ANALYSIS OF NEGATIVE REVISIONS TO NATURAL GAS RESERVES IN TEXAS

Final Report

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RESEARCH SUMMARY

Title	Analysis of Negative Revisions to Natural Gas Reserves in Texas
Contractor	Bureau of Economic Geology, The University of Texas at Austin, GRI Contract No. 5083-800-0908.
Principal Investigator	William L. Fisher
Objectives	To analyze the causes of the major negative revisions of natural gas reserves in Texas from 1966 through 1979, to determine leading indicators of any possible return of sustained negative revisions, and to assess the likelihood of additional sustained negative revisions to reserves within the United States.

Technical Perspective

Reserves of natural gas in Texas that once appeared nearly inexhaustible peaked in 1968 at 125 Tcf. Since then gas reserves have declined by 60 percent (1983). Reserves to production (R/P) ratios have been single digit values since 1976, and additions to reserves failed to replace production from 1966 through 1980. Part of the decline in reserves arose from a series of negative revisions to reserves, principally from the Texas Gulf Coast districts that supplied the greater part of Texas natural gas production. The revisions were remarkable for their magnitude and duration. The reasons for extensive negative revision to natural gas reserves have not previously been examined in detail; however, our analysis shows that a combination of technical, economic, and regulatory factors had a role in their occurrence, as follows: Very successful exploration and development in the gas prone area of the Texas Gulf Coast through the 1930's, 1940's, and 1950's resulted in the discovery of large quantities of natural gas. As markets were not immediately available for these additional supplies, transmission companies developed a policy of prorating their gas purchases on the basis of operator-declared reserves; i.e., those with largest reserves would be the ones to supply larger volumes. Operators were thus encouraged to provide the most optimistic estimate of reserves that could be justified. Several technical factors that affected negative revisions were examined. Recovery efficiencies, reservoir drive, and heterogeneity of reservoirs were factors that were deemed critical.

Economic and regulatory environments were reviewed and analyzed. There were significant changes that occurred during the 1970's. These events included the drastic price changes that resulted from the Arab Oil Embargo of 1973, the freezing of interstate gas prices through most of the decade and the institution of the Natural Gas Policy Act (NGPA) in 1978. So long as reserve additions appeared to easily replace production, no strong incentive existed to revise the optimistic early estimates of reserves. It was not until the late 1960's and on into the 1970's, many years after the original declaration of reserves, that many of the early estimates were critically reviewed. Extensive negative revisions resulted from this long delayed reassessment.

Results

Early problems in overestimating effective porosity in some deep Delaware Basin carbonate reservoirs in the Permian Basin in District 8 resulted in some noticeable negative revisions when these problems were finally resolved. However, the net negative volume of revisions for the Permian Basin (Districts 8, 8A, and parts of 7B and 7C) was nearly an order of magnitude less than that for the Gulf Coast Basin. The largest negative revisions of total natural gas reserves were found to be concentrated in the Gulf Coast within Texas Railroad Commission Districts 2, 3, and 4. District 4, with the largest volume of negative revisions, accounted for 56 percent of all negative revisions in Texas for the period 1966-1979. The total for the three districts was found to equal that in the whole state for the same period. Negative revisions of non-associated gas reserves in Districts 2, 3, and 4, accounted for more than two-thirds of that for total gas for the entire state from 1966 through 1979.

Large negative revisions were determined to be mainly due to a combination of interrelated factors. Principal among these was an original overestimation of natural gas reserves particularly in the Texas Gulf Coast that resulted from optimism encouraged by market-related incentives. These estimates were not subjected to early critical review and reassessment as supplies greatly exceeded demand. Continued high Reserves to Production (R/P) ratios into the 1960's further delayed reassessment. Water saturation, degree of reservoir heterogeneity, and recovery factors were significant technical variables that were analyzed. Non-technical variables included economic climate and regulatory controls.

There should be concern for the quality of reserve estimates declared in times of excess supply, as the stated reserves would not have been subjected to the test of extended maximum demand. However, there have been more frequent reviews of actual recoverable reserves over the last five years. Continued careful review of technical factors and awareness of the impacts of economic and regulatory environment changes suggest that a return of extensive negative revisions over the next 10 to 20 years can be avoided.

Technical Approach

Substantiation of the major role of the Texas Railroad Commission Gulf Coast Districts 2, 3, and 4 was provided by the data used in the preparation of graphs and charts of revisions, additions, production, and remaining reserves of non-associated, associated-dissolved, and total gas. The basic data for the charts and graphs were from American Petroleum Institute (API)/American Gas Association (AGA) annual reports from 1966 through 1979.

The still large but declining contribution to total production of the larger fields is documented in field data from the Gas Research Institute (GRI) data file supplemented by Texas Railroad Commission field production data assembled by Petroleum Information (PI), as well as surveillance field data from the Department of Energy (DOE)/Energy Information Administration (EIA).

A most important contribution to the study, as well as serving as a sounding board for our opinion and judgments, were interviews with experts, representing operating companies, transmission companies, industry associations, and government regulatory bodies; these individuals shared information, opinions, and judgments about the natural gas industry that were invaluable.

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INTRODUCTION

Beginning in the late 1960's, and continuing through much of the 1970's substantial negative revisions of proven natural gas reserves occurred along the Gulf Coast of Texas. Although these negative revisions were a major contributing factor to concerns about the adequacy of natural gas supply during the 1970's, awareness of these concerns was late in developing within industry.

Quite naturally, the focus of consumers is on deliverability of natural gas, and only within the petroleum industry itself was attention directed to changes in reserve figures. Even within the industry, such attention was minimal in the early days of gas resource development. Although there were shortfalls in gas supplies locally during severe cold spells in the 1950's and 1960's, it was not until the widespread shortfall during the winter of 1973 that the situation became acute and forced a more careful and thorough appraisal of natural gas availability. At that point greater attention began to be given to accurate assessment of gas reserves.

The present study has, as its objectives, an assessment of the distribution, nature, and causes of these significant negative revisions of natural gas reserves during the period 1966-1979. Further, indicators of possible future negative revisions were sought, and the likelihood of future negative revisions evaluated.

HISTORICAL OVERVIEW

A brief look at the role of natural gas in the history of the petroleum industry is essential in order to understand the history of natural gas reserve statistics. Early in this history, natural gas was seen as a necessary nuisance accompanying oil production and an embarrassing by-product or co-product of oil exploration; natural gas was the stepchild of the industry. Gas dissolved in crude oil in the reservoir was separated at the surface as "casinghead" gas and flared. In many fields having associated gas caps, the crude oil was produced with excessive gas-oil ratios as a result of the associated gas cap being dissipated along with the crude oil.

This gas, too, was flared in the field. Although Texas had a gas-oil ratio limitation for partial control of, and for the conservation of, associated gas deposits, the limitation was difficult to monitor and, hence, was not rigidly enforced. Although this wasteful practice was widely recognized and deplored, the fact remains that the demand, and consequently the price, was so low that the capital investment and expense required to gather the gas for any purpose could seldom be justified.

In the meantime, non-associated gas reservoirs were discovered in the course of oil exploration. These reservoirs were abandoned as non-commercial when they were small or of low producibility. The larger reservoirs were developed on a very wide well spacing and, local markets for the gas were sought. Seldom was this gas transported any great distance, with reserves developed within the Panhandle of Texas being a notable exception. Consequently, a huge reserve of natural gas was developed over the years from the early 1930's to the mid-1940's while industry sought in vain to develop widespread economic markets.

The Turnabout

It was not until the end of World War II that the markets for natural gas in large volume began to develop. This was made possible by the sudden availability of trunk pipelines formerly used for oil transport. As the war drew to a close, the threat of submarines to the coastal tanker fleet subsided and the Big Inch and Little Inch crude oil pipelines built to transport crude oil from the Gulf Coast to the Eastern Seaboard were no longer needed for that purpose. These pipelines were sold by the government as surplus and immediately converted to natural gas service. Thus, for the first time, a huge supply of natural gas became available to eastern markets hungry for what was an abundant, cheap energy source.

In 1947, the Railroad Commission of Texas decreed a "no-flare rule" that extinguished all oil well flares in the state. All gas produced with oil thereafter was to be gathered, sold, consumed on the lease, or returned to the reservoir. This, of course, meant that casinghead gas had first call on the local markets, leaving a major surplus of gas in non-associated gas reservoirs available for expanded markets. Diligent efforts were pursued to increase the use of this clean burning, easily handled, and distributed energy source.

However, the surplus was of such dimension that little concern was felt for an accurate measure of its magnitude. Early estimates of reserves had been determined by volumetric analyses based on sparse data from widely spaced wells, and depletion rates had been sufficiently low so that material balance data were probably not adequate in any case. Since major emphasis was placed on deliverability, there was little incentive for reserve re-evaluations. If the producibility and ultimate recovery fell short in one reservoir, another reservoir was readily available to meet demand, or another could soon be found and developed to take its place.

A Deterrent Arrives

About this time, however, another influence began to alter the gas market. In 1938 Congress passed the Natural Gas Act (NGA) that required the Federal Power Commission (FPC) to exercise utility price control on natural gas marketing. In 1949 the FPC proposed to extend the 1938 statute to the producer, and to include control of the natural gas price at the wellhead. In 1954 the Supreme Court ruled that FPC jurisdiction did indeed extend to the wellhead. When the FPC arbitrarily set the price below replacement cost, the development of gas reservoirs declined. Furthermore, because oil had to compete in price with an unrealistically low gas price, exploration for and development of new reserves of oil as well as gas declined. From a maximum number of wells drilled of more than 58,000, (including about 16,000 exploratory wells) in 1956, activity declined to a total of about 26,000 wells, including somewhat more than 6,000 exploratory wells in 1971 (DeGolyer and MacNaughton). No longer were discoveries replacing production. In fact, for gas, this probably had not occurred for some time as the "high" R/P ratios masked the underlying reserves problem. Consequently, the surplus gas reserve was being dissipated.

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Estimation of Reserves

Estimation of reserves is a continuing process throughout the life of a reservoir or field. Each well drilled to a reservoir, if fully assessed, will indicate a need for reevaluation of gas-in-place, and careful observation of the pressure-production behavior of a reservoir will provide information for a running reestimation of reserves. No company will, of course, fully follow such a process as the time and costs are not justified, nor does the precision of estimation warrant it. Reestimation, or revisions, occur when pressure-production behavior seriously departs from predicted terms. It must be understood that the ultimate recovery from any given reservoir or field can never be known with complete accuracy until the last well is abandoned.

The earliest reserve estimates are made, of course, with minimal data. Geological and geophysical information, together with core and log data from the discovery well, provide the statistical parameters for an estimation of the original gas-in-place. Reserves are then estimated by applying an assumed recovery efficiency, based on experience, to this estimate of gas-in-place. Since early assumptions of conditions tend to be more ideal than actually exist, these estimates normally require adjustment as more detailed information becomes available.

Later reserve estimates can be made by material balance based on pressure-production history of a reservoir, given that a sufficient time interval has occurred to provide adequate data. The engineering technology based on such calculations is well established, and reserve calculations can be reasonably reliable, except in the case of the most complex reservoirs. When normal calculations are not adequate, the ultimate resort is made to decline curve analysis. When fields have a sufficiently long record of production at full capacity, decline curve estimates, although empirical, can be remarkably accurate.

Nature and Causes of Revisions

Revisions of reserve estimates are a continuing process for any given reservoir or field. These revisions can be negative or positive. Early estimates are mere approximations of technical, regulatory, and economic factors. The most common physical or technical reasons for revisions reside in the inadequacy of basic data on the reservoir and its behavior. There are several sources of information over the life of a reservoir that provide this basic data for reestimation of reserves. The more important are included in the following discussion.

1. Because the geological and geophysical information on a given reservoir is sparse when original estimates of gas-in-place are made, the tendency is to assume more ideal conditions than actually exist which then leads to an optimistic estimate. Each new well drilled provides specific data on the stratigraphic thickness, quality, and continuity of pay zones that enable revisions to be made. Successful wildcat or step-out wells always add area and lead to reserve additions. In-fill wells often call for adjustments as updated isopachous contour maps of pay zones provide more definitive parameters for detailed quantitative reservoir description. As development drilling nears completion, if the individual well data are correlated using a good understanding of the depositional regime, these volumetric estimates can prove to be quite accurate.

2. The quality of the reservoir rock is usually determined from the quantitative interpretation of well logs that have, in turn, been calibrated with laboratory data from study of a lesser number of key wells. It must be understood that, even if these determinations were precise, only a very small volume of reservoir rock has been sampled. Consequently, the quantitative description of the reservoir is estimated by interpretation of the heterogeneous rock character based on the best geological understanding available. If the depositional environment of the sediments is adequately known and can be used as a guide, these quantitative estimates are satisfactory for all reasonable decisions as to the development and exploitation of the reservoir.

3. The pressure-production history of a reservoir, given a sufficient time interval, can provide the necessary information for an accurate material balance calculation of the volume of gas-in-place that is in pressure continuity with the producing wells. Reserves or ultimate recovery estimates based on this value are credible for any non-associated reservoir producing

by pressure depletion. The critical parameter is the pressure remaining in the reservoir at the economic limit of deliverability.

Associated gas reservoirs, or non-associated reservoirs producing with an associated active aquifer, represent more complex situations. Even in these cases, however, the technology is normally adequate for satisfactory estimates of reserves.

Some Common Difficulties

A common physical cause of revision results from variation in treatment of the lower permeability strata contained in, or adjacent to, recognized pay zones. The porosity-permeability cut-off used in assessing volumetric gas-in-place may include or exclude strata whose contribution will be determined by the method of exploitation. If a reservoir is produced by pressure depletion, tight zones, which would contribute insignificantly to a well, may, over the broad expanse of the formation, transmit gas to the more permeable strata and subsequently to the wellbore. On the other hand, if such a reservoir is produced under pressure maintenance as an active water drive, these strata may be bypassed by the encroaching water. Revisions, then, may be either negative or positive depending on the production method.

Another common cause for negative revisions is the recognition in recent years that the displacement efficiency of encroaching water in water drive fields is less (sometimes much less) than was formerly presumed. A significantly lower ultimate recovery of the original-gas-in-place therefore, occurs. In one case, a rapid advance of the water table in the reservoir indicated a much poorer displacement efficiency and hence a lower reserve. In this field, the residual gas saturation behind the water front was calculated to be 35 percent compared to an original assumption of 15 percent, resulting in a drastic negative revision of reserves. Several reservoirs in South Texas are known to have experienced this phenomenon. Some of these fields are now being dewatered to create a secondary gas cap for later pressure depletion and thus enhance their ultimate recovery. This, of course, is an expensive operation, and the extent to which it is practiced in the future depends on costs and gas price.

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Another frequent reason for revision resides in the inaccuracy of interstitial or connate water determinations. These are usually made using resistivity measurements from well logs. Ambiguities in this measurement were common in deeper wells and formations having high clay contents and/or abnormal pressures. In the case of one large reservoir, the early determinations of connate water saturation indicated a value of 25 percent. Later, more detailed tests indicated that a significant segment of the pay zone had a water saturation of 35 percent resulting in a negative revision of reserves of nearly 15 percent, or more than 150 BCF, in that one field.

A Case History

A major gas field in Texas discovered in the late 1930's had its main reservoirs fully developed and under production by pressure maintenance through cycling over the next two decades or more. The produced gas was stripped of condensate and returned to the reservoir. Gas-condensate reservoirs which included several large blanket sand deposits were successfully produced in this manner. Gas demand and price were low, and the cycling operation was profitable.

When the condensate yield began to fall, markets were sought, pipelines installed, and sale of gas initiated. There was a fair water drive in some of the reservoirs, and the field was produced partially under water drive and partially under pressure depletion. Additional wells were drilled at that time to provide the desired delivery rate within individual well efficiencies. In this drilling program, some new stringer sands were discovered at original pressure. Consequently, as the field was depleted, continuous drilling to maintain deliverability added sufficient reserves to replace depletion of the main blanket sands that had been produced by cycling of gas. Since reserves were never reported on a reservoir basis, there was no reduction in field reserve estimates until deliverability could no longer be maintained, at which time the negative revisions became marked.

Statistical Highlights

Beginning in the late 1960's and continuing through much of the 1970's, substantial negative revisions to proven reserves of natural gas were reported from Texas. These negative revisions posed serious concerns about the adequacy of the nation's natural gas supply, because Texas was such a major contributor to natural gas supplies for the nation. Table 1 includes highlights of our statisical review of negative revisions of natural gas reserves for the period 1966-1979 inclusive. Statistics for Texas were chosen for the study because a preliminary examination of the data revealed that the negative revisions in Texas dominated the national figures, overwhelming reserve addition, or positive revisions in other states. The years 1973, 1975, and 1978, were selected for tabulation because these were the only years in which total negative revisions exceeded additions (e.g., extensions and discoveries).

As can be seen, the negative reserve revisions for Texas during the three years were more than three times those for the U.S. as a whole, indicating that revisions for the nation outside of Texas were positive. Louisiana was the only region besides Texas that had significant negative revisions during this time. Because the geological setting of the gas reserves of Louisiana is similar to that for Texas, we concluded that review of the nature and causes of the negative revisions could be focused on Texas.

Table 1 also shows that the total of the combined negative revisions for Districts 2, 3, and 4 for the three years and for the period 1966-1979 are approximately equal to those for the State as a whole. In fact, the total negative revisions for Districts 2, 3, and 4 for the three main years were greater than the total of negative revisions for the U.S. for the period 1966-1979!

Non-Technical Factors

In addition to the uncertainties among technical factors that led to overstated reserve estimates, other issues, such as economic development, market pressures, and regulatory practices tended to encourage more optimistic estimates of reserves.

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Many gas fields reached economic limits at higher reservoir pressures than had been assumed initially because of a long period of inflation when gas prices were arbitrarily held low. When lease and well expenses made wells uneconomic under such a situation, reserves, quite naturally, had to be revised downward.

During the years of over-supply, available markets tended to be prorated or allocated on the basis of back-up reserves. Long term, favorable sales contracts often depended on the assurance of large reserves. Consequently, there was always pressure to state reserve estimates as optimistically as any rational basis would allow. Regulatory agencies further added to this pressure by insisting on minimum reserves to justify pipelines, gathering facilities and treatment plants necessary to market gas under contract.

There were numerous technical, regulatory, and economic reasons why revisions were made, however the general conclusion of the twenty experts interviewed as a part of this study was that the major reason for past extensive negative reserves revisions was the optimistic nature of early estimates. Part of the reason that these revisions were so precipitous and so drastic was the long delay and deferral in making them due to market conditions in the gas industry in the period prior to the late 1960's.

Reappraisals resulting in negative revisions followed the failure to supply market demand. This occurred when practically all wells and all fields were producing at capacity and yet were unable to meet demand. The serious short-falls in deliverability and failure to supply urgent market needs and the attendant negative revisions in reserve estimates were the factors which generated the "gas crisis" alarm and contributed to widespread concerns about the future of natural gas supplies in the United States.

OVERVIEW OF PROJECT

Introduction

The purpose of the study was an analysis of the phenomenon of extensive negative revisions of natural gas reserves that occurred from the late 1960's through the 1970's and that were a contributing factor to the "gas crisis" of the 1970's. The Texas Gulf Coast region that provided the bulk of natural gas supplies for Texas, the nation's largest producer, experienced revisions that were of such magnitude that they exceeded reserve additions from new field wildcats, new pools and extensions during the period from 1969 through 1979 by almost 5 trillion cubic feet (Tcf). Along with continued high rates of production the result was an alarming decline in remaining reserves.

Methodology

The analysis of the negative revisions in Texas was divided into four tasks that are discussed separately in this report.

1) Locate (geologically and geographically) the source of the largest negative revision.

2) Determine possible reasons for the negative revisions.

3) Identify those factors which might be useful as leading indicators of the likelihood of future sustained negative revisions.

4) Assess the likelihood of future sustained negative revisions of U.S. natural gas reserves.

Defining the origin of the negative revisions (Task 1) proved to be at once both simple, yet elusive. It could be readily ascertained that Texas Railroad Commission Districts 2, 3, and 4 (the Texas Gulf Coast) contributed an overwhelming proportion of the negative revisions reported for the state and for the nation. Overall net revisions for the 3 districts combined for the period from 1966 through 1979 exceeded -17 trillion cubic feet (Tcf) of total gas, which equaled the total net revision for the entire state (Table 1). However, more definitive efforts to assign volumes of negative revisions of reserves to particular reservoirs, productive plays, or geologic settings, were unsuccessful. Reserve information is considered highly confidential by operating companies, and although those contacted willingly shared information about general conditions affecting negative revisions, they were understandably reluctant to specify examples from their files.

Revisions of natural gas reserves result from one or more of several possible sources. These sources include:

1) Discoveries not recorded in a prior year due to delays in reporting discoveries indicated, but not confirmed, at year's end; or delays in reporting results of "tight holes" (wells drilled without releasing information which would affect nearby open acreage, etc.). These revisions would be positive and may be quite large.

2) Positive or negative corrections of numerical errors in original calculations of estimated reserves.

3) Miscellaneous corrections, particularly of estimations of production in previous years; adjustments could be positive or negative.

These three sources are considered adjustments and corrections by Department of Energy/Energy Information Administration (DOE/EIA) and are reported as such (negative adjustments and corrections and positive adjustments and corrections) in their reports that replaced American Petroleum Institute/American Gas Association (API/AGA) published natural gas reserves and production data after 1979. However, the three are included by API/AGA, under revisions with the appropriate positive or negative indication.

4) Changes in production economics resulted in revised abandonment pressures (economic limits). Unfavorable economic conditions were a significant factor in the negative revision of reserves particularly of interstate gas. Freezing of prices paid for this gas, despite the rapidly increasing production costs that accompanied the escalation in the price of oil and intrastate gas after the Arab Oil Embargo of 1973 created pressures for negative revisions. Favorable economic conditions resulted from passage of the Natural Gas Policy Act (NGPA) that caused

positive revisions due to lower abandonment pressures (after 1978). Changes in economic conditions also affected reserves as they allowed or disallowed the application of reservoir stimulation techniques that affect recovery efficiences.

5) Development drilling and production experience may require positive or negative revision. Discontinuity of reservoir beds may be indicated from improved geological correlations or production pressure information. Revision of OGIP and/or recoverable reserves often results from an advanced state of knowledge as to heterogeneity of the reservoir.

6) Presence of an active water drive. Many early calculations and estimates of recoverable reserves assumed depletion drives and continuous reservoirs with subsequent very high percent recovery of OGIP. Revisions to account for the lower recovery factors of water drive gas reservoirs (bypassing of gas trapped in lower permeability zones of a reservoir) may be quite substantial.

7) Ambiguities associated with early log determination of connate water saturations (too low) and gas-water contacts, resulted in later substantial negative revisions of OGIP.

Analysis of the reasons for the negative revisions (Task 2) benefited greatly from discussions with 20 selected individuals representing producers, pipelines, regulatory agencies and present and former API/AGA reserve team members.* In addition, earlier Bureau studies of the geologic setting and the producing plays of the Texas Gulf Coast provided background data on the nature of different reservoir units; articles in the Oil and Gas Journal, Wall Street Journal, publications of the Railroad Commission of Texas, and other pertinent literature served to provide additional information on production and reserves of natural gas required for the analysis.

The assessment of those factors identified (Task 2) which might be useful as leading indicators of sustained extensive negative revisions in the future (Task 3) entailed interpreta-

*At the request of most members of our panel, names are not included.

tions of geological and engineering factors (technical), as well as regulatory conditions, and economic influences (non-technical). The events that occurred prior to the period of extensive negative revision in the Texas Gulf Coast and the extent to which such conditions might occur again, either in the Texas Gulf Coast or elsewhere, were investigated. The group of experts served as a sounding board for our ideas and as sources of information; this activity was most helpful in fulfilling the aims of this task.

An assessment of the likelihood of future sustained negative revisions to U.S. natural gas reserves was made (Task 4). This assessment is based on all data collected, including the comments of numerous panel members who offered us their specific personal insight.

Summary of Overview

With completion of this overview it becomes appropriate to examine in greater detail the distribution and causes of negative revisions of natural gas reserves. By focusing on specific Railroad Commission districts in Texas where major (negative) revisions occurred, the causes of the negative revision can best be evaluated in a systematic manner. The chronology of gas reserve development, the geology of gas occurrences, and the regulatory and economic factors that may relate to the major negative revisions of gas reserves can all be closely examined for factors or trends that may be considered indicators of possible future extensive negative revisions.

TASK 1: IDENTIFY THE LOCATIONS OF SUSTAINED NEGATIVE REVISIONS TO PROVED NATURAL GAS RESERVES IN TEXAS

Statistics of Revisions

Annual additions to natural gas reserves in known fields consist of extensions, new pool (reservoir) discoveries in older fields and revisions of past reserve estimations. Although variable in amounts, the volumes attributable to discoveries and extensions have been proportional to the level of drilling activity and rates of discovery and development. Revisions, on the other hand, have been most erratic and variable for the period from 1966 through 1979. Revisions to reserves in the lower 48 states ranged from +6256 Bcf in 1967 to -3546 Bcf in 1973 (API/AGA). In Texas, where negative values were recorded for 10 of the above 14 years the range was from +2437 Bcf in 1967 to -4713 Bcf in 1973 (Appendix V). In the Gulf Coast TRRC Districts 2, 3, and 4, revisions ranged from +1345 in 1977 (District 3) to -3605 in 1973 (District 4). Only three years, 1966, 1967, and 1977, show a positive revision for the combined districts (Appendix X). Negative revisions were of such magnitude in these three districts that the total net revision (-17.5 Tcf) was fractionally greater than that for the entire state for the period 1966 through 1979 (Fig. 1). Thus, over the same period, the remaining 9 districts accumulated a slightly positive value for revisions. Net positive revisions in District 10 more than balanced the smaller negative values of the other districts. For the three Gulf Coast districts, total revisions for the same period for non-associated gas were -11.8 Tcf or almost two-thirds of the total gas revisions and nearly 90 percent of the non-associated gas revisions for the entire state (Fig. 2A and B). District 4 experienced the greatest negative revision for a single year (-3605 Bcf, 1973) as well as the largest total net revision for the period 1966-1979 (-10,708 Bcf) (Appendix V). District 4 also reported the largest percentage of non-associated gas as a proportion of total gas (Appendix V). It was readily apparent that the bulk of the negative revision of natural gas reserves in Texas occurred in the Gulf Coast Districts 2, 3, and 4, with

District 4 being the source of the largest negative revision of reserves (Fig. 2A, B, C). As District 4 was also among the leaders in production and remaining reserves, it is clear that a determined effort to assess causes of the reserve revision issue in that district would provide the most significant answers to the overall question. Stated another way, had District 4 not experienced negative revisions, the problem nationally would have been much reduced. (Table 2A, B, C)

Geologic Characterization of Gas Reserves

Production is almost exclusively from Tertiary sandstone deposits in the Gulf Coast region, with the Frio, Vicksburg, and Wilcox Formations providing the largest volume of recoverable gas reserves. For the U.S. as a whole, 1977, which is the last year in which AGA compiled these data, ultimate recovery from sandstone reservoirs represented 73 percent of the ultimate recovery of total gas; for non-associated gas the figure was 73 percent, and for associated-dissolved gas 75 percent (Table 3A). For Texas, (1977) sandstone reservoirs accounted for 59 percent of the ultimate recovery of total gas; 57 percent of non-associated gas; and 63 percent of associated-dissolved gas (Table 3A). The Gulf Coast is the source of most of the gas in sandstone reservoirs for Texas; nearly four-fifths of Texas's ultimate recovery of natural gas from sandstone reservoirs is from fields located in Districts 2, 3, and 4 (Table 3A); yet they account for less than one percent of the ultimate recovery of total gas from carbonate reservoirs. District 2 records slightly more than two percent of its total gas ultimate recovery from carbonates whereas for 3 and 4 less than one percent of their total gas ultimate recovery is from carbonate reservoirs (Table 3A). West Texas District 8, which experienced noticeable negative revisions, is characterized by production of natural gas from carbonate reservoirs (Fig. 4). Negative revisions then may also occur in carbonate reservoirs although the much larger net negative revisions of the Gulf Coast sandstone reservoirs dominate the picture.

The three Gulf Coast districts show a clear dominance of structural traps (Fig. 3A, Table 3B). In all three districts less than three percent of the total ultimate recovery is

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assigned to stratigraphic traps. However, this simple trap classification does not reflect the major contribution of stratigraphically assisted trapping within the dominantly structural traps; this compartmentalization or reservoir heterogeneity is a large part of the reason for difficulties in estimating reserves. In contrast, within District 8, 22 percent of the ultimately recoverable gas was located in stratigraphic traps in 1977 (Table 3B).

Large decreases in estimated ultimate recovery from 1970 to 1977 for non-associated gas and total gas in sandstone reservoirs in District 4 reflect the results of large scale negative revisions of reserves for these reservoirs (Table 3A). Sandstone reservoirs in District 3, however, recorded an increase in non-associated and total gas reserves which may be the result of successful offshore exploration.

Geopressured Reservoirs

A limited number of reservoirs in the deep Frio, Vicksburg, and Wilcox Formations exhibit abnormal fluid pressures. Normal overburden pressures can be approximated by a pressure gradient equal to that of a column of water, or 0.465 pounds per square inch (psi) per foot of depth in the Gulf Coast. Geopressured conditions result from abnormally thick deposits of sand and mud in areas of growth faults. These conditions also provide isolation of porous units, trapping fluids within the reservoirs so that, with further burial, the fluids support part of the added overburden weight. Under these conditions pressure gradients of 0.75 psi per foot or even higher have been noted.

Geopressured reservoirs require particular care. Drilling may prove difficult with possibilities of potentially dangerous blowouts. Completions also require the utmost care in equipment and planning. Of particular interest for this study, they also provide special problems for the estimation of reserves. Given a simple situation of a thick sand surrounded by impermeable shale, draw-down calculations can readily account for reserves. However, under the typically complex conditions of multiple sands of varying degrees of reservoir quality, calculations become much more difficult. Because of higher pressures, the better reservoirs deplete more rapidly leaving the bulk of the reserves to be produced over a longer period of time from the less permeable zones. Dependability of reserve estimations then varies with the stage of depletion of the reservoir.

Establishment of gas-water contacts and determination of water saturations, which are critical for reserve calculation, were made especially difficult in geopressured reservoirs due to inadequacies in earlier logging programs. Reserve determinations therefore were subject to substantial errors.

Depths to the top of geopressure vary greatly in the Gulf Coast region. However, there is a general tendency to encounter it at a shallower depth in District 4 than in Districts 2 and 3. Thus there would be more influence from this factor in District 4. However, as pointed out by several people we interviewed, gas reserves in geopressured reservoirs are not large, and their reevaluation should not have been a major factor in the negative revisions.

Intrastate Versus Interstate Dedicated Reserves

More than 70 percent of gas production in 1979 was for the intrastate market in Districts 2, 3, and 4 where negative revisions had been so pronounced through the 1970's, whereas the average for the state as a whole was 57 percent (Table 4). Somewhat different figures were supplied by Lloyd Roland, Texas State Comptroller's Office (Table 5). Part of the difference may be accounted for by the volume of gas in storage. Roland's data compiled for a longer period of time show decreasing volumes of interstate gas to 1978 (NGPA), reflecting the increasing price differential for intrastate supplies; then a reversal of the trend (except 1983). For the first 6 months of 1984, the highest percentage of interstate gas was marketed confirming the increased volume of interstate production. Roland's data are for the state as a whole and are not divisible into districts.

Although these data do not deal directly with negative revisions of reserves they do indicate a possible connection as those districts with large volumes of negative revisions of reserves have a much higher percent of intrastate production than the others. Districts 1, 5, 7B, and 8A with high percentages of intrastate gas only account for small percent of production.

Size of Field

Although there is no direct relationship between field size and volume of negative revisions, it is believed that it deserves attention as the larger fields represent high percentages of total reserves for different districts and therefore must have been involved in the large negative revisions.

Using computer print-outs from field data files, augmented by cumulative production figures compiled by the Texas Railroad Commission (TRRC) and listed by Petroleum Information Company (PI), charts of cumulative gas production to December 1983 were prepared for each of the TRRC Gulf Coast districts. All gas fields that had produced more than 60 Bcf were included (Appendix VI, A, B, C). This figure was selected as an approximate equivalent of the 10,000,000 barrels of oil used as a reference point in a recent study of the characterization of major oil fields.* These parameters resulted in a list of 46 fields for District 2; 70 for District 3; and 92 for District 4.

The 92 fields in District 4 contributed 61 percent of the total annual district production for 1983 (Appendix VI-C-5). The same fields account for 77 percent of the cumulative production through 1983 (Appendix VI-C-5). These data reflect the declining productivity of the older, large fields, which in turn is partially a response to the negative revision of reserves that the larger fields experienced during the 1970's.

Further confirmation of the declining productivity of these older, major fields is seen in data from the DOE/EIA publication Surveillance Gas Fields in Texas. The surveillance fields system was developed by the Energy Information Administration (EIA) in 1975 and included

*Atlas of Major Texas Oil Reservoirs. W. E. Galloway, T. E. Ewing, C. M. Garrett, Jr., N. Tyler and D. G. Bebout.

those gas fields that contributed 85 percent of nationwide gas well gas production in 1970. The smallest of the surveillance fields produced 2,427 MMcf annually sometime between 1970 and 1975. Updated surveillance fields in Texas (1981) include those that had produced 2,427 MMcf in any one year from 1970 through 1981 and had at least one well with a back pressure test in 1981. There were 606 surveillance fields in the 1981 study, representing 5.5 percent of the 10,971 gas fields in the state. The surveillance fields accounted for 3.12 Tcf or 58 percent of the total gas-well gas in Texas in 1981. District 4, which produced more gas-well gas than any other district in 1981, had 173 surveillance fields out of 3,393 or 5.1 percent of the total (Table 6). The production of 532 Bcf from these surveillance fields was 47 percent of the 1.14 Tcf gas-well gas produced in District 4 in 1981 (Table 6); or a lesser contribution from the larger fields here than for the state as a whole. District 8 and District 10 reported much higher percentages of surveillance field gas with 77 and 86 percent respectively. District 2 and 3, the other major gas-well gas producing districts, had smaller percentages of production for the surveillance fields than District 4.

Annual Production Rates and Decline Curves

Plots of annual production versus cumulative production for the 6 largest fields in District 2; 9 largest fields in District 3, and 14 largest fields in District 4 (Appendix VII A, B, C) were constructed to examine depletion patterns of fields in areas of large scale negative reserve revisions. In District 4 these 14 fields had cumulative production of 12.98 Tcf through 1983 (Table 7), which represents 38 percent of the district total. The volumetric significance of these fields suggests that they were at least partly responsible for revisions in reserves.

The largest gas fields in District 4 exhibited sharp declines in annual production rates as shown in Table 8. The reason for the decline may be related to revised reserve figures as decided anomalies in the Reserves to Production (R/P) ratio would be produced if reserves were not decreased in like manner. Prudent reservoir management would require a relationship between annual production rates and remaining reserves.

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Allowables and ratable takes depend upon operator declared deliverability and pipeline (purchaser) nominated takes (Appendix IV), and are assigned by the Railroad Commission of Texas. Significant underproduction (decreases in rates of annual production) of these allowables, indicates the inability of the reservoir to deliver assigned volumes of gas, and may show the need for negative revision of reserves. Obviously other factors, such as market interruptions, technical difficulties in production, etc., may be responsible for part of the decline in production; however, when wholesale concurrent negative revisions occur the relationship of the decline in rates of production to the revision of remaining reserves must certainly be considered.

Year of Discovery Tables

Charts that illustrate revisions in ultimate recovery by year of discovery for non-associated, associated, and total gas were constructed to test possible discovery-date influence on revision. The years 1972 through 1979 were chosen because the data were readily available for those years and they included the largest negative revisions of reserves. A problem with such plots is that of differing dates of discovery (reservoir rather than field?) for associated and non-associated gas reserves in the same field and/or variations in dates according to sources checked (International Oil Scouts, Texas Railroad Commission, GRI print-out, DOE/EIA Oil and Gas field code master list, 1983). Because non-associated gas in the Gulf Coast districts represents such a large part of the total gas, we concentrated our effort on non-associated gas fields. However, the ambiguities in dates of discovery for different types of gas, and the fact that our list of larger fields still left room for revisions that could not be accounted for, prevented the direct application of this approach. Some of the very large negative revisions, such as the 1975 decrease of 490 Bcf in estimated ultimate production for fields discovered in 1939 for District 4 non-associated gas (API/AGA Charts Appendix IX) may be related in part to revisions in reserves at La Gloria. This is indicated by abrupt changes in production rate (more than 20% annual decline) for this field in 1975 and 1976 (Table 8).

Grouping discoveries by decades resulted in a series of generalized graphs (Appendix IX) that illustrate the variable nature of the very large negative revisions.

A look at reserves, production, and revisions points out one reason for the difficulties encountered. Negative revisions for non-associated gas reserves of 6.3 Tcf in 1973 were recorded representing some 19% of the remaining reserves of non-associated gas for the 3 Gulf Coast districts. Reserve additions during 1973 totaled only 0.94 Tcf (3 percent of remaining reserves) while production was 2.74 Tcf (8.3 percent of remaining reserves). Incremental negative revisions for individual fields would show a smaller percent of total remaining reserves so that it would be difficult to document that all the revisions recorded necessarily came from these larger fields (60 Bcf cumulative production). Nonetheless, their size and importance suggest they were driving forces in the negative revisions process.

Task 1. Summary Statement

Revision of reserves as reported in the API/AGA 'Blue Book' (ref.) come from many sources. In the Texas Gulf Coast districts that dominated negative revisions in the state and provided a negative impact on national reserves, the negative revisions appear to be concentrated in non-associated fields, many of which have been producing for a very long time. District 4, the source of more than two-thirds of the state's negative revisions, also has the highest ratio of non-associated to total gas of any district in the state. Negative revisions of non-associated gas fields in District 4 occurred throughout the period (1966-1979) but were concentrated in 1972, 1973 and 1974. 1973 revisions (-3.48 Tcf) were by far the largest representing one-third of all the negative revisions of non-associated gas reserves (1966-1979) for the district. Large decreases in production rates for the largest fields in the district are only somewhat coincident with the negative revisions of reserves; therefore, it is not possible to establish a direct volumetric relationship though the larger fields must have been involved in the large scale negative revisions of reserves.

TASK 2: ANALYZE THE CAUSES OF THE NEGATIVE REVISIONS

Causes and Nature of Reserve Revision

Revision of reserve estimates concurrent with efforts to extend specific reservoirs are a continuing part of a gas field's history as is the discovery of additional reservoirs as new wells are drilled in and around a given field. Reserve revisions can be negative or positive with the dominant direction depending to some degree on the optimism or pessimism applied to the original estimate. It must be understood, however, that the ultimate recovery from a given reservoir or field can never be known precisely until the last well is abandoned.

The earliest estimates of reserves are usually determined by applying a recovery factor to an estimate of the volume of original hydrocarbons-in-place in the reservoir. Hydrocarbons-in-place are in turn calculated by multiplying the reservoir volume times one minus the initial connate water saturation (1-Sw). This estimation of original available hydrocarbons-in-place is often optimistic as reservoirs are prone to be more heterogeneous than initially assumed. Revisions are then made as new geologic and engineering data become available during development and production of the reservoir.

The most common physical reasons for revisions reside in the limited nature of initial data on the reservoir and its behavior. One common limitation is the accuracy of the determination of interstitial or connate water saturations from well logs. In one case, that of a large Gulf Coast gas reservoir, early determination of connate water saturation indicated a value of 25 percent. Later, more detailed, tests indicated that a significant segment of the pay zone had connate water saturation as high as 35 percent, that resulted in a negative revision of nearly 15 percent, or more than 150 Bcf, in that one field. Many large Gulf Coast fields experienced similar revisions as more accurate determinations of water saturation became available.

In another case, the displacement efficiency of the encroaching water in a strong water-drive field, as indicated by a rapid advance of the water table, was so much poorer than had been assumed, that a reevaluation of reserves was required. In this field, the residual gas saturation behind the water front was calculated to be 35 percent compared to an original assumption of 15 percent; again a drastic reduction of reserves occurred. Several reservoirs in Southwest Texas have experienced this type of performance record. Some of these fields are now being dewatered to create a secondary gas cap which will enhance ultimate gas recovery. This, of course, is an expensive operation, and the extent to which it is more widely practiced depends on costs and price.

Still another physical cause of revision results from treatment of lower permeability lenses or strata contained in or adjacent to recognized pay zones. The porosity-permeability cut-off in assessing volumetric gas-in-place may include or exclude strata whose contribution will be determined by the method of exploitation. If a reservoir is produced by pressure depletion, tight zones which would contribute little gas to the wellbore initially, will, over the broad expanse of the field, transmit gas to the more permeable strata for flow to the wellbore. On the other hand, if the reservoir is produced under pressure maintenance, these strata may be bypassed by the encroaching water resulting in a high residual gas saturation. Revisions, then, may be either negative or positive depending on the reservoir management program.

Estimation of Reserves

Accurate estimation of reserves calls for continuous revision throughout the life of a field. Each well that is drilled in a reservoir, if fully assessed, will indicate a need for reevaluation of original oil- or gas-in-place, and continuous observation of pressure-production history will provide information for continuous reestimation of reserves. Of course, no company will follow this process because the time and cost is not warranted and the precision of estimation does not justify it. For fields discovered three or more decades ago, the market demand and hence production volume made such a procedure superfluous. Consequently when market demand caught up with supply, the revisions necessitated fell over such a short time span that the impact was massive.

There are several sources of information over the life of a reservoir that provide data for reserve estimation. The more important are included in the following discussion.

1. The earliest estimates of reserves in a reservoir are made with limited geologic and engineering data. Geologic and geophysical information, together with core and log data from the discovery-well, provide the statistical parameters for an estimation of original-gas-in-place based on an assumption of stratigraphic homogeneity and continuity of pay zones. These characteristics are generally assumed to be more ideal than actually exist, consequently this estimate is normally optimistic. An optimistic recovery factor, when applied to this gas-in-place value, yields an overstated reserve volume.

2. Each new development well drilled into a reservoir provides additional information which may be used for revision of reserve estimates; these revisions may be either positive or negative. Successful field wildcats or step-out wells add area. In-fill wells that provide information on stratigraphic continuity and heterogeneity frequently call for negative revisions as more precise isopachous contour maps of pay zones provide definitive parameters for detailed reservoir description and volumetric estimates.

3. The pressure-production history of a reservoir, given a sufficient time interval, can provide information to permit a material balance estimate of the gas in the reservoir that is in pressure continuity with producing wells. For non-associated gas reservoirs producing by pressure depletion, calculations for the determination of this estimate are simple and straightforward following accepted reservoir engineering formulae, provided the properties of the gas in the reservoir have been determined in the laboratory. Associated gas reservoirs, or reservoirs producing with an associated active aquifer, are more complex. However, the engineering technology utilizing material balance and unsteady state calculations for such reservoirs is well established, and estimation of reserves is reasonably reliable except for the most complex reservoirs where adequate pressure production histories are not available.

When normal calculations are not adequate, decline curve analysis may be used. When fields have a sufficiently long performance record and are producing at capacity, a semi-log plot of production rate versus cumulative recovery will extrapolate to an ultimate reserve value. This value is determined by production rate decline to the economic limit.

Optimistic Bias

It is obvious that the earliest calculations by an operator of a new field would be biased toward an optimistic estimate of reserves. Explorationists responsible for the earliest estimates of discovered reserves are usually optimists by definition. Because early prorationing guidelines in the Gulf Coast favored those operators with highest reserve estimations, the more optimistic estimates were deemed appropriate, lacking contrary data. Daily contract quantity (D.C.Q.) agreements for purchasing of gas provided 1 MMcf daily allowable for every 8 Bcf of reserves of non-associated gas, or a 22 year supply at a given rate.

No pressing reason existed then, for reappraisals, so long as deliverable supply exceeded demand. However, as pressure declines were noted and deliverability was tested during periods of peak demand, more realistic reviews of reserves began to be made near the close of the 1960's and on into the 1970's.

Technical Factors Affecting Revisions

Recovery Factors

Original volumetric estimates for a gas field depend on parameters established by wells that define the extent of the field. The recovery factor is an integral part of the recoverable reserve formula, and relates to the efficiency of producing the original-gas-in-place (OGIP). The recovery factor $\left(\frac{\text{volume recoverable gas}}{\text{volume OGIP}}\right)$ must often be assumed because no accurate method exists to predict its value. Laboratory tests may supply useful information, however, duplication of actual field conditions is difficult, and large errors can occur. In a mature producing area, recovery factors, established by historical production data and/or material-balance calculations after stabilized maximum production has established a decline rate, are well-known and generally quite accurate. However, in the development of many of the early

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Texas Gulf Coast gas fields, reliable recovery factors had not been determined. Since the gas surplus at the time did not allow a maximum production rate that would permit determination of decline rates, the initial estimated recovery factors were maintained until such time as production history indicated that the factors were not adequate. This began to occur in the late 1960's and extended on through the 1970's.

Water-Drive Reservoirs

In many Gulf Coast gas fields, water influx can be a problem of some magnitude in heterogeneous reservoirs. This occurs because the water can bypass and thereby trap gas contained in less permeable parts of the reservoir, effectively reducing the producible reserves of the well. The wide spacing of gas wells compared to oil wells increases the possibility that trapped or bypassed gas would not be properly accounted for. Only when infill drilling programs provided more accurate data or when production performance indicated that water encroachment was a problem, did operators proceed to revise reserves in these fields. Recovery factors for water drive gas reservoirs may be in the 55 to 65 percent range, whereas for depletion drives recoveries may have been estimated at 85 to 90 percent, or more. Thus, the recognition of significant water-drive elements in Gulf Coast gas fields, necessitated large scale negative revisions.

Heterogeneity of Reservoirs

This pertains to discontinuity of discrete beds of the reservoir from well to well and impacts recovery factors as discussed above. Most of the early estimations of reserves in the Gulf Coast were based on assumptions that reservoirs penetrated in a well were homogeneous and continuous over the area of the field. With widely spaced gas wells and surplus supply conditions these assumptions were adequate. However, with infill drilling and increased demand, more sophisticated reservoir interpretations were possible and the degree of heterogeneity increased markedly (Sketch A*). Significant negative revisions of reserves resulted from the improved understanding of reservoir conditions.

* to be integrated into figure list

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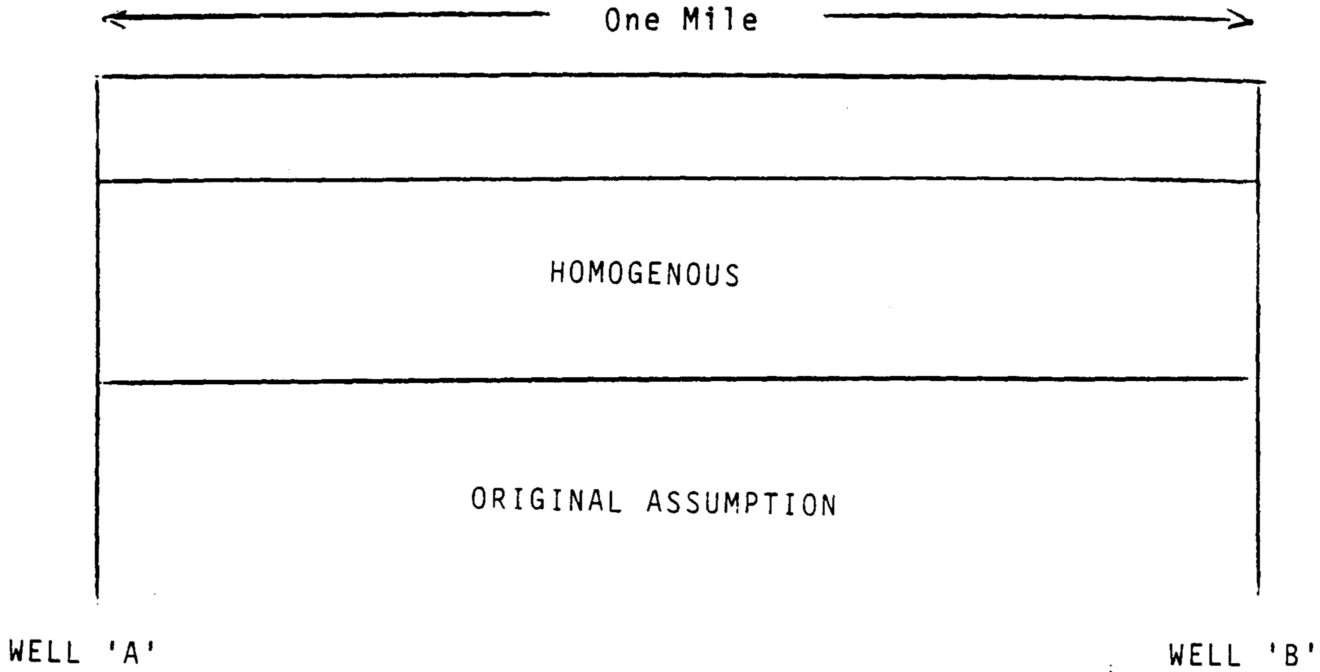
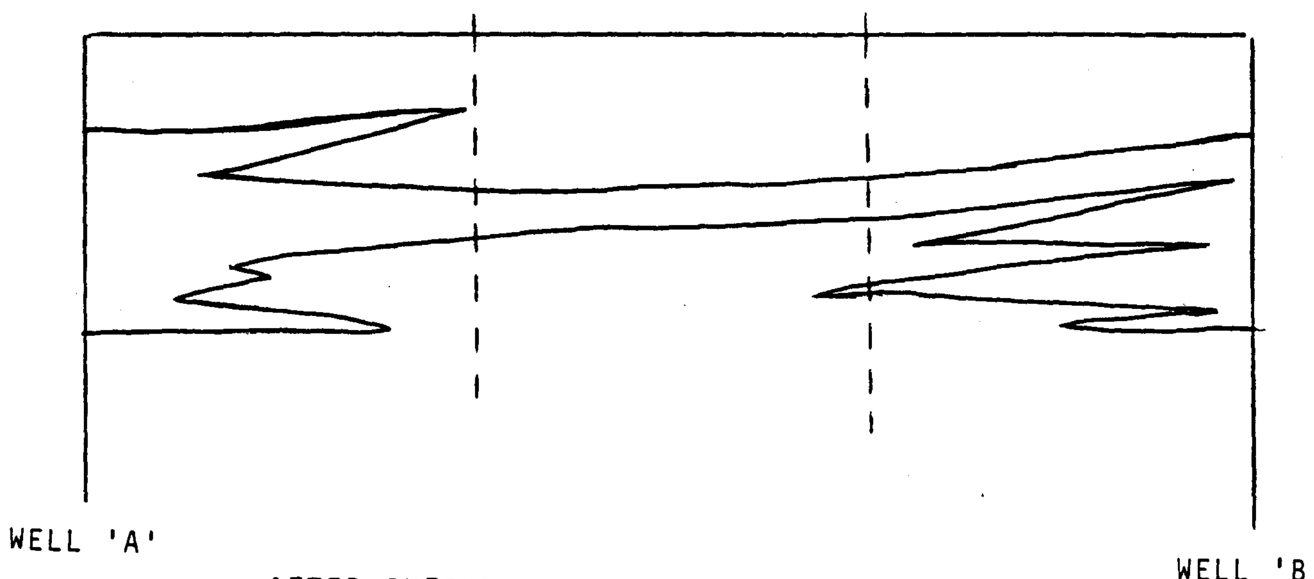
SKETCH 'A'





AFTER INFILL DRILLING AND PRODUCTION HISTORY - NEGATIVE REVISION OF RESERVES REQUIRED

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Geopressured reservoirs pose special problems in reserves estimation as log responses that are used to differentiate fluids have been found to be adversely affected by geopressured conditions. As discussed previously (p. 17) volumes affected may not be all that significant.

Sealing and non-sealing faults may be seen as special cases of compartmentalization that lead to changes in the heterogeneity of reservoirs in that compartments within the field would exist to a greater or lesser degree depending on the nature of the bounding faults (Sketch B*).

Non-Technical Factors Affecting Revisions

Regulatory Factor

Regulatory rulings can be a significant factor in determining reserves. This is true both at the national and state levels. Freezing of prices paid for gas in interstate commerce provided an incentive to operators to drill and produce gas for the intrastate market where prices had risen rapidly in response to the increased demand and limited supply. As a result of greatly increased costs of operation along with frozen gas prices (1973-1978), operators of interstate gas properties sometimes found it possible to shorten the life of a newly uneconomic property by decreasing reserves. Bias would exist for the most pessimistic interpretation of interstate gas reserves due to the significant price differential for the resource.

Optimistic Evaluation of Reserves

After discovering a new reservoir or field, several valid, different interpretations can be made as to recoverable reserves given exactly the same set of data. Excessive optimism as to reserve estimates that may have been encouraged by market conditions would lead to negative revisions when decline occurred and a realistic reappraisal was made.

Economic Factors Leading to Reserve Reduction

When price controls were applied to interstate markets, price frequently failed to keep pace with rising costs of production. Exploratory drilling, dropped in this case, and even

* to be integrated into figure list

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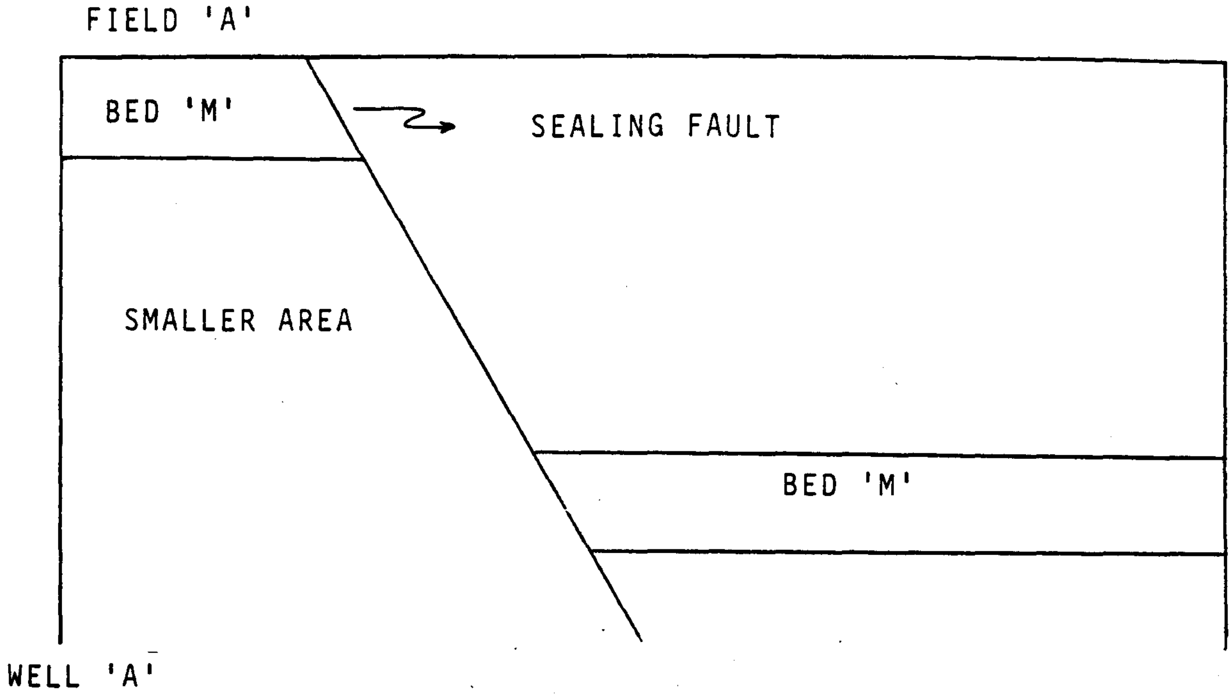
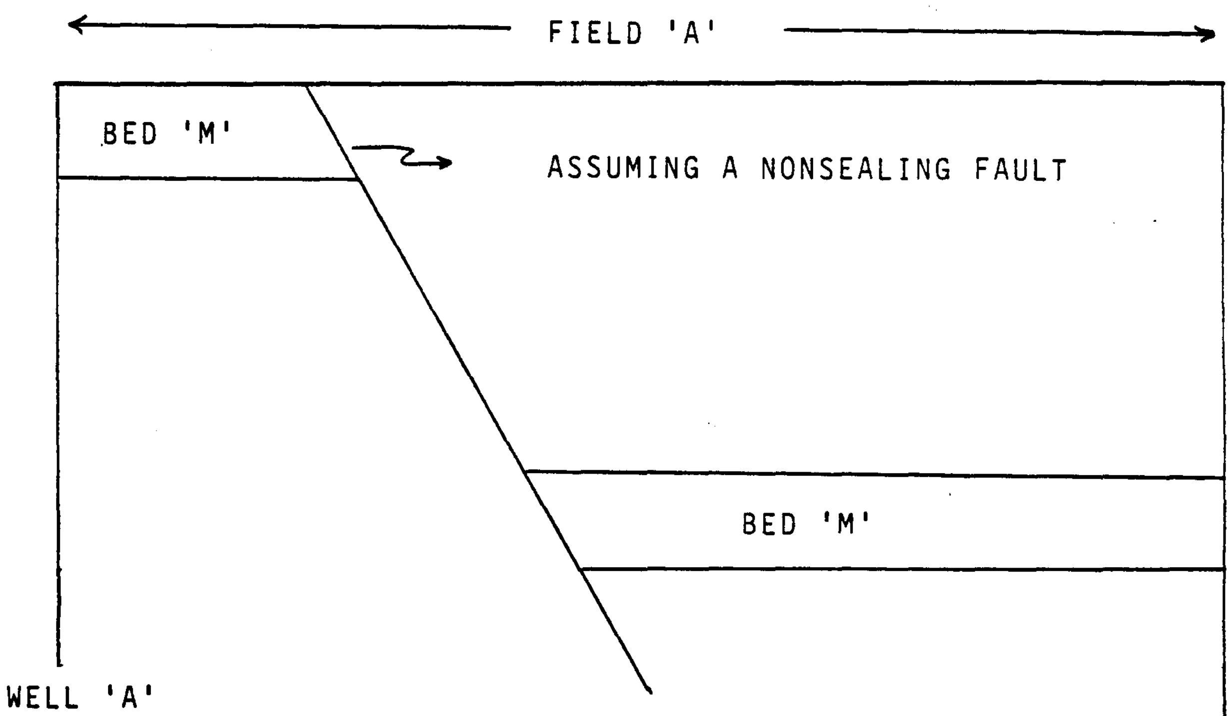
SKETCH 'B'





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development drilling was eliminated if price was below replacement cost. In some cases, particularly in low productivity reservoirs, the combination of the expense of repairs, maintenance, and general operations coupled with compression costs led to field abandonment at a higher final reservoir pressure than had been originally assumed. In this case, the ultimate recovery fell below initial reserve estimates and thereby acted as a cause of negative revisions.

Interviews with API/AGA Reserve Team Members and Other Experts

Causes for the downward revision in gas reserves were ascribed to both technical and non-technical factors. The original optimistic estimate of reserves cited previously can be attributed to both types of factors. An optimistic attitude is obviously a non-technical factor yet the volumetric analysis that was used has a technical basis.

Widespread reevaluation of reserves occurred when deliverability peaked and all fields went into decline. However, because of the confidential nature of this type of information, it was not possible to identify revisions quantitatively on a field by field basis. On the other hand frank discussions of the basis and nature of these negative revisions have allowed us to draw many of our conclusions.

Our interviews with individuals who have spent years estimating oil and gas reserves led to our findings that no one factor can be cited for the negative revisions in the Gulf Coast during the time period of the investigation. Rather, there were a number of coincident events that caused sustained negative revision of reserves.

1) The consensus of opinion among 20 contacts representing producers, pipeline companies, and regulatory agencies was that an original optimistic bias in estimating OGIP and in the assignment of recovery factors, certainly contributed to major negative revisions.

There is a tendency to be optimistic about a new field in making estimates of the original volume of hydrocarbons in-place. If there is the slightest possibility that good reservoirs will be

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continuous or that poor reservoirs will improve, such determinations will often be made by those responsible for the new field.

The primary pressure for an optimistic or inflated early estimate can be attributed to market factors. In the first place, a certain minimum reserve on the order of 8 Bcf for 1 MMcf of production was essential to justify a pipeline and related distribution facilities. Further, sales contracts usually call for a specific minimum back-up reserve. Such commitments were not a great cause for concern in the industry since extensions and new pool discoveries frequently made up for any deficiencies in deliverability from the main reservoirs from which the commitment was made. If these failed, it was always felt that exploration could find a new field to enable the company to meet its contracts and fulfill its obligations.

2) Many of the older, large producing fields entered a period of natural decline following sustained high production, and this was felt to be a contributing factor to the timing of major negative revisions.

3) We have suggested problems in log interpretation of water saturations in deep geopressured formations, however contact with API/AGA reserve committee members indicated that this was not a highly significant factor in the total reserve picture. However, there was general agreement that early water saturation determinations in the Gulf Coast had erred on the low side, and, in many cases, increased saturations were determined from later data resulting in some large negative revisions of recoverable reserves.

Positive Role of Optimism in the Oil and Gas Industry

It is quite apparent that original, optimistic estimates of natural gas reserves in older fields were a factor in the negative revisions that occurred during the 1970's. The fact that the negative revisions were so long delayed attests to the success of gas finding efforts of the industry. In a way, this success can be attributed to the positive role of optimism in exploration and production capabilities. Without optimism as a guiding principle, many oil and gas prospects would never be drilled, and most structures would be condemned by the first dry hole drilled. Examples are legion, however, where dry holes drilled on a structure, if drilled first rather than as development wells, would have condemned the prospect. Optimism then can be seen as a positive and necessary force in the oil and gas industry. The original optimistic estimates of natural gas reserves should be seen as a normal and proper situation. However, earlier closer scrutiny of the reserves estimates which should have been made, would have eliminated much of the drastic effect of the later major reductions in reserves.

Task 2: Summary Statement

Analysis of the factors responsible for the series of extensive negative revisions from non-associated gas fields of the Texas Gulf Coast allows us to draw several conclusions. The extended period of large negative revisions, particularly in Railroad Commissions District 4, was a response to a unique set of circumstances that should not reoccur. This is because the early optimistic estimate of reserves in many of the old, large fields cannot be repeated for today's producing fields and reservoirs. Overestimation alone would not have accounted for the phenomenon as normal assessment and review should have accounted for much of the overestimates in a systematic, incremental way. However, economic incentives in the form of higher takes for greater declared reserves was a powerful incentive for maintaining as favorable an estimate of reserves as could be justified. This, coupled with the continued addition of reserves in excess of production, resulted in high R/P ratios, that obscured the underlying weakness in reserve figures until such time as maximum demands could not be met without excessive pressure decline. This, in turn, indicated the need to revise reserve figures downward.

The original overestimates resulted from lack of detailed information on reservoir continuity, the selection of higher recovery factors than could be later justified, and water saturation determinations that failed to accurately indicate the amount of water and gas in the reservoirs.

TASK 3: ASSESS FACTORS IDENTIFIED IN TASK 2 WHICH MIGHT BE USEFUL AS LEADING INDICATORS OF SUSTAINED NEGATIVE REVISIONS IN THE FUTURE

Lack of Firmness of Reserves

During periods when supply exceeds demand by a considerable margin, as has occurred in the past and at present (termed the 'gas bubble'), some newly declared reserves are not subject to maximum production of sufficient duration to establish valid decline relationships. Rigorous long-duration testing is vital to proper evaluation of potential reserves, and lack of such data should be considered as being capable of producing inaccuracies in reserve figures that could result in negative revisions in the future. Possibly the greatest danger as far as this factor is concerned is that of complacency that may accompany the declaration of additional reserves without the test of deliverability of these reserves. However, the much reduced data base that resulted from the negative revisions of the past does not provide the conditions that would tend to obscure widespread, extensive weaknesses in reserves.

The Texas Gulf Coast experiences of 1968-1979 suggests that the productive life of very large reservoirs must be considered particularly those where R/P ratios are high. Fields that have produced large volumes of natural gas over a period of 25-30 years may be candidates for negative revisions, especially if multiple reservoirs with differing trapping factors are included in the fields.

Widespread Application of Unproved Recovery Factors

In the Texas Gulf Coast application of significantly lower recovery factors for water drive reservoirs resulted in significant decreases in recoverable reserves when they were determined to be applicable.

Wide Spacing of Gas Wells

Lack of appreciation of the heterogeneity of the reservoir and misunderstandings of the drainage capability of the wells occurred in many cases due to the wide-spacing of gas wells (often 320 or even 640 acres).

Market Conditions

The events that occurred in the 1970's in the Texas Gulf Coast disrupted market conditions drastically and contributed to negative revisions of reserves. Such occurrences would almost inevitably lead to revisions. However, the prediction of such events is beyond the scope of this paper.

TASK 4: LIKELIHOOD OF FUTURE SUSTAINED NEGATIVE REVISIONS TO U.S. NATURAL GAS RESERVES

Even with the history of negative revisions to reserves being due in no small part to the assumption that reported reserves are truly present -- and are deliverable -- there still exists a certain reluctance to come to grips with this. Gas well test forms (TRRC G-10) in Texas have been revised, and now both operator and purchaser must sign the test form. The program of joint signing by producer and buyer was initiated shortly after the Texas ratable-take committee, chaired by William J. Murray, Jr., submitted its recommendations in July 1983. Apparently, there has been little effect on the volumes reported on the semi-annual reports of deliverability required by the TRRC. According to Texas Railroad Commission, Oil and Gas Division Director, Jim Morrow, the slight decrease in volume reported on the first testing under the new rules has more recently been restored so that current deliverability according to these data is just over 25 Bcf/day or slightly in excess of that for the period just preceding the severe 1983-1984 winter. Deliverability tests are required by TRRC for most wells on a semi-annual basis. These newly declared deliverabilites have not, of course, yet been tested by maximum demand conditions to determine their validity. The extreme winter of 1983-1984 provided an extended period of high demand, and significant volumes of supposedly deliverable gas supplies were not available.* Deliverability and reserves are not precise equivalents, yet the lack of deliverability may lead to doubts about reserves. It is also true that certain bottlenecks in transportation and problems with connections can prevent immediate access to some valid reserves. The fact remains, however, that during a period of high demand that extended for more than three weeks the maximum volume available was less than 60 percent of that indicated by the deliverability tests on file with the Railroad Commission (interview with TRRC Commissioner Mack Wallace, as reported in TIPRO Reporter, Winter 1984). Concern certainly should be paid to the quality of these newly declared reserves that have not been subjected to the test of extended maximum demand. However, we should also point out that more sophisticated means of estimating reserves, greatly improved understanding of reservoir complexities, and better fluid flow models continue to improve the capability of accurately measuring reserves.

The fact that more is known about the geology and engineering properties of gas reservoirs due to the recent experience of the industry, such as the sustained negative revisions that occurred in the Texas Gulf Coast during the 1970's, would in itself suggest a lesser chance of such a situation recurring.

Heterogeneity of gas reservoirs, although not acknowledged to the extent that it is in oil reservoirs, does exist and provides new challenges to gas production and to calculation of reserves. More closely spaced gas wells (infill drilling), more precise material balance calculations, better understood depositional models, and refined fluid flow models have resolved many of these problems. The likelihood of negative revisions should therefore be less than was true in the past. Also, the smaller reserve base that resulted from the negative revisions would

*It should be pointed out that the lack of deliverability may reflect failure to conduct workovers, recompletions, and proper field maintenance.

reduce the room for future revisions on the presumption that actual reserves are now more accurately represented.

DISCUSSION AND SUMMARY

An analysis of the extensive negative revision of natural gas reserves in the Texas Gulf Coast from 1966 to 1979 has led to the following findings:

The specific location of negative revision as to pool and reservoir was not possible to determine within the time frame of the study, considering other objectives. However, some general information was assembled on the age of producing fields, size of fields, type trap, lithology, depositional systems, and TRRC districts, which may help to understand the conditions which led to the negative revisions.

Gulf Coast Districts 2, 3, and 4 dominated the negative revision listings for total gas with District 4 the leader followed by District 3, with District 2 a distant third. TRRC District 4, where non-associated gas represented a high percent of the total gas (Table 7), had very large negative revisions of non-associated gas reserves particularly in 1973, 1974, 1975, and 1978. These principally affected those non-associated gas fields discovered in the 1930's, through the 1950's (Appendix IX). Many large older fields suffered severe production declines during the years involved in the study. The production declines may, in part, be related to the revisions of reserves in this district, although other factors are present. The study concluded that negative revisions that occurred in the Texas Gulf Coast from 1966 through 1979 resulted from a combination of technical (geological and engineering) and non-technical (market and regulatory) events. Mentioned in nearly all our interviews as a cause were early optimistic estimates of the recovery factors and volume of original-gas-in-place. These estimates were not subjected to critical review due to market-related factors which included the existence of gas surpluses that resulted in pipeline determined proration within the largest prorated gas takes from those fields with the largest declared reserves. As reservoir depletion effects began to be noticed, it became apparent that the very high reserves-to-production ratios that existed into the 1960's had obscured the fact that optimistic reserve estimates required critical reevaluations. In addition, low natural gas prices in the 1960's created situations where economic values of some non-associated gas pools were improved by establishing production practices that maximized natural gas liquids production early in the life of the reservoir (cycling is one example).

From a technical standpoint, the assignment of lower recovery factors for a large number of at least partial water-drive reservoirs caused significant reductions in volume of potentially recoverable gas from these reservoirs. Reductions of 20 to 25 percent for particular fields could have been related specifically to this factor.

Ambiguities in resistivity measurements used in the initial establishment of gas/water contacts and water saturations led to later revisions of original-gas-in-place estimates.

The degree of heterogeneity of many reservoirs was not appreciated with the original widely spaced (often 640 acres or more) well control used to make estimates of OGIP. As infill drilling provided closer control, revisions of original estimates were often necessary. Sizeable volumes of reserves were negatively affected by this factor.

Although there is some concern about the accuracy of reserves being developed in times of surplus capacity, as reflected by current deliverability concerns, the low reserves-to-production ratios that now exist indicate that overestimates that might be made would be significantly smaller. The Texas Gulf Coast experience of a period of extensive negative revision of reserves during the 1970's in itself is a lesson to the natural gas industry. Increased awareness of the necessity to constantly review reserve estimates, improved knowledge and understanding of reservoir heterogeneity, more advanced techniques of reserve estimation, and an improved price outlook encourage the judgment that a return of extensive negative revisions should not occur. Such a condition is avoidable given that industry takes the proper steps and that the economic and regulatory climate is not drastically altered.

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The manuscript was prepared by Pat Smolka, Lisa Poppleton, and Dorothy Johnson under the direction of Lucille Harrell.

Graphs and charts were prepared by Robert C. Murray, Michael D. Davis, and Cristina Siqueira. Editorial review was by __________ and __________. The manuscript was reviewed by __________, __________, and __________.

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REFERENCES

American Petroleum Institute (API) and American Gas Association (AGA), Reserves of Crude Oil Natural Gas Liquids and Natural Gas in the United States, 1966, vol. 21; 1967, vol. 22; 1968, vol. 23; 1969, vol. 24; 1970, vol. 25; 1971, vol. 26; 1972, vol. 27; 1973, vol. 28; 1974, vol. 29; 1975, vol. 30; 1976, vol. 31; 1977, vol. 32; 1978, vol. 33; 1979, vol. 34.

DeGolyer and MacNaughton, 1983, 20th Century Petroleum Statistics.

Economics Planning Inc., 1983, The Texas Natural Gas Transmission Industry During the 1970's: Texas Energy and Natural Resources Advisory Council (TENRAC) Project #1189, 174 pages plus appendix.

Galloway, William E., Hobday, David K., Magara, Kinji, 1982, Frio formations of Texas Gulf Coastal Plain: Depositional systems, structural framework, and hydrocarbon distribution: The University of Texas at Austin, Bureau of Economic Geology, Report of Investigations no. 122. 78 p.

Petroleum Information (PI), 1983, Annual and Cumulative Field and Operators Production with Operator Rank Gas Statewide.

Petzinger, Thomas, Jr., April 6, 1984, "Houston oil and minerals royalty trust" Wall Street Journal.

Rahman, Hafaez, and Hicks, James, 1982, Gas-Deliverability and Flow Capacity of Surveillance Gas Fields in Texas: Energy Information Administration, Department of Energy. 44 p.

Schmitt, Richard B., January 30, 1984, "Texas International Company reported negative revision to natural gas reserves" Wall Street Journal.

Texas Railroad Commission (TRRC), 1984, The Natural Gas Policy Act: The Texas Approach, Revised, February 1984.

Texas Railroad Commission (TRRC), 1983, Advisory Committee on Natural Gas Proration and Ratable Take, William J. Murray, Jr., Chairman, Ratable Take Committee. 99 p.

Waner, Gregory Edwards, 1983, "A Study of Gas Proportioning in Texas," The University of Texas at Austin, Petroleum Engineering Department, Master's thesis.

Figure Captions

Figure 1. Map of Railroad Commission of Texas districts with district by district changes in total gas data for the period 1966-1979.

Figure 2A. The pie diagram illustrates the overwhelming predominance of the Gulf Coast districts on total Texas net negative revisions. Note that District 4 alone is responsible for nearly half of the state's total.

Figure 2B. This pie diagram shows that two of the Gulf Coast districts reported negative revisions for non-associated gas reserves that accounted for two-thirds of the total for the state, with District 4 alone responsible for nearly one-half. The large revision for District 8 is not reflected in revisions for total gas as positive revisions were recorded for associated gas in this district.

Figure 2C. This pie diagram highlights the nearly 90% contribution from Gulf Coast Districts 3 and 4 to the net negative revisions for associated gas.

Figure 3A. Graphs illustrating ultimate production estimates for total gas for all of Texas, for Gulf Coast Districts 2, 3, and 4 and combined 2, 3, and 4 by reservoir lithology and by type of trap. Data for 1970 and 1977 (last year for this data) indicate the effect of negative revisions in that decreases in ultimate production are shown for Districts 2 and 4 and combined 2 and 3 and 4 but that District 3 has actually increased slightly as has the total Texas volume.

Figure 3B. Graphs of non-associated gas ultimate recovery show very similar relationships indicating the dominance of non-asssociated gas particularly in the Gulf Coast districts.

Figure 4. Graphs for District 8 in the Permian Basin of West Texas are shown for comparison of both total gas and non-associated gas with the districts of the Gulf Coast. Note increases in estimated ultimate production from 1970 to 1977.

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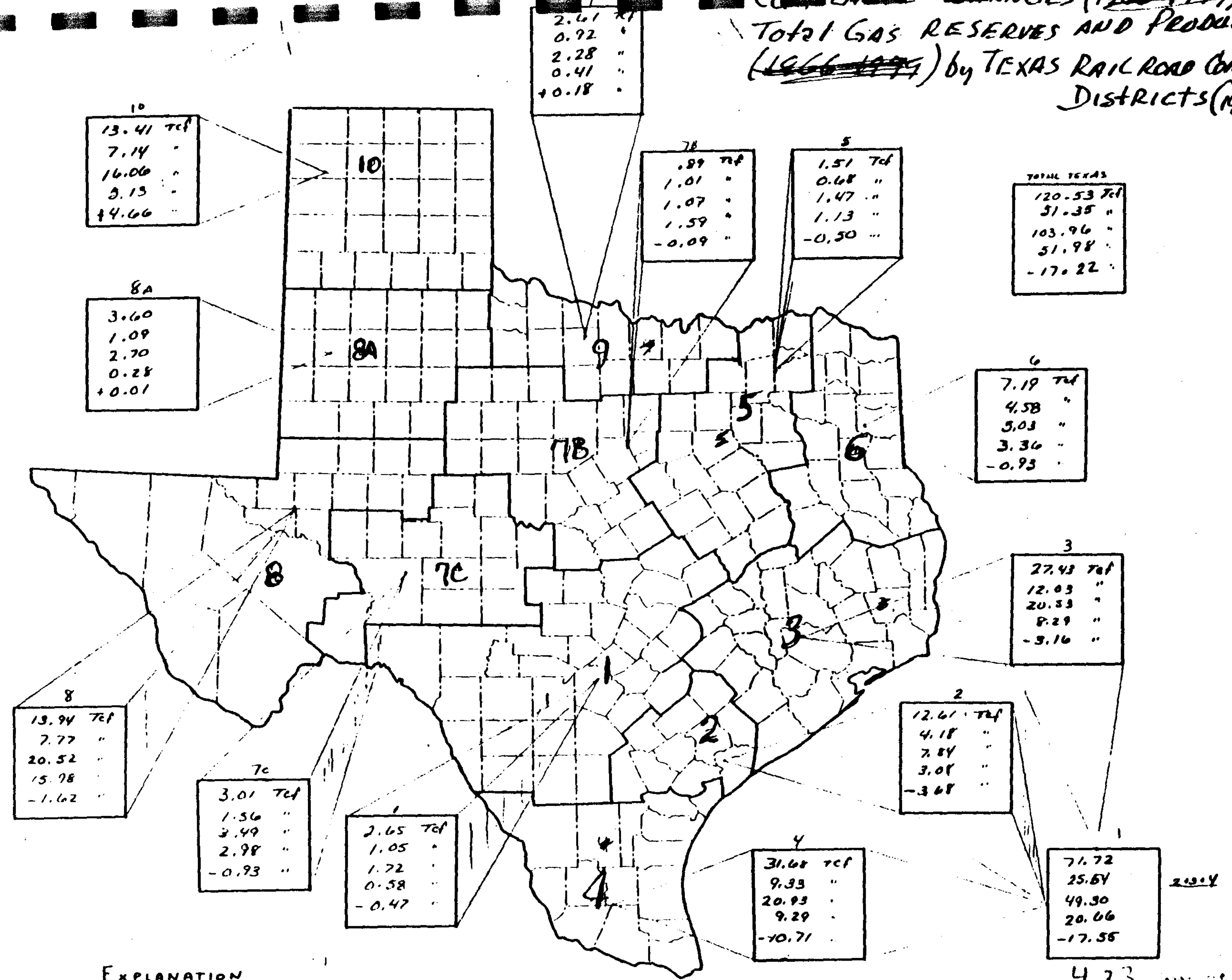
Total Gas Reserves and Production (~~1966-1979~~) by Texas Railroad Commission Districts (1966-1979)



EXPLANATION

70 Tcf	Reserves as of 1 Jan 1966
5 Tcf	Reserves as of 31 Dec 1979
80 Tcf	Production 1 Jan 1966 - 31 Dec 1979
6 Tcf	Reserve Additions 1 Jan 1966 - 31 Dec 1979
± 3 Tcf	Net Revisions 1 Jan 1966 - 31 Dec 197

Tcf = Trillion cubic feet

GA 3903

Figure 1.

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TOTAL GAS

NET NEGATIVE REVISIONS
1966-1979 inclusive

(only districts with net negative revisions are shown with their percent of the total of those districts) (put in caption, not draft)

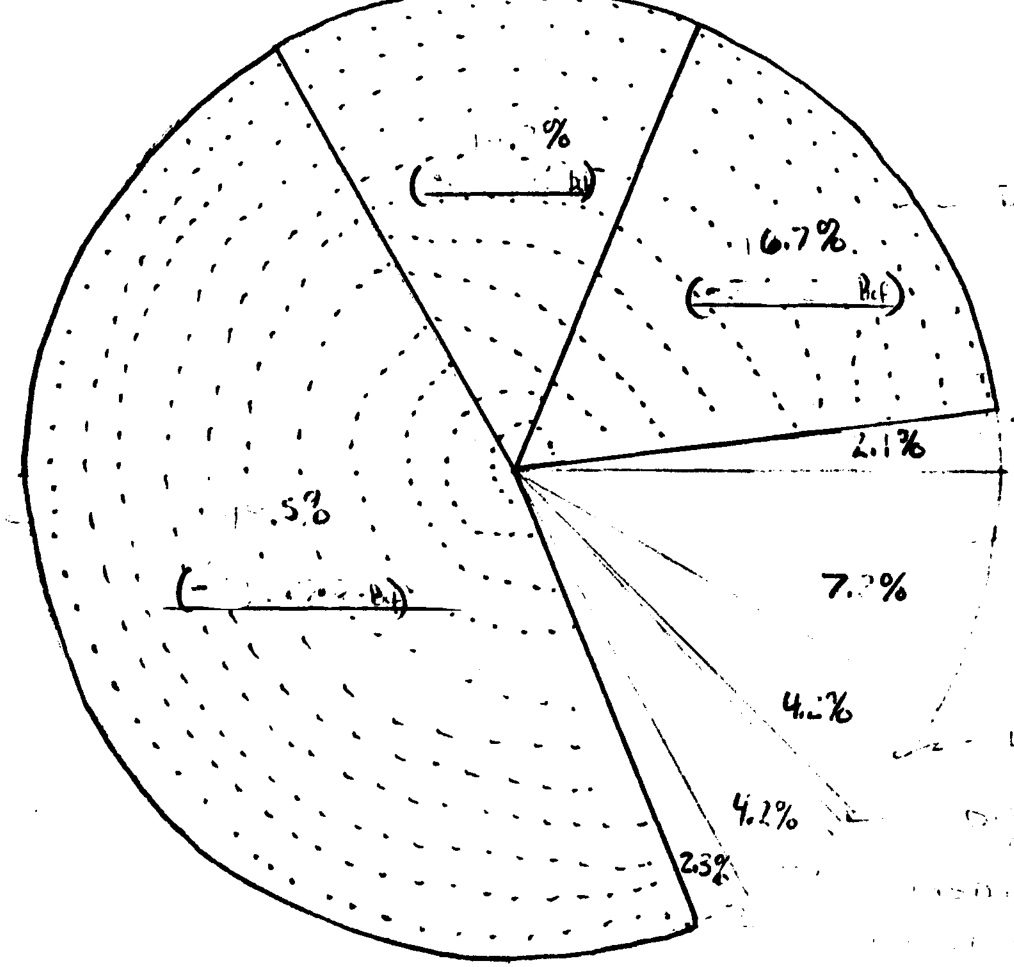

Figure 2A

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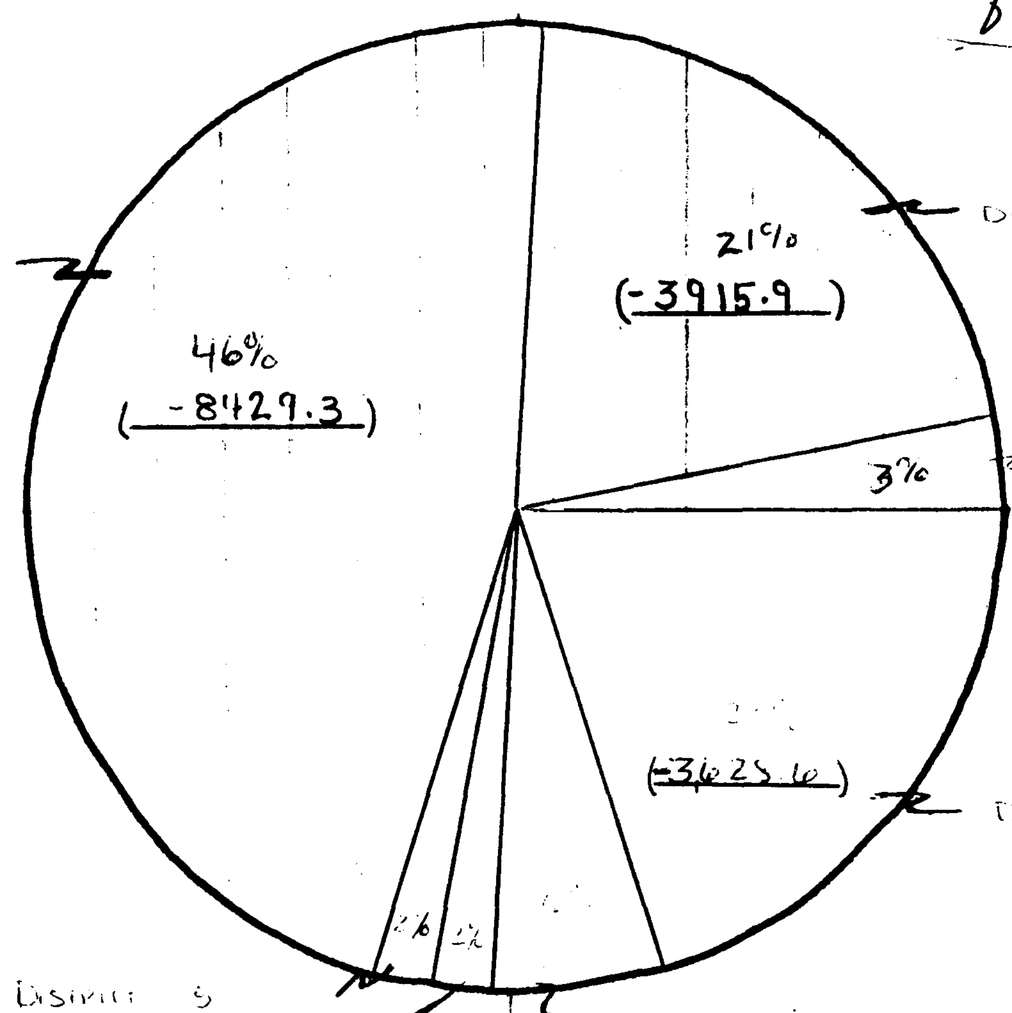
use same pattern for fig 2B, 2C

OA-3906

NON-ASSOCIATED GAS
NET NEGATIVE REVISIONS
1966-1979 inclusive
(districts with net negative revision are shown with their percent of the total for those districts)
delete from draft. put in caption



TOTAL NET NEGATIVE REVISIONS 18,438.6 bcf

28

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ASSOCIATED GAS

NET NEGATIVE REVISIONS

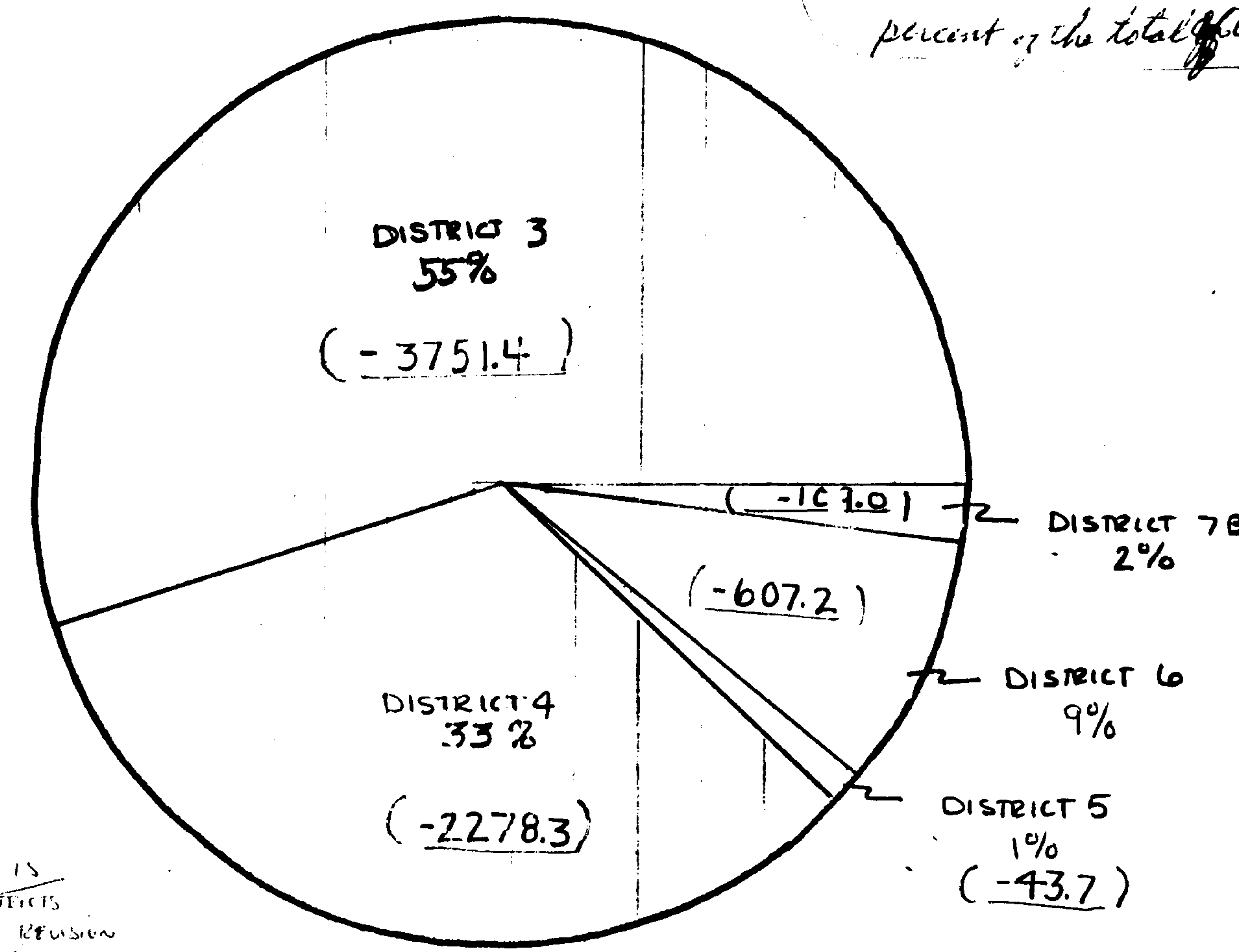
1966-1979 inclusive

(districts with net negative revisions are shown with their percent of the total of those districts)

in caption not figure

GA-3905

use pattern from fig 2.A



Total Net Negative Revisions -6789.6

(pattern) indicates ~~TEXAS~~ Gulf Coast

~~fig 2C~~ fig 2C

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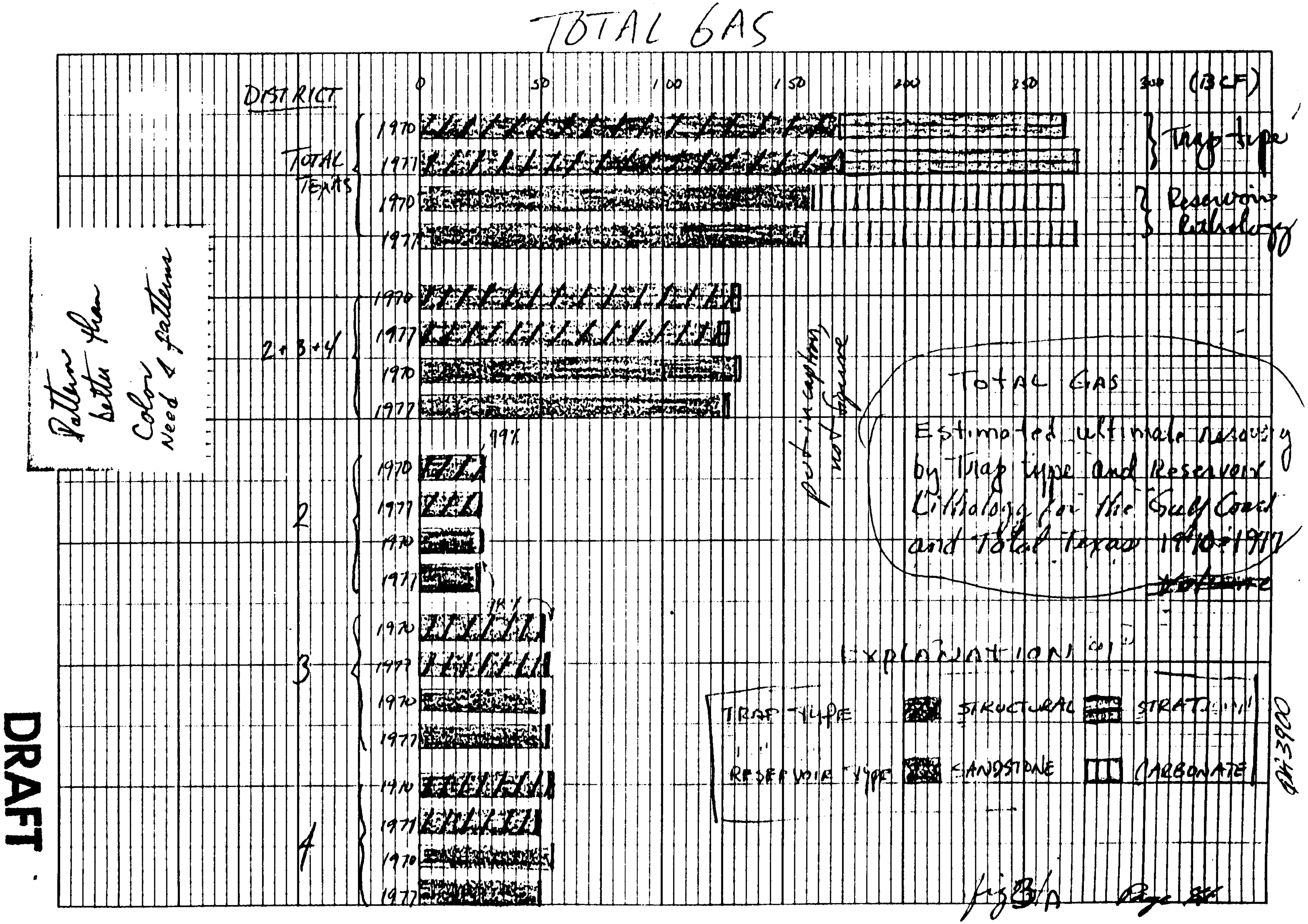
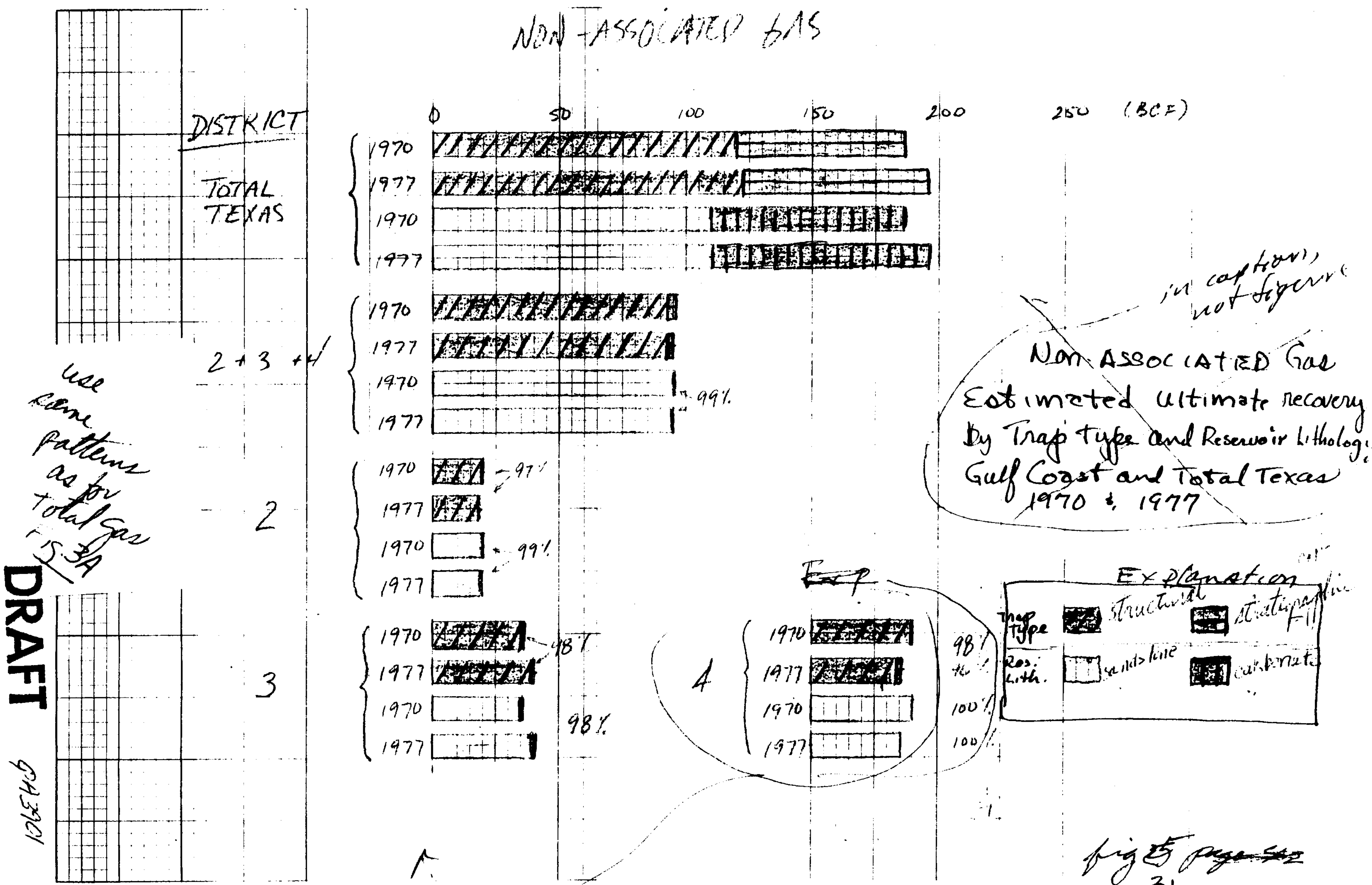
in caption not fig

THE NET NEGATIVE REVISION IS BASED ON ONLY THOSE DISTRICTS THAT SHOW A NET NEGATIVE REVISION OVER THE PERIOD FROM 1966 to 1979 ~~INCLUSIVE. THE MENTIONED AND DISTRICTS ...~~ TOTAL REVISIONS: 6,789.6 net negative


TOTAL GAS
DISTRICT
0
50
100
150
200
250
300
(BCF)
TOTAL TEXAS
2+3+4
2
3
4
1970
1977
Trap type
Reservoir Lithology
TOTAL GAS
Estimated ultimate recovery by Trap type and Reservoir Lithology for the Gulf Coast and Total Texas 1970-1977
EXPLANATION
TRAP TYPE
STRUCTURAL
STRAT.
RESERVOIR TYPE
SANDSTONE
CARBONATE
put in caption not figure
Pattern better than Color
Need 4 patterns
Fig B/A

DRAFT



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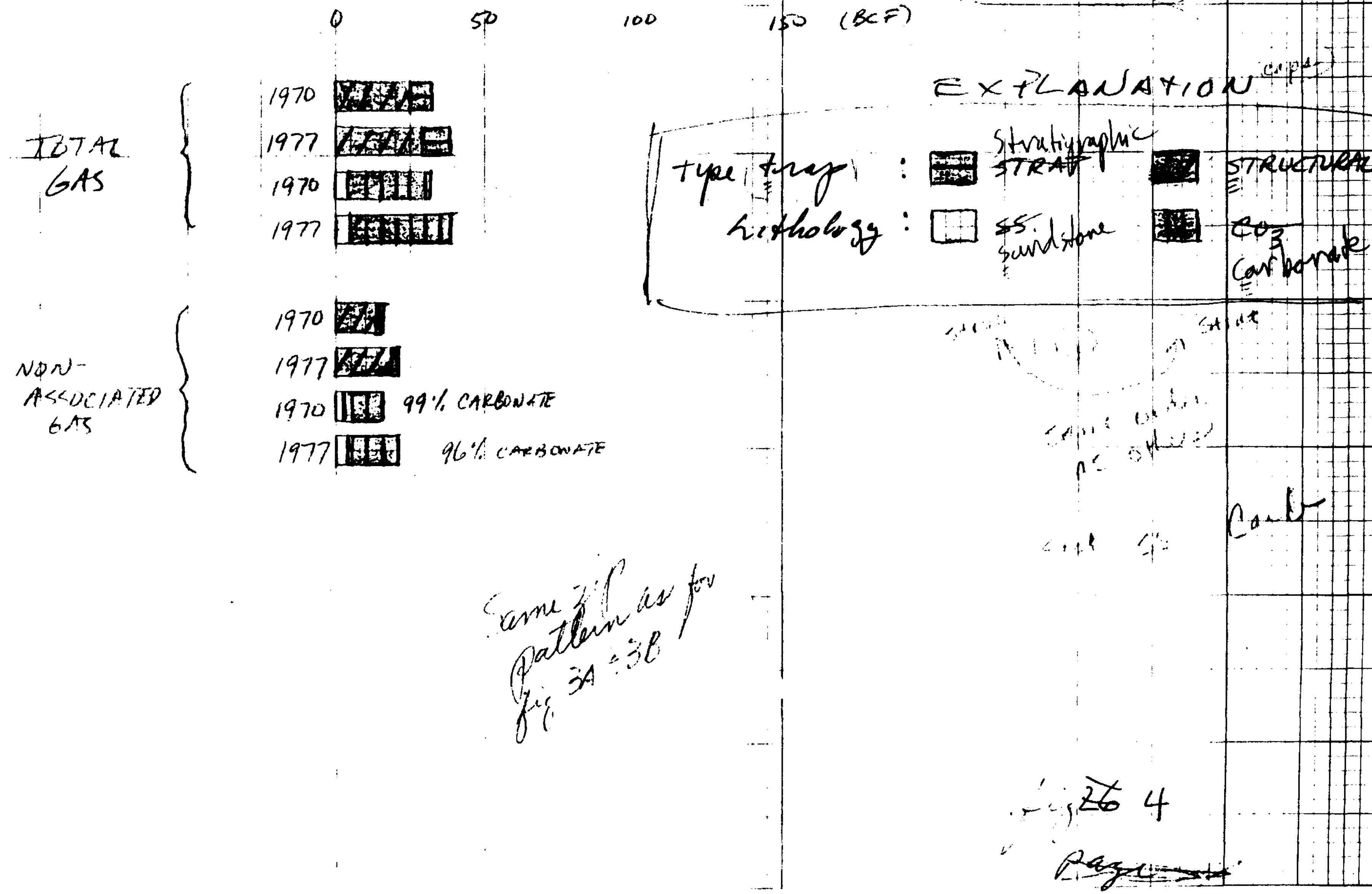
GA 3701

9743902

ESTIMATED ULTIMATE RECOVERY
BY TRAP TYPE ~~AND~~ RESERVOIR LITHOLOGY
District 8 (PERMIAN BASIN) — 1970 and 1977



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Tables

Table 1. Compilation of highlighted negative revision data for U.S., total Texas, and Gulf Coast districts.

Table 2A. Data for total gas for combined Districts 2, 3, and 4 - 1966-1979.

Table 2B. Data for non-associated gas for combined Districts 2, 3, and 4 - 1966-1979.

Table 2C. Data for associated gas for combined Districts 2, 3, and 4 - 1966-1979.

Table 3A. Estimated ultimate production of total gas by reservoir lithology for total Texas, Gulf Coast Districts 2, 3, and 4 and District 8 (West Texas). Decreases in ultimate recovery in sandstone reservoirs (principally Gulf Coast) did not match increases in District 8 (and others) so that the total for the state actually increased between 1970 and 1977. Note that this is not due to revisions of remaining reserves alone.

Table 3B. Ultimate production of total gas by type of trap. The data show that increases in District 3 non-associated gas between 1970 and 1977 were not enough to overcome decreases in Districts 2 and 4 non-associated reserves, and District 3 associated reserves, so that lower volumes of total gas for the Gulf Coast are indicated by 1977.

Table 4. Distribution of natural gas production in Texas for intrastate and interstate markets in 1979. Districts 2, 3, 4, 6, 8, and 10 are those with the largest volumes of natural gas.

Table 5. Volumes and percentages of intrastate and interstate natural gas distributed in Texas for the years 1976 through mid-1984 as compiled by the State Comptroller's Office. The impact of NGPA is seen in the decreasing share for interstate gas to 1978, then generally increasing.

Table 6. Surveillance fields and production in Texas by district. Districts 2, 3, 4, 6, 8, and 10 accounted for the bulk of gas well gas production in 1981. Larger fields (surveillance) account for a much lower percentage of production in the Gulf Coast districts than in the other large scale producing districts.

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Table 1. Negative Revisions of Total Natural Gas Reserves.*

Year	Total U.S.	Total Texas	Texas Districts 2	3	4	2, 3, 4
1973	-3,474	-4,713	-643	-1,149	-3,605	-5,397
1975	(+383)	-3,083	-953	(+152)	-925	-1,878
1978	(+118)	-3,817	-1,409	-1,324	-1,212	-3,945
Total	-3,474	-11,613	-3,005	-2,473	-5,742	-11,220
Total (neg. rev.)						
1966-1979	-9,578	-22,446	-4,685	-5,854	-12,504	-23,043
Net Revisions						
1966-1979	(+9,339)	-17,227	-3,677	-3,155	-10,708	-17,540

*Billions of Cubic Feet. Extracted from Tables, Appendix V. API/AGA Annual Reports.

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Table 2A. Total Gas for combined Districts 2, 3, and 4.

Year	Revisions (Bcf)	Additions (Bcf)	Production (Bcf)	Remaining Reserves (Bcf)
1966	925.4	2,886.7	3,611.4	71,925.6
1967	1,126.0	2,217.1	3,678.9	71,589.8
1968	-330.8	1,077.4	3,673.4	68,663.0
1969	-772.0	1,334.9	3,827.1	65,398.8
1970	-617.0	1,276.4	3,911.1	62,147.2
1971	-426.7	1,122.8	3,853.8	58,989.5
1972	-1,853.7	1,093.9	3,769.9	54,459.7
1973	-5,397.4	975.9	3,709.5	46,328.6
1974	-2,388.3	1,200.9	3,461.4	41,679.9
1975	-1,726.7	1,112.1	3,078.1	37,987.2
1976	-2,609.2	1,467.2	3,127.2	33,718.0
1977	1,175.8	1,872.9	3,148.1	33,618.6
1978	-3,945.3	1,423.1	3,064.7	28,031.4
1979	-702.1	1,604.4	3,388.0	25,545.5

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Table 2B. Non-Associated Gas for combined Districts 2, 3, and 4.

Year	Revisions (Bcf)	Additions (Bcf)	Production (Bcf)	Remaining Reserves (Bcf)
1966	950.9	2,777.4	2,831.8	50,996.2
1967	1,122.4	2,093.1	2,874.8	51,336.9
1968	1,776.2	1,023.4	2,896.3	51,240.1
1969	-547.5	1,258.7	3,018.2	48,933.2
1970	-699.4	1,224.9	2,994.4	46,464.4
1971	-83.6	1,059.2	2,902.4	44,537.6
1972	-2,038.3	1,045.4	2,854.7	40,689.9
1973	-6,330.8	936.0	2,743.3	32,551.9
1974	-2,068.6	1,152.0	2,661.7	28,973.5
1975	-1,195.5	1,036.4	2,245.6	26,568.8
1976	9.3	1,433.8	2,376.8	25,635.4
1977	774.9	1,808.5	2,343.5	25,875.1
1978	-2,961.7	1,349.4	2,296.8	21,965.8
1979	-458.4	1,540.1	2,731.8	20,315.9

Table 2C. Associated Gas for combined Districts 2, 3, and 4.

Year	Revisions (Bcf)	Additions (Bcf)	Production (Bcf)	Remaining Reserves (Bcf)
1966	-25.6	109.3	779.6	20,929.5
1967	3.7	124.0	804.3	20,252.8
1968	-2,106.9	54.0	777.1	17,422.8
1969	-224.5	76.2	808.8	16,465.7
1970	82.5	51.7	916.8	15,682.9
1971	-343.2	63.8	951.5	14,452.0
1972	184.6	48.5	915.2	13,769.8
1973	933.4	39.9	966.3	13,776.7
1974	-319.8	49.1	799.7	12,706.4
1975	-531.2	75.6	832.5	11,418.3
1976	-2,618.7	33.3	750.6	8,082.7
1977	401.0	64.5	804.8	7,743.3
1978	-983.7	74.0	768.0	6,065.6
1979	-243.7	64.1	656.4	5,229.6

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Table 3A. Ultimate Recovery by Reservoir Lithology.

	Sandstone						Carbonate						Other	
	Non-Assoc. (Bcf)	%	Assoc. (Bcf)	%	Total Gas (Bcf)	%	Non-Assoc. (Bcf)	%	Assoc. (Bcf)	%	Total Gas (Bcf)	%	Total Gas (Bcf)	%
1970 Total U.S.	331,864	73	164,372	77	496,236	73	124,389	27	48,868	23	173,257	26	9,807	1
Total Texas	110,431	59	51,918	66	162,349	61	76,061	41	26,716	34	102,777	39	367	~0
Percent of U.S. Total		33		32		33		61		55		59		0
Dist. 2	19,634	99	5,354	95	24,988	98	196	1	297	5	493	2	0	
Percent of Gulf Coast Districts		20		15		19		26		91		46		
Dist. 3	35,430	98	15,565	~100	50,995	99	542	2	29	0	570	1	0	
Percent of Gulf Coast Districts		37		44		39		72		9		53		
Dist. 4	40,915	~100	14,542	100	55,457	~100	18	~0	0	0	18	~0	0	
Percent of Gulf Coast Districts		43		41		42		2				<1		
Dists. 2 + 3 + 4	95,979	99	35,461	99	131,440	99	755	1	326	1	1,081	1	0	
Percent of Total Texas		87		68		81		1		1		1		
Dist. 8	683	4	3,808	23	4,491	14	15,321	96	12,499	77	27,820	86	313	~0
Percent of Total Texas		1		7		3		20		47		27		
1977 Total U.S.	374,751	73	164,280	75	539,031	73	135,703	27	55,535	25	191,238	26	11,608	1
Total Texas	112,311	57	48,436	63	160,747	59	83,772	43	27,894	37	111,666	41	558	~0
Percent of Total U.S.		30		29		30		62		50		58		5
Dist. 2	18,975	99	5,723	93	24,698	98	119	1	406	7	525	2	0	
Percent of Gulf Coast Districts		20		18		19		21		94		52		
Dist. 3	39,526	99	13,200	~100	52,726	99	450	1	27	~0	477	1	0	
Percent of Gulf Coast Districts		42		41		42		79		6		47		
Dist. 4	35,982	100	13,397	100	49,379	100	4	~0	0	0	4	~0	0	
Percent of Gulf Coast Districts		38		41		39		<1	0			<1		
Dists. 2 + 3 + 4	94,483	99	32,320	99	126,803	99	573	1	433	1	1,006	1	0	
Percent of Total Texas		84		67		79		1		2		1		
Dist. 8	893	4	3,950	23	4,843	13	20,003	96	13,407	77	33,410	87	320	0
Percent of Total Texas		1		8		3		24		48		30		57

1970 $\frac{\text{Dists. 2 + 3 + 4}}{\text{Total Texas}}$ $\frac{\text{ult. recovery total gas all lithologies = 132,521 Bcf}}{\text{ult. recovery total gas all lithologies = 265,126 Bcf}} = 50\%$

1977 $\frac{\text{Dists. 2 + 3 + 4}}{\text{Total Texas}}$ $\frac{\text{ult. recovery total gas all lithologies = 127,809 Bcf}}{\text{ult. recovery total gas all lithologies = 272,971 Bcf}} = 47\%$

% calculated for gas classification (non-assoc., assoc., or total) for lithology, by district
example: Total Texas non-assoc. gas for reservoir lithology sandstone, 110,431 (59%) + carbonate, 76,061 (41%) = 186,492 (100%) (in 1970)

Table 3B. Ultimate Recovery by Type of Trap.

	Structural						Stratigraphic					
	Non-Assoc. (Bcf)	%	Assoc. (Bcf)	%	Total Gas (Bcf)	%	Non-Assoc. (Bcf)	%	Assoc. (Bcf)	%	Total Gas (Bcf)	%
1970 Total U.S.	289,335	62	157,814	73	447,149	66	174,783	38	57,367	27	232,150	34
Total Texas	120,379	64	53,657	68	174,037	66	66,147	36	25,309	32	91,456	34
Percent of U.S. Total		42		34		39		38		44		39
Dist. 2	19,253	97	5,616	99	24,869	98	577	3	36	1	613	2
Percent of Gulf Coast Districts		20		16		19		27		7		23
Dist. 3	35,352	98	15,470	99	50,822	98	619	2	124	1	743	2
Percent of Gulf Coast Districts		37		44		39		29		23		28
Dist. 4	39,962	98	14,170	97	54,132	98	971	2	372	3	1,343	2
Percent of Gulf Coast Districts		42		40		42		45		70		50
Dists. 2 + 3 + 4	94,567	98	35,256	98	129,823	98	2,167	2	532	2	2,699	2
Percent of Total Texas		79		66		75		3		2		3
Dist. 8	14,036	88	10,967	66	25,003	77	1,968	12	5,653	34	7,622	23
Percent of Total Texas		12		20		14		3		22		8
1977 Total U.S.	318,088	61	161,011	72	479,099	65	201,708	39	61,069	28	262,777	35
Total Texas	123,202	63	51,743	67	174,945	64	73,099	37	24,926	33	98,025	36
Percent of Total U.S.		39		32		37		36		41		37
Dist. 2	18,298	97	6,096	99	24,394	97	637	3	35	1	672	3
Percent of Gulf Coast Districts		20		19		20		25		8		23
Dist. 3	39,457	99	13,089	99	52,546	99	519	1	138	1	657	1
Percent of Gulf Coast Districts		43		41		42		20		31		22
Dist. 4	34,601	96	13,125	98	47,726	97	1,384	4	272	2	1,656	3
Percent of Gulf Coast Districts		37		41		38		54		61		55
Dists. 2 + 3 + 4	92,356	97	32,310	99	124,666	98	2,540	3	445	1	2,985	2
Percent of Total Texas		75		62		71		3		2		3
Dist. 8	18,468	88	11,717	66	30,185	78	2,428	12	5,960	44	8,388	22
Percent of Total Texas		15		23		17		3		24		9

1970 Dists. 2 + 3 + 4 / Total Texas: ult. recovery total gas structural + stratigraphic traps = 132,522 Bcf / ult. recovery total gas structural + stratigraphic traps = 265,493 Bcf = 50%

1977 Dists. 2 + 3 + 4 / Total Texas: ult. recovery total gas structural + stratigraphic traps = 127,651 Bcf / ult. recovery total gas structural + stratigraphic traps = 272,970 Bcf = 47%

% calculated for gas classification (non-assoc., assoc., or total) for trap type, by district
example: district 2 assoc. gas for trap types structural, 5,615 (99%) + stratigraphic, 36 (1%) = 5,651 (100%) (in 1970)

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Table 2C. Associated Gas for combined Districts 2, 3, and 4.

Year	Revisions (Bcf)	Additions (Bcf)	Production (Bcf)	Remaining Reserves (Bcf)
1966	-25.6	109.3	779.6	20,929.5
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1970	82.5	51.7	916.8	15,682.9
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1978	-983.7	74.0	768.0	6,065.6
1979	-243.7	64.1	656.4	5,229.6

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Table 3A. Ultimate Recovery by Reservoir Lithology.

	Sandstone						Carbonate						Other	
	Non-Assoc.		Assoc.		Total Gas		Non-Assoc.		Assoc.		Total Gas		Total Gas	
	(Bcf)	%	(Bcf)	%	(Bcf)	%	(Bcf)	%	(Bcf)	%	(Bcf)	%	(Bcf)	%
1970 Total U.S.	331,864	73	164,372	77	496,236	73	124,389	27	48,868	23	173,257	26	9,807	1
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Percent of U.S. Total		33		32		33		61		55		59		0
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Dist. 3	35,430	98	15,565	~100	50,995	99	542	2	29	0	570	1	0	
Percent of Gulf Coast Districts		37		44		39		72		9		53		
Dist. 4	40,915	~100	14,542	100	55,457	~100	18	~0	0	0	18	~0	0	
Percent of Gulf Coast Districts		43		41		42		2				<1		
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Percent of Total Texas		87		68		81		1		1		1		
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Percent of Gulf Coast Districts		42		41		42		79		6		47		
Dist. 4	35,982	100	13,397	100	49,379	100	4	~0	0	0	4	~0	0	
Percent of Gulf Coast Districts		38		41		39		<1	0			<1		
Dists. 2 + 3 + 4	94,483	99	32,320	99	126,803	99	573	1	433	1	1,006	1	0	
Percent of Total Texas		84		67		79		1		2		1		
Dist. 8	893	4	3,950	23	4,843	13	20,003	96	13,407	77	33,410	87	320	0
Percent of Total Texas		1		8		3		24		48		30		57

1970 $\frac{\text{Dists. 2 + 3 + 4}}{\text{Total Texas}}$ $\frac{\text{ult. recovery total gas all lithologies} = 132{,}521 \text{ Bcf}}{\text{ult. recovery total gas all lithologies} = 265{,}126 \text{ Bcf}} = 50\%$

1977 $\frac{\text{Dists. 2 + 3 + 4}}{\text{Total Texas}}$ $\frac{\text{ult. recovery total gas all lithologies} = 127{,}809 \text{ Bcf}}{\text{ult. recovery total gas all lithologies} = 272{,}971 \text{ Bcf}} = 47\%$

% calculated for gas classification (non-assoc., assoc., or total) for lithology, by district
example: Total Texas non-assoc. gas for reservoir lithology sandstone, 110,431 (59%) + carbonate, 76,061 (41%) = 186,492 (100%) (in 1970)

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Table 3B. Ultimate Recovery by Type of Trap.

		Structural						Stratigraphic					
		Non-Assoc.		Assoc.		Total Gas		Non-Assoc.		Assoc.		Total Gas	
		(Bcf)	%	(Bcf)	%	(Bcf)	%	(Bcf)	%	(Bcf)	%	(Bcf)	%
1970	Total U.S.	289,335	62	157,814	73	447,149	66	174,783	38	57,367	27	232,150	34
	Total Texas	120,379	64	53,657	68	174,037	66	66,147	36	25,309	32	91,456	34
	Percent of U.S. Total		42		34		39		38		44		39
	Dist. 2	19,253	97	5,616	99	24,869	98	577	3	36	1	613	2
	Percent of Gulf Coast Districts		20		16		19		27		7		23
	Dist. 3	35,352	98	15,470	99	50,822	98	619	2	124	1	743	2
	Percent of Gulf Coast Districts		37		44		39		29		23		28
	Dist. 4	39,962	98	14,170	97	54,132	98	971	2	372	3	1,343	2
	Percent of Gulf Coast Districts		42		40		42		45		70		50
	Dists. 2 + 3 + 4	94,567	98	35,256	98	129,823	98	2,167	2	532	2	2,699	2
	Percent of Total Texas		79		66		75		3		2		3
	Dist. 8	14,036	88	10,967	66	25,003	77	1,968	12	5,653	34	7,622	23
	Percent of Total Texas		12		20		14		3		22		8
1977	Total U.S.	318,088	61	161,011	72	479,099	65	201,708	39	61,069	28	262,777	35
	Total Texas	123,202	63	51,743	67	174,945	64	73,099	37	24,926	33	98,025	36
	Percent of Total U.S.		39		32		37		36		41		37
	Dist. 2	18,298	97	6,096	99	24,394	97	637	3	35	1	672	3
	Percent of Gulf Coast Districts		20		19		20		25		8		23
	Dist. 3	39,457	99	13,089	99	52,546	99	519	1	138	1	657	1
	Percent of Gulf Coast Districts		43		41		42		20		31		22
	Dist. 4	34,601	96	13,125	98	47,726	97	1,384	4	272	2	1,656	3
	Percent of Gulf Coast Districts		37		41		38		54		61		55
	Dists. 2 + 3 + 4	92,356	97	32,310	99	124,666	98	2,540	3	445	1	2,985	2
	Percent of Total Texas		75		62		71		3		2		3
	Dist. 8	18,468	88	11,717	66	30,185	78	2,428	12	5,960	44	8,388	22
	Percent of Total Texas		15		23		17		3		24		9

1970 $\frac{\text{Dists. 2 + 3 + 4}}{\text{Total Texas}}$ $\frac{\text{ult. recovery total gas structural + stratigraphic traps = 132,522 Bcf}}{\text{ult. recovery total gas structural + stratigraphic traps = 265,493 Bcf}} = 50\%$

1977 $\frac{\text{Dists. 2 + 3 + 4}}{\text{Total Texas}}$ $\frac{\text{ult. recovery total gas structural + stratigraphic traps = 127,651 Bcf}}{\text{ult. recovery total gas structural + stratigraphic traps = 272,970 Bcf}} = 47\%$

% calculated for gas classification (non-assoc., assoc., or total) for trap type, by district
example: district 2 assoc. gas for trap types structural, 5,615 (99%) + stratigraphic, 36 (1%) = 5,651 (100%) (in 1970)

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Table 4. Distribution of Natural Gas Production in Texas
Between the Intrastate and Interstate Markets, 1979
(Percentages of Each District's Prod.).

District	Intrastate[1]	Interstate
1	73	27
2-Onshore	79	21
3-Onshore	87	13
4-Onshore	74	26
5	98	2
6	33	67
7B	99	1
7C	52	48
8	50	50
8A	72	28
9	68	32
10	26	74
State/Federal Offshore	23	77
Texas	57	43

[1]Intrastate share is derived by subtracting production reported by interstate pipelines on FPC Form 15 from total production in each district.

Sources: EIA, U.S. Crude Oil and Natural Gas Reserves, 1979; EIA, Gas Supplies of Interstate Natural Gas Pipeline Companies, 1979.

Table 5. Texas Gas
(Data from Lloyd Roland, State Comptrollers Office).

Year	Interstate*	Percentage	Intrastate	Percentage	Total
1976	2,408.5	32%	5,115.7	68%	7,524.2
1977	2,260.8	31%	5,082.8	69%	7,343.6
1978	2,029.0	29%	4,875.6	71%	6,904.6
1979	2,269.8	32%	4,888.1	68%	7,157.9
1980	2,318.5	34%	4,573.3	66%	6,891.8
1981	2,278.2	34%	4,403.1	66%	6,681.3
1982	2,198.0	37%	3,697.6	63%	5,895.6
1983	1,853.5	34%	3,558.0	66%	5,411.5
'84-June	1,067.2	38%	1,770.7	62%	2,837.9**

*Texas gas exported is from pipeline reports to RRC of Texas and is considered as Interstate.

**One-half year.

Gas volumes are in Bcf

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Table 6.
Surveillance Gas Fields by TRRC District.

TRRC District	1981 No. of Surveillance Fields / Total no. of Gas Fields			Surveillance Fields / Total Gas (MMcf)		
1	19/354	=	5.4%	70,202/109,418	=	64%
2	52/2,077	=	2.5%	127,231/376,694	=	34%
3	113/1,862	=	6.1%	397,787/944,396	=	42%
4	173/3,393	=	5.1%	532,138/1,136,164	=	47%
5	18/205	=	8.8%	75,024/151,156	=	50%
6	43/452	=	9.5%	240,166/398,910	=	60%
7B	7/991	=	0.1%	18,806/124,384	=	15%
7C	16/427	=	37%	173,368/255,641	=	68%
8	77/508	=	77%	740,350/958,122	=	77%
8A	4/36	=	11.1%	7,185/15,941	=	45%
9	4/362	=	1.1%	74,871/107,319	=	70%
10	80/354	=	22.6%	661,412/768,822	=	86%
State Surveillance / Total State Texas	606/10,971	=	5.5%	3,118,540/5,346,967	=	58%

Natural gas volumes are in millions of cubic feet (MMcf)

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Table 7.
Largest Gas Fields by Railroad Commission District.

District 2		District 3		District 4	
Field	Cum. prod. to 12/83 (Bcf)	Field	Cum. prod. to 12/83 (Bcf)	Field	Cum. prod. to 12/83 (Bcf)
Burnell	461	Chocolate Bayou	883	Alazan North	1,230
Heyser	542	College Port	325	Borregos	1,792
Lake Pasture	508	Fishers Reef	166	La Blanca	273
Provident City	411	Katy	6,382	La Gloria	1,379
Tom O'Connor	661	Magnet-Withers	896	Laguna Larga	666
Tulsita Wilcox	457	Old Ocean	2,596	McAllen	375
		Pledger	1,472	McAllen Ranch	595
		Redfish Reef	266	Sarita	229
		Sheridan	1,330	Seeligson	1,391
				Stillman	186
				Stratton	1,512
				Thompsonville NE	589
				TCB	469
				Zone 21B	2,289
Total Cum. prod.	3,040 (23%)		14,316 (48%)		12,975 (38%)
Total Dist. Cum. prod.	13,271		29,857		33,747

Cum. production from Railroad Commision data as listed by Petroleum Information Services (PI).

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Table 8. Production Declines - Largest Gas Fields in District 4.

Name of Field	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Alazan North	-41%*								*		*	*
Borregos						*				*		
La Gloria							*	*				
Laguna Larga							-28%*		*			
McAllen Ranch	*	-26%*				-22%*						
Sarita						*			-31%*			
Seeligson	*				*	-30%*						*
Stillman	*							-20%*				
TCB						-27%*	-33%*					
Thompsonville NE			-20%*									
Zone 21-B											*	*

* = Sharp break on decline curve plots.

-26% = percentage decrease in annual productions from preceding year.

APPENDIX I

DEFINITION OF TERMS

Allowable is the volume of gas that is permitted to be produced from a well, or field according to demand and deliverability schedules determined by regulatory authorities.

Associated - dissolved gas is the combined volume of natural gas which occurs in crude oil reservoirs, either as gas cap gas or as gas in solution with the crude oil at reservoir conditions (dissolved). The latter is often referred to as casinghead gas.

Deliverability is the volume of gas that can be produced from a well, reservoir, or field during a given period of time against a certain well head back-pressure under physical reservoir conditions taking into account restrictions imposed by pipeline capacity, contract, or regulatory bodies.

Flow capacity is the volume of gas that can be produced from a well reservoir, or field during a given period of time with no restriction other than well head back-pressure and reservoir capability.

Natural gas is a mixture of hydrocarbon compounds existing in a gaseous phase or in solution with oil at reservoir conditions in natural underground reservoirs.

Non-associated gas is defined as free natural gas not in contact with crude oil in the reservoir.

Reserves of natural gas for the purpose of this study are limited to proved reserves and are the current estimated volume of natural gas which geological and engineering data demonstrate with reasonable certainty to be recoverable in the future from known oil and gas reservoirs in a particular field under existing economic and operating conditions.

Revisions to reserves are changes in the estimates of the volume of natural gas that have been demonstrated to be recoverable from known oil and gas reservoirs in a particular field under current economic and operating conditions. There may be changes in volumes of original-gas-in-place (OGIP) or changes in the volume of gas recoverable. Revisions may be positive or negative and are in order as the drilling of additional wells in a reservoir provide new and improved geological or engineering data that allow more precision in reserve estimation. In addition productive performance may indicate the need to revise the volume or reserves.

Take is the volume of gas that is actually delivered to a pipeline.

Total gas is natural gas and includes non-associated gas and associated-dissolved gas.

Ultimate recovery of natural gas is an estimate of the total quantity of gas which will ultimately be produced from a reservoir as determined by the interpretation of current geological and engineering information and under prevailing economic and operating conditions.

Volumes of natural gas are listed in:

1) Cubic feet (Cu. ft.)
2) Thousands of cubic feet (Mcf)
3) Millions of cubic feet (MMcf)
4) Billions of cubic feet (Bcf)
5) Trillions of cubic feet (Tcf)

APPENDIX II

TEXAS RAILROAD COMMISSION REGULATION OF THE NATURAL GAS INDUSTRY

A chronological listing of important historical events, legislative acts, judicial decisions, orders, and other relevant data regarding the Railroad Commission of Texas regulation of the natural gas industry.

1. 1872 - First known gas production in Texas from well owned by the Graham brothers and located near Graham, Texas.

2. 1891 - Railroad Commission of Texas established by legislature, giving the commission jurisdiction over rates and operations of railroads, terminals, and express companies.

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3. 1899 - Legislature declares that any gas well is to be shut in within ten days after completion until such time as the gas produced is used for light, fuel, or power purposes.

4. 1917 - Legislature declares pipelines to be common carriers and gives Railroad Commission jurisdiction over them - First act to designate Railroad Commission as the agency to administer the conservation laws relating to oil and gas.

5. 1919 - Legislature enacts a statute requiring the conservation of oil and gas, forbidding waste and giving the Railroad Commission jurisdiction.

6. 1919 - Railroad Commission adopts first statewide rule regulating the oil and gas industry - Texas first state to adopt a well-spacing rule.

7. 1920 - Legislature declares the production and sale of natural gas to be a public utility and gives the Railroad Commission jurisdiction.

8. 1925 - Texas Court of Civil Appeals holds that casinghead gas is included within the term "oil."

9. 1928 - Railroad Commission issues its first proration order based on the conservation statutes pertaining to the Hendricks pool in Winkler County.

10. 1930 - Railroad Commission issues first statewide proration order to limit state production to 750,000 barrels per day. Reduced amount was based on market demand formula.

11. Legislature amends 1899 statute as to allowable uses for gas to include any other purpose which Railroad Commission finds to be practical and conducive to the public welfare. Act defines physical waste and forbids the Railroad Commission to consider market demand either directly or indirectly.

12. Federal court sustains statute and subsequent order of Railroad Commission enjoining producer from stripping gas and flaring residue as wasteful.

13. Special session of legislature hurriedly enacts act removing prohibition against consideration of economic waste or limitation of production to market demand to conform to Supreme Court U.S.A. decision.

14. 1935 - Legislature enacts comprehensive gas regulation statute with detailed provisions for apportioning the reasonable market demand of gas throughout the State. Prohibits production of gas in such a way as to cause underground waste, prohibits blowing to the air before or after processing for gasoline content, and prohibits the use of sweet gas for the manufacture of carbon black but allowing some gas to be used for such purpose.

15. 1945 - Texas Supreme Court holds that the Railroad Commission may prorate the production of gas for the protection of correlative rights even though no waste is involved.

16. 1947 - Railroad Commission issues the Seeligson Order restricting the production of gas and oil wells by prohibiting the production of oil and gas in the entire field until all of the casinghead gas produced with the oil is utilized for one of the beneficial uses set out in earlier statutes.

17. 1948 - Railroad Commission on the basis of the contested Seeligson case issues orders covering 16 fields shutting down every oil well in those fields from which casinghead gas was being flared.

18. 1949 - Supreme Court of Texas upholds Railroad Commission order shutting down 16 fields from which casinghead gas was being flared (wells were shut down from December 1, 1948 to April 1949).

19. 1953 - Railroad Commission enters an order shutting down all wells in the giant Spraberry field until all casinghead gas produced in the field can be devoted to one of the beneficial uses prescribed by law.

20. 1953 - Texas Supreme Court holds that Spraberry shut down order of March 25, 1953 was not a proper exercise of its authority.

21. 1953 - Railroad Commission alters order for Spraberry field by shutting in all wells in field for 20 days per month and fixing the field allowable in terms of market outlet for casinghead gas.

22. 1966 - Railroad Commission adopts statewide rule governing offshore allowable yardstick allowing increases over onshore production to make equitable offshore production considering unusual operating conditions for the offshore areas.

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23. 1973 - Commission issues special order requiring every natural gas utility to file with the Railroad Commission its curtailment program for natural gas by February 12, 1973. Also provided for priority curtailment program for each gas utility until such time as the Commission had approved the curtailment program. (Early indication of lack of deliverable volume indicated by forms filed with the Commission.)

24. 1975 - Supreme Court of Texas upholds Commission order holding Railroad Commission did not have jurisdiction to inquire into the effect of the public interest of contracts entered into by Lo-Vaca with specific customers at a time when it was unable to fulfill its contractual delivery obligations to two cities and a river authority. The Commission also could not require Lo-Vaca to apportion or share the gas in the Lo-Vaca system.

25. 1975 - The Commission issued a special order adopting rules and regulations pertaining to out-of-state sales of gas produced from publicly owned and leased minerals.

26. 1975 - The Commission issues a special order amending earlier rules and requiring annual well status reports on gas wells producing liquid hydrocarbons on new, modernized machine generated Form G-10. (Inflated G-10 forms still a problem, 1984).

27. 1975 - Supreme Court of Texas upholds a Commission order establishing priorities for gas deliveries by gas utilities.

28. 1976 - Commission holds a statewide market demand hearing to review market demand regulation of natural gas production, recognizing the need for modernizing market demand determinations and allowables in order to provide a more realistic relationship of demand to allowables.

29. 1977 - Texas legislature grants eminent domain powers for underground storage of gas with Railroad Commission designated as the agency which will determine, supervise, and classify all storage reservoirs to establish a better year-round supply for residential, commercial, and industrial gas customers.

30. 1977 - Legislature creates Texas Energy Advisory Council designed to articulate a state energy policy and facilitate extensive research and development in energy related matters of particular importance to the Texas energy situation.

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31. 1977 - U.S. Court of Appeals affirms Federal Power Commission orders requiring all large producers of natural gas and their affiliates to submit detailed information concerning their exploration and development activities on an annual basis.

32. U.S. Supreme Court affirms an FEC order requiring an application to abandon service once gas has begun to flow in interstate commerce from a field subject to a certificate of unlimited duration.

33. 1978 - Commission adopts rule prohibiting the escape of gas from a well into the air after 10 days from when the gas is first encountered unless it is proven to be prudent and necessary.

34. 1978 - Court holds that there are two distinct and separate gas markets (interstate and intrastate) and sales of intrastate gas are irrelevant to a determination of the fair market value of gas irrevocably committed to interstate commerce.

35. 1978 - Railroad Commission adopts the gas market demand rule to allow determination of gas market demands and provide procedures for gas well allowable allocations and ratable take between gas wells and fields in Texas.

36. 1978 - Texas Court of Appeals rules that a proper method of determining the market value of gas produced during a period is to compute a weighted average market price for all gas sold by all producers in the area.

37. 1978 - Commission issues rules pursuant to the Natural Gas Policy Act (NGPA).

38. 1979 - Commission adopts statewide rule stating that no operator producing gas for sale from publicly owned or leased minerals may sell or contract to sell to any person, corporation or other entity for ultimate use outside the State of Texas unless the Commission grants an exception.

39. 1979 - Senate bill grants Railroad Commission explicit authority to adopt rules necessary to implement federal programs such as energy determinations under NGPA and Underground Injection Control (UIC).

40. 1979 - Railroad Commission adopts revised and simplified NGPA determination procedures under authority which governs request for certain category determinations.

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41. 1979 - Establishment of Texas Energy and Natural Resources Advisory Council (TENRAC)...adopting and assessing Texas energy and natural resource policy, reviewing existing and proposed federal action to determine its impact, recommending legislation, etc.

42. 1979 - Commission officially approves a long-negotiated settlement plan for Lo-Vaca and its approximately 400 Texas customers. Plan establishes new company, Valero Energy Corporation. The undertaking of a massive $180,000,000 - $230,000,000 gas search program to supply Valero with gas at discounted prices and includes dropping of more than $1.6 billion in law suits and other legal claims against Lo-Vaca by its customers for alleged breach of gas supply contracts dating back to the early 1970's.

43. 1980 - In an emergency rule Commission adopts an amendment to the Curtailment Program for Natural Gas that directs intrastate gas companies to curtail all sales and deliveries to out-of-state markets under surplus sales clauses when the needs of their Texas customers are not met.

44. 1980 - Rule providing that NGPA applications may be reviewed and approved without a hearing, although hearings will be held when an examiner's recommendation is adverse to the applicant, when an intervention in protest is filed, when applicant makes a written request for a hearing, or when the staff determines a hearing is necessary.

APPENDIX III

TEXAS NATURAL GAS TRANSMISSION INDUSTRY DURING THE 1970'S

This period is of particular interest because it covered market disruptions in both intra- and interstate markets. Surpluses that had characterized the natural gas industry for forty years disappeared. Interstate markets suffered through years of severe curtailment during much of the period due to the freezing of prices and subsequent loss of supply. Intrastate gas supplies faced with declining availability of gas in the Gulf Coast area, found relief by increasing their share of gas in the Permian Basin. (Texas Railroad Commission Districts 8, 8A, and 7C).

The Texas Railroad Commission (TRRC) regulates the production, transmission and disposition of oil and gas within Texas. Conservation of resources and protection of correlative rights, twin goals of the Commission, have been sought through well-spacing rules, production allowables, prohibition of gas flaring and prorationing of gas production.

Although possessing appellate jurisdiction over local distribution companies and original jurisdiction over gathering and transmission companies, the Commission has chosen not to intervene in most pipeline investment decisions and gas sales transactions, preferring rather to depend on competition in the industrial market to insure efficient investment decisions and fair wellhead gas prices. The intrastate pipeline industry in Texas was dominated by a group of 11 companies that operated 69 percent of all intrastate pipelines. They purchased 56 percent of the intrastate wellhead gas and supplied 73 percent of the gas used by large industrial firms. Competition between these large pipeline companies performed relatively well in achieving the regulatory aims of the Commission.

During the 1970's the principal concern of the Texas gas pipeline industry was to secure additional gas supplies in a rapidly expanding market and to operate profitably at a time of rapidly rising gas costs. Difficulties are reflected in the varied performance of five of the largest companies during the decade.

Delhi is primarily a large gas gatherer that purchases gas at the wellhead and makes most of its sales to other pipelines. During the 1970's they increased by 700 percent the total length of their system. The company was not one of the major transmission companies when the decade began but grew rapidly by taking advantage of the opportunity of the opening of new supply areas and the added deliverability in established areas that occurred as infill drilling campaigns were launched. Delhi was not bound by long term fixed contracts so that in a period of rapidly rising prices and costs they were able to profitably handle these items.

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Houston Pipe Line Company, a major at the beginning of the decade in sales and miles of pipe in service profited from having most of its operations somewhat more geographically contained than the other majors. Due to the location of its market in the Houston area and to the fact that a large portion of its sales were to industrial users it was relatively easy for them to renegotiate contracts during the time of rapidly increasing prices and costs so that profit margins did not suffer. Although they bought most of their gas at the wellhead in 1970, by the end of the decade they were purchasing nearly 50 percent of their volume from other suppliers. Profit margins suffered during 1972-1973 when gas costs increased dramatically but recovered soon after.

Lone Star is both a gathering and transmission company and a residential distributor. It began the decade with 7,129 miles of pipe. In 1980 this had grown to slightly over 7,400 miles. It purchased at the wellhead 93 percent of its volume in 1970; by 1980 this had only decreased to 89 percent. Because of its status as a major distributor Lone Star was able to maintain its earnings margin at a time (1973-75) when many of its competitors could not.

United Texas Transmission Company began the decade purchasing 94 percent of its volume of gas at the wellhead. In 1980, 44 percent of its volume was supplied by other pipelines. The early part of the decade saw profit margins squeezed by rapidly rising gas costs. Unlike some others whose sales are principally to industrials they were unable to achieve acceptable profit margins until the latter part of the 1970's. It now enjoys a very healthy profit margin.

Valero Transmission Company, formerly named Lo-Vaca Gathering Company, along with Valero Energy Corporation were spun-off from the Coastal Corporation in December 31, 1979. Circumstances leading up to this spin-off were primarily rooted in Lo-Vaca having signed long-term contracts in the 1960's to supply many Texas cities including Austin, San Antonio, and Corpus Christi at the flat rate of 20 cents per MCF. When the price of purchased gas exceeded their sales price in 1973 it became apparent that Lo-Vaca could not long continue. Limited supplies were apparent when during the peak demand period accompanying the severe winter

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conditions of 1972-73, deliveries were curtailed 13 times. Regulatory and court appearances and decisions allowed Lo-Vaca to establish a system of pass through charges so that supplies could be made to the different cities. The spin-off and name change occurred as a final settlement of the issue and the establishment of Valero Transmission Company as a viable, independent, utility.

The effect of negative revisions of gas reserves impacted these companies in varying degrees according to their markets and supply base. Those dealing principally with industrial users found it relatively easy to renegotiate contracts under the changed conditions that resulted from first oversupply then undersupply and finally oversupply. As all these companies deal primarily with intrastate gas the rapidly increasing cost of the resource (as compared to the fixed rate of interstate gas till NGPA) was related directly to the reserves of the commodity. However, those like Lo-Vaca who found themselves short of reserves due in part to the negative revisions of their reserves were forced to purchase more expensive gas and experienced considerable difficulties in passing through these extra costs to city-run utilities.

APPENDIX IV

GAS PRORATIONING

All natural gas fields in the state are included in the prorationing activities of the Texas Railroad Commission. The aim is to allocate and adjust production so that each producing gas well in the state would be allowed to produce at a rate which would be an equal proportion of the states total demand based on acreage and deliverability formulae.

Determination of allowable is made by the TRRC.

Calculations for this determination are based on data supplied by two forms dealing with deliverability (G-10) and total pipeline nominations (T-3). Producer forecasts (G-10) are compared to the product of deliverability times the days of the month. The lesser of these two

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is; the adjusted G-10.* Pipeline nominations are compared to the monthly limit that has been pre-set by the Commission. The lesser of these is the adjusted T-3. Adjusted T-3 values are then divided by adjusted G-10 values. If the ratio is greater than 90 percent the adjusted G-10 is taken as market demand. If less than 90 percent the adjusted T-3 is the market demand.

Total field allowable is then established for each field based on the market demand plus or minus the third prior months growth adjustments (subtracted if allowable exceeded production, added if allowable was less than production) plus or minus any changes in limited status wells. A further adjustment for special conditions such as cold weather, etc. is allowed on the basis of a proration analyst's recommendation.

Individual well allowables within the field are based on deliverability tests (form G-10 which are required semi-annually) acreage factors, or not uncommonly, combinations of these. Some formulas are even based on bottom hole pressures (BHP) or acres time BHP. Any of these parameters for an individual well are divided by the total field parameter then multiplied by field demand to give individual well allowable.

*Special allowable wells, i.e., increasingly, higher water-cut, severely underproduced, associated gas either as solution (casinghead) or gas cap, (49B) are deducted from the field market demand before allowables are determined for the remaining wells.

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1st order reader APPENDIX V API/AGA TABLES FOR RESERVES and PRODUCTION

TABLES: TOTAL GAS FOR TX Total gas, non associated gas, associated gas - All Districts 1966

RR=TX

YEAR	REVIS	EXTENS	FIELDS	POOLS	TOT_ADD	PROD	RESERVES	RP_RATIO
66	2074331	4588528	1757257	1559755	9979871	6986904	123527582	17.6799
67	2436673	3745320	1542329	1206492	8930814	7128582	125329814	17.5813
68	-1757758	1409735	524924	647475	824376	7243974	118910216	16.4151
69	-2113344	1311513	1033730	814881	1046780	7658970	112298026	14.6623
70	-1372393	1952582	844932	756443	2181564	8219958	106259632	12.9270
71	-3791	2094864	318503	877841	3287417	8166437	101380612	12.4143
72	-1525321	2030625	460500	826449	1792253	8269094	94903771	11.4769
* 73	-4713311	1503765	746018	599637	-1863891	8240478	84799402	10.2906
74	-1524894	1882335	587548	594761	1539750	7942352	78396830	9.8707
* 75	-3083061	1492079	507372	609411	-474199	7041856	70880745	10.0656
76	-2536009	1748945	566505	718770	498211	6895921	64483035	9.3509
77	550509	2072330	836637	825368	4284844	6827303	61940576	9.0725
* 78	-3616971	1312557	622029	818212	-1064173	6528717	54347586	8.3244
79	156784	1880850	1120074	654154	3811862	6812795	51346753	7.5368

RR=01

YEAR	REVIS	EXTENS	FIELDS	POOLS	TOT_ADD	PROD	RESERVES	RP_RATIO
66	77728	2891	2575	3537	86731	139040	2600268	18.7016
* 67	-75093	22526	7219	7720	-37628	133138	2429502	18.2480
* 68	-50512	0	3842	3039	-43631	140394	2245477	15.9941
69	10537	0	2786	3063	16406	135143	2126740	15.7370
* 70	-56155	1558	1326	16534	-36737	135961	1954042	14.3721
71	-72365	52660	9152	29961	19408	130252	1843198	14.1510
* 72	-145756	27522	12660	6719	-98855	124440	1619903	13.0175
* 73	-46191	19419	5364	15988	-7420	139715	1472768	10.5412
74	13954	34992	3387	5037	57370	110698	1419440	12.8226
75	-7780	32156	8979	12438	45793	101704	1363529	13.4068
* 76	-139117	21318	16919	5857	-95023	103655	1164851	11.2378
77	-14528	28297	26611	9507	49887	106329	1108409	10.4243
78	12958	14639	21886	14929	64412	105750	1067071	10.0905
79	22228	46734	10669	9561	89192	110017	1046246	9.5099

RR=02

YEAR	REVIS	EXTENS	FIELDS	POOLS	TOT_ADD	PROD	RESERVES	RP_RATIO
66	-390296	91978	76996	386639	165317	819319	11957186	14.5941
67	262420	9674	40729	197324	510147	728151	11739182	16.1219
* 68	-359662	139	25269	54508	-279746	686245	10773191	15.6988
69	94621	0	74626	158065	327312	657166	10443337	15.8915
70	98362	35707	42966	72827	249862	634848	10058351	15.8437
71	108587	55560	6565	168034	338746	586205	9810892	16.7363
72	31812	1394	36648	149413	219267	534911	9495248	17.7511
* 73	-643178	0	27495	84386	-531297	514668	8445283	16.4170
* 74	-731249	15501	37460	116169	-562119	500872	7386292	14.7469
* 75	-953365	95601	33243	78168	-746353	453491	6186848	13.6418
76	282596	100930	59856	123235	566617	457821	6295244	13.7504
77	-193631	73964	47747	122298	50378	444472	5901150	13.2768
* 78	-1409246	15441	73587	140557	-1179661	395667	4325822	10.9330
79	120337	27591	49895	81826	279649	423974	4181497	9.8626

Total gas, non associated gas, associated gas – All districts

DRAFT

* Negative revisions exceeded additions

1st order reading Appendix V API/AGA Tables for Reserves and Production

RR=03

YEAR	REVIS	EXTENS	FIELDS	POOLS	TOT_ADD	PROD	RESERVES	RP_RATIO
66	426272	39771	653629	155449	1275121	1287189	27420332	21.3023
67	239798	36450	476769	185825	938842	1414058	26944816	19.0550
68	-231747	43511	76373	169581	57718	1483072	25519462	17.2072
* 69	-636395	73539	200081	177386	-185389	1594086	23739987	14.8925
70	86768	49438	366778	204466	707450	1645710	22801727	13.8553
71	450458	120250	74513	270970	916191	1612691	22105227	13.7070
72	-372428	69170	109443	313295	119480	1594275	20630432	12.9403
* 73	-1149334	113722	189203	254070	-586339	1580960	18463133	11.6784
74	-302464	158070	28311	124578	8495	1469302	17002326	11.5717
75	151435	144560	170601	127478	594274	1256967	16339633	12.9993
* 76	-1641919	148014	246234	187208	-1060463	1171690	14107480	12.0403
77	1344965	322069	491508	295701	2454243	1300848	15260875	11.7315
* 78	-1324194	195550	314148	121660	-692836	1389834	13178205	9.4819
79	-197917	191670	551043	41100	586096	1731969	12032332	6.9472

RR=04

YEAR	REVIS	EXTENS	FIELDS	POOLS	TOT_ADD	PROD	RESERVES	RP_RATIO
66	869443	419214	193189	869842	2371688	1504875	32548396	21.6286
67	623777	52076	500063	718198	1894114	1536725	32905785	21.4129
68	261020	286058	121519	300032	968629	1504068	32370340	21.5219
69	-230198	122414	186235	342622	421073	1575794	31215625	19.8095
* 70	-802104	17438	91154	395682	-297830	1630564	29287231	17.9614
* 71	-985812	25617	89900	311445	-558850	1654943	27073438	16.3591
* 72	-1514118	85018	90539	239979	-1098582	1640746	24334110	14.8311
* 73	-3604937	41982	50387	208619	-3303949	1613946	19416215	12.0303
* 74	-1354621	226045	281947	212897	-633732	1491189	17291294	11.5956
* 75	-924862	67400	56674	318325	-462463	1367664	15461167	11.3048
* 76	-1249892	267132	75211	319367	-648182	1497732	13315253	8.8903
77	21487	101253	98579	322847	544166	1402952	12456467	8.8788
* 78	-1211951	80799	76052	405694	-649806	1279220	10527441	8.2296
79	-624538	132938	142846	385212	36458	1232227	9331672	7.5730

RR=05

YEAR	REVIS	EXTENS	FIELDS	POOLS	TOT_ADD	PROD	RESERVES	RP_RATIO
66	-17823	34012	35638	601	52428	114450	1451898	12.6859
67	-101394	48485	125902	550	73543	107316	1418125	13.2145
68	-23430	5858	37316	0	19744	121689	1316180	10.8159
69	-115045	6	267211	48972	201144	120736	1396588	11.5673
70	22061	1840	28951	19087	71939	106769	1361758	12.7542
* 71	-42035	2452	16200	4063	-19320	115608	1226830	10.6120
72	16549	2500	5500	18280	42829	125688	1143971	9.1017
73	79147	3000	1280	3050	86477	112308	1118140	9.9560
* 74	-140132	11630	62005	6617	-59880	99315	958945	9.6556
75	3024	23400	9700	7412	44336	82358	920923	11.1819
* 76	-104660	39214	2757	10762	-55927	75213	789783	10.5006
* 77	-88778	32451	16495	3797	-35635	80242	673306	8.3287
78	-7028	75751	7013	2424	77760	92239	658827	7.1426
79	25043	91587	14284	4561	135475	114959	679343	5.9094

* Negative revisions exceeded additions

DRAFT

RR=06

YEAR	REVIS	EXTENS	FIELDS	POOLS	TOT_ADD	PROD	RESERVES	RP_RATIO
66	30234	65181	65510	16332	197257	514651	6873453	13.3497
67	-3776	112247	10951	12068	131490	482336	6519607	13.5167
68	151390	57719	21396	17439	247944	428129	6339422	14.8073
69	57621	8573	22679	6101	94974	437195	5997201	13.7175
70	220452	584	8390	7760	237186	403647	5830740	14.4451
71	192840	2928	43820	39342	278930	373167	5736503	15.3725
72	94959	154275	50310	8100	307644	333706	5710441	17.1122
73	-68572	61057	17080	21752	31317	309565	5432193	17.5478
* 74	-341762	168554	26567	27790	-118851	286659	5026683	17.5354
* 75	-833347	256604	4121	12105	-560517	264121	4202045	15.9095
76	77485	201586	88483	19302	386856	272783	4316118	15.8225
77	-295252	550767	71428	44652	371597	276229	4411486	15.9704
78	-102614	117166	51441	43574	109567	300950	4220103	14.0226
79	-119121	466529	274598	81279	712285	350111	4582277	13.0881

RR=08

YEAR	REVIS	EXTENS	FIELDS	POOLS	TOT_ADD	PROD	RESERVES	RP_RATIO
66	405924	3286633	357241	35401	4085199	0817912	17206882	21.0376
67	424026	2480414	186897	26685	3118022	0865641	19458263	22.4525
68	-686140	572816	178674	24571	89921	1110119	18438065	16.6091
69	-775931	603720	227353	54399	108541	1329267	17217339	12.9525
70	-1093026	1408008	187832	12235	515049	1628185	16104203	9.8909
71	-1117	1488396	6242	35287	1528808	1745509	15887502	9.1019
72	187347	1248709	77521	59645	1573222	1979387	15481337	7.8213
73	152165	836347	329357	7652	1325521	2010404	14796454	7.3599
74	506950	508290	73913	66110	1155263	1988830	13962887	7.0207
75	-241273	447611	43812	35968	286118	1707868	12541137	7.3432
* 76	-512644	313131	20231	30352	-148930	1512618	10879589	7.1926
77	-171541	216779	50003	8685	103926	1426183	9557332	6.7013
* 78	-228816	175373	19081	26424	-7938	1255087	8294307	6.6086
79	417743	172471	20955	11367	622536	1148444	7768399	6.7643

RR=09

YEAR	REVIS	EXTENS	FIELDS	POOLS	TOT_ADD	PROD	RESERVES	RP_RATIO
66	334568	29415	5012	4311	373306	222382	2760607	12.4138
67	140466	8999	2712	2584	154753	230784	2684576	11.6324
* 68	-285449	1740	5635	808	-277266	175463	2231947	12.7198
* 69	-185486	38552	13630	260	-137044	181395	1913408	10.5483
70	104193	19644	3480	671	127988	187940	1853456	9.8620
* 71	-11397	7253	1203	661	-2780	179211	1671465	9.3268
72	19220	15653	5494	158	40525	163106	1548884	9.4962
73	74713	7878	2847	116	85154	143465	1490573	10.3898
74	3846	49667	3898	4086	61497	145987	1406093	9.6316
75	15625	5328	11671	3100	35724	135843	1305964	9.6138
76	7190	14752	10810	1010	33762	132038	1257688	9.1465
77	-1582	27718	8253	2373	36662	132038	1112312	8.4242
* 78	-60475	22189	10925	24163	-4098	131798	976416	7.4084
79	27342	21337	6782	3948	60009	119945	916480	7.6408

* negative revisions exceeded additions

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RR=10

YEAR	REVIS	EXTENS	FIELDS	POOLS	TOT_ADD	PROD	RESERVES	RP_RATIO
66	84416	247330	279495	34291	645532	1089283	12964517	11.9019
67	885470	330432	94086	17242	1327230	1121530	13170217	11.7431
* 68	-630951	281859	38203	17951	-292938	1102208	11775071	10.6832
69	-265953	305191	29235	7872	76345	1120850	10730566	9.5736
70	295872	255911	86461	2973	641217	1279138	10092645	7.8902
71	642288	230120	57386	10927	940721	1208583	9824783	8.1292
72	512692	132686	54426	30310	730114	1195637	9359260	7.8278
73	565489	196757	100291	735	863272	1236612	8985920	7.2666
74	908979	369527	31027	12223	1321756	1253037	9054639	7.2262
75	291569	159434	147179	5602	603784	1167519	8490904	7.2726
76	615246	314972	13904	13417	957539	1141359	8307084	7.2782
77	-23693	441984	7362	7286	432939	1133317	7606706	6.7119
78	567224	304674	18453	23565	913916	1010052	7510570	7.4358
79	211908	383965	22607	15580	634060	999783	7144847	7.1464

RR=7B

YEAR	REVIS	EXTENS	FIELDS	POOLS	TOT_ADD	PROD	RESERVES	RP_RATIO
66	35590	18633	8320	2318	64861	104195	853386	8.19028
* 67	-69698	29809	6343	926	-32620	108071	712695	6.59469
68	93132	21461	4255	8455	127303	99692	740306	7.42593
69	70994	32122	3020	238	106374	94733	751947	7.93754
70	1673	42993	3808	4277	52751	86690	718008	8.28248
* 71	-86125	43680	2732	3081	-36632	86373	595003	6.88876
72	42946	75931	2603	142	121622	83723	632902	7.55948
73	19316	44909	4977	1258	70460	79090	624272	7.89318
74	-46592	108560	15658	8820	86446	77982	632736	8.11387
75	-51924	76874	17597	1857	44404	82867	594273	7.17141
76	7862	194248	13169	5604	220883	91998	723158	7.86058
77	-38551	222326	13967	6764	204406	114372	813192	7.11006
78	-45868	160181	19242	12920	146475	123638	836029	6.76191
79	-25438	309539	19561	19316	322978	148599	1010408	6.79956

RR=7C

YEAR	REVIS	EXTENS	FIELDS	POOLS	TOT_ADD	PROD	RESERVES	RP_RATIO
66	-107323	316203	56207	48525	313612	196775	3124114	15.8766
67	260181	603798	88873	35797	988649	220281	3892542	17.6756
68	20274	138297	11238	50344	220153	197521	3915174	19.8216
69	-83995	121120	6128	15322	58575	209646	3764103	17.9546
70	-74424	115350	22905	19866	83697	247150	3600850	14.5695
* 71	-354482	50031	9864	3923	-290664	237878	3072308	12.9155
* 72	-472324	216160	15031	1343	-240320	251656	2580332	10.2534
73	-72227	168441	17811	1197	115222	266608	2428946	9.1106
74	-81447	227771	12431	9553	168308	295639	2301615	7.7852
75	-126200	158093	3468	6862	42223	258903	2084935	8.0530
76	47426	175604	11662	1266	235958	268167	2052726	7.6547
77	-24581	50897	4484	1266	32066	257676	1827116	7.0907
78	-13296	144315	13735	2302	147056	296841	1677331	5.6506
79	152228	16102	6572	229	175131	289633	1562929	5.3959

* Negative revisions exceeded additions

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TABLE 3: TOTAL GAS FOR TX ~~16:39 WEDNESDAY, APRIL 4, 1989~~ 30

RR=8A

YEAR	REVIS	EXTENS	FIELDS	POOLS	TOT_ADD	PROD	RESERVES	RP_RATIO
66	305598	37267	3445	2509	348819	176833	3769843	21.3187
* 67	-149506	10420	1785	1573	-135728	179611	3454504	19.2333
* 68	-15283	277	1204	347	-13455	195374	3245675	16.6126
* 69	-49114	6276	746	561	-41531	202959	3001185	14.7971
* 70	-176265	4111	881	65	-171208	233356	2596621	11.1273
71	155969	15917	926	147	172859	236017	2533463	10.7342
72	73280	1607	355	65	75307	241819	2366951	9.7881
* 73	-17702	4253	326	814	-12309	233137	2121505	9.0998
74	39644	3728	10944	881	55197	222842	1953861	8.7679
* 75	-406963	5018	327	96	-401522	162551	1389787	8.5499
76	78418	18044	7269	1390	105121	170847	1324061	7.7500
77	32894	6823	300	192	40209	152045	1212225	7.9728
78	3335	7279	366	0	10980	147641	1075564	7.2850
79	137369	20187	262	175	157993	143134	1090423	7.6182

* = Negative revisions exceeded additions

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APPENDIX II B

RR=TX

YEAR	REVIS	EXTENS	FIELDS	POOLS	TOT_ADD	PROD	RESERVES	RP_RATIO
66	1392669	4313825	1699186	1404190	8809870	5078209	86554104	17.0442
67	983374	3515808	1492300	1084940	7076422	5123229	88507297	17.2757
68	936176	1278068	502014	577192	3293450	5310879	86489868	16.2854
69	-1700095	1158864	994223	783414	1236406	5665618	82060656	14.4840
70	-1534639	1769466	807561	721273	1763661	6106642	77717675	12.7267
71	251951	1823797	300071	835219	3211038	6057295	74871418	12.3605
72	-1725821	1869249	439566	790079	1373073	6244201	70000290	11.2104
* 73	-5832013	1352422	734268	575495	-3269828	6200039	60530423	9.7629
74	-1451410	1680436	563355	551613	1343994	6150526	55723891	9.0600
75	-2060395	1302152	489290	560255	291302	5376794	50638399	9.4180
76	-63936	1550187	543931	693649	2723831	5315414	48046816	9.0391
77	209421	1833089	814927	786943	3644380	5226630	46464566	8.8900
* 78	-2604524	1088806	588860	769340	-157518	4966537	41340511	8.3238
79	172517	1593802	1097386	623912	3487617	5373546	39454582	7.3424

RR=01

YEAR	REVIS	EXTENS	FIELDS	POOLS	TOT_ADD	PROD	RESERVES	RP_RATIO
66	59066	2791	2555	3414	67826	128363	2313456	18.0228
* 67	-81581	22022	6966	7313	-45280	120245	2147931	17.8630
* 68	-45681	0	3395	1029	-41257	126774	1979900	15.6176
69	-5120	0	2584	3083	547	122662	1857785	15.1456
* 70	-57587	481	1154	6912	-49040	122742	1686003	13.7362
* 71	-65615	0	9070	28845	-27700	113949	1544354	13.5530
* 72	-187464	27451	11974	4293	-143746	101716	1298892	12.7698
* 73	-46859	19419	5340	15804	-6296	116580	1176016	10.0876
74	11048	33179	3387	4857	52471	93940	1134547	12.0774
75	-8586	28504	8504	11856	40278	85757	1089068	12.6995
* 76	-86766	14449	15302	4444	-52571	83868	952629	11.3587
77	-49703	24078	24461	8498	7334	83532	876431	10.4922
78	-20791	14301	17611	14307	25428	81255	820604	10.0991
79	8731	46734	9631	9465	74561	88428	806737	9.1231

RR=02

YEAR	REVIS	EXTENS	FIELDS	POOLS	TOT_ADD	PROD	RESERVES	RP_RATIO
66	-453723	91848	75475	364053	77653	702001	9181799	13.0795
67	111959	5788	35463	192209	345419	619168	8908050	14.3871
* 68	-164473	0	21529	52804	-90140	556468	8251442	14.8462
69	81291	0	65297	154183	301371	527869	8034944	15.2215
70	-22226	35707	39102	70543	117126	486162	7665908	15.7682
71	121877	55560	6008	151176	334621	429816	7570713	17.6138
72	-140987	— 245	29996	141256	30610	384091	7217232	18.7904
* 73	-801239	0	27241	80994	-693004	386088	6138140	15.8983
* 74	-677356	15289	36259	112678	-513130	355999	5269011	14.8006
* 75	-820803	95590	33045	70199	-621969	314122	4332920	13.7937
76	194452	100175	59455	116946	471028	318757	4465191	14.0709
77	-192511	69895	47135	119472	44051	320129	4209113	13.1482
* 78	-1256930	13206	72515	133268	-1037941	280764	2890408	10.2948
79	110009	27316	47308	74628	259261	314365	2835284	9.0185

* Negative revisions exceeded additions

DRAFT

TABLE 1: NON-ASSOCIATED GAS FOR TX ~~15:39 WEDNESDAY, APRIL 4, 1984~~ 7

DRAFT

RR=03

YEAR	REVIS	EXTENS	FIELDS	POOLS	TOT_ADD	PROD	RESERVES	RP_RATIO
66	436928	31930	648021	151887	1268766	927088	18267066	19.7037
67	418352	27244	476207	174079	1095862	1039792	18323156	17.6219
68	1491356	30327	75104	160371	1757158	1197716	16882598	15.7655
* 69	-457866	49744	199077	161846	-47199	1302873	17532526	13.4568
70	31969	34360	365320	199514	631163	1305116	16858573	12.9173
71	518033	105228	72012	268758	964031	1279991	16542613	12.9240
72	-455524	57055	107620	308180	17331	1251710	15308234	12.2299
* 73	-2045375	104591	185661	250084	-1504739	1181522	12621973	10.6828
74	-151300	152607	26784	119304	147395	1235741	11533627	9.3334
75	249143	118914	168613	101692	638362	912592	11259397	12.3378
76	541233	138182	244244	182839	1106498	966269	11399626	11.7976
77	1470298	292494	491285	288665	2542742	1064960	12877408	12.0919
* 78	-1241251	170220	311771	120848	-638412	1151252	11087744	9.6310
79	-211476	156453	547413	39892	532272	1530161	10089855	6.5940

RR=04

YEAR	REVIS	EXTENS	FIELDS	POOLS	TOT_ADD	PROD	RESERVES	RP_RATIO
66	967743	418508	174313	821373	2381937	1202652	23547322	19.5795
67	591976	51406	486896	643917	1774195	1215758	24105759	19.8278
68	449252	279300	118601	285372	1132525	1142145	24096139	21.0973
69	-171535	117107	177077	334445	457094	1187448	23365785	19.6773
* 70	-703184	4678	89141	386569	-222796	1203103	21939886	18.2361
* 71	-723476	16315	88649	295486	-323026	1192592	20424268	17.1259
* 72	-1441885	83012	90021	228001	-1040851	1218899	18164518	14.9024
* 73	-3484507	41407	50387	195623	-3197090	1175653	13791775	11.7312
* 74	-1239940	212296	281873	194839	-550932	1069982	12170861	11.3748
* 75	-623784	82124	56577	309697	-175386	1018937	10976538	10.7725
* 76	-726339	204690	73738	313620	-134291	1091668	9750579	8.9318
* 77	-502936	100584	97317	301499	-3536	958401	8788642	9.1701
78	-463474	77434	75013	374772	63745	864672	7987715	9.2379
79	-356943	131629	141435	374121	290242	887228	7390729	8.3301

RR=05

YEAR	REVIS	EXTENS	FIELDS	POOLS	TOT_ADD	PROD	RESERVES	RP_RATIO
66	4534	33712	35570	500	74316	90241	1153917	12.7871
67	-101410	43526	124550	0	66666	84531	1136052	13.4395
68	-22560	987	34969	0	13396	96033	1053415	10.9693
69	-60927	0	266769	48972	254814	95234	1212995	12.7370
70	14671	1800	22700	19010	58181	88910	1182266	13.2973
* 71	-44791	1100	16200	2950	-24541	98513	1059212	10.7520
72	21250	2500	5500	17000	46250	108868	996594	9.1541
73	50381	3000	950	3050	57381	94659	959316	10.1344
* 74	-141297	11500	61000	6500	-62297	81595	815424	9.9936
75	-2320	23400	9650	7400	38130	67334	786220	11.6764
* 76	-111172	39080	2600	10350	-59142	62566	664512	10.6210
* 77	-69474	32200	16200	3670	-17404	68834	578274	8.4010
78	-14312	74300	6923	1720	68631	80745	566160	7.0117
79	23537	30050	13600	4550	132037	132275	535922	5.8267

* Negative revisions exceeded additions

TABLE 1: NON-ASSOCIATED GAS FOR TX ~~15:39 WEDNESDAY, APRIL~~

RR=06

YEAR	REVIS	EXTENS	FIELDS	POOLS	TOT_ADD	PROD	RESERVES	RP_RATIO
66	-45137	61137	84101	14894	114995	433576	4269941	9.8482
67	-43358	112247	1750	11852	82491	398221	3954211	9.9297
68	147245	53259	21236	13313	235053	350179	3839085	10.9632
69	239853	5387	17100	5744	268084	348030	3759139	10.8012
70	243880	0	8294	4543	256717	295202	3720654	12.6038
71	168697	0	42578	39184	250459	258075	3713038	14.3874
72	226588	153231	49420	3000	432239	244146	3901131	15.9787
73	-50614	56076	17000	21752	44214	226392	3718953	16.4271
74	-125197	168084	25775	27246	95908	216738	3598123	16.6013
*75	-863351	251767	2948	11777	-596859	207750	2793514	13.4465
76	97827	197807	86067	19034	400735	217204	2977045	13.7062
77	-280143	542415	69530	44652	376454	226505	3126994	13.8054
78	-110102	113134	50733	39779	93544	250892	2969646	11.8364
79	70568	453209	273450	77873	875100	300088	3544658	11.8121

RR=08

YEAR	REVIS	EXTENS	FIELDS	POOLS	TOT_ADD	PROD	RESERVES	RP_RATIO
66	59754	3149982	350633	6992	3567361	315773	11216203	35.5198
67	-864545	2438722	177370	19708	1771255	348829	12638629	36.2316
68	-324384	522763	173798	15567	387744	581697	12444686	21.3941
69	-779509	545118	225118	53025	43752	792285	11696153	14.7626
70	-1360746	1334591	173949	10425	158219	1097923	10756449	9.7971
71	25056	1341443	2985	32378	1401862	1248483	10909828	8.7385
72	40649	1197760	70821	57064	1366294	1510771	10765351	7.1257
73	73351	791211	326670	5891	1197123	1533476	10428998	6.8009
74	97399	474247	72032	56702	700380	1547329	9582049	6.1926
75	-195044	345330	37591	35169	223046	1329938	8475157	6.3726
*76	-584714	220957	20110	27719	-315898	1144390	7014869	6.1298
77	-94049	146275	48841	7030	108097	1073064	6049902	5.6380
78	144617	107428	17299	24420	193764	899794	5343872	5.9390
79	233534	76679	18398	10810	339421	805391	4877902	6.0566

RR=09

YEAR	REVIS	EXTENS	FIELDS	POOLS	TOT_ADD	PROD	RESERVES	RP_RATIO
66	334435	13825	994	628	349882	97879	1941190	19.8325
67	56998	0	0	0	56998	106041	1892147	17.8435
68	15864	1500	3170	0	20534	110381	1802300	16.3280
*69	-233512	27282	11000	0	-195230	113601	1493469	13.1466
70	43190	11180	1500	0	55870	123378	1425961	11.5577
*71	-20771	0	0	0	-20771	118847	1286343	10.8235
72	17408	0	5000	0	22408	110146	1198605	10.8820
*73	-1564	0	500	0	-1064	96876	1100665	11.3616
74	-8079	48984	995	0	41900	100866	1041699	10.3276
75	42793	298	9150	0	52241	97521	996419	10.2175
*76	-42162	0	1417	0	-40745	89378	866296	9.6925
77	6713	18424	5197	0	30334	90464	806166	8.9115
*78	-46683	13163	5272	22463	-5785	89169	711212	7.9760
79	4090	4286	3588	1417	13381	75978	648615	8.5369

* = NEGATIVE REVISIONS EXCEEDED ADDITIONS

DRAFT

RR=10

YEAR	REVIS	EXTENS	FIELDS	POOLS	TOT_ADD	PROD	RESERVES	RP_RATIO
66	72597	234498	270192	31156	578443	1022172	12137741	11.8745
67	898161	288558	91639	15551	1293909	1048675	12382975	11.8082
* 68	-612590	261701	37208	16559	-297122	1021057	11064796	10.8366
69	-252699	291108	26177	7797	72383	1017825	10119354	9.9421
70	389911	247048	86411	2297	725667	1192717	9652304	8.0927
71	641155	224182	57386	10927	933650	1127459	9458495	8.3892
72	470480	128570	54026	30002	683078	1109785	9031788	8.1383
73	457656	193067	99544	0	750267	1165979	8616076	7.3896
74	899412	354758	30199	11139	1295508	1189138	8722446	7.3351
75	283335	144635	146808	3747	578525	1113137	8187834	7.3556
76	592380	283928	11925	13295	902028	1085753	8004109	7.3719
77	-35070	418097	6682	6824	396533	1079207	7321435	6.7841
78	562633	289438	11282	23446	886799	960346	7247888	7.5472
79	160346	342093	21197	13059	536695	944372	6840211	7.2431

RR=7B

YEAR	REVIS	EXTENS	FIELDS	POOLS	TOT_ADD	PROD	RESERVES	RP_RATIO
66	20671	10345	4784	0	35800	48248	256739	5.32124
67	10423	24125	4540	0	39088	46065	249762	5.42195
68	47719	6920	2750	7450	66839	45315	271286	5.98667
69	18461	31306	0	100	49867	46043	275110	5.97507
70	10878	28324	3400	2550	45152	38780	281482	7.25843
71	1425	30434	200	3000	35059	38516	278025	7.21843
72	10831	24317	1600	0	36748	35922	278851	7.76268
73	-12503	22788	4100	1100	15485	34115	260221	7.62776
74	-21463	74206	5250	8820	66813	36651	290383	7.92292
75	-28546	51923	15060	1857	40294	40877	289800	7.08956
76	10971	163765	11900	2800	189436	50507	428729	8.48851
77	-15055	153308	4605	5804	148662	68184	509207	7.46813
78	-38189	94138	10281	12920	79150	77308	511049	6.61056
79	683	251187	16022	17916	285808	101294	695563	6.86677

RR=7C

YEAR	REVIS	EXTENS	FIELDS	POOLS	TOT_ADD	PROD	RESERVES	RP_RATIO
66	-67357	295249	50957	9293	288142	103734	2153969	20.7643
67	-14583	494894	85849	20155	586315	88169	2652115	30.0799
68	-50927	119311	9083	24727	102194	76019	2678290	35.2318
69	-78624	89842	4024	14219	29461	109962	2602789	24.7974
70	-85144	70105	16590	18910	20461	145900	2477350	16.9798
* 71	-369997	36301	4983	2515	-326198	144009	2007143	13.9376
* 72	-317326	195108	13588	1283	-107347	160067	1739729	10.8688
73	-65837	120863	16875	1197	73098	179805	1633022	9.0822
74	-87868	134296	8911	9528	64867	213275	1484614	6.9610
75	-88903	157949	1344	6861	77251	181276	1350589	7.6160
76	43843	172333	10016	1266	227458	191837	1416210	7.3824
77	-29588	32636	3614	829	7693	162549	1241354	6.8001
78	-15913	118704	10160	1397	114348	220787	1134915	5.1403
79	116805	494	5344	191	122744	209902	1047757	4.9916

* negative revisions exceeded additions

DRAFT

RR=8A

YEAR	REVIS	EXTENS	FIELDS	POOLS	TOT_ADD	PROD	RESERVES	RP_RATIO
66	3158	0	1591	0	4749	6482	114761	17.7046
67	982	7276	1070	156	9484	7735	116510	15.0627
68	5355	0	1171	0	6526	7105	115931	16.3168
69	-508	1970	0	0	1462	6786	110607	16.2993
* 70	-34251	1192	0	0	-33059	6709	70839	10.5588
71	358	13234	0	0	13592	7045	77386	10.9845
72	30059	0	0	0	30059	8080	99365	12.2976
* 73	-5203	0	0	0	-5203	8894	85268	9.5871
74	-6769	990	10890	0	5111	9272	81107	8.7475
* 75	-4329	1718	0	0	-2611	7553	70943	9.3927
76	6011	14791	7157	1336	29295	13217	87021	6.5840
77	939	2481	0	0	3420	10801	79640	7.3734
* 78	-4129	3340	0	0	-789	9553	69298	7.2541
79	12333	13762	0	0	26095	14044	81349	5.7924

* negative revisions exceeded additions

DRAFT

APPENDIX V

TABLE ASSOCIATED GAS FOR TX ~~15:19 WEDNESDAY, APRIL 4, 1984 16~~

RR=TX

YEAR	REVIS	EXTENS	FIELDS	POOLS	TOT_ADD	PROD	RESERVES	RP_RATIO	GOR_PROD	GOR_RESV
66	681662	274703	58071	155565	1170001	1908695	36973478	19.3711	1.91513	2.62649
67	1453299	229512	50029	121552	1854392	2005353	36822517	18.3621	1.90889	2.54052
*68	-2693934	131667	22910	70283	-2469074	1933095	32420348	16.7712	1.80845	2.34762
*69	-413249	152649	39507	31467	-189626	1993352	30237370	15.1691	1.80459	2.31470
70	162246	183116	37371	35170	417903	2113316	28541957	13.5058	1.75713	2.16301
71	-255742	271067	19432	42622	76379	2109142	26509194	12.5687	1.78322	2.03548
72	200500	161376	20934	36370	419180	2024893	24903481	12.2987	1.60944	2.05067
73	1218702	151343	11750	24142	1405937	2040439	24268979	11.8940	1.62158	2.06428
74	-73484	201899	24193	43148	195756	1791826	22672909	12.6535	1.46104	2.06089
*75	-1022666	189927	18082	49156	-765501	1665062	20242346	12.1571	1.41557	2.00816
*76	-2472073	198758	22574	25121	-2225620	1580587	16436219	10.3993	1.36399	1.78146
77	341088	239241	21710	38425	640464	1600673	15476010	9.6684	1.45908	1.82771
*78	-1212447	223751	33169	48872	-906655	1562180	13007175	8.3263	1.49500	1.69144
79	-15733	287048	22688	30242	324245	1439249	11892171	8.2628	1.46737	1.55737

RR=01

YEAR	REVIS	EXTENS	FIELDS	POOLS	TOT_ADD	PROD	RESERVES	RP_RATIO	GOR_PROD	GOR_RESV
66	19662	100	20	123	19905	10677	286812	26.8626	0.59825	2.04050
67	6488	504	253	407	7652	12893	281571	21.8391	0.69718	1.76606
*68	-4831	0	447	2010	-2374	13620	265577	19.4990	0.79677	1.77201
69	15657	0	202	0	15859	12481	268955	21.5492	0.73164	1.71128
70	1432	1077	172	9622	12303	13219	268039	20.2768	0.78242	1.74818
71	-6750	52660	82	1116	47108	16303	298844	18.3306	0.77915	1.90252
72	41708	71	686	2426	44891	22724	321011	14.1265	0.95947	2.17895
*73	-1332	0	24	184	-1124	23135	296752	12.8270	1.13574	2.05865
74	2906	1813	0	180	4899	16758	284893	17.0004	0.91714	2.13581
75	806	3652	475	582	5515	15947	274461	17.2108	0.91549	2.17039
*76	-52351	6869	1617	1413	-42452	19787	212222	10.7253	0.98184	1.53218
77	35175	4219	2150	1009	42553	22797	231978	10.1758	0.90504	1.94161
78	33749	338	4275	622	38984	24495	246467	10.0619	1.10752	2.23537
79	13497	0	1038	96	14631	21569	239509	11.0940	1.16101	2.47062

RR=02

YEAR	REVIS	EXTENS	FIELDS	POOLS	TOT_ADD	PROD	RESERVES	RP_RATIO	GOR_PROD	GOR_RESV
66	63427	130	1521	22586	87664	117318	2775387	23.6570	2.36996	2.95836
67	150461	3986	5266	5115	164728	108983	2831132	25.9777	1.92166	2.92951
*68	-195589	135	3740	2104	-189606	129777	2511749	19.3543	2.02530	2.75955
69	12730	0	9329	3882	25941	129297	2408393	18.6268	1.82121	2.71680
70	126588	0	3864	2284	132736	148686	2392443	16.0906	1.92369	2.83142
71	-13290	0	557	16858	4125	156389	2240179	14.3244	2.13087	2.85141
72	173699	1149	6652	7157	188657	150820	2278016	15.1042	1.90651	3.57747
73	158061	0	254	3392	161707	128580	2311143	17.9744	1.73032	3.41317
*74	-53823	212	1201	3491	-48989	144873	2117281	14.6147	2.10654	3.39915
*75	-132562	11	198	7969	-124384	139369	1853528	13.2994	2.14500	3.29104
76	88144	755	401	6289	95589	139064	1810053	13.0160	2.20796	3.60490
77	1880	1069	552	2926	6327	124343	1692037	13.6078	2.11195	3.68158
*78	-152716	2235	1872	7289	-141720	114903	1435414	12.4924	2.08003	3.75577
79	11328	275	2567	7198	21368	109589	1346213	12.2842	2.19780	3.81771

* negative revisions exceeded additions

DRAFT

RR=03

YEAR	REVIS	EXTENS	FIELDS	POOLS	TOT_ADD	PROD	RESERVES	RP_RATIO	GOR_PROD	GOR_RESV
66	-10656	7841	5608	3562	6355	360101	9152966	25.4178	2.85086	4.35790
* 67	-178554	9206	562	11746	-157040	374266	8621660	23.0362	2.66421	4.21539
* 68	-1723103	13184	1269	9210	-1699440	285356	6636864	23.2582	2.00286	3.42837
* 69	-178529	23795	1004	15540	-138190	291213	6207461	21.3159	2.00474	3.38387
70	54799	15078	1458	4952	76287	340594	5943154	17.4494	2.11970	3.52292
* 71	-67575	15022	2501	2212	-47840	332700	5562614	16.7196	2.14335	3.39471
72	83096	12115	1823	5115	102149	342565	5322198	15.5363	1.97811	3.46401
73	895741	15131	3542	3986	918400	399438	5841160	14.6234	2.35152	3.92175
* 74	-151164	5463	1527	5274	-138900	233561	5468699	23.4144	1.36973	4.04459
* 75	-97508	25646	1988	25786	-44088	344375	5080236	14.7520	2.13786	4.08189
* 76	-2183152	9832	1990	4369	-2166961	205421	2707854	13.1820	1.32327	2.63952
* 77	-125333	29575	223	7036	-88499	235888	2383467	10.1042	1.61136	2.56053
* 78	-82943	25330	2377	812	-54424	238582	2090461	8.7620	1.73265	2.60389
79	13559	35417	3630	1218	53824	201808	1942477	9.6254	1.70899	2.90275

RR=04

YEAR	REVIS	EXTENS	FIELDS	POOLS	TOT_ADD	PROD	RESERVES	RP_RATIO	GOR_PROD	GOR_RESV
* 66	-78300	706	18876	48469	-10249	302223	9001074	29.7829	3.7276	12.0151
67	31801	670	13167	74281	119919	320967	8800026	27.4172	3.6844	12.7246
* 68	-188232	6758	2918	14660	-163896	361923	8274207	22.8618	4.2098	12.9447
* 69	-58663	5307	9158	8177	-36021	388346	7849840	20.2135	4.7685	13.9215
* 70	-98920	12760	2013	9113	-75034	427461	7347345	17.1883	5.5378	13.9048
* 71	-262336	9302	1251	15959	-235824	462351	6649170	14.3812	6.8134	15.9965
* 72	-72233	2006	518	11978	-57731	421847	6169592	14.6252	7.1858	17.9478
* 73	-120430	575	0	12996	-106859	438293	5624440	12.8326	8.4973	18.4758
* 74	-114681	13749	74	18058	-82800	421207	5120433	12.1566	9.9007	21.5877
* 75	-301078	5276	97	8628	-287077	348727	4484629	12.8600	9.8394	23.1920
* 76	-523553	2442	1473	5747	-513891	406064	3564674	8.7786	13.7128	22.4471
77	524423	669	1262	21348	547702	444551	3667825	8.2506	17.9218	25.3511
* 78	-746477	2965	1039	30922	-713551	414548	2539726	6.1265	18.2067	20.7179
* 79	-267595	1309	1411	11091	-253784	344999	1940943	5.6259	16.2613	16.5581

RR=05

YEAR	REVIS	EXTENS	FIELDS	POOLS	TOT_ADD	PROD	RESERVES	RP_RATIO	GOR_PROD	GOR_RESV
* 66	-22357	300	68	101	-21888	24209	297981	12.3087	2.23495	1.82242
67	16	4959	1352	550	6877	22785	282073	12.3798	1.98199	1.81947
68	-670	4671	2347	0	6348	25656	262765	10.2419	2.09556	1.76675
* 69	-54118	6	442	0	-53670	25502	183593	7.1992	1.87446	1.36130
70	7390	40	6251	77	13758	17859	179492	10.0505	1.08204	1.40116
71	2756	1352	0	1113	5221	17095	167618	9.8051	1.01956	1.41683
* 72	-4701	0	0	1280	-3421	16820	147377	8.7620	0.83152	1.48921
73	28766	0	330	0	29096	17649	158824	8.9990	0.85746	1.25590
74	1165	130	1005	117	2417	17720	143521	8.0994	0.88702	1.29424
75	6144	0	50	12	6206	15024	134703	8.9659	0.77845	1.47592
76	2512	134	157	412	3215	12647	125271	9.9052	0.68090	1.62037
* 77	-18904	251	295	127	-18231	12008	95[illegible]32	7.9141	0.77078	1.50002
78	7254	1051	90	734	9129	11494	92667	8.0622	0.90632	1.70585
79	1236	1537	684	11	3468	12684	83421	6.5769	1.16271	1.85[illegible]92

* negative revisions exceeded additions

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PR=06

YEAR	REVIS	EXTENS	FIELDS	POOLS	TOT_ADD	PROD	RESERVES	RP_RATIO	GOR_PROD	GOR_RESV
66	75371	4044	1409	1438	82262	81075	2600512	32.0754	0.872056	0.926324
67	39582	0	9201	216	48999	84115	2565396	30.4987	0.832739	0.927931
68	4145	4460	160	4126	12891	77950	2500337	32.0762	0.716511	0.932985
* 69	-182232	3185	5579	357	-173110	89165	2238062	25.1002	0.756353	0.864023
* 70	-23428	584	96	3217	-19531	108445	2110386	19.4577	0.701596	0.844788
71	24143	2928	1242	158	28471	115092	2023465	17.5813	0.774669	0.857537
* 72	-131629	1044	890	5100	-124595	89560	1809310	20.2022	0.537756	0.819271
* 73	-17958	4981	80	0	-12897	83173	1713240	20.5985	0.509514	0.836034
* 74	-216565	470	792	544	-214759	69921	1428560	20.4311	0.452209	0.746507
75	30004	4837	1173	328	36342	56371	1408531	24.9868	0.383018	0.794034
* 76	-20342	3779	2416	268	-13879	55579	1339073	24.0931	0.391418	0.768212
* 77	-15109	8354	1898	0	-4857	49724	1284492	25.8324	0.387996	0.792723
78	7488	4032	708	3795	16023	50058	1250457	24.9802	0.423069	0.826511
* 79	-180689	13320	1148	3406	-162815	50023	1037619	20.7428	0.456298	0.818811

PR=08

YEAR	REVIS	EXTENS	FIELDS	POOLS	TOT_ADD	PROD	RESERVES	RP_RATIO	GOR_PROD	GOR_RESV
66	346170	136651	6608	28409	517838	502139	5990679	11.9303	1.17814	1.03561
67	1288571	41652	9527	6977	1346767	517812	6819634	13.1701	1.87080	1.87895
* 68	-361756	50053	4876	9004	-297823	528432	5993379	11.3418	1.92087	1.76596
69	2578	58602	2235	1374	64789	536982	5521186	10.2819	1.88811	1.74248
70	267720	73417	13883	1810	356830	530262	5347754	10.0851	1.82758	1.72126
71	-26173	146953	3257	2909	126946	497026	4977674	10.0149	1.74251	1.41051
72	146698	50949	6700	2581	206928	468616	4715986	10.0636	1.63029	1.38609
73	78814	45136	2687	1761	128398	476928	4367456	9.1575	1.72311	1.36247
74	409551	34043	1881	3408	454883	441501	4380838	9.9226	1.66045	1.42954
75	-46229	102281	6221	799	63072	377930	4065980	10.7586	1.53040	1.39132
76	72070	92144	121	2633	166968	368228	3864720	10.4955	1.44925	1.42607
* 77	-77492	70504	1162	1655	-4171	353119	3507430	9.9327	1.41797	1.37003
* 78	-273433	67945	1782	2004	-201702	355293	2950435	8.3042	1.41673	1.23454
79	184209	95792	2557	557	283115	343053	2890497	8.4258	1.39332	1.27200

RR=09

YEAR	REVIS	EXTENS	FIELDS	POOLS	TOT_ADD	PROD	RESERVES	RP_RATIO	GOR_PROD	GOR_RESV
66	133	15590	4018	3683	23424	124503	819417	6.58150	1.83168	1.95969
67	63470	8989	2712	2584	97755	124743	792429	6.35249	1.85150	1.83172
* 68	-301313	240	2465	808	-297800	65082	429547	6.60009	1.08344	1.17284
69	44026	11270	2630	260	58186	67794	419939	6.19434	1.17761	1.25143
70	61003	8464	1980	671	72118	64562	427495	6.62146	1.19783	1.17619
71	8874	7253	1203	661	17991	60364	385122	6.37999	1.17259	1.08178
72	1812	15653	494	158	18117	52960	350279	6.61403	1.08040	1.08105
73	76277	7878	1947	116	86218	46589	389908	8.36910	1.01344	1.07204
74	11925	683	2903	4086	19597	45121	364384	8.07571	1.07173	0.98530
* 75	-27168	5030	2521	3100	-16517	38322	309545	8.07748	1.01228	1.01653
76	49352	14752	9393	1010	74507	42660	341392	8.00263	1.15500	1.27174
77	-8395	9254	3056	2373	6328	41574	306146	7.36388	1.16975	1.35429
78	-13792	9026	4753	1700	1687	42629	265204	6.22121	1.25100	1.41281
79	23652	17851	3194	2531	46628	43967	267865	6.09241	1.35304	1.26436

* negative revisions exceeded additions

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TABLE 2: ASSOCIATED GAS FOR TX

RR=10

YEAR	REVIS	EXTENS	FIELDS	POOLS	TOT_ADD	PROD	RESERVES	RP_RATIO	GOR_PROD	GOR_RESV
66	11819	42832	9303	3135	67089	67111	826776	12.3195	1.96277	2.83562
67	-12691	41874	2447	1691	33321	72855	787242	10.8056	2.20887	2.85781
68	-18361	20158	995	1392	4184	81151	710275	8.7525	2.56620	2.74465
69	-13254	14083	3058	75	3962	103025	611212	5.9327	3.55639	2.60126
* 70	-94039	8863	50	676	-84450	86421	440341	5.0953	3.18427	2.02054
71	1133	5938	0	0	7071	81124	366288	4.5152	3.27337	1.82919
72	42212	4116	400	308	47036	85852	327472	3.8144	3.76759	1.64725
73	107833	3690	747	735	113005	70633	369844	5.2361	3.43730	2.17097
74	9567	14769	828	1084	26248	63899	332193	5.1987	3.27033	1.96714
75	8234	14799	371	1855	25259	54382	303070	5.5730	3.01703	1.95894
76	22366	31044	1979	122	55511	55606	302975	5.4486	3.04891	2.06562
77	11377	23887	680	462	36406	54110	285271	5.2721	3.20083	2.15067
78	4591	15236	7171	119	27117	49706	262682	5.2847	3.17976	1.94276
79	51562	41872	1410	2521	97365	55411	304636	5.4978	3.46275	2.00825

RR=7B

YEAR	REVIS	EXTENS	FIELDS	POOLS	TOT_ADD	PROD	RESERVES	RP_RATIO	GOR_PROD	GOR_RESV
66	14919	8288	3536	2318	29061	55947	596647	10.6645	1.40850	2.13247
* 67	-80121	5684	1803	926	-71708	62006	462933	7.4659	1.59464	1.75430
68	45413	12541	1505	1005	60464	54377	469020	8.6253	1.48425	1.94823
69	52533	816	3020	138	56507	48690	476837	9.7933	1.27799	1.96679
70	-9205	14669	408	1727	7599	47910	436526	9.1114	1.27275	1.82798
* 71	-87550	13246	2532	81	-71691	47857	316978	6.6234	1.31508	1.51322
72	32115	51614	1003	142	84874	47801	354051	7.4068	1.29272	1.50046
73	31819	22121	877	158	54975	44975	364051	8.0945	1.26694	1.54344
74	-25129	34354	10408	0	19633	41331	342353	8.2832	1.15948	1.36730
75	-23378	24951	2537	0	4110	41990	304473	7.2511	1.22324	1.33674
76	-3109	30483	1269	2804	31447	41491	294429	7.0962	1.23743	1.43965
77	-23496	69018	9262	960	55744	46188	303985	6.5815	1.44668	1.51053
78	-7679	66043	8961	0	67325	46330	324980	7.0145	1.59171	1.72018
79	-26121	58352	3539	1400	37170	47305	314845	6.6556	1.71949	1.86003

RR=7C

YEAR	REVIS	EXTENS	FIELDS	POOLS	TOT_ADD	PROD	RESERVES	RP_RATIO	GOR_PROD	GOR_RESV
66	-39966	20954	5250	39232	25470	93041	970145	10.4271	1.86078	2.40172
67	274764	108904	3024	15642	402334	132052	1240427	9.3935	2.49150	3.24606
68	71201	18986	2155	25617	117959	121502	1236884	10.1799	2.51406	3.42454
69	-5371	31278	2104	1103	29114	104684	1161314	11.0935	2.34507	3.33373
70	10920	45245	6315	956	63436	101250	1123500	11.0963	2.47749	3.76358
71	15515	13730	4881	1408	35534	93869	1065165	11.3474	2.63914	4.23855
* 72	-155498.	21052	1413	60	-132973	91589	840603	9.1780	2.62312	3.51320
73	-6391	47579	936	0	42124	86803	795924	9.1693	2.57209	3.88263
74	6421	93475	3520	25	103441	82364	817001	9.9194	2.79039	4.09346
* 75	-37297	144	2124	1	-35028	77627	704346	9.0735	2.81176	3.80247
76	3583	3271	1646	0	8500	76330	636516	8.3390	2.86685	3.47595
77	5007	18059	870	437	24373	75127	585762	7.7970	2.71119	3.37263
78	5617	25611	575	905	32708	76054	542416	7.1320	2.69752	3.26100
79	35433	15698	1228	38	52397	79731	515072	6.4601	2.31407	3.10947

* negative revisions exceeded additions

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RR=BA

YEAR	REVIS	EXTENS	FIELDS	POOLS	TOT_ADD	PROD	RESERVES	RP_RATIO	GOR_PROD	GOR_RESV
66	302440	37267	1854	2509	344070	170351	3655082	21.4562	.	.
* 67	-150488	3144	715	1417	-145212	171876	3337994	19.4209	1.03418	1.22355
* 68	-20638	277	33	347	-19981	188269	3129744	16.6238	1.00939	1.14832
* 69	-48606	4306	746	561	-42993	196173	2890578	14.7348	0.95847	1.12641
* 70	-142014	2919	881	65	-138149	226647	2525782	11.1441	0.90701	0.80687
71	155511	2683	926	147	159267	228972	2456077	10.7265	0.85880	0.81799
72	43221	1607	355	65	45248	233739	2267586	9.7014	0.76499	0.81174
* 73	-12499	4253	326	814	-7106	224243	2036237	9.0805	0.64846	0.73106
74	46413	2738	54	881	50086	213570	1872753	8.7688	0.59490	0.72638
* 75	-402634	3300	327	96	-398911	154998	1318844	8.5088	0.42339	0.57525
76	72407	3253	112	54	75826	157630	1237040	7.8477	0.43692	0.59826
77	31955	4342	300	192	35789	141244	1132585	8.0186	0.41920	0.59797
78	7464	3939	366	0	11769	138088	1006266	7.2871	0.43381	0.59400
79	125036	6425	262	175	131898	129090	1009074	7.8168	0.42747	0.47667

* negative revisions exceeded additions.

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APPENDIX VI-A
LARGEST FIELDS
DISTRICT 2

County	Name of field	Year disc.	1968-1980 (Bcf)	Cum. gas well gas 1983 (MMcf)	Formation	1983 Prod. gas well gas (MMcf)	Depth
Calhoun/Jackson	Appling	1935	27	348,698	Frio Wilcox	982	6,000-9,300 8,000-9,000
De Witt	Arneckeville	1950	30	75,209	Yegua	670	5,000
Refugio/Bee	Blanconia	1943	12	61,598	Frio	354	2,000-5,000
Lavaca	Borchers	1953	79	86,706	Frio	1,415	1,500-4,700
Bee/Karnes	Burnell	1944	204	461,227	Wilcox	1,869	6,000-7,500
Live Oak	Clayton	1944	54	221,103	Wilcox	1,454	8,000
Victoria	Cologne	1939	DNA*	76,294	Miocene Frio	568	500-4,500
De Witt	Cook, South	1963	46	79,202	Lower Wilcox		1,063
Live Oak	Elms	1957	30	64,054	Wilcox	347	6,900-7,900
Refugio	Fagan	1940	49	83,211	Frio	857	2,000-5,500
Jackson	Francitas	1938	DNA	146,222	Frio	356	7,300-8,600
Jackson	Ganado	1937	DNA	126,783	Miocene Frio	347	3,600-4,100 5,700-7,700
Live Oak	George West, W	1953	21	61,102	Wilcox	14,559	7,300-7,600
Refugio	Greta	1933	DNA	778,317	Miocene	2,641	1,500-5,000
Live Oak	Harris	1947	DNA	112,570	Wilcox	806	7,300-8,600
Bee	Heard Ranch	1939	145	235,532	Frio	2,512	4,700-8,000
De Witt/Victoria	Helen Gohlke	1950	75	122,145	Wilcox	1,009	1,300-8,200
Victoria	Helen Gohlke, SW	1953	32	63,864	Wilcox	313	8,500-8,600

County	Name of field	Year disc.	1968-1980 (Bcf)	Cum. gas well gas 1983 (MMcf)	Formation	1983 Prod. gas well gas (MMcf)	Depth
Calhoun/Victoria	Heyser	1936	208	541,833	Frio (Greta)	12,308	4,300-8,200
Refugio/Victoria	Huff	1951	DNA	143,546	Miocene (Frio)	1,475	3,400-5,200
Goliad	Karon	1957	75	126,681	Wilcox	6,039	7,000-7,500
Live Oak	Katz Slick	1959	DNA	67,720	Wilcox	140	10,500
Jackson	La Ward, North	1941	DNA	108,180	Upper Frio	132	4,600
Refugio	Lake Pasture	1939	293	507,985	Frio	19,374	4,500-5,100
Calhoun	Magnolia Beach-Kellers Bay	1952	103	233,972	Frio	1,278	7,600-8,800
Calhoun	Matagorda Bay	1947	31	75,517	Miocene	419	4,300-4,500
Calhoun/Jackson	Maude B. Traylor, N	1957	38	87,450	Frio	341	8,800-9,300
Jackson	Mayo	1942	DNA	74,685	Frio	499	3,300-5,300
Refugio/Victoria	McFaddin	1930	155	261,249	Miocene	1,432	1,800-2,700
Victoria	McFaddin, North	1962	29	83,821	Miocene Frio	237	3,700-5,300
Jackson/Lavaca	Morales, North	1953	DNA	83,064	Frio Wilcox	581	3,600-10,000
Bee	Normanna	1930	82	177,496	Wilcox	1,236	8,800-9,600
Live Oak	Oakville-Wilcox	1946	DNA	68,774	Wilcox	144	6,800-7,500
Victoria	Placedo	1935	DNA	86,040	Frio	138	4,000-6,000
Lavaca	Provident City	1941	188	411,325	Yegua Wilcox	8,617	8,400-13,500
Bee	Ray-Wilcox	1943	DNA	69,231	Wilcox	338	7,700-8,200
Goliad	Sarco Creek	1938	37	70,074	Frio	1,549	2,800-4,700
Lavaca	Speaks, SW	1949	DNA	91,289	Wilcox	1,515	8,000-9,900

County	Name of field	Year disc.	1968-1980 (Bcf)	Cum. gas well gas 1983 (MMcf)	Formation	1983 Prod. gas well gas (MMcf)	Depth
Jackson	Texana	1939	DNA	75,190	Frio	271	5,300-6,600
Live Oak	Tom Lune	1948	DNA	61,729	Queen	418	6,000±
Refugio	Tom O'Connor	1934	262	660,643	Frio	6,795	2,500-6,500
Bee	Tuleta, West	1937	31	74,696	Wilcox	835	7,500-9,500
Goliad/Karnes	Tulsita Wilcox	1945	208	456,872	Wilcox	1,914	6,600-7,100
Jackson	West Ranch	1938	118	216,815	Miocene Upper Frio	5,572	3,500-6,000
Lavaca	Word, North	1944	47	97,692	Wilcox Edwards	21,168	7,000-14,000
De Witt	Yorktown	1942	71	82,131	Wilcox	609	
	46 Fields			8,299,537		127,496	
	Total District 2			13,271,025		333,942	
	*DNA: data not available			62.5%		38.2%	

From field data sheets (playout)
Fields with less than 60 Bcf cum. prod.
(12/83) Prod. total = 88,073 MMcf 1983 = 26.4% of
District 2 annual prod. 1983 = 333,942 MMcf

From field data sheets (playout)
Fields with more than 60 Bcf cum. prod.
(12/83) Prod. total = 117,127 = 35.1% of
District 2 annual prod. 1983 = 333,942 MMcf

APPENDIX VI-B
LARGEST FIELDS
DISTRICT 3

County	Name of field	Year disc.	1968-1980 (Bcf)	Cum. gas well gas 1983 (MMcf)	Formation	1983 Prod. gas well gas (MMcf)	Depth
Galveston	Alta Loma, W	1956	DNA*	63,845	Frio	212	12,000±
Brazoria	Alvin, South	1956	DNA	96,784	Frio	826	9,400-11,000
Chambers	Anahuac	1935	118	193,935	Frio Miocene	3,288	1,600-8,800
Harris	Bammel	1938	DNA	151,568	Cockfield	11	6,200-7,000
Matagorda	Bay City, East	1936	DNA	419,697	Frio	1,159	8,500-10,000
Wharton	Bernard, West	1947	DNA	94,855	Frio Yegua	748	2,700-7,600
Jefferson	Big Hill	1949	DNA	212,241	Miocene Frio	1,250	8,500-10,000
Jefferson	Big Hill, West	1952	DNA	83,010	Marginulina	432	7,600-8,100
Matagorda	Blessing	1940	37	126,055	Frio	441	8,250-10,500
Offshore State	Brazos Blk 386-S	1972	52	65,163	Miocene	2,564	7,700-10,500
Offshore State	Brazos Blk 405 B	1966	DNA	158,346	Miocene	1,736	7,800-10,800
Offshore State	Brazos Blk 440	1966	DNA	153,074	Miocene	1,868	6,700-8,500
Offshore State	Brazos Blk 446	1966	DNA	81,970	Miocene	1,476	7,000-9,400
Matagorda	Cavallo	1980	43	94,642	Marginulina	3,697	8,000-12,000
Colorado	Chesterville	1945	DNA	106,569	Wilcox	1,024	6,000-9,700
Brazoria	Chocolate Bayou	1941	123	883,165	Frio	1,770	9,500-11,500
Brazoria	Chocolate Bayou, South	1960	DNA	75,600	Frio	1,130	11,700-13,600
Brazoria	Clemens, North	1963	91	82,662	Frio	950	9,800-11,600

County	Name of field	Year disc.	1968-1980 (Bcf)	Cum. gas well gas 1983 (MMcf)	Formation	1983 Prod. gas well gas (MMcf)	Depth
Matagorda	College Port	1939	159	325,399	Miocene	5,455	2,200-5,600
Colorado	Columbus	1944	DNA	240,166	Wilcox	2,373	7,300-9,700
Montgomery	Conroe	1931	DNA	133,311	Cockfield	276	4,600-5,000
Offshore State	Cove	1967	DNA	128,234	Miocene	916	7,600-8,600
Matagorda	El Gordo	1976	82	126,769	Miocene	11,308	11,900-13,000
Chambers	Fishers Reef	1940	118	165,994	Frio	3,300	8,000-8,700
Madison	Fort Trinidad	1970	140	173,906	Glen Rose	2,214	10,200-11,000
Galveston	Franks	1953	DNA	79,258	Frio	953	10,500-11,500
Galveston	Galveston Island	1949	62	78,347	Miocene	2,975	7,700-8,800
Lee	Giddings	1960	24	101,494	Austin Chalk	19,919	7,000-10,000
Galveston	Gillock, South	1948	DNA	106,470	Frio	5,444	7,500-9,000
Hardin	Hampton, South	1952	DNA	100,082	Yegua	109	7,600-8,100
Jefferson	Hamshire, West	1950	DNA	67,362	Frio	390	11,300-12,800
Offshore State	High Isl Blk 14L	1971	125	148,096	Miocene	6,238	9,300-10,400
Offshore State	High Isl Blk 24L	1969	478	288,686	Miocene	5,994	7,400-12,800
Offshore Fed	High Isl Blk 160	1966	309	308,684	Miocene	0	DNA
Galveston	Hitchcock, NE	1957	DNA	85,955	Frio	738	7,000-9,000
Fort Bend Harris/Waller	Katy	1935	4,219	6,381,834	Wilcox	165,757	5,500-10,500
Galveston	Lafittes Gold	1971	52	61,881	Miocene	3,452	8,000-10,000
Colorado/Wharton	Lissie	1954	DNA	64,572	Wilcox	538	9,400-9,700
Brazoria	Lochridge	1936	DNA	62,959	Miocene	175	4,700-6,200
Wharton	Louise, North	1943	DNA	76,254	Miocene Frio	396	2,200-4,600

County	Name of field	Year disc.	1968-1980 (Bcf)	Cum. gas well gas 1983 (MMcf)	Formation	1983 Prod. gas well gas (MMcf)	Depth
Jefferson	Lovells Lake	1938	135	179,802	Frio	555	7,600-7,800
Grimes/Madison	Madisonville	1946	DNA	139,120	Clarksville	1,679	8,200-9,300
Matagorda/Wharton	Magnet-Withers	1936	487	895,784	Miocene Upper	6,435	3,000-6,600
Brazoria	Manor Lake	1955	DNA	120,661	Frio	107	9,800-10,000
Matagorda	Markham, North Bay City, North	1938	DNA	363,719	Frio	454	8,500-8,600
Jefferson	Marrs McLean	1954	DNA	281,070	Frio	852	9,800-11,200
Harris	Milton, North	1963	DNA	139,381	Wilcox	3,482	9,800-13,100
Brazoria	Old Ocean	1934	1,472	2,595,675	Frio	51,268	9,300-10,800
Matagorda	Palacios	1937	DNA	215,438	Frio	962	7,800-8,900
Matagorda	Pheasant	1956	DNA	108,077	Frio	185	8,700-9,100
Matagorda	Pheasant, SW	1959	DNA	81,011	Frio	1,044	11,200-11,700
Brazoria	Pledger	1925	892	1,472,044	Miocene Frio	4,462	4,600-7,700
Galveston	Point Bolivar, N	1966	281	341,744	Frio	8,648	12,200-13,000
Jefferson	Port Acres	1957	DNA	290,522	Frio	109	9,200-10,600
Jefferson	Port Arthur	1958	DNA	74,191	Frio	0	12,000
Jefferson Orange	Port Neches, N	1946	67	344,733	Frio Hack	887	7,900-8,500
Liberty	Raywood	1953	DNA	107,215	Yegua	1,009	10,600-11,700
Chambers	Redfish Reef	1940	209	266,158	Frio Miocene	5,742	3,000-11,000
Chambers	Redfish Reef, SW		1951DNA		106,027	Frio	704
Austin	Sealy	1942	DNA	60,686	Wilcox	568	8,600-10,700
Colorado	Sheridan	1940	745	1,330,171	Wilcox	12,104	8,000-10,800

County	Name of field	Year disc.	1968-1980 (Bcf)	Cum. gas well gas 1983 (MMcf)	Formation	1983 Prod. gas well gas (MMcf)	Depth
Galveston	Shipwreck	1976	125	143,458	Frio	2,316	8,000-12,500
Hardin	Silsbee	1936	DNA	74,672	Yegua	249	7,000-8,000
Matagorda	Sugar Valley	1946	DNA	68,782	Frio	641	8,700-10,200
Brazoria	Sweeney	1958	DNA	64,880	Frio	414	11,600-11,700
Galveston	Texas City Dike	1975	59	67,938	Frio	1,093	10,100-10,500
Harris	Tomball	1954	130	207,095	Miocene Vicksburg	5,243	3,300-5,500
Chambers	Trinity Bay	1950	87	145,336	Frio	947	7,000-8,300
Matagorda	Wadsworth	1951	DNA	108,364	Frio	749	9,600
Chambers	Willow Slough	1937	DNA	169,262	Frio	726	8,100-8,400
	70 Fields			23,011,910		377,136	
	Total District 3			29,857,288		697,113	
	*DNA: data not available			77%		54%	

From field data sheets (playout)
Fields with less than 60 Bcf cum. prod.
(12/83) Prod. 1983 = 44,045 MMcf = 6.3%
Dist 3 annual prod. 1983 = 697,112 MMcf

From field data sheets (playout) - fields with more than 60 Bcf cum. production 12/83
1983 Annual prod. = 339,022 MMcf = 48.6%
Dist 3 annual prod. 1983 = 697,112 MMcf

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APPENDIX VI-C
LARGEST FIELDS
DISTRICT 4

County	Name of field	Year disc.	1968-1980 (Bcf)	Cum. gas well gas 1983 (MMcf)	Formation	1983 Prod. gas well gas (MMcf)	Depth
Nueces	Agua Dulce	1928	DNA*	957,097	Frio	11,270	52-89
Kleberg	Alazan, North	1958	897	1,230,397	Frio	8,439	89-195
Nueces	Arnold-David	1960	56	74,989	Frio	2,990	9,200-10,600
Kleberg	Borregos	1945	1,401	1,791,840	Frio Vicksburg	35,725	50-70 75-82
Nueces	Brayton	1944	DNA	99,839	Frio	508	6,600-7,000
Brooks	Cage Ranch	1946	DNA	68,095	Frio Vicksburg	881	6,900-8,000
Kenedy	Calandria	1952	39	104,761	Frio 100%	20,973	
Kenedy	Candelaria	1954	DNA	74,401	Frio 100%	3,327	8,600
Nueces	Chapman Ranch	1941	DNA	84,646	Catahoula Upper Frio	476	3,000-4,200
Kleberg	Chevron	1954	DNA	205,863	Miocene 35% Frio 65%	250	6,400-7,200 7,500-9,500
Aransas	Copano Bay, S	1962	DNA	73,850	Frio	336	7,000-9,000
Nueces	Corpus Channel, NW	1956	DNA	68,089	Frio	248	8,800-11,100
Nueces	Corpus Christi, E	1953	DNA	70,075	Frio	86	6,200-6,300
Hidalgo	Donna	1949	DNA	164,034	Frio	3,047	5,200-8,100
Kenedy	El Paistle, Deep	1964	87	98,230	Frio	2,595	13,600-14,450
Nueces	Encinal Channel	1965	126	146,078	Frio	1,593	8,800-11,000
Brooks	Encinitas	1940	64	80,509	Vicksburg	1,442	8,200-8,500

County	Name of field	Year disc.	1968-1980 (Bcf)	Cum. gas well gas 1983 (MMcf)	Formation	1983 Prod. gas well gas (MMcf)	Depth
Nueces	Flour Bluff	1936	331	199,723	Frio 100%	1,521	6,000-7,000
Nueces	Flour Bluff, Deep, East	1940	DNA	171,483	Frio	1,220	9,300-9,900
Nueces	Flour Bluff, E	1940	DNA	138,112	Frio	709	6,600-9,300
Aransas	Fulton Beach	1947	DNA	151,648	Frio	330	6,900-7,100
Aransas	Fulton Beach, W	1951	DNA	106,232	Frio	321	6,100-6,500
(Nueces) Offshore State	GOM-State 904	1957	DNA	90,331	Frio	4	7,700-8,900
Duval	Government Wells, North	1928	DNA	74,927+	Frio/Yegua-Jackson Wilcox >90%	578	7,600-8,200
Duval	Hagist Ranch	1932	108	254,059	Frio 20% Wilcox 80%	5,030	Shallow:750-2,100 > 7,000-10,000
Hidalgo	Hidalgo	1951	DNA	220,258	Frio	1,826	6,000-7,000
Cameron	Holly Beach	1960	69	108,414	Miocene	400	7,100-7,800
Zapata	J.C. Martin	1974	186	262,338	Lower Wilcox Lobo	21,992	6,700-9,800 most 8,000-9,000
Hidalgo	Jeffress	1960	149	176,864	Vicksburg	9,216	8,100-12,700
Brooks/Jim Hogg	Kelsey	1938	DNA	125,273	Frio	797	4,600-5,000
Starr Brooks/Jim Hogg	Kelsey, Deep	1944	141	172,344	Frio/Vicksburg Jackson	3,830	5,000-7,800
Starr Brooks/Jim Hogg	Kelsey, South	1938	262	128,172	Frio Vicksburg	1,848	5,300-7,200
Hidalgo	La Blanca	1936	151	273,177	Frio	2,726	6,500-9,500
Starr	La Copita	1948	52	106,446	Vicksburg	5,067	7,400-9,400
Brooks/Jim Wells	La Gloria	1939	672	1,378,697	Frio Vicksburg	6,861	5,700-6,200
Kleberg/Nueces	Laguna Larga	1949	539	666,425	Frio	31,714	6,000-9,000

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County	Name of field	Year disc.	1968-1980 (Bcf)	Cum. gas well gas 1983 (MMcf)	Formation	1983 Prod. gas well gas (MMcf)	Depth
Zapata	La Perla Ranch	1958	15	73,768	Wilcox Queen	18,205	2,400-9,700
Hidalgo/Starr	La Reforma	1938	DNA	68,920	Frio Vicksburg	612	5,500-8,500
Webb	Laredo	1973	243	363,242	Lower Wilcox Lobo	32,959	5,200-9,200
Willacy	La Sal Vieja	1945	DNA	72,829	Frio	2,005	8,600-11,500
Brooks	Loma Blanca	1962	77	118,374	Frio Vicksburg	1,002	8,900-9,200
Zapata	Lopeno	1934	DNA	117,504	Queen Wilcox	1,581	2,000-10,300
Nueces	Luby	1937	DNA	275,788	Catahoula Frio	1,673	3,800-9,000
Duval/Webb	Lundell	1937	DNA	129,001	Queen Wilcox	2,647	1,500-8,100
Kleberg	Madero	1963	61	73,984	Frio	4,057	9,500
Kleberg	Madero, East	1968	85	91,894	Frio	947	9,100-9,500
Brooks	Mariposa	1945	DNA	69,159	Frio Vicksburg	498	8,900
Kleberg	May	1955	57	151,875	Frio	313	8,000-9,400
Hidalgo	McAllen	1938	129	374,653	Frio (Vicksburg)	2,104	5,700-10,400
Hidalgo	McAllen Ranch	1960	413	595,271	Vicksburg	22,228	9,300-14,200
Hidalgo	McCook, East	1970	55	73,646	Vicksburg	4,459	12,000-14,000
Hidalgo	Mercedes	1935	DNA	108,384	Frio	1,654	6,700-10,200
San Patricio	Midway, East	1960	127	84,906	Frio	5,840	9,200-13,000
Nueces	Mobil-David	1965	129	170,777	Frio	736	9,200-13,000

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County	Name of field	Year disc.	1968-1980 (Bcf)	Cum. gas well gas 1983 (MMcf)	Formation	1983 Prod. gas well gas (MMcf)	Depth
Hidalgo	Monte Christo	1953	62	168,248	Frio	18,159	7,400-9,500
Kenedy	Murdock Pass	1952	101	193,947	Marginulina Frio	669	7,200-7,300
Nueces	Mustang Island	1949	DNA	131,394	Frio	1,092	7,000-7,500
Aransas	Nine Mile Point	1965	DNA	62,762	Frio	2,123	10,900-11,900
San Patricio	Odem	1939	DNA	108,535	Miocene Frio	4,908	2,100-7,000
Nueces	Petronilla	1941	DNA	78,675	Frio	295	7,500-8,000
Hidalgo	Pharr	1949	DNA	167,430	Frio	701	9,700-10,600
Duval	Piedre Lumbre	1935	DNA	84,139	Jackson Wilcox	478	6,900-7,400
Brooks	Pita	1946	DNA	92,429	Frio	170	8,000-8,300
Brooks	Pita, NW	1975	68	79,504	Upper Frio Miocene	2,219	5,500-7,800
San Patricio	Plymouth	1935	DNA	61,891	Frio	494	1,400-5,600
Nueces	Redfish Bay-Mustang Island	1949	98	393,843	Frio	1,836	6,800-7,200
Starr	Rincon	1938	DNA	81,000	Frio	1,356	3,300-4,200
Starr	Rincon, North	1940	125	274,769	Frio Vicksburg	3,841	2,900-8,300
Kenedy	Rita	1949	112	128,180	Miocene Frio	4,408	-12,900
Kleberg	Samedan	1979	DNA	86,890	Frio	22,726	5,000-8,900 10,300-12,100
Hidalgo	San Carlos	1953	DNA	235,046	Frio	1,121	7,100-7,800
Brooks/Hidalgo	San Salvador	1935	DNA	256,529	Frio	2,914	6,100-9,000
Brooks	Santa Fe, East	1959	DNA	94,505	Frio	2,578	7,900-8,400

County	Name of field	Year disc.	1968-1980 (Bcf)	Cum. gas well gas 1983 (MMcf)	Formation	1983 Prod. gas well gas (MMcf)	Depth
Hidalgo	Santellana, S	1957	DNA	66,753	Frio Vicksburg	353	7,900-8,500
Kenedy/Kleberg	Sarita	1948	187	228,785	Miocene Frio	4,686	1,900-8,300
Kenedy	Sarita, East	1967	DNA	74,269	Frio	1,439	1,200-1,500
Nueces	Saxet	1923	DNA	117,943	Miocene Frio	936	1,600-4,000
Jim Wells/Kleberg	Seeligson	1938	976	1,391,384	Frio Vicksburg	24,897	4,300-7,400
Duval	Sejita	1942	113	253,545	Yegua Jackson	3,833	5,200-7,300
Duval	Seven Sisters, E	1961	DNA	127,366	Wilcox	38,929	9,400-10,100
Kenedy	Stillman	1961	124	186,102	Frio	6,474	5,600-12,500
Jim Wells Kleberg/Nueces	Stratton	1937	1,244	1,512,301	Frio Vicksburg	21,757	4,000-8,300
Starr	Sun	1938	DNA	109,724	Frio	2,259	3,800-5,100
Starr	Sun, North	1941	DNA	111,164	Frio Vicksburg	5,658	3,900-5,500
Hidalgo	Tabasco	1952	148	153,861	Frio	5,167	5,800-8,600
Jim Hogg/ Webb	Thompsonville, NE	1959	357	589,026	Wilcox	4,608	7,400-12,700
Jim Wells/Kleberg	Tijerina-Canales- Blucher (TCB)	1942	347	469,150	Vicksburg	Frio 12,366	6,800-11,200
Brooks	Viboras	1949	DNA	1,837,236	Frio	46,181	6,300-7,500 8,000-8,800
Nueces/San Patricio	White Point, East		1938	83	Miocene/Frio/ 242,639	Vicksburg	4,397
Willacy	Willamar West	1941	DNA	102,234	Miocene	410	4,900-6,300

County	Name of field	Year disc.	1968-1980 (Bcf)	Cum. gas well gas 1983 (MMcf)	Formation	1983 Prod. gas well gas (MMcf)	Depth
Kleberg	Yeary	1953	82	173,254	Frio	1,373	8,300-10,700
Jim Wells/Kleberg	Zone 21-B, Trend	1974 (created)	969	2,288,620	Frio Vicksburg	48,687	6,300-7,300
	92 fields			26,029,763		600,194	
	Total District 4:			33,747,030		981,353	
	*DNA: data not available			77.1%		61.2%	

From field data sheets (playout)
Fields with less than 60 Bcf cum. prod. (12/83)
Annual prod. these fields = 53,289 MMcf = 5.4%
Annual prod. District 4 1983 = 981,353 MMcf

From field data sheets (playout)
Fields with more than 60 Bcf cum. prod. (12/83)
Annual prod. these fields 1983 = 425,789 MMcf = 43.4%
Annual prod. District 4 1983 = 981,353 MMcf

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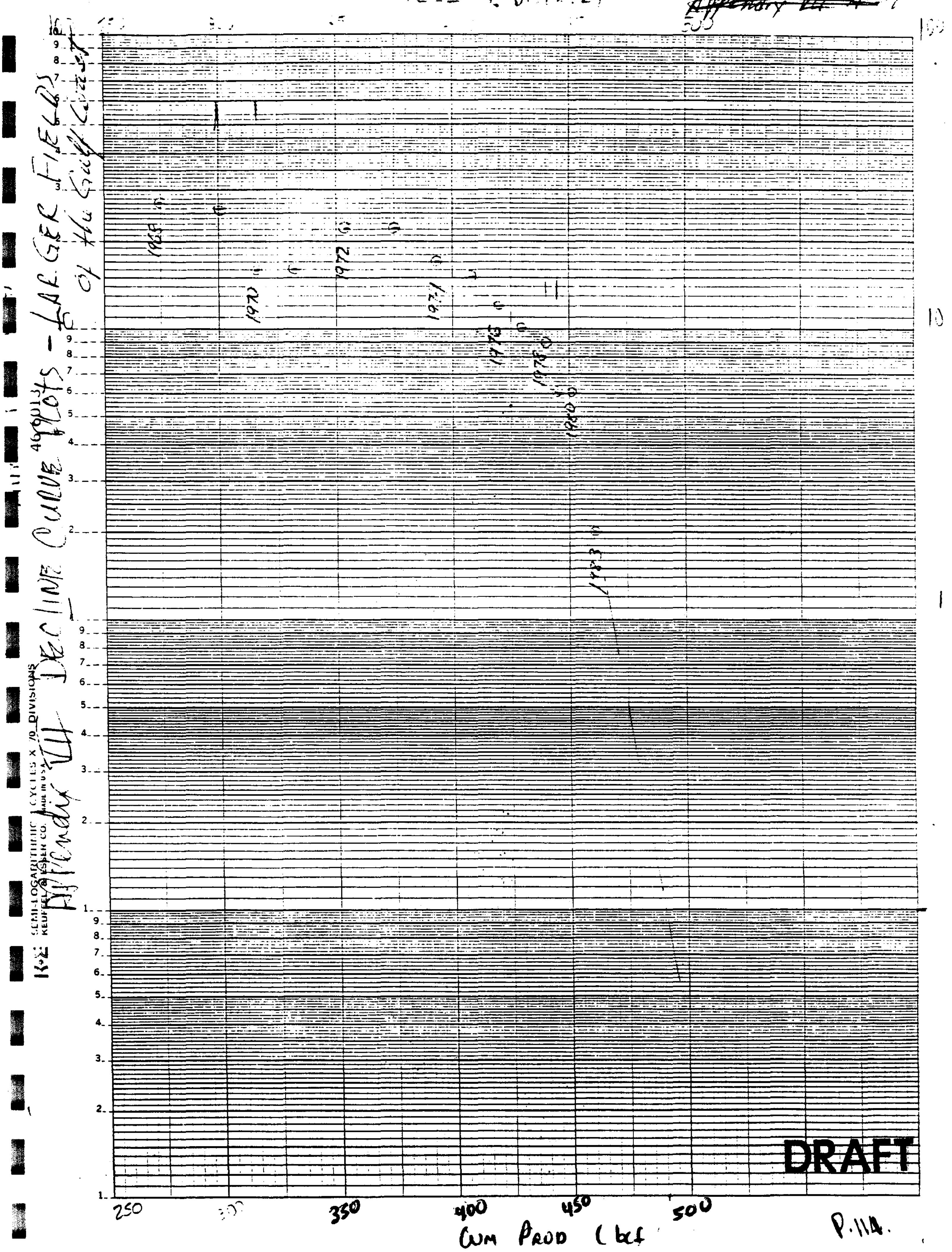
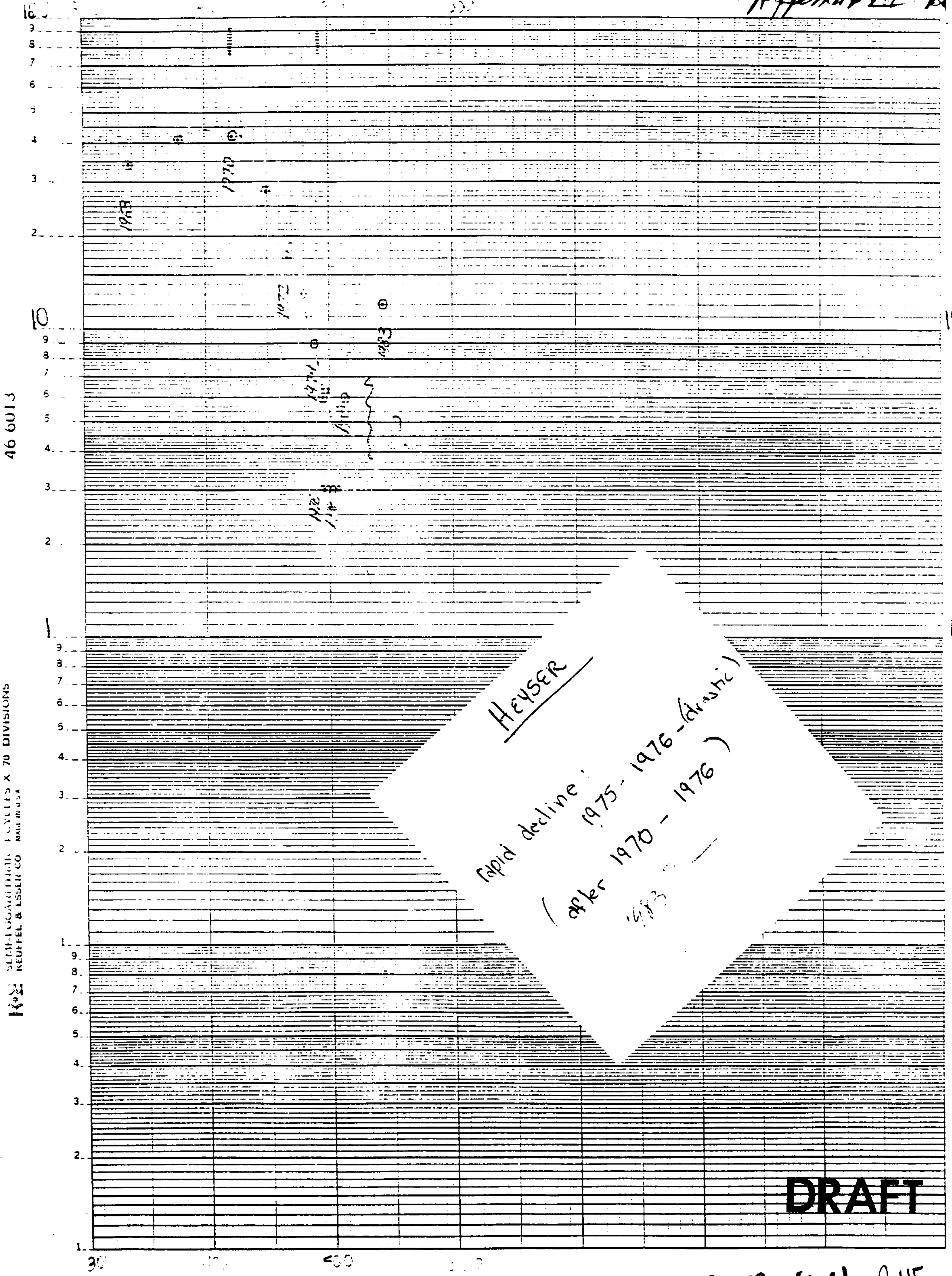
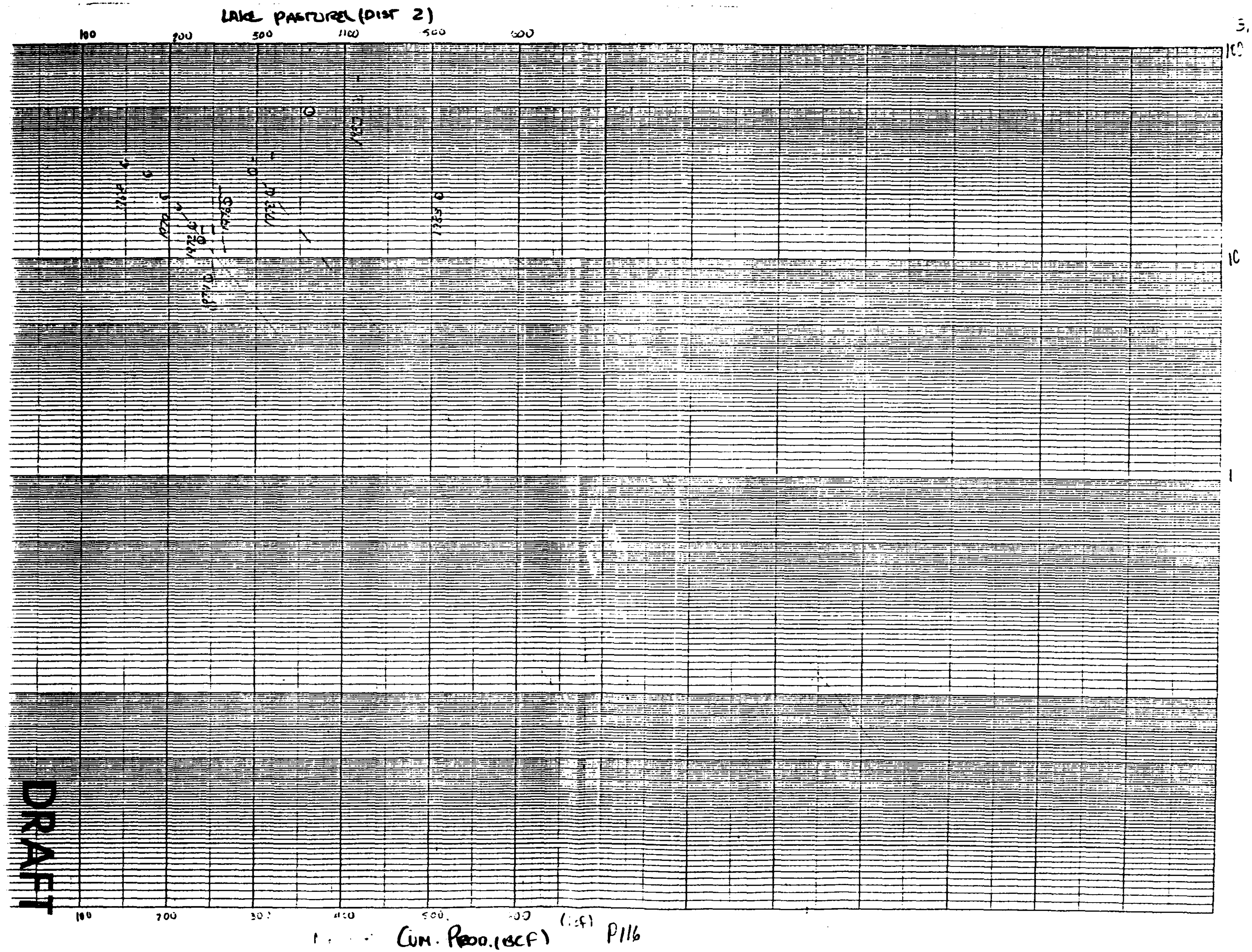

Appendix III Decline Curve Plots - Larger Fields of the Gulf Coast
SEMI-LOGARITHMIC 4 CYCLES X 70 DIVISIONS
KEUFFEL & ESSER CO. MADE IN USA
1969
1970
1972
1971
1975
1978
1980
1983
250
300
350
400
450
500
Cum Prod (bcf
100
10
1
DRAFT

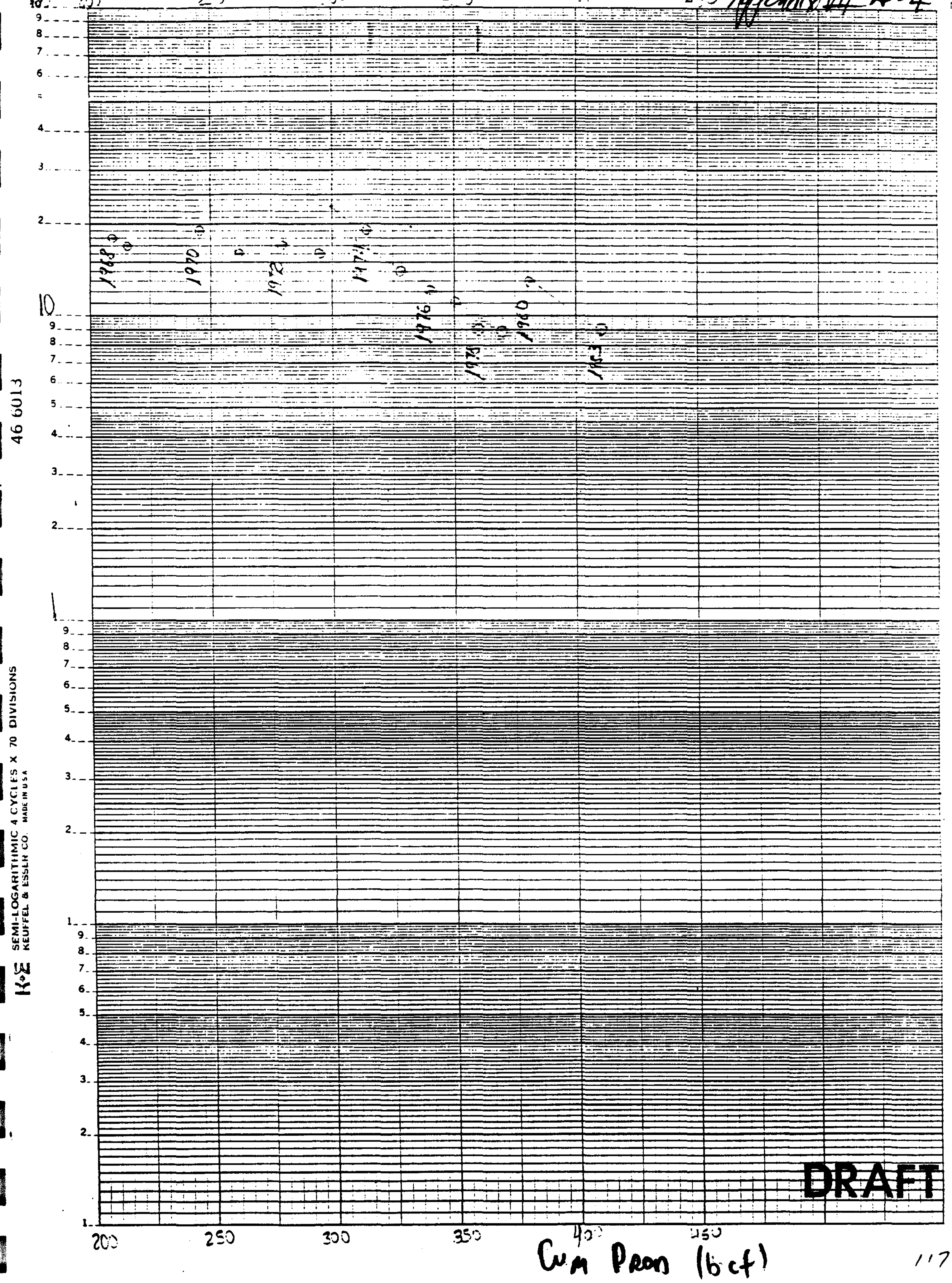


Heyser
rapid decline: 1975 - 1976 (drastic)
(after 1970 - 1976)
DRAFT
46 6013
SEMI-LOGARITHMIC 4 CYCLES X 70 DIVISIONS
KEUFFEL & ESSER CO.


LAKE PASTUREL (DIST 2)
100
200
300
400
500
600
CUM. PROD. (BCF)
DRAFT

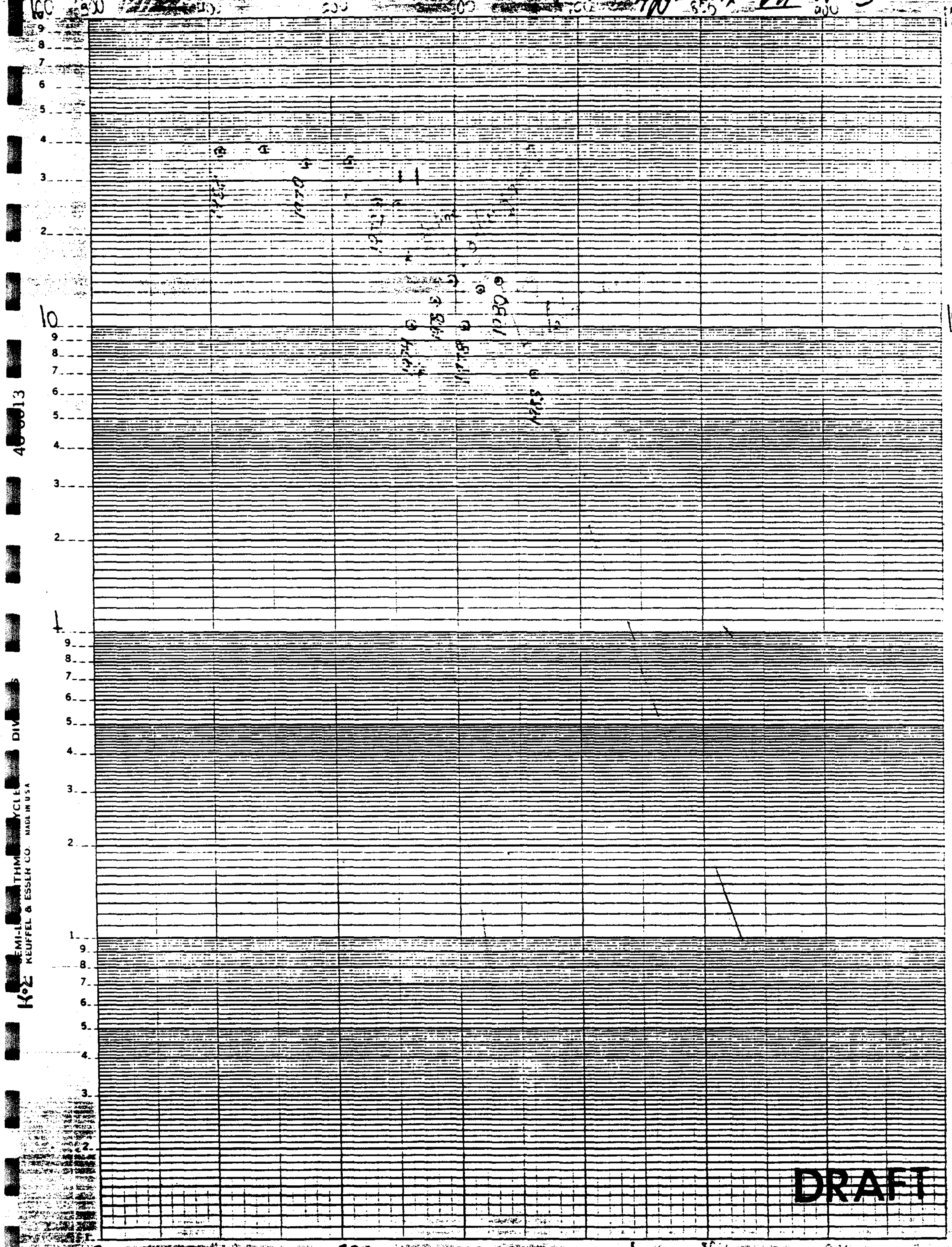
P116

Appendix VII A-4



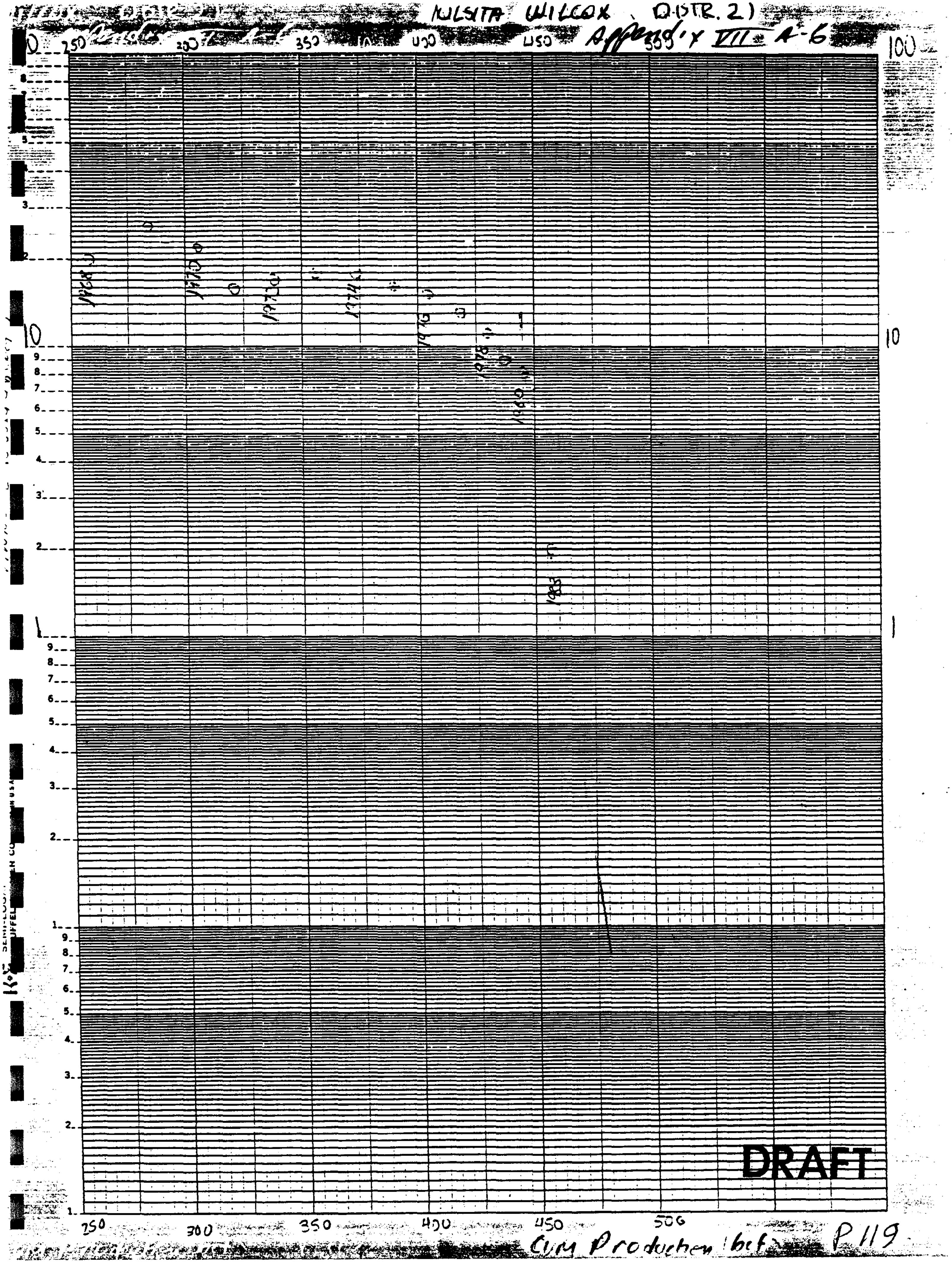
TOM O' CONNOR (DISTR 2)

Appendix VII A-5

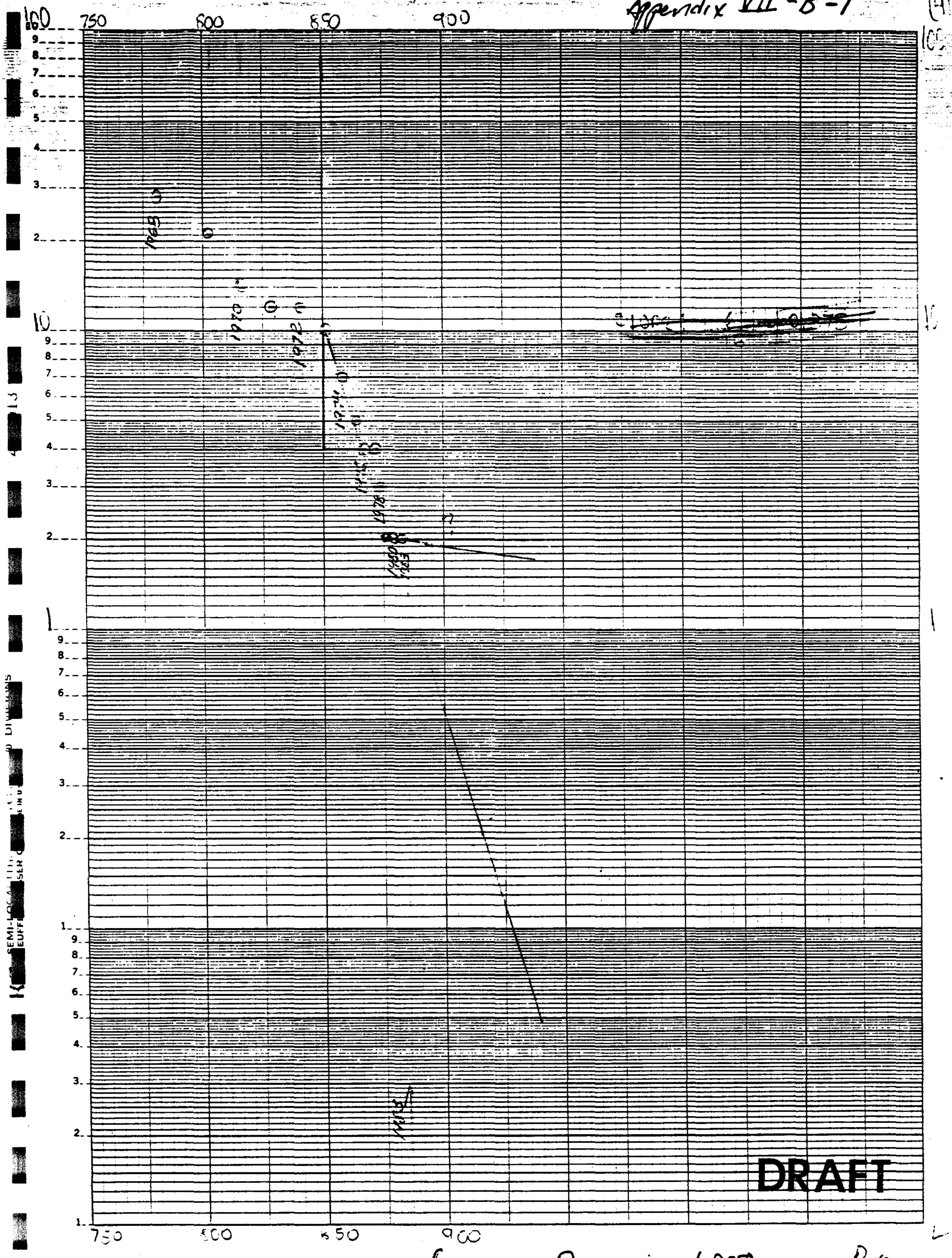


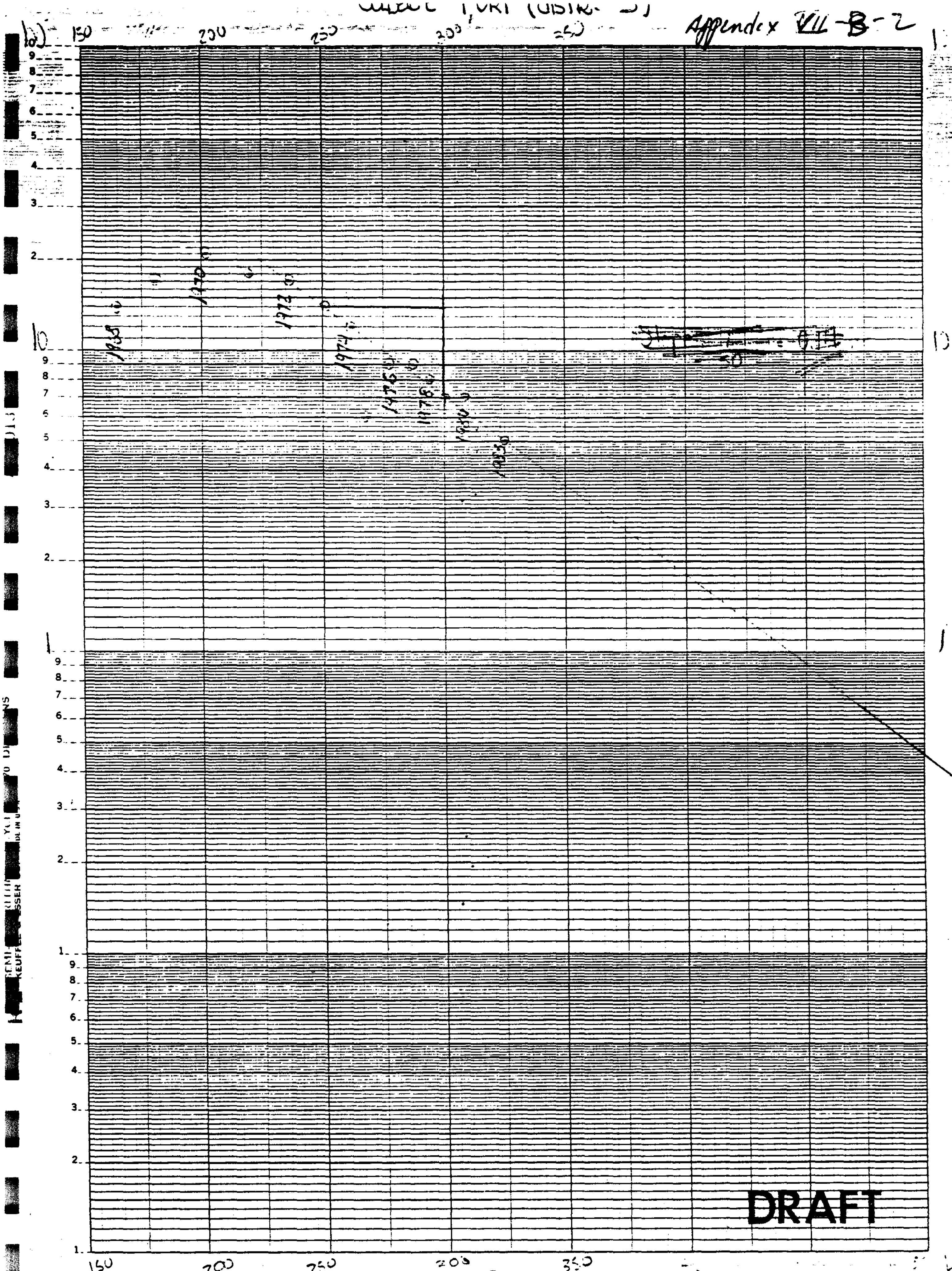
Cum. Prod. (bcf) P. 118

DRAFT


NILSITA WILCOX , DISTR. 2)
Appendix VII A-6
100
10
1
1968
1970
1972
1974
1976
1978
1980
1983
250
300
350
400
450
500
DRAFT
Cum Production (bcf)
P 119

Appendix VII-B-1

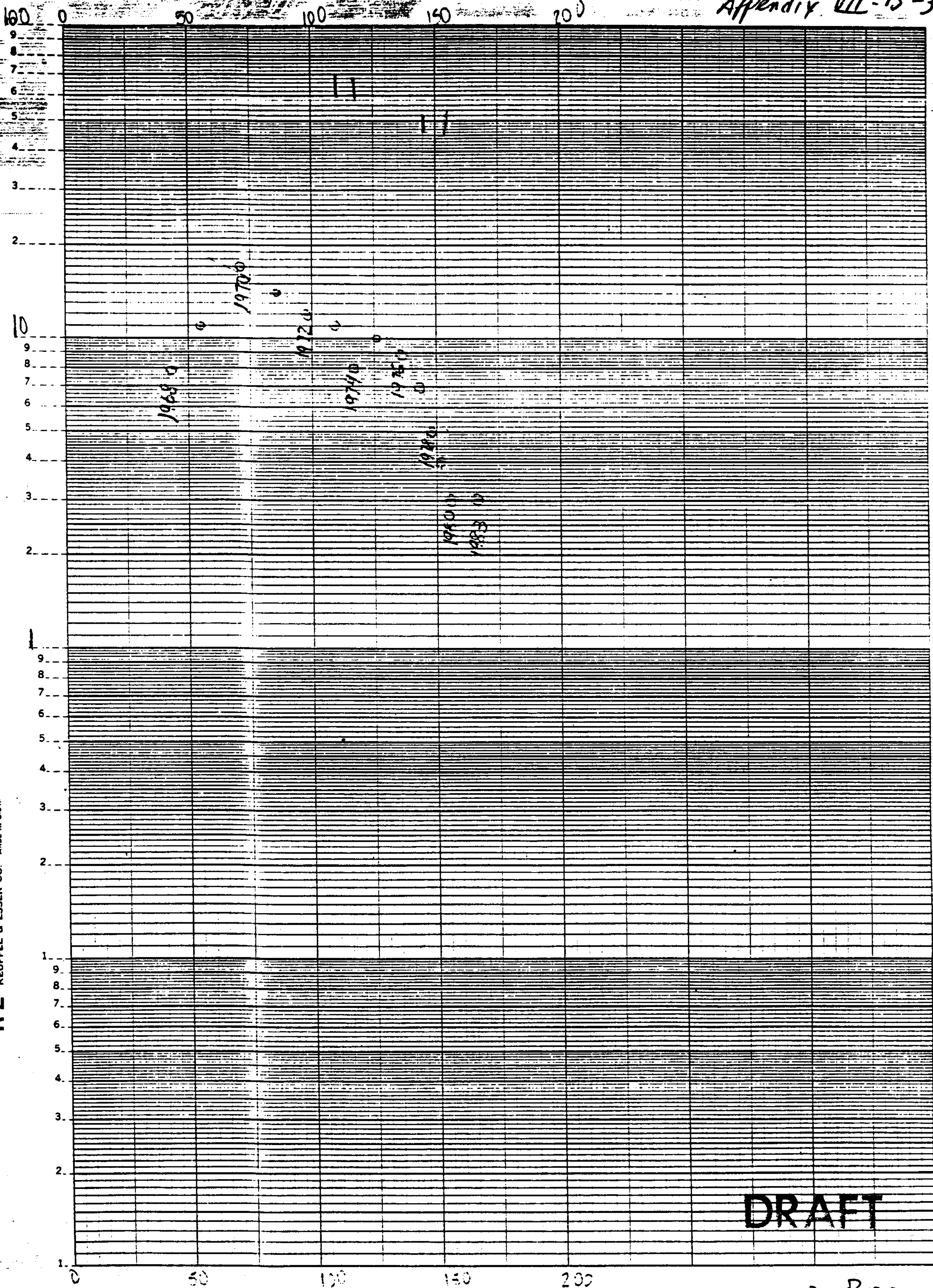


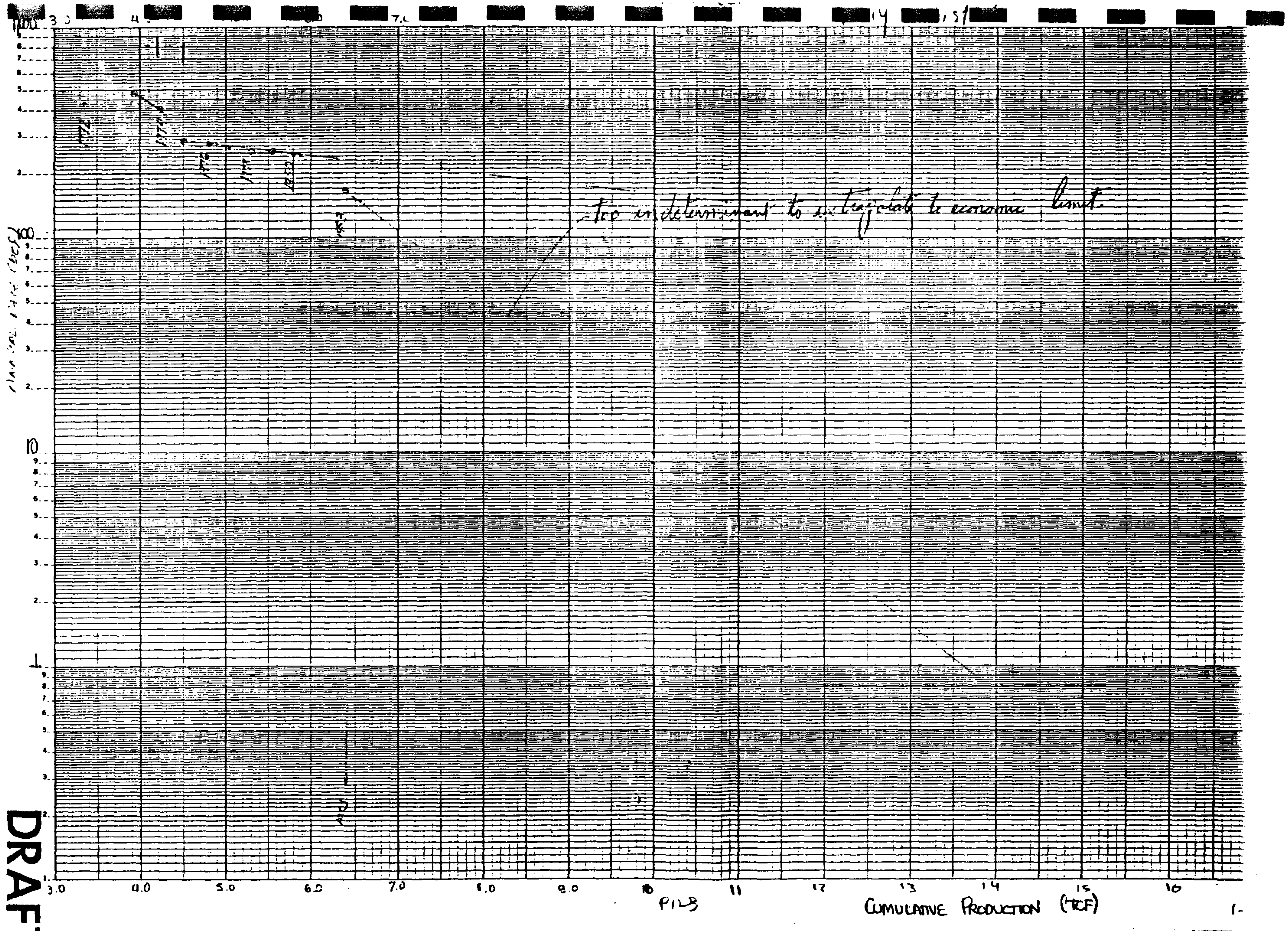


Cum. Production (BCF)

FISHER'S REEF (DISTR. 3)

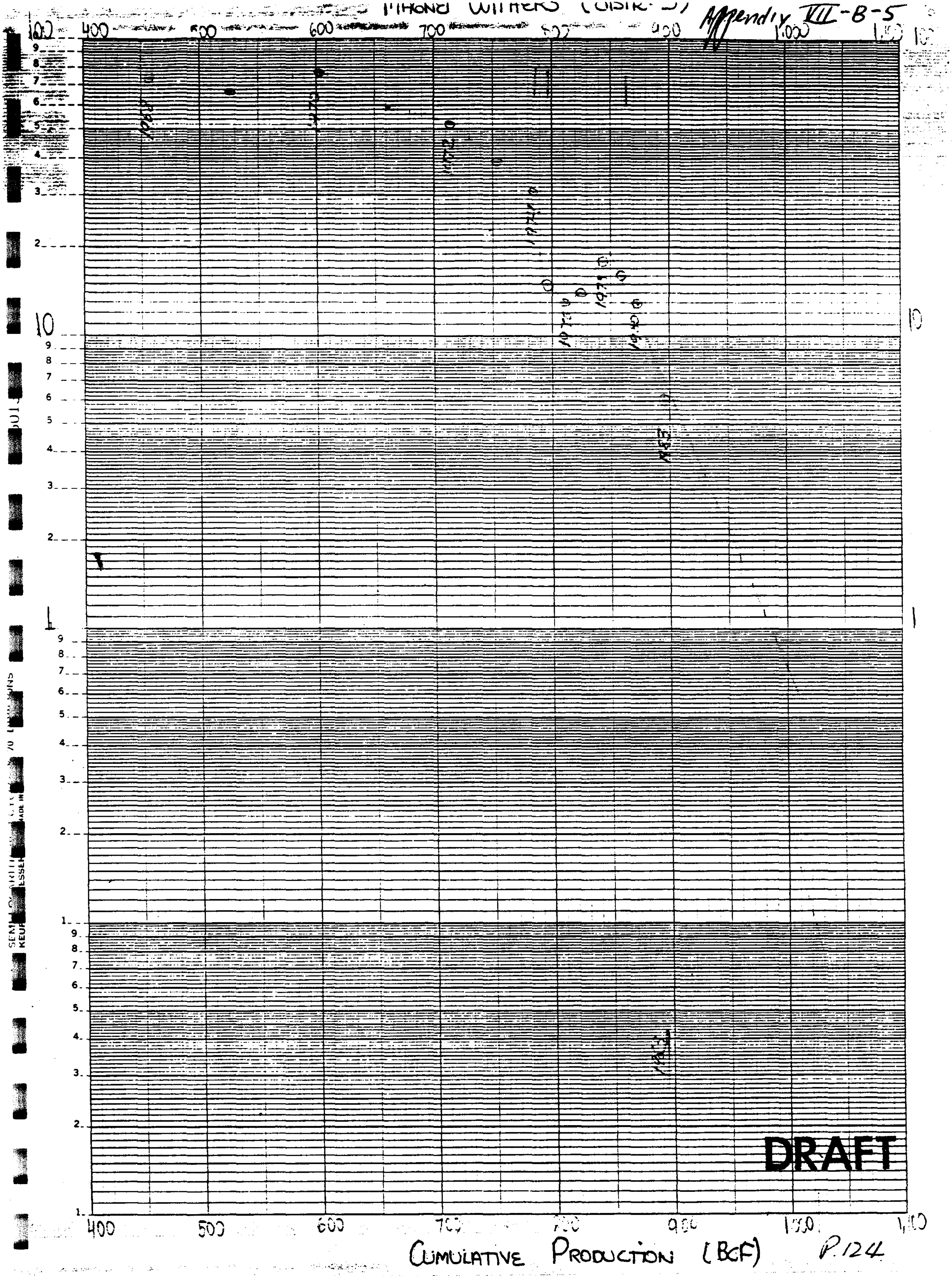
Appendix VII-13-3

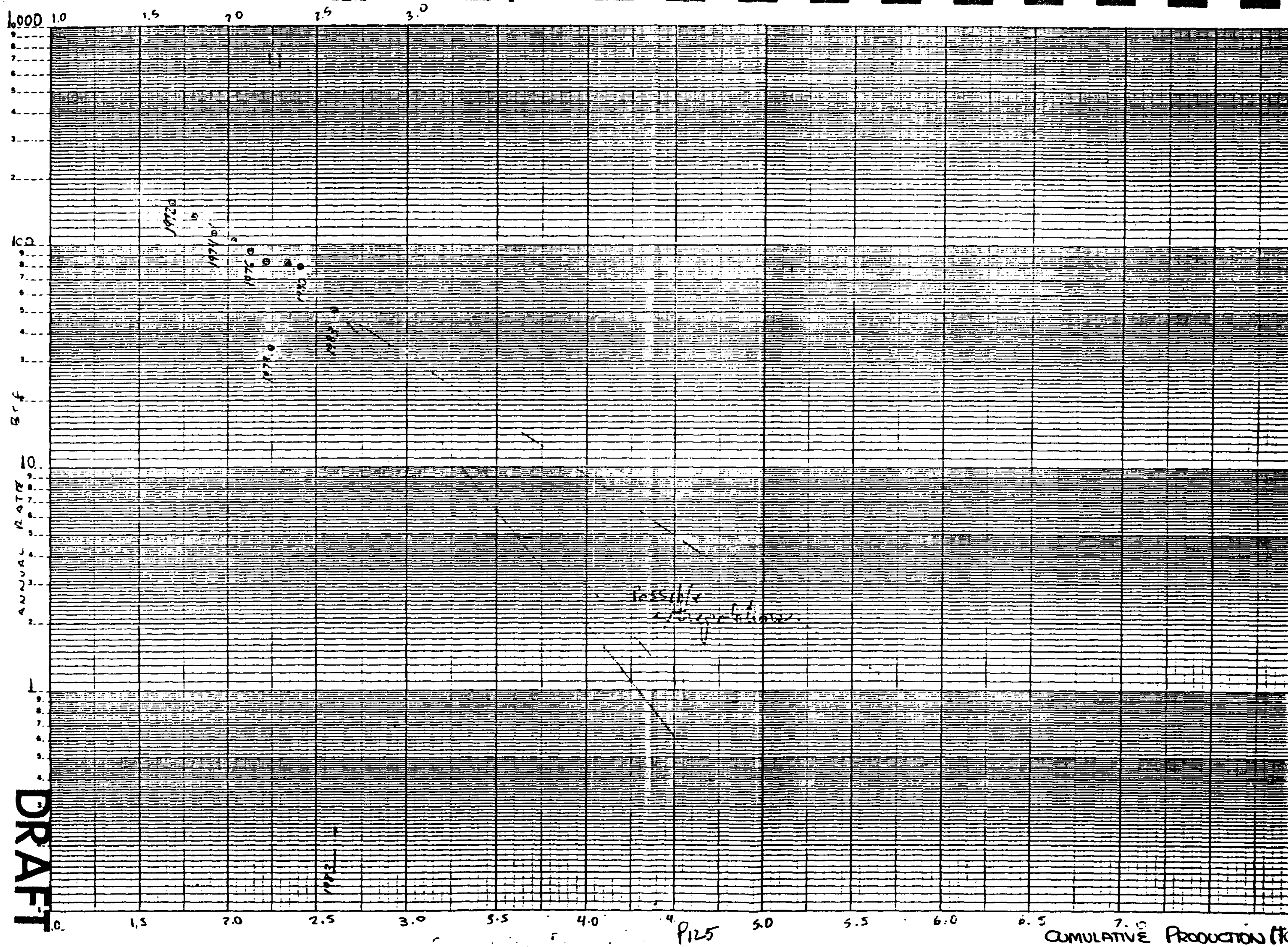




too indeterminant to extrapolate to economic limit.
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10
11
12
13
14
15
16
P12B
CUMULATIVE PRODUCTION (MCF)
1000
100
10
1

DRAFT

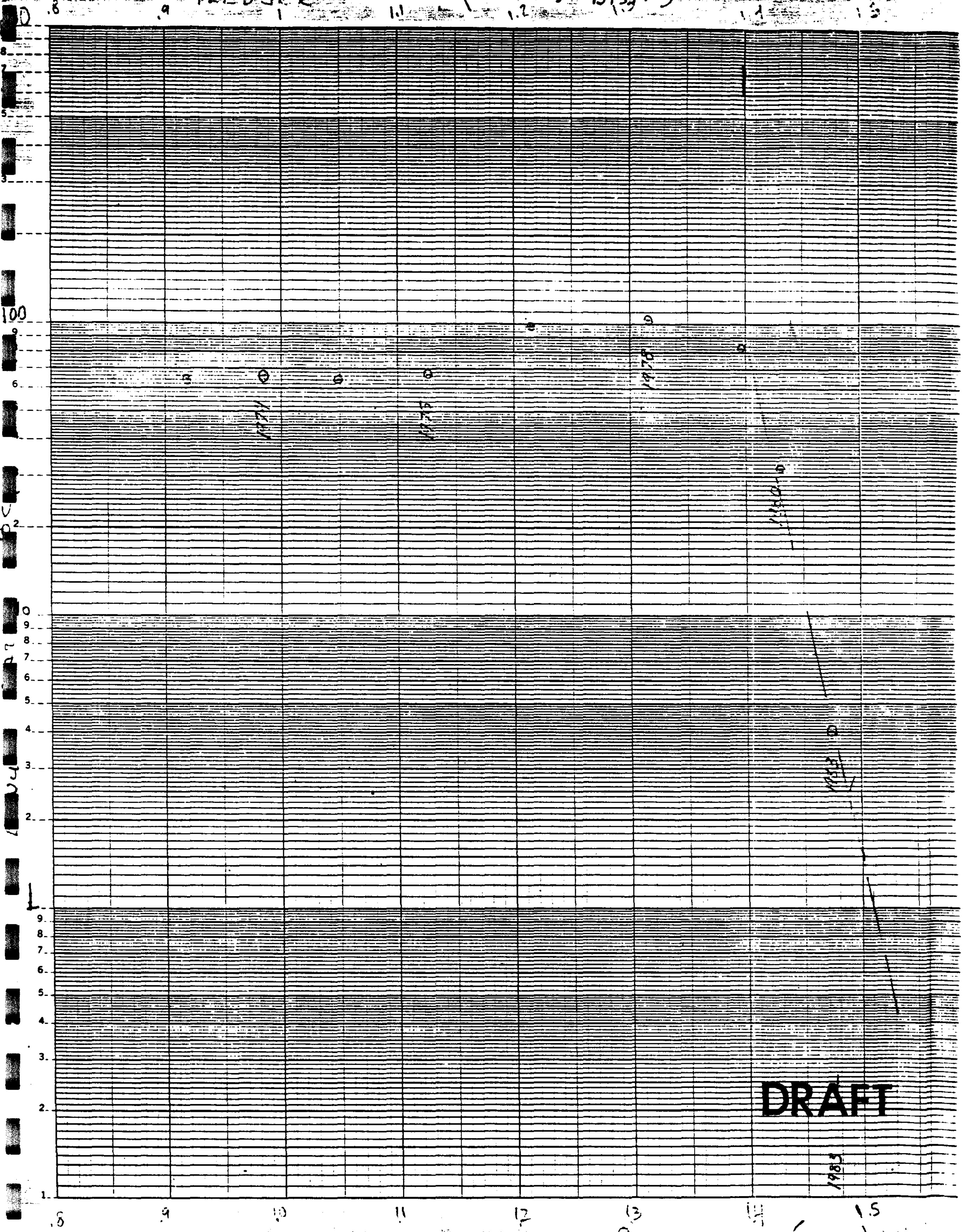

Pinon Withers (Distr. 5)
1969
1970
1972
1974
1975
1976
1980
1982
1983
DRAFT
400
500
600
700
800
900
1,000
1,100
Cumulative Production (BCF)


ANNUAL RATE
CUMULATIVE PRODUCTION
Possible extrapolation
1972
1974
1975
1978
1983

P125

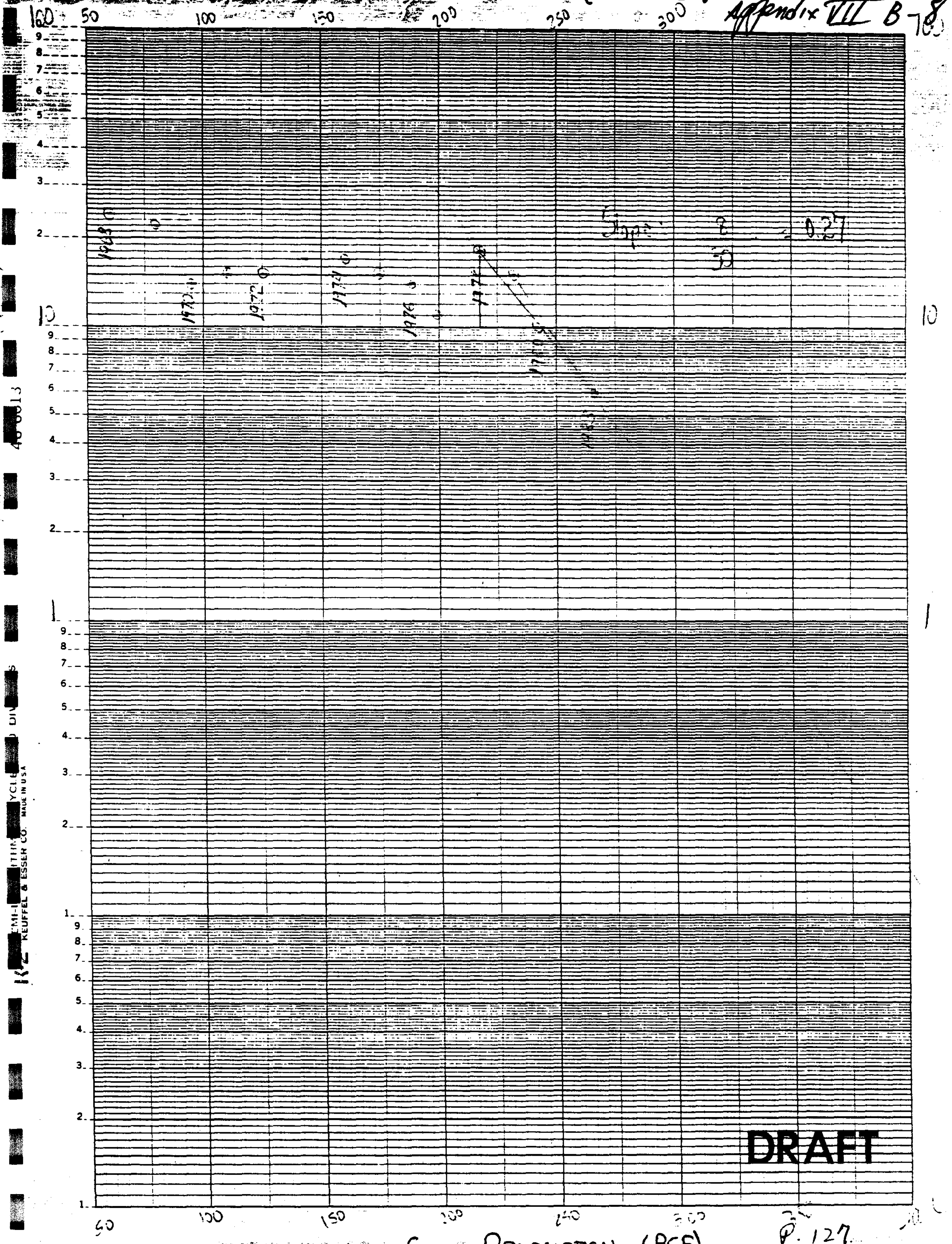
DRAFT

PLEDGE ~~PLEDGE (dist 3)~~ DIST. 3



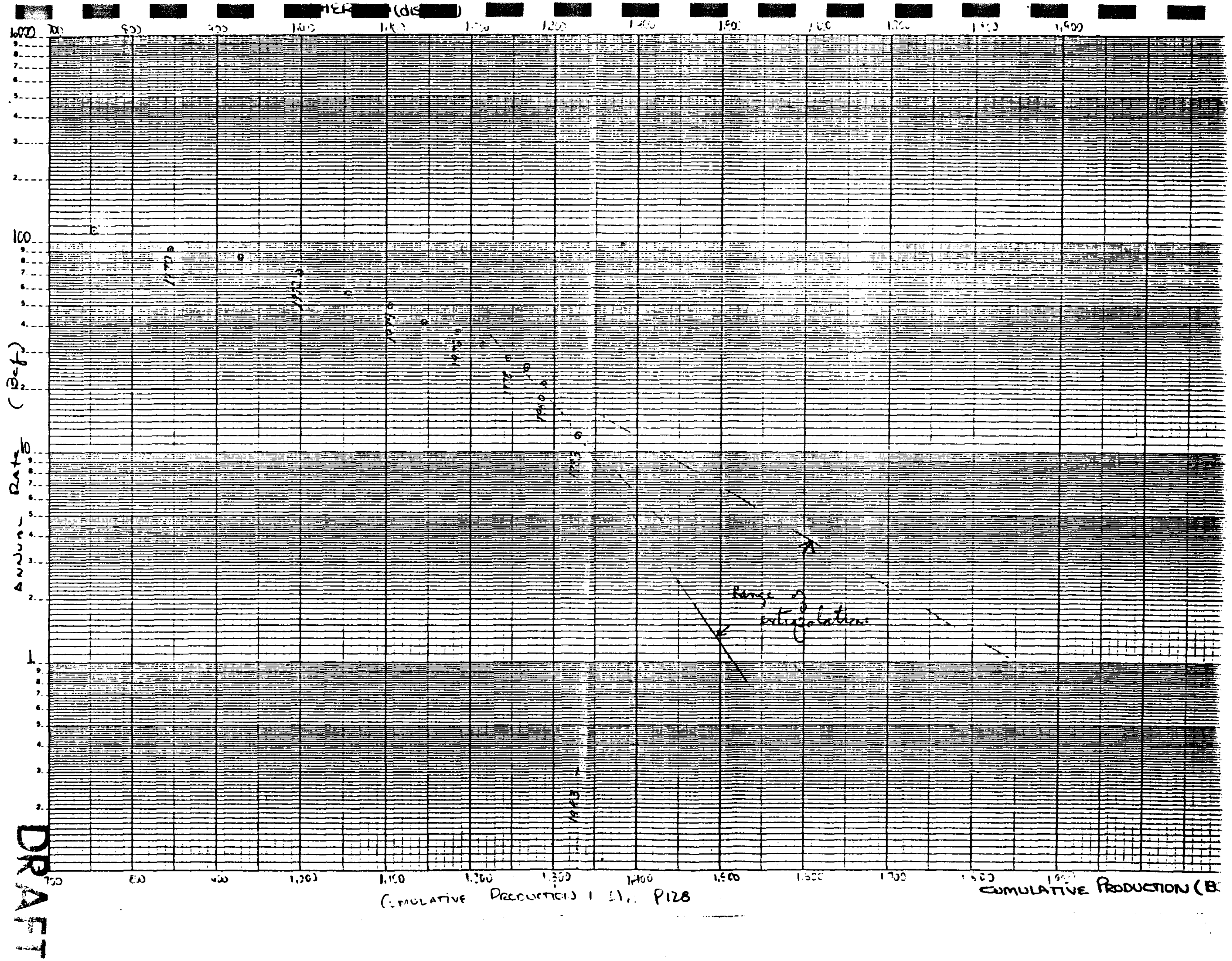
REDFISH REEF (distr. 3)

Appendix VII B-8

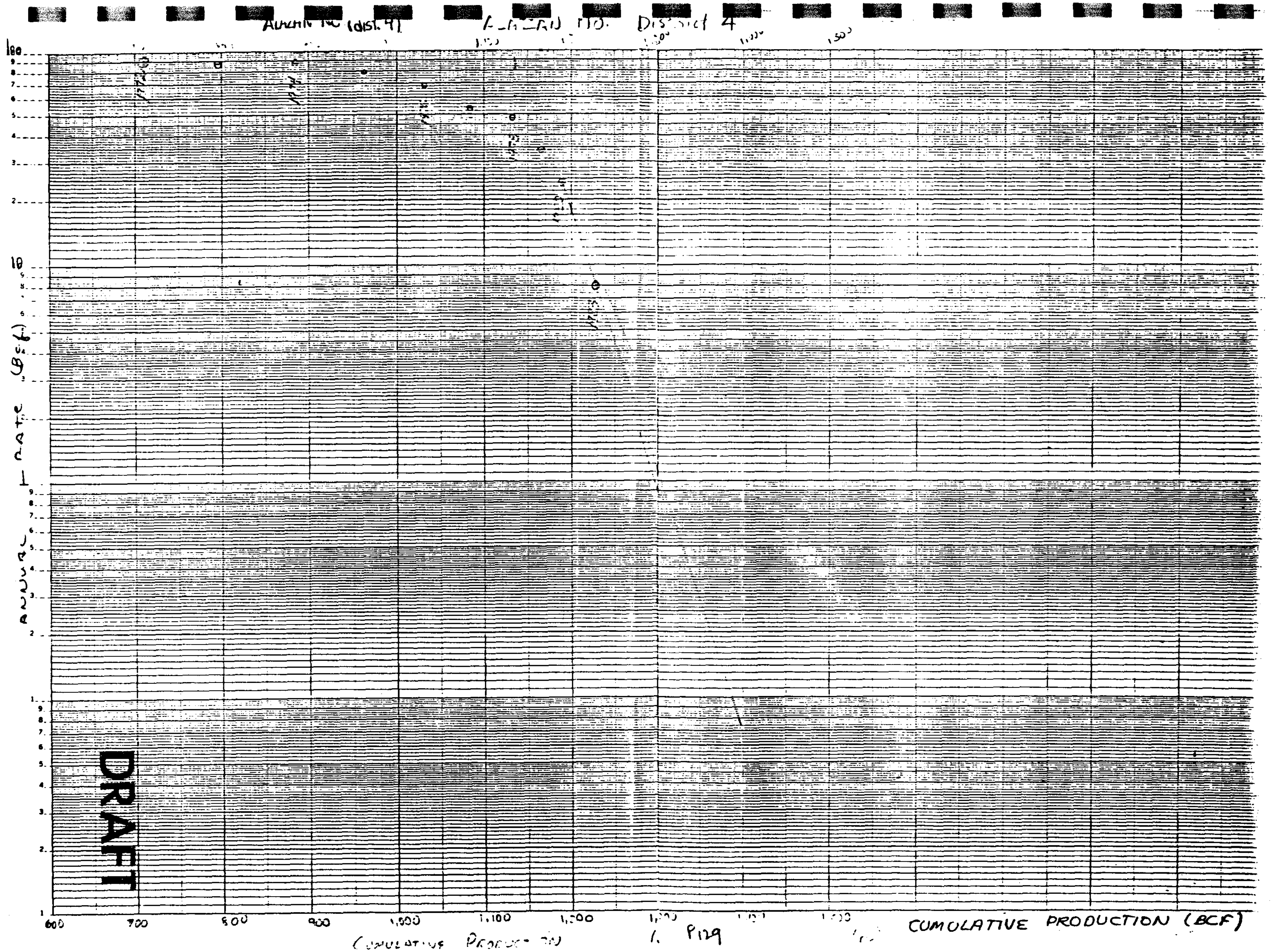


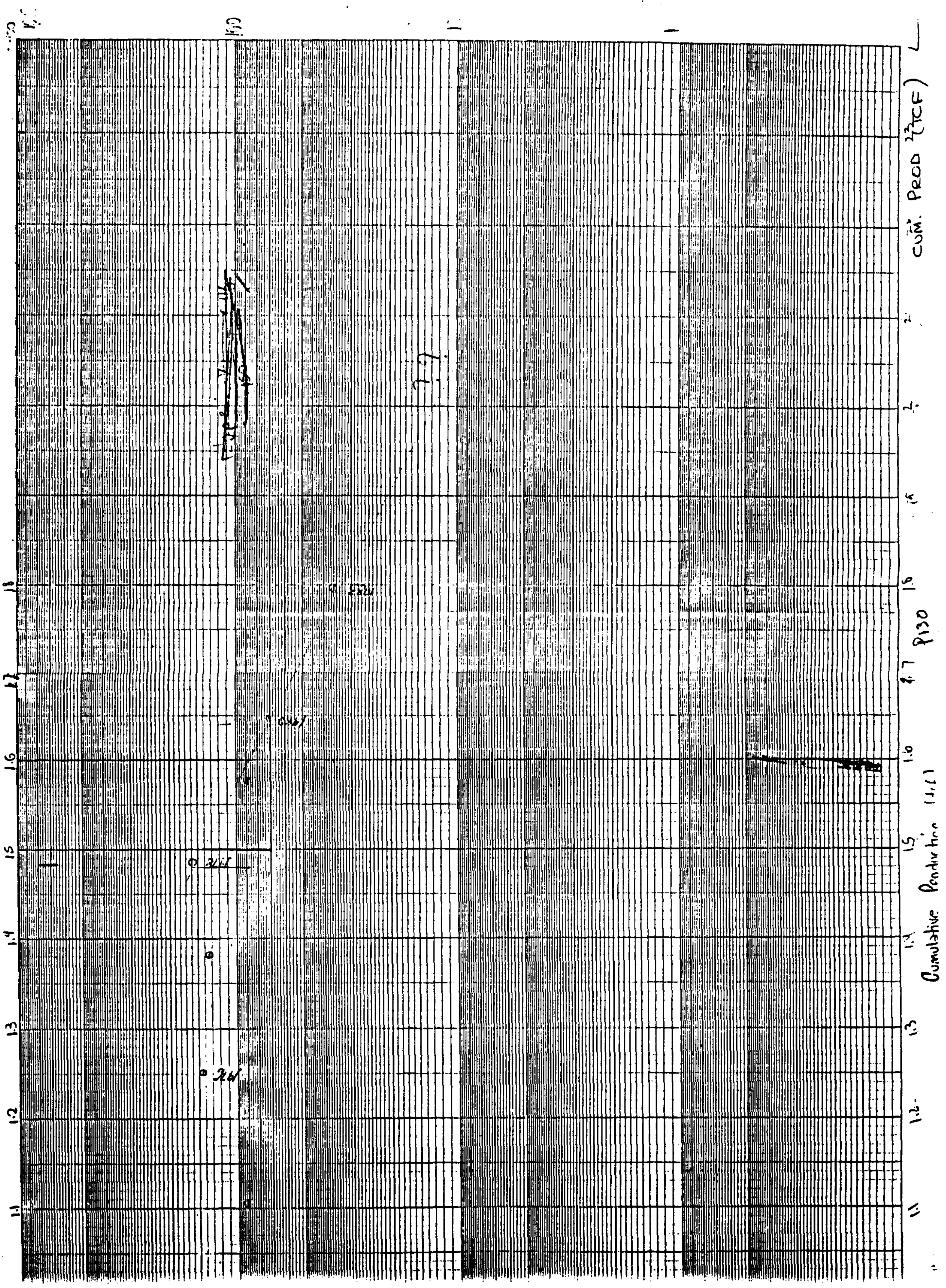
Cum. Production (BCF)

P. 127



Annual Rate (Bcf)
Range of extrapolation
Cumulative Production ([illegible]), P128
CUMULATIVE PRODUCTION (B
DRAFT


Aucun No (dist. 4)
District 4
DRAFT
Annual rate (Bcf)
CUMULATIVE PRODUCTION (BCF)
Cumulative Production
600
700
800
900
1,000
1,100
1,200
P129



CUM. PROD (TCF)
Cumulative Production (TCF)
Borrego - (Dist. 4)
P130
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8

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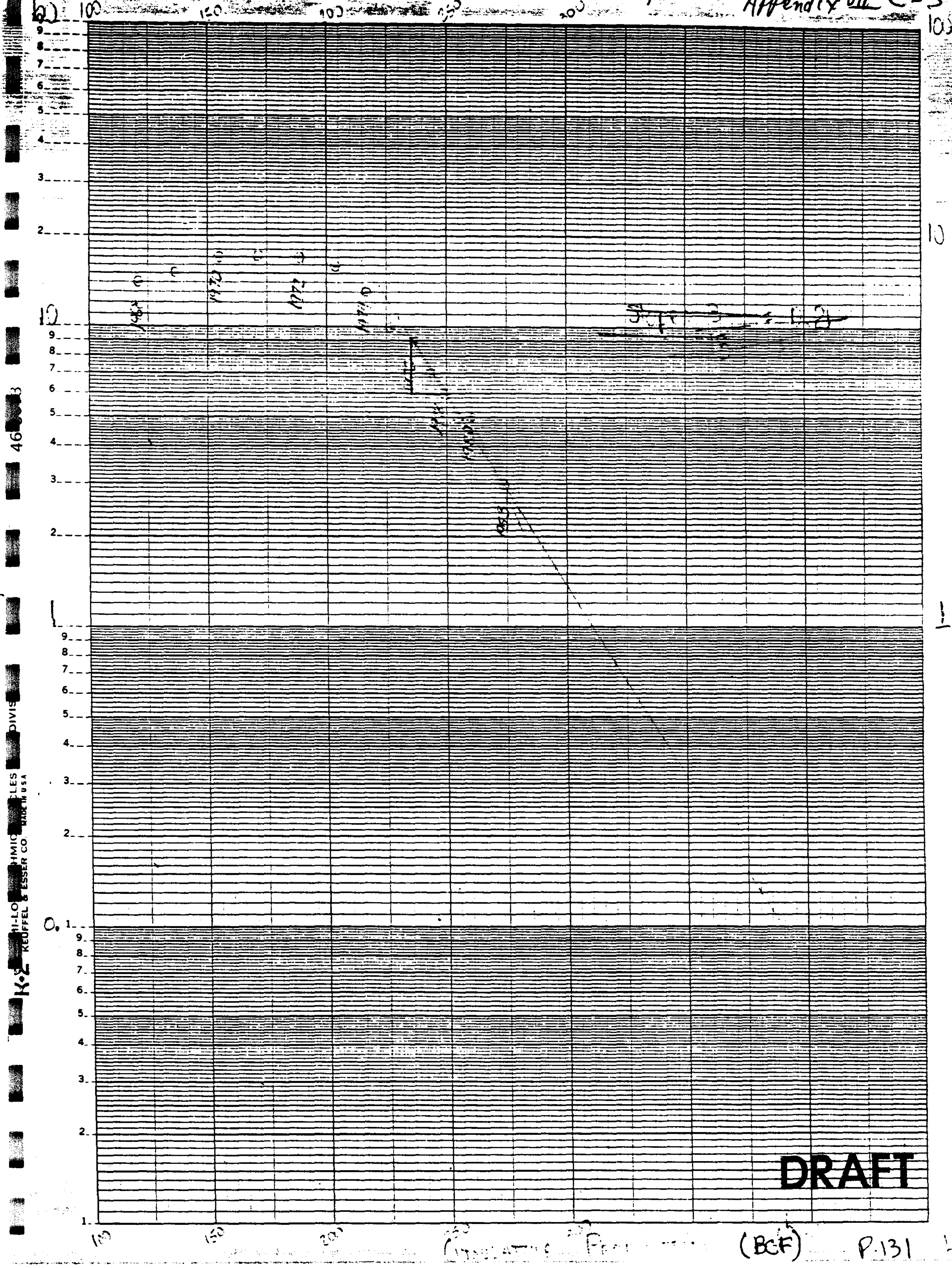
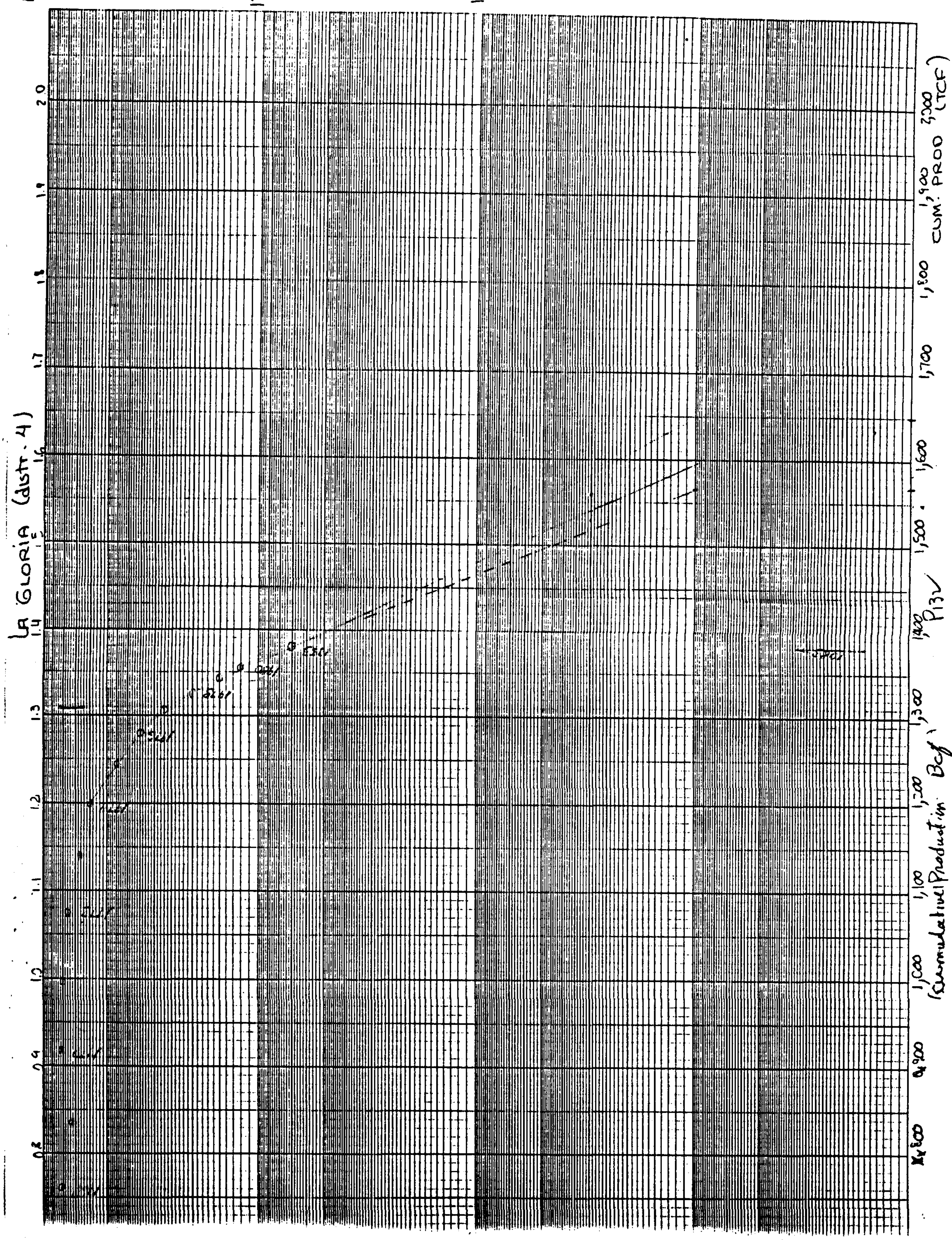
LA BLANCA (distr. 4)

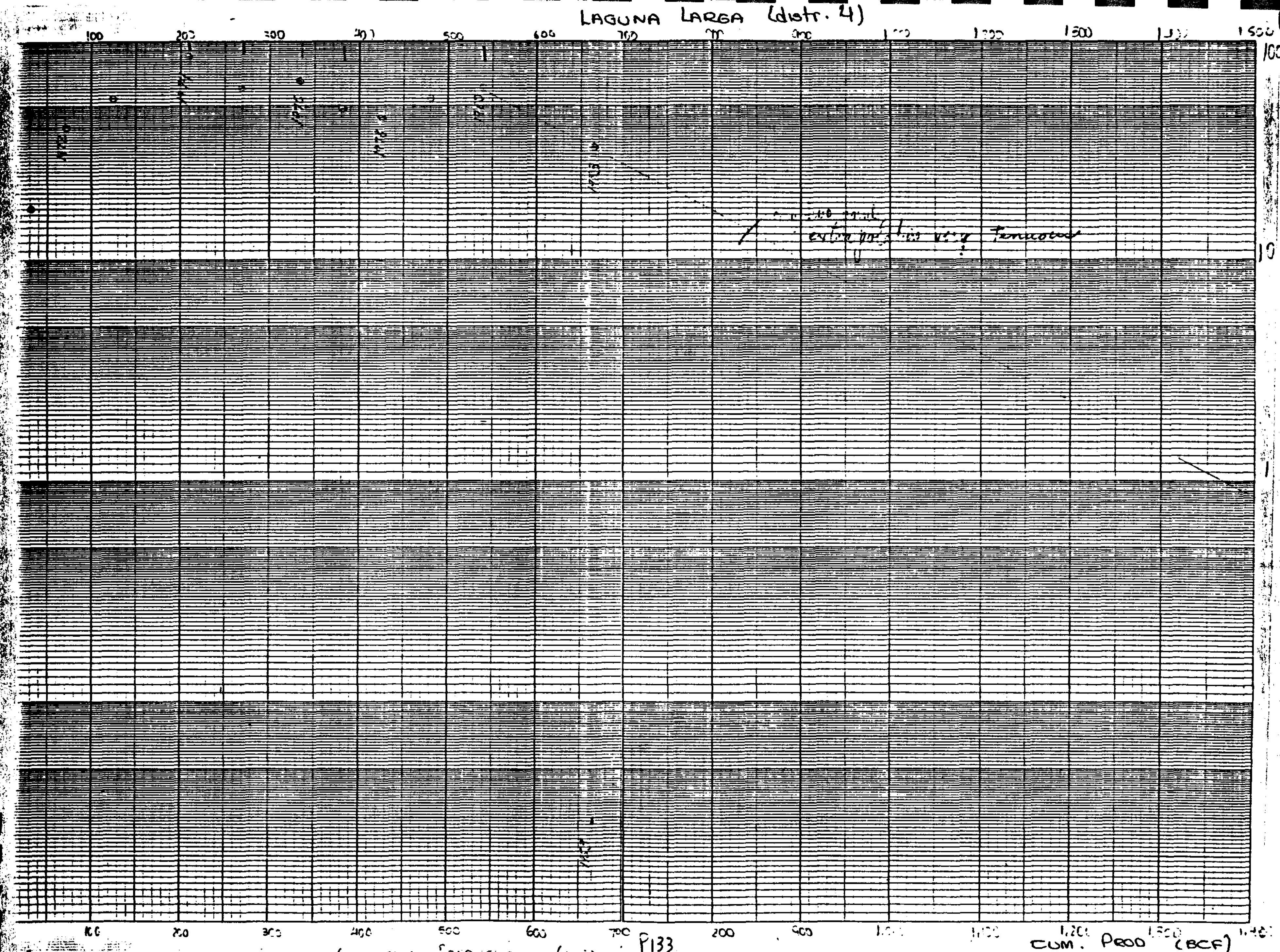
Appendix VII C-3





LA GLORIA (dist. 4)
CUM. PROD (TCF)
(Cumulative Production in Bcf)
0.8
0.9
1.0
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
1.9
2.0
800
900
1,000
1,100
1,200
1,300
1,400
1,500
1,600
1,700
1,800
1,900
2,000

DRAFT



P133

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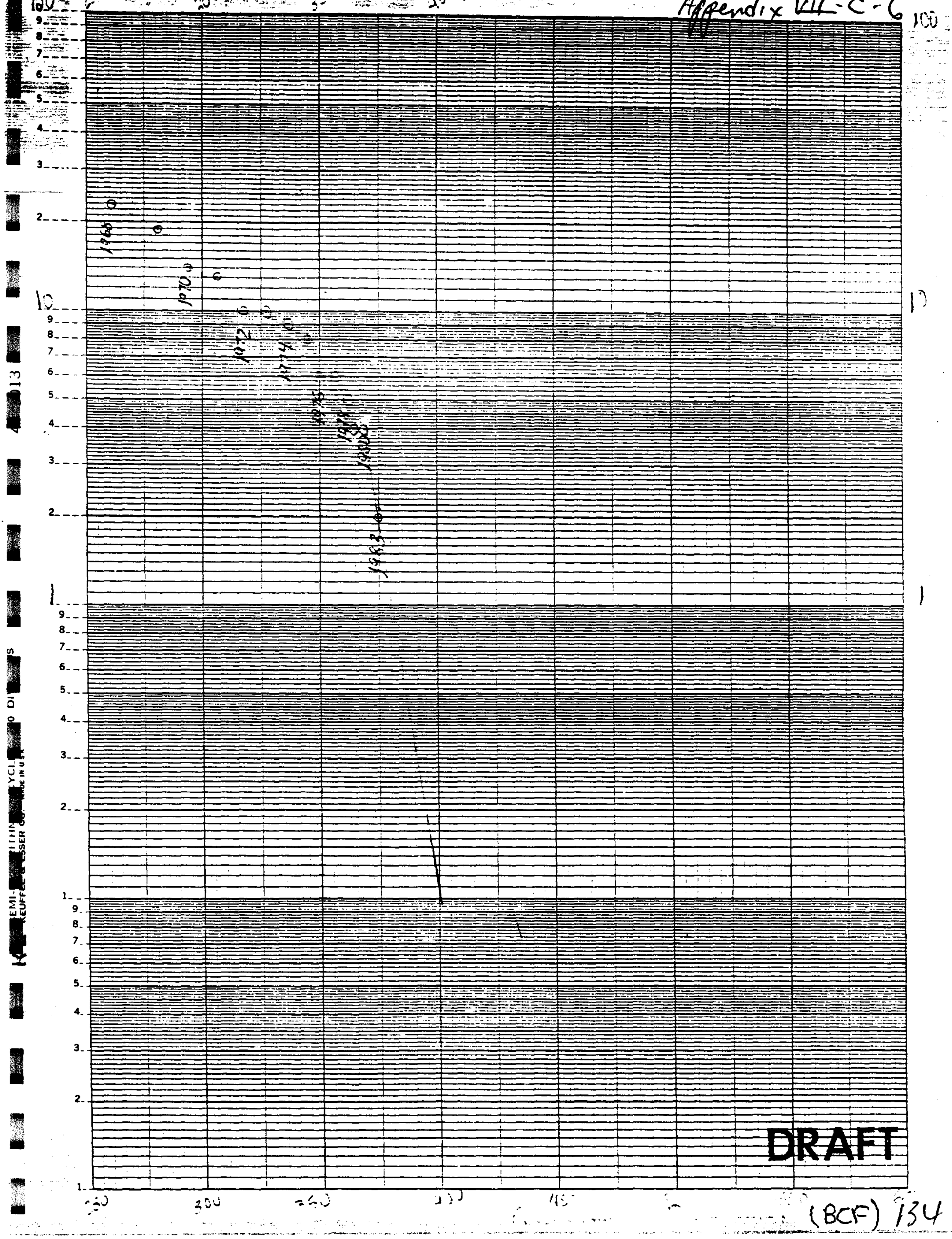
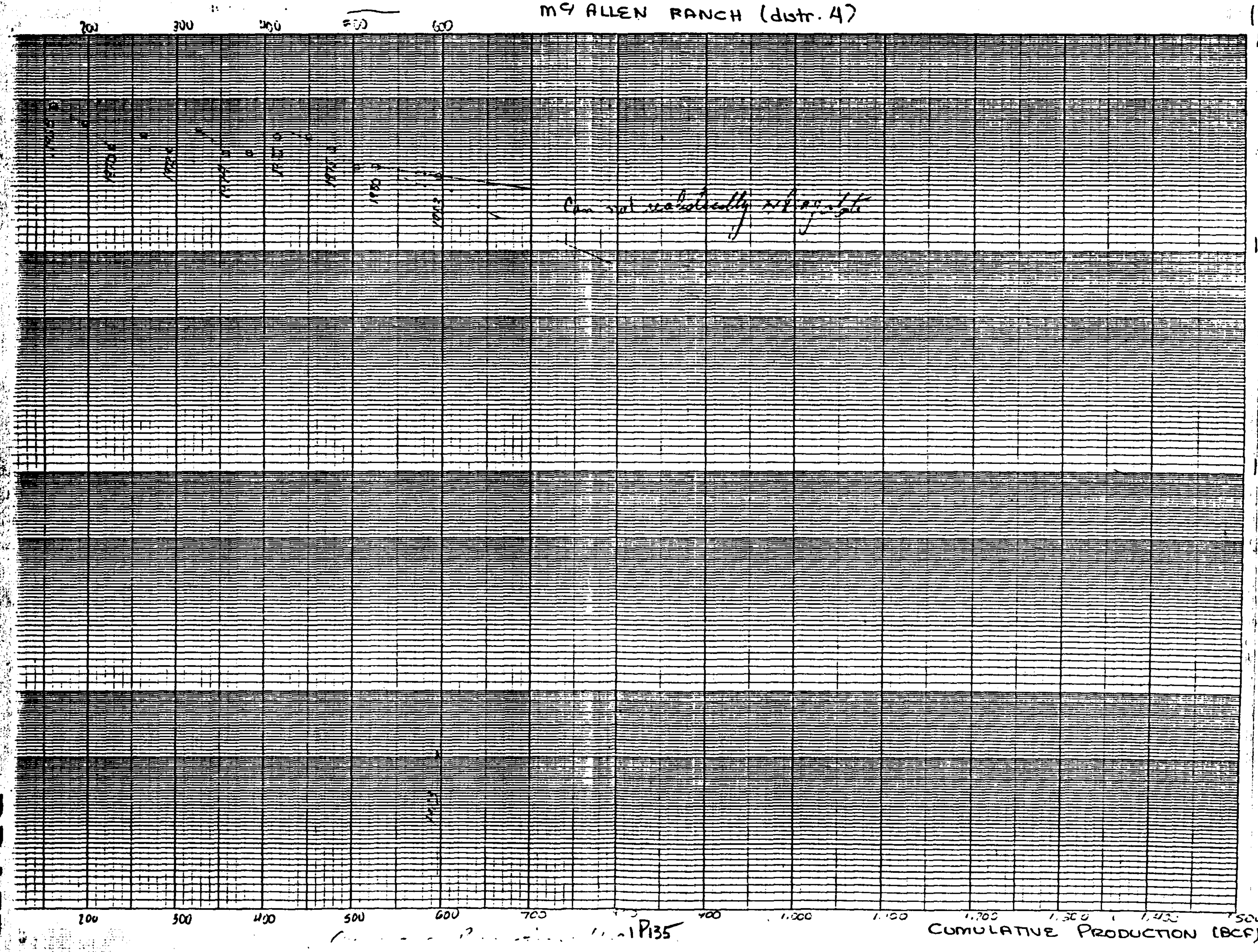
McAllen (distr. 4)

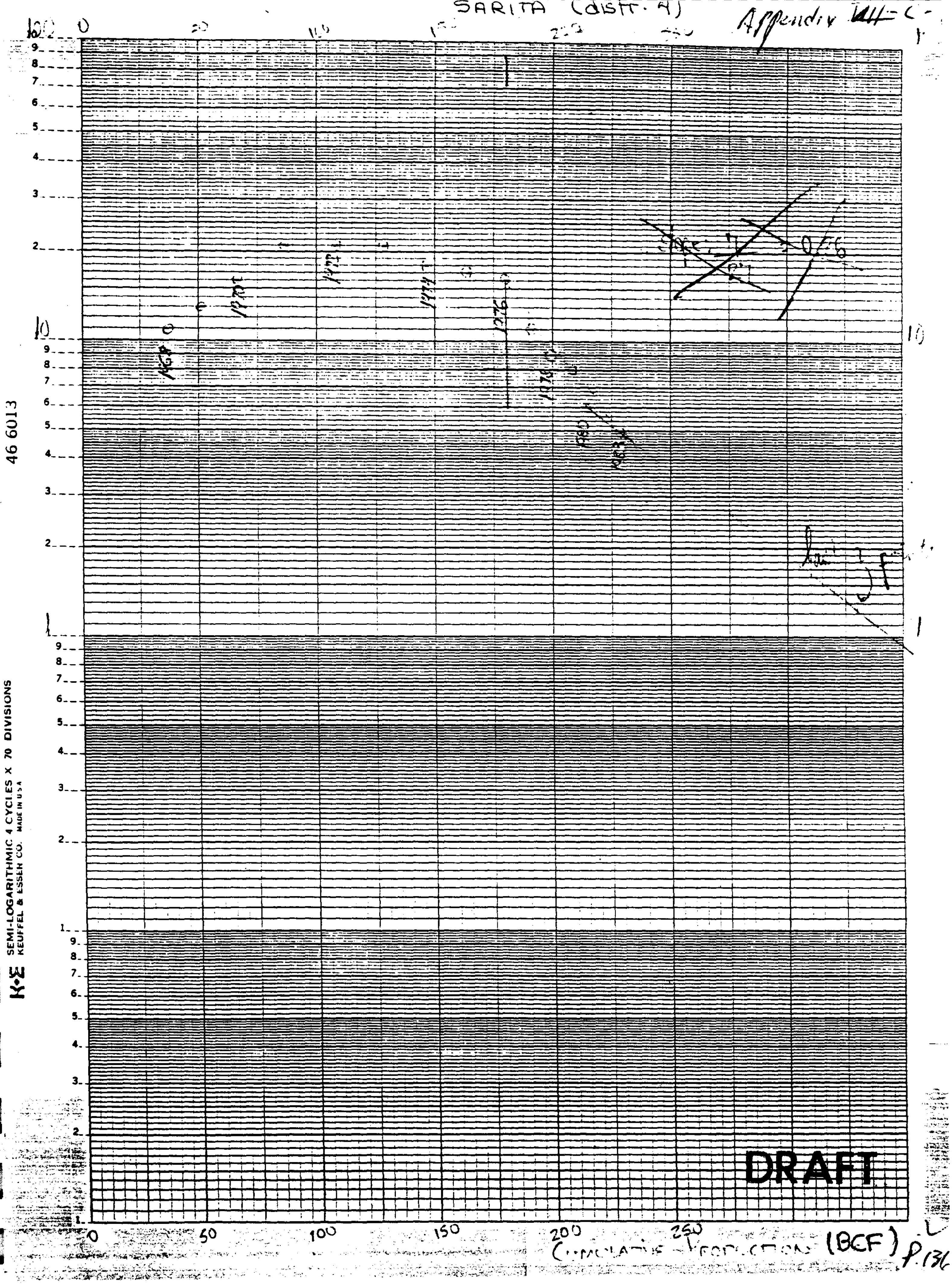
Appendix VII-C-6



(BCF) 134

Mc ALLEN RANCH (dstr. 4)




SARITA (DIST. 4)
(BCF)
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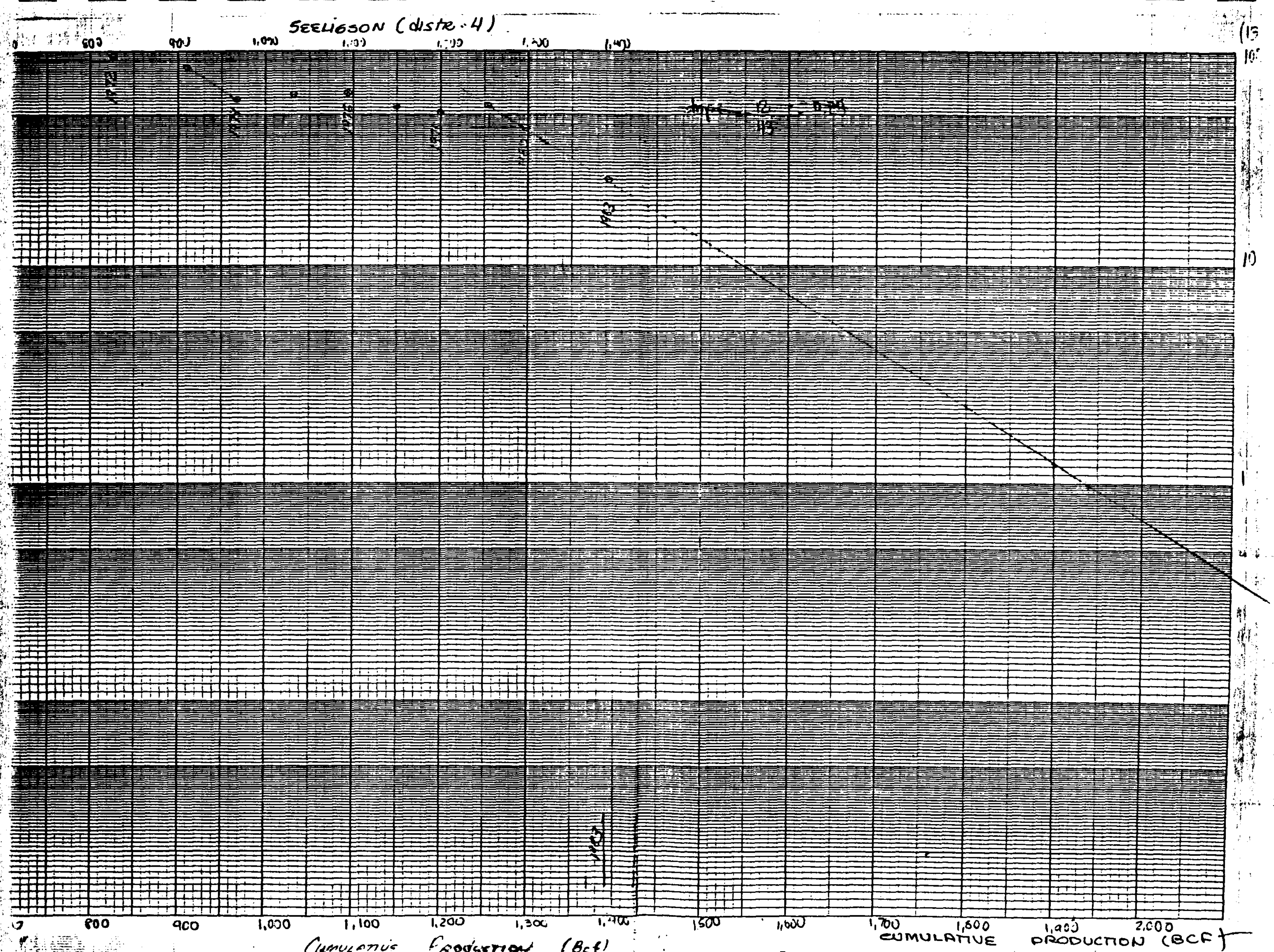
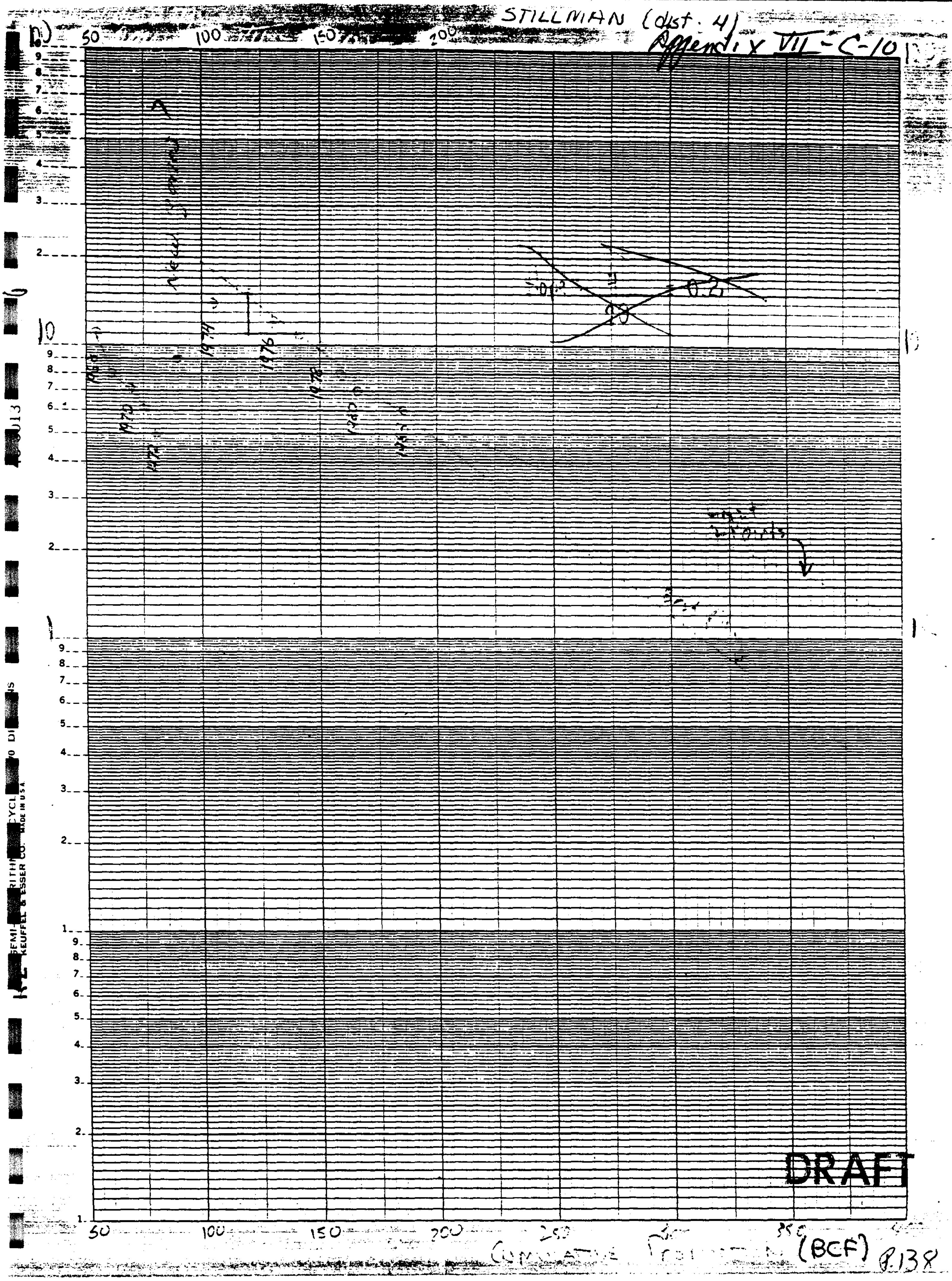
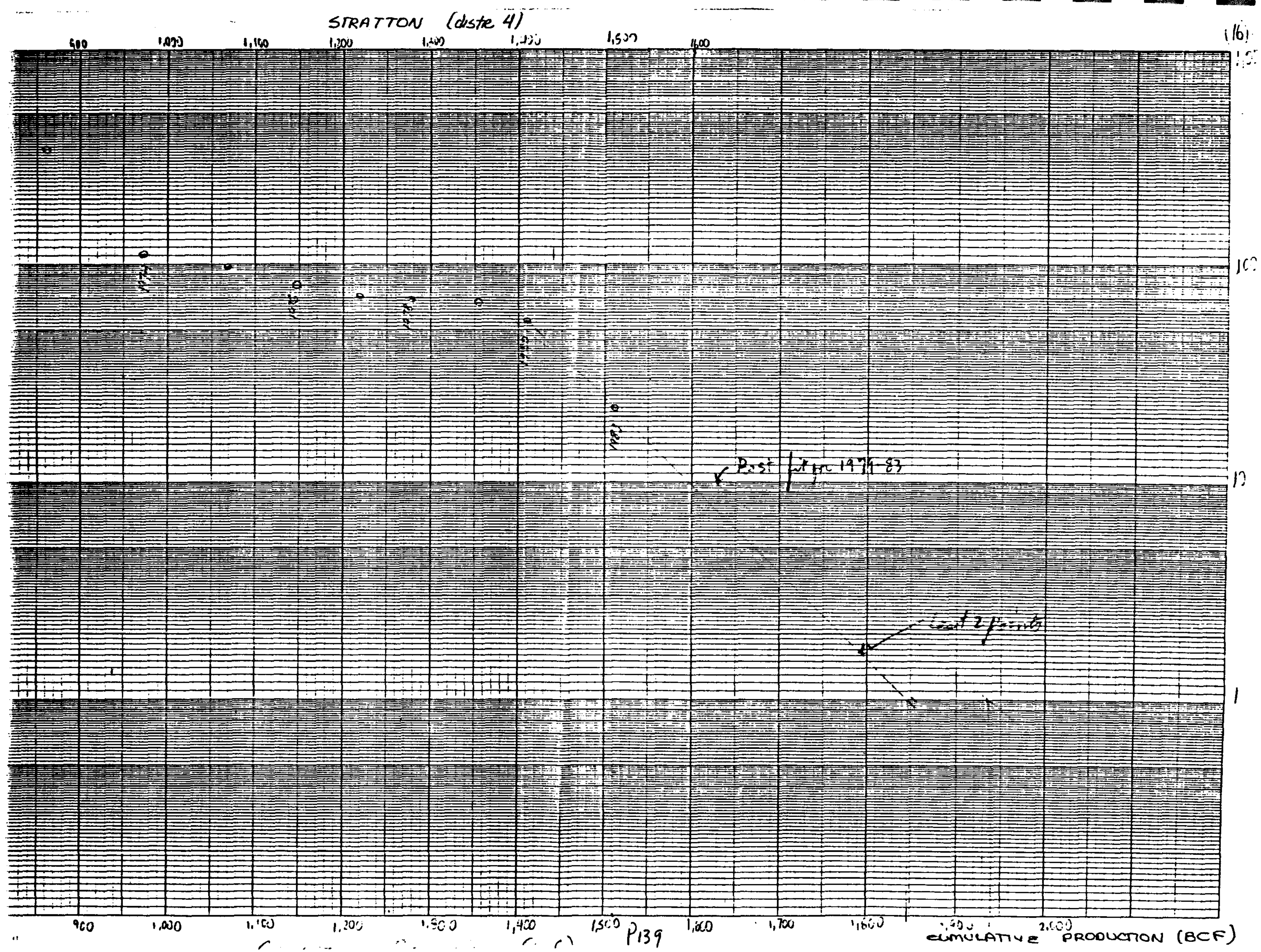
46 6013
K•E SEMI-LOGARITHMIC 4 CYCLES X 70 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.


SEELIGSON (distr. 4)
CUMULATIVE PRODUCTION (BCF)
Cumulative Production (Bcf)
0
800
900
1,000
1,100
1,200
1,300
1,400
1500
1,600
1,700
1,800
1,900
2,000
10
1963

DRAFT

STILLMAN (dist. 4)
Appendix VII - C-10




STRATTON (diste 4)
CUMULATIVE PRODUCTION (BCF)
Past fit for 1979-83
Last 2 points
P139

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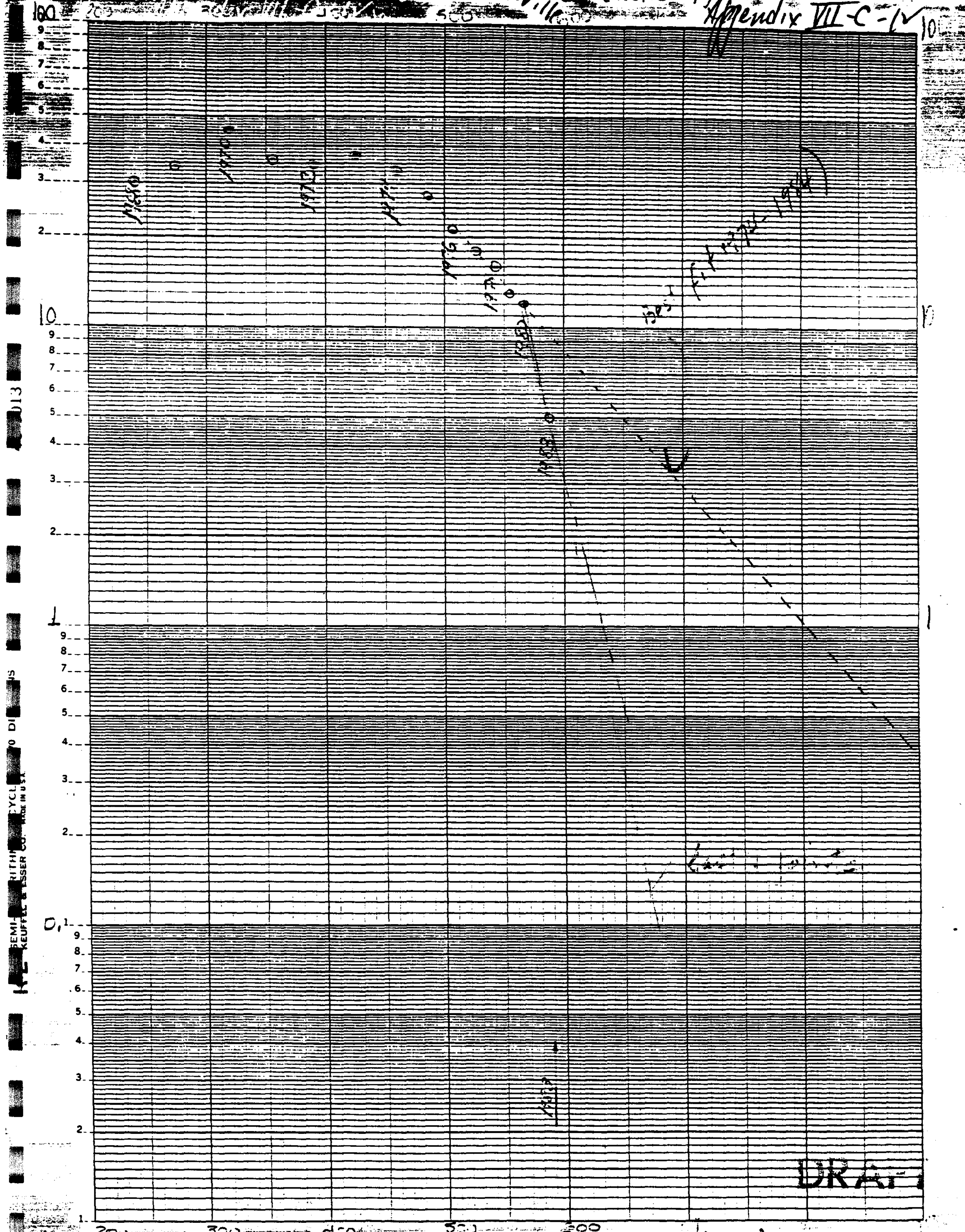
THOMPSON, NE (distr. 4) Appendix VII-C-1

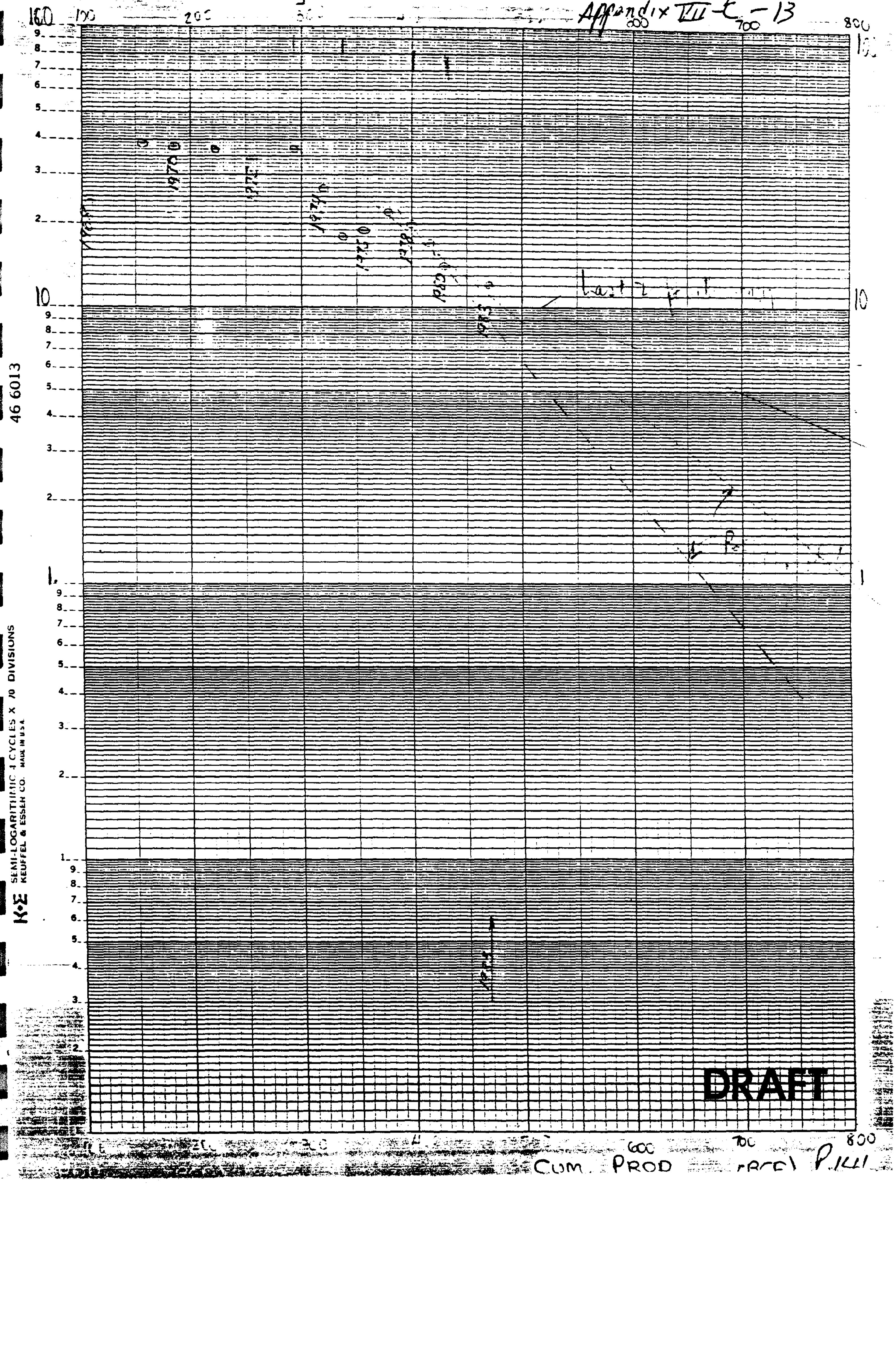


CUMULATIVE PRODUCTION (BCF)

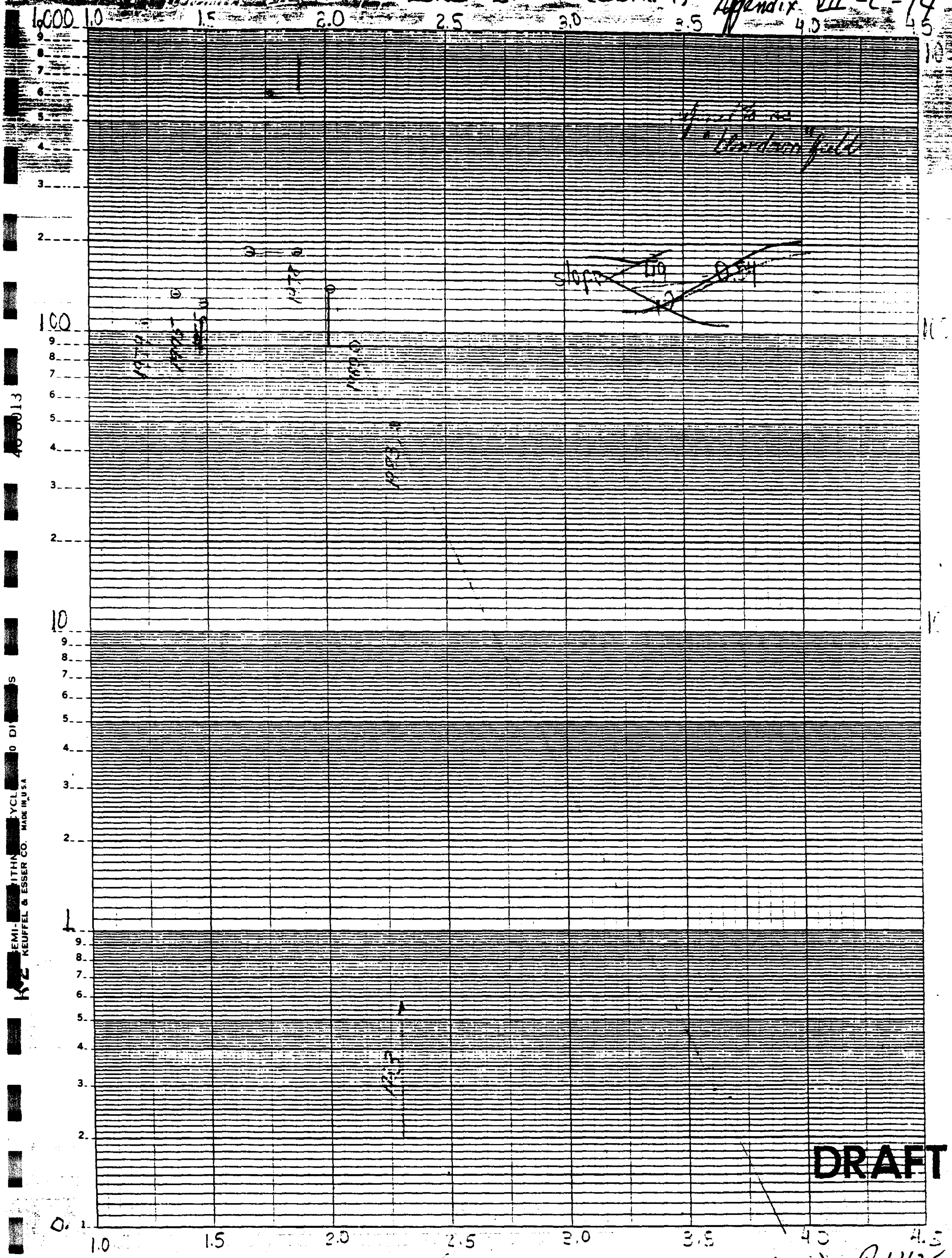
p.140.

Canales Blucher (TCB) - (disme. 4)

Appendix VII-C-13



ZONE 21 B (distr. 4) Appendix VII-C-14



P.14V

APPENDIX VIII-A

TABLES OF ANNUAL PRODUCTION AND CUMULATIVE PRODUCTION
FOR LARGEST FIELDS IN DISTRICT 2

one Correction — paperclipped

YEAR	Calhoun/Victoria Counties HEYSER Frio ± 5,000'		Refugio County LAKE PASTURE Frio 2,000'-6,000'		Refugi TOM O Frio 3,0	
	Bcf ANNUAL RATE	Bcf CUM. PROD.	Bcf ANNUAL RATE	Bcf CUM. PROD.	Bcf ANNUAL RATE	
1968	34	338	27	150	37	408
1969	41	379	24	174	37	445
1970	42	421	19*	193	34	479
1971	28*	449	17	210	34	513
1972	17*	466	14	224	25*	538
1973	13*	479	12	236	15*	553
1974	9*	488	8*	244	10*	563
1975	6*	494	6*	250	7*	570
1976	3*	497	18	268	12	582
1977	3	500	25	293	14	596
1978	3	503	20*	313	10	606
1979	3	506	47	360	13	619
1980	6	512	54	414	14	633
1981						
1982						
1983	12	542	19	508	7	661

*Abrupt decrease in annual productive rate (20% or more) may indicate negative revision of reserves.

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APPENDIX VIII-A

TABLES OF ANNUAL PRODUCTION AND CUMULATIVE PRODUCTION
FOR LARGEST FIELDS IN DISTRICT 2

	Bee-Karnes Counties BURNELL Wilcox 6,000'-7,500'		Lavaca County PROVIDENT CITY Wilcox 8,000'-14,000'		Goliad-Karnes Counties TULSITA WILCOX Wilcox 6,800'-8,900'	
YEAR	Bcf ANNUAL RATE	Bcf CUM. PROD.	Bcf ANNUAL RATE	Bcf CUM. PROD.	Bcf ANNUAL RATE	Bcf CUM. PROD.
1968	27	274	18	210	20	257
1969	26	300	17	227	26	283
1970	16*	316	19	246	22	305
1971	16	332	16	262	16*	321
1972	22	354	17	279	17	338
1973	22	376	16	295	18	356
1974	17*	393	19	314	18	374
1975	15	408	14*	328	16	390
1976	12	420	12	340	15	405
1977	10	430	11	351	13	418
1978	9	439	9	360	11	429
1979	6*	445	9	369	9	438
1980	6	451	13	382	8	446
1981						
1982						
1983	2	461	9	411	2	457

*Abrupt decrease in annual productive rate (20% or more) may indicate negative revision of reserves.

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APPENDIX VIII-B

TABLES OF ANNUAL PRODUCTION AND CUMULATIVE PRODUCTION FOR LARGEST FIELDS IN DISTRICT 3

	Brazoria County CHOCOLATE BAYOU Frio 9,500'-11,500'		Fort Bend/Harris/Waller Cos. KATY Cockfield Wilcox 5,500'-10,500'		Matagorda/Wharton Cos. MAGNET WITHERS Miocene 3,000'-6,600'	
YEAR	Bcf ANNUAL RATE	Bcf CUM. PROD.	Bcf ANNUAL RATE	Bcf CUM. PROD.	Bcf ANNUAL RATE	Bcf CUM. PROD.
1968	28	782	265	1,848	74	458
1969	21*	803	324	2,172	67	525
1970	14*	817	364	2,536	77	602
1971	12	829	389	2,925	59*	661
1972	12	841	420	3,345	52	713
1973	10	851	476	3,821	39*	752
1974	7	858	404	4,225	31	783
1975	5	863	282*	4,507	15*	798
1976	4	867	276	4,783	13	811
1977	4	871	269	5,052	14	825
1978	3	874	250	5,302	18	843
1979	2	876	252	5,554	16	859
1980	2	878	248	5,802	13	872
1981						
1982						
1983	2	883	166	6,382	6	896

*Abrupt decrease in annual productive rate (20% or more) may indicate negative revision of reserves.

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APPENDIX VIII-B

TABLES OF ANNUAL PRODUCTION AND CUMULATIVE PRODUCTION
FOR LARGEST FIELDS IN DISTRICT 3

	Brazoria County OLD OCEAN Frio 9,300'-10,800'		Brazoria County PLEDGER Miocene/Frio 4,600'-7,700'		Colorado County SHERIDAN Wilcox 8,000'-10,800'	
YEAR	Bcf ANNUAL RATE	Bcf CUM. PROD.	Bcf ANNUAL RATE	Bcf CUM. PROD.	Bcf ANNUAL RATE	Bcf CUM. PROD.
1968	118	1,061	63	603	100	640
1969	161	1,222	65	668	113	753
1970	157	1,379	67	735	92	845
1971	152	1,531	61	796	84	929
1972	154	1,685	59	855	70	999
1973	137	1,822	64	919	56*	1,055
1974	113	1,935	66	985	50	1,105
1975	104	2,039	64	1,049	41	1,146
1976	95	2,134	67	1,116	37	1,183
1977	84	2,218	98	1,214	32	1,215
1978	34*	2,252	102	1,316	28	1,243
1979	83	2,335	83*	1,398	25	1,268
1980	79	2,414	32*	1,430	21	1,289
1981						
1982						
1983	51	2,596	4	1,472	12	1,330

*Abrupt decrease in annual productive rate (20% or more) may indicate negative revision of reserves.

APPENDIX VIII-B

TABLES OF ANNUAL PRODUCTION AND CUMULATIVE PRODUCTION FOR LARGEST FIELDS IN DISTRICT 3

	Matagorda County COLLEGE PORT Miocene 2,200'-5,600'		Chambers County FISHERS REEF Frio 8,000'-8,700'		Chambers County REDFISH REEF Miocene/Frio 3,000'-11,000'	
YEAR	Bcf ANNUAL RATE	Bcf CUM. PROD.	Bcf ANNUAL RATE	Bcf CUM. PROD.	Bcf ANNUAL RATE	Bcf CUM. PROD.
1968	14	163	8	44	24	59
1969	17	180	11	55	22	81
1970	21	201	17	72	14*	95
1971	18*	219	14	86	15	110
1972	17	236	12	98	15	125
1973	14	250	11	109	17	142
1974	12	262	8	117	17	159
1975	6*	268	10	127	15	174
1976	9	277	9	136	14	188
1977	9	286	7*	143	11*	199
1978	8	294	5*	148	18	217
1979	7	301	4	152	15	232
1980	7	308	3	155	10	242
1981						
1982						
1983	5	325	3	166	6	266

*Abrupt decrease in annual productive rate (20% or more) may indicate negative revision of reserves.

APPENDIX VIII-C

TABLES OF ANNUAL PRODUCTION AND CUMULATIVE PRODUCTION
FOR LARGEST FIELDS IN DISTRICT 4

YEAR	Hidalgo County LA BLANCA Frio 6,500'-9,400' Bcf ANNUAL RATE	Bcf CUM. PROD.	Hidalgo County McALLEN Frio (Vicksburg) 5,800'-10,400' Bcf ANNUAL RATE	Bcf CUM. PROD.	Kenedy/Kleberg Counties SARITA Miocene/Frio 1,900'-8,300' Bcf ANNUAL RATE	Bcf CUM. PROD.
1968	14	122	23	261	11	37
1969	15	137	19	280	13	50
1970	17	154	14*	294	16	66
1971	17	171	13	307	21	87
1972	17	188	10*	317	21	108
1973	16	204	10	327	21	129
1974	13	217	9	336	18	147
1975	10*	227	8	344	17	164
1976	9	236	6*	350	16	180
1977	7*	243	6	356	11*	191
1978	6	249	5	361	9	200
1979	5	254	4	365	8	208
1980	5	259	4	369	6	214
1981						
1982						
1983	3	273	2	375	5	229

*Abrupt decrease in annual productive rate (20% or more) may indicate negative revision of reserves.

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APPENDIX VIII-C

TABLES OF ANNUAL PRODUCTION AND CUMULATIVE PRODUCTION
FOR LARGEST FIELDS IN DISTRICT 4

YEAR	Kenedy County STILLMAN Frio 5,600'-12,400'		Kleberg County ALAZAN NORTH Deep Frio 6,400'-11,400'		Kleberg County BORREGOS Frio 5,000'-7,000' Vicksburg 7,500'-8,200'	
	Bcf ANNUAL RATE	Bcf CUM. PROD.	Bcf ANNUAL RATE	Bcf CUM. PROD.	Bcf ANNUAL RATE	Bcf CUM. PROD.
1968	11	54	117	410	103	350
1969	8*	62	69*	479	97	447
1970	7	69	63	542	103	550
1971	6	75	78	620	108	658
1972	5	80	90	710	124	782
1973	9	89	87	797	157	939
1974	14	103	87	884	76*	1,015
1975	15	118	79	963	92	1,107
1976	12*	130	68	1,031	144	1,251
1977	11	141	53*	1,084	131	1,382
1978	10	151	48	1,132	106	1,488
1979	8*	159	34	1,166	89	1,577
1980	7	166	24*	1,190	71*	1,648
1981						
1982						
1983	6	186	8	1,230	36	1,792

*Abrupt decrease in annual productive rate (20% or more) may indicate negative revision of reserves.

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APPENDIX VIII-C

TABLES OF ANNUAL PRODUCTION AND CUMULATIVE PRODUCTION
FOR LARGEST FIELDS IN DISTRICT 4

	Brooks/Jim Wells Counties LA GLORIA Frio 5,200'-8,200'		Kleberg/Nueces Counties LAGUNA LARGA Frio 6,000'-6,500'		Hidalgo County McALLEN RANCH Vicksburg 9,300'-14,000'	
YEAR	Bcf ANNUAL RATE	Bcf CUM. PROD.	Bcf ANNUAL RATE	Bcf CUM. PROD.	Bcf ANNUAL RATE	Bcf CUM. PROD.
1968	81	762	4	7	46	160
1969	73	835	2	9	38*	198
1970	82	917	5	14	30*	228
1971	80	997	17	31	34	262
1972	76	1,073	40	71	29	291
1973	67	1,140	54	125	36	327
1974	60	1,200	84	209	28*	355
1975	45*	1,245	60	269	28	383
1976	35*	1,280	65	334	33	416
1977	27*	1,307	48*	382	33	449
1978	20*	1,327	44	426	29	478
1979	15*	1,342	54	480	24	502
1980	12*	1,354	60	540	24	526
1981						
1982						
1983	7	1,379	32	666	22	595

*Abrupt decrease in annual productive rate (20% or more) may indicate negative revision of reserves.

APPENDIX VIII-C

TABLES OF ANNUAL PRODUCTION AND CUMULATIVE PRODUCTION
FOR LARGEST FIELDS IN DISTRICT 4

YEAR	Jim Wells/Kleberg Cos. SEELIGSON Frio 4,200'-7,500' Bcf ANNUAL RATE	Bcf CUM. PROD.	Jim Wells/Kleberg/Nueces Cos. STRATTON Wardner/Frio 4,000'-9,000' Bcf ANNUAL RATE	Bcf CUM. PROD.	Jim Hogg/Webb Cos. THOMPSONVILLE NE Wilcox 9,400'-12,600' Bcf ANNUAL RATE	Bcf CUM. PROD.
1968	125	447	93	262	30	240
1969	98*	545	108	370	34	274
1970	90	635	110	480	45	319
1971	97	732	119	599	36*	355
1972	94	826	127	726	35	390
1973	84	910	134	860	37	427
1974	59*	969	111	971	33	460
1975	62	1,031	97	1,068	27	487
1976	63	1,094	80	1,148	21*	508
1977	55	1,149	71	1,219	18	526
1978	51	1,200	69	1,288	16	542
1979	55	1,255	67	1,355	13	555
1980	43*	1,298	55	1,410	12	567
1981						
1982						
1983	25	1,391	22	1,512	5	589

*Abrupt decrease in annual productive rate (20% or more) may indicate negative revision of reserves.

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APPENDIX VIII-C

TABLES OF ANNUAL PRODUCTION AND CUMULATIVE PRODUCTION
FOR LARGEST FIELDS IN DISTRICT 4

	Jim Wells/Kleberg Counties TIJERINA-CANALES-BLOCHER Frio 6,700'-11,400'		Jim Wells/Kleberg Counties ZONE 21B Frio 6,500'-7,200'	
YEAR	Bcf ANNUAL RATE	Bcf CUM. PROD.	Bcf ANNUAL RATE	Bcf CUM. PROD.
1968	24	108	0	
1969	39	147	0	
1970	38	185	0	
1971	37	222	0	
1972	34	256	0	
1973	37	293	0	
1974	27*	320	107	1,239
1975	18*	338	132	1,371
1976	19	357	126	1,497
1977	22	379	188	1,685
1978	20	399	188	1,873
1979	17	416	139*	2,012
1980	14	430	90*	2,102
1981				
1982				
1983	12	469	49	2,289

*Abrupt decrease in annual productive rate (20% or more) may indicate negative revision of reserves.

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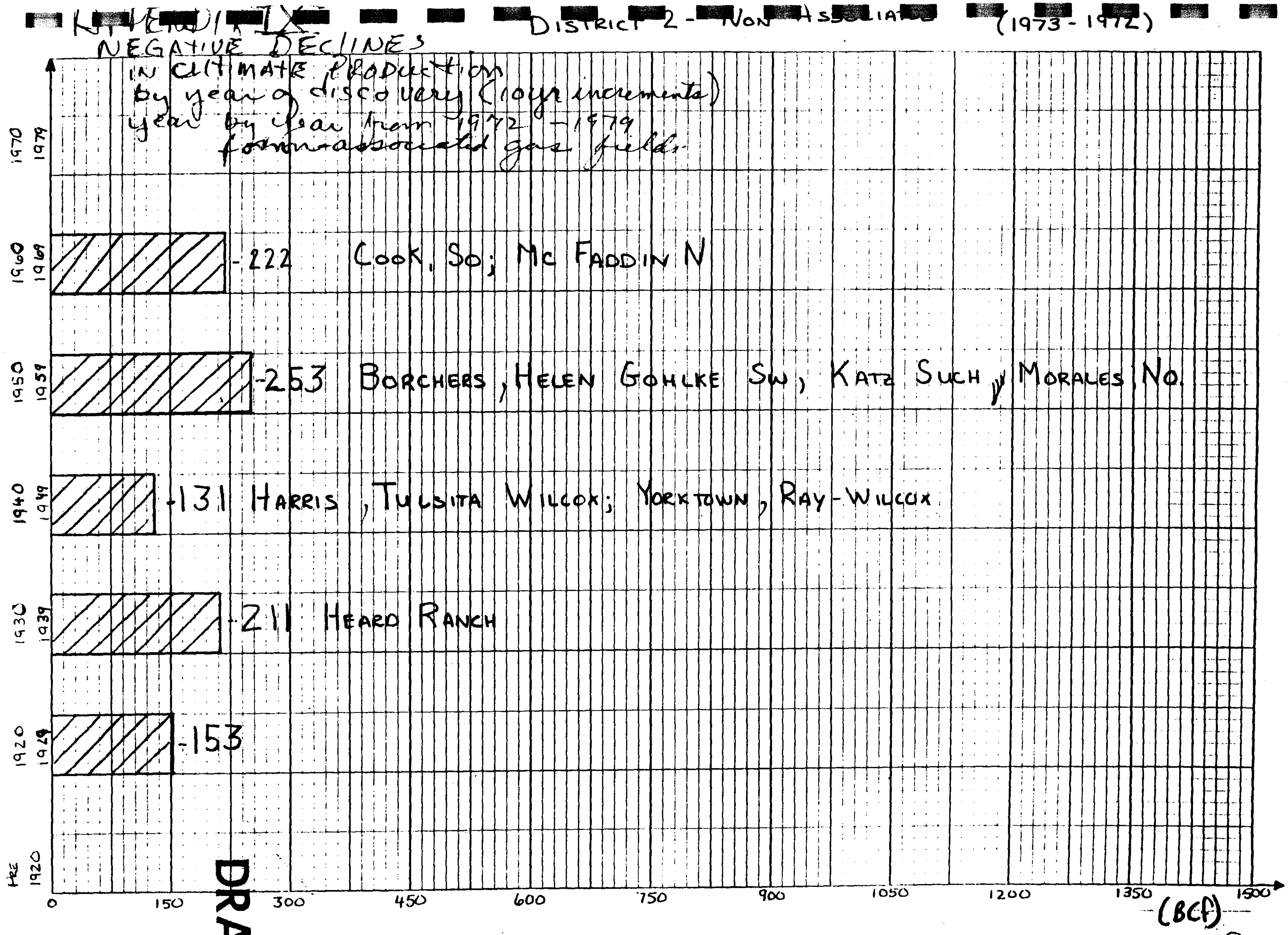

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APPENDIX A-1

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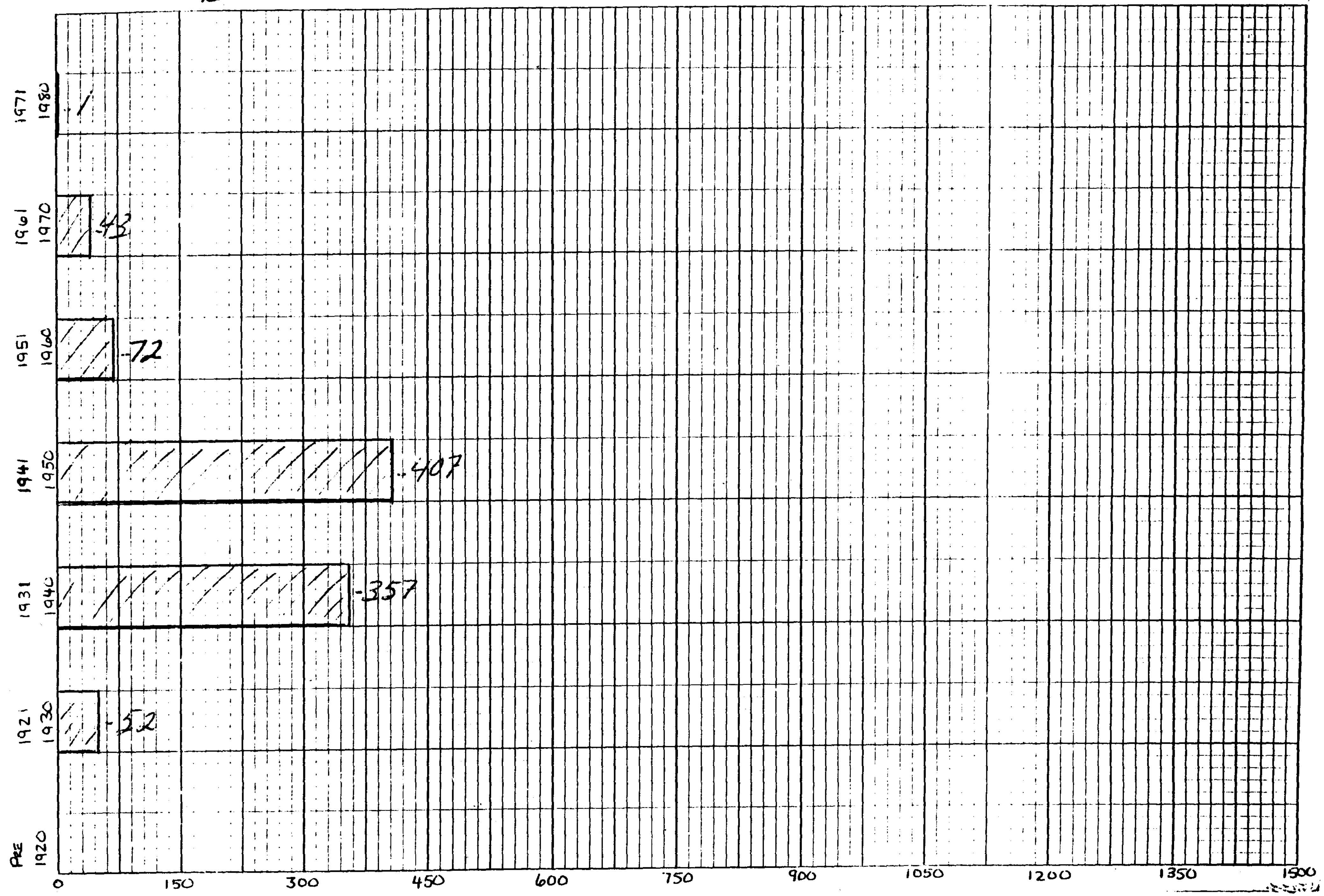
DISTRICT 2 NON ASSOCIATED (1974-1973)

A-2



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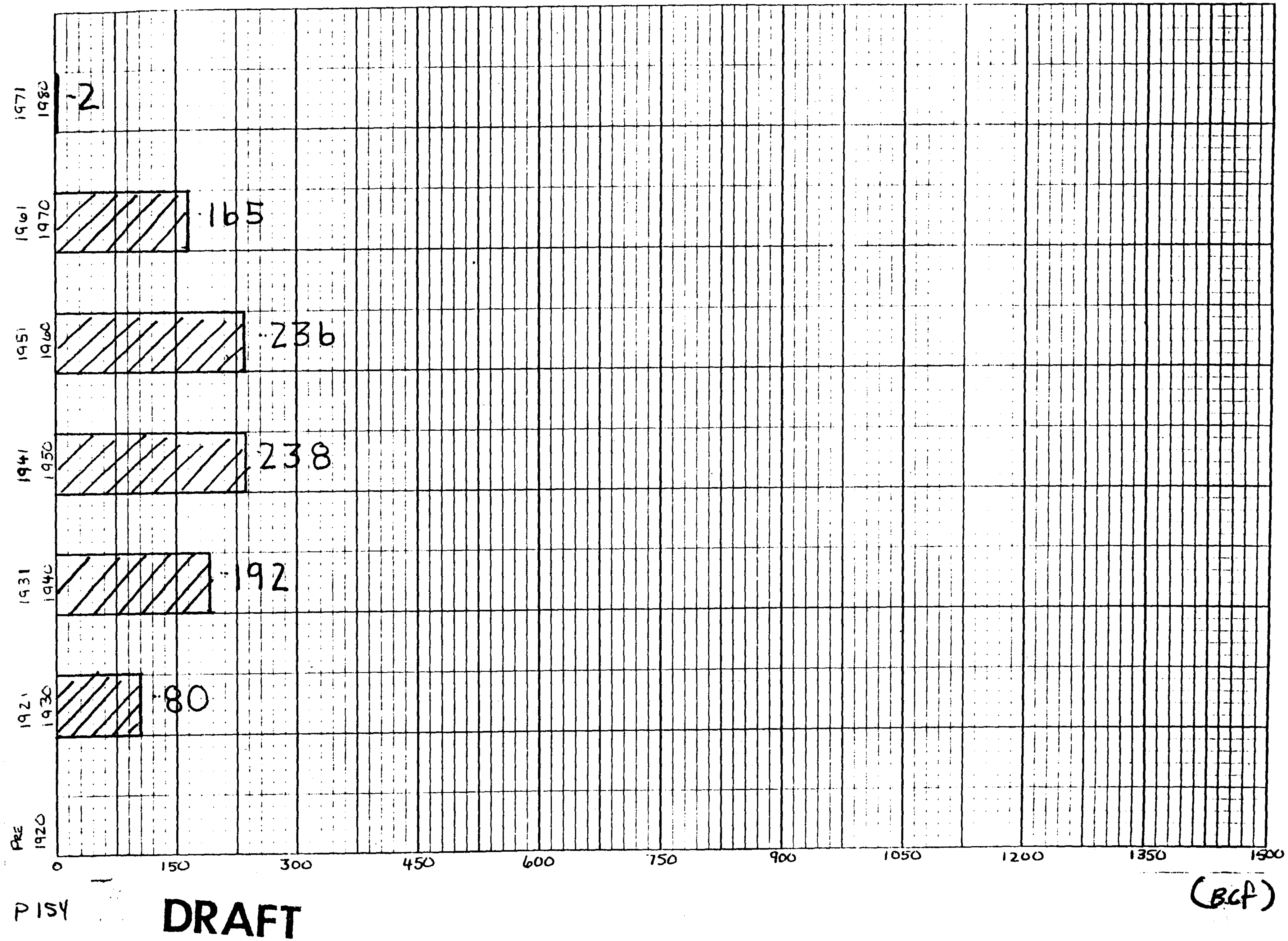
DISTRICT 2 [redacted] A-3



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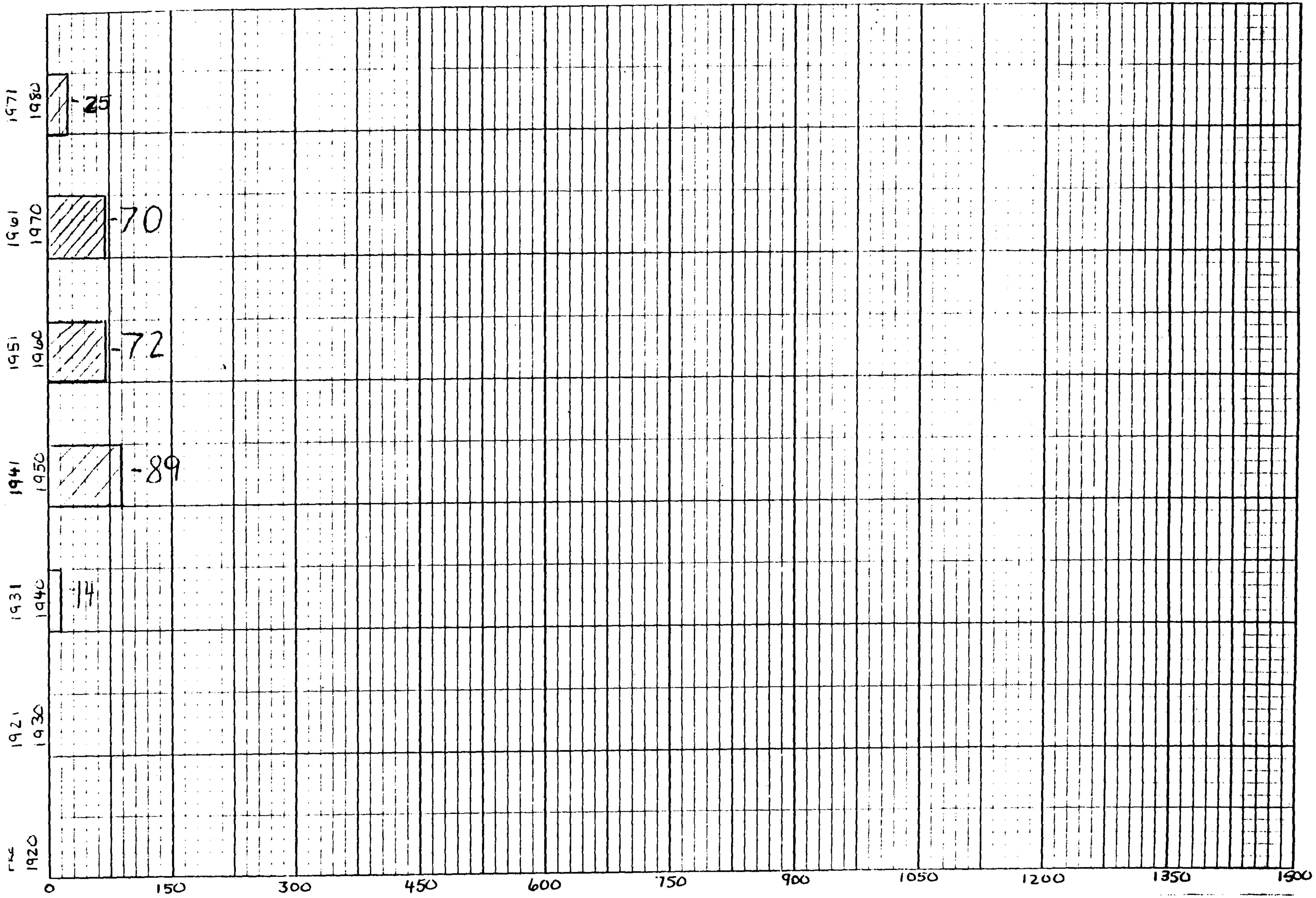

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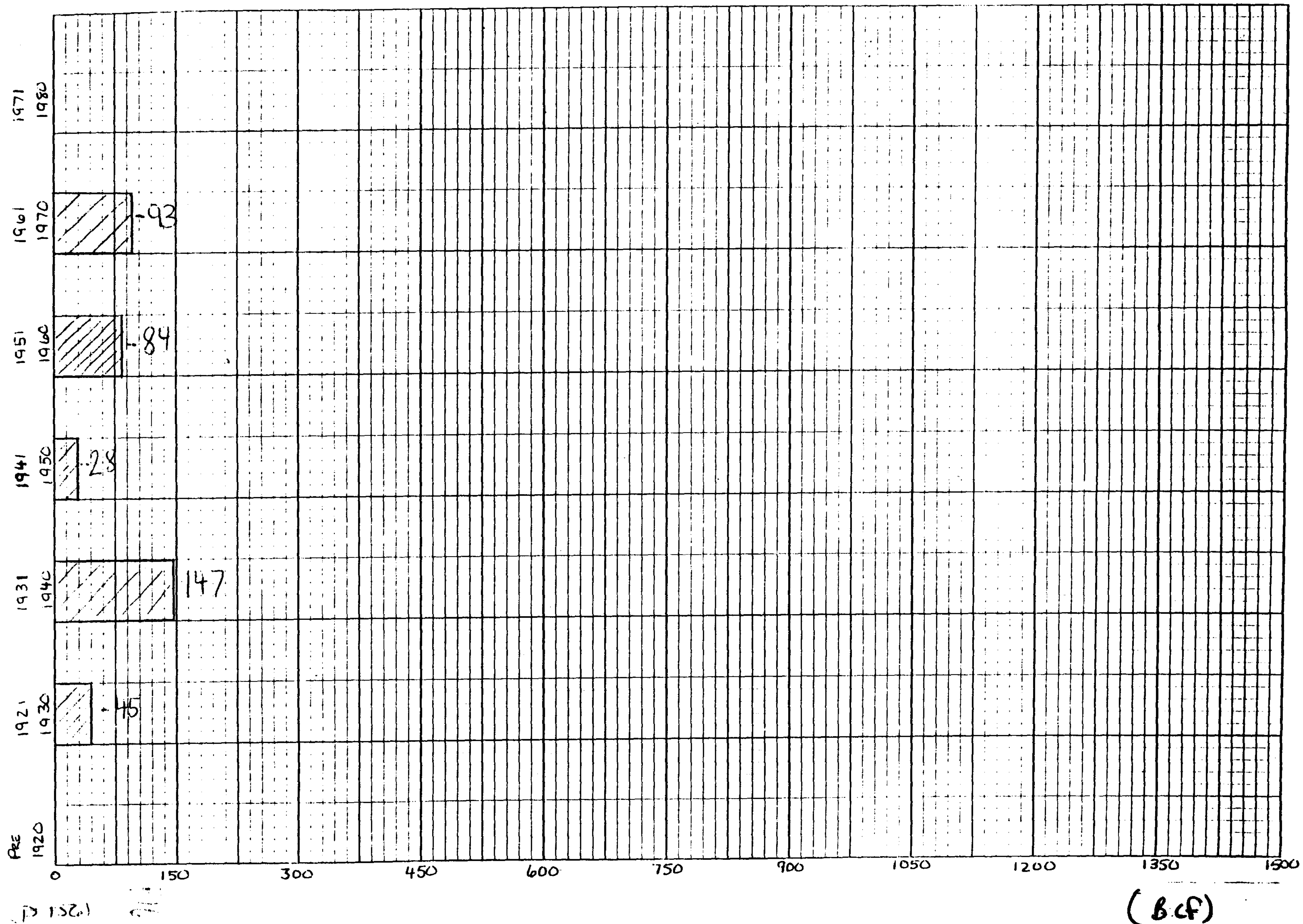

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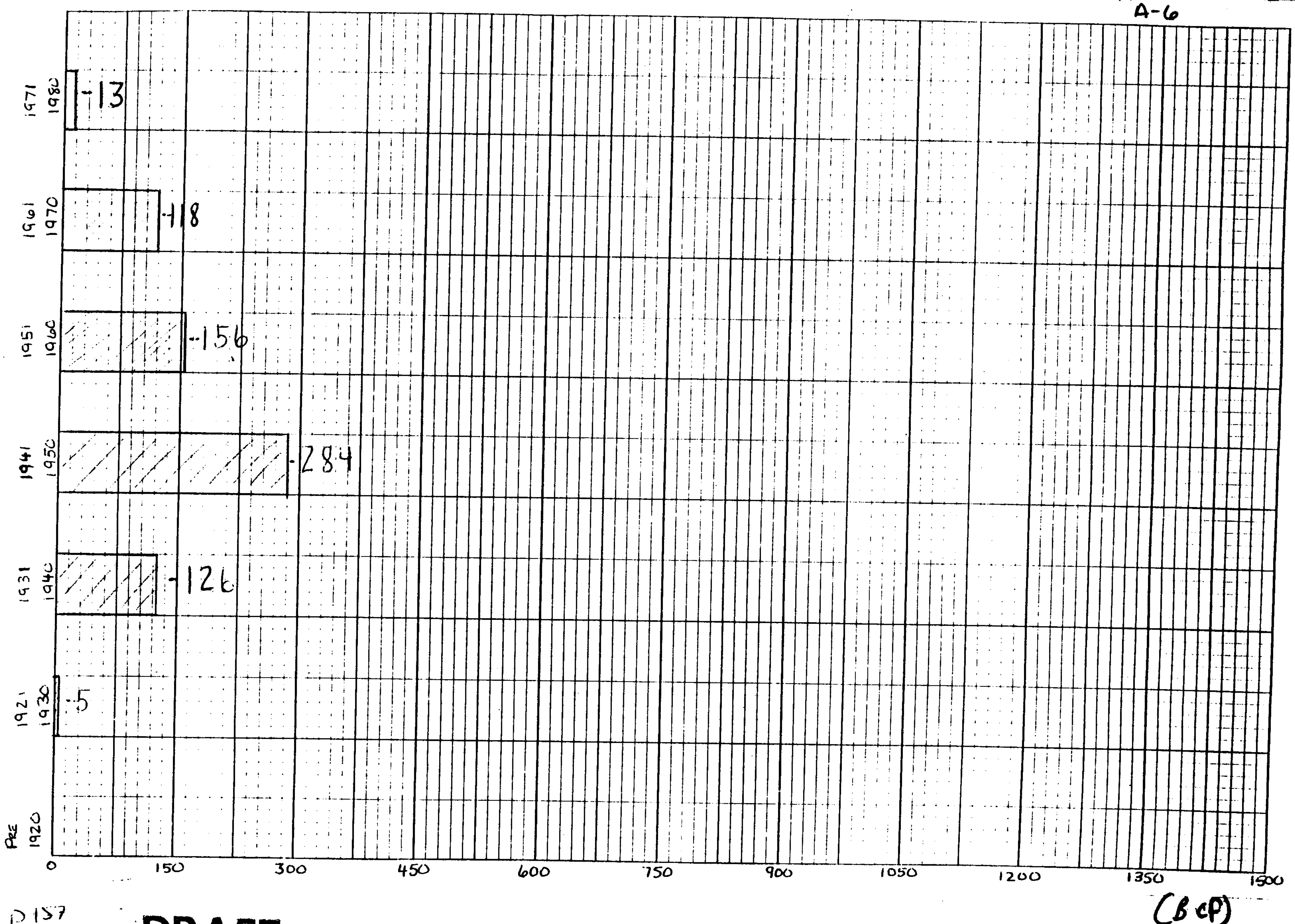
A-6



p 157

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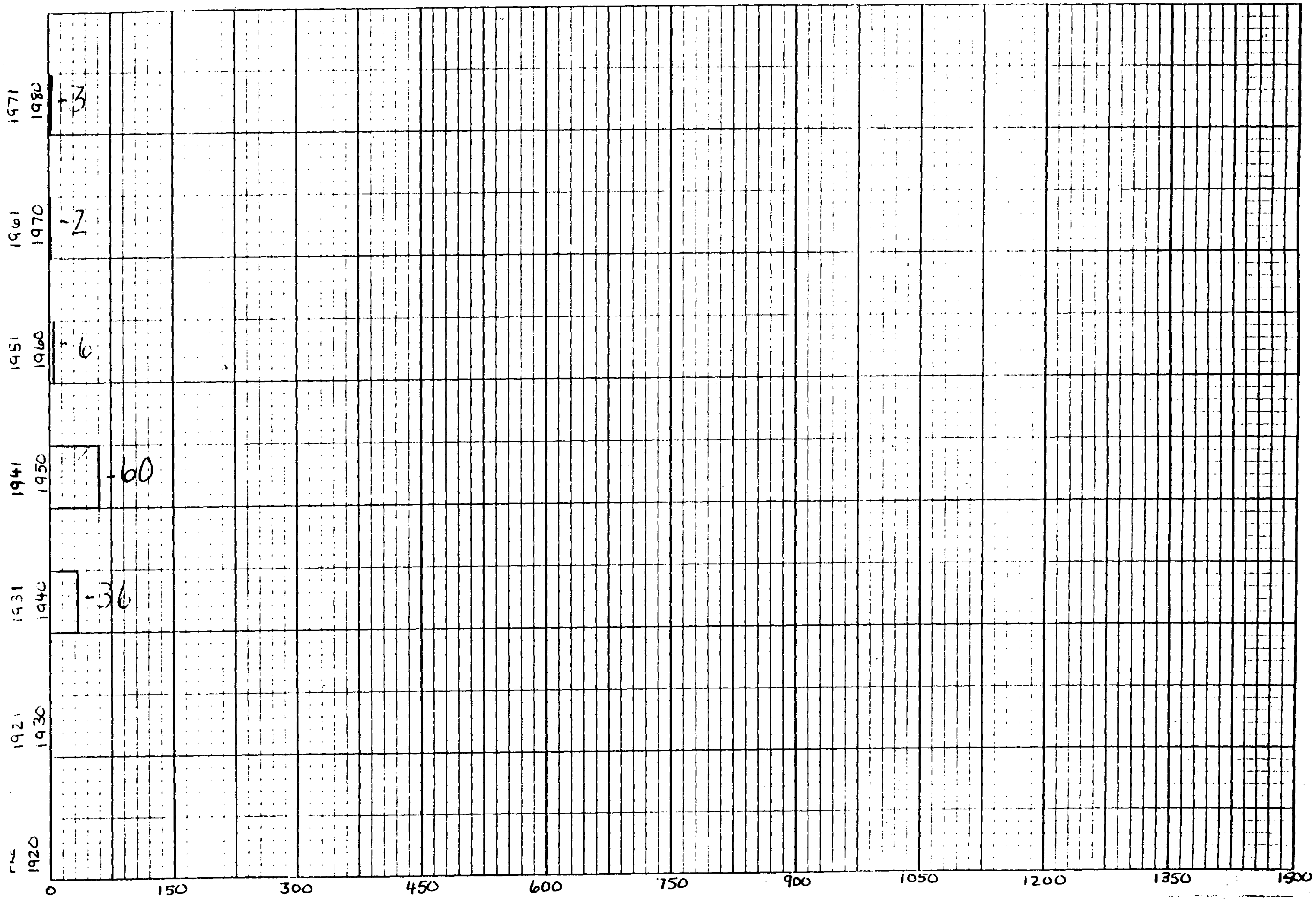
Appendix A-7



(B:cf)

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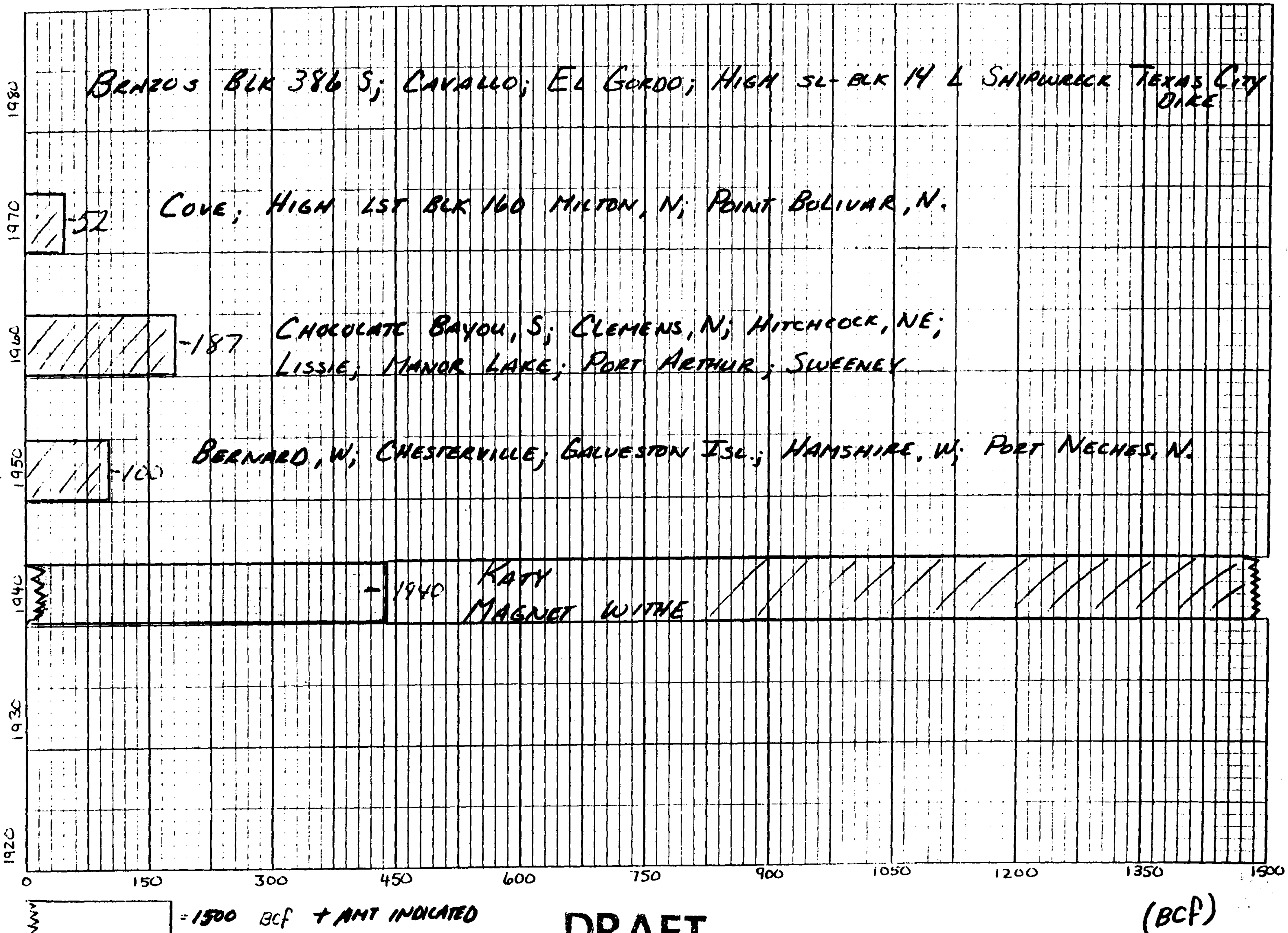
DISTRICT 3 NON ASSOCIATED (1973-1972) APPENDIX B-1



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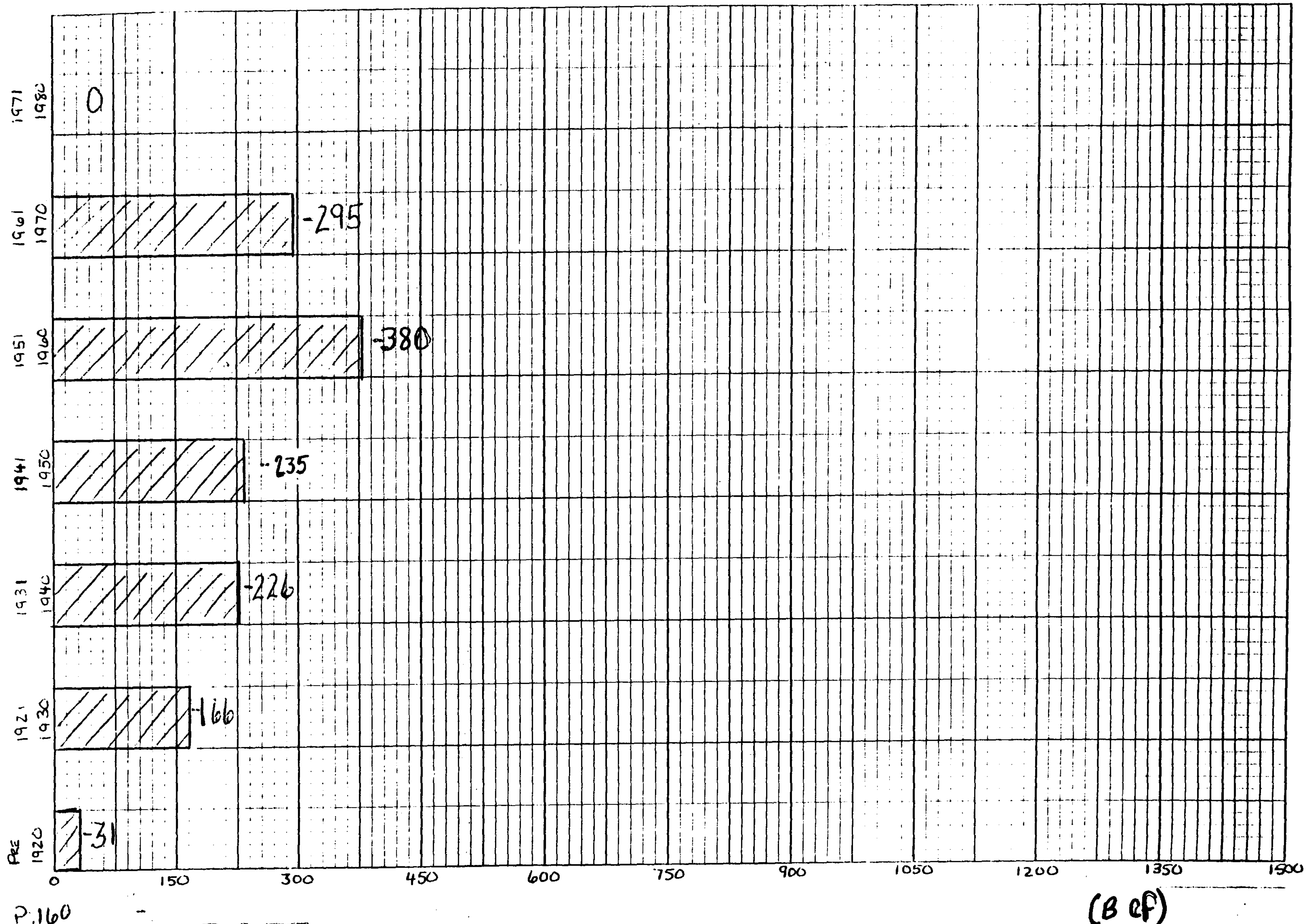
District 3 Non Associated (1974 – 1975) Appendix B-2



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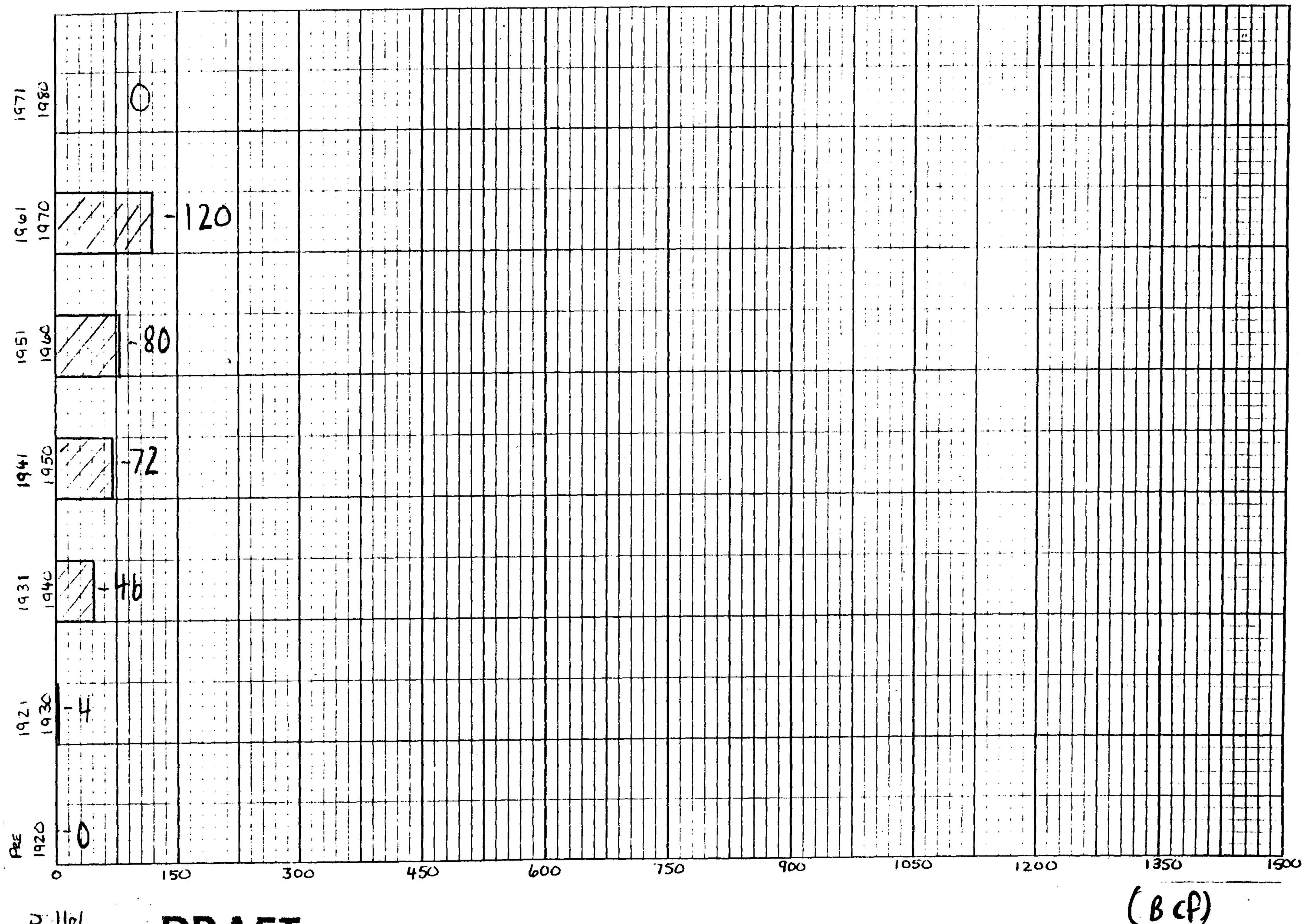
APPENDIX B-3

DISTRICT 5 NON ASSOCIATED (1975-19[illegible])



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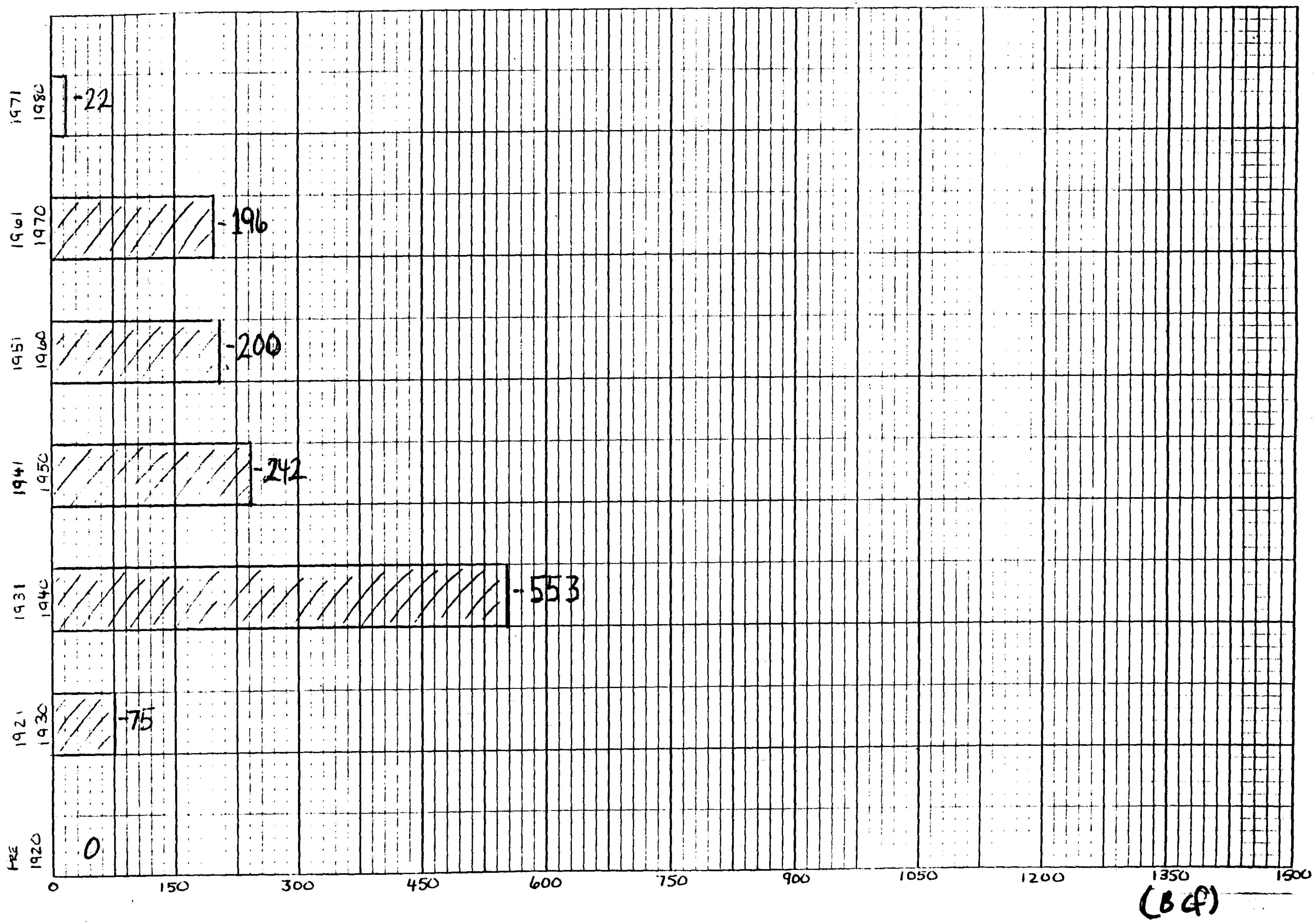
[redacted] District [redacted] Non [redacted] As [redacted] ci [redacted] o [redacted] (197 [redacted] 197 [redacted]) [redacted]

B-4



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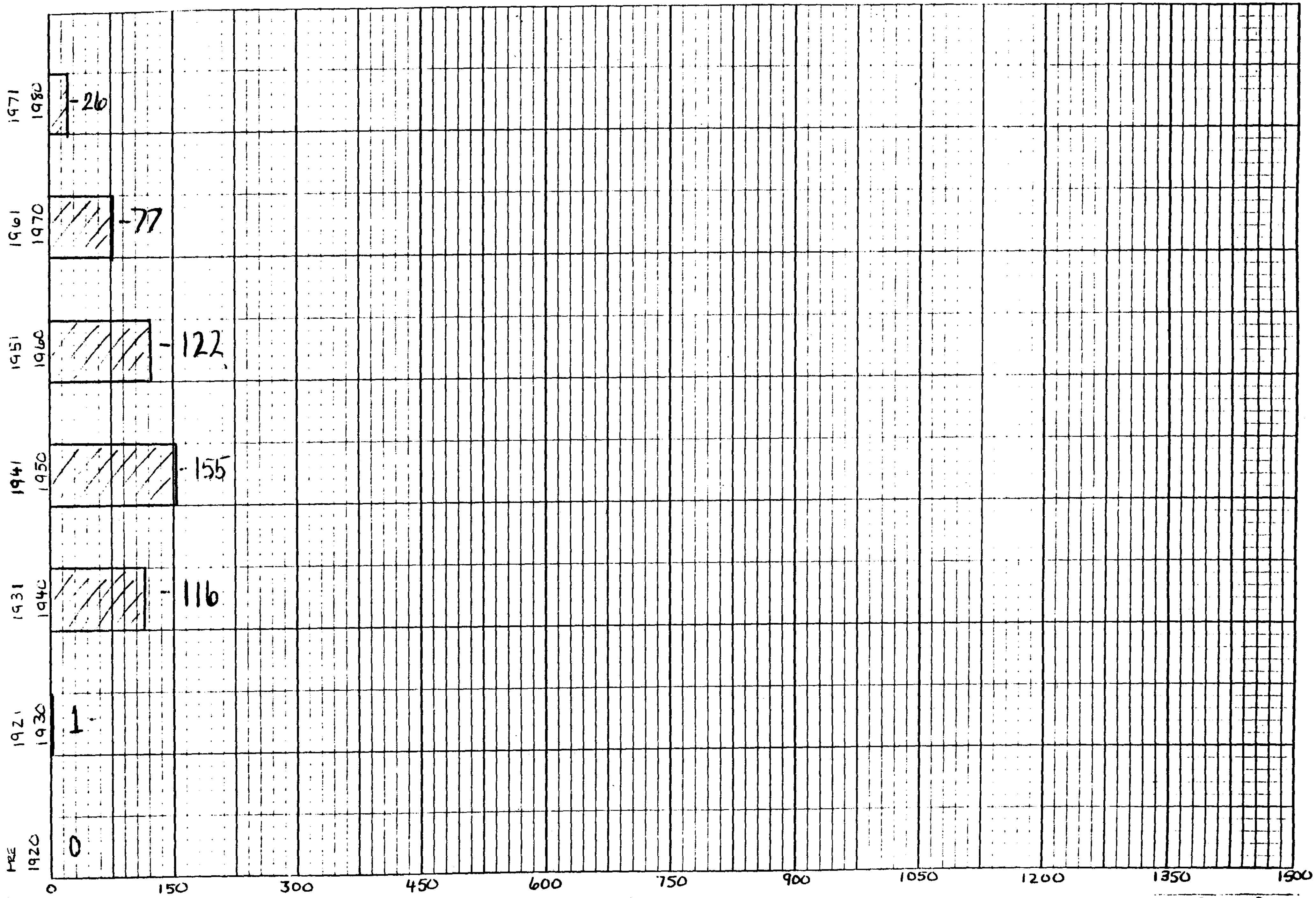
DISTRICT J NON ASSOCIATED (1977-1976) B-5



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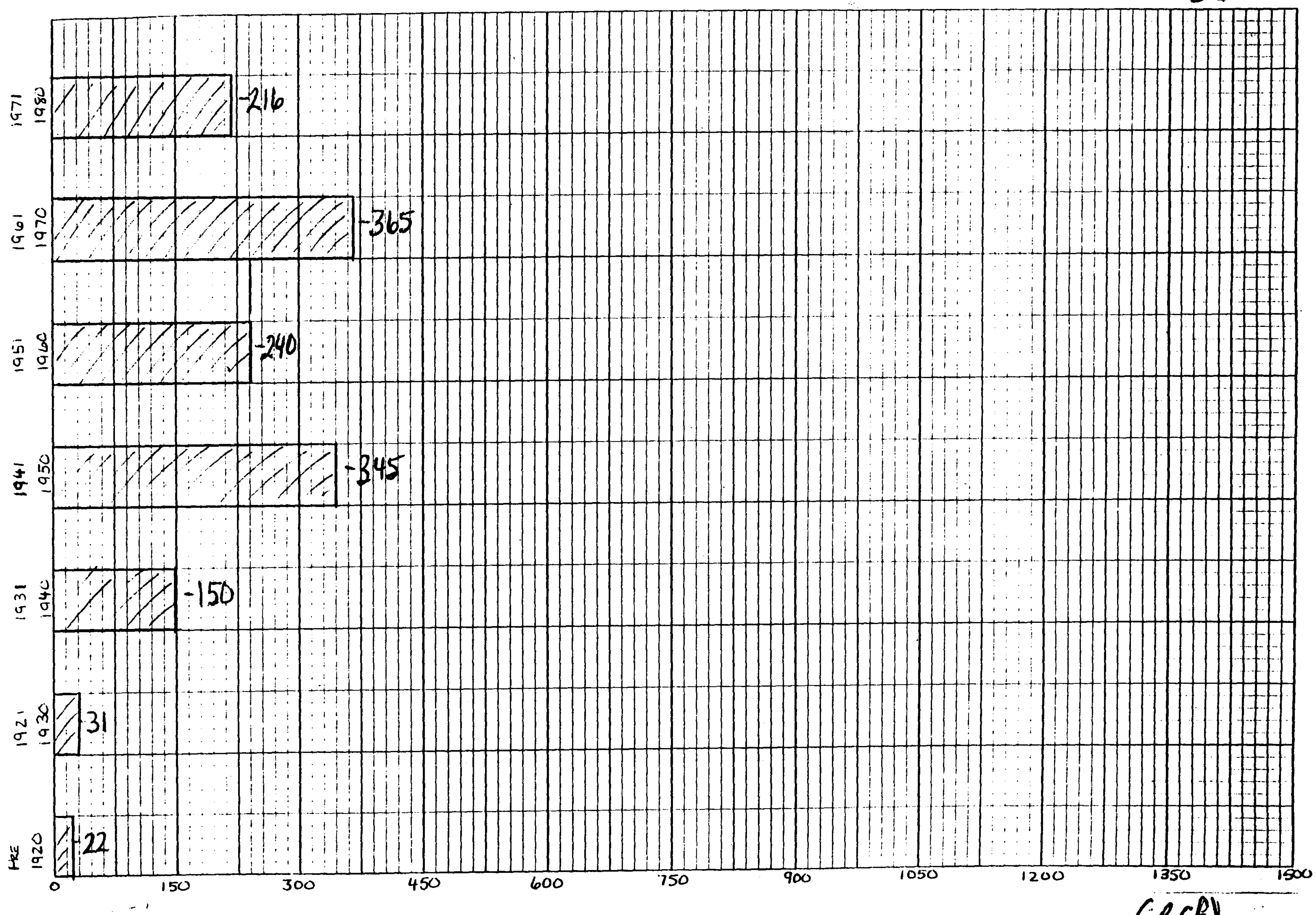
DISTRICT 3 NON ASSOCIATED (1978-1977) APPENDIX B-6



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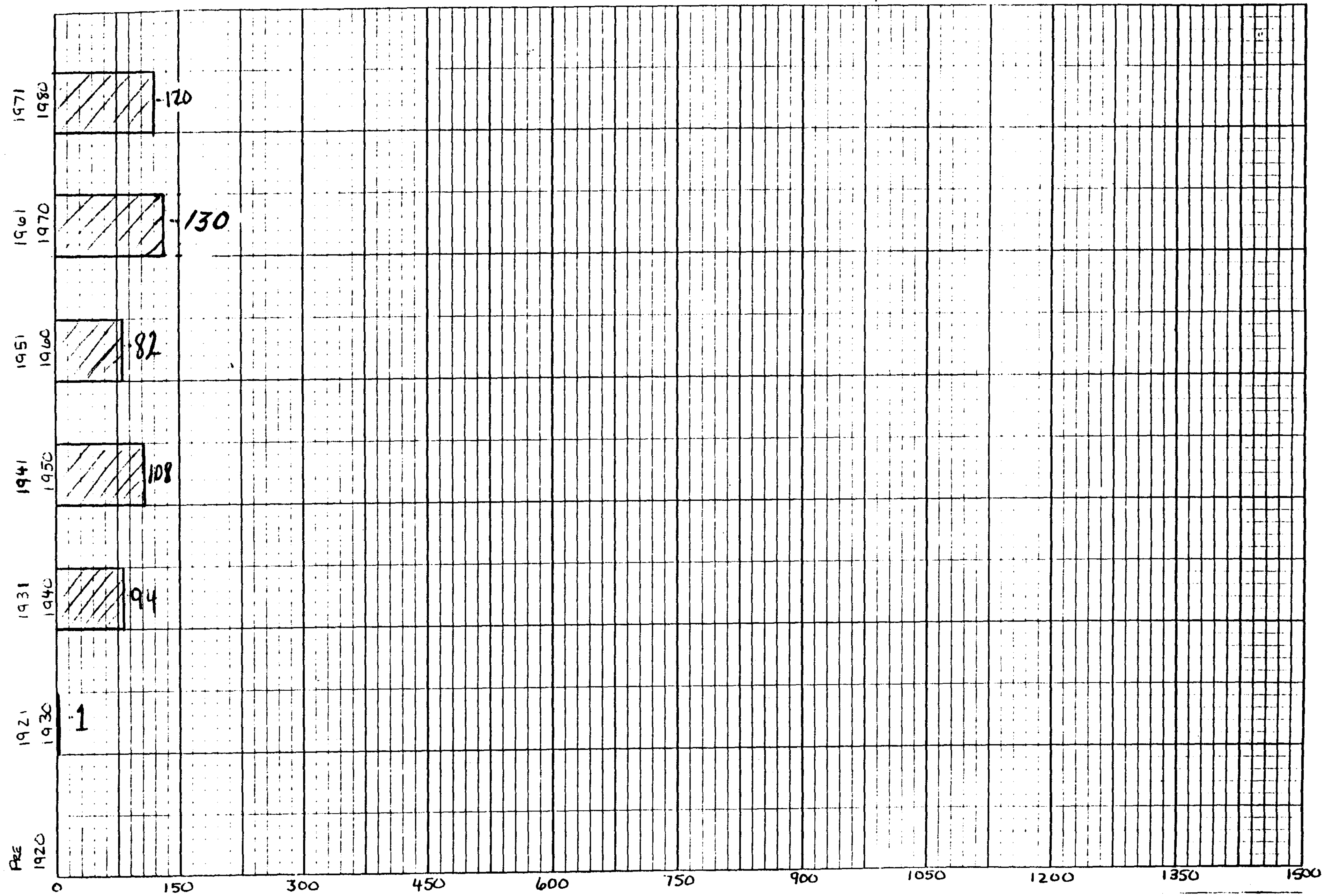
District 3 Non Associated (1919 - 1978)



(BCF)

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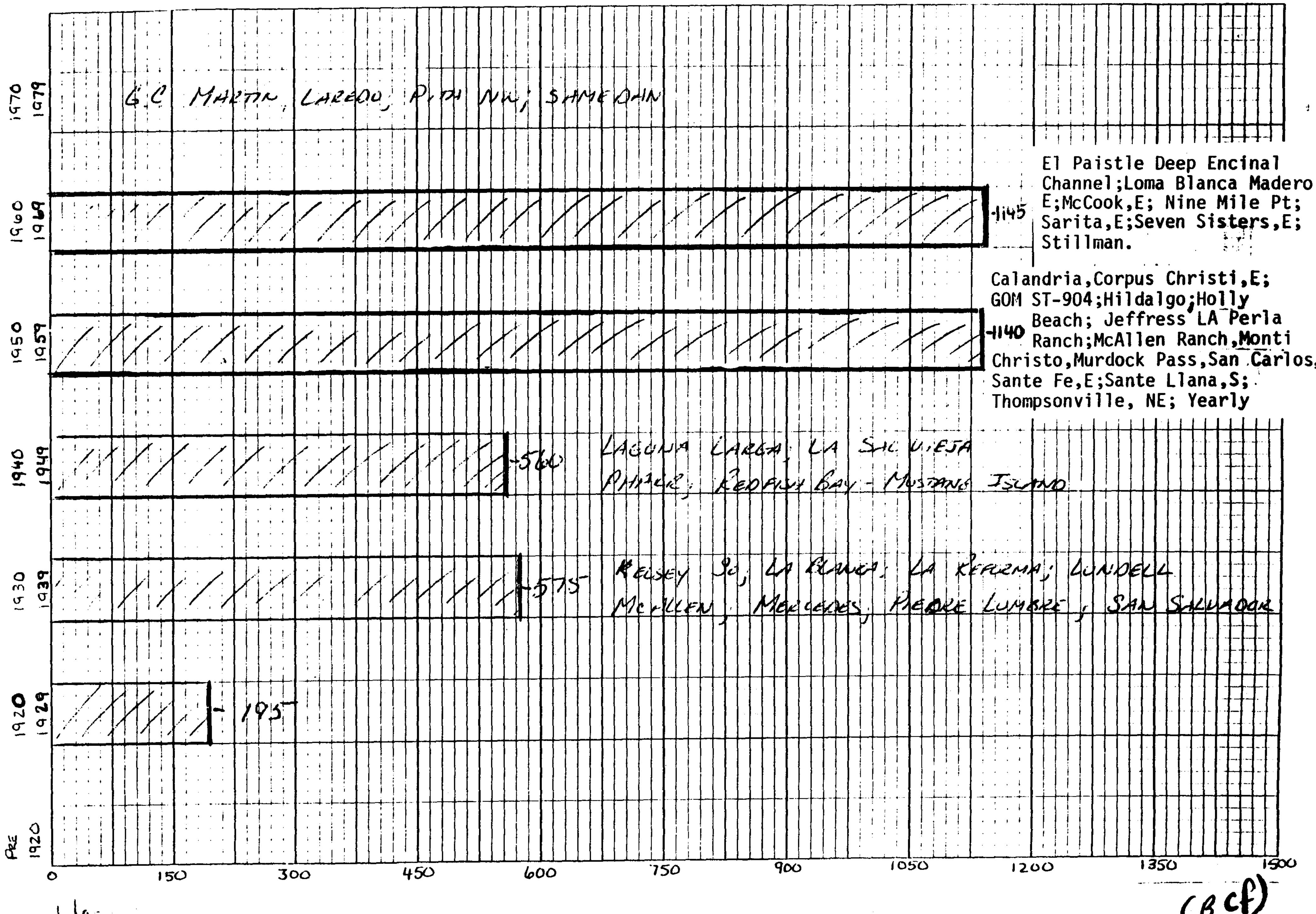
DISTRICT 4 NON ASSOCIATED (1973 - 1972)

APPENDIX C-1



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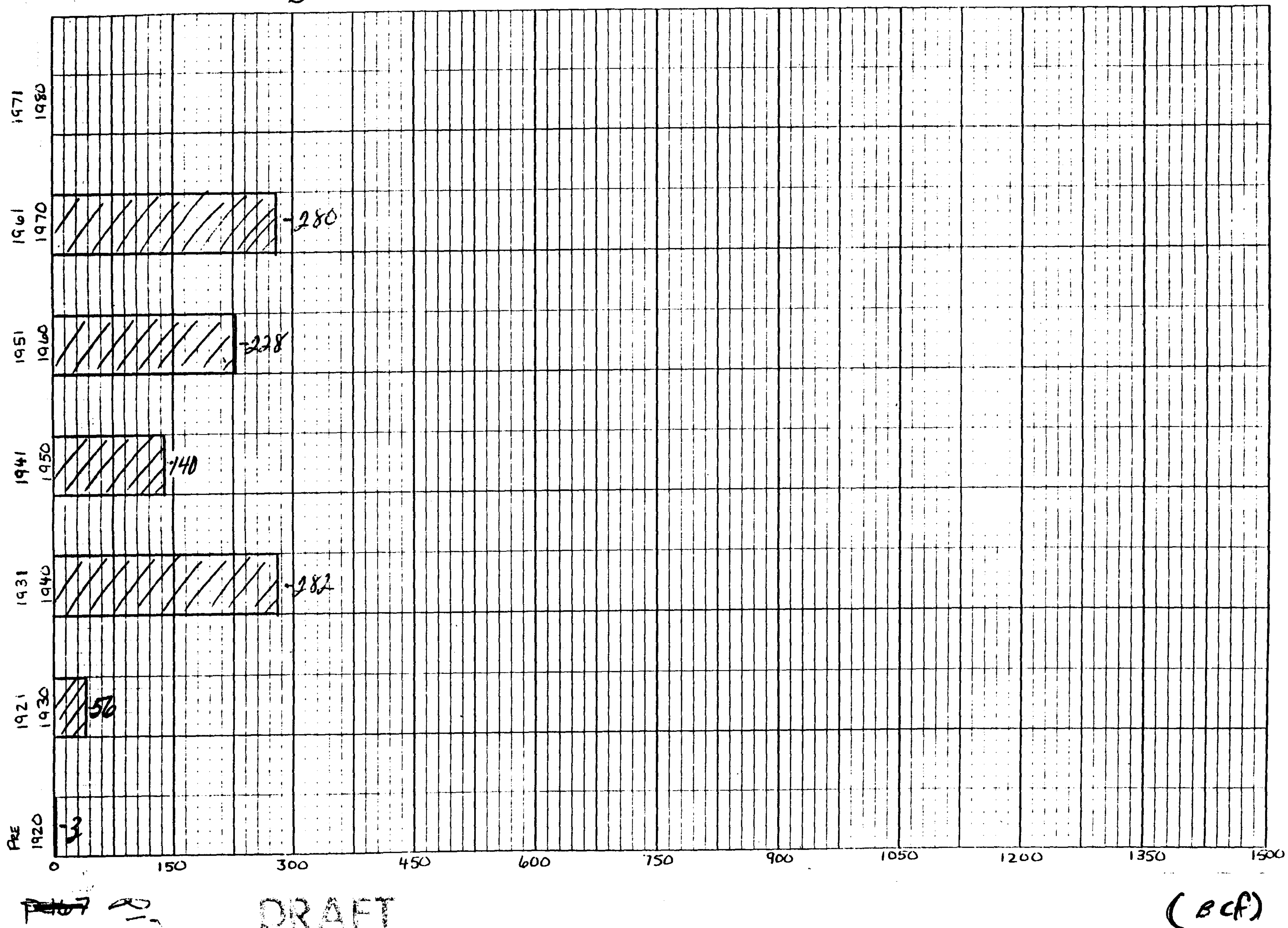
Appendix C-2

DISTRICT 4 NON ASSOCIATED (1974 - 1973)



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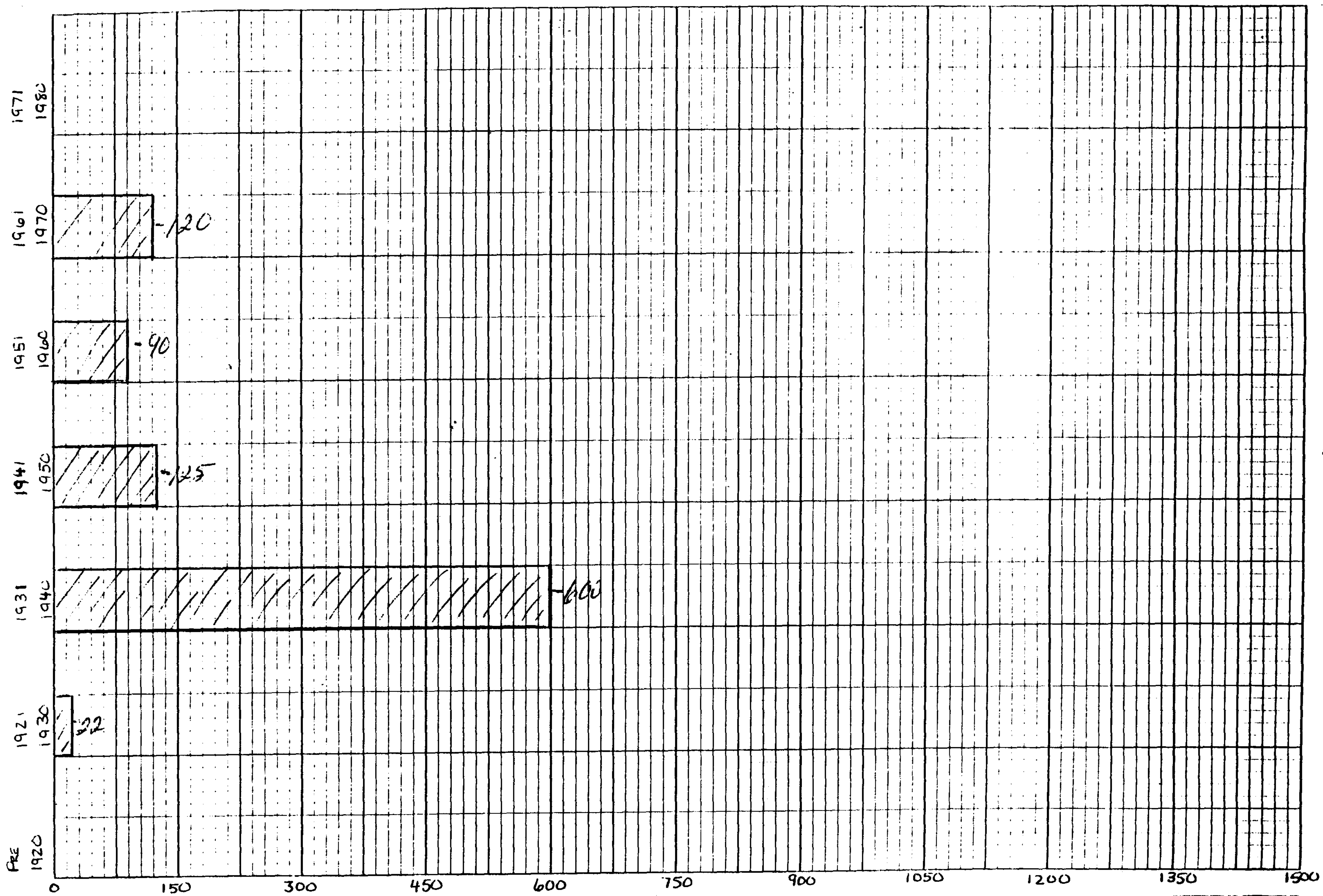
DISTRICT 4 NON ASSOCIATED (1975-1979) Appendix C-3



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(B.cf)

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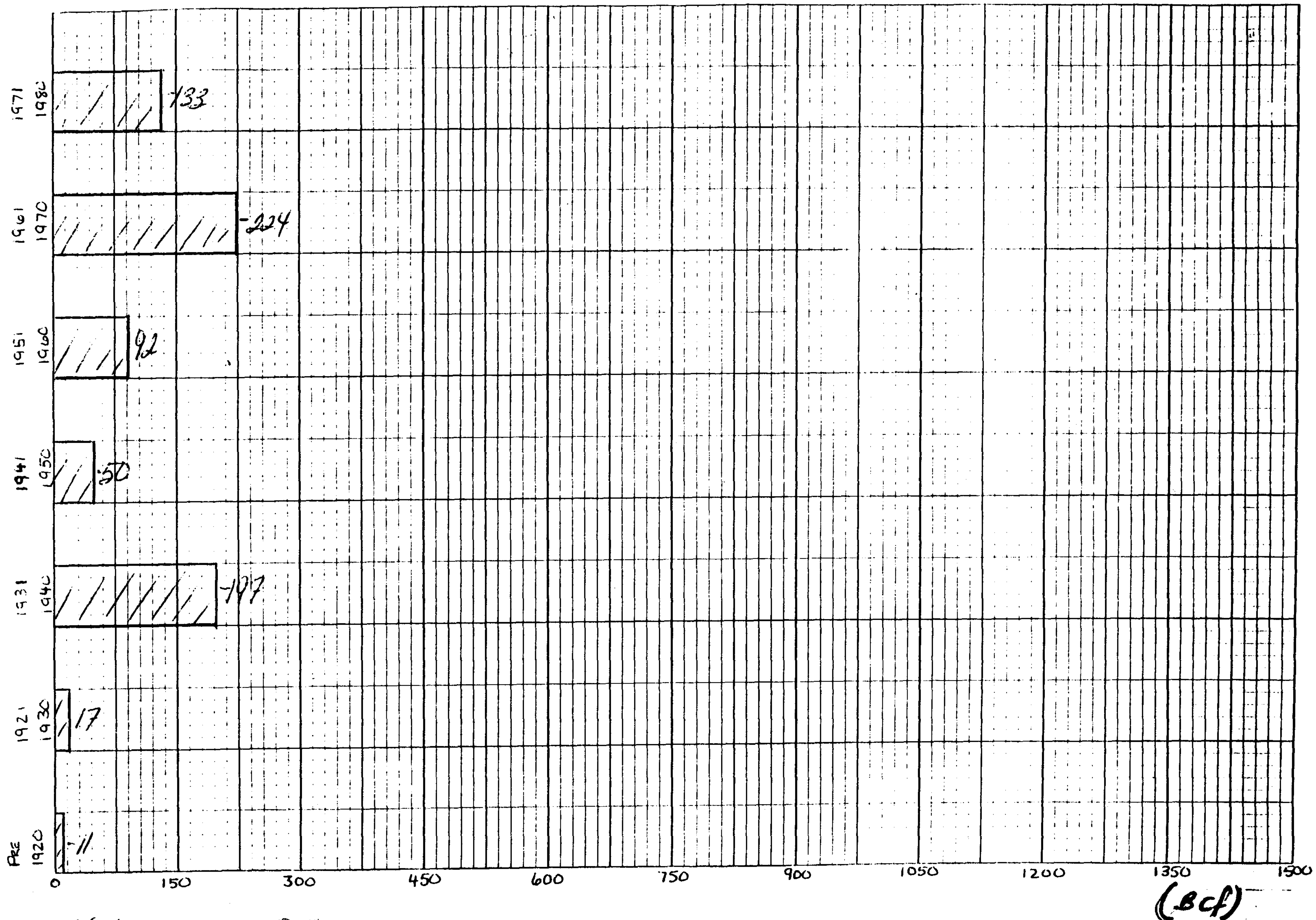

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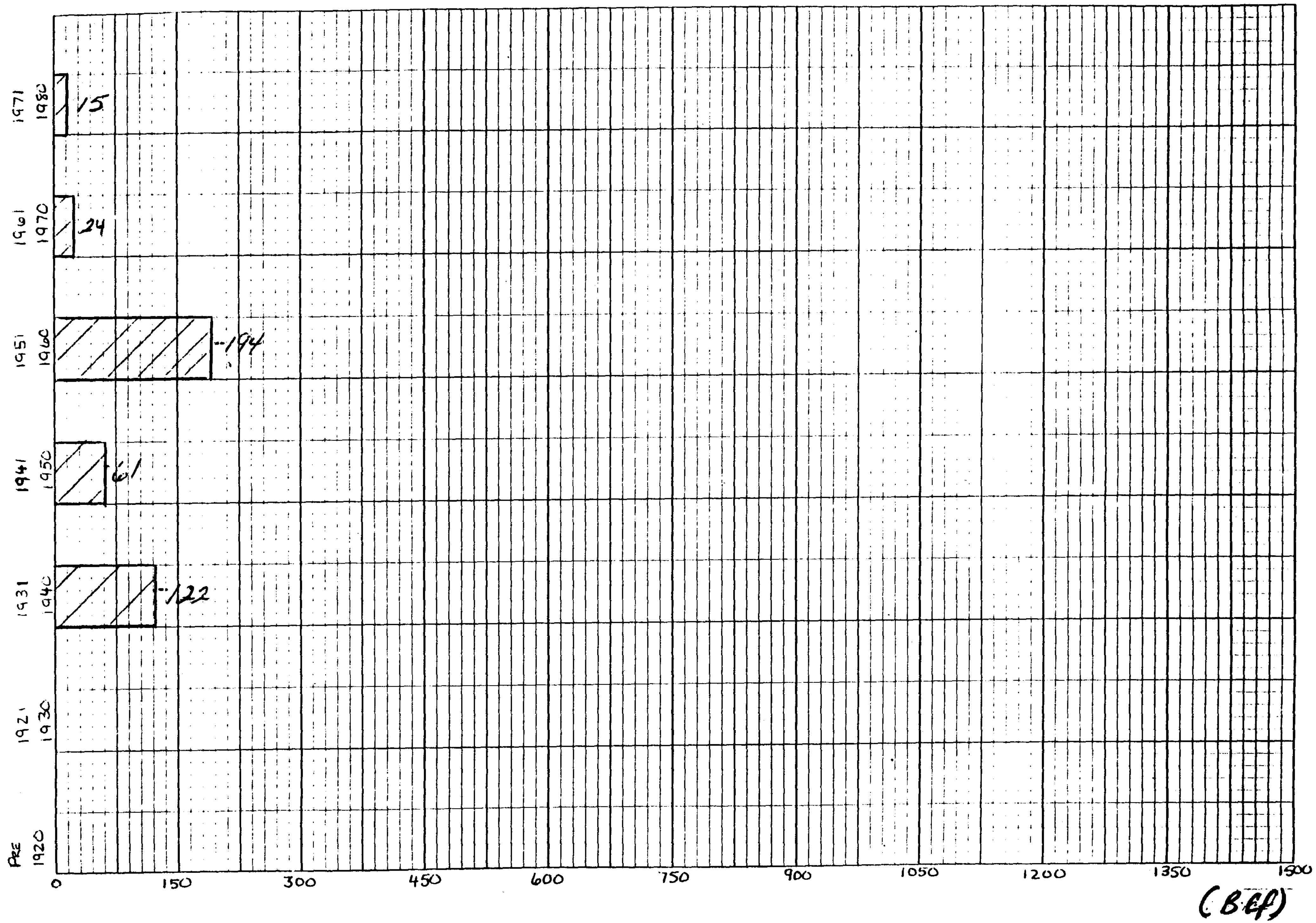
DISTRICT 4 NON ASSOCIATED

C-5



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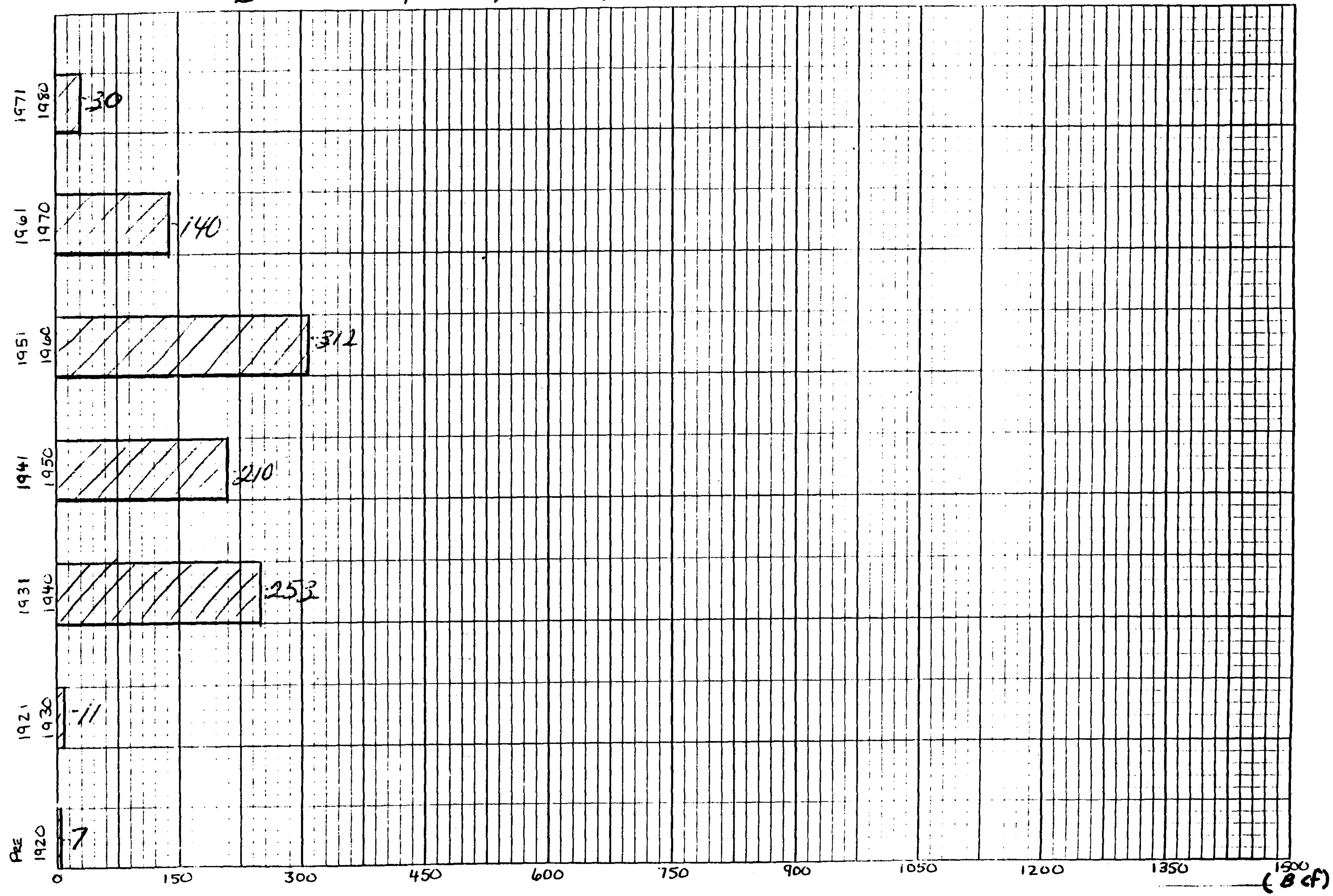
DISTRICT 4 NON ASSOCIATED (1978-1977)

C-6



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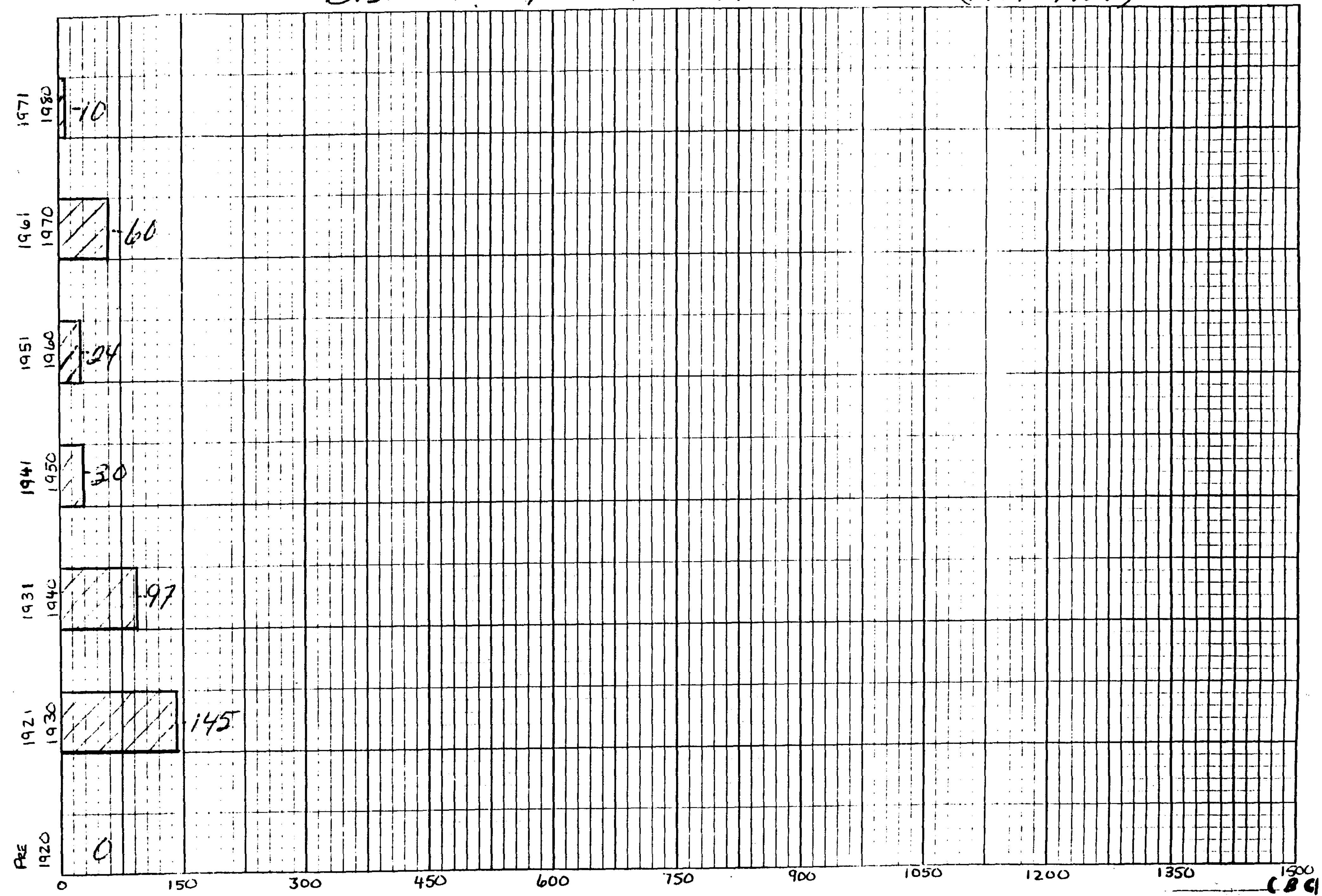
DISTRICT 4 NON ASSOCIATED (1979-1978)



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APPENDIX X
HISTORY OF TEXAS NATURAL GAS
Railroad Commision of Texas 1983 Annual Report

Year	Gas Well Gas Produced (Mcf)[1]	Percent of Total Gas %	Casinghead Gas Produced* (Mcf)	Percent of Total Gas %	Total Gas Produced* (Mcf)	Natural Gas Reserves as of Jan. 1 (MMcf)[2]	Reserves Total U.S. "Lower 48" AGA[3] (MMcf)	Reserves Texas Percent of U.S. Total %
1936	575,275,000	67	269,463,000	33	844,738,000			
1937	658,713,000	66	335,175,000	34	993,888,000			
1938	705,908,000	64	393,367,000	36	1,099,275,000			
1939	872,286,000	66	442,773,000	34	1,315,059,000			
1940	1,087,089,000	71	452,238,000	29	1,539,327,000			
1941	1,382,830,000	76	427,462,000*	24	1,810,292,000			
1942	1,508,794,000	79	402,328,000*	21	1,911,122,000			
1943	1,683,920,809	79	438,647,209	21	2,122,568,018			
1944	1,907,704,332	78	527,013,593	22	2,434,717,925			
1945	2,065,266,423	78	599,911,322	22	2,665,177,745			
1946	2,098,867,220	76	664,545,023	24	2,763,412,243	78,306,676		
1947	2,231,430,080	76	706,070,607	24	2,937,500,687	86,363,459		
1948	2,540,917,386	78	707,303,721	22	3,248,221,107	90,025,566		
1949	2,739,790,600	78	770,732,048	22	3,510,522,648	95,708,553		
1950	3,099,606,096	77	924,570,897	23	4,024,176,993	99,170,403		
1951	3,518,486,197	75	1,155,049,259	25	4,673,535,456	102,404,077		
1952	3,779,106,990	74	1,310,269,791	26	5,089,376,781	105,653,229		
1953	3,835,635,847	72	1,479,135,184	28	5,314,771,031	105,732,763		
1954	3,955,492,811	72	1,555,169,157	28	5,510,661,968	106,529,626		
1955	4,061,169,733	71	1,679,288,713	29	5,740,458,446	105,129,062*		

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Year	Gas Well Gas Produced (Mcf)[1]	Percent of Total Gas %	Casinghead Gas Produced* (Mcf)	Percent of Total Gas %	Total Gas Produced* (Mcf)	Natural Gas Reserves as of Jan. 1 (MMcf)[2]	Reserves Total U.S. "Lower 48" AGA[3] (MMcf)	Reserves Texas Percent of U.S. Total %
1956	4,196,274,738	70	1,808,459,532	30	6,004,734,270	108,287,548		
1957	4,209,022,841	70	1,827,840,669	30	6,036,863,510	112,728,750		
1958	4,383,259,164	72	1,666,868,115*	28	6,050,127,279	113,084,518		
1959	4,707,673,353	73	1,714,236,548	27	6,421,909,901	115,045,743		
1960	5,017,874,190	75	1,657,295,605*	25	6,675,169,795	120,475,783		
1961	5,126,897,899	75	1,667,118,864	25	6,794,016,763	119,489,393*		
1962	5,258,336,700	76	1,647,302,820*	24	6,905,639,520	119,838,711		
1963	5,530,700,927	77	1,682,973,822	23	7,213,674,749	119,503,798*		
1964	5,846,879,988	77	1,707,287,547	23	7,554,167,535	117,809,376*		
1965	6,132,764,258	78	1,721,780,862	22	7,854,545,120	118,855,055	252,376	47
1966	6,258,199,039	77	1,839,765,501	23	8,097,964,540	120,616,760	252,068*	48
1967	6,314,445,633	76	2,022,348,049	24	8,336,793,682	123,609,326	251,034*	49
1968	6,512,818,553	76	2,100,053,643	24	8,612,872,196	125,415,064	242,103*	52
1969	6,838,026,114	76	2,125,458,089	24	8,963,484,203	119,001,106*	230,344*	52
1970	7,204,522,710	76	2,245,335,308	24	9,449,858,018	112,392,622*	217,191*	52
1971	7,367,204,617	77	2,203,426,957*	23	9,570,631,574	106,352,993*	204,168*	52
1972	7,450,363,616	78	2,152,266,013*	22	9,602,629,629	101,472,108*	190,919*	53
1973	7,322,579,995*	78	2,018,102,992*	22	9,340,682,987*	95,042,043*	177,006*	54
1974	7,068,268,065*	79	1,839,160,750*	21	8,907,428,815*	84,936,502*	165,531*	51
1975	6,491,849,189*	81	1,560,262,733*	19	8,052,111,922*	78,540,717*	154,176*	51
1976	6,247,330,373*	81	1,460,988,470*	19	7,708,318,843*	71,036,854*	142,555*	50
1977	6,150,029,884*	81	1,414,605,290*	19	7,564,635,174*	64,651,410*	134,590*	48
1978	5,690,601,922*	80	1,386,498,376*	20	7,077,100,298*	62,157,836*	127,915*	49

Year	Gas Well Gas Produced (Mcf)[1]	Percent of Total Gas %	Casinghead Gas Produced* (Mcf)	Percent of Total Gas %	Total Gas Produced* (Mcf)	Natural Gas Reserves as of Jan. 1 (MMcf)[2]	Reserves Total U.S. "Lower 48" AGA[3] (MMcf)	Reserves Texas Percent of U.S. Total %
1979	5,775,570,824	81	1,340,247,339*	19	7,115,818,163	54,600,235*	123,143*	44
1980	5,675,595,010*	81	1,322,296,207*	19	6,997,891,217*	51,610,771*	165,639[4]	(31)
1981	5,376,163,312*	80	1,356,878,719	20	6,733,042,031*	50,287,000*	176,385[4]	(29)
1982	4,721,572,710*	77	1,392,277,794	23	6,113,850,504*	50,469,000		
1983	4,227,636,672*	75	1,415,546,191	25	5,643,182,863*	49,757,000*		

*declined from previous year

[1] Mcf = Thousand cubic feet

[2] MMcf = Million cubic feet

[3] AGA = American Gas Association

[4] DOE/EIA - Department of Energy/Energy Information Administration

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