems, but are not recommended for furrow irrigation tracts. Also, chisel furrows are not recommended for use on sloping land which is subject to water erosion.

As with any new practice, it is recommended that irrigators try the chisel furrow on a small area for a year or two to see how it works before they begin incorporating the practice on their total acreage.

Furrow dikes are very difficult if not impossible to remove from full grown corn fields without causing severe damage to the corn. If they are not removed, the dikes, if installed in every row, cause a very bumpy ride for the combine or silage harvester. —AWW

THE CROSS SECTION (USPS 564-920)
HIGH PLAINS UNDERGROUND WATER
CONSERVATION DISTRICT NO. 1
2930 AVENUE Q
LUBBOCK, TEXAS 79405

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THE Cross SECTION

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A FIRST IN WATER DISTRICT 35-YEAR HISTORY

Volume of Water in Storage in the Ogallala Aquifer Stabilizes

Annual depth-to-water level measurements in the Ogallala aquifer in 950 water-level observation wells throughout the Water District's 15-county, 5.2 million-acre service area have been completed. Comparing the changes in the depth-to-water level measurements taken in all wells this January to the measurements made in the same group of wells last January reveals a zero overall average change. This zero change indicates that the total volume of water in storage in the Ogallala aquifer in the Water District's service area as of January 1986 remains the same as it was in January 1985.

County Water-Level Changes

The one-year average change in depth-to-water level measurements in individual counties throughout the District show either a small decline in the water level, or an actual rise.

Average depth-to-water level measurements in wells in Armstrong, Cochran, Crosby, Floyd, Hale, Hockley, Lubbock and Lynn Counties showed a rise. Crosby County showed the largest average rise in the water table with a rise of 2.50 feet.

The average depth to water in the remaining seven counties (Bailey, Castro, Deaf Smith, Lamb, Parmer, Potter and Randall Counties) showed a small increase in the depth to water, indicating a decline in the water table. Average declines for individual counties ranged from an 0.08 of a foot decline in Bailey County to a 1.40 foot decline in Parmer County.

Past Average Changes Compared

Over the past five years there has been a dramatic decrease in the rate of decline in the aquifer District-wide.

The change in water levels from 1981 to 1986 indicates that there has been a 69 percent reduction in the rate of decline during the immediate past five-year period as compared to the previous five-year period from 1976 to 1981.

The average change in water levels for the five-year period 1981 to 1986 shows a total decline of 2.30 feet. This equals an average annual decline of 0.46 of a foot. The average change in water levels from 1976 to 1981 shows a total decline of 7.40 feet during this five-year period, for an average decline of 1.48 feet per year.

The ten year average change in water levels, from 1976 to 1986, for all wells measured shows a total decline in the water level of 9.70 feet, for an average annual decline rate of 0.97 of a foot.

Water-Level Measurements Tabulated

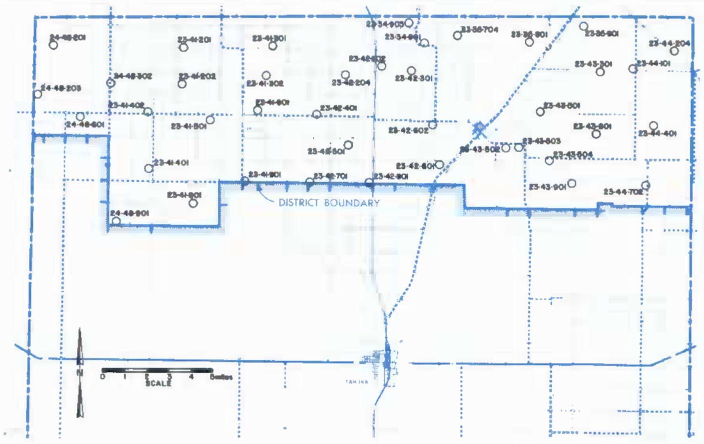
The water-level observation well network consists of 950 privately-owned water wells that are located at an approximate density of one well per three square miles throughout the Water District's service area. The depth to water in this network of wells is measured annually by the Water District's staff.

On the inside pages of this month's issue of *The Cross Section* a compilation of the data obtained in the water-level measuring

continued on page 8...AQUIFER STABILIZED

Average Changes in Depths to Water In Observation Wells - 1986

	Number of Observation Wells Maintained	Average Annual Change-1976 to 1986	Average Annual Change-1981 to 1986	Average Annual Change-1983 to 1986	Average Change 1985-1986
Armstrong	9	−0.62	−0.16	+0.13	+0.37
Bailey	74	−1.16	−0.60	−0.51	−0.08
Castro	89	−2.06	−1.65	−1.51	−0.78
Cochran	52	+0.00	+0.39	+0.33	+0.86
Crosby	23	−1.22	+0.51	+0.85	+2.50
Deaf Smith	82	−1.23	−0.76	−0.70	−0.40
Floyd	97	−1.34	−0.50	−0.40	+0.02
Hale	27	−1.20	−0.80	−0.22	+0.28
Hockley	88	−0.10	+0.32	+0.19	+0.71
Lamb	99	−2.09	−1.48	−1.38	−0.82
Lubbock	116	−0.15	+0.61	+0.38	+0.97
Lynn	40	+0.35	+1.08	+0.83	+0.84
Parmer	97	−2.35	−1.64	−1.48	−1.40
Potter	6	−0.99	−0.05	−0.93	−0.33
Randall	50	−0.35	−0.12	−0.27	−0.15



LYNN COUNTY

Well Number	Depth to Water Below Land Surface In Feet 1976	1981	1983	1985	1986	Total Change In Water Levels In Feet 1976 to 1986	1981 to 1986	1983 to 1986	1985 to 1986
23-34-901	144.03	148.45	149.12	142.94	141.89	+2.14	+6.56	+7.23	+1.05
23-34-903	151.80	156.79	156.23	153.55	153.34	−1.54	+3.45	+2.89	+0.21
23-35-704	132.80	138.42	139.49	135.03	135.65	−2.85	+2.77	+3.84	−0.62
23-35-801	87.69	87.52	87.89	89.84	87.50	+0.19	+0.02	+0.39	+2.34
23-35-901	89.96	91.61	91.22	90.85	91.06	−1.10	+0.55	+0.16	−0.21
23-41-201	104.06	107.45	105.75	105.57	101.80	+2.26	+5.65	+3.95	+3.77
23-41-202	0.0	0.0	0.0	0.0	112.52	0.0	0.0	0.0	0.0
23-41-301	0.0	136.24	133.67	131.96	131.80	0.0	+4.44	+1.87	+0.16
23-41-302	0.0	0.0	0.0	0.0	109.32	0.0	0.0	0.0	0.0
23-41-401	90.87	95.65	93.39	92.00	90.10	+0.77	+5.55	+3.29	+1.90
23-41-402	0.0	108.10	105.20	100.84	99.62	0.0	+8.48	+5.58	+1.22
23-41-501	70.53	74.46	69.60	66.25	65.56	+4.97	+8.90	+4.04	+0.69
23-41-601	0.0	106.12	104.62	103.34	103.02	0.0	+3.10	+1.60	+0.32
23-41-801	0.0	75.53	64.88	67.99	66.75	0.0	+8.78	−1.87	+1.24
23-41-901	128.58	126.02	123.30	119.88	119.70	+8.88	+6.32	+3.60	+0.18
23-42-202	124.83	124.70	122.79	121.48	121.17	+3.66	+3.53	+1.62	+0.31
23-42-204	0.0	120.79	119.85	119.04	117.65	0.0	+3.14	+2.20	+1.39
23-42-301	110.20	110.66	110.78	106.80	106.32	+3.88	+4.34	+4.46	+0.48
23-42-401	114.40	114.82	111.22	108.59	107.43	+6.97	+7.39	+3.79	+1.16
23-42-501	100.06	103.18	100.86	96.20	96.38	+3.68	+6.80	+4.48	−0.18
23-42-601	41.70	44.64	39.40	40.98	41.20	+0.50	+3.44	−1.80	−0.22
23-42-602	87.47	89.86	90.33	87.60	88.29	−0.82	+1.57	+2.04	−0.69
23-42-701	101.70	97.65	88.28	86.88	85.96	+15.74	+11.69	+2.32	+0.92
23-42-801	65.98	66.93	62.59	60.20	60.14	+5.84	+6.79	+2.45	+0.06
23-43-301	31.03	34.67	21.05	27.08	26.08	+4.95	+8.59	−5.03	+1.00
23-43-501	72.84	72.22	71.48	68.37	68.04	+4.80	+4.18	+3.44	+0.33
23-43-502	77.92	79.22	77.75	76.49	75.68	+2.24	+3.54	+2.07	+0.81
23-43-503	85.02	85.83	84.78	83.11	82.57	+2.45	+3.26	+2.21	+0.54
23-43-504	76.28	76.29	74.00	71.84	70.94	+5.34	+5.35	+3.06	+0.90
23-43-601	0.0	41.76	37.45	38.37	36.70	0.0	+5.06	+0.75	+1.67
23-43-901	57.74	56.47	52.61	53.05	51.67	+6.07	+4.80	+0.94	+1.38
23-44-101	64.58	65.40	58.92	56.01	55.18	+9.40	+10.22	+3.74	+0.83
23-44-204	0.0	0.0	152.17	144.66	0.0	0.0	0.0	0.0	0.0
23-44-401	38.09	44.36	38.51	38.97	39.17	−1.08	+5.19	−0.66	−0.20
23-44-702	23.82	27.38	24.14	24.25	23.90	−0.08	+3.48	+0.24	+0.35
24-48-201	99.64	101.42	100.06	97.60	96.51	+3.13	+4.91	+3.55	+1.09
24-48-203	0.0	0.0	92.51	89.12	86.54	0.0	0.0	+5.97	+2.58
24-48-302	106.89	111.20	107.05	102.00	100.52	+6.37	+10.68	+6.53	+1.48
24-48-601	86.76	89.82	87.75	84.26	82.38	+4.38	+7.44	+5.37	+1.88
24-48-901	0.0	0.0	0.0	0.0	115.22	0.0	0.0	0.0	0.0

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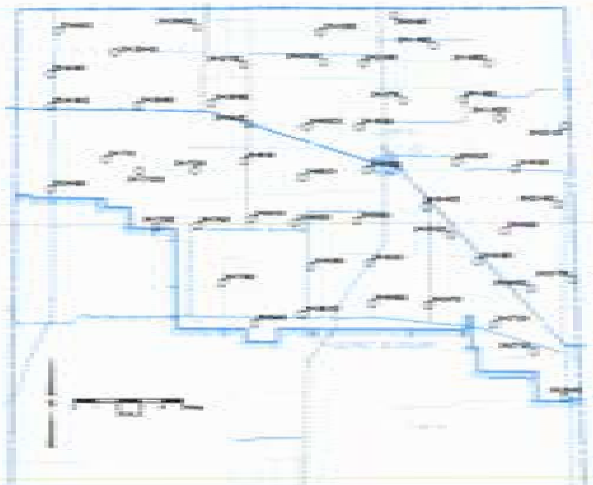

COCHRAN COUNTY

Well Number	Depth to Water Below Land Surface In Feet 1976	1981	1983	1985	1986	Total Change In Water Levels In Feet 1976 to 1986	1981 to 1986	1983 to 1986	1985 to 1986
24-09-401	0.0	93.72	95.48	96.48	96.62	0.0	−2.90	−1.14	−0.14
24-09-602	124.78	130.11	129.33	130.12	128.74	−3.96	+1.37	+0.59	+1.38
24-09-801	0.0	124.78	123.79	123.45	124.02	0.0	+0.76	−0.23	−0.57
24-09-901	103.79	110.87	108.58	109.14	108.05	−4.26	+2.82	+0.53	+1.09
24-10-501	93.74	95.31	94.19	93.71	92.71	+1.03	+2.60	+1.48	+1.00
24-10-503	0.0	106.67	105.53	104.41	103.92	0.0	+2.75	+1.61	+0.49
24-10-601	91.71	93.36	92.48	92.23	91.75	−0.04	+1.61	+0.73	+0.48
24-10-702	110.12	112.79	111.70	112.59	112.21	−2.09	+0.58	−0.51	+0.38
24-10-901	93.46	93.54	92.86	92.80	0.0	0.0	0.0	0.0	0.0
24-11-402	0.0	127.18	126.45	126.70	125.72	0.0	+1.46	+0.73	+0.98
24-11-701	126.01	126.41	126.39	126.31	125.90	+0.11	+0.51	+0.49	+0.41
24-11-801	106.62	109.31	109.00	109.85	0.0	0.0	0.0	0.0	0.0
24-11-802	113.50	115.54	114.36	115.09	114.07	−0.57	+1.47	+0.29	+1.02
24-11-803	0.0	131.16	130.51	131.16	130.25	0.0	+0.91	+0.26	+0.91
24-17-101	0.0	136.12	134.93	133.98	132.98	0.0	+3.14	+1.95	+1.00
24-17-202	0.0	143.82	141.66	139.82	139.88	0.0	+3.94	+1.78	−0.06
24-17-301	144.23	148.85	146.63	145.57	143.87	+0.36	+4.98	+2.76	+1.70

COCHRAN COUNTY

Well Number	Depth to Water Below Land Surface In Feet 1976	1981	1983	1985	1986	Total Change In Water Levels In Feet 1976 to 1986	1981 to 1986	1983 to 1986	1985 to 1986
24-17-502	158.46	158.60	155.53	154.11	152.80	+5.66	+5.80	+2.73	+1.31
24-17-601	151.13	153.38	151.20	150.46	150.00	+1.13	+3.38	+1.20	+0.46
24-17-901	167.10	168.75	165.91	165.19	164.28	+2.82	+4.47	+1.63	+0.91
24-18-101	148.56	146.52	146.21	145.67	144.09	+4.47	+2.43	+2.12	+1.58
24-18-102	0.0	157.73	153.79	153.55	154.63	0.0	+3.10	−0.84	−1.08
24-18-201	177.04	180.48	178.61	177.69	176.09	+0.95	+4.39	+2.52	+1.60
24-18-202	135.15	139.09	137.42	138.22	136.73	−1.58	+2.36	+0.69	+1.49
24-18-301	135.00	136.23	136.46	137.01	136.44	−1.44	−0.21	+0.02	+0.57
24-18-302	163.79	166.30	164.79	164.54	0.0	0.0	0.0	0.0	0.0
24-18-401	152.85	156.76	154.16	154.35	152.57	+0.28	+4.19	+1.59	+1.78
24-18-501	197.62	197.77	198.49	198.52	197.60	+0.02	+0.17	+0.89	+0.92
24-18-601	176.32	178.93	176.66	176.33	174.77	+1.55	+4.16	+1.89	+1.56
24-18-801	192.11	195.46	194.19	193.96	191.40	+0.71	+4.06	+2.79	+2.56
24-18-901	114.76	116.12	114.02	113.42	113.00	+1.76	+3.12	+1.02	+0.42
24-18-902	0.0	139.72	139.62	139.05	138.80	0.0	+0.92	+0.82	+0.25
24-19-201	148.11	148.07	150.09	151.30	151.01	−2.90	−2.94	−0.92	+0.29
24-19-301	172.25	168.24	170.87	169.59	166.16	+6.09	+2.08	+4.71	+3.43
24-19-403	0.0	155.90	154.89	154.16	153.18	0.0	+2.72	+1.71	+0.98
24-19-502	173.28	176.04	174.41	173.21	171.87	+1.41	+4.17	+2.54	+1.34
24-19-601	156.52	159.43	160.15	160.52	160.35	−3.83	−0.92	−0.20	+0.17
24-19-701	154.31	151.95	151.00	150.11	149.53	+4.78	+2.42	+1.47	+0.58
24-19-801	166.28	169.88	167.60	168.49	167.18	−0.90	+2.70	+0.42	+1.31
24-19-902	129.34	130.66	130.24	130.95	130.82	−1.48	−0.16	−0.58	+0.13
24-20-103	147.17	147.97	145.34	146.48	145.65	+1.52	+2.32	−0.31	+0.83
24-20-402	149.57	154.32	156.80	157.99	158.55	−8.98	−4.23	−1.75	−0.56
24-20-702	152.62	154.36	154.44	155.91	156.05	−3.43	−1.69	−1.61	−0.14
24-26-101	0.0	153.21	150.59	150.37	148.70	0.0	+4.51	+1.89	+1.67
24-26-202	165.22	161.09	160.09	158.82	158.55	+6.67	+2.54	+1.54	+0.27
24-27-201	181.15	183.45	182.34	180.98	179.61	+1.54	+3.84	+2.73	+1.37
24-27-301	179.87	181.61	181.94	180.61	180.42	−0.55	+1.19	+1.52	+0.19
24-28-401	186.05	189.55	188.46	189.18	189.53	−3.48	+0.02	−1.07	−0.35
25-16-602	76.52	80.97	80.47	80.24	78.35	−1.83	+2.62	+2.12	+1.89
25-16-901	91.46	93.90	93.99	95.99	92.40	−0.94	+1.50	+1.59	+3.59
25-16-902	0.0	109.87	109.42	109.58	109.20	0.0	+0.67	+0.22	+0.38
25-24-601	0.0	143.63	141.41	140.01	139.82	0.0	+3.81	+1.59	+0.19

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CROSBY COUNTY

Well Number	Depth to Water Below Land Surface In Feet 1976	1981	1983	1985	1986	Total Change In Water Levels In Feet 1976 to 1986	1981 to 1986	1983 to 1986	1985 to 1986
23-12-606	180.28	195.70	203.04	208.07	0.0	0.0	0.0	0.0	0.0
23-12-801	200.43	208.29	208.59	211.82	209.06	−8.63	−0.77	−0.47	+2.76
23-12-902	223.68	242.57	238.52	242.65	0.0	0.0	0.0	0.0	0.0
23-12-905	205.71	216.22	218.82	220.78	218.65	−12.94	−2.43	+0.17	+2.13
23-13-401	194.59	210.70	213.94	217.26	216.77	−22.18	−6.07	−2.83	+0.49
23-13-502	214.46	229.01	230.37	233.85	232.24	−17.78	−3.23	−1.87	+1.61
23-13-803	214.06	247.03	253.92	248.30	247.50	−33.44	−0.47	+6.42	+0.80
23-20-201	0.0	192.39	193.47	191.99	191.10	0.0	+1.29	+2.37	+0.89
23-20-305	0.0	224.62	229.34	225.01	219.27	0.0	+5.35	+10.07	+5.74
23-20-503	203.61	216.97	215.03	215.25	213.71	−10.10	+3.26	+1.32	+1.54
23-20-608	0.0	0.0	0.0	223.22	222.36	0.0	0.0	0.0	+0.86
23-20-901	204.26	215.75	219.14	215.83	208.20	−3.94	+7.55	+10.94	+7.63
23-21-101	0.0	250.86	248.60	248.16	0.0	0.0	0.0	0.0	0.0
23-21-706	206.45	213.02	210.96	211.85	209.56	−3.11	+3.46	+1.40	+2.29
23-28-202	133.58	137.70	136.30	138.05	0.0	0.0	0.0	0.0	0.0
23-28-310	0.0	0.0	176.92	177.94	175.48	0.0	0.0	+1.44	+2.46
23-28-601	148.99	167.05	145.67	144.35	0.0	0.0	0.0	0.0	0.0
23-28-901	0.0	102.35	101.32	97.05	92.70	0.0	+9.65	+8.62	+4.35
23-29-102	0.0	190.73	185.10	184.05	180.95	0.0	+9.78	+4.15	+3.10
23-29-103	0.0	0.0	207.39	208.88	0.0	0.0	0.0	0.0	0.0
23-29-401	206.09	211.40	208.20	206.80	203.30	+2.79	+8.10	+4.90	+3.50
23-29-701	0.0	113.30	105.60	113.78	113.10	0.0	+0.20	−7.50	+0.68
23-36-301	0.0	0.0	152.69	152.65	151.41	0.0	0.0	+1.28	+1.24

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Well Number	1976	1981	1983	1985	1986	1976 to 1986	1981 to 1986	1983 to 1986	1985 to 1986
23-25-304	38.28	36.71	30.75	31.60	30.04	+8.24	+6.67	+0.71	+1.56
23-25-401	144.29	149.44	145.43	144.96	143.84	+0.45	+5.60	+1.59	+1.12
23-25-704	128.28	133.59	131.18	128.28	127.26	+1.02	+6.33	+3.92	+1.02
23-25-801	0.0	113.79	112.32	110.59	110.17	0.0	+3.62	+2.15	+0.42
23-25-904	0.0	81.03	74.93	69.20	66.68	0.0	+14.35	+8.25	+2.52
23-26-101	61.10	54.77	52.10	52.43	51.06	+10.04	+3.71	+1.04	+1.37
23-26-301	93.49	93.72	91.60	90.10	88.85	+4.64	+4.87	+2.75	+1.25
23-26-603	13.47	12.87	18.35	21.81	12.67	+0.80	+0.20	+5.68	+9.14
23-26-604	50.44	52.35	48.18	49.46	48.69	+1.75	+3.66	−0.51	+0.77
23-26-802	0.0	74.17	69.73	67.52	65.39	0.0	+8.78	+4.34	+2.13
23-27-102	0.0	83.47	81.47	81.08	79.37	0.0	+4.10	+2.10	+1.71
23-27-201	93.40	96.66	92.41	90.60	89.79	+3.61	+6.87	+2.62	+0.81
23-27-204	92.95	96.03	91.90	90.75	90.04	+2.91	+5.99	+1.86	+0.71
23-27-207	91.40	111.83	97.86	97.80	95.66	−4.26	+16.17	+2.20	+2.14
23-27-302	78.80	83.50	79.48	77.56	76.90	+1.90	+6.60	+2.58	+0.66
23-27-402	74.05	74.33	71.16	72.55	71.94	+2.11	+2.39	−0.78	+0.61
23-27-601	87.30	87.64	82.50	82.70	82.14	+5.16	+5.50	+0.36	+0.56
23-27-603	0.0	88.66	84.87	84.64	83.20	0.0	+5.46	+1.67	+1.44
23-27-701	0.0	77.31	62.97	64.86	63.36	0.0	+13.95	−0.39	+1.50
23-27-801	0.0	128.43	127.15	124.64	123.71	0.0	+4.72	+3.44	+0.93
23-28-203	0.0	180.81	163.57	165.70	0.0	0.0	0.0	0.0	0.0
23-28-501	0.0	89.57	87.97	87.48	86.32	0.0	+3.25	+1.65	+1.16
23-28-701	60.21	64.08	56.04	58.66	54.13	+6.08	+9.95	+1.91	+4.53
23-33-201	130.07	130.18	129.32	128.58	128.41	+1.66	+1.77	+0.91	+0.17
23-33-301	0.0	106.05	102.14	100.04	101.00	0.0	+5.05	+1.14	−0.96
23-33-401	104.83	106.71	105.61	104.75	104.38	+0.45	+2.33	+1.23	+0.37
23-33-501	111.14	112.46	111.53	110.55	110.16	+0.98	+2.30	+1.37	+0.39
23-33-601	104.95	107.24	105.88	104.43	104.30	+0.65	+2.94	+1.58	+0.13
23-33-801	99.18	99.42	99.39	97.04	97.10	+2.08	+2.32	+2.29	−0.06
23-33-901	119.46	120.20	118.30	117.73	117.18	+2.28	+3.02	+1.12	+0.55
23-34-101	113.93	116.43	113.32	110.76	110.61	+3.32	+5.82	+2.71	+0.15
23-34-202	0.0	100.95	94.13	93.21	92.76	0.0	+8.19	+1.37	+0.45
23-34-402	116.32	118.21	116.52	115.22	114.87	+1.45	+3.34	+1.65	+0.35
23-34-502	138.67	142.56	141.83	140.02	139.59	−0.92	+2.97	+2.24	+0.43
23-34-503	120.38	124.09	121.75	119.72	119.22	+1.16	+4.87	+2.53	+0.50
23-34-601	127.36	129.32	129.41	127.37	127.38	−0.02	+1.94	+2.03	−0.01
23-34-801	147.83	148.89	147.98	146.08	146.60	+1.23	+2.29	+1.38	−0.52
23-34-805	142.84	144.22	144.12	140.86	141.31	+1.53	+2.91	+2.81	−0.45
23-34-902	136.40	138.64	138.65	136.58	136.82	−0.42	+1.82	+1.83	−0.24
23-35-101	82.58	81.45	78.01	76.20	76.45	+6.13	+5.00	+1.56	−0.25
23-35-301	113.42	111.24	110.73	111.05	109.50	+3.92	+1.74	+1.23	+1.55
23-35-502	98.48	99.14	98.40	96.48	95.94	+2.54	+3.20	+2.46	+0.54
23-35-503	126.92	130.85	128.75	128.04	126.99	−0.07	+3.86	+1.76	+1.05
23-35-701	130.62	133.44	132.81	130.96	131.25	−0.63	+2.19	+1.56	−0.29
23-35-703	136.14	138.93	137.82	134.00	132.64	+3.50	+6.29	+5.18	+1.36
23-35-706	129.07	132.41	130.30	130.53	130.54	−1.47	+1.87	−0.24	−0.01
23-35-707	0.0	133.75	132.83	131.81	131.71	0.0	+2.04	+1.12	+0.10
23-35-802	118.06	120.37	117.84	118.64	118.61	−0.55	+1.76	−0.77	+0.03
23-35-902	151.20	145.86	143.52	143.29	144.54	+6.60	+1.32	−1.02	−1.25
23-35-903	150.44	151.89	151.34	152.28	147.68	+2.76	+4.21	+3.66	+4.60
23-36-201	0.0	78.73	75.85	77.14	75.36	0.0	+3.37	+0.49	+1.78
23-36-401	104.70	103.29	102.07	101.56	101.81	+2.89	+1.48	+0.26	−0.25
23-36-701	118.36	117.83	117.05	117.70	119.10	−0.74	−1.27	−2.05	−1.40
23-36-702	219.14	219.77	213.44	211.31	208.69	+10.45	+11.08	+4.75	+2.62
23-36-703	203.74	206.27	201.85	200.53	197.62	+6.12	+8.65	+4.23	+2.91
24-16-601	128.62	136.18	136.47	135.80	134.93	−6.31	+1.25	+1.54	+0.87
24-16-901	170.62	170.51	170.08	170.00	169.90	+0.72	+0.61	+0.18	+0.10
24-24-201	65.90	69.96	70.02	70.82	69.28	−3.38	+0.68	+0.74	+1.54
24-24-301	134.32	137.43	135.83	135.79	134.95	−0.63	+2.48	+0.88	+0.84
24-24-602	82.84	86.95	86.50	86.02	84.64	−1.80	+2.31	+1.86	+1.38
24-24-901	166.40	172.14	170.43	168.03	165.60	+0.80	+6.54	+4.83	+2.43
24-24-902	102.35	126.47	123.51	123.99	123.50	−21.15	+2.97	+0.01	+0.49
24-32-201	0.0	104.62	103.63	103.40	103.03	0.0	+1.59	+0.60	+0.37
24-32-303	0.0	120.06	119.28	119.97	119.35	0.0	+0.71	−0.07	+0.62
24-32-304	141.52	147.60	145.95	146.27	146.03	−4.51	+1.57	−0.08	+0.24
24-32-305	0.0	0.0	0.0	0.0	126.01	0.0	0.0	0.0	0.0
24-32-502	0.0	0.0	121.10	120.40	119.15	0.0	0.0	+1.95	+1.25
24-32-601	131.10	136.25	134.53	134.17	134.18	−3.08	+2.07	+0.35	−0.01
24-40-201	136.75	138.68	134.92	134.09	133.07	+3.68	+5.61	+1.85	+1.02
24-40-301	144.98	148.78	146.97	145.76	145.24	−0.26	+3.54	+1.73	+0.52
24-40-601	123.50	129.94	126.65	126.16	125.63	−2.13	+4.31	+1.02	+0.53
24-40-603	0.0	88.80	88.28	86.97	86.15	0.0	+2.65	+2.13	+0.82
24-40-901	67.56	70.79	69.93	67.09	67.23	+0.33	+3.56	+2.70	−0.14

0.0 - Denotes data not available

Well Number	1976	1981	1983	1985	1986	1976 to 1986	1981 to 1986	1983 to 1986	1985 to 1986
10-26-502	0.0	339.73	346.09	351.90	353.20	0.0	[illegible]	[illegible]	[illegible]
10-26-603	0.0	0.0	0.0	0.0	338.44	0.0	0.0	0.0	0.0
10-26-702	225.28	239.33	241.64	243.88	243.20	-17.92	-3.87	-1.56	+0.68
10-26-802	234.89	252.89	261.69	265.60	262.80	-27.91	-9.91	-1.11	+2.80
10-27-102	282.56	300.59	308.03	312.67	314.91	-32.35	-14.32	-6.88	-2.24
10-27-103	0.0	388.94	394.23	399.95	403.24	0.0	-14.30	-9.01	-3.29
10-27-301	320.83	338.71	343.65	348.48	351.92	-31.09	-13.21	-8.27	-3.44
10-27-501	355.28	384.48	388.75	395.30	403.03	-47.75	-18.55	-14.28	-7.73
10-27-601	0.0	361.53	366.45	373.00	376.88	0.0	-15.35	-10.43	-3.88
10-27-702	0.0	297.70	302.25	304.83	308.32	0.0	-10.62	-6.07	-3.49
10-27-901	265.70	290.43	0.0	296.18	296.50	-30.80	-6.07	0.0	-0.32
10-28-102	0.0	330.87	340.24	345.55	347.10	0.0	-16.23	-6.86	-1.55
10-28-202	293.70	316.21	319.42	324.70	328.40	-34.70	-12.19	-8.98	-3.70
10-28-501	310.86	344.05	354.11	356.30	360.39	-49.53	-16.34	-6.28	-4.09
10-28-703	0.0	276.67	282.68	288.05	289.71	0.0	-13.04	-7.03	-1.66
10-28-801	0.0	301.46	310.56	316.13	318.46	0.0	-17.00	-7.90	-2.33
10-33-103	0.0	311.82	316.93	321.10	324.19	0.0	-12.37	-7.26	-3.09
10-33-310	0.0	274.67	280.26	280.30	286.39	0.0	-11.72	-6.13	-6.09
10-33-501	281.37	303.78	310.82	315.00	0.0	0.0	0.0	0.0	0.0
10-33-502	0.0	335.41	338.64	342.88	344.84	0.0	-9.43	-6.20	-1.96
10-33-603	0.0	0.0	319.98	323.86	327.33	0.0	0.0	-7.35	-3.47
10-33-801	0.0	262.29	270.49	277.80	279.62	0.0	-17.33	-9.13	-1.82
10-33-802	217.22	238.03	244.22	251.19	253.20	-35.98	-15.17	-8.98	-2.01
10-33-902	214.55	231.03	240.67	245.25	247.01	-32.46	-15.98	-6.34	-1.76
10-34-102	227.32	243.60	251.05	257.75	255.75	-28.43	-12.15	-4.70	+2.00
10-34-202	0.0	285.87	292.49	294.50	293.16	0.0	-7.29	-0.67	+1.34
10-34-302	223.00	241.86	249.48	250.90	252.04	-29.04	-10.18	-2.56	-1.14
10-34-403	0.0	301.65	307.37	311.00	313.43	0.0	-11.78	-6.06	-2.43
10-34-404	292.18	313.16	317.93	321.92	323.48	-31.30	-10.32	-5.55	-1.56
10-34-602	0.0	283.99	288.13	291.96	293.44	0.0	-9.45	-5.31	-1.48
10-34-801	225.17	241.45	248.74	251.74	254.64	-29.47	-13.19	-5.90	-2.90
10-34-802	251.28	270.02	275.13	279.02	279.88	-28.60	-9.86	-4.75	-0.86
10-35-304	221.09	240.58	247.09	246.14	249.03	-27.94	-8.45	-1.94	-2.89
10-35-401	254.01	275.48	281.56	285.23	286.56	-32.55	-11.08	-5.00	-1.33
10-35-501	245.45	0.0	268.91	269.80	271.55	-26.10	0.0	-2.64	-1.75
10-35-603	0.0	218.72	227.57	230.53	234.45	0.0	-15.73	-6.88	-3.92
10-35-702	231.00	256.75	259.52	261.52	263.93	-32.93	-7.18	-4.41	-2.41
10-35-802	0.0	261.72	270.58	274.30	0.0	0.0	0.0	0.0	0.0
10-35-901	260.62	281.34	284.79	288.90	289.04	-28.42	-7.70	-4.25	-0.14
10-35-902	255.35	276.47	284.97	287.85	288.24	-32.89	-11.77	-3.27	-0.39
10-36-102	0.0	239.45	242.49	244.75	246.18	0.0	-6.73	-3.69	-1.43
10-36-401	0.0	192.82	196.01	203.10	207.71	0.0	-14.89	-11.70	-4.61
10-36-602	0.0	0.0	0.0	0.0	247.80	0.0	0.0	0.0	0.0
10-36-702	0.0	225.14	232.15	238.30	240.67	0.0	-15.53	-8.52	-2.37
10-36-801	201.91	221.86	230.40	232.20	236.40	-34.49	-14.54	-6.00	-4.20
10-41-209	201.06	219.15	225.34	234.19	239.24	-38.18	-20.09	-13.90	-5.05
10-41-301	190.04	208.25	214.27	218.84	220.90	-30.86	-12.65	-6.63	-2.06
10-41-403	0.0	194.49	198.68	200.92	203.40	0.0	-8.91	-4.72	-2.48
10-42-104	0.0	0.0	0.0	208.74	210.52	0.0	0.0	0.0	-1.78
10-42-202	0.0	229.24	237.69	238.92	240.33	0.0	-11.09	-2.64	-1.41
10-42-302	0.0	194.55	205.35	209.57	208.16	0.0	-13.61	-2.81	+1.41
10-42-506	0.0	184.17	190.22	194.85	198.34	0.0	-14.17	-8.12	-3.49
10-43-203	0.0	225.96	232.67	234.46	236.73	0.0	-10.77	-4.06	-2.27
10-44-102	0.0	221.83	226.92	231.37	234.64	0.0	-12.81	-7.72	-3.27
10-44-202	208.12	232.95	238.29	242.72	243.75	-35.63	-10.80	-5.46	-1.03
10-44-203	0.0	232.73	236.95	243.20	247.02	0.0	-14.29	-10.07	-3.82

0.0 - Denotes data not available

ARMSTRONG COUNTY

Well Number	Depth to Water Below Land Surface In Feet					Total Change In Water Levels In Feet			
	1976	1981	1983	1985	1986	1976 to 1986	1981 to 1986	1983 to 1986	1985 to 1986
11-12-401	123.76	127.87	129.10	129.99	130.47	-6.71	-2.60	-1.37	-0.48
11-12-601	113.85	119.47	121.20	120.67	120.65	-6.80	-1.18	+0.55	+0.02
11-12-701	143.29	147.40	149.28	149.38	148.80	-5.51	-1.40	+0.48	+0.58
11-12-702	152.78	157.49	157.51	157.97	156.83	-4.05	+0.66	+0.68	+1.14
11-12-801	148.15	155.97	152.48	152.24	151.96	-3.81	+4.01	+0.52	+0.28
11-12-802	156.80	161.37	162.11	162.51	162.75	-5.95	-1.38	-0.64	-0.24
11-12-803	135.80	143.02	144.94	146.90	146.39	-10.59	-3.37	-1.45	+0.51
11-12-901	129.70	133.95	134.84	135.64	135.85	-6.15	-1.90	-1.01	-0.21
11-13-702	0.0	123.28	124.35	124.97	123.28	0.0	0.00	+1.07	+1.69

0.0 - Denotes data not available

Well Number	1976	1981	1983	1985	1986	1976 to 1986	1981 to 1986	1983 to 1986	1985 to 1986
10-54-701	0.0	93.51	99.51	105.78	109.77	0.0	-16.26	-10.26	-3.99
10-54-801	77.01	87.91	94.87	102.82	108.90	-31.89	-20.99	-14.03	-6.08
10-55-203	183.35	205.44	212.88	217.85	218.66	-35.31	-13.22	-5.78	-0.81
10-55-301	206.25	228.11	233.42	236.02	239.10	-32.85	-10.99	-5.68	-3.08
10-55-404	181.09	201.26	207.67	208.50	208.94	-27.85	-7.68	-1.27	-0.44
10-55-701	93.49	108.41	110.65	116.66	118.53	-25.04	-10.12	-7.88	-1.87
10-55-802	0.0	114.46	122.61	131.59	133.02	0.0	-18.56	-10.41	-1.43
10-55-902	158.48	182.37	192.84	199.25	199.94	-41.46	-17.57	-7.10	-0.69
10-55-904	154.14	175.64	181.79	185.73	185.17	-31.03	-9.53	-3.38	+0.56
10-56-102	213.16	234.28	240.29	245.12	244.33	-31.17	-10.05	-4.04	+0.79
10-56-403	195.11	222.43	233.83	240.48	240.40	-45.29	-17.97	-6.57	+0.08
10-56-404	214.16	234.95	245.88	250.48	252.61	-38.45	-17.66	-6.73	-2.13
10-60-103	140.40	142.49	142.14	142.11	141.18	-0.78	+1.31	+0.96	+0.93
10-60-304	84.05	101.92	107.01	111.79	109.44	-25.39	-7.52	-2.43	+2.35
10-60-401	127.19	124.36	123.43	123.09	121.93	+5.26	+2.43	+1.50	+1.16
10-60-604	0.0	97.05	96.79	96.44	95.28	0.0	+1.77	+1.51	+1.16
10-60-904	135.40	0.0	134.49	134.20	133.28	+2.12	0.0	+1.21	+0.92
10-61-101	85.20	105.35	109.38	116.20	117.11	-31.91	-11.76	-7.73	-0.91
10-61-105	0.0	0.0	0.0	97.20	98.94	0.0	0.0	0.0	-1.74
10-61-201	62.87	73.69	77.34	81.38	82.97	-20.10	-9.28	-5.63	-1.59
10-61-501	144.45	159.57	161.04	165.25	167.14	-22.69	-7.57	-6.10	-1.89
10-61-602	99.19	119.06	123.98	130.75	133.35	-34.16	-14.29	-9.37	-2.60
10-61-701	135.68	148.15	148.55	151.33	150.49	-14.81	-2.34	-1.94	+0.84
10-62-101	59.43	71.85	76.76	83.10	84.74	-25.31	-12.89	-7.98	-1.64
10-62-207	0.0	0.0	130.27	134.35	136.15	0.0	0.0	-5.88	-1.80
10-62-304	0.0	0.0	0.0	103.51	0.0	0.0	0.0	0.0	0.0
10-62-603	0.0	110.89	112.89	116.13	116.23	0.0	-5.34	-3.34	-0.10
10-62-701	134.36	143.94	147.51	152.72	153.84	-19.48	-9.90	-6.33	-1.12
10-63-102	0.0	0.0	98.89	104.19	111.38	0.0	0.0	-12.49	-7.19
10-63-202	0.0	0.0	116.90	124.29	125.28	0.0	0.0	-8.38	-0.99
10-63-306	0.0	0.0	150.09	156.83	158.04	0.0	0.0	-7.95	-1.21
10-63-404	0.0	129.54	132.81	136.68	137.64	0.0	-8.10	-4.83	-0.96
10-63-601	119.15	141.01	143.42	146.73	147.65	-28.50	-6.64	-4.23	-0.92
10-63-702	142.94	151.12	152.09	153.74	154.36	-11.42	-3.24	-2.27	-0.62
10-63-801	0.0	130.32	131.06	132.52	131.00	0.0	-0.68	+0.06	+1.52
10-64-103	0.0	160.79	165.38	170.70	172.24	0.0	-11.45	-6.86	-1.54
10-64-701	128.17	140.18	144.02	149.12	0.0	0.0	0.0	0.0	0.0
24-04-301	49.20	59.00	61.25	63.43	61.02	-11.82	-2.02	+0.23	+2.41
24-05-102	0.0	54.28	54.42	54.55	54.21	0.0	+0.07	+0.21	+0.34
24-05-303	0.0	140.46	145.82	146.79	0.0	0.0	0.0	0.0	0.0
24-05-601	79.80	73.29	72.79	71.85	71.02	+8.78	+2.27	+1.77	+0.83
24-06-101	0.0	136.86	141.16	143.00	143.71	0.0	-6.85	-2.55	-0.71
24-06-201	136.10	142.55	143.38	144.69	143.91	-7.81	-1.36	-0.53	+0.78
24-06-402	86.50	88.24	86.78	87.65	86.82	-0.32	+1.42	-0.04	+0.83
24-06-507	0.0	84.29	83.02	85.10	83.66	0.0	+0.63	-0.64	+1.44
24-06-604	133.64	147.94	148.15	151.69	151.25	-17.61	-3.31	-3.10	+0.44
24-06-902	97.26	103.78	102.63	105.63	104.25	-6.99	-0.47	-1.62	+1.38
24-07-101	0.0	139.84	143.37	144.53	144.69	0.0	-4.85	-1.32	-0.16
24-07-202	156.02	163.58	163.47	164.60	0.0	0.0	0.0	0.0	0.0
24-07-301	137.12	140.83	140.43	141.97	142.42	-5.30	-1.59	-1.99	-0.45
24-07-602	0.0	0.0	0.0	147.84	148.52	0.0	0.0	0.0	-0.68
24-07-701	142.37	146.43	146.41	147.47	147.29	-4.92	-0.86	-0.88	+0.18
24-07-901	118.94	126.16	126.98	128.93	129.26	-10.32	-3.10	-2.28	-0.33
24-08-402	0.0	155.70	156.98	158.25	158.88	0.0	-3.18	-1.90	-0.63
24-08-701	135.84	141.88	143.57	145.67	146.42	-10.58	-4.54	-2.85	-0.75
24-14-301	0.0	57.37	58.06	58.28	0.0	0.0	0.0	0.0	0.0
24-15-201	117.53	120.97	120.78	121.19	120.88	-3.35	+0.09	-0.10	+0.31
24-15-506	79.72	82.54	82.49	81.48	81.65	-1.93	+0.89	+0.84	-0.17
24-15-609	134.45	138.39	140.81	138.36	137.50	-3.05	+0.89	+3.31	+0.86
24-16-101	0.0	166.19	165.41	167.50	167.24	0.0	-1.05	-1.83	+0.26

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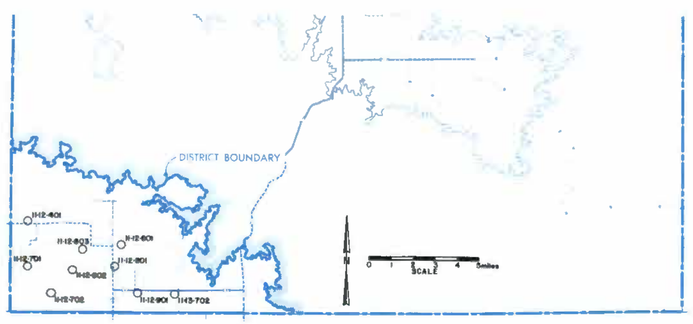

Well Number	1976	1981	1983	1985	1986	1976 to 1986	1981 to 1986	1983 to 1986	1985 to 1986
11-61-801	224.15	242.04	248.80	250.65	253.70	-29.55	-11.66	-4.90	-3.05
11-61-901	0.0	238.99	244.71	244.74	246.70	0.0	-7.71	-1.99	-1.96
11-62-201	144.53	145.47	145.08	144.90	143.79	+0.74	+1.68	+1.29	+1.11
11-62-301	0.0	155.66	155.48	155.83	155.80	0.0	-0.14	-0.32	+0.03
11-62-401	61.59	62.25	63.68	63.95	61.50	+0.09	+0.75	+2.18	+2.45
11-62-601	150.69	151.36	150.70	151.02	150.98	-0.29	+0.38	-0.28	+0.04
11-62-602	156.65	156.25	157.90	156.31	156.47	+0.18	-0.22	+1.43	-0.16
11-62-701	129.97	132.06	132.59	134.72	135.08	-5.11	-3.02	-2.49	-0.36
11-62-702	102.01	108.80	108.80	110.01	108.21	-6.20	+0.59	+0.59	+1.80
11-62-801	110.72	117.20	116.64	115.54	0.0	0.0	0.0	0.0	0.0
11-63-401	0.0	156.98	156.96	157.16	157.59	0.0	-0.61	-0.63	-0.43
11-63-501	234.66	237.88	240.20	238.80	239.39	-4.73	-1.51	+0.81	-0.59
11-63-801	208.98	212.47	212.98	212.53	212.70	-3.72	-0.23	+0.28	-0.17
11-63-901	0.0	247.89	248.12	248.70	251.48	0.0	-3.59	-3.36	-2.78
11-64-101	234.05	251.58	252.30	249.15	249.79	-15.74	+1.79	+2.51	-0.64
11-64-402	227.67	231.42	231.02	231.40	230.61	-2.94	+0.81	+0.41	+0.79
11-64-803	0.0	0.0	0.0	267.70	266.93	0.0	0.0	0.0	+0.77
23-04-301	0.0	199.80	208.08	210.14	211.61	0.0	-11.81	-3.53	-1.47
23-04-504	0.0	0.0	214.15	215.82	216.21	0.0	0.0	-2.06	-0.39
23-04-602	202.51	214.69	222.58	224.30	222.55	-20.04	-7.86	+0.03	+1.75
23-04-603	202.04	215.04	213.39	222.85	221.74	-19.70	-6.70	-8.35	+1.11
23-04-802	195.06	205.89	210.46	213.77	213.75	-18.69	-7.86	-3.29	+0.02
23-05-202	0.0	232.44	239.96	240.40	240.79	0.0	-8.35	-0.83	-0.39
23-05-301	198.72	215.30	216.35	220.19	0.0	0.0	0.0	0.0	0.0
23-05-502	0.0	239.41	241.53	245.82	246.40	0.0	-6.99	-4.87	-0.58
23-05-602	246.22	264.62	267.33	266.63	264.59	-18.37	+0.03	+2.74	+2.04
23-05-603	0.0	262.20	263.97	266.12	266.48	0.0	-4.28	-2.51	-0.36
23-05-701	0.0	220.78	222.67	226.39	225.98	0.0	-5.20	-3.31	+0.41
23-05-802	221.89	240.44	244.98	241.73	242.55	-20.66	-2.11	+2.43	-0.82
23-06-302	0.0	194.88	194.14	194.99	194.50	0.0	+0.38	-0.36	+0.49
23-06-502	251.94	264.22	264.46	265.58	266.28	-14.34	-2.06	-1.82	-0.70
23-06-503	0.0	285.37	285.90	287.09	286.14	0.0	-0.77	-0.24	+0.95
23-06-601	0.0	282.99	280.26	280.29	278.82	0.0	+4.17	+1.44	+1.47
23-06-704	0.0	261.60	263.10	265.72	265.58	0.0	-3.98	-2.48	+0.14
23-07-103	247.67	268.27	263.90	260.70	261.02	-13.35	+7.25	+2.88	-0.32
23-07-202	0.0	290.79	281.19	287.95	287.66	0.0	+3.13	-6.47	+0.29
23-07-401	291.28	295.69	295.40	297.34	296.28	-5.00	-0.59	-0.88	+1.06
23-07-501	292.72	297.69	296.80	298.48	296.35	-3.63	+1.34	+0.45	+2.13
23-07-601	298.24	303.19	302.67	302.41	302.32	-4.08	+0.87	+0.35	+0.09
23-07-702	0.0	211.63	211.17	212.45	213.55	0.0	-1.92	-2.38	-1.10
23-07-801	236.49	238.30	238.12	238.85	239.11	-2.62	-0.81	-0.99	-0.26
23-07-901	0.0	286.54	283.05	286.80	285.34	0.0	+1.20	-2.29	+1.46
23-08-201	268.69	274.29	277.22	278.40	276.55	-7.86	-2.26	+0.67	+1.85
23-08-401	293.26	293.47	292.37	293.15	293.44	-0.18	+0.03	-1.07	-0.29
23-08-502	273.59	279.47	277.84	279.60	278.37	-4.78	+1.10	-0.53	+1.23
23-08-701	281.86	287.79	291.86	289.59	289.64	-7.78	-1.85	+2.22	-0.05
23-12-301	207.88	216.04	217.95	220.40	220.29	-12.41	-4.25	-2.34	+0.11
23-13-101	197.99	210.63	212.45	213.05	215.03	-17.04	-4.40	-2.58	-1.98
23-13-302	234.63	257.69	258.14	259.69	0.0	0.0	0.0	0.0	0.0
23-13-303	0.0	240.55	238.67	241.81	240.60	0.0	-0.05	-1.93	+1.21
23-14-101	254.48	266.33	264.94	265.94	264.50	-10.02	+1.83	+0.44	+1.44
23-14-301	245.99	252.36	252.69	254.70	253.81	-7.82	-1.45	-1.12	+0.89
23-15-203	0.0	0.0	0.0	305.93	303.19	0.0	0.0	0.0	+2.74
23-15-302	301.21	307.02	308.03	311.84	307.36	-6.15	-0.34	+0.67	+4.48
23-16-101	0.0	320.44	321.96	320.55	319.63	0.0	+0.81	+2.33	+0.92
23-16-201	0.0	307.15	0.0	306.20	307.31	0.0	-0.16	0.0	-1.11

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"Don't Pray For Rain
If You Don't Take
Care Of What You Get."
R.E. Dixon — 19[illegible]

10-49-202	0.0	0.0	72.70	74.95	75.39	0.0	0.0	−2.69	−0.44
10-49-303	52.16	72.20	77.62	84.19	85.02	−32.86	−12.82	−7.40	−0.83
10-49-501	0.0	54.81	55.88	62.18	57.10	0.0	−2.29	−1.22	+5.08
10-49-602	61.00	74.82	84.32	89.90	91.12	−30.12	−16.30	−6.80	−1.22
10-49-603	0.0	64.59	66.90	68.09	69.11	0.0	−4.52	−2.21	−1.02
10-49-801	78.73	82.35	81.85	83.00	85.25	−6.52	−2.90	−3.40	−2.25
10-49-803	0.0	0.0	105.39	106.20	105.79	0.0	0.0	−0.40	+0.41
10-50-104	0.0	107.97	114.72	123.63	123.90	0.0	−15.93	−9.18	−0.27
10-50-505	81.78	105.19	108.07	111.00	112.62	−30.84	−7.43	−4.55	−1.62
10-50-602	0.0	79.59	81.85	81.58	82.01	0.0	−2.42	−0.16	−0.43
10-50-702	94.80	109.14	111.25	109.08	0.0	0.0	0.0	0.0	0.0
10-50-801	70.75	69.82	0.0	69.60	68.81	+1.94	+1.01	0.0	+0.79
10-50-901	0.0	72.00	73.80	76.69	76.50	0.0	−4.50	−2.70	+0.19
10-51-101	84.65	99.65	100.89	103.80	0.0	0.0	0.0	0.0	0.0
10-51-105	72.69	88.39	90.16	89.93	91.34	−18.65	−2.95	−1.18	−1.41
10-51-311	0.0	103.89	102.70	104.29	104.59	0.0	−0.70	−1.89	−0.30
10-51-403	49.00	70.25	71.01	72.35	75.06	−26.06	−4.81	−4.05	−2.71
10-51-406	0.0	0.0	69.26	70.14	72.00	0.0	0.0	−2.74	−1.86
10-51-501	58.65	78.20	83.94	88.65	89.12	−30.47	−10.92	−5.18	−0.47
10-51-507	0.0	77.02	81.98	84.81	85.60	0.0	−8.58	−3.62	−0.79
10-51-602	66.58	0.0	93.82	97.69	98.64	−32.06	0.0	−4.82	−0.95
10-51-609	0.0	0.0	0.0	0.0	113.66	0.0	0.0	0.0	0.0
10-51-703	96.32	100.82	102.02	104.90	104.13	−7.81	−3.31	−2.11	+0.77
10-51-704	0.0	0.0	0.0	0.0	84.92	0.0	0.0	0.0	0.0
10-51-808	0.0	0.0	0.0	0.0	100.67	0.0	0.0	0.0	0.0
10-51-908	0.0	109.30	112.09	113.75	114.60	0.0	−5.30	−2.51	−0.85
10-51-909	0.0	0.0	0.0	0.0	124.17	0.0	0.0	0.0	0.0
10-51-910	0.0	0.0	0.0	0.0	119.51	0.0	0.0	0.0	0.0
10-51-911	0.0	0.0	0.0	0.0	128.00	0.0	0.0	0.0	0.0
10-52-408	78.06	99.09	101.45	103.94	105.36	−27.30	−6.27	−3.91	−1.42
10-57-103	79.80	86.04	81.99	81.92	83.10	−3.30	+2.94	−1.11	−1.18
10-57-401	109.06	114.35	111.61	111.36	112.00	−2.94	+2.35	−0.39	−0.64
10-57-501	40.22	39.36	38.48	41.44	42.38	−2.16	−3.02	−3.90	−0.94
10-58-201	0.0	32.65	30.57	30.89	28.61	0.0	+4.04	+1.96	+2.28
10-58-502	70.36	69.55	68.08	67.37	66.88	+3.48	+2.67	+1.20	+0.49
10-58-601	0.0	74.76	73.89	74.50	74.39	0.0	+0.37	−0.50	+0.11
10-58-701	47.89	46.38	44.61	46.60	46.67	+1.22	−0.29	−2.06	−0.07
10-58-801	25.00	27.08	25.91	26.90	25.52	−0.52	+1.56	+0.39	+1.38
10-59-106	112.51	111.91	113.27	113.97	113.96	−1.45	−2.05	−0.69	+0.01
10-59-107	0.0	99.55	101.18	101.00	101.51	0.0	−1.96	−0.33	−0.51
10-59-302	111.13	113.08	113.38	114.30	113.74	−2.61	−0.66	−0.36	+0.56
10-59-401	116.24	117.19	117.85	117.90	117.21	−0.97	−0.0	+0.64	+0.69
10-59-501	98.38	96.40	95.53	95.40	95.36	+3.02	+1.04	+0.17	+0.04
10-59-601	135.00	134.18	133.49	132.10	131.19	+3.81	+2.99	+2.30	+0.91
24-02-701	55.81	49.42	49.45	48.73	48.14	+7.67	+1.28	+1.31	+0.59
24-09-101	0.0	168.75	167.38	166.10	164.23	0.0	+4.52	+3.15	+1.87
24-09-302	0.0	87.10	86.34	86.15	86.40	0.0	+0.70	−0.06	−0.25
24-10-201	110.29	117.05	114.56	113.25	111.56	−1.27	+5.49	+3.00	+1.69
24-10-303	135.03	137.22	126.34	121.90	116.34	+18.69	+20.88	+10.00	+5.56
24-11-201	102.22	102.36	101.05	96.00	93.92	+8.30	+8.44	+7.13	+2.08
24-11-202	0.0	85.04	84.82	85.20	84.90	0.0	+0.14	−0.08	+0.30

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10-30-802	212.32	238.08	245.10	255.09	253.68	−41.36	−15.60	−8.58	+1.41
10-31-201	182.44	191.61	194.47	196.60	201.19	−18.75	−9.58	−6.72	−4.59
10-31-301	184.48	187.72	0.0	188.38	0.0	0.0	0.0	0.0	0.0
10-31-501	217.59	224.29	227.10	228.79	228.76	−11.17	−4.47	−1.66	+0.03
10-31-601	171.37	183.75	187.69	190.60	191.64	−20.27	−7.89	−3.95	−1.04
10-31-701	253.32	269.64	267.85	263.00	263.11	−9.79	+6.53	+4.74	−0.11
10-31-803	0.0	255.44	263.70	270.18	271.65	0.0	−16.21	−7.95	−1.47
10-32-201	177.14	177.58	177.64	178.88	178.26	−1.12	−0.68	−0.62	+0.62
10-32-301	0.0	185.30	178.44	177.34	176.89	0.0	+8.41	+1.55	+0.45
10-32-501	138.25	143.66	143.62	144.53	145.20	−6.95	−1.54	−1.58	−0.67
10-32-601	0.0	130.06	130.26	133.93	0.0	0.0	0.0	0.0	0.0
10-32-703	0.0	264.16	266.52	270.00	269.53	0.0	−5.37	−3.01	+0.47
10-32-801	215.86	217.83	217.44	217.98	218.60	−2.74	−0.77	−1.16	−0.62
10-36-301	0.0	218.80	224.69	229.23	230.13	0.0	−11.33	−5.44	−0.90
10-37-301	0.0	204.90	207.78	214.35	215.12	0.0	−10.22	−7.34	−0.77
10-37-403	0.0	0.0	0.0	206.00	206.67	0.0	0.0	0.0	−0.67
10-37-501	0.0	191.37	197.20	203.07	204.43	0.0	−13.06	−7.23	−1.36
10-37-601	161.77	184.46	189.20	194.55	195.93	−34.16	−11.47	−6.73	−1.38
10-37-801	0.0	180.71	186.62	191.75	193.80	0.0	−13.09	−7.18	−2.05
10-37-901	160.50	179.45	185.93	191.45	193.58	−33.08	−14.13	−7.65	−2.13
10-38-101	0.0	205.21	210.01	213.12	217.67	0.0	−12.46	−7.66	−4.55
10-38-201	0.0	192.17	200.63	207.34	208.50	0.0	−16.33	−7.87	−1.16
10-38-401	0.0	197.42	202.98	207.22	209.57	0.0	−12.15	−6.59	−2.35
10-38-603	166.42	186.82	195.14	201.55	201.20	−34.78	−14.38	−6.06	+0.35
10-38-802	168.24	190.28	197.49	202.49	203.59	−35.35	−13.31	−6.10	−1.10
10-39-101	210.87	230.66	238.82	243.99	244.19	−33.32	−13.53	−5.37	−0.20
10-39-201	0.0	255.34	271.85	267.08	268.49	0.0	−13.15	+3.36	−1.41
10-39-302	0.0	262.60	269.37	276.65	0.0	0.0	0.0	0.0	0.0
10-39-402	0.0	0.0	0.0	217.37	219.30	0.0	0.0	0.0	−1.93
10-39-501	0.0	209.29	214.47	218.74	220.00	0.0	−10.71	−5.53	−1.26
10-39-702	156.30	175.59	180.60	185.96	187.86	−31.56	−12.27	−7.26	−1.90
10-39-801	171.38	190.80	195.04	201.22	201.77	−30.39	−10.97	−6.73	−0.55
10-39-901	0.0	183.41	190.09	197.53	197.36	0.0	−13.95	−7.27	+0.17
10-40-301	0.0	169.36	172.20	173.96	173.46	0.0	−4.10	−1.26	+0.50
10-40-402	0.0	217.20	226.02	230.98	231.08	0.0	−13.88	−5.06	−0.10
10-40-502	224.28	242.75	251.34	259.18	260.92	−36.64	−18.17	−9.58	−1.74
10-40-601	0.0	232.34	238.50	243.02	244.60	0.0	−12.26	−6.10	−1.58
10-40-803	196.25	219.59	227.15	234.40	235.08	−38.83	−15.49	−7.93	−0.68
10-44-601	0.0	184.66	196.14	202.45	203.45	0.0	−18.79	−7.31	−1.00
10-45-102	174.74	193.69	199.26	205.73	206.45	−31.71	−12.76	−7.19	−0.72
10-45-301	182.10	200.76	208.50	214.14	0.0	0.0	0.0	0.0	0.0
10-46-101	160.54	179.56	187.58	0.0	204.37	−43.83	−24.81	−16.79	0.0
10-46-302	0.0	171.35	176.69	182.95	184.54	0.0	−13.19	−7.85	−1.59
10-46-303	0.0	0.0	0.0	192.09	191.77	0.0	0.0	0.0	+0.32
10-46-405	183.52	201.72	0.0	209.67	0.0	0.0	0.0	0.0	0.0
10-47-101	0.0	166.15	174.01	179.41	181.58	0.0	−15.43	−7.57	−2.17
10-47-201	183.49	201.82	207.85	213.17	214.77	−31.28	−12.95	−6.92	−1.60
10-47-302	0.0	188.47	193.65	199.93	201.55	0.0	−13.08	−7.90	−1.62
10-48-103	0.0	0.0	194.39	196.35	198.04	0.0	0.0	−3.65	−1.69
10-48-302	0.0	183.67	190.53	198.13	198.02	0.0	−14.35	−7.49	+0.11
10-48-303	0.0	202.14	209.76	215.03	215.60	0.0	−13.46	−5.84	−0.57
10-48-603	164.09	189.65	196.94	202.35	202.42	−38.33	−12.77	−5.48	−0.07

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24-23-102	0.0	113.43	113.29	113.52	112.87	0.0	+0.56	+0.42	+0.65
24-23-302	118.14	117.86	119.60	118.86	119.50	−1.36	−1.64	+0.10	−0.64
24-23-304	0.0	127.22	127.03	127.34	126.63	0.0	+0.59	+0.40	+0.71
24-23-501	106.45	108.99	112.15	107.17	106.74	−0.29	+2.25	+5.41	+0.43
24-23-701	105.94	108.69	108.62	109.98	109.50	−3.56	−0.81	−0.88	+0.48
24-24-402	155.41	158.74	157.45	157.07	156.82	−1.41	+1.92	+0.63	+0.25
24-24-701	125.50	125.27	124.98	124.51	124.18	+1.32	+1.09	+0.80	+0.33
24-28-103	141.27	144.54	141.25	143.54	139.01	+2.26	+5.53	+2.24	+4.53
24-28-203	0.0	141.98	144.60	145.30	145.21	0.0	−3.23	−0.61	+0.09
24-28-303	0.0	0.0	122.86	122.80	123.10	0.0	0.0	−0.24	−0.30
24-28-501	150.89	155.89	154.87	156.46	155.36	−4.47	+0.53	−0.49	+1.10
24-28-601	0.0	141.74	139.39	138.58	137.85	0.0	+3.89	+1.54	+0.73
24-28-901	166.13	172.27	168.90	169.82	169.08	−2.95	+3.19	−0.18	+0.74
24-29-308	148.67	154.15	153.73	155.07	154.81	−6.14	−0.66	−1.08	+0.26
24-29-312	0.0	139.00	138.96	139.76	140.03	0.0	−1.03	−1.07	−0.27
24-29-401	140.45	142.60	141.23	141.98	141.35	−0.90	+1.25	−0.12	+0.63
24-29-603	0.0	135.76	135.13	134.25	134.17	0.0	+1.59	+0.96	+0.08
24-29-901	196.04	194.08	187.99	188.89	186.68	+9.36	+7.40	+1.31	+2.21
24-30-10[illegible]	139.79	139.5[illegible]	138.4[illegible]	136.76	136.0[illegible]	+3.7[illegible]	+3.54	−2.46	+0.73
24-30-304	107.93	110.74	110.02	109.28	108.80	−0.87	+1.94	+1.22	+0.48
24-30-409	0.0	0.0	0.0	108.07	108.58	0.0	0.0	0.0	−0.51
24-30-502	0.0	136.62	133.60	134.34	132.98	0.0	+3.64	+0.62	+1.36
24-30-801	175.65	179.39	178.79	179.77	179.16	−3.51	+0.23	−0.37	+0.61
24-30-901	157.82	159.19	157.74	157.75	156.56	+1.26	+2.63	+1.18	+1.19
24-31-101	0.0	71.23	69.20	71.49	70.55	0.0	+0.68	−1.35	+0.94
24-31-203	0.0	105.20	0.0	104.15	104.16	0.0	+1.04	0.0	−0.01
24-31-401	132.00	135.08	128.39	129.37	127.42	+4.58	+7.66	+0.97	+1.95
24-31-501	76.86	80.14	77.91	76.79	76.00	+0.86	+4.14	+1.91	+0.79
24-31-601	116.72	117.63	115.15	113.79	112.52	+4.20	+5.11	+2.63	+1.27
24-31-801	147.67	150.33	149.87	148.52	148.41	−0.74	+1.92	+1.46	+0.11
24-31-902	0.0	127.16	125.27	124.20	123.40	0.0	+3.76	+1.87	+0.80
24-32-401	104.14	106.46	101.34	100.38	99.05	+5.09	+7.41	+2.29	+1.33
24-32-702	0.0	0.0	129.20	128.36	127.44	0.0	0.0	+1.76	+0.92
24-36-302	0.0	174.12	173.67	174.76	174.60	0.0	−0.48	−0.93	+0.16
24-36-601	146.89	149.54	148.15	147.95	147.96	−1.07	+1.58	+0.19	−0.01
24-37-101	153.92	157.24	158.94	157.87	158.03	−4.11	−0.79	+0.91	−0.16
24-37-204	152.90	156.10	155.14	155.48	155.41	−2.51	+0.69	−0.27	+0.07
24-37-308	147.10	147.89	147.62	149.23	148.99	−1.89	−1.10	−1.37	+0.24
24-37-502	0.0	0.0	0.0	142.74	143.34	0.0	0.0	0.0	−0.60
24-38-201	174.20	177.44	175.89	177.34	177.75	−3.55	−0.31	−1.86	−0.41
24-38-403	163.61	167.13	166.25	166.64	165.69	−2.08	+1.44	+0.56	+0.95
24-38-501	0.0	0.0	0.0	162.19	161.79	0.0	0.0	0.0	+0.40
24-38-602	0.0	123.29	120.64	120.63	121.43	0.0	+1.86	−0.79	−0.80
24-38-801	164.93	163.99	160.85	161.09	159.69	+5.24	+4.30	+1.16	+1.40
24-39-101	156.08	156.43	152.64	152.41	150.49	+5.59	+5.94	+2.15	+1.92
24-39-302	148.72	150.65	148.45	149.46	148.60	+0.12	+2.05	−0.15	+0.86
24-39-501	135.39	135.10	134.10	133.59	133.10	+2.29	+2.00	+1.00	+0.49
24-39-701	114.84	117.36	105.72	107.49	106.14	+8.70	+11.22	−0.42	+1.35
24-39-901	95.11	97.76	95.94	94.96	94.00	+1.11	+3.76	+1.94	+0.96
24-40-401	143.24	146.26	146.59	145.65	145.10	−1.86	+1.16	+1.49	+0.55
24-40-403	148.09	151.33	149.98	149.36	149.40	−1.31	+1.93	+0.58	−0.04
24-40-702	0.0	114.00	113.02	112.60	111.41	0.0	+2.59	+1.61	+1.19

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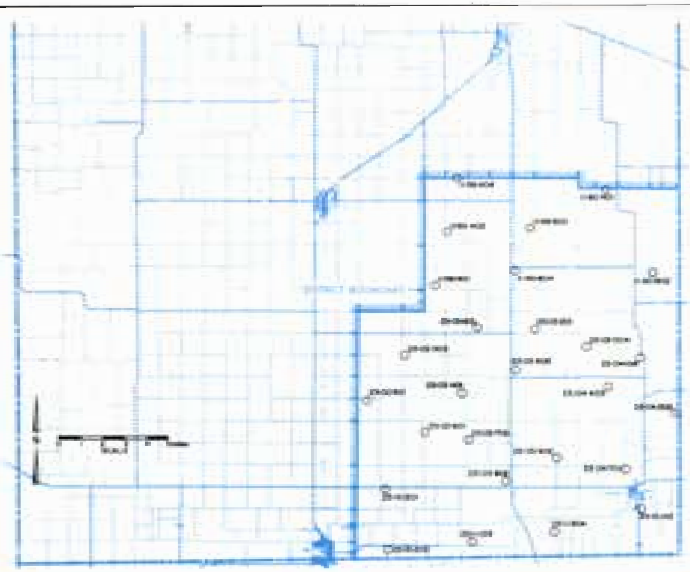

HALE COUNTY

Well Number	Depth to Water Below Land Surface In Feet					Total Change In Water Levels In Feet			
	1976	1981	1983	1985	1986	1976 to 1986	1981 to 1986	1983 to 1986	1985 to 1986
11-58-901	0.0	103.57	104.01	0.0	99.15	0.0	+4.42	+4.86	0.0
11-59-402	79.77	94.14	92.14	88.02	0.0	0.0	0.0	0.0	0.0
11-59-404	0.0	184.83	191.03	195.92	196.40	0.0	−11.57	−5.37	−0.48
11-59-503	82.82	85.60	85.06	85.93	80.80	+2.02	+4.80	+4.26	+5.13
11-59-804	0.0	0.0	105.48	104.54	105.03	0.0	0.0	+0.45	−0.49
11-60-401	94.96	95.82	97.83	100.71	101.07	−6.11	−5.25	−3.24	−0.36
11-60-802	0.0	0.0	185.30	181.58	179.49	0.0	0.0	+5.81	+2.09
23-02-302	108.59	112.30	114.42	113.81	113.64	−5.05	−1.34	+0.78	+0.17
23-02-501	183.65	200.95	205.97	209.82	209.31	−25.66	−8.36	−3.34	+0.51
23-02-901	0.0	188.15	192.60	192.98	193.67	0.0	−5.52	−1.07	−0.69
23-03-103	111.77	117.62	118.66	117.35	114.99	−3.22	+2.63	+3.67	+2.36
23-03-201	0.0	136.57	137.80	133.58	133.14	0.0	+3.43	+4.66	+0.44
23-03-304	0.0	134.62	134.80	134.53	133.30	0.0	+1.32	+1.50	+1.23
23-03-401	0.0	106.04	108.99	108.18	108.30	0.0	−2.26	+0.69	−0.12

Well Number	Depth to Water Below Land Surface In Feet					Total Change In Water Levels In Feet			
	1976	1981	1983	1985	1986	1976 to 1986	1981 to 1986	1983 to 1986	1985 to 1986
23-03-505	0.0	0.0	126.02	125.34	123.74	0.0	0.0	+2.28	+1.60
23-03-702	0.0	177.27	187.51	190.30	194.70	0.0	−17.43	−7.19	−4.40
23-03-802	181.44	196.25	202.09	205.22	206.88	−25.44	−10.63	−4.79	−1.66
23-03-902	0.0	183.20	184.10	189.27	188.80	0.0	−5.60	−4.70	+0.47
23-04-106	0.0	207.76	208.83	209.70	209.01	0.0	−1.25	−0.18	+0.69
23-04-403	0.0	155.65	159.05	0.0	161.79	0.0	−6.14	−2.74	0.0
23-04-502	201.50	211.91	215.04	217.96	218.10	−16.60	−6.19	−3.06	−0.14
23-04-701	156.49	160.75	163.08	161.80	161.84	−5.35	−1.09	+1.24	−0.04
23-10-201	166.91	167.32	165.46	167.50	169.69	−2.78	−2.37	−4.23	−2.19
23-10-203	0.0	167.10	169.96	174.85	169.36	0.0	−2.26	+0.60	+5.49
23-11-103	0.0	0.0	216.10	216.75	217.65	0.0	0.0	−1.55	−0.90
23-11-304	183.13	198.15	205.90	208.12	209.85	−26.72	−11.70	−3.95	−1.73
23-12-102	188.92	200.25	204.04	206.19	206.40	−17.48	−6.15	−2.36	−0.21

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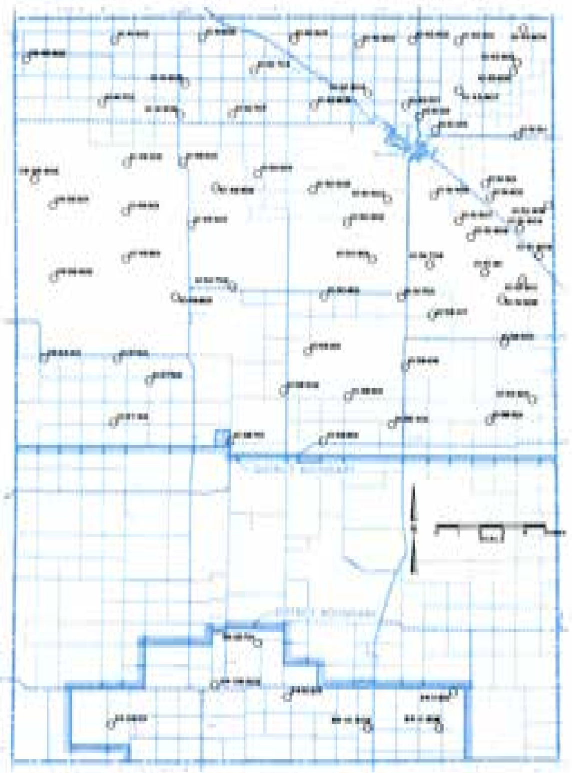
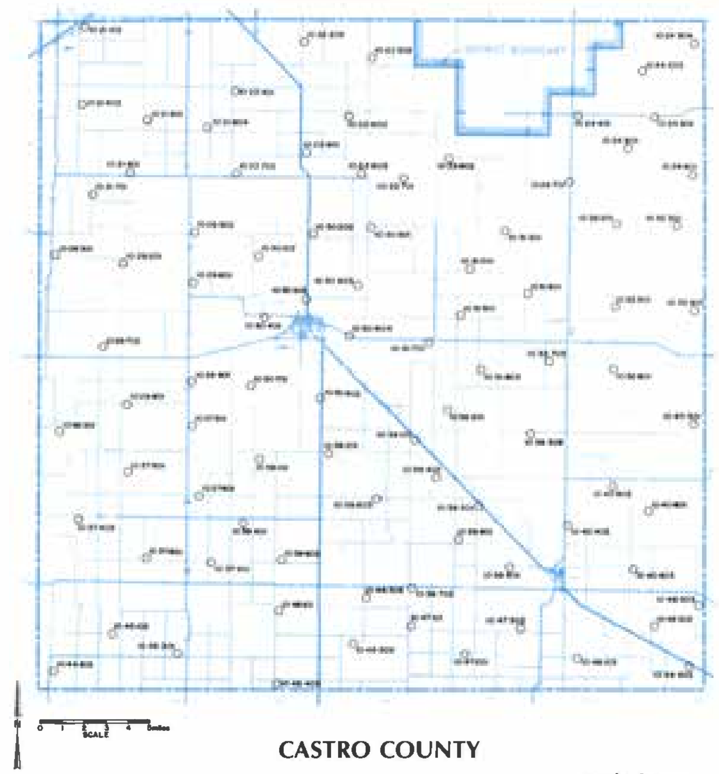
Water-Level Observation Well Measurements Tabulated



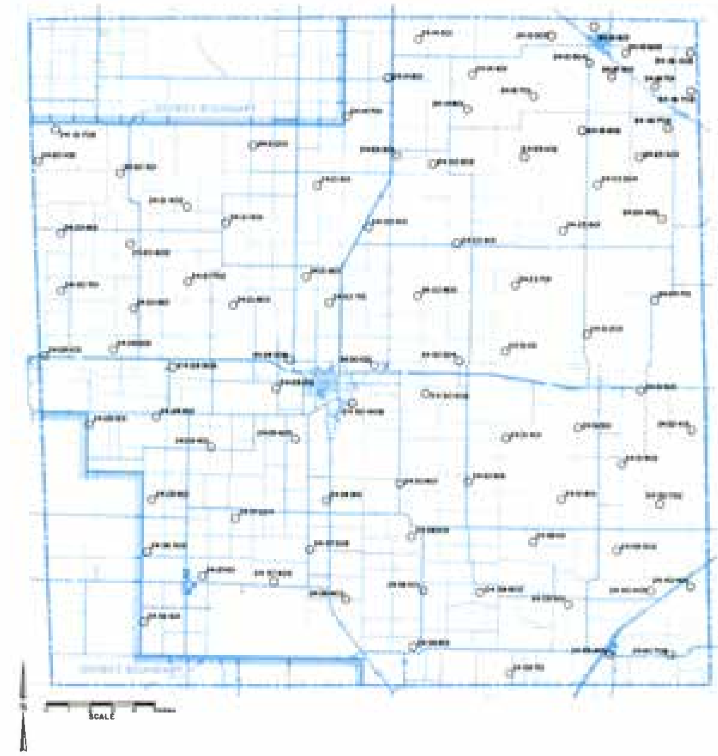
BAILEY COUNTY

Well Number	Depth to Water Below Land Surface In Feet 1976	1981	1983	1985	1986	Total Change In Water Levels In Feet 1976 to 1986	1981 to 1986	1983 to 1986	1985 to 1986
09-48-902	146.59	160.30	164.58	166.80	168.09	−21.50	−7.79	−3.51	−1.29
09-56-601	0.0	41.40	43.14	48.85	44.04	0.0	−2.64	−0.90	+4.81
09-56-602	0.0	0.0	0.0	0.0	64.60	0.0	0.0	0.0	0.0
09-56-902	42.71	44.20	45.29	46.35	46.98	−4.27	−2.78	−1.69	−0.63
09-64-301	60.44	75.10	74.47	68.35	67.00	−6.56	+8.10	+7.47	+1.35
10-41-402	161.69	172.75	176.03	177.27	177.64	−15.95	−4.89	−1.61	−0.37
10-41-602	0.0	0.0	0.0	168.64	170.73	0.0	0.0	0.0	−2.09
10-41-702	101.38	116.92	120.97	122.47	123.80	−22.42	−6.88	−2.83	−1.33
10-41-905	115.88	132.25	134.90	135.56	134.87	−18.99	−2.62	+0.03	+0.69
10-41-906	0.0	105.31	109.25	110.75	111.84	0.0	−6.53	−2.59	−1.09
10-42-505	129.69	147.70	154.18	157.59	161.45	−31.76	−13.75	−7.27	−3.86
10-42-602	0.0	143.02	147.93	151.61	152.15	0.0	−9.13	−4.22	−0.54
10-42-704	122.07	133.44	140.61	139.43	139.86	−17.79	−6.42	+0.75	−0.43
10-42-707	98.66	110.54	113.87	111.94	113.11	−14.45	−2.57	+0.76	−1.17
10-42-808	90.72	102.60	105.27	105.72	105.97	−15.25	−3.37	−0.70	−0.25
10-42-904	0.0	111.19	0.0	114.96	115.87	0.0	−4.68	0.0	−0.91
10-43-402	0.0	150.43	155.17	159.05	158.31	0.0	−7.88	−3.14	+0.74
10-43-501	0.0	140.85	146.08	153.10	154.15	0.0	−13.30	−8.07	−1.05
10-43-604	0.0	165.15	171.97	176.20	177.34	0.0	−12.19	−5.37	−1.14
10-43-707	96.68	114.28	116.09	117.48	117.77	−21.09	−3.49	−1.68	−0.29
10-43-807	0.0	0.0	114.23	118.46	117.34	0.0	0.0	−3.11	+1.12
10-43-903	113.38	132.64	137.18	140.40	140.87	−27.49	−8.23	−3.69	−0.47
10-43-905	101.65	119.27	123.32	126.27	126.69	−25.04	−7.42	3.37	−0.42



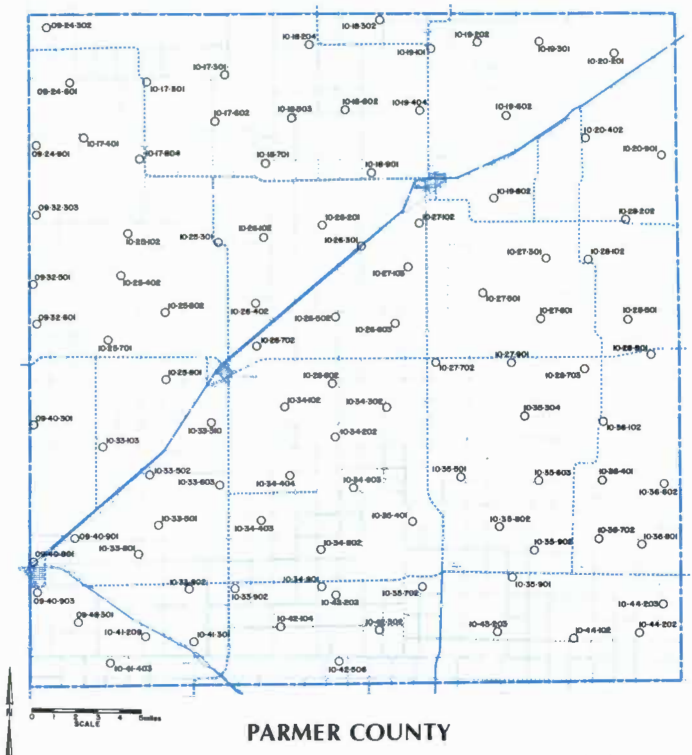
CASTRO COUNTY

Well Number	Depth to Water Below Land Surface In Feet 1976	1981	1983	1985	1986	Total Change In Water Levels In Feet 1976 to 1986	1981 to 1986	1983 to 1986	1985 to 1986
10-21-102	0.0	235.26	234.64	237.52	236.25	0.0	−0.99	−1.61	+1.27
10-21-402	171.10	194.89	198.79	205.30	207.80	−36.70	−12.91	−9.01	−2.50
10-21-501	161.67	179.55	184.40	187.50	187.65	−25.98	−8.10	−3.25	−0.15
10-21-604	146.93	161.68	163.32	167.00	167.71	−20.78	−6.03	−4.39	−0.71
10-21-701	228.04	242.90	242.74	243.33	244.13	−16.09	−1.23	−1.39	−0.80
10-21-801	211.80	232.07	235.40	240.30	243.00	−31.20	−10.93	−7.60	−2.70
10-22-203	173.48	183.38	185.45	191.05	193.24	−19.76	−9.86	−7.79	−2.19
10-22-302	107.05	109.18	107.74	108.60	107.48	−0.43	+1.70	+0.26	+1.12
10-22-401	153.62	172.39	176.92	0.0	0.0	0.0	0.0	0.0	0.0
10-22-602	0.0	84.47	84.05	86.38	86.09	0.0	−1.62	−2.04	+0.29
10-22-702	167.40	191.85	192.67	194.97	195.56	−28.16	−3.71	−2.89	−0.59
10-22-801	162.50	176.98	0.0	183.43	184.00	−21.50	−7.02	0.0	−0.57
10-22-903	148.56	153.29	152.10	153.70	153.82	−5.26	−0.53	−1.72	−0.12
10-23-701	122.20	117.27	113.43	116.75	113.35	+8.85	+3.92	+0.08	+3.40
10-23-802	0.0	143.23	139.92	140.37	140.20	0.0	+3.03	−0.28	+0.17
10-24-202	176.52	176.86	177.18	177.65	177.83	−1.31	−0.97	−0.65	−0.18
10-24-304	0.0	164.48	165.06	165.52	165.61	0.0	−1.13	−0.55	−0.09
10-24-401	192.75	192.12	191.61	191.36	191.05	+1.70	+1.07	+0.56	+0.31
10-24-601	161.89	161.90	161.48	161.95	161.94	−0.05	−0.04	−0.46	+0.01
10-24-701	190.51	190.07	189.67	189.03	188.64	+1.87	+1.43	+1.03	+0.39
10-24-801	185.76	186.27	186.15	185.94	185.45	+0.31	+0.82	+0.70	+0.49
10-24-901	0.0	200.04	199.81	199.48	199.20	0.0	+0.84	+0.61	+0.28
10-28-301	0.0	300.98	305.86	309.90	311.23	0.0	−10.25	−5.37	−1.33
10-29-201	0.0	259.68	270.43	276.57	281.27	0.0	−21.59	−10.84	−4.70
10-29-302	279.74	297.84	298.65	300.73	301.35	−21.61	−3.51	−2.70	−0.62
10-29-601	266.10	285.00	285.86	287.00	287.47	−21.37	−2.47	−1.61	−0.47
10-29-702	0.0	318.83	325.86	332.35	334.20	0.0	−15.37	−8.34	−1.85
10-29-801	220.25	244.06	251.03	256.60	258.92	−38.67	−14.86	−7.89	−2.32
10-29-901	239.00	253.94	257.02	263.40	266.32	−27.32	−12.38	−9.30	−2.92
10-30-102	256.12	273.01	273.72	276.62	277.06	−20.94	−4.05	−3.34	−0.44
10-30-202	241.39	259.04	258.50	260.75	261.33	−19.94	−2.29	−2.83	−0.58
10-30-301	0.0	172.52	173.06	174.65	174.66	0.0	−2.14	−1.60	−0.01
10-30-401	0.0	285.80	288.90	292.00	292.79	0.0	−6.99	−3.89	−0.79
10-30-505	235.24	242.37	245.61	246.94	247.52	−12.28	−5.15	−1.91	−0.58
10-30-603	211.66	219.46	218.78	220.71	219.77	−8.11	−0.31	−0.99	+0.94
10-30-604	260.68	273.48	276.96	278.30	278.64	−17.96	−5.16	−1.68	−0.34
10-30-701	0.0	242.88	246.83	254.72	255.59	0.0	−12.71	−8.76	−0.87



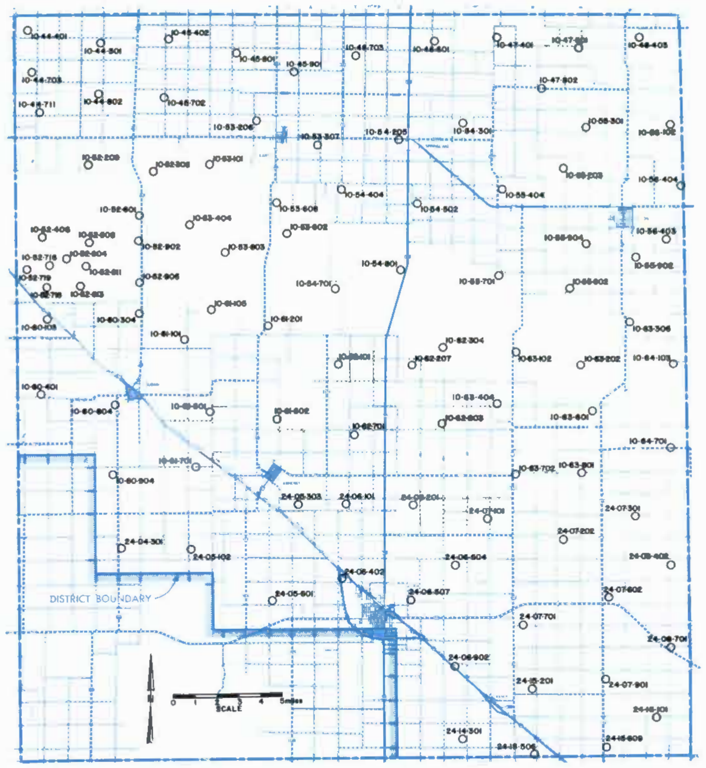
HOCKLEY COUNTY

Well Number	Depth to Water Below Land Surface In Feet 1976	1981	1983	1985	1986	Total Change In Water Levels In Feet 1976 to 1986	1981 to 1986	1983 to 1986	1985 to 1986
24-12-705	0.0	142.93	140.94	141.82	141.19	0.0	+1.74	−0.25	+0.63
24-14-501	104.46	104.45	101.17	101.02	99.06	+5.40	+5.39	+2.11	+1.96
24-14-601	0.0	132.57	129.83	130.26	128.49	0.0	+4.08	+1.34	+1.77
24-14-701	0.0	44.39	44.74	46.23	43.03	0.0	+1.36	+1.71	+3.20
24-14-801	49.30	52.23	51.45	52.47	46.08	+3.22	+6.15	+5.37	+6.39
24-14-901	97.61	100.29	100.31	99.94	99.88	−2.27	+0.41	+0.43	+0.06
24-15-504	66.82	71.50	71.39	71.48	70.28	−3.46	+1.22	+1.11	+1.20
24-15-507	79.63	83.61	86.02	83.41	82.93	−3.30	+0.68	+3.09	+0.48
24-15-601	108.15	113.14	115.90	113.44	113.22	−5.07	−0.08	+2.68	+0.22
24-15-605	99.35	102.20	102.29	103.24	103.15	−3.80	−0.95	−0.86	+0.09
24-15-701	0.0	102.68	102.15	101.50	100.71	0.0	+1.97	+1.44	+0.79
24-15-802	179.68	183.28	181.30	179.30	177.73	+1.95	+5.55	+3.57	+1.57
24-15-901	44.65	52.34	53.03	55.98	53.61	−8.96	−1.27	−0.58	+2.37
24-16-405	131.54	133.39	134.51	135.13	134.25	−2.71	−0.86	+0.26	+0.88
24-16-701	67.02	72.64	74.47	75.84	75.68	−8.66	−3.04	−1.21	+0.16
24-16-702	98.98	102.02	102.75	103.10	102.31	−3.33	−0.29	+0.44	+0.79
24-16-705	0.0	95.12	94.24	93.10	92.61	0.0	+2.51	+1.63	+0.49
24-20-102	149.71	152.16	150.32	151.29	150.79	−1.08	+1.37	−0.47	+0.50
24-20-301	137.85	139.20	137.28	140.25	140.29	−2.44	−1.09	−3.01	−0.04
24-20-401	121.16	128.06	129.79	132.46	133.60	−12.44	−5.54	−3.81	−1.14
24-20-602	151.47	156.87	156.25	158.34	158.90	−7.43	−2.03	−2.65	−0.56
24-20-701	147.26	149.86	150.85	151.35	151.73	−4.47	−1.87	−0.88	−0.38
24-20-901	147.97	153.35	153.08	155.29	155.20	−7.23	−1.85	−2.12	+0.09
24-21-201	42.78	46.26	45.46	46.95	46.14	−3.36	+0.12	−0.68	+0.81
24-21-301	94.38	94.37	95.69	94.44	94.32	+0.06	+0.05	+1.37	+0.12
24-21-401	153.78	157.71	156.24	156.65	156.27	−2.49	+1.44	−0.03	+0.38
24-21-402	0.0	141.25	140.10	140.99	140.37	0.0	+0.88	+0.27	+0.62
24-21-702	0.0	151.58	149.53	151.20	150.70	0.0	+0.88	−1.17	+0.50
24-21-803	167.05	170.26	169.84	170.47	170.15	−3.10	+0.11	−0.31	+0.32
24-21-901	163.78	168.04	169.65	170.12	170.57	−6.79	−2.53	−0.92	−0.45
24-22-201	71.32	73.43	74.13	73.20	72.13	−0.81	+1.30	+2.00	+1.07
24-22-202	84.41	85.21	84.85	84.69	84.36	+0.05	+0.85	+0.49	+0.33
24-22-401	87.01	85.13	85.35	85.59	84.17	+2.84	+0.96	+1.18	+1.42
24-22-601	101.96	100.92	100.93	99.79	99.54	+2.42	+1.38	+1.39	+0.25
24-22-701	176.33	178.63	177.20	177.71	177.08	−0.75	+1.55	+0.12	+0.63
24-22-802	122.07	123.65	119.94	118.54	116.10	+5.97	+7.55	+3.84	+2.44



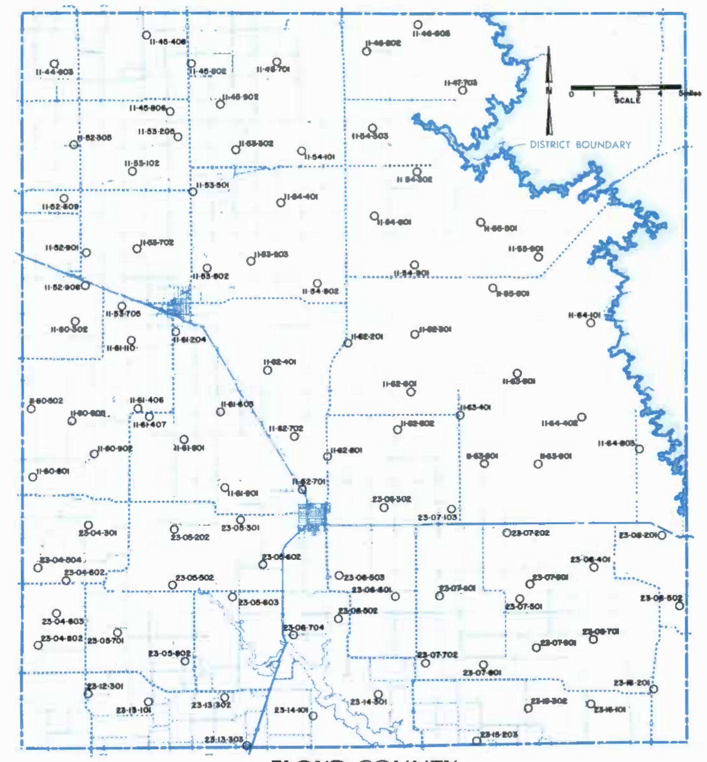
PARMER COUNTY

Well Number	Depth to Water Below Land Surface In Feet 1976	1981	1983	1985	1986	Total Change In Water Levels In Feet 1976 to 1986	1981 to 1986	1983 to 1986	1985 to 1986
09-24-302	0.0	291.05	289.43	290.60	291.85	0.0	−0.80	−2.42	−1.25
09-24-601	335.78	337.01	336.15	339.45	340.39	−4.61	−3.38	−4.24	−0.94
09-24-901	0.0	0.0	290.84	292.05	293.08	0.0	0.0	−2.24	−1.03
09-32-303	0.0	347.13	341.65	337.40	337.88	0.0	+9.25	+3.77	−0.48
09-32-501	0.0	354.34	356.57	357.90	359.43	0.0	−5.09	−2.86	−1.53
09-32-601	0.0	321.92	322.48	325.01	326.24	0.0	−4.32	−3.76	−1.23
09-40-301	303.46	0.0	329.50	338.34	0.0	0.0	0.0	0.0	0.0
09-40-801	0.0	254.55	260.80	265.89	269.78	0.0	−15.23	−8.98	−3.89
09-40-901	0.0	293.55	299.47	306.60	309.97	0.0	−16.42	−10.50	−3.37
09-40-903	248.49	265.57	269.97	278.00	276.84	−28.35	−11.27	−6.87	+1.16
09-48-301	229.32	246.39	247.61	250.32	0.0	0.0	0.0	0.0	0.0
10-17-301	193.73	193.58	192.46	192.30	0.0	0.0	0.0	0.0	0.0
10-17-401	285.48	0.0	281.96	282.03	282.49	+2.99	0.0	−0.53	−0.46
10-17-501	266.83	264.45	262.40	261.83	262.71	+4.12	+1.74	−0.31	−0.88
10-17-602	0.0	191.24	192.64	191.32	192.57	0.0	−1.33	+0.07	−1.25
10-17-804	0.0	222.25	219.22	219.80	220.12	0.0	+2.13	−0.90	−0.32
10-18-204	0.0	316.47	313.67	311.80	311.45	0.0	+5.02	+2.22	+0.35
10-18-302	0.0	249.38	248.55	249.40	247.69	0.0	+1.69	+0.86	+1.71
10-18-503	0.0	266.39	0.0	264.50	266.70	0.0	−0.31	0.0	−2.20
10-18-602	308.23	308.65	308.00	306.53	305.64	+2.59	+3.01	+2.36	+0.89
10-18-701	0.0	258.78	256.45	253.90	252.36	0.0	+6.42	+4.09	+1.54
10-18-901	269.55	279.19	272.76	272.42	269.68	−0.13	+9.51	+3.08	+2.74
10-19-101	285.74	292.83	292.57	293.70	293.54	−7.80	−0.71	−0.97	+0.16
10-19-202	0.0	308.70	311.03	314.00	314.68	0.0	−5.98	−3.65	−0.68
10-19-301	278.68	282.36	279.55	279.42	278.70	−0.02	+3.66	+0.85	+0.72
10-19-404	0.0	234.80	236.93	240.53	241.85	0.0	−7.05	−4.92	−1.32
10-19-602	250.39	273.36	274.76	278.45	279.03	−28.64	−5.67	−4.27	−0.58
10-19-802	0.0	229.28	230.16	231.70	232.20	0.0	−2.92	−2.04	−0.50
10-20-201	0.0	189.71	190.73	191.35	191.95	0.0	−2.24	−1.22	−0.60
10-20-402	247.43	260.23	257.06	258.45	258.96	−11.53	+1.27	−1.90	−0.51
10-20-901	0.0	197.55	199.04	202.92	203.80	0.0	−6.25	−4.76	−0.88
10-25-102	294.16	290.25	287.17	285.76	284.55	+9.61	+5.70	+2.62	+1.21
10-25-301	303.07	304.79	304.61	304.18	303.80	−0.73	+0.99	+0.81	+0.38
10-25-402	0.0	262.88	265.85	265.83	265.45	0.0	−2.57	+0.38	+0.40
10-25-502	175.73	181.40	182.00	185.22	185.29	−9.56	−3.89	−3.29	−0.07
10-25-701	279.83	298.45	304.58	309.05	0.0	0.0	0.0	0.0	0.0
10-25-801	0.0	251.89	253.54	255.14	255.60	0.0	−3.71	−2.06	−0.46
10-26-102	0.0	0.0	0.0	300.74	297.75	0.0	0.0	0.0	+2.99
10-26-201	0.0	283.81	287.28	290.37	292.01	0.0	−8.20	−4.73	−1.64
10-26-301	336.78	360.97	367.07	371.66	372.99	−36.21	−12.02	−5.92	−1.33
10-26-402	0.0	324.38	323.11	328.00	326.15	0.0	−1.77	−3.04	+1.85
10-26-503	0.0	339.75	346.09	351.90	353.26	0.0	−13.51	−7.17	−1.36



LAMB COUNTY

Well Number	Depth to Water Below Land Surface In Feet 1976	1981	1983	1985	1986	Total Change In Water Levels In Feet 1976 to 1986	1981 to 1986	1983 to 1986	1985 to 1986
10-44-401	150.00	177.90	182.42	185.71	187.48	−37.48	−9.58	−5.06	−1.77
10-44-501	153.22	174.68	177.58	181.82	184.21	−30.99	−9.53	−6.63	−2.39
10-44-703	113.66	130.65	132.82	136.83	140.02	−26.36	−9.37	−7.20	−3.19
10-44-711	94.26	105.92	108.54	111.25	112.50	−18.24	−6.58	−3.96	−1.25
10-44-802	91.99	106.37	111.17	113.57	115.48	−23.49	−9.11	−4.31	−1.91
10-45-402	153.45	174.67	179.82	186.00	192.87	−39.42	−18.20	−13.05	−6.87
10-45-702	106.23	118.17	122.38	126.10	127.82	−21.59	−9.65	−5.44	−1.72
10-45-801	167.41	186.86	192.96	196.56	197.52	−30.11	−10.66	−4.56	−0.96
10-45-901	167.07	186.33	192.56	194.18	0.0	0.0	0.0	0.0	0.0
10-46-601	189.51	210.50	215.56	221.76	221.87	−32.36	−11.37	−6.31	−0.11
10-46-703	183.65	199.86	204.18	206.82	207.74	−24.09	−7.88	−3.56	−0.92
10-47-401	166.57	181.82	188.24	197.40	198.84	−32.27	−17.02	−10.60	−1.44
10-47-501	163.16	180.39	187.21	192.46	194.75	−31.59	−14.36	−7.54	−2.29
10-47-802	0.0	213.12	218.24	222.47	223.95	0.0	−10.83	−5.71	−1.48
10-48-403	178.02	198.97	205.44	211.49	212.05	−34.03	−13.08	−6.61	−0.56
10-52-209	0.0	98.58	103.92	106.26	105.85	0.0	−7.27	−1.93	+0.41
10-52-308	0.0	0.0	101.26	104.11	104.56	0.0	0.0	−3.30	−0.45
10-52-406	0.0	0.0	0.0	0.0	114.05	0.0	0.0	0.0	0.0
10-52-508	0.0	0.0	0.0	0.0	77.33	0.0	0.0	0.0	0.0
10-52-601	37.41	43.65	45.99	48.27	49.58	−12.17	−5.93	−3.59	−1.31
10-52-715	0.0	0.0	0.0	0.0	133.99	0.0	0.0	0.0	0.0
10-52-718	0.0	105.79	105.84	0.0	0.0	0.0	0.0	0.0	0.0
10-52-719	0.0	0.0	0.0	0.0	122.55	0.0	0.0	0.0	0.0
10-52-804	0.0	0.0	0.0	0.0	119.39	0.0	0.0	0.0	0.0
10-52-811	0.0	0.0	0.0	0.0	89.74	0.0	0.0	0.0	0.0
10-52-813	0.0	0.0	0.0	0.0	85.57	0.0	0.0	0.0	0.0
10-52-902	54.95	58.66	60.53	62.40	63.32	−8.37	−4.66	−2.79	−0.92
10-52-905	0.0	99.27	98.84	100.23	99.02	0.0	+0.25	−0.18	+1.21
10-53-101	75.30	89.43	92.89	95.48	95.81	−20.51	−6.38	−2.92	−0.33
10-53-206	0.0	139.47	142.80	145.38	146.25	0.0	−6.78	−3.45	−0.87
10-53-307	115.11	132.17	135.81	138.98	139.93	−24.82	−7.76	−4.12	−0.95
10-53-404	0.0	0.0	68.94	71.58	72.89	0.0	0.0	−3.95	−1.31
10-53-602	60.71	74.17	79.67	83.10	85.16	−24.45	−10.99	−5.49	−2.06
10-53-608	0.0	94.02	98.54	0.0	101.53	0.0	−7.51	−2.99	0.0
10-53-803	0.0	65.77	69.98	70.30	0.0	0.0	0.0	0.0	0.0
10-54-205	124.70	140.91	145.71	150.19	150.07	−25.37	−9.16	−4.36	+0.12
10-54-301	178.48	200.57	207.50	212.25	212.44	−33.96	−11.87	−4.94	−0.19
10-54-404	0.0	114.10	118.99	123.55	124.37	0.0	−10.27	−5.38	−0.82
10-54-502	116.54	132.42	138.59	140.90	140.57	−24.03	−8.15	−1.98	+0.33
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]



FLOYD COUNTY

Well Number	Depth to Water Below Land Surface In Feet 1976	1981	1983	1985	1986	Total Change In Water Levels In Feet 1976 to 1986	1981 to 1986	1983 to 1986	1985 to 1986
11-44-903	0.0	0.0	177.65	181.60	185.93	0.0	0.0	−8.28	−4.33
11-45-408	0.0	202.54	207.65	212.80	212.99	0.0	−10.45	−5.34	−0.19
11-45-802	174.77	186.51	190.58	194.62	0.0	0.0	0.0	0.0	0.0
11-45-806	165.75	172.99	175.28	175.80	175.66	−9.91	−2.67	−0.38	+0.14
11-45-902	180.23	186.40	187.67	189.64	188.67	−8.44	−2.27	−1.00	+0.97
11-46-605	0.0	0.0	0.0	215.20	215.24	0.0	0.0	0.0	−0.04
11-46-701	209.09	219.12	221.49	224.03	224.48	−15.39	−5.36	−2.99	−0.45
11-46-802	249.73	259.17	260.38	261.38	262.05	−12.32	−2.88	−1.67	−0.67
11-47-703	0.0	239.16	236.45	237.85	238.50	0.0	+0.66	−2.05	−0.65
11-52-305	173.66	185.43	188.50	190.78	191.85	−18.19	−6.42	−3.35	−1.07
11-52-609	0.0	0.0	208.35	212.95	213.90	0.0	0.0	−5.55	−0.95
11-52-901	191.61	209.95	218.75	222.46	224.03	−32.42	−14.08	−5.28	−1.57
11-52-908	187.20	214.53	226.93	228.04	229.47	−42.27	−14.94	−2.54	−1.43
11-53-102	190.17	198.34	200.02	199.93	199.89	−9.72	−1.55	+0.13	+0.04
11-53-205	153.85	158.18	159.46	160.42	160.56	−6.71	−2.38	−1.10	−0.14
11-53-302	0.0	200.10	198.77	201.10	203.44	0.0	−3.34	−4.67	−2.34
11-53-501	208.06	220.02	222.50	223.04	222.36	−14.30	−2.34	+0.14	+0.68
11-53-702	176.71	191.98	197.94	201.36	202.20	−25.49	−10.22	−4.26	−0.84
11-53-705	199.39	229.34	237.27	237.70	236.57	−37.18	−7.23	+0.70	+1.13
11-53-802	0.0	152.84	152.92	153.14	152.63	0.0	+0.21	+0.29	+0.51
11-53-903	161.56	162.90	163.38	161.81	160.98	+0.58	+1.92	+2.40	+0.83
11-54-101	210.37	217.99	218.72	218.81	220.13	−9.76	−2.14	−1.41	−1.32
11-54-302	255.11	264.06	265.91	267.91	266.44	−11.33	−2.38	−0.53	+1.47
11-54-303	0.0	250.73	251.68	255.16	253.10	0.0	−2.37	−1.42	+2.06
11-54-401	181.32	183.05	183.60	183.42	184.08	−2.76	−1.03	−0.48	−0.66
11-54-601	0.0	247.28	247.70	247.05	246.31	0.0	+0.97	+1.39	+0.74
11-54-802	0.0	0.0	0.0	176.38	175.57	0.0	0.0	0.0	+0.81
11-54-901	223.27	223.45	223.27	222.80	222.87	+0.40	+0.58	+0.40	−0.07
11-55-501	0.0	282.80	283.44	281.10	278.71	0.0	+4.09	+4.73	+2.39
11-55-801	0.0	247.60	243.84	243.74	245.64	0.0	+1.96	−1.80	−1.90
11-55-901	0.0	289.29	291.94	290.61	289.60	0.0	−0.31	+2.34	+1.01
11-60-302	191.43	224.71	232.00	232.53	233.58	−42.15	−8.87	−1.58	−1.05
11-60-502	193.34	223.43	232.86	233.15	230.79	−37.45	−7.36	+2.07	+2.36
11-60-605	202.94	232.96	235.12	236.02	235.72	−32.78	−2.76	−0.60	+0.30
11-60-801	0.0	147.90	153.64	155.68	155.89	0.0	−7.99	−2.25	−0.21
11-60-902	197.34	224.10	225.76	227.24	233.45	−36.11	−9.35	−7.69	−6.21
11-61-110	0.0	0.0	0.0	0.0	234.19	0.0	0.0	0.0	0.0
11-61-204	206.69	224.77	228.08	229.70	228.90	−22.21	−4.13	−0.82	+0.80
11-61-406	228.97	246.01	245.01	247.15	248.35	−19.38	−2.34	−3.34	−1.20
11-61-407	229.74	243.34	245.34	248.17	249.64	−19.90	−6.30	−4.30	−1.47
11-61-603	87.74	90.12	91.09	89.97	90.75	−3.01	−0.63	+0.34	−0.78

DEAF SMITH COUNTY

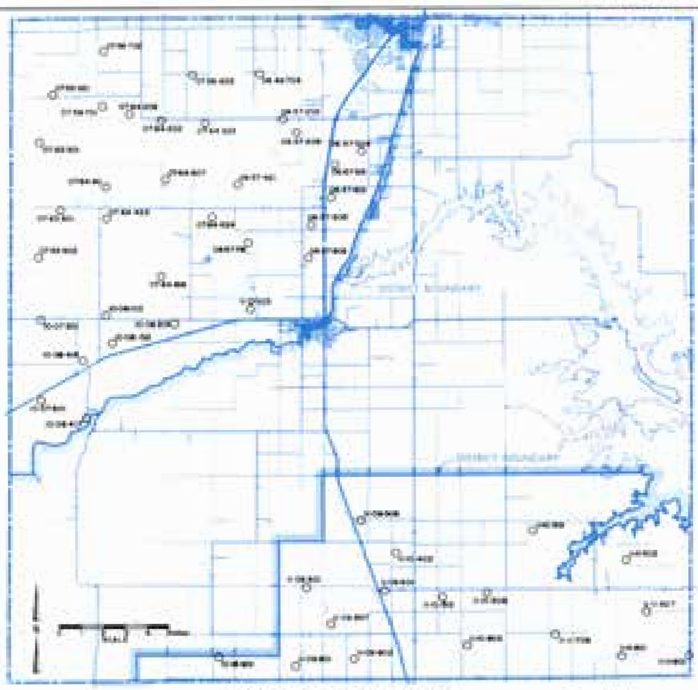
Well Number	Depth to Water Below Land Surface In Feet 1976	1981	1983	1985	1986	Total Change In Water Levels In Feet 1976 to 1986	1981 to 1986	1983 to 1986	1985 to 1986
07-53-701	0.0	236.60	236.29	236.23	236.59	0.0	+0.01	−0.30	−0.36
07-53-902	222.64	236.61	236.18	236.59	237.11	−14.47	−0.50	−0.93	−0.52
07-54-701	0.0	0.0	0.0	161.83	0.0	0.0	0.0	0.0	0.0
07-54-901	0.0	184.79	186.93	188.42	189.38	0.0	−4.59	−2.45	−0.96
07-55-701	222.78	235.80	235.16	238.50	237.59	−14.81	−1.79	−2.43	+0.91
07-60-301	279.15	292.11	294.10	296.98	300.49	−21.34	−8.38	−6.39	−3.51
07-60-401	296.89	305.50	308.45	308.34	307.59	−10.70	−2.09	+0.86	+0.75
07-60-601	246.53	259.34	261.77	265.48	266.07	−19.54	−6.73	−4.30	−0.59
07-60-901	222.00	236.91	241.19	244.03	245.59	−23.59	−8.68	−4.40	−1.56
07-61-224	0.0	255.75	260.18	262.09	262.57	0.0	−6.82	−2.39	−0.48
07-61-301	216.65	225.30	227.02	228.96	229.49	−12.84	−4.19	−2.47	−0.53
07-61-502	209.79	223.82	226.00	228.64	228.91	−19.12	−5.09	−2.91	−0.27
07-61-601	202.11	0.0	0.0	221.71	221.55	−19.14	0.0	0.0	+0.16
07-61-802	0.0	0.0	0.0	0.0	218.97	0.0	0.0	0.0	0.0
07-61-902	0.0	0.0	0.0	206.04	209.19	0.0	0.0	0.0	−3.15
07-62-101	223.18	230.28	232.84	234.12	233.28	−10.10	−3.00	−0.44	+0.84
07-62-301	186.95	190.05	189.04	192.16	192.25	−5.30	−2.20	−3.21	−0.09
07-62-502	0.0	0.0	0.0	208.12	208.72	0.0	0.0	0.0	−0.60
07-62-601	196.70	206.73	203.37	0.0	207.69	−10.99	−0.96	−4.32	0.0
07-62-823	0.0	181.10	183.43	189.14	0.0	0.0	0.0	0.0	0.0
07-63-202	198.03	193.94	191.58	191.90	195.01	+3.02	−1.07	−3.43	−3.11
07-63-501	132.00	142.40	148.14	150.96	0.0	0.0	0.0	0.0	0.0
07-63-702	158.57	173.02	175.98	179.72	177.45	−18.88	−4.43	−1.47	+2.27
09-16-901	120.46	125.88	127.11	128.80	129.39	−8.93	−3.51	−2.28	−0.59
10-03-201	0.0	296.15	299.29	300.35	301.44	0.0	−5.29	−2.15	−1.09
10-03-501	0.0	261.90	258.20	257.36	258.57	0.0	+3.33	−0.37	−1.21
10-03-701	222.86	224.70	225.10	225.46	225.47	−2.61	−0.77	−0.37	−0.01
10-03-902	266.71	272.79	273.27	272.65	271.14	−4.43	+1.65	+2.13	+1.51
10-04-101	330.87	340.72	342.18	336.95	327.96	+2.91	+12.76	+14.22	+8.99
10-04-202	287.12	303.59	305.66	307.74	307.17	−20.05	−3.58	−1.51	+0.57
10-04-301	0.0	307.35	307.10	311.34	310.41	0.0	−3.06	−3.31	+0.93
10-04-504	0.0	0.0	0.0	0.0	281.59	0.0	0.0	0.0	0.0
10-04-603	0.0	261.62	266.35	268.35	268.34	0.0	−6.72	−1.99	+0.01
10-04-901	204.62	214.14	215.80	216.09	216.45	−11.83	−2.31	−0.65	−0.36
10-05-225	0.0	225.05	0.0	240.33	242.32	0.0	−17.27	0.0	−1.99
10-05-502	196.99	212.20	215.47	214.96	217.28	−20.29	−5.08	−1.81	−2.32
10-05-601	154.49	169.83	173.05	178.28	180.37	−25.88	−10.54	−7.32	−2.09
10-05-804	0.0	181.81	171.60	178.40	180.35	0.0	+1.46	−8.75	−1.95
10-05-905	0.0	0.0	0.0	199.37	202.10	0.0	0.0	0.0	−2.73
10-06-101	0.0	169.54	176.25	181.39	183.69	0.0	−14.15	−7.44	−2.30
10-06-201	0.0	171.49	175.03	177.42	178.59	0.0	−7.10	−3.56	−1.17
10-06-302	0.0	177.29	181.44	188.98	189.94	0.0	−12.65	−8.50	−0.96
10-06-403	177.34	189.77	193.28	197.02	197.98	−20.64	−8.21	−4.70	−0.96

Well Number	Depth to Water Below Land Surface In Feet 1976	1981	1983	1985	1986	Total Change In Water Levels In Feet 1976 to 1986	1981 to 1986	1983 to 1986	1985 to 1986
10-06-801	79.53	80.55	81.42	82.49	82.11	−2.58	−1.56	−0.69	+0.38
10-06-909	149.65	156.12	158.05	159.72	160.24	−10.59	−4.12	−2.19	−0.52
10-07-401	175.21	189.53	189.71	192.75	194.44	−19.23	−4.91	−4.73	−1.69
10-07-403	154.91	160.32	163.61	167.07	167.25	−12.34	−6.93	−3.64	−0.18
10-07-404	159.55	171.00	176.32	182.58	184.33	−24.78	−13.33	−8.01	−1.75
10-07-701	127.15	116.58	113.38	111.06	110.14	+17.01	+6.44	+3.24	+0.92
10-07-802	0.0	145.85	145.64	145.66	145.34	0.0	+0.51	+0.30	+0.32
10-09-701	135.37	136.45	136.73	137.01	137.43	−2.06	−0.98	−0.70	−0.42
10-09-801	54.00	54.30	53.93	55.13	56.58	−2.58	−2.28	−2.65	−1.45
10-10-701	161.85	162.00	162.28	161.70	162.25	−0.40	−0.25	+0.03	−0.55
10-11-401	188.16	191.95	192.20	193.19	193.88	−5.72	−1.93	−1.68	−0.69
10-11-501	195.94	198.95	200.08	201.17	201.33	−5.39	−2.38	−1.25	−0.16
10-11-601	165.13	162.28	161.61	161.36	161.41	+3.72	+0.87	+0.20	−0.05
10-11-802	220.22	234.11	235.88	237.66	237.29	−17.07	−3.18	−1.41	+0.37
10-11-901	184.35	197.30	198.93	200.12	200.68	−16.33	−3.38	−1.75	−0.56
10-12-102	160.32	166.06	170.07	172.37	173.03	−12.71	−6.97	−2.96	−0.66
10-12-201	69.95	72.90	72.65	72.10	72.55	−2.60	+0.35	+0.10	−0.45
10-12-302	181.79	198.82	201.59	204.28	206.27	−24.48	−7.45	−4.68	−1.99
10-12-404	0.0	227.48	224.23	224.56	223.24	0.0	+4.24	+0.99	+1.32
10-12-504	217.67	0.0	230.87	232.01	230.09	−12.42	0.0	+0.78	+1.92
10-12-703	0.0	0.0	0.0	193.73	192.94	0.0	0.0	0.0	+0.79
10-12-904	168.32	185.67	188.65	192.38	194.27	−25.95	−8.60	−5.62	−1.89
10-13-103	199.01	221.75	228.21	0.0	0.0	0.0	0.0	0.0	0.0
10-13-302	161.52	178.80	183.42	185.80	0.0	0.0	0.0	0.0	0.0
10-13-304	173.57	184.55	184.95	185.77	187.73	−14.16	−3.18	−2.78	−1.96
10-13-305	164.01	179.48	186.10	189.96	189.14	−25.13	−9.66	−3.04	+0.82
10-13-401	170.62	197.10	205.87	211.14	211.93	−41.31	−14.83	−6.06	−0.79
10-13-404	0.0	172.18	178.04	184.62	185.95	0.0	−13.77	−7.91	−1.33
10-13-806	0.0	0.0	0.0	188.85	190.06	0.0	0.0	0.0	−1.21
10-13-903	182.38	197.42	203.38	205.96	208.15	−25.77	−10.73	−4.77	−2.19
10-14-104	81.82	80.68	79.11	78.50	78.28	+3.54	+2.40	+0.83	+0.22
10-14-205	0.0	116.93	111.52	110.33	108.79	0.0	+8.14	+2.73	+1.54
10-14-303	77.55	74.50	74.40	74.65	73.33	+4.22	+1.17	+1.07	+1.32
10-14-404	145.47	159.90	163.65	162.66	162.21	−16.74	−2.31	+1.44	+0.45
10-14-701	182.65	189.80	192.34	0.0	0.0	0.0	0.0	0.0	0.0
10-14-702	184.55	194.42	197.93	199.34	199.39	−14.84	−4.97	−1.46	−0.05
10-14-704	151.68	157.19	159.10	160.79	161.11	−9.43	−3.92	−2.01	−0.32
10-14-901	112.39	110.75	111.00	111.17	111.25	−1.14	−0.50	−0.25	−0.08
10-21-201	204.78	225.23	228.73	231.65	231.54	−26.76	−6.31	−2.81	+0.11

0.0 - Denotes data not available

LUBBOCK COUNTY

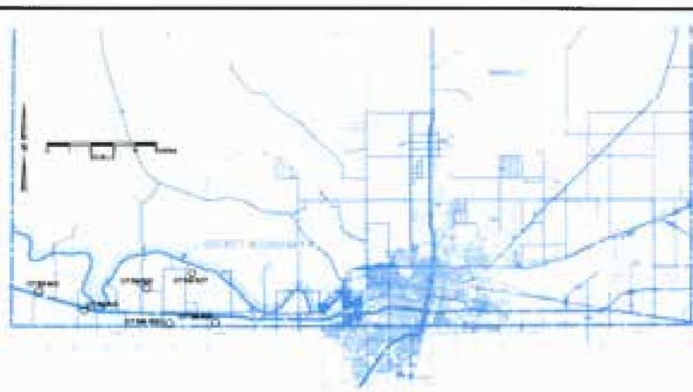
Well Number	Depth to Water Below Land Surface In Feet 1976	1981	1983	1985	1986	Total Change In Water Levels In Feet 1976 to 1986	1981 to 1986	1983 to 1986	1985 to 1986
23-09-501	165.40	168.42	169.11	170.08	168.82	−3.42	−0.40	+0.29	+1.26
23-09-601	144.60	145.42	145.69	145.76	145.87	−1.27	−0.45	−0.18	−0.11
23-09-701	164.60	169.35	169.06	169.84	169.53	−4.93	−0.18	−0.47	+0.31
23-09-903	0.0	172.34	169.16	170.98	169.57	0.0	+2.77	−0.41	+1.41
23-10-502	196.93	203.85	204.19	207.86	207.81	−10.88	−3.96	−3.62	+0.05
23-10-703	0.0	174.15	170.88	172.58	171.42	0.0	+2.73	−0.54	+1.16
23-11-401	206.64	215.47	216.45	218.02	217.57	−10.93	−2.10	−1.12	+0.45
23-11-501	0.0	193.58	195.54	196.82	196.71	0.0	−3.13	−1.17	+0.11
23-11-601	169.24	174.19	174.40	175.22	175.03	−5.79	−0.84	−0.63	+0.19
23-11-702	189.13	198.87	201.45	205.34	204.20	−15.07	−5.33	−2.75	+1.14
23-11-801	0.0	212.00	212.99	215.05	214.44	0.0	−2.44	−1.45	+0.61
23-12-401	175.89	183.01	185.43	186.73	186.78	−10.89	−3.77	−1.35	−0.05
23-12-402	190.20	207.86	211.32	214.95	213.28	−23.08	−5.42	−1.96	+1.67
23-12-803	183.60	199.17	199.40	199.38	197.10	−13.50	+2.07	+2.30	+2.28
23-17-104	0.0	136.92	137.15	136.76	137.66	0.0	−0.74	−0.51	−0.90
23-17-202	156.85	0.0	164.58	164.30	163.60	−6.75	0.0	+0.98	+0.70
23-17-301	0.0	168.87	165.96	168.13	166.65	0.0	+2.22	−0.69	+1.48
23-17-406	0.0	79.86	77.83	79.47	80.41	0.0	−0.55	−2.58	−0.94
23-17-501	129.17	132.03	132.30	132.83	132.46	−3.29	−0.43	−0.16	+0.37
23-17-601	0.0	118.28	118.80	119.83	120.31	0.0	−2.03	−1.51	−0.48
23-17-704	75.18	79.14	78.00	76.96	76.64	−1.46	+2.50	+1.36	+3.32
23-17-801	87.98	89.27	87.53	87.37	86.13	+1.85	+3.14	+1.40	+1.24
23-17-802	76.22	80.19	80.50	82.21	83.77	−7.55	−3.58	−3.27	−1.56
23-17-901	70.70	73.67	68.42	65.76	64.07	+6.63	+9.60	+4.35	+1.69
23-18-201	164.59	168.94	168.86	169.40	168.35	−3.76	+0.59	+0.51	+1.05
23-18-301	190.44	202.57	201.51	203.58	201.99	−11.55	+0.58	−0.48	+1.59
23-18-409	0.0	0.0	151.24	152.70	150.90	0.0	0.0	+0.34	+1.80
23-18-502	132.50	139.63	135.58	137.13	135.18	−2.68	+4.45	+0.40	+1.95
23-18-602	0.0	154.90	152.62	153.09	151.19	0.0	+3.71	+1.43	+1.90
23-18-701	85.18	91.75	88.44	89.38	89.27	−4.09	+2.48	−0.83	+0.11
23-18-703	80.60	81.02	77.68	77.75	77.22	+3.38	+3.80	+0.46	+0.53
23-18-704	80.22	83.03	80.65	80.70	80.13	+0.09	+2.90	+0.52	+0.57
23-18-802	0.0	101.42	98.60	99.00	97.48	0.0	+3.94	+1.12	+1.52
23-19-101	181.60	194.03	192.37	193.72	192.32	−10.72	+1.71	+0.05	+1.40
23-19-304	206.70	215.29	215.58	214.66	213.55	−6.85	+1.74	+2.03	+1.11
23-19-501	199.43	208.92	209.25	209.17	207.38	−7.95	+1.54	+1.87	+1.79
23-19-601	0.0	211.79	211.40	210.45	208.89	0.0	+2.90	+2.51	+1.56
23-19-704	101.09	105.58	102.05	101.65	100.24	+0.85	+5.34	+1.81	+1.41
23-19-804	101.48	123.30	115.24	118.08	113.95	−12.47	+9.35	+1.29	+4.13
23-19-901	160.90	169.23	168.03	168.45	168.50	−7.60	+0.73	−0.47	−0.05
23-20-401	191.94	201.79	203.00	203.86	201.64	−9.70	+0.15	+1.36	+2.22
23-20-701	184.97	193.13	192.42	191.70	189.30	−4.33	+3.83	+3.12	+2.40
23-20-802	205.42	215.25	215.81	216.28	213.60	−8.18	+1.65	[illegible]	+2.68



RANDALL COUNTY

Well Number	Depth to Water Below Land Surface In Feet 1976	1981	1983	1985	1986	Total Change In Water Levels In Feet 1976 to 1986	1981 to 1986	1983 to 1986	1985 to 1986
06-49-704	0.0	0.0	0.0	212.68	214.18	0.0	0.0	0.0	-1.50
06-57-202	201.18	199.91	201.30	200.60	201.78	-0.60	-1.87	-0.48	-1.18
06-57-208	0.0	0.0	200.35	200.88	200.35	0.0	0.0	0.00	+0.53
06-57-304	0.0	0.0	163.20	160.54	161.03	0.0	0.0	+2.17	-0.49
06-57-315	0.0	0.0	152.04	153.02	153.11	0.0	0.0	-1.07	-0.09
06-57-421	0.0	189.93	191.07	189.87	188.28	0.0	+1.65	+2.79	+1.59
06-57-505	0.0	0.0	186.44	187.41	187.60	0.0	0.0	-1.16	-0.19
06-57-601	181.14	192.88	188.29	187.62	189.30	-8.16	+3.58	-1.01	-1.68
06-57-716	0.0	166.01	167.67	168.61	169.15	0.0	-3.14	-1.48	-0.54
06-57-802	158.68	161.95	157.13	158.95	158.07	+0.61	+3.88	-0.94	+0.88
07-55-921	0.0	224.88	225.85	228.09	229.10	0.0	-4.22	-3.25	-1.01
07-56-701	218.73	229.70	221.13	222.24	223.33	-4.60	+6.37	-2.20	-1.09
07-56-702	245.01	249.86	245.80	250.97	252.17	-7.16	-2.31	-6.37	-1.20
07-56-902	207.84	215.14	215.90	215.35	215.64	-7.80	-0.50	+0.26	-0.29
07-63-301	228.87	234.45	233.70	234.00	232.67	-3.80	+1.78	+1.03	+1.33
07-63-601	167.20	182.03	184.44	188.30	190.65	-23.45	-8.62	-6.21	-2.35
07-63-902	149.21	161.67	159.29	163.20	164.44	-15.23	-2.77	-5.15	-1.24
07-64-202	0.0	0.0	184.97	186.76	187.30	0.0	0.0	-2.33	-0.54
07-64-209	0.0	179.14	178.79	179.59	179.92	0.0	-0.78	-1.13	-0.33
07-64-323	0.0	156.06	0.0	160.35	160.50	0.0	-4.44	0.0	-0.15
07-64-411	0.0	114.84	0.0	118.38	119.65	0.0	-4.81	0.0	-1.27
07-64-422	0.0	0.0	0.0	109.52	108.83	0.0	0.0	0.0	+0.69
07-64-507	0.0	171.80	164.66	160.63	160.48	0.0	+11.32	+4.18	+0.15
07-64-624	0.0	0.0	170.09	171.07	171.20	0.0	0.0	-1.11	-0.13
07-64-816	0.0	0.0	137.85	138.38	140.66	0.0	0.0	-2.81	-2.28
10-07-301	134.46	137.36	136.91	138.79	139.66	-5.20	-2.30	-2.75	-0.87
10-07-601	105.01	0.0	102.64	105.05	104.78	+0.23	0.0	-2.14	+0.27
10-08-102	145.70	146.52	147.46	148.00	148.52	-2.82	-2.00	-1.06	-0.52
10-08-132	0.0	0.0	176.24	178.68	177.98	0.0	0.0	-1.74	+0.70
10-08-213	0.0	130.56	131.10	131.45	131.92	0.0	-1.36	-0.82	-0.47
10-08-415	0.0	112.60	113.64	114.28	114.81	0.0	-2.21	-1.17	-0.53
10-08-417	0.0	0.0	0.0	97.77	96.89	0.0	0.0	0.0	+0.88
10-16-901	181.77	183.62	184.43	184.62	184.90	-3.13	-1.28	-0.47	-0.28
11-01-103	0.0	0.0	83.35	84.35	84.70	0.0	0.0	-1.35	-0.35
11-09-306	0.0	162.55	162.26	164.96	162.58	0.0	-0.03	-0.32	+2.38
11-09-501	184.58	187.50	187.24	186.68	186.58	-2.00	+0.92	+0.66	+0.10
11-09-601	200.60	199.04	198.33	196.55	196.99	+3.61	+2.05	+1.34	-0.44
11-09-801	196.04	197.57	196.34	195.09	194.51	+1.53	+3.06	+1.83	+0.58
11-09-837	0.0	0.0	0.0	178.52	178.19	0.0	0.0	0.0	+0.33
11-09-902	210.08	0.0	204.01	206.40	200.17	+9.91	0.0	+3.84	+6.23
11-10-301	127.39	128.92	130.20	129.77	129.20	-1.81	-0.28	+1.00	+0.57
11-10-402	175.84	175.56	175.76	175.46	175.27	+0.57	+0.29	+0.49	+0.19
11-10-506	0.0	0.0	141.20	141.65	142.86	0.0	0.0	-1.66	-1.21
11-10-512	0.0	180.03	179.02	180.14	181.27	0.0	-1.24	-2.25	-1.13
11-10-802	182.57	180.87	180.69	179.85	179.19	+3.38	+1.68	+1.50	+0.66
11-11-502	166.28	166.15	166.95	166.51	166.90	-0.62	-0.75	+0.05	-0.39
11-11-709	0.0	0.0	0.0	185.92	185.70	0.0	0.0	0.0	+0.22
11-11-801	0.0	132.27	134.71	136.67	137.21	0.0	-4.94	-2.50	-0.54
11-11-901	125.30	132.70	134.35	135.05	135.70	-10.40	-3.00	-1.35	-0.65
11-11-927	0.0	146.12	148.79	147.96	149.05	0.0	-2.93	-0.26	-1.09

0.0 - Denotes data not available



POTTER COUNTY

Well Number	Depth to Water Below Land Surface In Feet 1976	1981	1983	1985	1986	Total Change In Water Levels In Feet 1976 to 1986	1981 to 1986	1983 to 1986	1985 to 1986
07-55-601	0.0	256.50	255.83	255.53	255.52	0.0	+0.98	+0.31	+0.01
07-56-307	0.0	225.77	223.77	224.52	224.78	0.0	+0.99	-1.01	-0.26
07-56-401	0.0	237.77	239.05	242.51	243.60	0.0	-5.83	-4.55	-1.09
07-56-501	220.47	232.19	229.35	230.00	230.38	-9.91	+1.81	-1.03	-0.38
07-56-520	0.0	240.76	244.99	242.23	242.34	0.0	-1.58	+2.65	-0.11
07-56-601	0.0	226.17	222.10	223.86	224.06	0.0	+2.11	-1.96	-0.20

0.0 - Denotes data not available

Aquifer Stabilizes cont'd from p. 1

program is presented for each county or portion of a county in the Water District's service area.

County highway maps are presented showing the location of each of the water-level observation wells along with the assigned well number. Also presented are tabulations of water-level data including measurements of the depth to water below land surface for each well measured for the years 1976, 1981, 1983, 1985 and 1986.

Additionally, tabulated data showing the total change in water levels in feet for each well measured for the periods 1976 to 1986 (ten-year period), 1981 to 1986 (five-year period), 1983 to 1986 (three-year period), and 1985 to 1986 (one-year change) is presented.

A summary of this information for each county is presented in the accompanying table on page 1. This summary contains county average water-level measurements for a ten-year period, a five-year period, a three-year period and the one-year average county-wide change from 1985 to 1986.

A plus sign denotes a gain in the water level and a minus denotes a loss.

THE CROSS SECTION (USPS 564-920)
HIGH PLAINS UNDERGROUND WATER CONSERVATION DISTRICT NO. 1
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LUBBOCK, TEXAS 79405

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THE Cross SECTION

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ONE PICTURE IS WORTH A THOUSAND WORDS: The expression on four-year old Jared Artho's face as he emerged from a 260-foot deep abandoned well into which he accidentally fell in 1981 should provide sufficient encouragement for anyone who knows of an open, uncovered, or abandoned well hole to see that the hole is properly sealed. (Photo courtesy Amarillo Globe News)

The Dangers Of Open Holes

Open uncovered well holes, improperly covered well holes and abandoned wells are potentially dangerous hazards to both human and animal life, as well as a threat to the quality of water stored in the Ogallala aquifer.

Accidents Do Happen

An example of this hazard occurred on Thursday, February 13, 1986, as a six-year old boy stepped off a school bus in Randall County. The boy stepped off the bus, and while chasing some papers he had dropped, he slipped into a snow-covered well hole.

Fortunately, the boy's mother reacted quickly upon noticing that her son had disappeared. Within seconds she found him sliding down the sides of the open hole, slipping toward the narrow opening in the bottom, and managed to catch him by four fingers avoiding a possible tragedy.

The hole, an old well drilled by the Texas Highway Department when they constructed FM 1721 in Randall County, was filled the following day with a mountain of caliche and surrounded by four road blocks.

This incident is only the second incident of a person falling into an abandoned well hole in the Water District's 35-year history. The first occurred in August of 1981 when four-year old Jared Artho fell 260 feet down an abandoned irrigation well that his uncle was in the process of filling with sand. Miraculously Jared emerged from the hole with only a few scratches. He was a very fortunate little boy.

Constant Watch

It is to avoid accidents like these that the Water District has worked with landowners and operators to close more than 1,100 abandoned and uncovered holes since its creation in 1951. Obbie Goolsby, an engineer technician at the Water District who is in charge of the abandoned well program, alone has identified more than 550 wells needing to be capped since 1978.

"The District has been very fortunate in cases where children have fallen into these wells that they've always been able to get them out. But it's far better to never have them fall in to begin with," he says.

As District personnel carry out their normal duties within the District's service area, they keep their eyes peeled for open holes. An open or uncovered well is defined by District rules as any artificial excavation constructed to produce water from the aquifer, which is as much as 10 feet deep and not less than 10 inches nor more than 6 feet in diameter.

"Last year we were doing some supplemental water-level surveys in Lubbock, Hockley and Cochran Counties. During this work, staff members came across numerous open wells," said Goolsby. "The District staff worked with landowners and operators in these three counties to cover about 105 wells."

District staff personnel normally carry legal description maps with them to use in the course of their day's

continued on page 4 . . . DANGERS

Playa Basins Valuable Irrigation Commodity

Utilizing water collected in playa basins for pre-plant and summer irrigations can save irrigators water and fuel costs, while providing valuable nutrients for the crop.

Fuel costs for pumping water from playa basins average approximately 25 percent of the cost of pumping water from the Ogallala aquifer. Additionally, the temperature of water pumped from the aquifer averages about 63°F, whereas the temperature of water pumped from playa basins averages about 80°F from April through September.

The higher water temperatures are important in terms of crop production. Most of the major crops grown on the Southern High Plains of Texas are highly sensitive to soil temperature variations. The warmer water pumped from playa lakes will not lower soil temperatures as much as the cooler water pumped from the aquifer, which retards plant growth.

Another benefit to utilizing playa water is the valuable nutrients contained in the water. Chemical analyses of playa basin water indicate that the playa water contains most of the major, minor and trace elements necessary for crop production.

Practical Application

John Lee Carthel who farms near Lockney, Texas, has utilized the water from his playa basins for irrigation for the past several years and believes the practice is very beneficial and cost effective. "I have already pre-watered 52 acres of cotton ground and 30 acres of wheat out of my playa basins this year," notes Carthel. "We figured out that the water cost us about $2 per acre, at fifty-five cents per gallon for propane.

"That's fairly cheap water. Also, the lake water in the summer time is better for cotton production than the cooler water from the aquifer." Carthel also likes to pump the water out of the lake so he can reclaim the land and plant wheat on it.

Unfortunately, Carthel has encountered some problems with utilizing playa water through the center pivot sprinklers, which he has converted most of his irrigation systems to in the past several years. "The marine life in the playa water gives us trouble in the sprinklers. I haven't figured out how I can use the lake water in the sprinklers yet without stopping up the nozzles."

"I didn't crank up an irrigation well last year."

Gilbert Fawver, who owns land near Floydada, completely irrigated his land during the 1985 growing season with playa lake water. "I didn't crank up an irrigation well last year. And I wouldn't be pumping from my wells now if our lake pump hadn't gone out on us."

Growing primarily cotton, with some milo and wheat, Fawver pre-watered 29 acres of milo last year then watered it four times after that pre-watering. In addition, he watered his cotton two times; all out of one 45-acre playa

continued on page 4 . . . PLAYA BASINS

WATER EDUCATION MANDATED

The Texas State Board of Education has approved the Texas Society of Professional Engineers Water Education Council's efforts to have water education made a part of the standard public school curriculum. The Board included water education language in Proclamation 63, which is a directive to textbook publishers listing the content that must be included in Texas textbooks. Through Proclamation 63, water education is mandated in 3rd through 6th grade social studies texts and high school introductory physical science books. The Water Education Council will continue to work with the State Board and the Texas Education Agency to ensure that water education continues to be made a part of Texas public education.

"This is a tremendous milestone for our Council's efforts," said Dave Dorchester, TSPE Liaison to the Council. "These textbooks will be in adoption for six years, and many, many Texas students will be exposed to learning situations involving this important natural resource."

(Reprinted from TSPE Insider, April, 1986)

THE SURGE PRINCIPLE IS THE SAME

Variety Of Features Offered In Surge Systems

As surge irrigation becomes more widely accepted and manufacturers offer more models, options and innovations, choosing the best surge system to meet the irrigator's needs may become a confusing task.

The surge market offers a variety of valves for the irrigator to choose from, ranging from simple single-time units to complex computer-operated systems. All the surge valves perform the same basic function, sending water out on alternate sets of furrows for specific lengths of time. However, a variety of options can be added to the basic functions if the irrigator wishes a more sophisticated system. Most surge units will integrate with common gated pipe requiring little or no extra equipment to install and operate.

The initial investment in surge valves is relatively small. The valves usually pay for themselves within a year in increased crop yields and energy and water savings. Prices on models vary depending on the complexity of the system, ranging from $600 for a single time, battery operated surge unit to $1644 for a computerized programmable surge system.

A visit with surge dealers representing each of the major valves marketed reveals some interesting variations, program options and advantages as the dealers themselves see them.

Hastings Valves

While surge equipment has only recently gained extensive attention for the improvements it can make in furrow irrigation, the makers of the Hastings valve have been in business a long time. And this, says dealer James P. Mitchell, is important. "The people that have been making the surge valve that we distribute are old line companies, and they'll be here for years to come. Some of the more recent companies have gone in and out of business, as have the parts and maintenance for the systems they sold. Hastings Manufacturers in Hasting, Nebraska, will always be around."

Mitchell emphasizes the long-term service and parts that Hastings can provide as a primary advantage. "These valves are the same as they have been since the beginning. We have the parts and maintenance for everything that's ever been built," Mitchell points out.

The Hastings surge valve uses a bladder-type device, which operates from water pressure but doesn't use much power. A bladder is located at each valve opening. The full bladder blocks the valve opening, forcing water out the other passage past the deflated bladder. To change sides, one bladder fills as the other drains. Water travels through the switch mechanism and the bladders and drains through a series of hose connected nozzles.

"It takes about one to one and one-half pounds of water pressure to change water. That's one of the nice things about our valve, it doesn't change real fast," says Mitchell, adding that the switch takes one to two minutes. "Our valves have been trouble-free."

A lever controls the water pressure entering the valve by operating a butterfly valve on the front pipe. "If you've got a full pipe of water, you don't use the pressure lever," Mitchell explains. If available water pressure is low, the lever may be adjusted to close the valve opening somewhat, building up enough water pressure to make the valve switch.

The control box, made locally by Brandon and Clark, Inc., of Lubbock, is available with single or dual timers. It includes an on/off switch, a reset button and liquid digit display showing the remaining time on the surge cycle and how many cycles have been run. Three thumbwheels set the first surge time, second surge time and the number of cycles. A 12-volt disposable battery powers the time-control box and runs for about one year. The battery may be replaced with a rechargeable battery.

"If you have problems with the control box, it can be changed without taking the valve to town. You can take the box off and put another on without turning the water off and disconnecting the pipe," Mitchell points out.

Valve weight ranges from 40 pounds for the four-inch valve to 65 pounds for the eight inch. "We're kind of proud of our surge system," Mitchell says. "Ours hasn't been changed since it came out. It's not complicated, but it will do the job. I felt we should keep the surge system as clean and simple as possible."

For more information about Hastings surge valves and the Brandon and Clark time-control box, contact James P. Mitchell at Box 517, Wolfforth, Texas 79382, or telephone (806) 863-2534 or (806) 924-6706.

The Bartos Valve

The surge valve manufactured by Jim Bartos, owner of Aluminum Metal Products, Inc. in Lubbock, focuses on the basics. Bartos' valve uses no computer, assuming the farmer knows the amount of time it will take the water to flow to the end of the row under various field conditions. "The main thing about our surge system is simplicity and reliability," Bartos says.

The surge unit operates with a Y-shaped valve that swings between the valve openings, simultaneously blocking one opening and guiding water through the other. An ordinary 12-volt car battery powers the time-control box, which may operate automatically or manually. Two sets of buttons set the surge time, and the off-time. The sets consist of buttons marked in minute increments, starting with one minute and successively doubling up to 512 minutes. The desired surge time is obtained by pressing combinations of buttons.

Once the system is on, it will run until the times are changed or the box is switched off. A more advanced time-control box can be programmed for up to three consecutive surge times. A four-inch model is available with a solar-powered battery.

Bartos notes the easy maintenance of his surge unit as a primary advantage. "If the timer goes bad, you just have to unplug it and put in a new one. You don't have to take the whole system in to have it repaired. With 99 percent of our surge valves I can go out in the field and fix it on-line, without ever pulling it out of the field."

Bartos' valve requires no water pressure to operate the valves, and it weighs about 50 pounds. Now in its third year of distribution, the surge unit features long slip couplers for row adjustment and three- to eight-inch pipe sizes.

For more information about the Bartos surge valve, contact Jim Bartos, Aluminum Metal Products, Inc., Route 10, Box 7, Lubbock, Texas 79404, or phone (806) 745-6026.

Hydropulse

"I looked at them from the standpoint of the farmer, not the engineer," says Ken Jamerson, sales and marketing director of Hydropulse, Inc., as he explains the design of the Hydropulse surge unit. "Basically what the farmers like is the simplicity of it. There's just less to go wrong."

Jamerson used his farming experience to develop guidelines for Michael Wiseman, the engineer and president of Hydropulse, Inc., who designed and manufactures Hydropulse surge valves.

The Hydropulse surge unit operates with a valve that moves along the top of the inside of the tee, over the water. "The unique thing about this valve is that the valve doesn't drive against water at all. Sand and rocks don't cause any problem with this valve," Jamerson explains. The valve eliminates drag and water chatter and reduces power consumption.

On the control box, three buttons operate the surge valve. One button turns the power on, one loads the time and one switches the valve back and forth to test the surge. Two thumbwheels set the surge time in hours and minutes, and two liquid display panels show the elapsed time and number of cycles run. "All a farmer has to do is load it and it's set," Jamerson says. The control box may be powered by a self-contained rechargeable battery or a solar panel.

An advanced timer called Master Link, which will include a cut-back timer, should be available in a few months. The Hydropulse also features a flanged body which enables the valve to interchange with different pipe sizes.

Another advantage according to Jamerson is the valve's mid-row watering capability, which allows water to flow out the back of the tee. "It lets you hit the row without moving the valve around," Jamerson points out. Simultaneous water flow out both sides of the valve is also possible.

Hydropulse comes in a six-inch valve size that weighs 51 pounds with ends and an eight-inch valve size that weighs 59 pounds with ends. It features a fold-down carry handle.

Hydropulse is manufactured in Bryan, Texas, and is available through local dealers. For a list of Hydropulse dealers, contact Ken Jamerson at Box 476, Clovis, New Mexico 88101, or Hydropulse, Inc., at 1108 Mockingbird, Bryan, Texas 77803.

Smar-Tee and Sparc-Tee

The key to his valve, says Jim Miller, president of Miller Manufacturing Systems, Inc., is simplicity of operation and ease of understanding. "The main purpose for the simplicity of our valve is so that everybody can work it," he says. "The lower the level of expertise needed, the more apt a person is to use the valve the way it should be used."

Both lines of surge units, the Smar-Tee and the Sparc-Tee, operate with dual butterfly valves. Each disc is attached to an arm. The two arms con-

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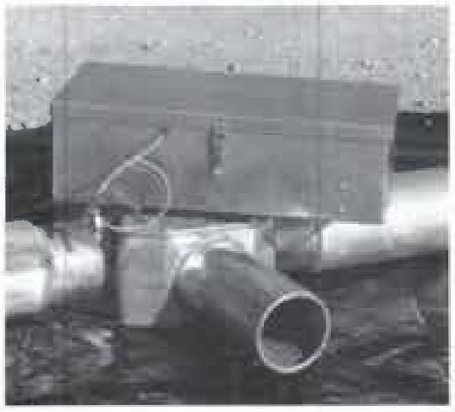

DECISIONS, DECISIONS, DECISIONS: That's what faces irrigators as they check out the variety of features offered on the various surge systems available today. Pictured left to right are the Hastings Valve, the Bartos Valve (top row), the Hydropulse Valve, and the Sparc-Tee (bottom row).

SOLAR POWERED surge units come in all sizes and shapes with various types of valve openings. Pictured here are three units, the Solar Surge (top left), P&R Auto Pro Jr (top right) and the Waterman surge unit (bottom left), which all operate on the power of the sun.

VARIETY . . . continued from page 2

nect to a common rod and move together to open or close the valves with no possibility of both valves being closed at the same time.

Miller Manufacturing Systems offers three options in the Smar-Tee, the simpler of the valve lines, which was first introduced in 1983. It may run with either a battery or a solar panel. "We introduced this valve trying to keep it as simple as we could," says Miller describing the single timer. "With this valve all you do is set it on run and turn it to the time you want it to run."

The multi-timer control boxes available on Smar-Tee II and Sparc-Tee are more advanced. "It's an advancement into multi-level programming," says Miller. On the control box, two bar graphs display the time and number of cycles in 15-minute increments up to eight hours. In addition to the graphs, five buttons allow operation of the box. One button is marked "P" and combined with buttons marked "1" and "2", it will set the time of two surge cycles and also show how much time remains on each cycle. A button labeled "S" will program a soak cycle. The fifth button, "R", automatically switches surge sides. Both boxes run on solar power.

The specialty of Sparc-Tee is a radio transmitter which provides "absolute control of tailwater," says Miller. A tripod equipped with a radio transmitter and containing a water sensing device is set in a tailwater pit or potential water stream. When water hits the water sensing device, the transmitter signals the control box which automatically "forgets" its programmed interval and goes into soak cycle. If water again reaches the tripod, the control box will switch back to the other set. Sparc-Tee weighs about 55 pounds.

All valves include long slip couplets to aid in row adjustment and gated pipes behind the tee to allow surging behind the tee.

For inquiries about Smar-Tee and Sparc-Tee, contact Jim Miller at Miller Manufacturing Systems, Inc., 3201 Northwest Canyon Street, P. O. Box 1685, Plainview, Texas 79073-1685, or call (806) 293-1304.

Solar Surge

The Solar Surge valve system combines an optional single, dual or multi-program time-control box with a patented drive mechanism to move the valve. "I think the big thing that I have is a slow valve change," says Robin Spain, who developed the system and manages Olton Farm Supply which manufactures the valve.

"The patented rack and pinion drive mechanism moves a plunger back and forth between the seats. A spring in the valve mechanism allows flexibility when closing one side in case shale or other foreign objects get caught in the valve."

The slow moving main valve contains a pressure relief valve. This valve opens initially to relieve water pressure, immediately followed by the opening of the main valve. "One of the big advantages of this valve is that it is a slow opening valve unit. Most of our motors will open on roughly a 20-second opening time," points out Don Spain, owner of Olton Farm Supply and partner in the Solar Surge valve. These modifications enable the valve to switch under high pressure and prevents "water pound," which can jolt pipes out of line.

The Solar Surge also features Teflon bearings at all wear points. "The big advantage to Teflon is that it has less friction than any other material we know of. It's very durable and has good wear characteristics," notes Don Spain.

Control boxes are available with single, dual, or multi-program timers. With the single timer, the operator merely sets the surge time on the thumbwheel dial, flips the switch to "on" and pushes a reset button. The machine is then ready to operate.

A dual timer provides a cut-back surge time. Two thumbwheels control the dual timer; one sets the initial surge time and the other sets the number of cycles and the cut-back time. A reset button triggers the plunger back and forth between seats to test the surging and clear the time. A second reset button clears the cycle.

"It's so simple to use. You don't even have to have instructions to figure it out," comments Robin Spain. The boxes may be powered by a solar battery or a common car battery.

A new multi-program timer equipped with a keyboard and microprocessor will soon be available. It will have an eight program capability and a countdown display.

"The Solar Surge is one of the lighter valves on the market for the power," says Don Spain, noting that the eight-inch valve weighs about 43 pounds. He also points out the long slip couplets that allow for easier adjustment of the gated pipe to match up with the furrows. In addition, gates are built into the pipe to water behind the tee.

To find out more about Solar Surge contact Robin Spain by writing Drawer U, Olton, Texas 79064, or calling (806) 285-2404.

P&R Surge Systems

The trick to managing P&R surge valve systems, Auto Pro and Pro Jr, is out-time; the time it takes the water to travel to the end of the row. According to Patricia Bruno, co-founder of P&R Surge Systems, all an operator has to do to operate the Pro units is enter the time of one irrigation set. The control box of the surge unit will do the rest, dividing that time into sets of surge cycles.

Multiple time settings highlight the P&R control box, with the option of manual or automatic programming. The operator may program the box with up to 12 time and cycle settings, or the computer may automatically program the number of cycles and time of each cycle, including a cut-back time. In this case, the user merely enters the out-time. Cycle times may be changed at any point and the computer will automatically adjust the program.

"The common misconception is that there's too many irrigation variables, that you can't make a surge system automatic," Bruno says. "We realized that even though all factors affect irrigation, the one common variable was how long does it take water to get to the end of the row. That's the number you want to put in the box."

On the Auto Pro, a numbered keyboard facilitates programming and a display panel shows the cycle number, the total elapsed run time and how much time is left on the cycle. "The trick to surge is managing your timing to suit your needs. When you have the option of a variable cycle time, you have a tool that allows more control and more even water infiltration into the soil profile," Bruno explains.

Pro Jr. is a smaller, simpler version of Auto Pro, but it functions basically the same. Pro Jr. is programmed by dials, and the program may not be changed midstream as with Auto Pro. "It's smaller and it's just as smart as Auto Pro. All a farmer has to know is the out-time to set it and turn it on. Anyone can run Pro Jr.," Bruno says.

"The biggest factor about Pro Jr. is that it's much cheaper. It's very inexpensive and very simple to run, but it doesn't sacrifice the sophistication of having automatic variable cycles or the ability to adjust cut-back time or to have a manual system if the farmer wants it."

P&R surge valves use a butterfly valve to control the direction of the water flow. The disc swivels from a center position inside the tee, forcing the water through one valve opening while blocking flow into the other. All P&R control boxes use solar charge batteries for power. The valves can accommodate pipe sizes from four to ten inches and weigh about 20 to 55 pounds.

For inquiries about P&R surge valves, contact Robert or Patricia Bruno at P&R Surge Systems, P. O. Box 3361, Lubbock, Texas 79452, (806) 747-0065.

Waterman

If you know the length of your rows, then you can operate the Waterman surge valve. "It's very sophisticated, yet we've tried to make it as simple as

continued on page 4 . . . SURGE

DEALERS BELIEVE IN SURGE

Numerous sophisticated options, designs and programmable functions are available in the surge units on the market today. However, a common thread runs throughout the surge market. The dealers believe that it's more important to use surge in your furrow irrigation system than it is to have any or all of the sophisticated functions available in the valves and time-control mechanisms themselves.

- "It doesn't matter whose surge unit you use as long as you use one. They just give you so much more management of irrigation water, and you just can't furrow irrigate without one in today's economic times." —James P. Mitchell, Hasting Valves.
- "What it boils down to is a savings on cost and water. The main advantage to surge is that there is a more uniform distribution of the water applied. Surge can cut watering costs down to where the farmer can have a better chance of making a profit. Along with that, you can better determine the amount of water you want to put down with a surge system than you can without one." —Jim Bartos, The Bartos Valve.
- "I believe if you're using furrow irrigation, you need a surge unit. The surge pays for itself in a year, and you can save water." —Ken Jamerson, Hydropulse Inc.
- "It's much more important to have a surge than it is to have one with a lot of capabilities." —Jim Miller, Miller Manufacturing Systems, Inc.
- "The main benefit of surge valves is the crop uniformity. You get better yields with surge valves if they are properly managed. That's where you make your money, in improved yields." —Robin Spain, Solar Surge.
- "Surge can lower your water, energy, fertilizer and labor costs. It can raise your irrigation efficiency and deliver water and energy savings of 10 to 25 percent or more. With surge you can pump less and leave more water for the next time." —Patricia Bruno, P&R Surge Systems.

DANGERS . . . continued from page 1
activities. "Sometimes they find that the wells they plan to check have been abandoned, or they discover an open hole and mark the location on their map," Goolsby clarified.

During the first two months of 1986, the District staff conducted similar supplemental water-level surveys in Bailey, Lamb, Hale and Floyd Counties. "No doubt upon completion of this surveying work, numerous people will be notified of open holes that exist in these areas," Goolsby said.

Protected By Law

It is against state law and the District's rules for unused wells to be improperly covered except when the well is in actual use by the owner or operator of the property. A permanent covering must sustain a weight of at least 400 pounds by District rules.

Direct Route For Pollution

The danger posed by open holes consists of more than the hazard of people falling in, Goolsby explains. "There have been a lot of cases where animals have fallen into wells. Pollution is also a big concern for the Water District's staff as well as for landowners. Open holes can be a direct route for pollution to enter the fresh water aquifer. If you have an open hole and someone decides to get rid of some old chemicals by dumping them in the hole, the chemical will go directly to the aquifer. Once the aquifer is polluted, it is very difficult to clean it up."

Permits Checked

Another way the District discovers abandoned wells is by checking permitted wells for various reasons in the course of District activities. Goolsby explains, "Nearly all the wells that are permitted are visited at one time or another to make sure the well is where the permit showed it to be. All cancelled permits are investigated to see whether or not the well was actually drilled, and if it was drilled and abandoned, to see if it was properly covered."

Reports from individuals constitute a third way abandoned wells are found. "Open holes can be found because of complaints from individuals who for one reason or another see the open hole," says Goolsby. "A lot of times surveyors will note these open holes, and hunters also are very conscientious about notifying the District of open holes they happen upon during hunting season."

Tell-Tail Signs

One reason open holes can present such a danger is because they are often hard to see. However, they may be spotted by some common characteristics.

"There are a lot of tell-tail signs," Goolsby points out. "It used to be that almost all wells were drilled on a high point in the field. There may also be a clump of weeds that the farmer plows around. There's usually a reason why the farmer doesn't plow in a certain location.

"A real tell-tail sign of an abandoned well is a lonesome tree. Almost all the old wells used to have trees planted by them. If a producing well is still by the tree, a farmer will generally keep the area around the tree clean. If weeds have grown up actively around the tree, then that's usually a good indication that an abandoned well is there, and its a good bet that it is an open hole."

Correcting The Problem

When a District staff member spots an open hole, the well location is marked on a legal description map. Goolsby heads the open hole program for the Water District, so he then investigates the report. Goolsby visits the County Agricultural Stabilization and Conservation Service and/or the county appraisal district to identify the landowner and get the correct mailing address of the owner and operator.

The landowner/operator is then notified of the condition of the open hole and allowed a reasonable amount of time, at least 30 days, to correct the problem. After that time period, a return visit is made to the site to determine whether or not the condition still exists or has been properly taken care of.

If the well hole has not been properly sealed and the correct landowner has been notified, then a certified letter is sent, which allows the owner/operator 10 days to correct the problem. After 10 days, if the condition still exists, then the District will take legal action to remedy the problem.

"The District is not interested in taking legal action," Goolsby comments. "Our only interest is getting the open hole covered. Legal action is pursued only as a last resort.

"I often write the landowner another letter in cases where the well can be taken care of by the District staff," he adds. The District, at its cost, installs plugs for wells that can be capped.

Because abandoned wells present such serious safety and health concerns for residents of the Water District's service area, it is very important that these holes be suitably sealed. "The open hole program is a continuous, on-going part of the District's operation. Any person having knowledge of these hazardous situations is asked to notify the District and provide a good description of where the well is located." —BS

SURGE . . . continued from page 3
we possibly could, to make it simple on the irrigator," says Waterman salesman Alan Uptergrove.

Waterman offers single butterfly valve discs for six-, eight- and ten-inch pipe sizes, and dual butterfly discs for a seven-inch pipe size. The single disc directs the flow of water from a center position in the tee, blocking flow from one valve opening while sending water through the other side. The disc may also be centered allowing water flow out both sides simultaneously.

"Its universal in the fact that it allows you to split water on both sides. Some farmers like to push water to the end of the row as fast as they can, then cut back. This valve allows them to do that," Uptergrove points out.

The control box works on a row-length principle. "It is very sophisticated in that it has two automatic programs that enable the farmer to set his controller for quarter-mile rows and also half-mile rows. It has a third program which allows the farmer to enter the length of his rows if they are not quarter- or half-mile rows."

The control box consists of a numbered keyboard for programming. The box also positions the disc at left, right or center and displays the program number, the program level, the remaining time on the left and right sides, the disc position and the number of cycles.

To operate the control box, the operator enters the program he wishes to use and then runs the program. "For instance, if the irrigator has a quarter-mile row, all he has to do is turn on the box and push the run button to run the program," Uptergrove says.

Each of the programs contains five levels corresponding to preset times. "The programs get longer until the fifth cycle, which is a cut-back cycle time. This allows you to get uniform application and reduce tailwater," Uptergrove explains.

If the user sets his own row length then he must set his own times. The time on any level may be changed without disturbing the other levels. Waterman surge units are solar powered and the valves fit six- to ten-inch pipe sizes, and weigh 40 to 60 pounds.

For more information on Waterman valves, contact Alan Uptergrove at Waterman Industries Sales, Inc., P. O. Box 3194, 1111 N. Avenue T, Lubbock, Texas 79417, (806) 763-5934, or contact Waterman Industries, Inc. at 25500 Road 204, P. O. Box 458, Exeter, California 93221, for a list of dealers.

No matter which of the valve design options or innovative time-control programming functions the irrigator selects, all the dealers believe in the benefits of surge irrigation as a major improvement in the efficiency and uniformity of applying irrigation water under furrow irrigation. —BS

PLAYA BASINS . . . continued from page 1
basin that was full of water when they started irrigating.

"I wouldn't be a bit surprised if we saved more than half of our fuel costs last year," notes Fawver. "Utilizing the playa water saved my renter a lot of money."

Fawver sees additional benefits to utilizing his playa water in his particular farming situation. "My lake pump will pump more water than my wells will," adds Fawver. "I can run 30 gates off two irrigation wells, but I can run 60 gates off of the lake pump."

Minimal Investment

A pumping plant for reclaiming water from a playa basin can be set up and ready to deliver water for an initial investment of about $3,000; an investment that can be recovered in the first year based on fuel savings and increased yields.

There are additional benefits to pumping water from playa basins that many irrigators might not think of as they consider utilizing the water for irrigation. By pumping water from the basin, a primary breeding ground for mosquitos is eliminated and weed growth can be reduced.

Playa basins in the High Plains have served various purposes throughout the centuries. However, in today's agricultural economy they may be one of the greatest resources available to the irrigator, helping him increase profits through crop production on the reclaimed land, controlling weeds and mosquitos and, most importantly, conserving fuel costs and the valuable water resources of the Ogallala aquifer for later use. —KR

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Soil Samples May Unravel Declining Cotton Yield Mystery

PRODUCTION/WATER-USE EFFICIENCY AFFECTED BY NUTRIENT AVAILABILITY

By Kathy Redeker

Over the past 20 years, cotton yields in the High Plains of Texas have steadily declined, losing an estimated ten pounds of lint production per acre per year, according to recent studies by Don Ethridge, PhD, Agricultural Economist, Texas Tech University. Results of analyses on soil samples suggest that the availability of phosphorus and nitrogen may be the two most limiting factors in cotton production in the Texas High Plains.

Producers in this area normally strive to achieve cotton yields of one bale or more per acre. Dan Krieg, PhD, Plant and Soil Sciences, Texas Tech University, after reviewing the analysis of approximately 250 samples collected in seven Southern High Plains Counties says, "On a majority of the farms sampled, there is only enough nitrogen present in the top four feet of the soil profile to support yields of one-half bale per acre, no matter what the water supply." Additionally, Krieg says that the analyses reveal that in most cases, almost 50 percent of the total available phosphorus in the soil profile is held in the four-foot level, making it less available to the plant.

What the Analyses Show

Results of analyses on 250 soil samples taken from 72 fields show that only nitrogen and phosphorus levels are low enough to limit crop production. Plant nutrient levels measured included nitrogen, phosphorus, potassium, calcium, magnesium, zinc, iron, manganese, copper and sodium. Additionally, soil pH and salinity were measured.

In the 72 fields sampled, 52 had low or very low nitrogen levels, and 50 had low or very low phosphorus levels in the top foot of the soil profile. In the second foot, 36 had low or very low nitrogen levels and 54 had low or very low phosphorus levels.

Research to date also shows that the water-use efficiency of cotton grown under dryland and irrigated conditions can be increased eight percent and 15 percent respectively with proper fertilizer applications.

Obtaining Plant Nutrients

Most plants have a root growth pattern where 40 percent of the water extracted from the soil for plant growth is taken from the top foot of the soil profile, with 30 percent taken from the second foot, 20 percent from the third foot and 10 percent from the fourth foot. All plant nutrients taken from the soil are absorbed into the roots in a water solution.

"Under full irrigation, where good moisture is maintained in the top foot of the soil profile throughout the growing season, plants can draw the moisture and plant nutrients necessary for growth from this top foot," explains Art Onken, PhD, Professor of Soil Chemistry, Texas Agricultural Experiment Station in Lubbock. "But under dryland or limited irrigation, plants have to depend on the lower root zone soil profile to supply a part of the water and nutrients needed."

In dryland production systems or limited irrigation, the top foot of the soil profile is exposed to repeated wetting and drying cycles. Plants extract nutrients from the soil in the presence of plant available water. Soil nutrients cannot be obtained from the top foot during the dry cycles when plant available water is not present. Therefore, water and some nutrients will be obtained from the lower root zones. "If either water or the proper nutrients are not available in these lower zones at critical growth stages when the surface soil is dry, then we can only expect reduced yields," says Onken.

Nitrogen

Nitrogen is utilized by plants in the formation of proteins, which form the protoplasm of all living cells. Nitrogen is also required by plants in the production of compounds such as chlorophyll, nucleic acids and enzymes.

Of the two limiting factors revealed by this study, it appears that the nitrogen deficiency may be the easiest to overcome, because nitrogen moves within the soil profile in the presence of soil moisture, thus becoming readily available to the plant at depths where moisture is present.

Phosphorus

Phosphorus stimulates early growth and root formation in plants, while hastening maturity and promoting seed production.

Phosphorus deficiencies and applications create a whole new set of conditions since phosphorus does not move with moisture in the soil. Although producers may realize the need for additional phosphorus, addressing the problems of placement, distribution in the soil profile and plant availability can create more concern than the lack of phosphorus. In essence, phosphorus stays where it is placed in the soil. Research indicates that it will move down into the soil profile at a rate of only two-tenths of one inch per year under natural conditions.

"Results of the analyses of soil samples collected thus far," notes Krieg, "indicate that while the total phosphorus levels in the four-foot soil profile may be high, the availability of that phosphorus to the cotton plant and the distribution of that phosphorus in this four-foot soil profile create major problems with phosphorus utilization by the cotton plant."

With 50 percent of the phosphorus held in the fourth foot of the soil profile, Krieg explains, "This phosphorus is available only to a very limited extent due to the small percentage of the root system at this depth. The second foot of the soil profile represents the zone containing the most active roots. Here, phosphorus is very deficient in most cases. Krieg re-emphasizes that phosphorus does not move readily within the soil profile, and he adds that it is easily tied up on soil particles or in combination with other chemical constituents.

According to Soil Scientist Mike Risinger with the USDA-Soil Conservation Service in Lubbock, 85 percent of the phosphorus uptake by cotton occurs from emergence to peak flowering. The need for phosphorus uptake declines as the plant ages, dropping to 15 percent from the middle of the growth cycle to maturity. Following the high phosphorus uptake necessary during the rapid growth cycle, phosphorus

continued on page 4 . . . COTTON YIELDS

Maps Depict Total Change In Depth-To-Water

The maps on pages two and three of this issue of *The Cross Section* depict the net change in the depth-to-water as measured in the Water District's network of 950 water-level observation wells for the 10-year period from 1976 to 1986 and the 5-year period from 1981 to 1986. Figures denoted as pluses indicate a lessening depth-to-water, or an actual rise in the water level. Contours containing negative figures denote an increase in the depth-to-water level, or a declining water level in the aquifer.

A close inspection of the map on page two reveals that little or no change in the depth-to-water has occurred over the past ten years in the southern portions of the Water District's service area, most notably in Cochran, Hockley, Lubbock and Lynn Counties.

However, moving northward toward the central part of the Water District's service area, net changes in the measured depth-to-water range from a total decline of 10 feet to a total decline of 40 feet.

In the northernmost part of the Water District, including primarily Armstrong, Potter and Randall Counties, the net change in the depth-to-water level measurements drops back slightly, ranging from a total decline of 10 feet to a total decline of 20 feet.

By making a comparison of the ten-year net change map on page two and the five-year net change map on page three reveals that the rates of decline over the last five years have been reduced significantly throughout the Water District's service area, and in some portions of the southern areas of the District, water-level rises in excess of ten feet have been observed.

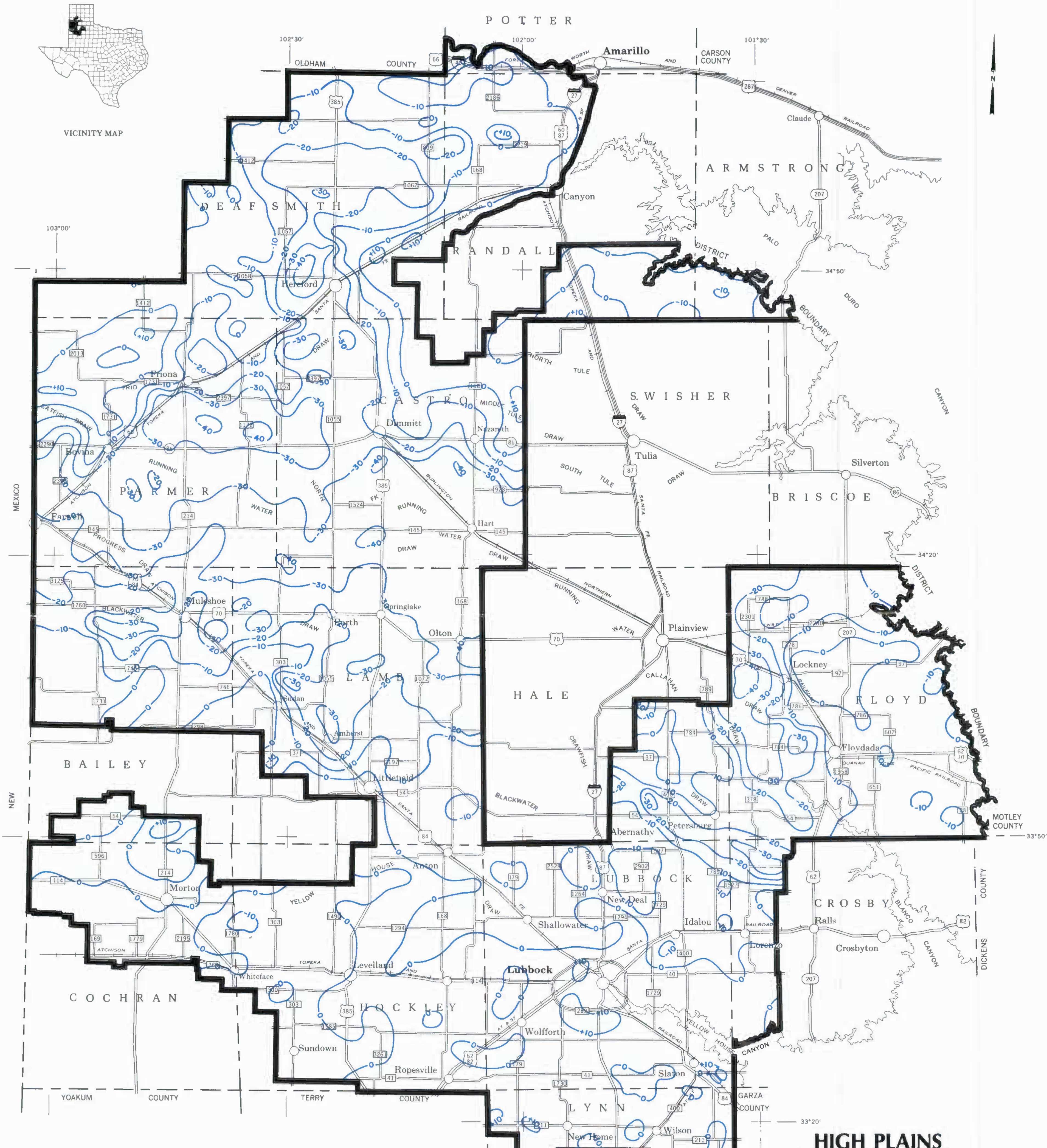
Averaging the declines illustrated on the ten-year net change map shows an annual rate of decline in the water level ranging from three to four feet or more. This condition exists throughout the areas where larger saturated thicknesses of the water formation occur, which are also the more heavily pumped areas of the aquifer.

However, on the same average basis, the five-year net change map indicates a lessening rate of decline for these same areas. Over the past five years, the annual rate of change has averaged a decline of only two to three feet per year.

"Over the last ten years, the northern counties have, in some instances, seen declines in excess of 40 feet in localized areas," notes Don McReynolds, District Geologist and Director of the Technical Division. "These declines may simply reflect the hydrology of the aquifer in those areas, or they may reflect extensive pumpage.

"In the last five years, particularly in the southern part of the District, I think we have seen the results of for-

continued on page 4 . . . CHANGE

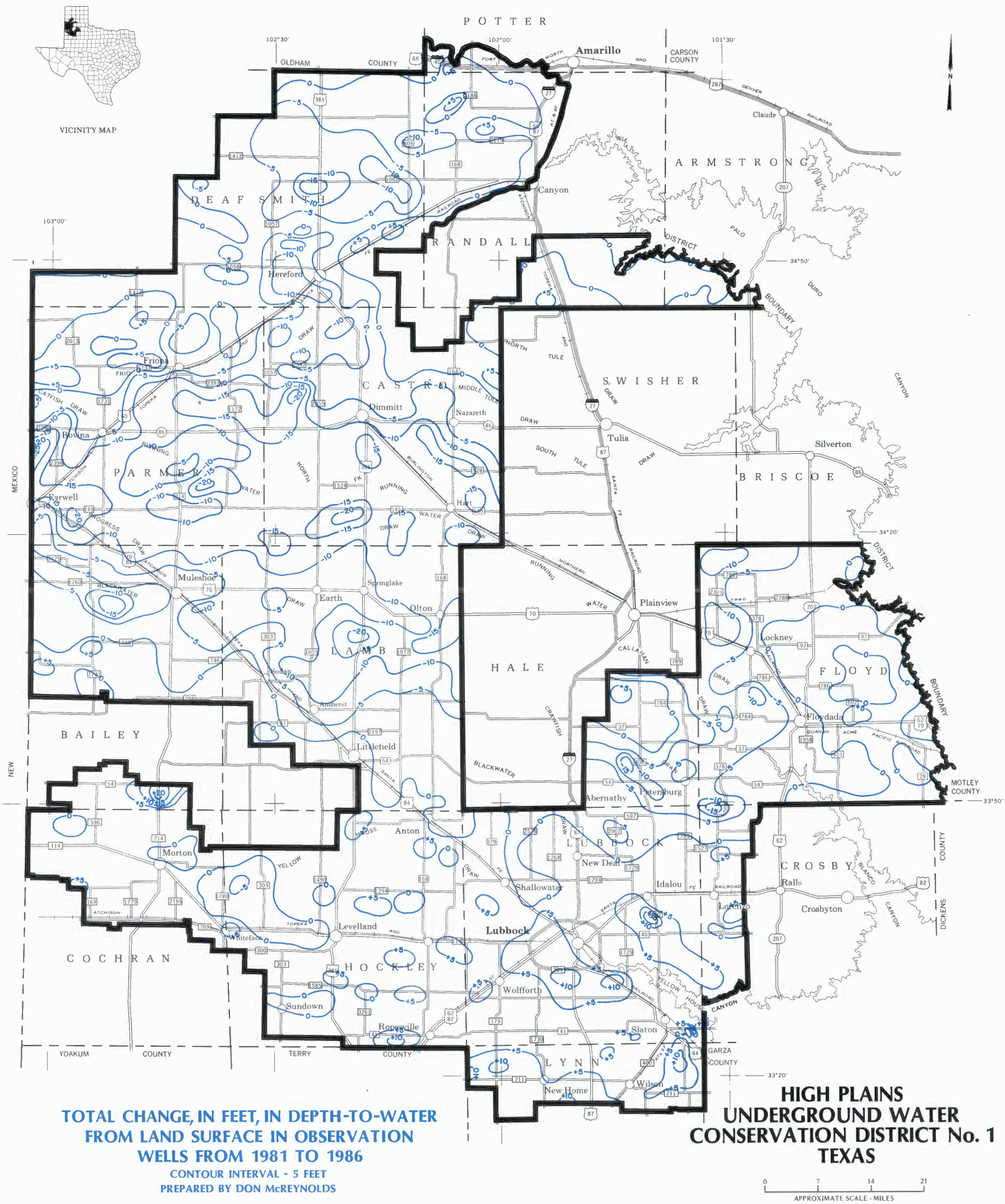


TOTAL CHANGE, IN FEET, IN DEPTH-TO-WATER FROM LAND SURFACE IN OBSERVATION WELLS FROM 1976 TO 1986

CONTOUR INTERVAL - 10 FEET

PREPARED BY DON McREYNOLDS

HIGH PLAINS UNDERGROUND WATER CONSERVATION DISTRICT No. 1 TEXAS



TOTAL CHANGE, IN FEET, IN DEPTH-TO-WATER FROM LAND SURFACE IN OBSERVATION WELLS FROM 1981 TO 1986

CONTOUR INTERVAL - 5 FEET

PREPARED BY DON McREYNOLDS

HIGH PLAINS UNDERGROUND WATER CONSERVATION DISTRICT No. 1 TEXAS

COTTON YIELDS . . . continued from pg. 1
that was previously taken in by the plant is remobilized in the plant for seed and lint production.

"The availability of phosphorus in the fourth foot of the soil profile is almost like not having any," notes Risinger. "By the time the plant's roots reach this level, the need for phosphorus is at its lowest point." Risinger also points out that high phosphorus levels in these lower zones also normally occur in conjunction with the presence of caliche. Calcium carbonate, when combined with phosphorus, tends to make phosphorus less available to plants.

Fertility Investments vs. Benefits

In today's agricultural economy, many producers have seen trimming down on their fertility program as one place where they could economize, trying to reduce input expenses and hold on to their limited profit potential.

"Fertilizer is an investment," notes Onken. "We are going to make that investment with the expectation of realizing a reasonable dollar return on the investment. If you put money into too much fertilizer, too little fertilizer, or the wrong combination of nutrients in the fertilizer you purchase, that affects the return on your investment."

Ethridge says, "If something isn't done to reverse the trend toward reduced cotton production, it is going to have serious effects on the ability of the High Plains producer to compete in the cotton market.

"When I look at yields in the Lubbock area for the past five years, I find that we average 360 pounds under supplementally irrigated conditions. According to Krieg's research, it appears we are putting on enough water and paying the fuel bills associated with that water production to realize a yield of 480 pounds," notes Ethridge.

Krieg's research indicates that obtaining a cotton yield of one bale per acre requires 80 to 90 pounds of nitrogen and 20 to 25 pounds of phosphorus.

Putting A Pencil To It

To determine the economic benefits of applying additional quantities of nitrogen and phosphorus, Ethridge sets up a hypothetical situation. In this analysis it is assumed that some plant nutrients are available based on soil samples and that only a limited amount of additional fertilizer is added. "When irrigated cotton yields are 360 pounds of lint per acre, with 40 pounds of nitrogen and 7 pounds of phosphorus applied per acre and 10 acre-inches of water applied, the variable costs would be $181 and total costs would be $271 per acre.

"Now let's say that we increase the nitrogen by 20 pounds per acre and the phosphorus by 10 pounds per acre; and as a result, we achieve a 120 pound yield increase per acre (from 360 pounds of lint per acre to 480 pounds of lint per acre). Here we assume that we have no additional fertilizer application or incorporation costs, because we are applying fertilizer already and adding more phosphorus and nitrogen would not increase our application costs. Now, if nitrogen costs 18 cents per pound and phosphorus costs 23 cents per pound, we have increased our fertilizer costs by $6 per acre. The yield increase would also increase harvesting and ginning costs by $17 per acre.

"If the producer's price of lint is 50 cents per pound, the $23 added cost for the nutrients, harvesting and ginning would produce $60 of added income. Thus the producer would be better off even with the current depressed cotton market."

Looking at it another way, Ethridge notes that the per pound variable cost of producing cotton would decline from 50 cents to 43 cents per pound, or reduce the producer's cost by 7 cents per pound as a result of the yield increase. The total value of 7 cents per pound on the two million bales of cotton produced in the High Plains of Texas would equal increased producer profits in the neighborhood of $70 million dollars. Multiplying the producer's increased profits through spin-offs into the area's economy could mean $210 million into the economy of West Texas.

Economically speaking, it appears that the cost of the proper plant nutrients, purchased and applied to achieve optimum benefits, may be well worth the investment in the above hypothetical situation. The economics for the individual producer would, of course, depend on his particular situation.

Soil samples have thus far been collected at one-foot intervals to a depth of four feet in Cochran, Crosby, Floyd, Hale, Hockley, Lubbock and Lynn Counties at the soil moisture monitoring sites maintained by the High Plains Underground Water Conservation District No. 1. Analyses have been performed by the Texas Agricultural Extension Service in Lubbock.

Researchers all agree that the data collected thus far seem to indicate that availability of phosphorus and nitrogen may be limiting the potential for cotton production in the area. They also agree that deep placement of phosphorus might be beneficial to cotton production in those years when the surface is dry and the crop needs to depend on the subsoil for water and nutrients. Charles Wendt, PhD, Texas Agricultural Experiment Station, notes, "Research at the station during the past two years shows that no response can be expected in years when the rainfall is well distributed during the growing season so that adequate water and nutrients are available on the surface for a good yield."

The researchers also caution producers about applying the preliminary results of these analyses too broadly. They suggest that individual soil samples be collected at both the one-foot and two-foot levels for analysis to determine fertility requirements based on site specific information.

The Texas Agricultural Extension Service has over 20 years experience in analyzing soil samples and providing recommendations on the fertility requirements for optimum production in soils in the Texas High Plains. Samples collected by the individual can be analyzed for a cost of $10. For further information on collecting soil samples for analysis, contact Michael Hickey, PhD, Soil Chemist/Fertility, Texas Agricultural Extension Service, Route 3, Box 213AA, Lubbock, Texas 79401, or phone 806-746-6101.

This soil sampling program resulted from work performed by Charles Wendt who collected soil samples at the station at six-inch intervals to a depth of six feet. Wendt's concern over the lack of available nutrients in the lower parts of the soil profile prompted the Water District's sampling efforts. Indications that water-use efficiency is adversely affected by the availability of plant nutrients enhanced the Water District's interest in soil sampling to verify Wendt's theory.

Further refinement of the results obtained in this program to date will develop as additional soil samples are taken throughout the High Plains Water District's service area. Additionally, research plots are being selected to determine the effects of various fertility treatments, such as deep placement of phosphorus, on cotton production.

Nutrient requirements for select yield levels of cotton and grain sorghum.

Nutrient contents are the amount that is taken up by the plant.

Cotton (pounds/acre)			*Total Nitrogen*	*Total Phosphorus*	*Water Requirement*
Lint	*Veg.*	*Seed*	*pounds/acre*		*inches/acre*
300	1000	580	50 - 60	12 - 15	18
500	1600	900	80 - 90	20 - 25	22
750	2000	1350	110 - 120	35 - 40	30
1000	2400	1800	140 - 150	50 - 60	36

One inch of water above eight inches will yield approximately 35 pounds of lint and 60 pounds of seed and requires the presence of five pounds of nitrogen and one pound of phosphorus.

Grain Sorghum (pounds/acre)		*Total Nitrogen*	*Total Phosphorus*	*Water Requirement*
Veg.	*Grain*	*pounds/acre*		*inches/acre*
1200	1000	40	8	10
6000	5000	150	35	16
9000	8000	210	60	21

Each inch of water above eight inches will yield about 600 to 700 pounds of grain and requires about 10 to 12 pounds of nitrogen and 2 to 3 pounds of phosphorus to maximize the use efficiency of the water. Water stress reduces grain yield more than it reduces stalk and leaf production. When less water is available, plant efficiency is reduced and soil fertility requirements are higher per unit of grain yield.

CHANGE . . . continued from page 1
tunate rainfall and a lack of well use resulting in actual rises in the water level in some wells. These rises may follow general trends of a stabilizing of the aquifer and a filling in of the cones of depression created over years of continual pumpage as well as some natural recharge," adds McReynolds.

"Naturally, the areas with the largest change in the depth-to-water correspond to areas with the largest saturated thickness," explains McReynolds.

All records of observation wells were used in the construction of the maps. However, for wells that were more recently added to the observation well network, where records for a complete ten-year period were unavailable, averages were used for the yearly declines that could be expected for the area in which the well is located. —KR

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Soil Fertility Deficits Spark Plant Nutrient Studies

EDITOR'S NOTE: *In the June issue of The Cross Section, we reported that results and interpretation of soil sample analyses suggest that the availability of phosphorus and nitrogen may be limiting the potential for cotton production in the Southern High Plains of Texas. Continuation of this soil sampling effort has been hampered in recent weeks by rainfall throughout the High Plains. However, District personnel are now continuing this effort throughout the Water District's service area. Meanwhile, several research projects have evolved as a result of this initial soil sampling work performed by the High Plains Water District and the Soil Conservation Service. The following presents an overview of the research projects that have developed to date.*

Recent fertility analyses on soil samples taken from a four-foot root zone soil profile at select sites in seven Southern High Plains counties show that producers could be robbed of valuable soil moisture as well as potential yields by limited availability of nitrogen and phosphorus.

All plants draw the nutrients necessary for growth and fruit development from the soil in a water solution. Consequently, it is theorized that plants will continuously draw moisture from the soil until their nutrient needs are met. If adequate nutrients are not available in the soil, plants draw more moisture than what is actually needed, attempting to satisfy their nutrient needs. Thus water-use efficiency is reduced.

To better define the relationships between nutrient availability and water-use efficiency and to evaluate the potential economic benefits of increasing fertilizer applications, including the deep placement of phosphorus, the Board of Directors of the High Plains Underground Water Conservation District No. 1 recently approved contracts with researchers at the Texas Agricultural Experiment Station and Texas Tech University.

Water-Use Efficiency Evaluated

The first of the research projects funded is designed to: 1) determine the influence of different water application levels on water-use efficiency, 2) determine the influence of nitrogen and phosphorus applied separately and together on water-use efficiency, 3) determine the interaction of water and nutrients on water-use efficiency, and 4) determine the influence of different water application levels on the uptake of nitrogen and phosphorus from different fertilizer treatments. This effort centers on cotton production.

Utilizing a 60-foot by 40-foot rain-out shelter at the Lubbock Experiment Station, Dr. Charles Wendt and Dr. Arthur Onken propose to treat cotton in container grown conditions to water applications equalling 100 percent of the evaporative demand and 50 percent of the evaporative demand, while applying fertilizers in amounts ranging from none for control, to 80 pounds per acre of nitrogen and 80 pounds per acre of phosphorus applied separately, to 80 pounds per acre of nitrogen and phosphorus applied together.

By harvesting eight plants from each treatment level six times during the growing season, the researchers hope to determine nitrogen and phosphorus levels in the plants and thus evaluate the effect of the water and fertility treatments on nutrient uptake.

Phosphorus Deep Placement

The second research project, also to be conducted by Drs. Onken and Wendt, is designed to determine the effects of deep placement of phosphorus on crop yields. Natural movement of phosphorus in the soil is only about two-tenths of one inch annually. Phosphorus applied on the surface may not get worked into the soil deep enough to be available for plant use under normal cultivation practices.

In this project, the researchers will be working with ten cooperators who will allow a small part of their fields to be used to evaluate the effect of various phosphorus placement techniques on the yield of different crops. Additionally, the researchers intend to apply different fertilizer treatments, based on soil sample analysis, to determine the nutrient requirements of various crops.

Using a minimum of four 100-foot rows, the researchers plan to utilize several phosphorus placement techniques to determine the most effective and cost efficient means of supplementing phosphorus in the soil. Plot one will receive no phosphorus treatment at all, and it will be used as a check plot. The second site will be deep chiseled to a depth of 16 inches only, with no additional phosphorus applied. The third will receive the recommended phosphorus application, based on soil sample analysis. Here the fertilizer will be applied with conventional chisels at a depth of four to six inches. Next, the researchers will apply the recommended phosphorus rates with conventional chisels and adding fertilizer at a depth of 16 inches. And finally, the recommended fertilizer rates will be applied with conventional chisels plus a deep chiseling.

To accomplish the second objective of this study, various fertilizer rates will be applied to a minimum of four 50-foot rows in all possible combinations. Nitrogen rates applied will include 0, 15, 30, 45, and 60 pounds per acre. Phosphorus will be applied at rates of 0, 15 and 30 pounds per acre.

continued on page 2 . . . SOIL FERTILITY

PLAYA WATER VALUABLE—With recent rains, many playa basins contain large quantities of water that will evaporate quickly if not utilized for irrigation. Comparing the cost of pumping playa water to pumping water from the aquifer, irrigators report savings of 50 percent or more. Doubling or tripling the number of rows per set watered with playa water and saving water in the aquifer are also advantages reported by irrigators.

DISTRICT BOARD APPROVES FIRST WATER CONSERVATION LOANS

Ten High Plains irrigators recently received approval of their loan applications made under the new Agricultural Water Conservation Loan Program which was created by voter approval of a constitutional amendment in the November 1985 general election. These 10 loans are the first loans to be made state-wide under the new program.

At the conclusion of the High Plains Water District's June 1986 Board of Directors meeting, 11 low-interest loans totalling approximately $169,000 had been approved which will allow these irrigators to upgrade the efficiency of their irrigation application and distribution systems.

Not only are these loans the first made under the newly created state-wide program, but they are also the first loans made by the Water District since receiving a loan of $1 million from the Texas Water Development Board.

These first loans consist of applications for six center pivot sprinkler irrigation systems, three separate applications for ten surge valves per applicant, one laser land levelling equipment application, and one application for the purchase of furrow diking equipment.

Of the first irrigators who will receive a loan from the Water District under this program, four were from Castro County, three from Parmer County, two from Lubbock and one each from Deaf Smith and Lamb counties.

Several new applications have been received by the District that will be presented for Board consideration at the July Board of Directors meeting.

Through the District's ag loan program, farmers may borrow funds to develop better water management practices, particularly in regard to purchase of equipment to upgrade the efficiency of their irrigation distribution and application systems. Up to $100,000 may be loaned to an individual applicant for a maximum term of eight years. The loans carry a 6.75 percent interest rate plus a one-time service fee of 2.5 percent of the loan amount. The District must distribute the first $1 million in loan funds within 120 days or return any remaining funds to the Texas Water Development Board.

Anyone interested in taking advantage of this low-interest loan program may obtain loan application forms and program guidelines at the Water District's Lubbock office, 2930 Avenue Q, Lubbock, Texas 79405, 806-762-0181.

—BS/KR

TIPS HELP URBAN IRRIGATORS PRACTICE WATER CONSERVATION

"Urban irrigators," who water lawns, flower beds and vegetable gardens during the summer months, utilize 1.25 million acre feet of water annually in the care and maintenance of residential landscapes. Urban irrigators should take the same care and precaution as farmers do to assure that the water they use is applied efficiently, with minimal water losses, and effectively for maximum plant use.

In West Texas, the average family of four utilizes about 660 gallons of water per day in and around the home, with 35 percent of that total used outside.

Why Conserve Water?

There are several reasons for urban residents to conserve water:

- To reduce their utility bills,
- To eliminate or postpone the need for their city to construct new water facilities to meet growing demands, and
- To extend the life of existing groundwater resources.

As an example, in a city of 200,000 people with an average per person per day water use of 165 gallons, the city would use an average of 33,000,000 gallons of water per day. If a 20 percent decrease in daily use could be obtained through conservation, the same 33,000,000 gallons of water would supply the needs of 250,000 people.

Additionally, here in West Texas water is a limited resource. The ground water we save now will be available for use in the future.

Helpful Hints

There are some helpful hints that can be followed by urban residents to help conserve their water resources, while maintaining attractive landscapes and productive garden areas.

First, remember that rainfall runoff from your house, driveway and sidewalks provide a free source of good quality water. Directing this water onto your lawn and into the garden will provide a large part of the water needs of lawns and gardens during the growing season.

General Tips For Lawn Care

As a general rule, it is important to maintain good moisture during seed germination and seedling emergence when establishing a new lawn. A mulch or residue placed on the surface after seeds are scattered will help retain moisture for seedling emergence. During the heat of the day, moisture in the top inch of the soil will evaporate, so light daily waterings will be needed until the seedlings emerge and grass gets established.

After lawns are established, watering needs vary depending mostly on weather conditions. Lawn water use is highest on hot days accompanied by high winds and low humidities.

The most common lawn grasses in this area are common and hybrid bermuda grasses. These grasses, with proper fertility, can go five to seven days or longer between waterings without loss of quality. Over fertilization will result in rapid growth, high water use and frequent mowing. Small applications of fertilizer in the spring, midsummer and early fall will keep your lawn grasses healthy and attractive with minimal effort and less water use.

It is also important to know when to water. Grass needs to be watered when tracks remain after someone has walked across the lawn or when the grass turns a gray-green color. Watering the lawn at night or in the early morning, when evaporation rates are low, is best. When watering, allow the soil to become wet to a depth of five to six inches.

The next time you water, why not check to see to what depth the soil has been wet? A small steel or wooden rod will push easily into the soil to the

continued on page 3 . . . URBAN

THE Cross SECTION

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Roger B. Gist, III, 1988 .... Rt. 1, Happy
Tom Payne, 1988 .... Rt. 1, Box 306, Canyon

NOTICE: Information regarding times and places of the monthy County Committee meeting can be secured from the respective County Secretaries.
Applications for well permits can be secured at the address shown below the respective County Secretary's name.

SOIL FERTILITY . . . continued from pg. 1

The researchers theorize that significant amounts of water, one to two inches per acre, are being left in the soil that could be used by plants if adequate nutrient supplies were available. By providing the proper fertilizer applications, the researchers believe that water-use efficiency can be increased by eight percent under dryland conditions and 15 percent under irrigated conditions.

Cotton Management System

In the third research proposal approved by the Board, Dr. Dan Krieg, Plant and Soil Sciences, Texas Tech University, proposes to develop a management system that will maximize the yield of a desirable quality cotton fiber on the Texas High Plains, where water supply and growing season length are less than optimum for cotton production.

Specifically, objectives of the project include: 1) development of a production system which will maximize the yield of a quality product when water is the single most important limitation (rainfed conditions); and 2) development of a production system which will maximize yield of a quality product when supplemental irrigation water can be used to alleviate water stress, and thus the nutrient supply and thermal environment (available heat units) become the greatest limitations to yield and fiber quality. A yield of 40 pounds of lint per inch of water applied is the goal in the first objective, and in the second, Krieg will be attempting to obtain a yield of 50 pounds of lint per inch of water applied.

Krieg's study will be performed on a clay loam soil in northeastern Lubbock County and a loamy fine sand soil in Terry County, which are representative soils of the major cotton production areas in the Southern High Plains. One system will be farmed as dryland and the other will receive water applications when 50 percent of the available water in the top three feet of the soil profile has been depleted. Fertility treatments will include two preplant nitrogen treatments, one of 0 and one of 50 pounds of nitrogen per acre, and two preplant polyphosphate treatments, one of 0 and one of 50 pounds per acre. Five midseason fertility treatments will include: 1) a sidedress of nitrogen and phosphorus at first flower, with 30 pounds of nitrogen chiseled into the soil, and with 30 pounds of nitrogen and 15 pounds of phosphate both chiseled into the soil; 2) foliar applications will be made beginning at the onset of flowering, with five pounds of nitrogen applied in three applications, and with five pounds of nitrogen and two pounds of phosphate applied in three applications; and 3) the fifth treatment will be the control site and will receive no additional fertilizer applications.

The primary objective of this experiment is to evaluate the water supply-nutrient supply interaction affecting water-use efficiency and productivity of cotton in a short growing season.

Verification

All three of these research proposals are designed to verify the preliminary conclusions that evolved from the soil sampling work performed by the Water District and the Soil Conservation Service which indicate that declining cotton yields may be linked to the availability of nitrogen and phosphorus in subsoil areas and to determine the most appropriate method of correcting the problem. —KR

Playa Recharge Experiments Await Rainfall Runoff

Continuing their research into artificial recharge utilizing water from playa basins, researchers at the Water Resources Center at Texas Tech University have installed three new drain fields in a playa basin near Shallowater, Texas.

"The filters are installed, the lines connecting the filter fields with the recharge well are completed and the flow meters are in place. All we're waiting for is sufficient runoff water to drain into the playa so we can open the valves and check the results," explains Dr. Lloyd Urban, Acting Director of the Water Resources Center.

These new drain fields have been designed and installed to further evaluate the potential for using native soil materials, sand and geotextile fabric filter materials to remove the silt, sand, sediments and biological life from playa water before the water is recharged into the Ogallala aquifer.

Previous experiments into artificial recharge utilizing playa water tested a wide variety of wick filters, geotextile filters and other drainage materials in various design configurations to evaluate the potential of using these materials to filter playa water for recharge.

Using the three best performing types of filter materials and drain installation designs identified in 1984-85 recharge experiments, project participants hope to find a practical, effective and economical method of recharging playa water.

Each of the new drain fields covers approximately eight-tenths of an acre in the base of a playa basin owned jointly by Hank and R. W. Woodruff and Pat and Sonny Lupton. This playa basin is the same used in previous experiments. Approximately 2400 feet of trenches and filter materials have been installed in each field.

How It Works

Rainfall runoff water collected in playa basins normally contains more than one ton of clay, silt and sand per acre foot when it first enters a playa basin. During the 24 to 48 hour period immediately after water is collected in the playa, a large portion of these suspended solids settles out of the water.

In this recharge project, valves on the lines that run from each drain field to the instrument shelter near the recharge well will be opened after this initial settling period. Water will then flow into the recharge well.

This recharge project is designed to take advantage of the inherent filtering capabilities of the natural materials which make up the base of playa basins. Almost all of the suspended solids contained in runoff water will be trapped in the soil and sand layers lying above the filter materials as water passes through them. Thus, only very fine suspended particles should remain in the water. These fine particles should be removed as the water passes through the filter materials.

Water samples will be collected from each drain line before the water enters the recharge well. The amount of suspended solids remaining in the water filtered from each drain field will be monitored, as will water quality, flow rates and recharge volumes.

"We hope that the project will have enough longevity for the system to remain in place and operational for several years," Urban says, noting that a portion of the economic and technical success of the project is dependent on the effective life of the installations.

Working On A Proven Theory

Results of previous work utilizing this recharge concept show that the concept is viable.

Artificial recharge tests have been conducted in the High Plains since the early 1950s. Most were of limited success due to the silt and suspended sediments contained in the playa water. Typically, these silts and sediments clogged either the filter material that had been selected or the formation causing the recharge well to stop accepting water.

The success of these recharge efforts will be evaluated based on three criteria: 1) the method must be economically feasible, with an operating cost per unit volume of water below the value of irrigation water; 2) the method must be technically feasible, showing high flow rates of good quality water for recharge; and 3) the method must be acceptable to the user (mainly the landowner/operator) in that it is easy to install, operate, maintain and replace.

This recharge project is partially funded by a grant received from the Texas Water Development Board. Additional funds and technical assistance are being provided by the High Plains Water District and the Texas Advanced Technology Research Program. Researchers from the Water Resources Center designed and supervised the installation of the new recharge system. These researchers will also be responsible for operation and monitoring of the project during the study period.

Additional information on this recharge concept may be obtained by contacting Dr. Lloyd Urban or Dr. Bill Claborn who can be reached through the Water Resources Center at Texas Tech University by calling 806-742-3597 or writing P. O. Box 4630, Lubbock, Texas 79409. —BS/KR

URBAN . . . continued from page 2

depth the soil has been wet. An old kitchen or table knife will do just as well if a steel or wooden rod is not available. If your lawn is a pale green or yellow, it probably needs fertilizer more than it needs water.

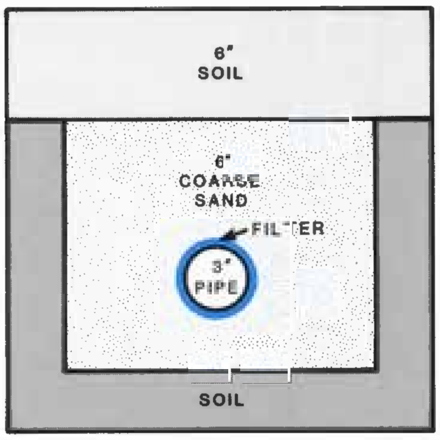
Watering Trees

After planting new trees, a deep thorough soaking will be required at least once each week during the growing season for the first year. New trees should be watered at least monthly during the winter months when the trees are dormant. Grass and weeds compete with trees for plant nutrients and water from the soil. Therefore, it is recommended that grass and weeds not be allowed to grow beneath newly planted trees.

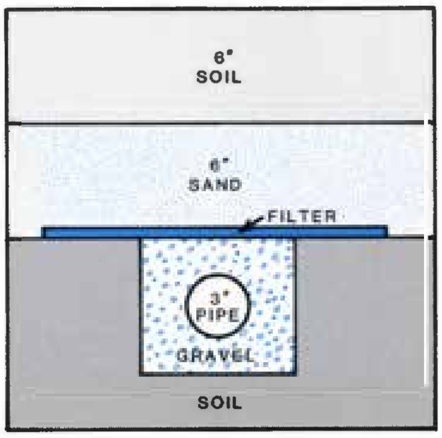
Once trees are established, grass may be allowed to grow beneath the tree. However, a thorough weekly soaking will still be needed to support the water needs of the tree during the summer months. Again, monthly waterings during the dormant period are a good practice. Deep soakings should be confined to the area beneath the drip-line or outer edge of the branches of the tree to encourage deep root penetration and development. Light waterings of the area under a tree encourage the tree to extend roots laterally away from the tree into areas where tree roots may become a nuisance, such as into flower beds and garden areas.

Trees need additional plant nutrients added to the soil for proper development and growth. Lawn fertilizers should be applied evenly throughout the yard, including areas under trees. To take care of the additional fertility needs of trees, deep placements of fertilizers directly under the drip-line area of trees should be considered. An effective and easy method of providing deep placement of fertilizers is the installation of tree fertilizer spikes at three or four locations around the tree in the drip-line area. If fertilizer spikes are not available, a steel rod can be used to make a hole 12 to 14 inches deep at the same three to four locations around the tree. Fill each hole with fertilizer to within four inches of the soil surface, then fill the remainder

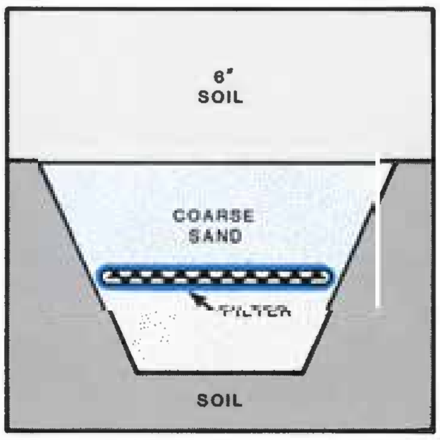
continued on page 4 . . . URBAN



FILTERS IN PLACE—Sixteen-inch wide and 16-inch deep V-shaped trenches were dug in the base of the playa. A geotextile fabric filter was then slipped over three-inch diameter flexible plastic pipe like a sleeve. The fabric-covered pipe was then laid in a gravel bed in each trench, and six inches of sand and six inches of natural playa material backfilled each trench.



INSTALLATION COMPLETED—A 12-inch layer of soil was excavated from the bottom of the playa basin, creating a pan. Forty trenches, 16-inches by eight-inches, were then dug in the pan. A layer of gravel was placed in the bottom of each trench, then three-inch perforated flexible plastic pipe was installed and covered with gravel. A two-foot wide strip of fabric filter material was then installed directly above each trench and the pan was backfilled with six inches of sand and six inches of the natural material that was removed from the base of the playa. Each drain line is connected to central collection line in the center of the field.



DRAIN FIELDS INSTALLED—Nineteen V-shaped trenches were excavated, extending outward from a central collection trench. A bed of gravel was placed in the bottom of each trench, then 12-inch wide Hitek Stripdrain filters were placed on top of the bed of gravel. Each of the filter drain lines was connected to PVC pipe, which serves as the collection and delivery line for transporting water to the recharge well. The Stripdrain was then covered with a six-inch layer of sand and a six-inch layer of the top soil that was removed from the playa when the V-shaped trenches were excavated.

URBAN . . . continued from page 3

of the hole with soil. The soil plug in the top four inches should prevent over fertilization of the grass, which would be evident as dark green, fast growing spots in the lawn.

Gardening Tips

From seed planting to seedling emergence, it is equally important in the garden to maintain good soil moisture. Shallowly planted seeds, such as lettuce, may need daily sprinklings. Seeds planted deeper, such as okra, will need frequent but not daily waterings.

After plants are established, the most critical stage of plant development in terms of water is at flowering and fruit set. During this period, the top foot of the soil should be kept moist but not wet.

To determine when water is needed in the garden, dig down a few inches in the soil to check the soil moisture content before irrigating. Keep in mind that water evaporates from the soil surface very rapidly, so the surface soil may look dry while the soil may be very moist a few inches below the surface. If this is the case, then application of additional water is not needed. Also, a cultivated soil surface will help reduce moisture loss from the soil.

Generally speaking, if you keep your tomato plants happy in your garden, the rest of the vegetables will receive enough water. The leaves of tomato plants will begin to wilt by noon if they need water.

Too much water applied at certain times can do more harm in the garden than not having enough water. For instance, fruit quality may be reduced if plants are over irrigated during the ripening period. Over watering during this period reduces the sugar content and adversely affects the flavor of crops such as tomatoes, sweet corn and melons.

Mulching Saves Moisture

As previously mentioned, mulching, or maintaining a protective cover on bare soil surfaces, is a recommended practice for the urban farmer. A good mulch conserves moisture, prevents soil compaction, keeps soil temperatures lower, reduces weed population and, in case weeds do get a start, they are easier to pull if a mulch has been used.

A soil mulch can be anything from commercially available peat moss, bark chips or packaged compost mixtures to a compost made from leaves and plant clippings from your own lawn and garden areas.

Watering Alternatives

There are numerous irrigation methods available to urban landowners such as hose-end sprinkling, which is the most popular and most commonly used, permanently installed sprinkler systems, porous hoses and drip irrigation systems.

Sprinklers, for hose-end irrigation, are normally inexpensive and easy to use. They can, however, be extremely wasteful of water if not utilized properly. Improper timing, varying water pressures, and operation of sprinklers in the wind can waste water. For example, watering during periods when wind speeds exceed five miles per hour may distribute water unevenly over the yard or blow water onto sidewalks, driveways or into the street. Additionally, watering patterns may change from those initially set because of changes in wind speeds or changes in water pressure. The same problems occur when using permanent sprinkler systems.

In the hot dry climate of the Texas High Plains, sprinklers that put out water in a fine mist or in small droplets are normally very wasteful. Sprinklers that deliver water in large drops near the ground, such as those put out by an adjustable travelling sprinkler or a porous hose, are more efficient in this area.

Drip irrigation has received a lot of attention in recent years as one of the easiest and most efficient methods for watering the lawn or garden. With drip irrigation, soil moisture can be maintained at a relatively constant level and air, which is essential to the plant root system, should always be available. Additionally, very little water is lost to evaporation in a drip irrigation system.

Water quality and improper installation of lawns on non-uniform soil types can adversely affect the benefits of drip irrigation. Soils excavated during housing construction that are not backfilled in the same manner as they were removed can create non-uniform soil structures. Lateral water movement in these mixed soils generally will not be uniform.

Water is a valuable commodity. Remember, it is not a free resource. The next water supply source or treatment plant your city builds or purchases will likely result in a significant increase in your utility bills. As Ben Franklin said, "Waste not, want not." —BS/KR

Field Days Demonstrate Irrigation Innovations

Would you buy a car without test driving it first? Probably not. In the same light, most farmers would probably like to "test-drive" new irrigation technology before committing their capital to it. On-farm irrigation demonstration days offer producers and anyone else who is interested in new water management technology an opportunity to see state-of-the-art technology up close and in action.

Each summer the High Plains Underground Water Conservation District No. 1 and its local county committees, in cooperation with the USDA-Soil Conservation Service, the Texas Agricultural Extension Service and local Soil and Water Conservation districts, sponsor irrigation demonstration days in communities throughout the District's service area to demonstrate to local citizens new irrigation technology and to explain how this technology can aid producers in improving the efficiency of their irrigation water management systems.

"Field days are designed to increase public awareness of the potential savings that can be obtained through increased water-use and energy-use efficiency as well as improved water management. During our field days, we show producers ways they can reduce their production costs through higher levels of efficiency," says Water District Agricultural Engineer Jerry Funck.

By stopping at the various display points set up in one of their neighbor's fields, local farmers can watch surge irrigation in action as it is used to effectively and efficiently water alternate sets of furrows. Producers may also witness an evaluation of pump plant energy-use efficiency. At the same time, producers can discuss each of these practices with qualified professionals who can help them evaluate how the technology would fit into their management system and discuss the potential benefits of the practice on their farm.

Additional stops are normally set up at these field days to show irrigation application efficiency testing. Recent field days have evaluated the application efficiency of drop-line center pivot sprinkler systems and shown the various hoses and spray nozzles developed to improve the efficiency of center pivot sprinkler systems, such as the LEPA conversion. At a recent Castro County Irrigation Demonstration Day, Leon New, Texas Agricultural Extension Service Irrigation Specialist, demonstrated a new nozzle that releases water in a bubble-like shape. According to New, the bubble puts 98 percent of the water on the ground because wind will not dispense the water, it just changes the pattern of the bubble.

The newest addition to these irrigation demonstration days is a location in the field where a rainfall simulator is shown by Water District Agriculturalist David Swaringen, who helped design and build the simulator. "Basically, the rainfall simulator is used to show producers the effects of various rainfall or sprinkler irrigation amounts on different soil types, under different tillage practices," explains Swaringen.

Tools used to measure soil moisture are also demonstrated to producers who attend these field days. Producers are encouraged to handle the equipment and learn how it can be used to measure their own soil moisture. Mike Risinger, Soil Scientist for the Soil Conservation Service, notes, "We can explain to producers how the information they get from their soil moisture readings can be utilized to determine the daily rate of water use by crops. Additionally, soil moisture monitoring equipment can show root development through changes in soil moisture at the two, three and four foot soil depths. This information can be very helpful to irrigators when they try to determine when to begin their next irrigation and the amount of water that needs to be applied."

"This is not your normal field tour where producers have to spend all day or even half a day. We are on the selected farm all day long, so producers can just drop by any time they have time to see all of the demonstrations, or just a few minutes to see the demonstration that they are particularly interested in," says Ken Carver, Assistant Manager of the Water District.

By showing the devices at work in the field and illustrating the positive results that can be achieved, demonstration day sponsors hope to encourage farmers to adopt the improved water management practices that are available to them.

Watch your local newspaper for notice of the next on-farm irrigation demonstration day to be held in your area and plan to attend. —BS

THE CROSS SECTION (USPS 564-920)
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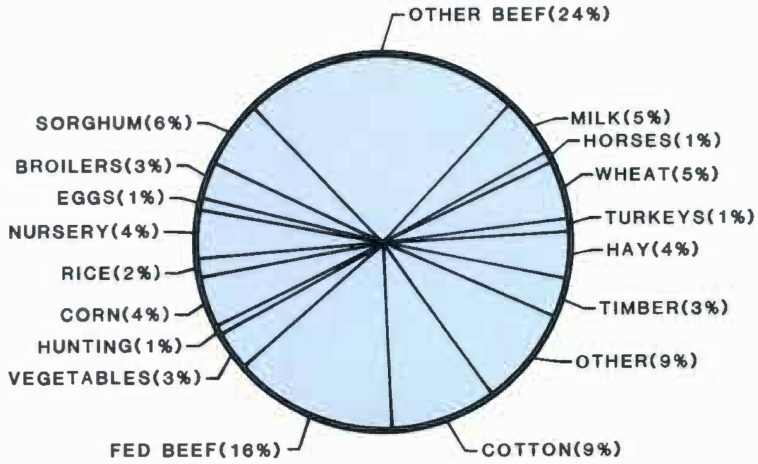
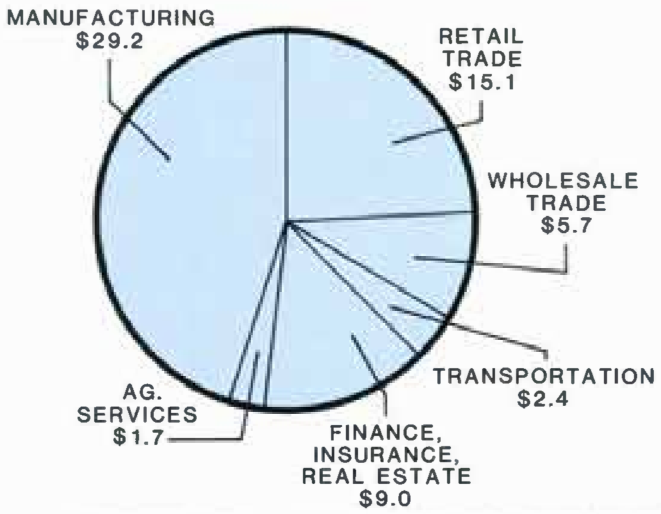
AGRICULTURE IN TEXAS
$74,000,000/YEAR
$10.9 BILLION/YEAR
TOTAL CASH VALUES
BY COMMODITY GROUPS



AGRICULTURE IN TEXAS
$74,000,000,/YEAR
$63.1 BILLION/YEAR
COMES FROM AGRIBUSINESS



IRRIGATION, GRAZING, FERTILITY

Winter Wheat Management Options

Irrigation and grazing options as well as information on soil fertility levels are all important considerations for winter wheat producers as planting time fast approaches.

First, is the wheat to be dryland farmed or irrigated? If we irrigate, are we going to shoot for maximum irrigated yields? Or, are we going to stress the wheat some and irrigate for lower yields?

What about grazing? Should we graze the wheat? If so, when should we plan to remove the cattle to have minimal affect on yields?

What about our soil fertility levels? Do we have enough plant nutrients without additional fertilizer? If we plan to go dryland, will additional fertilizers help our wheat yields and return a profit? What will grazing do to our soil fertility levels? Will we need more fertilizer if we graze?

All of these management alternatives can affect the final outcome at the elevator next spring. Dr. Harold Eck, Soil Scientist with the USDA Agricultural Research Service at Bushland, offers some observations to help wheat producers with these management decisions.

Dryland Wheat

"On dryland Pullman soils, we do not recommend additional fertilization to increase wheat yields," notes Dr. Eck. "On continuously dryland wheat, the fertility in the soil is sufficient to produce 25 to 30 bushels of wheat per acre. The potential for wheat production, due to moisture, will only give us that high an average yield."

Eck is quick to note, however, that there are situations when producers may get a response from additional fertilizer applications. For instance, notes Eck, "if a soil test really shows that nitrogen, phosphorus or other essential plant nutrients are needed, then the recommended amounts should be applied."

Irrigated Wheat

For irrigated wheat, there are several different options and several factors that affect those options.

"If producers are irrigating for maximum yields of around 100 bushels per acre," notes Eck, "we recommend 125 pounds of nitrogen per acre." Additionally, if producers are irrigating for that type of yield, they may also need to add phosphorus.

Based on two years of data from a fertilizer/irrigation interaction study at Bushland, yield increases of 9 and 17 percent respectively were documented through the addition of 40 and 80 pounds of phosphate. "Normally, we would recommend adding 40 pounds of phosphate under fully irrigated conditions," states Eck.

Less intense irrigation, which would probably result in less production, would require lower levels of fertility. "Now, if irrigation is reduced, and the plants are stressed to some degree so that production is limited to 40 to 60 bushels per acre, 60 pounds of nitrogen per acre would be sufficient," states Eck. "At this production level, our studies show no response to the addition of phosphorus."

Grazing

"The two years of study referenced previously, were done without grazing," notes Eck. "However, if the wheat is grazed, more nitrogen will be re-

continued on page 4 . . . WHEAT

Perennial Weeds Rob Moisture And Nutrients

"Perennial weeds compete very strongly with field crops for both water and plant nutrients," says Dr. Wayne Keeling, Systems Agronomist for the Texas Agricultural Experiment Station at Lubbock.

"In our crop production on the Southern High Plains, we don't have any moisture to waste on weeds," adds Dr. John Abernathy, Weed Science Professor and Resident Director of the TAES at Lubbock. "The results of perennial weed infestations can be very serious. Where you have a large number of weeds that have established a good stand, chances are those areas will make essentially no profit. In fact, if some weed species take over, it can make the land itself virtually worthless."

Pinning Down The Problem

Annual field surveys conducted by the TAES since 1979 have estimated losses in cotton production due to major weed species. The surveys were conducted at four locations in each of two counties in the Texas High Plains. The surveys included estimated yield losses and yield losses based on field surveys for pigweed, Johnsongrass, lanceleaf sage, woollyleaf bursage, silverleaf nightshade, yellow nutsedge, cocklebur, morning glory, prairie sunflower, field bindweed and barnyard grass.

As an example of the survey results, in seven years of data the average loss to silverleaf nightshade was 4.2 percent for the entire Southern High Plains. Of course, some fields were much worse than others in terms of cotton losses due to silverleaf nightshade.

What That Means In Terms Of Yield

A four percent loss may not sound like much. But, with that four percent loss of production because of a silverleaf nightshade infestation, cotton producers can lose 6.72 acres of production from a 160 acre tract of land. The yield from that acreage could produce 3,360 pounds of cotton lint at 500 pounds per acre, or $2,000 in income at a cotton price of $0.60 per pound.

An Increasing Problem

Keeling notes, "Perennials are constant, tough competitors. Over the past few years, the perennials, especially lakeweed, are an increasing problem. Because of economics, producers may plow and hoe less. Part of the problem

continued on page 2 . . . WEEDS

AUTHENTICATION OF WEED LOSS ESTIMATES IN TEXAS COTTON

JOHN R. ABERNATHY and J. W. KEELING
Texas Agricultural Experiment Station, Lubbock, TX 79401

Annual field surveys and estimates have been made to determine losses in cotton production due to major weed species. For each weed, yields of weedy and weed-free cotton were calculated at four locations in each of two counties of the Texas High Plains.

Greater losses from weeds were documented by field surveys as compared to estimates in 1979 and 1980. Field survey losses were more closely related to estimated losses in 1981-85. In 1983, 1984 and 1985 greater field survey losses were documented from Johnsongrass and woollyleaf bursage as compared to estimated losses. Losses due to pigweed were less in the field survey. In 1985, cotton losses due to weeds were about the same as in 1984. The greatest losses of cotton in 1985 were caused by pigweed, silverleaf nightshade, Johnsongrass and woollyleaf bursage. For all other species, estimates and field survey losses were closely related. The following table lists the estimated and surveyed yield percentage reductions for 11 important weed species.

	% Yield Reduction													
	1979		1980		1981		1982		1983		1984		1985	
Weed	*Estimated*	*Field survey*	*Estimated*	*Field survey*	*Estimated*	*Field survey*	*Estimated*	*Field survey*	*Estimated*	*Field survey*	*Estimated*	*Field survey*	*Estimated*	*Field survey*
Pigweed	4.0	9.0	2.9	1.7	2.5	2.4	2.5	1.2	2.3	0.4	2.2	1.8	1.4	0.9
Johnsongrass	0.5	2.5	0.7	2.0	0.1	0.5	0.6	3.9	0.5	2.3	0.4	2.3	0.4	1.5
Lanceleaf Sage	0.2	2.4	0.5	1.3	0.1	0.4	0.1	1.3	0.1	0.6	0.3	0.5	0.2	0.4
Woollyleaf Bursage	0.1	1.4	0.1	1.0	0.1	0.3	0.1	1.1	0.2	1.3	0.2	1.2	0.3	1.1
Silverleaf Nightshade	2.0	18.4	1.5	5.9	1.3	0.3	1.3	1.5	1.2	1.2	1.1	1.1	1.1	1.3
Yellow Nutsedge	0.2	0.3	0.3	1.0	0.4	0.1	0.4	0.2	0.4	0.2	0.4	0.2	0.4	0.2
Cocklebur	0.1	1.1	0.3	1.2	0.4	0.2	0.4	0.3	0.4	0.4	0.4	0.4	0.4	0.2
Morning Glory	0.1	3.0	0.4	2.1	0.3	0.2	0.3	0.4	0.4	0.3	0.3	0.4	0.3	0.2
Prairie Sunflower	0.1	8.4	0.2	1.1	0.2	0.1	0.2	0.1	0.2	0.1	0.1	0.1	0.3	0.1
Field Bindweed	0.2	0.7	0.2	1.5	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1
Barnyard Grass	0.1	1.1	0.1	0.7	0.3	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1

WEEDS . . .

continued from page 1

occurs when producers plow through spots that are heavily infested with these perennial weeds. When you plow through infested areas, you are dragging roots into fresh areas.

"This is especially noticeable when you can drive around the edges of playa basins that have been cultivated and the lakeweeds drug out into the fields. The lakeweeds are getting more widespread each year and literally taking over in some areas. It is important to realize that and try to limit cultivation through these spots," he continues.

"A combination of all this is making this problem worse. That would be my best guess as to why our perennial weed infestations might be getting worse," Keeling states.

Now's A Prime Time For Control

In general terms, Keeling states that weed control has become a little more sophisticated. "There are specific treatments for specific weed problems," Keeling says. However, he basically advises all applicators to read the label directions and use herbicides according to those directions to obtain the most effective control of perennial weeds. Additionally, the optimum time for applying herbicides and tackling perennial weed problems is from the middle of August through the fall.

With most cotton crops established, producers may have time now to concentrate on treating perennial weeds.

"In general terms we can get better results dealing with perennials, the weeds that come back from the roots, late in the summer and into the fall. They are more susceptible to herbicidal control now as opposed to early in the season. For best results, the plants need to grow into the late summer or fall to get the most from your dollar in terms of treatment," Keeling says.

The most common perennials in this area, according to Keeling, are silverleaf nightshade or whiteweed, Texas blueweed and woollyleaf bursage or lakeweed. "Additionally, Johnsongrass and bermudagrass are still problems in a lot of areas," Keeling adds.

Herbicidal Controls Available

With silverleaf nightshade or whiteweed, Dr. Abernathy's TAES weed research of several years has found that the best treatment is a broadcast, ropewick or spot spray application of Roundup on mature whiteweed plants. "If Roundup is applied in the right way and at the right time, a 90 percent control of whiteweeds can be obtained," Abernathy explains.

"Blueweed is a little more difficult. With blueweed good results can be achieved with applications of one to two quarts per acre of Banvel. Through this treatment, combined with tillage the next summer and then retreatment with Banvel, we are able to reduce the blueweed spots from cotton," continues Abernathy.

Banvel at one to two quarts per acre is also an effective treatment for lakeweed. With this treatment, producers can suppress lakeweed until the next year, but erradication is more difficult. MSMA provides effective burn-down of lakeweed when applied prior to cotton planting.

New Materials For Control

Both Keeling and Abernathy are involved in the weed research program at TAES, looking at all new chemicals on the crops and weeds grown in this area to see how they might offer better control of weeds. Additionally, chemicals that are designed for other weeds and crops are evaluated on the specific weeds and crops that are predominant in this area.

"Within any one year we will have 50 to 60 weed experiments, each one having 20 to 50 different treatments, looking at specific crops or weeds on different soil types," states Keeling.

There are several new chemicals that have proven successful in previous experiments. Keeling notes, "Arsenal, which is registered for use on noncropland areas, looks very effective on lakeweed. Arsenal prevents cotton production for two to three years, but will control lakeweed for that period of time. This herbicide has not been looked at long enough to know whether the lakeweed will regrow when that time period has passed.

"Another herbicide being investigated, that is not commercially available, is called Reflex. Reflex may be applied to the soil before cotton is planted, and it will provide good to excellent control of lakeweed. Field use of this chemical is at least a couple of years down the line though."

Landowners Need To Be Involved

In these tough economic times, landowners may need to become involved and perhaps buy some chemicals or go into some cost-share arrangements with their tenants on rented land.

Keeling remarks, "On a yearly basis, it may not pay the operator to go out and spend from $20 to $40 per acre on herbicides. The tenant may be better off losing production from the infested acreage. But, when you look at it over a 10-year period, or in terms of preserving the value of the land for the future, there is more of a long-term benefit than a short one. So we need to look at the investment of herbicides for perennial weed control as a long-term investment."

"Lakeweed has the most potential for infesting more acres and really reducing the productivity of the farm than most of the other perennial weeds we have," notes Abernathy. "If lakeweed takes over, it can make the land worthless, because no crop can compete with lakeweed and produce a normal yield."

—KR

Avoid Potential Farm Hazards

Irrigators are usually very cautious when dealing with potentially dangerous farm equipment. However, accidents do happen. The following tips are offered to help irrigators avoid some possible risky situations and to help keep irrigation water management as safe as possible.

- Don't go near the unprotected drive shaft on your internal combustion engine, it can be potentially fatal. The drive shafts commonly found on irrigation wells rotate at 1750 revolutions per minute. Accidents may occur when a shirttail or sleeve gets caught on one of the U-joints located at either end of the shaft. In just a fraction of a second, the clothing winds around the spinning shaft and the results are usually very serious. To avoid these hazards, place a guard or shield over the shaft.
- Check electrical equipment to assure that it is properly grounded prior to using it. An electrical tester provides a simple, effective way to check electrical equipment for voltage that may be passing through it before an accident happens. A reading on the electrical meter indicates that there is a direct current running through the equipment. Irrigators should contact qualified professional help for repair to avoid electrical shock. Electrical testers are commonly available from your local electric supply store.
- Check for loose and exposed wires in all electrical equipment.
- Watch for highline wires when moving portable aluminum pipe. Unfortunately, many irrigators have been severely injured when they tried to shake a rabbit or other small animal out of a section of aluminum pipe and the pipe accidentally came in contact with an overhead highline wire.
- Check the wires on your center pivot. Shorted out wires will cause the entire pivot to be "hot," sending 440 volts of electric current down the pivot.
- Make sure your center pivot and the electric pump panel boxes are properly grounded. If the boxes are not properly grounded, they may be "hot" even when turned off. Also the wires may weather and fray or cattle may disturb the wires, which can make the box dangerous.

—BS

Limiting Applied Nitrogen Reduces Corn Yields

Limiting expenditures for fertilizer may seem like an attractive alternative when producers look at their overall production costs as compared to declining commodity prices. However, triming investments on fertilizer may not pay, particularly in corn production.

Dr. Art Stoecker, Associate Professor of Agricultural Economics at Texas Tech University, and Dr. Arthur Onken, Professor, Texas Agricultural Experiment Station in Lubbock, recently evaluated the effect of limiting the amounts of applied nitrogen on the residual nitrate-nitrogen levels in the soil profile and how this combination affects corn yields.

This analysis was specifically designed to examine the effects of applying less than the optimal quantities of nitrogen fertilizer on irrigated corn produced on Pullman clay loam soils in the Texas High Plains.

Generally, the study shows that even a small reduction in applied nitrogen results in a reduction in revenue substantially greater than the costs of the nitrogen. Additionally, the researchers found that the resulting income reduction extends at least one year after nitrogen limitations are removed.

> "... even a small reduction in applied nitrogen results in a reduction in revenue ..."

The Study

Basically, the study was designed to evaluate whether or not nitrogen application rates affect future residual soil nitrate levels. It was theorized that since residual nitrate-nitrogen is a factor of crop production, any change in the amount of residual nitrate-nitrogen caused by crop management would be important.

The researchers found that 12.25 pounds of residual nitrate-nitrogen would be present in the soil each year from natural causes, while each pound of nitrogen applied in one year would add 0.04 pounds to the top six inches of the soil profile the following year. Additionally, it was found that each additional pound of residual nitrate-nitrogen would add 0.21 pounds of residual nitrate-nitrogen to the same top six inches of the soil the next year.

The presence of this carry-over effect means that the amount of nitrogen applied in any one year does affect the amount of residual nitrate-nitrogen and, consequently, also affects the rate of corn yield response from applied nitrogen in subsequent periods.

Two Approaches Used

The study was approached from two different standpoints. One is from the standpoint of a tenant producer, who has only a one-year rental agreement. This producer would be most interested in applying an amount of nitrogen that would maximize his single period profits.

Secondly, the study was approached from the standpoint of a producer, such as a landowner or a landowner-tenant, with an agreement that had a ten-year planning horizon.

The Analysis

The researchers analyzed the results which would occur if a producer applied less than optimal quantities of fertilizer because of a lack of knowledge of the appropriate level of fertilizer and/or because of expenditure limitations.

The price of corn grain at harvest time was assumed to be $3.00 per bushel when discounted to the date of fertilizer purchase. The cost of one pound of nitrogen fertilizer applied was $0.30.

To test the effects of less than optimal fertility levels, the researchers evaluated both "slightly to moderately" and "severely" restricted amounts of applied nitrogen. Applied nitrogen was considered "slightly" to "moderately" restricted when no more than 150 pounds of nitrogen could be applied. "Severe" restrictions were imposed where no more than 100 pounds of nitrogen per acre could be applied.

The duration of the restrictions was assumed to be one, two, or three years. It was also assumed that as soon as the restrictions on applied nitrogen were removed the producer again followed a policy of maximizing long-run returns.

One additional assumption was made. The researchers assumed that the producer with no nitrogen limitation would apply 182 pounds of nitrogen the first year and would expect to apply 172 pounds the second year, if he had 10 pounds of residual nitrate-nitrogen in the top soil profile.

The Results

The producer with a severe two-year limitation of 100 pounds of applied nitrogen, did have some buildup of residual nitrate-nitrogen in the soil. However, the buildup occurred at a slower rate than where there was less restriction in the amount of nitrogen that could be applied.

The resulting corn yields for the producer with 10 pounds of residual nitrate-nitrogen in the top soil profile who faced a severe nitrogen limitation increased over time, but remained below the yields for producers with moderate or no limitations.

After lifting the limitations, it was optimal for this producer to apply more fertilizer than producers with lesser restrictions. However, the third-year yield for the severely restricted producer remained below those of producers with lesser restrictions.

From this evidence, an assumption could be made that the effects of the presence or absence of residual nitrate-nitrogen may not be overcome simply by applying larger quantities of nitrogen after a nitrogen limitation has occurred.

> "... the yield following the lifting of the restriction remained below the yields of producers who faced lesser restrictions."

With 30 pounds or more residual nitrate-nitrogen and a severe limitation of 100 pounds of applied nitrogen, there was a small loss in yield the first year, followed by a much larger loss the second year. Similarly, the yield following the lifting of the restriction remained below the yields of producers who faced lesser restrictions.

When a producer with 10 pounds of residual nitrate-nitrogen in the top soil applied only 100 pounds of nitrogen, he was applying 83 pounds less than the optimal 183 pounds of nitrogen per acre. As a result, his projected yield was 21 bushels per acre less than the optimal yield of 149 bushels. Consequently, his returns over fertilizer cost were reduced by $40 per acre from what they would have been if the optimal quantity of 183 pounds of nitrogen had been applied.

In the second year, the producer would optimally apply slightly more nitrogen than would the producer who was unrestricted the first year. However, his yield was still six bushels less and his per acre profit would be $18 less than that of the unrestricted producer. That is, the income reduction for the restricted producer continued for one period after the restriction was removed.

When the fertilizer limitation was 150 pounds per acre the income effects were more subtle. In the first year, the producer restricted to 150 pounds actually increased income by one dollar over that of the unrestricted producer. This resulted from a one year reduction in fertilizer costs of $4.50 per acre and a revenue reduction of only $3.50.

However, the projected residual nitrate-nitrogen level for the restricted producer was less than for the unrestricted producer. So, in the second year the restricted producer faced a $3.00 per acre loss as compared to the unrestricted producer. Here, the analysis results indicate that a slight to moderate reduction in nitrogen application would have only a small impact on net income.

To Sum It All Up

In summary, the effects of applied nitrogen limitations lasting one, two or three years show that even the slight to moderate nitrogen limitations result in discounted revenue reductions of at least 50 percent greater than any savings in fertilizer costs. That is, a producer could afford to borrow money at very high interest to bring nitrogen applications to their optimal long-run level.

On an annual basis, having a soil test is extremely important in determining the appropriate fertilizer level.—*KR*

THE BEST HARVEST EVER—OR IS IT? Harvest time is not necessarily the best time to consider the fertility requirements of corn, but it may be a good time to plan for next year. Limiting the amount of nitrogen applied to corn affects not only this year's yields, but also affects the residual nitrate-nitrogen levels in the soil for next year's crop, which in turn affects next year's yields.

NYLON BRUSH HELPS REJUVENATE WELLS

A Good Idea Made Better!

Who would have thought that a small piece of the technology that helps keep our streets clean could be used to rejuvenate the pumping capacity of old irrigation wells. Well, Gordon "Doc" Willis, Hydrologist with the Water Utilities Engineering Department for the City of Lubbock, did and has proved that the technique works.

Basically, what Willis did was take the surge and bail well development technique and make it better. He did this by adding a brush below the surge block. Starting at the top of the perforations in the well casing or screen and working down slowly five feet at a time, the stiff bristles of the brush, which is the same type used by street sweepers, scrub off the deposits inside the casing that are normally hard to remove.

Willis explains, "The brush helps dislodge the rust and scale deposits that form on the inside of well casings through years of use. It will work inside screens cleaning off deposits there, and it will also work in the slots of most types of casings."

Willis explains what made him think of this idea. "I just thought we needed something below the surge block to make the surge and bail technique more effective. I thought if we had a real stiff brush, it would wear stuff loose and enable the surge block to do a better job."

So far the brush idea seems to have proven effective. Of the five wells the city has cleaned using the new technique, additional cleaning was required in only one after a test pump was run. In fact, the city wells cleaned have displayed remarkable recovery rates.

The first well cleaned with the brush attachment was one of 156 wells in the city-owned Sandhills well field, located between Muleshoe and Sudan in Bailey County. This particular well was chosen as a test for the new cleaning technique after casing in a well less than one-half mile away collapsed, requiring that a new well be drilled. The new well pumped 600-700 GPM, which caused Willis and his crew to wonder why the original well broke suction at 200 GPM.

Deciding that the well must have been clogged, Willis took the opportunity to try the brush attachment on the surge block. The brush worked, and the well was brought back up to the original capacity of 700 GPM.

With the success of this first attempt, Willis decided to try the technique again. The second well on which they tried the technique pumped less than 100 GPM from a pumping depth of 129 feet before scrubbing. After scrubbing, the well pumped 450 GPM from a depth of 150 feet.

A third well, pumping less than 100 GPM before scrubbing was improved to pump 425 GPM.

The brush is manufactured by the Three B Brush Company of Lubbock. The specific brush selected by Willis features one-eighth inch diameter, stiff nylon bristles that may be trimmed to fit any size casing. The brush is very durable and easily cleaned by rinsing it off.

The brush cost about $300 and the outfit, including the surge block, may be put together for $600-$800 including labor, Willis says.

Willis comments, "You can hardly tell that it's worn at all after being used in several cleaning operations. I don't know what the life of it is, but at the rate it's going, it should last a long time."

He notes, "It's one tool that is very effective on wells that have slotted pipe, which most irrigation wells have."

Unfortunately the service is not available commercially because well drillers are reluctant to risk their equipment in unknown well situations. Unknown wells present a danger because they may not be gravel packed or the gravel may not be stabilized, leading to the risk of a cavity collapsing and breaking the casing.

"You could save a lot of wells from being abandoned by going in and cleaning them out like this," states Willis. "Ordinarily you'd have to drill another well." —BS

JUST LIKE SCRUBBIN' A RUSTY BOLT— The stiff nylon bristles of this street sweeper brush proved to be just what was needed to scrub out old well casings to remove the accumulated rust and scale deposits. Adding the brush to the bottom of the surge block has successfully rejuvenated several wells for the City of Lubbock.

77th ANNUAL TAES FIELD DAY AT THE LUBBOCK STATION

TUESDAY, SEPT. 9, 1986

1:00 P.M.

WHEAT . . .

continued from page 1

quired. A spring top dressing of 40 to 50 pounds of nitrogen per acre may be in order after heavy grazing."

As to how grazing termination dates affect yields, Dr. S. R. Winter, USDA-ARS, has performed irrigated grazing trials to determine the effects of grazing duration on the growth and grain yield of winter wheat at Bushland.

In these studies, wheat forage was removed to two to three inch stubble height by stocker cattle. Three year average grain yields were 82 bushels per acre for grain-only, 82 bushels per acre with a grazing termination date of February 1, 73 bushels per acre for a grazing termination date of March 6, 63 bushels per acre for a March 17 termination date, 55 bushels per acre for a March 31 termination date, and 41 bushels per acre for a grazing termination date of April 13.

Based on these studies, the current recommendation suggests grazing termination by March 15 to avoid loss of grain yield.

Soils	No. of tests	Check	Fertilized	Increase	Increase
		— — — bu/A	— — —		%
Sandy soils					
Nitrogen	6	17.2	23.1	5.9	34
Phosphorus	3	18.1	19.2	1.1	6
Pullman-like soils					
Nitrogen	8	18.1	27.3	9.2	51
Phosphorus	1	53.2	59.8	6.6	13

Summary of dryland wheat yields and yield increases from fertilizer treatments in Extension Service demonstrations.

Soil Tests Recommended

"The best way to determine fertilizer needs is to have them tested at the Texas A&M Extension Service Soil Testing Laboratory at Lubbock," notes Eck. "Fertilizer may not pay for itself when applied routinely on normal dryland Pullman soils. But, if water is not a limiting factor, it probably will." —KR

THE CROSS SECTION (USPS 564-920)
HIGH PLAINS UNDERGROUND WATER
CONSERVATION DISTRICT NO. 1
2930 AVENUE Q
LUBBOCK, TEXAS 79405

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THE Cross SECTION

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PLANNING IS THE KEY

Consider "Sodbuster" and "Conservation Compliance" Effects Now

As more and more of us try to define, evaluate and understand the implications of the interim rules that have been developed and adopted to implement the "sodbuster" and "conservation compliance" portions of the 1985 farm bill, more and more of us begin to realize that farmers in the Texas High Plains will face a challenge in devising plans to comply with the law while preserving the economic future of their farming operations.

Basically, the interim rules state that farmers who produce agricultural commodities on highly erodible lands will not be eligible for USDA support programs unless they implement a conservation plan to control wind and/or water erosion within tolerable limits. Programs covered by the regulations are USDA price and income supports, disaster payments, crop insurance, Farmers Home Administration loans, Commodity Credit Corporation storage payments, farm storage facility loans, and other programs under which payments are made with respect to commodities produced by the farmer.

The interim rules were published in the Federal Register on June 27 and became effective on that date. Comments on the interim rules are currently being accepted.

Grace Period Allowed

Farmers who produced agricultural commodities on highly erodible lands in any year between 1981 and 1985 have a brief grace period, so to speak, to develop and implement a conservation plan. These farmers have until January 1, 1990, to develop and actively begin to apply a conservation plan. They have until January 1, 1995, to have the plan fully in effect.

Sticky Situation

Farmers who continue to plant agricultural commodities on highly erodible lands after the effective date of these interim rules and the end of the grace period without meeting the conditions of the law are not eligible to participate in USDA covered programs for any crop they produce on any land they own or operate.

There Are Ways To Make It Work

If the interim sodbuster and conservation compliance rules are not revised, it appears highly likely that there will have to be changes made in the cropping systems in many agricultural production areas of Texas, particularly in the Texas Southern High Plains.

Thus, the challenge is presented. Southern High Plains farmers need to begin now to devise a conservation plan for gradual implementation that will satisfy the conservation requirements and meet their economic needs.

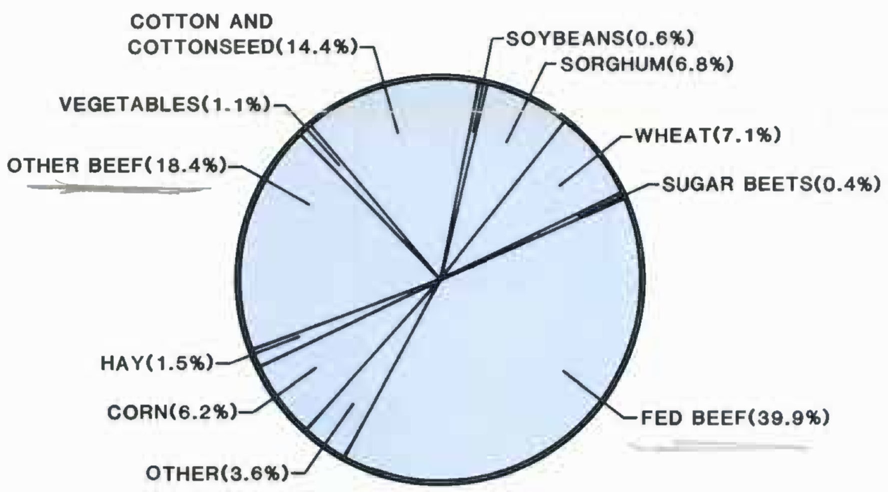
There are ways, in many instances, to make it work. Participation in the USDA 50/92 program may bring some producers into compliance very quickly. Wind stripcropping in conjunction with cotton production may be a viable alternative for some producers. Rotation systems may reduce erosion in certain circumstances. Livestock production on irrigated or dryland permanent cover crops may be a profitable solution for others.

Bottom-Line Options

Under the law and the published regulations, farmers who have highly erodible land

continued on page 2 ... SODBUSTER

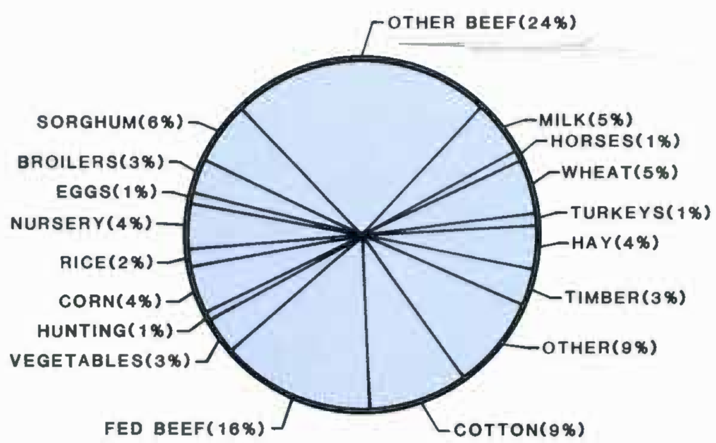
TEXAS HIGH PLAINS
MAJOR AGRICULTURAL COMMODITIES
$3.8 BILLION/YEAR



THE VALUE OF THE HIGH PLAINS — Producers who farm in the Texas High Plains contribute substantially to the economies of their own area towns and cities. Additionally, these producers have an effect on the economy of Texas. Presented above is the total value of the major agricultural commodities produced in the High Plains area, and the percentage of that value which is derived from each commodity.

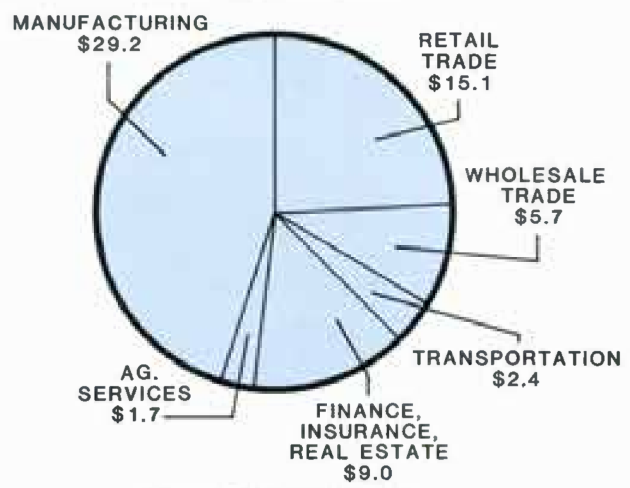
OOPS! Watch for falling "O's" . . . In the August edition of *The Cross Section,* we inadvertently let some zeros fall off the end of the value of agriculture in Texas. The correct value is $74.0 billion per year.

AGRICULTURE IN TEXAS
$74.0 BILLION/YEAR



TOTAL CASH VALUES
BY COMMODITY GROUPS
$10.9 BILLION/YEAR

AGRICULTURE IN TEXAS
$74.0 BILLION/YEAR



$63.1 BILLION/YEAR
COMES FROM AGRIBUSINESS

SODBUSTER . . .

continued from page 1

have several options they may take in dealing with the regulations.

- They can produce agricultural commodities on the highly erodible land without using an approved conservation plan. If they do so, they will lose their eligibility for covered USDA programs.
- They can develop and apply conservation plans that will reduce excessive erosion on highly erodible cropland and retain their eligibility for covered USDA programs.
- They may apply to enroll their highly erodible land in the Conservation Reserve Program and plant permanent cover on the land.

Every County In The Nation Affected

Nationally there are an estimated 345 million acres of highly erodible agricultural lands in the United States. Nearly every county in the nation has some highly erodible land. However, preliminary analysis of the impacts of these interim sodbuster and conservation compliance provisions reveal that the Southern High Plains of Texas will be more severely affected than any other area. In fact, for many counties, 100 percent of the soils in the county may be classified as highly erodible.

Looking At Just One High Plains County

As a median example of the effects of the sodbuster provisions on the Southern High Plains of Texas, look at Lubbock County. Randy Underwood, Lubbock County District Conservationist with the Soil Conservation Service, states, "There are about 400,000 acres of cropland in Lubbock County. Based on the interim criteria, approximately one-half of that total acreage, or 200,000 acres, may be considered highly erodible.

"North of Lubbock County in the Texas High Plains, the soils generally will be considered less erodible; but south and west of Lubbock County, the soils will probably be considered more highly erodible," notes Underwood.

Conservation Plans

Conservation plans must provide for reducing soil erosion to a tolerable level. Local conservation districts, in consultation with county ASC committees, will approve conservation plans.

"Basically, what we are looking at in Lubbock County is putting a lot more acres into some type of conservation cropping system like wind stripcropping or high residue rotation systems," comments Underwood. "The decision on whether a conservation plan will be needed or the extent of the conservation plan needed to manage wind erosion will take current land management practices into consideration. Most current farm management practices decrease the erosion rate significantly.

"If we go more to stubble mulch farming, where we maintain residue similar to conservation tillage systems, we can do a lot to control erosion. Unfortunately, it cannot be done with all cotton.

"In Lubbock County, wind stripcropping will probably control much of our wind erosion within tolerable limits. On the more erosive soils, however, the wind strips will need to be closer together," says Underwood.

Under the law and interim criteria, use of windstrips, strip-cropping, and conservation tillage practices could possibly allow for production of low residue crops, such as cotton, on more highly erodible soils, than would otherwise be allowed.

Erodible Soils

Highly erodible lands are those that could, without cover or conservation practices, erode at least eight times faster than natural processes can rebuild them. For example, soils with tolerable erosion rates of five tons per acre annually would be considered highly erodible if they could erode at a rate of 40 or more tons per acre annually without cover or if they were not protected by some other type of conservation practice (5 tons per year × 8 = 40 tons per year). Soils with tolerable erosion rates of two tons per acre would be considered highly erodible if the actual erosion rate was 16 tons per acre under the same conditions (2 tons × 8 = 16 tons annually).

Generally speaking, coarse sandy soils will probably not be considered suitable for production of low residue crops such as cotton under the guidelines. These soils will be restricted to production of high residue crops or returned to a permanent grass cover to control erosion within tolerable limits.

The next lower level of requirements is for loamy fine sands, fine sandy loams, and similar soil textures. For these soils, a conservation plan may be a rotation system including high residue crops produced on a percentage of the acres or in some type of strip-cropping pattern.

There is one exception. Soil erosion up to twice the tolerable level may be allowed where the Soil Conservation Service determines that reduction to a lower level is impractical. This exception is based on the reasonable judgement of local professional soil conservationists and includes consideration of the economic consequences.

Farming Outside the Programs

Current budgets calculated by the Texas Agricultural Extension Service indicate that producing cotton in the Texas High Plains generates about $43 per acre above variable costs when participating in the farm program. Without program benefits, producing cotton results in a loss of $23 per acre.

Wheat production returns $8 with program benefits, but loses $13 without those benefits. Grain sorghum returns $4 with program benefits and loses $18 without benefits.

Obviously then, farming outside the USDA programs is not a realistic option for most producers.

Profitability of Crop Rotations

Based on current Extension budgets, a one-third to two-thirds rotation of cotton and wheat, where the farmer has no wheat base, would result in a return above variable cost of $5.57 per acre. In this case, then, farming under the conservation plan would be preferred to continually producing cotton and not receiving program benefits, but would still lead to an annual reduction in net returns of about $38 per acre. Similar calculations with a cotton and grain sorghum rotation shows a $2.32 return resulting in comparable losses of income.

Acreage Bases

One of the most confusing aspects of the interim regulations regards acreage bases. Currently, most farmers in the Texas High Plains have substantial acreage bases for cotton, but have few other established crop bases. Speculation on the requirements for conservation plans to control wind erosion shows that closely spaced crops such as wheat or oats would be among the alternative crops recommended for planting on highly erodible soils.

If these or other program crops are recommended as part of a conservation plan, the farmer may not have the appropriate acreage base to receive full program benefits.

Under the interim guidelines, this could create a "Catch 22" for the producer. He could choose to relinquish farm program benefits rather than implementing a conservation plan. Then it becomes a matter of choice between producing the soil conserving, less financially rewarding crop for which he has no base acreage out of the USDA program or producing a low residue crop, such as cotton, on highly erosive soils out of the program. Neither option, according to the Extension budgets for producing agricultural commodities out of the programs, appears to be a viable alternative.

It is extremely important that producers realize the impacts that these farm program regulations have on their farming operation. However, it is equally important that they realize that there are options available to them that will bring them into compliance with the law that may not drastically affect their farming operations.

The key to successfully managing the sodbuster and conservation compliance provisions is planning. Producers are encouraged to contact their local Soil Conservation Service field office to evaluate the erodibility of their soils and to start looking at the alternatives that are available if they are currently farming highly erodible soils. —*KR*

Playa Basin Finally Catches Runoff For Recharge Demonstration

Rains received in the early morning hours of August 4, 1986, provided the first runoff water collected in the playa basin near Shallowater, Texas, where three large drain fields were previously installed. This runoff allowed the first full-scale demonstration of artificial recharge using playa water and geotextile fabric filter materials.

"During the first week we operated the playa basin recharge system following collection of runoff water into the playa, we were able to recharge one million gallons of water into the recharge well," states Dr. Lloyd Urban, Acting Director of the Texas Tech University Water Resources Center and a co-investigator on the project.

"We believe we could have increased that to 2.5 million gallons if the recharge well were capable of accepting more water. Currently, we are recharging at a rate of approximately 100 gallons per minute, which is all the recharge water the well can handle."

Building On the Past

This full-scale playa recharge installation was designed to further evaluate the potential for using native soil materials and geotextile fabric filter materials to remove the silt, sand, sediments and biological life from playa water before the water is recharged into the Ogallala aquifer. (See the July, 1986 issue of *The Cross Section*.)

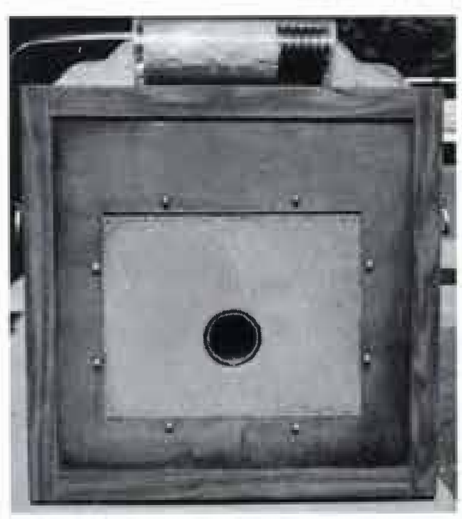
Not only were the drain field designs improved from previous experiments, but the operation of the recharge system was improved with that previous experience as well. "During this initial runoff event, we allowed the water to settle in the playa basin for a 24-hour period prior to initiating recharge," notes Urban.

"We found out from earlier experiments and evaluation of these types of filter materials, that turbidity in the runoff water has a tendency to be high immediately after the basin receives a charge of runoff water. This turbidity can clog the filters if you begin recharge too soon after initial runoff."

Individual Performers

The highest flow rates are being exhibited through the drain field which the researchers commonly referred to as the "pan system." This system produces water at a rate of approximately 160 to 170 gallons per minute. The researchers theorize that this high

continued on page 4 ... RECHARGE



MOCK-UPS . . . Visualizing something that is buried beneath the land surface is not always easy. Here, the Water District has created mock-ups of the drain field installations for playa recharge. Clockwise from top left, the mock-ups are 1) the pan system, 2) the Hiteck system and 3) the A.D.S. system.

Researchers Investigate Year-Round Forage System

Seeking a combination of forage materials that will produce livestock grazing throughout the year to enhance livestock production potentials here in the High Plains of Texas is the focus of research being conducted by Texas Tech University.

"Basically, our goals are to even out the seasonal peaks that producers have in their present forage systems," states Dr. A.G. Matches, Forage Specialist and Thornton Chairholder in the Department of Plant and Soil Sciences at Texas Tech University. "We know that we have gaps in our feeding system. Generally, we have a gap when we go from range to wheat in the fall and then again in the spring when we move from wheat back to range.

"We are trying to identify, both through slant-tube analyses and field trials, those available forage materials that we can put together for use at different times of the year. Additionally, we not only want to know what types of forages grow better by themselves, but also which ones are compatible for growing in a grass and legume mixture to enhance their production potentials in terms of forage for livestock."

CATTLE APPETIZERS . . . Sainfoin, a perennial legume, seems to hold promise as an additive to our current livestock forage systems by providing green grazing early in the spring when other forage is dormant. Not only is sainfoin high quality grazing material, but it seems to encourage the animals to eat more, which in turn creates more gain in the animals.

Slant-Tube Analyses

One phase of this research begins in the greenhouse where investigators Howard Taylor of Texas Tech University, Bobby McMichaels with the USDA-Agricultural Research Service in Lubbock and Matches are evaluating different annual and perennial legumes for cattle forage. The research is specifically designed to evaluate seedling establishment as it relates to rooting characteristics, such as root depth and size.

Slant-tube techniques are used in the greenhouse to see if predictions can be made of forage legume rooting depths in the field. Matches explains, "We believe that those plant materials that put roots down farthest will have a better survival rate in the winter and be capable of making the best use of available moisture."

Legumes Hold Promise

The researchers thus far have performed substantial tests using different types of legumes, both perennials and annuals, theorizing that legumes may fit well into a year-round production system, while providing beneficial animal forage.

"Not only are we interested in filling the gaps in our forage system, but we are particularly interested in improving forage quality in terms of its nutritional value."

Matches sees legumes as an attractive forage supplement for several reasons. "First, you get some free atmospheric nitrogen fixed in the soil by bacteria in the nodules on legume roots. Secondly, it has been my experience that anytime you have any legume in a forage system with grasses, you are going to get improved animal performance.

"Generally, I'd say that with even 25 percent legumes in grasses for forage, I'd expect a quarter pound more gain per day in the animal. Legumes are simply higher in digestibility and more complete in terms of mineral balance," notes Matches.

"Additionally, there are some unidentifiable positive factors supporting legumes as forage materials. For instance, legumes seem to stimulate forage intake in animals. In other words, with legumes you get more forage into the animal, and as a result you get more gain in the animal. Legumes also improve the overall forage quality. Legumes are just generally higher quality forage than the grasses."

Alfalfa and Sainfoin Standouts

Based on four years of study, the researchers have identified alfalfa and sainfoin as two outstanding perennial legumes for forage production in both irrigated and dryland systems.

"My feelings are that sainfoin might do better than alfalfa with less moisture," says Matches. "The other thing we are seeing is that sainfoin likes to grow up in the front part of the season when it's cooler. Now, if I were going to irrigate in the summer, I would not use sainfoin. I would use alfalfa, because tests in progress show that we get more forage from alfalfa from the same amount of water during the hotter part of the summer.

"Sainfoin is an introduced legume that came into the United States in the 1800s. It was mainly tested in the eastern parts of the country where the soils are acidic. Sainfoin is not adapted to acidic soils. As trials of sainfoin moved west, it was found to be better adapted to our neutral or slightly alkaline soils. Sainfoin is currently being effectively used in combination with grasses in the High Plains of Texas in the Hereford and Muleshoe areas; so we think it has promise here."

Matches notes that sainfoin has two qualities that make it somewhat more attractive as a forage alternative in certain cases than alfalfa. "First, sainfoin is a non-bloating legume. It contains tannin, which is probably precipitated in the proteins, so it doesn't cause bloating problems.

"The second thing is that sainfoin produces most of its feed in the front part of the season (in March, April and May) and really takes advantage of the rainfall in the spring. It looks like it would fit nicely into a forage system with some of the wheat grasses which are early season growers."

Field Research Highlights Production Potential

Results of 1983 field research show that sainfoin yielded 43 percent more than alfalfa in the sandy soils of the Terry County dryland research plots. Dry matter yields of sainfoin averaged 2,389 pounds per acre as compared to 1,365 pounds per acre for alfalfa. Additionally, the researchers noted that nearly all of the seasonal production of sainfoin came in the first of two harvests, in May and June.

> "A good grass you ain't got ain't as good as a poor grass that you do got."

In 1983 and 1984 irrigation tests, irrigation applications ranging from 8 to 12 inches were applied. The researchers noted that generally irrigations resulted in little increase in sainfoin yields. This occurred because sainfoin has much earlier growth and likely utilized accumulated fall and winter precipitation for unusually high first harvest yields in early May.

From these irrigated field trials, the researchers believe that if you have accumulated moisture early in the season, sainfoin will begin growth earlier than alfalfa and additional irrigation would not give significant increases in production. However, if it is dry early in the season, alfalfa may be able to draw moisture from a greater depth.

Winter Annual Legumes

Matches and his associates also are looking at winter annual legumes that make their growth from fall to spring. "We are particularly concerned with those that have a hard seed and will reseed naturally. If you have a hard seed and you get fall rains, more seed will germinate. That may carry you through. We think these winter annual legumes may have a place in our forage systems. They can provide a limited amount of green forage from the fall to spring when grown in combination with native grasses. We need higher forage quality during this period, particularly in a cow/calf operation.

"Winter annuals might go with some of the cool-season grasses or with some of the standing dormant grasses. There are a lot of natives that are left standing and/or grazed during the winter. These legumes will come on when the natives are tapering off in growth. They might provide some green forage then."

Wheat Grasses

The researchers also are investigating a number of wheat grasses. With some field trials, Matches states that he sees a lot of plant materials with various growth patterns.

"I'm thrilled with the fact that we see different stages of growth out there in the field. That means that maybe we can take one species of wheat grass for this time of year and let the animals graze that first. Then we can move into the second type, which is a little later. The advantage to that is that we would have a higher quality forage spread over a longer period of time because of the more juvenile stages of growth. Maybe we can put these things together."

In field trials, most of the species of wheat grasses tested have survived for nearly five years under dryland conditions. The survival rates suggest that there is a possibility of long-term persistence of wheat grasses. The main season of production of these cool-season grasses appears to be April through June.

Additional Concerns

"When you get into looking at a year-round forage system, there are a lot of things that you have got to be thinking about," notes Matches. "For example, we have to keep in mind the moisture use of annual legumes. Do they use moisture that should be used on native grasses later? Additionally, what about bloat and estrogenic activities? Are the legumes a weed problem? And, first and foremost, you have to keep the nutritional needs of the animal in mind."

The researchers are not yet ready to say what plant materials should be combined for a year-round forage system. Matches explains that different materials show promise at various times of the year; and under different conditions, each material performs somewhat differently. Matches states, "When you talk about livestock production in terms of acres per animal as we do here in West Texas, instead of animals per acre as they do in East Texas, even a small amount of forage is better than nothing." Matches also notes that as a colleague once said, "A good grass you ain't got ain't as good as a poor grass that you do got." —*KR*

MONITORING GROWTH PATTERNS — Texas Tech University researchers are delighted with the various wheat grass growth characteristics they see in this field trial. By providing tender green forage at various times during the season, some of these wheat grasses may fill the fall forage gap in our year-round livestock production systems.

RECHARGE . . .

continued from page 2

recharge volume is probably a function of the complexity of the system and the installation process.

"There are several times more sand and gravel around the drain lines themselves in the pan installation," notes Urban. "The amount of sand and gravel and the labor required during the installation phase make this system more complex and expensive, which is probably reflected in the volume of recharge water.

"The Hiteck filter material, which was installed in V-shaped trenches, shows a relatively constant flow rate of 75 to 80 gallons per minute. This is the intermediate installation in terms of cost and degree of complexity in the installation processes.

"The least expensive installation, which we tend to refer to as the A.D.S. system, is flowing at a rate of approximately 30 gallons per minute. This is to be expected, due to the fact that this is the least expensive of the three installations, and it was also quickly installed."

Numbers Encouraging

Initially the researchers had hoped to recharge at least one-half the normal evaporation rate from the playa surface. "The numbers under this limited demonstration are extremely encouraging," says Urban.

"The daily evaporation rate during the recharge period averaged less than one-half inch. At 150,000 gallons per day, we are recharging at a rate 2.5 times greater than the daily evaporation rate.

"We had six acres of land covered with water to a depth of one foot: that's six acre-feet of water. We recharged one million gallons of water to the formation during the first week, which would equal about three acre-feet of recharge water. Basically, we are recharging 1.15 acre-feet of water per day."

Urban notes that if the recharge well had been capable of accepting larger recharge volumes, the results could have been even better. "With this facility, if the recharge well could have taken more water, we could have exceeded the evaporation rate by five times."

Some Questions Still Remain

"We still have a few questions that remain to be answered before we can recommend installation of a playa basin recharge system for artificial recharge on a wide scale. First, will the recharge rates we have experienced during this initial test increase with greater lake depth? The data we collected in previous evaluation tests show that they should. In fact, the data show that if we get a good depth of water in the lake, the rates could double.

"Secondly, we need to determine if the system will perform the same next year and five years from now. Previous playa lake recharge experiments show that over time filter materials clog. We anticipate that our rates will decrease to some degree over time. We hope that with the improved designs we have in this test, we will not experience the same problems as have historically hindered playa recharge."

Water Quality

Urban states that, in general, the quality of the recharge water is good. "In fact, it may be better than the quality of the original well water." Prior to recharge, water samples were collected for complete organic and chemical analyses. "Although final results are not in at this time, we don't anticipate any serious problems with water quality."

Practicality

Work is currently under way to identify the factors, decisions and design parameters involved in installing a practical individual playa basin recharge system.

The researchers think that a practical installation would involve approximately two acres of land in the base of a playa basin. Additionally, Urban says that approximately 5,000 to 10,000 feet of geotextile fabric filter material would probably be needed.

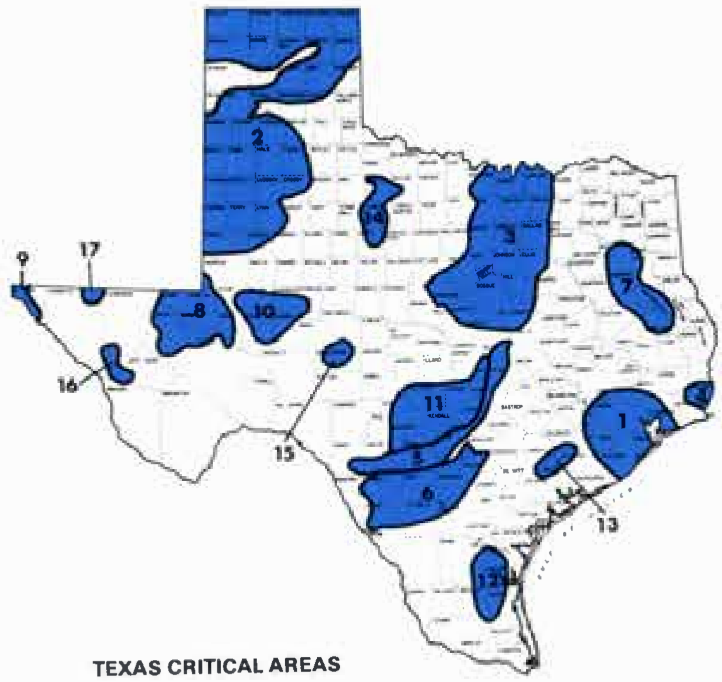
Optimism Runs High

"All in all, we are extremely pleased with the demonstration thus far," states Urban. "The numbers are adding up. We are probably recharging 260+ gallons per minute through the three combined drain fields. In two weeks of recharge at this rate, we would be able to recharge 16 acre-feet of water, or enough water to keep a small vineyard, orchard or 20 acres of cotton going for some time." —KR

NUTRIENTS MAKE A DIFFERENCE . . . Preliminary visual results of nutrient application studies at the Texas Agricultural Experiment Station at Lubbock show the difference in month-old cotton that had (from left to right): 1) no fertilizer added, 2) 80 ppm of nitrogen only added, 3) 80 ppm of phosphate only added, and 4) nitrogen and phosphorus added at rates of 80 ppm.

PUBLIC HEARINGS SCHEDULED

Critical Ground-Water Areas Designated



TEXAS CRITICAL AREAS

BY THE NUMBERS . . . The critical ground-water areas of Texas are: 1) the Houston area; 2) parts of the High Plains; 3) the Dallas-Fort Worth, Waco area; 4) the Orange County area; 5) the Edwards Limestone Aquifer area; 6) the Winter Garden area; 7) the Lufkin, Nacogdoches, Tyler, Kilgore area; 8) parts of Pecos, Reeves, Ward, Loving and Winkler Counties; 9) parts of the El Paso area; 10) the Midland-Odessa area; 11) the Bandera, Boerne, Dripping Springs, Florence area; 12) the Kingsville area; 13) the rice irrigation areas; 14) Haskell and Knox Counties; 15) Schleicher County; 16) the Van Horn area; and 17) the Dell City area.

The Texas Water Commission has released its list of 17 areas in the state of Texas that have been designated as critical ground-water areas. This listing responds to directives of House Bill 2, which was passed by the 1985 Legislature.

According to Bill Klemt, Head of the Water Commission's new Ground-Water Conservation Section, a critical area means that the area is experiencing or is expected to experience critical ground-water problems. These are areas which are characterized by ground-water overdraft problems, due to extensive use of underground water for drinking, irrigation or industrial uses. Many of the areas' problems also are complicated because of other situations, such as subsidence or contamination.

During September and October, the Texas Water Commission will hold 14 public hearings around the state to discuss the 17 designated critical areas. The purpose of these hearings is to receive information from the public, to discuss boundaries of the areas and to discuss the problems and potential solutions in the areas.

Further details on the designation of critical areas and specifics of the hearings may be obtained by contacting Bill Klemt or Brad Cross, Ground-Water Conservation Section, Texas Water Commission, P.O. Box 13087, Capitol Station, Austin, Texas 78711-3087, 512-463-8273. —KR

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STRIPS OF HAY GRAZER protected this cotton from the potentially damaging effects of the West Texas wind. The strips have been baled twice since the cotton became established enough to hold its own against the wind. (Photo courtesy Crosby County Soil Conservation Service.)

Wind Strip-Cropping Holds Numerous Advantages

The ever-present wind on the Southern High Plains of Texas constantly batters the land, picking up topsoil and sandblasting young crops. However, a simple cultivation technique called wind strip-cropping provides, among its many benefits, a way to reduce wind erosion.

Wind strip-cropping consists of placing rows of a tall-growing crop like sorghum or wheat intermittently between rows of a shorter crop that is susceptible to wind erosion damage, such as young cotton. "We use them as a barrier to cut down wind velocity and thus soil erosion," says Crosby County District Conservationist Silas Flournoy of the USDA-Soil Conservation Service.

Flournoy notes, "Blowing sand particles can damage cotton considerably. Using wind strip-cropping, we're trying to hold soil movement down to a minimum from the time the cotton is planted until it comes up and is established."

Soil Losses Decreased Dramatically

Crosby County SCS estimates show substantial reductions in wind erosion rates on fields using wind strip-cropping. For example, one field of Amarillo Fine Sandy Loam soil was estimated to be losing 15 tons of soil per acre per year under straight cotton farming. A wheat wind strip-crop was planted using a pattern of 27 rows of cotton alternated with eight rows of wheat. Soil erosion was cut to four tons of soil lost per acre per year. The amounts were calculated using the wind erosion equation.

Another field with a loam soil that was farmed in straight cotton was losing 12 tons of soil per acre per year. A wind strip-cropping pattern of 24 rows of cotton and six rows of wheat reduced the loss to one ton per acre per year.

In addition to using the wind strip-crop as protection for young crops, many farmers bale the sorghum or wheat for hay once the cotton is established and does not require protection from the wind.

New Government Regulations

New government regulations concerning the 1985 Farm Program and program payments to producers will probably make the use of wind strip-crops a necessity in coming years. Flournoy explains, "People will have to do it to comply with the sodbuster regulations. I expect that the use of wind strip-crops will be the most logical and economical solution for farmers who must comply with the sodbuster requirements to be eligible for farm program payments."

In most instances, complying with sodbuster in the Southern High Plains of Texas either will require the use of wind strip-cropping or require that producers rotate their cotton with other high residue crops. "Wind strip-cropping is a whole lot easier to adapt to and will actually do the producer a better job of controlling wind erosion," notes Flournoy.

Other Advantages

If planted in an even pattern all the way across the field, wind strips also may be counted as conservation reserve acres. Currently, farmers participating in the government layout programs can harvest hay from the strips for their own use, but not

continued on page 2 ... WIND STRIP

The 1985 Farm Bill

New Conservation Rules Will Affect High Plains Farmers

EDITOR'S NOTE: In the September issue of *The Cross Section* we discussed many of the implications of the "sodbuster" and "conservation compliance" interim regulations of the new farm program. This month, with the help of Soil Scientist Mike Risinger, Soil Scientist Dan Blackstock, and Agronomist Monty Dollar who are with the USDA-Soil Conservation Service Lubbock area office, and B.L. Harris, Soil Specialist with the Texas Agricultural Extension Service in College Station, we are taking a second look at the implications of these programs and at identifying how most producers in the Water District's 15-county service area will be able to manage the new regulations.

At first look, the implications of the "sodbuster," "conservation compliance" and "swampbuster" provisions of the new farm program seem to hit the Southern High Plains of Texas very hard. However, on closer inspection, there are alternatives open to producers who choose to manage the new provisions, instead of allowing the provisions to manage them.

> "... There Are Alternatives Open To Producers Who Choose To Manage The New Provisions ..."

In order for High Plains producers to manage the new farm program provisions, they must first take a close look at each provision.

Impacts of the New Regulations

First, it is generally felt that the 1985 Farm Bill will do more to promote soil and water conservation than any national legislation since the 1930s. Secondly, it is common knowledge that the new provisions will force many farmers to choose between changing their farming systems or losing their eligibility for covered USDA programs.

Programs Covered

The USDA programs that are covered under the interim regulations are: USDA price and income supports, disaster payments, crop insurance, Farmers Home Administration loans, Commodity Credit Corporation storage payments, farm storage facility loans, and other programs under which payments are made with respect to commodities produced by the farmer.

Who Will Be Affected?

Any farmer currently participating in any of the USDA programs listed above who farms land that is classified as "highly erodible land," or who farms land which falls under the "sodbuster" or "swampbuster" provisions will be affected.

Conservation Provisions of the 1985 Farm Bill

There are three main conservation components of the 1985 Farm Bill that may affect producers in the High Plains of Texas. First, there is conservation compliance. This provision probably will have the most dramatic effect on High Plains producers.

The conservation compliance provisions of the 1985 Farm Bill require farmers who request certain USDA farm program benefits and who are farming highly erodible lands to plan and apply locally approved conservation plans to control erosion. The provisions will have no effect on farmers who are already using an approved conservation plan.

Conservation compliance includes a grace period for those farmers who are not currently using an approved conservation plan, because of the hardships that immediate compliance would impose on farmers who already have an established cropping history. Additionally, the grace period was put in place due to the impossible single-season workload that would be placed on SCS field staffs and on local conservation districts who will be helping farmers plan and apply the necessary conservation measures. Therefore, farmers who currently are

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producing agricultural commodities on highly erodible lands will have until January 1, 1990 to develop and actively begin to apply a conservation plan. They will have until January 1, 1995 to have the plan fully in effect.

The second provision of the new farm program is commonly referred to as sodbuster. The sodbuster provision applies to any land that has been newly cultivated for crop production since December 23, 1985. However, a farmer who cultivated land after that date but planted a crop before the regulations were issued will remain eligible for USDA farm program benefits for the 1986 crop year. To retain eligibility for subsequent crop years, the farmer must apply a locally approved conservation plan.

The third provision is known as swampbuster. The wetland conservation provision denies eligibility for some USDA farm programs to farmers who convert wetlands to produce agricultural commodities. The sanctions will apply to all commodity crops produced by farmers who convert wetlands, not just those commodity crops produced on the converted wetlands. This provision will have little impact on High Plains farmers.

Compliance Options

Basically, there are four options available to producers who face compliance with the new regulations.

- They can produce agricultural commodities on highly erodible lands without using an approved conservation plan and lose eligibility for covered USDA programs.
- Likewise, they can produce commodities on converted wetlands and lose eligibility.
- They can produce commodities on highly erodible land that is protected by an approved conservation plan and retain eligibility.
- They can plant grasses on their highly erodible land. If they are eligible for the Conservation Reserve, they may bid to enter that program.

Conservation Reserve As An Option

One of the most prominent options available to High Plains producers who must comply with the new farm program provisions is entering their highly erodible lands into the Conservation Reserve Program. This program has received much publicity in recent months and is therefore probably understood by most producers.

However, the Conservation Reserve Program basically allows that owners of highly erodible cropland may submit bids to the USDA to retire their highly erodible lands from production for a period of 10 years. The owner must establish an acceptable cover crop on all land enrolled in this program. The USDA will pay up to 50 percent of the costs for establishment of the cover crop and will make 10 equal rental payments for retirement of the land based on the bid rate submitted by the landowner and accepted by the USDA. In return, the landowner is restricted as to what he can do with the land during the retirement period.

Right of Appeal

Anyone who has been or would be denied eligibility for USDA programs under the Highly Erodible Land or Wetland Conservation provisions of the 1985 farm program has the right to appeal the decision, starting with the local office of the agency that made the adverse determination. Appeals then follow the normal agency appeal procedures.

What Makes Lands Highly Erodible

The classification of highly erodible lands involves a complicated process of determining the soil type and determining the soil's "tolerable" erosion rate.

Natural processes such as the action of air, water, soil micro-organisms and other factors continually create new soil from the underlying material. These processes can offset a small amount of erosion, up to five tons per acre each year. Erosion slower than the rate of soil replacement is considered "tolerable." When SCS soil scientists prepare soil maps, they assign a soil loss tolerance value to each soil type based mainly on the depth of the topsoil.

Highly Erodible Land Defined

SCS soil conservationists will determine if a soil is highly erodible according to its potential for erosion. They use factors of the Universal Soil Loss Equation and the Wind Erosion Equation to predict potential erosion caused by water and wind.

The water erosion formula relates the effects of rainfall, soil characteristics, and length and steepness of slope to the soil's tolerable erosion rate. The wind erosion formula relates wind speed and soil characteristics to the tolerable rate.

Any soil with an inherent potential to erode at eight times its tolerable erosion rate is considered highly erodible under the new provision. The formulas do not consider crop management or conservation practices which influence the actual erosion rate.

Determination of Highly Erodible Soils

Soil conservationists will determine if a field is highly erodible by consulting soil maps or by visiting the site. The SCS has developed a list of highly erodible soil types. Even where soil maps are available, on-site inspection may be required to verify the determination.

Maintaining Eligibility For USDA Programs

There are ways for High Plains producers to manage the new farm program provisions while maintaining their eligibility for USDA program payments. The best way is for producers to begin now to develop acceptable conservation plans.

Conservation plans include specific, practical, cost-effective conservation measures that will allow farmers to produce crops without excessive erosion. They usually include such management practices as conservation tillage and wind strip-cropping, which can reduce erosion at a fairly low cost. They also may include practices such as terraces and grassed waterways that are more expensive to install. Other practices may be needed to control gully erosion on lands covered under the new regulations.

SCS field employees will be available to help farmers develop and apply conservation plans. All conservation plans must be approved by the local Soil and

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TABLE 1

MAJOR HIGHLY ERODIBLE SOILS OF THE SOUTHERN HIGH PLAINS OF TEXAS

Soil Type	I-Value*	Soil Loss Tolerance** (tons/acre/year)
Amarillo Fine Sandy Loam	86	5
Amarillo Loamy Fine Sand	134	5
Arvana Fine Sandy Loam	86	2
Brownfield Fine Sand	310	5
Estacado Clay Loam	86	5
Estacado Loam	86	5
Patricia Fine Sand	310	5
Patricia Fine Sandy Loam	86	5
Patricia Loamy Fine Sand	134	5
Ulysses Clay Loam	86	5
Ulysses Loam	86	5
Tivoli Fine Sand	310	5
Zita Loam	86	4
Zita Fine Sandy Loam	86	4

* I-values are estimates of the average annual soil loss that would occur on an isolated, smooth, unsheltered, wide, bare field where the climatic factor is 100. For example, on an Amarillo Fine Sandy Loam soil the I-value of 86 would indicate that 86 tons of soil would be lost per acre per year if the land remained unsheltered, smooth tilled and bare all year. I-values are estimated for each individual soil type. Climatic conditions, ridge roughness, vegetative cover and sheltered distances (such as those calculated with wind strip-cropping or wind breaks) would each reduce the calculated soil loss.

** Natural processes such as the action of air, water, soil micro-organisms and other factors continually create new soil from the underlying material. These processes can offset a small amount of erosion, up to five tons per acre each year. Erosion slower than the rate of soil replacement is considered "tolerable."

WIND STRIP ... continued from page 1

for sale. In this way, the farmer might be able to derive a double benefit: meeting both his layout acreage requirement and the sodbuster requirements, while protecting his main cash crop.

Wind strips also will act as a barrier to help control water erosion after a hard rain. Wind strips influence the temperature between the rows of different crops. The strips reduce air movement, which allows the temperature between the strips to rise. This improves heat unit accumulation. Additionally, by reducing air movement, evapotranspiration losses are reduced and water-use efficiency is thus increased. These factors can be very beneficial to cotton production.

Flournoy mentions the reduced use of sand fighters as another benefit of wind strip-cropping. "You will have to run a sand fighter to stop erosion very few times with wind strips. This also saves labor by eliminating several trips over the field." Also, when a sand fighter is used, the crops can be damaged. "If you can reduce the use of sand fighters, you can reduce the losses entailed from them," Flournoy notes.

Flournoy adds that wind strips have a good possibility for use with vegetable crops as well. "I have known wind strips to be used successfully with a combination of onions and wheat," he explains.

Still another benefit of wind strip-cropping is the protection offered to seedlings against the potential sandblasting that is commonly associated with spring thunderstorms. By saving the first cotton planting, wind strip-cropping can insure a full growing season and save replanting expenses such as seed and labor. In addition, wind strips are also advantageous for wildlife such as pheasant and quail because they provide food and cover.

Advanced Planning Required

Although wind strip-cropping can provide many benefits and will probably become a common farming practice as the government regulations take effect, the method does require some advance preparation.

The key to managing wind strip-cropping is planning; and the main objective with a wind strip-crop is height, so that it can offer protection to the shorter crop. Flournoy adds, "Timing is real important on wind strip-crops. You have to get the strip-crop planted in time to get it up tall enough to provide the wind protection needed."

For instance, sorghum must be planted in early April so it may gain height before the cotton is planted. If the spring is dry and farmers wait until it rains before planting their sorghum, the sorghum may not grow tall enough in time to offer much protection to cotton. Flournoy also recommends leaving a blank row between sorghum and cotton when using sorghum as a wind strip-crop. The sorghum will sap water from the first one or two rows of the cotton, he explains.

Small grains such as wheat and rye also make effective wind strip-crops. Wheat and rye planted in the early fall have completed their growth by the time cotton is planted and thus have attained their full height. In addition, they do not compete with the cotton for moisture.

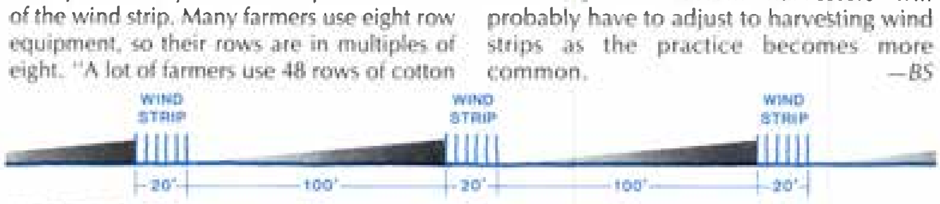
Farmers also must consider their soil type when planning a wind strip-crop. Clayey soils are less subject to wind erosion, so the spacing between wind strip-crops may be wider than with sandy soils. The type of equipment used in farming also may influence the number of rows planted to your cash crop and the size of the wind strip. Many farmers use eight row equipment, so their rows are in multiples of eight. "A lot of farmers use 48 rows of cotton and eight rows of wind strip," says Flournoy. He adds that farmers with sandier soils may plant only 24 rows of cotton between wind strips to hold wind erosion down to an acceptable rate.

Other Considerations

The use of herbicides also requires some advance calculation. "You have to do a lot of planning in how you apply herbicides, because you may have to apply them in strips. It's a little more trouble," Flournoy explains.

He continues, "Harvesting will be a little more of a problem. If your wind strips are wheat, custom harvesters don't particularly like to harvest wheat in strips because they have to cover more ground. Also, their machines may not fit the strips. For farmers who own their own machines, it's not so much of a problem." Flournoy notes, however, that custom harvesters will probably have to adjust to harvesting wind strips as the practice becomes more common.

—*BS*



THIS TYPICAL WIND STRIP-CROPPING pattern for an Amarillo Fine Sandy Loam soil is designed to disrupt surface wind flows to stop soil movement and thus protect young plants.

FARMERS

... continued from page 2

Water Conservation District in consultation with the County ASC committee.

When To Ask For A Conservation Plan

Farmers who think they may be farming highly erodible land, or who think they need a conservation plan for any reason, should contact the local office of the Soil Conservation Service or the local conservation district right away. This will ensure timely service and give farmers time to plan and apply appropriate cropping and conservation systems.

The SCS has developed a list of highly erodible soils for each county. This list is available at the local SCS office. Table 1 lists the major highly erodible soil types found in the Southern High Plains of Texas and the soil loss tolerance values for those soil types.

Current rules provide that fields containing 33.3 percent or more of soils classified as highly erodible, or fields containing 50 or more acres of highly erodible soils, shall be determined to be highly erodible land. Soil surveys are available for all counties in the Southern High Plains. Through the use of the soil survey maps and the list of highly erodible soils, it is possible to identify fields which contain highly erodibile soils.

Determining Management Or Treatment Required To Maintain USDA Program Eligibility

Each soil type and crop combination results in different treatment alternatives that may be necessary to maintain program eligibility. Some soils are so sandy that they cannot be farmed to cotton at all and meet eligibility requirements. Other soils with lower erosion potentials offer several cotton conservation cropping system alternatives. Examples are given in Table 2 and in Figures 1 and 2.

Every farmer should evaluate the impacts of the proposed rules for implementation of the sodbuster, conservation compliance and swampbuster provisions of the 1985 Farm Bill and make the comments he feels are appropriate during the extended comment period.

The closing date for comments on the proposed conservation provisions of the Food Security Act of 1985 has been extended until October 25, 1986. All comments must be received by October 27th to be assured of consideration.

Comments should be sent to: Director, Cotton, Grains and Rice Division, USDA/ASCS, P.O. Box 2415, Washington, D.C. 20013.

These rules and regulations will have a BIG impact on farming activities for the next 10 years. *KR*

Conservation Plan Alternatives Based on Current Soil Conservation Service Standards

The alternatives that can be used in developing a suitable conservation plan are based primarily on the I-value of the soil. I-values are estimates of the average annual soil loss that would occur on an isolated, smooth, unsheltered, wide, bare field where the climatic factor is 100. For example, on an Amarillo Fine Sandy Loam soil the I-value of 86 would indicate that 86 tons of soil would be lost per acre per year if the land remained unsheltered, smooth tilled and bare all year. I-values are estimated for each individual soil type. Climatic conditions, ridge roughness, vegetative cover and sheltered distances (such as those calculated with wind strip-cropping or windbreaks) would each reduce the calculated soil loss.

I-values can be modified with deep tillage, where the soil surface is turned under and mixed with a minimum of 25 percent or more of the clayey-textured subsoil material. This results in topsoil aggregates that are considerably more wind stable and that protect the soil to a higher degree. Some soils with an I-value of 310 can be modified to an I-value of 86 by proper deep tillage once every third year (see the accompanying table and graphics). Similarly, soils with an I-value of 134 or an I-value of 86 can be modified to an I-value of 56 by practicing proper deep tillage. Usually, if the sand surface layer is greater than 20 inches thick, deep tillage practices are less effective in producing conditions that allow the use of modified I-values. Field checks by qualified individuals will be necessary to determine the correct I-value when deep tillage practices are used.

Table 1 on page 2, gives the I-value that has been assigned to the major soils in the area. In Table 2, "crop rotation" indicates the percent of land that must be planted in high residue crops rather than planted to cotton based on the assigned or modified I-value. In "crop rotation" a low residue crop, such as cotton, must be rotated with a high residue crop, such as grain sorghum, and all residues must be left standing until April 1. Figure 2 illustrates the percent of land in a high residue crop based on the I-value and the ridge roughness factor (k) for crop rotations.

In Table 2, "wind strip" indicates that a low residue crop can be continuously planted between protective strips of sorghum, small grain or perennial grasses that are perpendicular to erosive winds. These strips must be maintained throughout the critical erosion period (November to April). In Table 2 and Figure 1, "wind strip" gives the distance that a low residue crop can be planted between each strip based on I-values and k factors. Wind strips must be a minimum of 20 feet in width for grain sorghum or small grain and 80 inches if perennial grasses such as weeping love grass are used. It is also assumed that emergency tillage will be performed as needed when strips or residues are inadequate to control erosion.

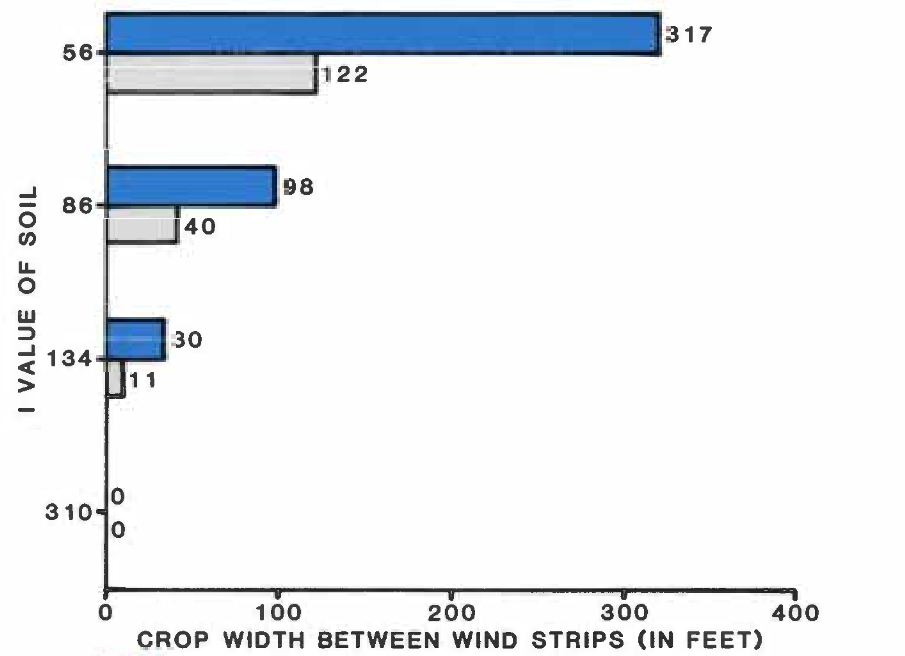
To obtain the crop rotation and wind strip information presented in Table 2 and Figures 1 and 2, the following wind erosion factors were assumed: (1) the unsheltered distance (L) equals 3,000 feet; (2) the vegetative cover (V) equals zero pounds in cotton years and 2,250 pounds in high residue crop years; (3) the climatic factor equals 70; and (4) the ridge roughness factor (k) equals 0.5 when the field is listed soon after harvest and maintained until April 1, or k=0.7 if cotton stalks are shredded and residue is covered with tandum or sweeps, then the field is left unlisted until April 1. *—KR*

TABLE 2

I-Value Assigned	I-Value Modified*	CROP ROTATION High Residue Crop Requirements (Percent of land in high residue) k=0.7	k=0.5	WIND STRIP Distance Between Strips (in feet) k=0.7	k=0.5
310		100	100	0	0
	86	90	80	40	98
134		100	90	11	30
	56	80	70	122	317
86		90	80	40	98
	56	80	70	122	317

*Modified with deep tillage.

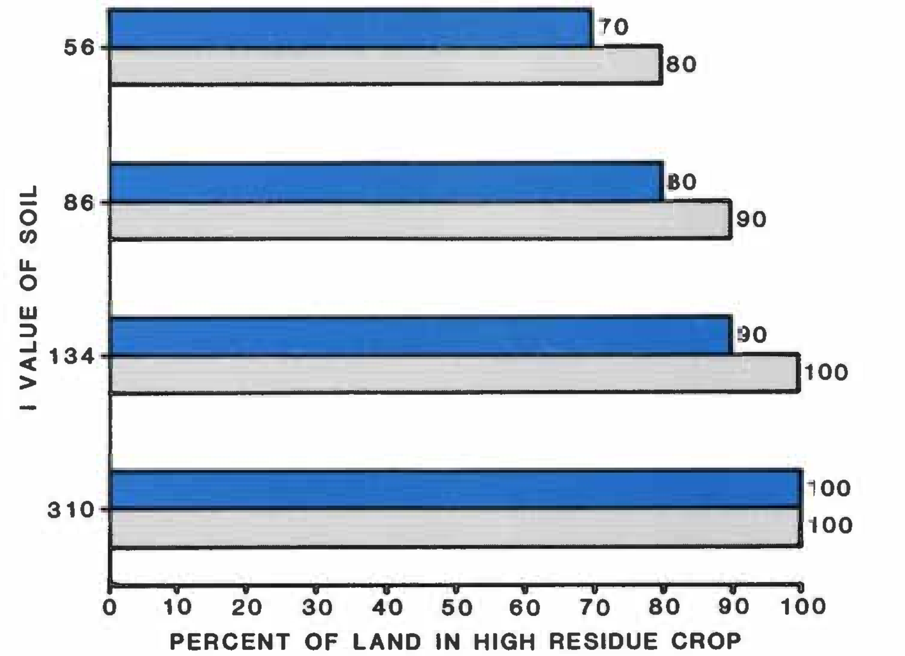
Figure 1: WIND STRIP-CROPPING (Distance Between Wind Strips)



K = 0.5 k=0.5 when the field is listed soon after harvest and maintained until April 1.

K = 0.7 k=0.7 if cotton stalks are shredded and residue is covered with tandum or sweeps, then the field is left unlisted until April 1.

Figure 2: CROP ROTATIONS (Percent of Land in High Residue Crops)



K = 0.5 k=0.5 when the field is listed soon after harvest and maintained until April 1.

K = 0.7 k=0.7 if cotton stalks are shredded and residue is covered with tandum or sweeps, then the field is left unlisted until April 1.

Irrigators Save Water And Improve Efficiencies

Recent research shows that planting drought tolerant crops, letting rain supply preplant irrigation, using surge systems for furrow irrigation or converting from furrow irrigation to sprinkler systems can reduce irrigation water needs and water losses to deep percolation and runoff. All of these things can save water and improve water-use efficiency in the Texas High Plains area underlain by the Ogallala aquifer. So says Jack Musick, Agricultural Engineer at the U.S. Department of Agriculture Research Laboratory at Bushland, who recently reported these findings to the American Association of Agricultural Engineers.

The researcher says the ground-water aquifer in Texas supported 4.7 million acres of irrigated crops in 41 counties during the 1984 crop season. From 1974 to 1984, irrigated acres decreased 24 percent. During the same time period, irrigation water pumpage decreased from 8.13 to 5.24 million acre-feet. According to Musick, this drop in water use and irrigated acreage has not resulted in a comparable decrease in production. Farmers have adopted new conservation practices that research has developed in the last 20 years. These changes have markedly improved the efficiency of irrigation water use.

Water application can be reduced by planting certain crops. Limited irrigation has proven very practical on winter wheat and cotton, the two predominant crops in the area. Sorghum, insilage corn, soybeans and sugar beets are grown with either limited or adequate irrigation depending on the supply of water on a particular farm. Corn, alfalfa and potatoes usually are watered for maximum production, because yield and water-use efficiency decrease if these crops are not watered adequately. In the last 10 years, growers have shifted from high water-use crops like corn to the drought tolerant crops of wheat and cotton, according to Musick.

Farmers are using limited irrigation to cover as much acreage as possible in order to maximize total farm production. Most farms have an excess of land over water and have both irrigated and dryland cropping. Farm production is increased further by grazing cattle on wheat pasture from November to early March.

In an effort to improve efficiency, sprinkler irrigation has expanded while furrow irrigation has declined. Graded furrow irrigation peaked at about 4.60 million acres in 1974 and by 1984 had declined to 2.81 million acres. Sprinkler irrigation, on the other hand, had expanded from about 1.37 million acres in 1974 to 1.73 million acres in 1979. Since 1979, an eight percent increase in sprinkler irrigation in the central and northern counties equalled declines in the southern counties.

Conversion to sprinklers has been prompted by the increased water application efficiencies and reduced labor requirements of sprinkler irrigation as compared to furrow irrigation. Reductions in furrow irrigation primarily occurred on moderately permeable soils where water application efficiency was low due to water losses below the root zone. Musick said the Soil Conservation Service evaluated 161 sprinkler systems in the Amarillo and Lubbock areas and the water application efficiency averaged 82 percent. Low Energy Precision Application (LEPA) systems with drop tubes, recently developed by Dr. Bill Lyle with the Texas Agricultural Experiment Station at Lubbock, can have application efficiencies of 95 to 99 percent. In a similar study on furrow irrigated land, the SCS found application efficiency was 62 percent, not counting tailwater reuse.

> "This Drop In Water Use And Irrigated Acreage Has Not Resulted In A Comparable Decrease In Production."

Research has proven that a widely-spaced bed furrow system improves water-use efficiency, and water application can be reduced on some soils without hurting yields. The best furrow spacing on Pullman Clay Loam was found to be 60 inches according to Musick. Eighty-inch spacing caused excessive yield reductions on the lower ends of the field. Wide-spaced furrows have been most successful on medium textured soils that normally have deep percolation with 30 to 40 inch beds. Musick says, "Increased yields per unit of water are achieved with wide beds because deep percolation is reduced and rainfall readily soaks into the dry beds or furrows."

Systems of reducing tailwater, such as the installation of tailwater pits and reuse systems, have markedly increased water-use efficiency and reduced water losses. Without tailwater pits, wasted tailwater is usually about 25 percent of the water applied. In cooperative SCS and USDA tests on many farms, reuse from tailwater pits averaged 20 percent of the water applied.

More recent innovations for irrigating almost eliminate tailwater runoff. The first system devised used a short set where irrigation was stopped before water reached the end of the field. Using this type of system, some yield reduction occured on the lower end of the field. However, irrigation water-use efficiency is very high. In one study, water-use efficiency was 306, 373 and 479 pounds of grain sorghum per acre-inch of irrigation water in the upper, middle and lower parts of the field. The Limited Irrigation Dryland (LID) system, developed by Dr. B.A. Stewart, Director of the USDA Conservation and Production Research Laboratory at Bushland, is a refinement of the short set system. Furrow dikes are used to hold all irrigation and rainfall on the field.

Compacting furrows with tractor wheels can prevent deep percolation on medium textured soil or during preplant and early seasonal irrigations on clay loam soils that have been loosened by tillage. In a two-year experiment on an Olton Clay Loam soil, water application was reduced by 20 and 30 percent by greatly reducing deep percolation. Grain yields were not affected and water-use efficiency was increased.

Surge-flow irrigation is a new innovation for graded furrow irrigation. Surge systems alternate flushes of water for one to two hours on two field strips, one on each side of the surge unit. The time between flushes of water reduces intake rates and helps prevent deep percolation. Also, with careful management, surge-flow irrigation can be used to reduce and perhaps eliminate tailwater runoff from the end of the field. Fields can be wet more uniformly with surge than with conventional irrigation. In an experiment using a preplant plus six seasonal irrigations on corn, a well-managed surge irrigation system reduced water application by 31 percent, tailwater by 57 percent and deep percolation by 64 percent compared to conventional irrigation. Corn yield was reduced only six percent. Musick says surge-flow irrigation will be most beneficial for preplant or first seasonal irrigations when the soil is loose from tillage.

Eliminating preplant irrigation and planting summer crops after spring rains has greatly improved efficiency. The most reliable 30-day period for rain on the High Plains is from mid-May to mid-June, which coincides with normal sorghum planting. Wheat can be planted in the fall after late August and early September rains. Crops like corn, vegetables and sugar beets that are planted early in the year before spring rains do not have this advantage. Using a fallow period prior to planting can fill the soil profile with water as well as provide a preplant irrigation. In eight years of study, each acre-inch of preplant irrigation produced only 206 pounds of grain sorghum. Summer irrigations without preplant irrigations produced 420 pounds of grain sorghum per acre-inch of irrigation water. Musick said it takes two to three inches of preplant irrigation water to add one inch of water to the soil root zone at planting, so avoiding preplant irrigations can save a lot of water.

Research over the last 15 years has resulted in many ways to improve irrigation water-use efficiency. "This has enabled farmers to grow crops more profitably and conserve a very valuable resource," Musick says. —*KR*

Trading Away
The Agricultural Problem:
Myth or Reality?
4th Annual Professional
Improvement Conference
October 31, 1986
Civic Center Theatre, Lubbock, Texas

THE CROSS SECTION (USPS 564-920)
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Studies Show Soil Fertility May Limit Cotton Yields

Studies under way at the Texas Agricultural Experiment Station at Lubbock may shed some light on why cotton yields in the Texas High Plains have declined an average of 10 pounds per acre per year over the past 20 years.

For years, the assumption has been made that a decreasing water supply was the principal reason for continuously declining cotton yields in this area. "I think what our studies may show is that soil fertility may really be the limiting factor in some cases, instead of water," says Dr. Charles Wendt, Profesor of Soil Physics with the Texas Agricultural Experiment Station in Lubbock.

Wendt and Dr. Arthur Onken, Professor of Soil Chemistry with the Experiment Station, are conducting experiments using container-grown cotton to determine the role that nutrients play in plant production and plant water-use efficiency. "The results thus far indicate that there is an important relationship between soil fertility levels, the availability of water and the crop response," comments Wendt.

Wendt and Onken planted cotton in 384 buckets containing soil that was deficient in nitrogen and phosphorus. The experiment involves two water treatments and four fertility treatments for a total of eight treatment combinations. The water treatments are replacement of 100 percent of the evaporative demand and replacement of 50 percent of the evaporative demand. The fertility treatments consist of a control to which nothing is added, a treatment of nitrogen at 160 pounds per acre, a treatment of phosphorus at 160 pounds per acre, and a treatment of nitrogen and phosphorus at 160 pounds per acre each. (It is normal research practice to use higher fertilizer rates in container studies than normally would be used in field production due to restricted soil volume.) Every two weeks, approximately 64 plants are harvested and tissue analyses made to determine nitrogen and phosphorus levels in the plants.

Fertilizer Results

Results of the experiments so far indicate that phosphorus is the most limiting nutrient and that additions of phosphorus alone will increase plant growth. On the other hand, the application of nitrogen alone has little or no effect. "If you only add nitrogen to soils with a significant phosphorus deficiency, your chances of greatly increasing plant growth are very small," notes Onken.

The following results were obtained where water applications equal to 100 percent of the evaporative demand were added as necessary.

- The cotton plants display no response to nitrogen added alone. "If anything, it looks like a slight depression," comments Wendt.
- The plants respond to phosphorus added alone.
- The best results were obtained when phosphorus and nitrogen were added in combination.

The addition of phosphorus alone generates plant responses even when nitrogen is low because biological interactions within the soil will cause the release of some nitrogen, Onken says. However, similar interactions to release phosphorus do not occur, he explains.

The cotton plants also displayed some fruiting when phosphorus was added; but no fruiting occurred in the plants where no fertilizer was added or where nitrogen alone was added. This emphasizes the fact that a phosphorus deficiency can delay plant maturity. "However, if you have sufficient amounts of phosphorus, adding more phosphorus will not affect maturity," Onken points out.

Interaction With Water

Each container was weighed one to three times per week to determine water use. The phosphorus treatments had a greater effect on water-use efficiency than did the nitrogen treatments. Early indications suggest that the availability

continued on page 4 ... FERTILITY

CONTAINER GROWN COTTON vividly shows the plant response to various fertilizer treatments. From left to right are the control treatment to which nothing was added, a nitrogen only treatment, a phosphorus only treatment, and the combined treatment of phosphorus and nitrogen. Note that the response to phosphorus alone is significantly higher than the response to nitrogen alone, but it does not equal the response to nitrogen and phosphorus applied in combination. These results were obtained when water equal to 100 percent of the evaporative demand was applied.

Producers Save Water And Money

A group of 22 farmers should save more than 1,985 acre-feet of water per year through the installation and use of agricultural water conservation equipment, which they purchased through the Agricultural Water Conservation Loan Program administered by the High Plains Underground Water Conservation District No. 1.

As of October 15, the District had loaned more than $469,000 to 22 farmers in seven counties in the District's 15-county service area. This money was used by the producers to purchase more than $650,000 worth of equipment, including 22 center pivot sprinkler systems, 28 surge valves, one set of laser land-leveling equipment and one set of furrow dikers.

Improved Efficiencies Substantial

The conservation equipment will save water by improving irrigation system efficiencies. System efficiency is a combination of the distribution efficiency, which refers to the uniformity or evenness of water application over the field, and the application efficiency, which compares the amount of water entering the soil profile to the amount of water pumped.

The average system efficiency of a typical furrow irrigation system is 60 percent. The average system efficiency of a drop-line center pivot sprinkler system is 82 percent. The Low Energy Precision Application (LEPA) sprinkler system efficiency can be as high as 98 percent. The average system efficiency of a surge irrigation system is about 80 percent.

Saving With Center Pivots

Seventeen of the farmers who obtained loans have replaced furrow irrigation systems with 22 center pivot sprinkler systems on 2,795 acres. This change should raise irrigation efficiencies from 60 percent to an average of about 82 percent. This improvement in efficiency should result in a water savings of 1,210 acre-feet per year.

The installation of these 22 sprinkler systems will result in additional water savings by eliminating open ditch losses and tailwater losses. By preventing these losses, the farmers implementing the conversion from furrow to sprinkler irrigation should save an additional 140 acre-feet of water per year from open ditch water losses and about 336 acre-feet of water per year from tailwater losses. One LEPA modification increased water savings on one farm by an additional 46.5 acre-feet per year.

An illustration of how multiple water savings can occur is described in the following example. One producer purchased a center pivot sprinkler system modified with LEPA drops to replace his furrow irrigation system. The producer

continued on page 3 ... SAVE

High Plains Proposed As "Critical Ground-Water Area"

See Commentary, Page 2

Committee Hears Testimony On Designation

Is The Texas High Plains A "Critical" Ground-Water Area?

Editor's Note: On September 30, 1986, a joint committee of the Texas Water Commission and the Texas Water Development Board met in Lubbock, Texas, to accept public comment on the proposal to designate a large portion of the Texas High Plains as a "critical ground-water area" of the State of Texas. The following are the comments presented by High Plains Water District Manager A. Wayne Wyatt, who expressed the District's opinion of the proposed designation. Following additional hearings around the state, the committee will report its findings and recommendations to the Texas Legislature in January 1987.

We in the High Plains of Texas have a very serious problem with being labeled as a "critical ground-water area" of the State of Texas. We believe that such a label will cause those who might be interested in living and investing in our area to look elsewhere.

The word "critical," we believe, is much too strong and severe in describing the water concerns of the High Plains of Texas.

Our Current Water Reserves

In the Texas High Plains, 36,080 square miles are underlain by the Ogallala Formation. The Ogallala Formation contained 420 million acre-feet of gravity water in 1980. That is enough water to cover the 23,091,200-acre area with a layer of water 18.19 feet deep. Additionally, the Ogallala Formation in the High Plains of Texas contains 1.46 billion acre-feet of capillary water. This 1.46 billion acre-feet of water would cover the area with a layer of water 63.23 feet deep.

Recent field tests indicate that at least 25 percent of the capillary water in storage can be released for recovery by wells. Twenty-five percent of the 1.46 billion acre-feet of capillary water in storage would equal about 370 million acre-feet of recoverable water.

Adding the 370 million acre-feet of capillary water to the 420 million acre-feet of gravity water brings the area's total available ground-water reserves in the Ogallala Formation to 790 million acre-feet. This amount of water would cover the area with a layer of water 34.21 feet deep.

Our annual precipitation averages about 18 inches at Lubbock and about 20 inches at Amarillo. This rainfall is also a very important part of our annual water supplies. Natural recharge and irrigation recirculation also occur in the area. We are not sure of the average annual amounts, but believe they could range from 500,000 to 1.5 million acre-feet, depending upon the amounts and timeliness of precipitation events.

Annual Water Use

Annual water use throughout the 36,080 square mile area ranges between four and eight million acre-feet, again depending on the amount and timeliness of precipitation events. Assuming an average annual pumpage of six million acre-feet, the 790 million acre-feet of water in storage would provide a 131-year water supply for the area, based on current technology and practices.

Area of "Concern" Maybe, But "Critical"?

We respectfully request that the Texas Water Commission reconsider classifying the entire area of the High Plains of Texas underlain by the Ogallala Formation as a "critical ground-water area." Certain portions of the High Plains of Texas should probably be classified as areas of "concern." These areas need to protect their water resources and improve their water-use efficiency.

However, the area as a whole, especially that served by the three underground water conservation districts, is far from "critical." Perhaps "areas of concern" would be a more appropriate term to describe those areas where serious attention to the ground-water problems is needed.

High Plains Water District Service Area

The total quantity of gravity water in storage in the Ogallala aquifer within the 5.2 million-acre area served by the High Plains Water District as of January 1960, was almost 100 million acre-feet. Twenty-six years later, as of January 1986, that total quantity of gravity water had been reduced by approximately one-third to 66.6 million acre-feet. Additionally, 100 million acre-feet of capillary water can be recovered from the Ogallala Formation within the Water District's service area, assuming a recovery rate of 25 percent of the total quantity of capillary water in storage.

In the 15-county area served by the High Plains Water District, improved water-use efficiencies have substantially reduced the rate of net depletion in the Ogallala aquifer.

Water Depletion Rates Decreasing

Averaging the net depletion over the past 26 years gives an average annual net depletion rate of about 1.28 million acre-feet. However, during the past ten years, 1976 to 1986, the average annual net depletion rate averaged about 71 percent of the 26-year average, for a net depletion rate of 911,992 acre-feet per year.

The annual rate of net depletion has declined even further during the past five years, 1981 to 1986. The net depletion during this period amounts to about 621,868 acre-feet per year, which is only about 49 percent of the past 26-year average. During this past year, 1985, the net depletion rate dropped even further to a net change of "0" acre-feet in the High Plains Water District's service area. Assuming a net depletion rate of 621,868 acre-feet per year, which was the 1981 to 1986 average, the 66.6 million acre-feet of gravity water in storage would provide a 107-year water supply for the Water District's service area.

You Might Ask Why?

There are numerous reasons for recent decreases in the rate of net depletion from the Ogallala aquifer. The most notable is the declining prices producers receive for their products, as compared to ever-increasing production costs. Some farmers have abandoned irrigation, others have reduced the number of times they irrigate, and still others have changed irrigation practices to reduce water pumpage. The majority have made serious efforts to improve their irrigation water-use efficiencies.

The High Plains Water District, the USDA-Soil Conservation Service, Texas Tech University, the Texas Agricultural Research and Experiment Station, the Texas Agricultural Extension Service, the Texas Water Development Board and the irrigation industry all have strived to assist irrigators in improving their water-use efficiency.

Examples of the most recent efforts made by these organizations include:

- *The introduction and utilization of mobile field water conservation laboratories to evaluate on-farm irrigation application efficiency. From these evaluations, recommendations are made to the irrigator as to how he might reduce water losses.*
- *The development of the drop-line center pivot sprinkler system. These drop-line systems virtually eliminate evaporative losses in sprinkler irrigation.*
- *The introduction and demonstration of the surge irrigation valve and time control mechanism. This device has increased water-use efficiency in furrow irrigation by 20 to 40 percent.*
- *Furrow dikes, which capture and hold precipitation in place until it can infiltrate the soil, are yet another example of recent technological improvements. The use of furrow dikes has resulted in a savings by some irrigators of their pre-plant irrigation or, in some instances, the savings of one summer irrigation for their field crops.*
- *Extensive educational programs have also helped make irrigators far more aware of the cost and value of their water resources. Consequently, they have turned to some of the aforementioned techniques, as well as others in efforts to conserve water and energy and cut production costs.*

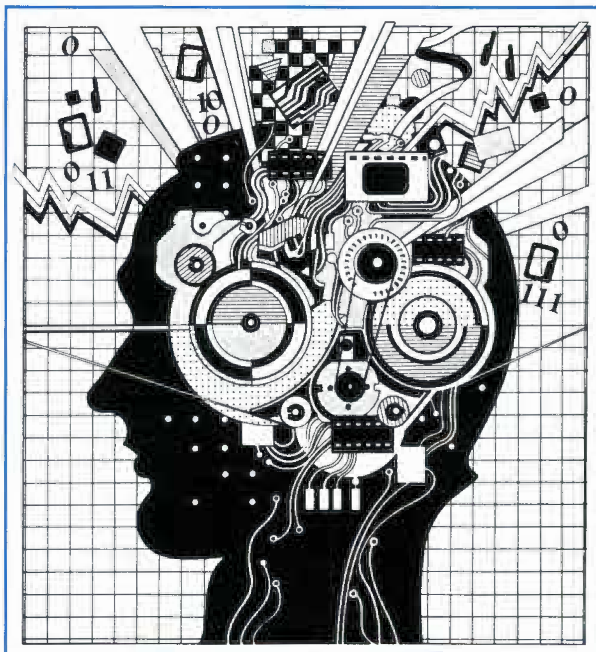
What About the Future?

What happens when the agricultural economy turns around and it again becomes profitable for the irrigator to produce water for irrigation? It is my opinion that with the new technology in place and improved conservation habits already developed by the individual irrigator, he will continue to conserve his water to the maximum potential. I do believe that in some areas water use will increase, but the savings from conservation practices will offset increased water use in areas where maximum efficiency has not yet been attained.

Additionally, the 1985 Farm Bill and the sodbuster, swampbuster and conservation compliance provisions contained therein, as well as the Conservation Reserve Program, may have dramatic effects on annual water use. As a result of the Conservation Reserve Program, many acres in the area served by the High Plains Water District will be planted to permanent grasses for a ten-year period. This will no doubt decrease the amount of water that is pumped from the aquifer. As a result of the other provisions, numerous additional acres may be farmed under some type of conservation tillage practice or wind strip-cropping system which will help retain moisture in the soil and thus reduce ground-water pumpage for irrigation.

When we recall the predictions that have been made in the past regarding the expected life of the water supplies of the Ogallala Formation in the High Plains of Texas, we are extremely gratified that these predictions have proven to be wrong. We are very proud of our irrigators and the conservation efforts they have made. We can hardly believe that now is the time to label the entire High Plains of Texas as a "critical ground-water area," when so much progress is being made by the residents of this area to conserve our water supplies.

Respectfully,
A. Wayne Wyatt, Manager



OUR OLD COMPUTER'S BRAINS GOT SCRAMBLED ... So Beth Snell Has Re-Entered Our Subscriber List In A Newer Model.

Please Check Your Mailing Label And If Changes or Corrections Are Needed, Just Let Beth Know.

Thank You,
Kathy Redeker, Editor

SEMI-DETERMINATE SESAME grows 20 to 30 inches tall and develops cluster of seed-containing capsules at the end of the branch. If researchers can perfect a non-shattering, mechanically harvestable variety, High Plains producers could grow enough sesame seed on 100,000 acres to meet the U.S. demand and bring millions of dollars into the local economy.

SAVE ...

continued from page 1

previously used an open irrigation ditch to transport water to the field. As a result, the producer was losing 7.4 acre-feet of water per year to evaporation and deep percolation in the open ditch. Additional water was lost to tailwater runoff and deep percolation in the furrow irrigation system. The LEPA center pivot sprinkler system will save 35 percent of the water required for furrow watering, or about 96.7 acre-feet, as well as eliminate tailwater, deep percolation and open ditch water losses. Thus, on this farm, a total of 104.1 acre-feet of water can be saved per year.

Assuming that the water saved can be used at some time in the future to produce $100 worth of product per acre-foot, the 104.1 acre-feet saved would have a future value of $10,410. The life of the irrigation system should be at least 10 years; therefore, the potential water savings over the 10-year period would be 1,041 acre-feet, with a future production value of $104,100.

Saving With Surge Valves

In another case, the clayey soils on the farm have a low water intake rate which results in tailwater runoff. Water losses of about 22 acre-feet of water per year occur as a result of this runoff. Adding surge units to improve the furrow irrigation system increased the irrigation efficiency by 20 percent, saving about 55 acre-feet of water per year. Tailwater waste also was eliminated. A total water savings of 77 acre-feet per year will be obtained with this installation.

The farmers who purchased a total of 28 sets of surge irrigation valves will save at least 169 acre-feet of water per year through improved efficiencies on 1,680 acres. The addition of surge valves improves furrow irrigation efficiency from 60 to 80 percent. By eliminating tailwater losses with surge valves, the irrigators should save an additional 46 acre-feet of water per year.

Others Ways to Save

In addition to the center pivots and surge valves purchased under the water conservation loan program, one set of furrow dikers was purchased for use on 376 acres of land. The use of the furrow dikers should save about 70 acre-feet of water per year by creating small reservoirs in the furrow that will capture and hold both rainfall and irrigation water in place until it has time to infiltrate the soil.

The set of laser land-leveling equipment that was purchased should save about 16 acre-feet of water per year by evening out the slope of the purchaser's land. The equipment will be utilized under contract to level additional land in the area. Therefore, each additional acre leveled will increase the water savings potential of this equipment purchase.

Adding It Up

The amount of water saved by the various conservation measures implemented with the equipment purchased through the loan program varies according to the individual case, based on the previous irrigation system, the new irrigation system, soil type, the slope of the land and other factors. However, when all the water savings enabled by the purchase and installation of this equipment are added up, the total savings from open ditches will amount to about 140 acre-feet annually. The prevention of tailwater will save about 382 acre-feet of water per year. The greatest water savings, however, will be produced through the improved irrigation system efficiencies. These improvements should save a total of 1,463 acre-feet of water per year, bringing the collective water savings for these 22 farmers to 1,985 acre-feet of water.

Use of the conservation equipment will save the farmers more than water, however, notes Ken Carver, Assistant Manager of the High Plains Water District. "By saving water, the producers can save money. The use of the efficient equipment allows the farmers to use less water because more of the water that is pumped gets to the crops and is not lost. This puts more money in the farmer's pocket because he has reduced his pumping costs. Also, the equipment applies water across the field more evenly, which usually results in increased crop yields."

Ag Loan Program

The District began making loans to qualified farmers for agricultural water conservation equipment under provisions of the pilot program set up by House Bill 2 and passed by state voters in November 1985. The District originally contracted with the Texas Water Development Board for a $1 million loan and received the money on May 29. As provided in the loan program guidelines of the State, uncommitted loan funds were returned to the Water Development Board on September 29, 120 days after the loan was made to the District. The District has applied to the Texas Water Development Board for a second $1 million loan to continue making loans to producers in its area.

The District's loan program is intended to operate on a self-supporting basis. A one-time service fee of 2.5 percent of the loan is charged to cover the administrative expenses. The interest rate the District charges to its borrowers is the same as the interest rate charged by the Texas Water Development Board on the District's loan. Equipment that is eligible under the provisions of the District's loan program includes center pivot sprinkler systems, surge systems, furrow dikers, soil moisture monitoring equipment, computer software used to monitor irrigation scheduling parameters such as soil moisture, and crop water use and laser land-leveling equipment. Program guidelines and loan applications are available from the High Plains Water District's Lubbock office. *—BS*

High Plains Could Become Sesame Capital

The United States currently spends $20-30 million a year importing 40,000 metric tons of sesame seed from Mexico, China, Venezuela and other countries. Growing 100,000 acres of sesame on the Texas High Plains could meet the U.S. demand and channel millions of dollars into the local economy.

Dr. Raymond Brigham, an Associate Professor and Plant Breeder at the Texas Agricultural Experiment Station in Lubbock, notes that there are several advantages to growing sesame in the Texas High Plains. It is well-adapted to the dry climate, has a short growing season and easily rotates with other crops commonly grown in the area. "Processors like the seed quality and the low moisture content of seeds grown in this area. This is probably the best part of the state for producing sesame seed because of those facts," adds Brigham.

We've Done It Before

In the 1950s and 1960s, 10,000-12,000 acres of sesame were grown in Lubbock, Floyd, Bailey, Parmer and Swisher counties. During this period, sesame was shocked by hand and hand-loaded into a combine. Most of the labor was performed by "braceros," Mexican nationals who obtained permits to work in the United States. After new laws prevented these laborers from working legally in the United States, area farmers could no longer produce sesame efficiently enough to the make the crop profitable, and they ceased to plant it. "Now there's a renewed interest in sesame in our area because of the need for alternate crops," says Brigham.

Today's Research

Brigham is working to cross sesame varieties to develop a non-shattering sesame that produces thin-walled capsules that can be mechanically harvested.

The types of sesame that are commonly grown around the world are shattering varieties that produce seed-containing capsules up and down the stems. Shattering types develop capsules which open, or shatter, naturally when the seed is ripe. The problem with this variety is that the seed loss is so great when combines are used for harvesting that these types of sesame must be harvested by hand. "In most other parts of the world, they don't want to incur the cost of machines to harvest, so shatter types are grown because the crop is harvested by hand," notes Brigham.

Brigham explains that there are problems in removing seeds from the heavy-walled capsules that are common to non-shattering varieties. "It's difficult to remove seed from heavy-walled non-shattering capsules without damaging the seed. If you crack the seed when opening the non-shattering capsule, the seed becomes rancid.

"We're putting a lot of effort into trying to reduce the thickening of the capsule wall so the crop can be harvested more efficiently." Also, scientists are working on increasing the yield of the non-shattering variety, which now produces less than the shattering variety.

A new type of sesame plant which exhibits semi-determinate type growth also is under investigation. Indeterminate sesame normally grows to a height of five to six feet under irrigation in the Texas High Plains. The semi-determinate type grows to be 20-30 inches tall and produces capsules in clusters at the end of the branch. However, the plant does not shed its leaves. It has to dry in the field until the capsules are sufficiently dry and the seed moisture content is dry enough to allow combining. Researchers would prefer a completely determinate sesame plant. "In developing the smaller plant, we hope it will be efficient in utilization of water and grow in dryland conditions," adds Brigham.

He continues, "We also have done extensive crossing of the semi-determinate type with the best shattering and non-shattering varieties available. We have the results of some of our crosses in the field this year. There are several promising new plant types in those populations that we hope to grow out in the following year (1987). We're generating completely new combinations in the program."

Additional work is being conducted in the lower Rio Grande Valley where two crops of sesame may be grown in a single year, which may help speed up the development process. "There's lots of work that has to be done to get the correct capsule type and seed characteristics," Brigham points out.

Cultivating Sesame

Sesame adapts easily to farming conditions on the Texas High Plains. "The relatively low humidity is especially favorable for growing sesame because it helps prevent foliar diseases," notes Brigham.

Sesame grows well on loam soils and may be grown on sandy soils as well. "On sandy loams it requires higher fertilizer applications and more water than on loams, but it makes good growth on sandy loams," Brigham says.

Sesame is planted in June and harvested in October. The soil temperature should be 70°F at the eight-inch soil depth on a 10-day average. June is ideal for planting because night temperatures are warmer, which favors seed germination and rapid emergence. Also, much of the severe winds and rains have passed by late May. A pre-plant irrigation usually is not necessary

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THE RESULTS of the fertility studies indicate that phosphorus is the most limiting nutrient and that additions of phosphorus alone will increase plant growth. Here, only 50 percent of the evaporative demand for water was applied. However, even under the lower water conditions, the crop response to the addition of phosphorus alone (pictured in the third container from the left) is still significant.

FERTILITY ...

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of nutrients affects the plant's ability to utilize water efficiently. A nitrogen-phosphorus deficiency can hamper the plant's water uptake.

"If you have low levels of soil nutrients, you won't get efficient use of water," explains Onken. He emphasizes, "You can't substitute water for fertilizer, and you can't substitute fertilizer for water. They interact in how efficiently water is used or in the production you can expect."

The following responses were observed under the two water treatments.

- The most efficient use of water overall occurred when phosphorus, alone or in combination with nitrogen, was applied.
- The least efficient use of water occurred when nitrogen alone was applied under both the high and low water treatments.
- The control treatment, where both nitrogen and phosphorus were deficient in the soil and nothing was added, showed very inefficient use of water.

Dry Matter Studies

Dry matter study results are not yet available, but Onken and Wendt hope to shed further light on the interactions of nutrients and water and how they affect plant growth. The scientists will study nutrient uptake from the soil in relation to the availability of soil nutrients and the availability of water. They also will study nutrient availability as it relates to water-use efficiency and dry matter production.

"We found with other crops that one of the most critical factors relating to crop growth is the amount of nutrients removed from the soil," notes Onken.

In their dry matter analyses, the researchers will study the distribution of nutrients between the roots and tops of the cotton to determine how the availability of nutrients influences the translocation of water and nutrients in the plant.

The fertility experiments were conceived after analyses of soil samples collected by the High Plains Underground Water Conservation District No. 1 showed that soils in the area are often deficient in nitrogen and phosphorus. Also, Wendt observed that plants were not utilizing all the available water in soils that were low in fertility.

"The objective is to try to get some handle on a concept that will help us to determine what relationship exists between fertilizer and water use and water use as it relates to production," Onken says.

Eventually the researchers hope to determine how much fruit the plant produces per unit of water it uses, how much fruit the plant produces per unit of water available, and the relationship of soil fertility levels on the water-use processes. Onken explains, "When the plant uses water, we need to know how efficiently the plant uses it once it is taken up." *—BS*

SESAME ...

continued from page 3

because spring rains already have put sufficient moisture in the soil. Sesame should be planted using a vegetable planter to accommodate the small seed.

Sesame does not start off as a hardy seedling. "Once you get it growing," comments Brigham, "it grows quickly and shades quickly. It will help keep wind erosion from being a problem. Because it is a small seedling, it is susceptible to wind and sand damage. However, by the time this crop is planted, most of the weather problems from blowing wind have passed."

Typically sesame is grown under irrigations of one or two summer applications of about three acre-inches per irrigation. Furrow and LEPA irrigation systems are the preferred irrigation methods, although other types of sprinklers also may be used. "There are foliage diseases of sesame that might be aggravated by drops of water. The splashing of the droplets, such as with a conventional sprinkler system, might spread a disease if it is present," explains Brigham.

Early sesame has a growing season of 90-100 days, and the longer season types have a growing season of about 120 days. Sesame is a good crop to grow in rotation with sorghum or wheat or with cotton every other year. For instance, it can be harvested in time to follow it with winter wheat.

In addition, sesame is a moderate residue crop that leaves more residue on the soil than cotton but less than sorghum. "The stubble actually can be a good deterrent to wind and water erosion because it is left on the field after the crop is harvested," Brigham adds.

Fertilization

Brigham recommends maintaining acceptable levels of phosphorus and potassium and adding 40-80 pounds of nitrogen per acre. However, fertilizer amounts may vary, depending on the previous crop. For example, vegetable crops are heavily fertilized, and it may not be necessary to add as much fertilizer for succeeding sesame crops. If sesame follows cotton, sorghum or soybeans, additional fertilizer may be necessary.

Herbicides

Weeds usually do not present a problem and can be controlled with trifluralin herbicides, such as Treflan. Since sesame typically is planted after the first of June, frequently early weeds have been controlled already by herbicides or cultivation practices. Once the plant emerges, it grows rapidly and shades out later weeds which may develop. "It's quite competitive," comments Brigham.

Insects

Insects also do not present a large problem. "Aphids are known to build up in plantings at times, but usually there are enough natural predators to control them," says Brigham.

Sesame Seed Use

Sesame is used in the United States mainly by bakeries and confectioners. The seed produces a very high quality oil which is the preferred cooking oil of the Middle East, India and Africa where available. The Middle East and India often use sesame oil as an ingredient in sweetmeats. Some oriental recipes use sesame seeds as well.

However, sesame seed is expensive in the United States and therefore the oil is more expensive than other common U.S. cooking oils such as safflower oil, corn oil and cottonseed oil. *—BS*

THE TEXAS WATER DEVELOPMENT BOARD met in Lubbock, Texas, on Thursday, October 16. Pictured from left to right are: George W. McCleskey, Member; Charles E. Nemir, Executive Administrator; Thomas M. Dunning, Chairman; Stuart S. Coleman, Vice-Chairman; Louie Welch, Member and Glen E. Roney, Member. Among other items of business, the Board members considered and approved the High Plains Water District's application for a second loan of $1 million for the continuation of the Agricultural Water Conservation Loan Program within the Water District's service area.

THE CROSS SECTION (USPS 564-920)
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Kenneth Chambers smiles while standing amidst his high yielding cotton.

Crop Management Enhances Cotton Production

"First you've got to start with stewardship of the soil, and you have to have optimism," says James Chambers, who, with his son Kenneth, stripped 1,100 to 1,200 pounds of cotton per acre off the first acres of his son's field in late October.

James Chambers estimates that he and his son invested about $40 more per acre on the high yielding field than on another field, but that the high yielding field will net about $140 more than the other field, returning more than three times the additional investment. The entire field averaged 927 pounds of cotton per acre. The same field produced about one-half bale per acre last year.

"Mainly, we think it has to do with management of the crop," explains James Chambers. Chambers also attributes the field's success to an early planting date of April 28, good weather, the application of fertilizer and the timing of a summer irrigation.

The farmers deep broke the field about 13 inches deep last winter and applied one and one-third pints per acre of Treflan in February. They had the soil fertility analyzed in February, which revealed deficiencies in nitrogen and phosphorus. Based on the test results, they applied 70 pounds per acre of nitrogen and 60 pounds per acre of phosphorus. In addition, the farmers added four pounds per acre of zinc, 15 pounds per acre of sulphur and two pounds per acre of manganese of their own accord.

In March, the Chambers applied a pre-plant irrigation of about six inches. In July at pre-bloom, they irrigated again, applying about three inches.

About first bloom, the farmers applied 6.25 pounds per acre of Burst, a plant enhancer. Burst includes a kelp (a type of seaweed) extract which contains cytokinins. Cytokinins stimulate cell division and thus production of squares on the cotton plant, leading to maturation.

In the latter part of September, the Chambers applied two-thirds of a gallon per acre of Prep, a defoliant. Then around October 15th, they applied a desiccant. They harvested the last week of October.

The high yields of Kenneth Chamber's field is all the more impressive when compared to another field which James Chambers describes as "not properly taken care of." This field stripped 561 pounds per acre, because the cotton was not properly fertilized and was not watered all summer.

"It's been a very fortunate year for us, and we feel very lucky," says James Chambers. *—BS*

Directors' Election Upcoming

Just a minute ... don't put away your voter registration yet! The election of members of the Board of Directors of the High Plains Underground Water Conservation District No. 1 from Directors' Precincts Three and Four will take place January 17, 1987.

Webb Gober of Farwell currently represents Precinct Three, which consists of the portions of Bailey, Castro and Parmer counties that lie within the Water District's boundaries. Jim Conkwright of Hereford is currently serving the residents of Precinct Four. Parts of Armstrong, Deaf Smith, Potter and Randall counties comprise Precinct Four.

Absentee ballots can be cast from December 29, 1986, through January 13, 1987, during the normal business hours of the balloting locations. Election-day polling locations and election judges have not yet been set, but will be published in the January issue of *The Cross Section.*

Board members elected in January will serve a one-year term. House Bill 332, passed during the last session of the Texas Legislature, revised the terms of Water District Directors. To comply with this legislation, another election will take place in 1988 for the same positions. The back-to-back elections will place elections in Precincts Three and Four in presidential election years. Board members elected in the 1988 election will serve four-year terms.

All registered voters living within Precincts Three and Four are urged to vote. Absentee polling places are as follows:

Armstrong County — Tulia Wheat Growers, Wayside, TX 79094; Chris White, Clerk

Bailey County — High Plains Water District Office, 224 W. Second Street, Muleshoe, TX 79347; Doris Wedel, Clerk

Castro County — High Plains Water District Office, 120 Jones, Dimmitt, TX 79027; Dolores Baldridge, Clerk

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Water Quality Checks Can Detect Bacteriological Contamination

Public awareness concerning the importance of the quality of rural domestic water supplies seems to be growing, if a recent increase in the demand for domestic well sampling indicates a developing trend.

In a typical year, Water District Engineer Technician Dan Seale samples about 10 wells for possible bacteriological contamination. However, in one week in August of this year, Seale received 29 requests for domestic well sampling. Since August, Seale has sampled more than 75 wells, more than seven times the usual number.

Although the majority of the wells sampled showed no contamination, 10 wells tested positive for fecal coliform contamination. The presence of fecal coliform bacteria, which live primarily in the intestines of warm-blooded animals, is one form of water quality contamination. The most common causes of the presence of fecal coliform bacteria in wells are from household sewage facilities being located too near the domestic water supply well and from rodents entering the well.

Seale notes, "All of the contaminated wells were treated and then resampled and found to be clear of fecal coliform bacteria. The contaminated wells were treated with either calcium hypochlorite or liquid laundry bleach. All of them were probably contaminated from rodents. I did not find any sign of sewage contamination."

continued on page 4 ... WATER QUALITY

Water Management And Fertility Increase Cotton Yields See Page 2 . . .

Small Changes Make For Big Yield Advantage

Water Management / Fertility Program Linked To Improved Cotton Yields

Knowing just a few facts about how the cotton plant grows and the roles that water, nitrogen and phosphorus play in that growth can make you a better manager and perhaps return profitability to your cotton farming operation.

"We've always addressed agriculture (farming) as a tradition and not as a business," comments Ronnie Aston, a Floyd County cotton farmer. "We can't continue to farm from a traditional standpoint."

FARMING BY TRADITION ... Ronnie Aston cites planting cotton on 40-inch centers as a prime example of farming by tradition. Aston checked with several old-timers in Floyd County and found that the only reason they could remember for planting cotton on 40-inch centers was because it fit the horse and the singletree plow. Recent research shows that narrower row-spacings can increase cotton yields.

Aston and several other Floyd County cotton farmers have decided to get into the "cotton farming business." And with a little advice from Dr. Dan Krieg, Crop Physiologist with the Plant and Soil Science Department at Texas Tech University, and some help from Ricky Kellison and a new company called Comprehensive Agri Services in Lockney, Texas, and a fertility and water management computer program that helps the producers make management decisions, they seem to be doing just that.

The Basic Idea

"What we are trying to do is develop a management system that will maintain the development of the cotton plant in balance with the thermal environment," comments Krieg. "If you know what controls yield and you know when the plant is developing its yield potential, then you can do something about making sure that it is not suffering any kind of stress at that point.

"What we have seen in recent years is that people are not cutting back on their irrigation water as much as they are cutting back on other things, such as their fertility program. When the plant's demand is not met by the environmental supply, development is delayed; and in our short growing season the plant does not have adequate time to catch up."

Krieg notes that the knowledge about what it takes to grow cotton is there. "We know how much water, nitrogen and phosphorus it takes to make a certain amount of cotton," states Krieg. "To make a bale of cotton, we feel you need somewhere in the neighborhood of 80 to 100 pounds of nitrogen available in the top two feet of the soil, and you need about 30 to 35 pounds of phosphate (P_2O_5) available in the soil. To get the second bale, you need only an additional 50 pounds of nitrogen, because you don't have to build much more leaf area or any more stalk.

"The soils around here don't have that much nitrogen and phosphorus in them anymore, and most people have cut costs by cutting their fertility program, which may help explain the trend toward declining cotton yields in the past several years."

To reverse the trend, Krieg is working with a fertility/water management computer program to keep water, nitrogen, phosphorus and heat units in balance to enhance cotton production. "We can't do anything about the number of heat units available, but we can control the other three. By matching the controllable inputs to the duration of the growing season and making some management decisions during the growing season based upon what we expect to happen in terms of heat units, we can increase cotton production."

How It Works

Basically, with Krieg and Kellison's assistance, the growers are using data on the number of heat units that are being accumulated on a day-to-day basis. Heat unit accumulation is calculated from the daily minimum and maximum temperatures. Daily water use is calculated as a function of the evaporative demand, based on climatic data and the stage of crop development. The water-holding capacity of the soil and how much water the plant can extract out of the soil were measured. "Then, by using this data in a computer program, we are able to calculate the future water-use rate of the crop and predict when irrigation should be scheduled."

The results so far have turned out very well, even considering the poor growing conditions the producers had to work with during the 1986 growing season, explains Krieg.

"It works," exclaims Ronnie Aston. "All my cotton's had on it is Dan Krieg's magic wand and some nitrogen added in with my irrigation water." Aston's cotton is projected to make one and three-quarter to two bales per acre after having been hailed on and having been flooded during most of September and October.

Aston's cotton was planted April 28 at a seeding rate of 18 pounds per acre on 40-inch beds. It was watered twice, on July 14 and August 1, and 100 to 125 pounds of nitrogen was put down with the first irrigation.

"Going in, Ronnie told me that he was only going to water one time, and that was at the first of August," remembers Krieg. "Ronnie was our biggest critic. I told him that if he was going to water by the calendar, around August 1, he might as well not water at all. I explained that if he was going to wait that long, there was no sense in wasting the water, because he was going to do more harm than good."

Following Krieg's recommendations was not necessarily an easy thing for Aston to do, he admits. "We'd had 11 inches of rain in late June. On the 14th of July, Krieg told me I needed to start irrigating. I said you're crazy, we don't need to water." But Aston did water, despite his neighbors threatening to call out the ambulance when he started to haul out his irrigation pipe two weeks after they had all that rain.

"That watering made all the difference in the world," notes Krieg. "By watering in mid-July, Aston set himself up to make a good yield. If he had waited until the first of August to irrigate, his yield potential would have been lost, especially this year."

What people fail to remember is that not all of the rain soaks into the soil, that the soil will only hold a certain volume of water, that crop water-use is a quarter of an inch or more at this stage of growth, and that the soil surface evaporation rate is high during mid-summer. A lot of moisture is used or lost during this time of year. "Also," comments Krieg, "the roots only have a certain depth they can explore for water. That sets the limit as to how much water is really available to the plant. There is a given water-use rate and a given water volume that is available to the plant. Before those two equal zero, you'd better be there with water.

DAN KRIEG'S MAGIC WAND and some nitrogen applied with his first irrigation is all that this field of cotton had on it, according to Ronnie Aston, kneeling in center. The field is projected to yield one and three-quarters to two bales per acre. Pictured from left to right are Rick Kellison, Eddie Teeter, Ronnie Aston, and Kevin Evans.

CLOSE INSPECTION reveals that Ronnie Aston's cotton, pictured at left, has mature, open bolls all the way to the top of the plant. Aston credits these results to a mid-July watering and proper fertility. In comparison, the field pictured at right, which was not watered until the first of August, shows numerous un-opened, immature bolls at the top of the plant. According to Dan Krieg, the lateness of the watering created bolls that did not have a chance to mature.

"Ronnie's goal going into the program was to make 600 pounds of cotton per acre," explains Krieg. "He's going to make 750 to 800, and probably close to 1,000 pounds. Not only that, it's going to be good quality. Unfortunately, our recent weather has probably reduced his yield by 100 to 150 pounds per acre due to leaching from the open cotton. So, if he gets 850 pounds per acre out of it now, he had over two bales of cotton per acre out there initially.

"The cost of putting the system in balance is minimal as compared to the benefits that you can get from it. And I think that is obvious in the work we've done around Lockney this year," comments Krieg. "It took very little extra cost."

Eddie Teeter, another Floyd County producer who cooperated in the project, explains, "All we changed was the timing and amount of water based on Krieg's recommendations. We had our fertilizer down this year before we got into the program. But next year, we'll do more post-plant fertility than ever before, and we'll position our phosphorus in the root zone rather than broadcasting it as we have previously. All Dan is trying to tell us is that if we irrigate for 600 pound yields, then we have to have the fertility for 600 pound yields, and he's trying to tell us that timing our irrigations is also critical."

What Made the Difference?

"What we did up there (in Floyd County) is we watered when the early fruiting sites were being initiated, which meant that we produced fruit low on the cotton plant and early in the season, giving the bolls a chance to mature. Now, instead of having to count on fruit up on the top of the plant for our yield, we actually picked up most of the yield from the fruiting sites produced early. That's where the actual yield advantages come from," comments Krieg.

Krieg explains further, "It all goes back to the fact that the most sensitive process in the cotton plant is the initiation of fruiting sites. Once the cotton plant has produced one fruit, it has served its purpose in life. And once it gets that first fruit set, it has the ability to limit the production of additional fruiting sites. The development of secondary fruiting sites on a sympodial branch is the most sensitive process in the cotton plant. If cotton has any water stress during that sensitive stage, it will limit the number of fruiting sites that produce squares."

Early fruiting sites are important to final yield potential, according to Krieg, because we run into cool temperatures in September. In the Floyd County project, the producers watered at just the right time to get that early fruit set. "If we had waited until the first of August, the plant would then have produced the second and third fruiting sites on the branches, but they would not have flowered until after August 25. That's too late. By watering in mid-July, the plant produced fruiting sites early enough so that they flowered by the first of August and were able to mature by the middle of September. Some of the other cotton in the county, which was not watered until August 1, did not get the early fruit set, and if it did, it probably didn't stay because it didn't have enough fertility due to excessive rain resulting in nitrogen leaching.

"Water results in the production of fruiting sites. Nitrogen and phosphorus result in the retention of the fruiting sites," notes Krieg. "We believe that we must have five pounds of nitrogen available for every inch of water provided during the growing season when the plant needs it."

Preparations have already begun for next year's crop. "We are going to start soil sampling as soon as we can get in the field so that the producers can make changes and put their pre-plant fertility out properly," says Krieg. "We're recommending that they put their phosphorus out in bands as deep as they can (10 to 15 inches deep) and that they put just enough nitrogen (30 to 40 pounds of nitrogen) on to get the crop started. Most of the nitrogen application will be done during the growing season, either through the water or as side-dressing. Again, what we are trying to do is keep the nitrogen and the water pretty much at a ratio of five pounds of nitrogen to each inch of water during the growing season. If we do that, with 18 to 20 inches of total water from irrigation and rainfall and a lot of good luck, we ought to make two bales of cotton per acre." —*KR*

Measurement Of Soil Moisture Under Way

Measurements of soil moisture will soon reveal if the unusually large fall rains experienced over much of the Texas High Plains have provided irrigators with a full soil moisture profile for the 1987 growing season. Soil moisture monitoring by staff of the High Plains Underground Water Conservation District and the USDA Soil Conservation Service began November 17. The field teams hope to finish taking measurements by Christmas.

Past experience has shown that the lower part of the profile is often not as wet as expected, according to Mike Risinger, Soil Scientist with the SCS in Lubbock, who serves as the project leader. "Large rains fell over much of the District during late summer and early fall, but lots of the water ran off into playas and did not soak into the soil during the high intensity storms."

The main purpose of the soil moisture monitoring program is to gather data for construction of soil moisture availability maps and soil moisture deficit maps. Information from these maps can be used by producers to help them make pre-plant irrigation decisions. The maps illustrate to producers the approximate amount of water in the soil profile, the distribution of water in the profile and how much water is needed to fill the profile to field capacity.

Historically, High Plains irrigators have applied anywhere from 4 to 12 inches of water in their pre-plant irrigations. Recent soil moisture surveys have shown a typical soil moisture deficit of only two to eight inches, indicating that irrigation applications can be reduced from one-fourth to one-half in some instances.

The maps are expected to be completed and published by February 1987. In addition, the District provides the soil moisture readings to the individual landowners and operators on whose land the monitoring sites are located.

About 220 soil moisture monitoring sites are scattered across the District, located approximately three to five miles apart. Statistical procedures were used in selecting sites that would represent the area in which the site occurs in terms of soil type, cropping pattern and saturated thickness of the aquifer.

The soil moisture monitoring program is performed in cooperation with the SCS and individual landowners who allow the neutron tubes to be placed in their fields. Water District personnel Ken Carver, Jerry Funck, Obbie Goolsby and Keith Whitworth are working with Mike Risinger in taking the soil moisture measurements. —*BS*

Tax Reforms Do Not Affect Water Depletion Deductions

Although recent tax reforms have either changed or eliminated most of the allowable federal income tax deductions, one thing that was not affected is the cost-in-water income tax deduction allowed by the Internal Revenue Service for water that is removed from the Ogallala aquifer for use in the business of irrigation farming in the High Plains Underground Water Conservation District's service area.

A check with Water District Accountant Joe Ehler, of Richardson and Ehler, Certified Public Accountants, confirms that landowners and accountants may continue to claim the water depletion deduction as they have previously.

Within the High Plains Water District's service area, anyone who purchased, inherited or otherwise obtained land since 1948 and whose ground water is depleted by use of the water in irrigated farming is eligible to claim the tax deduction. In order for landowners to claim the deduction, the IRS requires documentation of the price paid for the water at the time of land acquisition, the quantity of ground water in storage at the time of land acquisition and yearly decline data.

The High Plains Water District has been providing cost-in-water guidelines and water decline and saturated thickness information to landowners within its service area for more than 20 years, so that the landowners could claim the income tax deduction for water depletion.

The Water District handles six to seven thousand requests for water decline data each year. The water depletion deduction has been estimated to reduce the taxes owed by Water District landowners by $3 to $5 million per year.

The tax deduction is based on the price the landowner paid for the ground water in storage under the property at the time of land acquisition. The value of the water is basically determined by comparing the difference between the sales price for irrigated farmland and the sales price for non-irrigated farmland. Annually, land appraisers hired by the Water District update guidelines for the cost allowed for water and the value which must be attributed to the land.

Bobbie Bramblett, Water Depletion Coordinator at the High Plains Water District, notes, "Requests for water-level declines will be processed in the order that they are received. The sooner the requests are received, the sooner the response will be. Our 1986 decline data will be reviewed by IRS engineers in December and hopefully approved for use in providing the necessary decline data to landowners. Requests for water decline parcels will be processed and mailed to accountants and landowners on a first-come-first-served basis beginning January 5."

The District charges a small fee for the data to maintain the program on a self-supporting basis, since not all taxpayers can take advantage of the service. Requests for 1986 water declines are $5 each, if there is a decline. If there is no decline, there is no charge for the decline information. Upon request, first-time claims will be provided with the saturated thickness of the aquifer at the time of the land acquisition and, if applicable, up to three years of decline information, from 1984 to 1986, for $25.

Information necessary to file a new water decline request includes the taxpayer's name, address and social security or federal identification number; a legal description of the land; and the date of the land acquisition. If a previous claim has been made, only the permanent reorder number is necessary.

Interested landowners or their accountants may obtain water-level decline data and forms on which to request new claims by contacting Bobbie Bramblett at the High Plains Water District's Lubbock office.—*BS*

WATER QUALITY . . .

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Some indications of contaminated water include odd-tasting or funny-smelling water. Repeated episodes of an upset stomach or diarrhea by family members may also be signs of bacteriological contamination.

"The biggest problem I found in checking these domestic wells was that the wells were not sealed properly around the pump base. Even though the majority of the wells sampled showed no signs of contamination, most were not sealed properly, leaving a potential for future contamination," comments Seale.

He recommends, "Keep the area around both the well and the well house clear. Weeds, lumber and other supplies left lying around the well or the well house provide attractive cover for rodents. By keeping these areas clear, you will be able to see if you have a rodent problem. Also, repair any holes around the pump base where rodents might get into the well borehole."

Seale also advises against storing chemicals such as pesticides, herbicides and fertilizers in the well house. "Don't store anything in the well house or near the well that you don't want in the water," he cautions.

The recent surge of testing activities may have resulted from news releases that were published earlier this year in several area newspapers. These releases called the reader's attention to the possible problem of bacteriological contamination, and they informed the reader that the Water District would perform the testing service for rural residents. Seale received requests from all over the District's service area.

Domestic water quality sampling is one of the many services of the High Plains Water District. To request that a water sample be taken from your domestic well, contact either Don McReynolds, Geohydrologic Division Director, or Seale at the High Plains Water District's Lubbock office. —*BS*

DIRECTORS . . .

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Deaf Smith County — High Plains Water District Office, 110 E. Third Street, Hereford, TX 79045; Gloria Escamilla, Clerk

Parmer County — High Plains Water District Office, 323 North Street, Bovina, TX 79009; Pat Kunselman, Clerk

Potter County — Bushland Grain Co-op, Bushland, TX 79012; Bruce Blake, Clerk

Randall County — Richardson Farm Supply, Hereford Highway, Canyon, TX 79015; Robert Tucek, Clerk

Candidates for Water District Director must be at least 18 years old, a resident of Texas; and they must have resided within the Director's Precinct for which they are seeking office for at least six months. Applications to have names placed on the ballot may be obtained at the Water District's Lubbock office. Completed applications must be notarized and returned to the Water District office no later than December 26.

Board members oversee all activities of the Water District, including all legal, financial and business matters. For example, the Directors set the tax rate and approve yearly budgets and all financial expenditures. The Board also directs the activities of the Water District's staff through the Water District's Manager. The Texas Water Code requires that the Board of Directors meet at least quarterly. However, the Board normally meets monthly to consider business concerning the Water District.

Questions related to the upcoming election should be addressed to Election Coordinator Becca Williams at the District's Lubbock office.—*BS*

THE CROSS SECTION (USPS 564-920)
HIGH PLAINS UNDERGROUND WATER
CONSERVATION DISTRICT NO. 1
2930 AVENUE Q
LUBBOCK, TEXAS 79405

SECOND CLASS PERMIT