

**MINERAL RESOURCE EVALUATION OF THE PROPOSED  
BIG SANDY RESERVOIR SITE**

by

**E. W. Collins and Mary L. W. Jackson**

**Prepared for the  
Sabine River Authority**

**Bureau of Economic Geology  
W. L. Fisher, Director  
The University of Texas at Austin  
Austin, Texas 78713**

**Contract Report  
Sabine River Authority  
May 1985**

## Contents

|  | Page |
|--|------|
| Introduction . . . . .                           | 1    |
| Geology . . . . .                                | 1    |
| Oil and gas . . . . .                            | 4    |
| Introduction . . . . .                           | 4    |
| Pine Mills Field . . . . .                       | 21   |
| Pine Mills East Field . . . . .                  | 35   |
| Deupree and Deupree North Fields . . . . .       | 35   |
| Hawkins Field . . . . .                          | 41   |
| Hawkins Northeast Field . . . . .                | 41   |
| Hydrocarbon potential . . . . .                  | 47   |
| Lease Values . . . . .                           | 47   |
| Pipelines . . . . .                              | 49   |
| Estimates for slant and raised drilling. . . . . | 49   |
| Sand and gravel . . . . .                        | 49   |
| Lignite . . . . .                                | 51   |
| Summary . . . . .                                | 51   |
| Acknowledgments . . . . .                        | 53   |
| References . . . . .                             | 54   |

## Figures

|   |   |
|---|---|
| 1. Geologic map of the proposed Big Sandy reservoir site . . . . .  | 2 |
| 2. Generalized stratigraphic column and mineral resources for the proposed Big Sandy reservoir site . . . . .                               | 3 |
| 3. Schematic cross sections showing evolution of salt structures . . . . .  | 5 |
| 4. Location and cross sections of Hawkins salt-pillow anticline, Earl-Lee turtle-structure anticline, and Hainesville salt diapir . . . . . | 7 |

|     |   |    |
|-----|---|----|
| 5.  | Location map of all wells within the study area . . . . .   | 8  |
| 6.  | Typical geophysical log for the Pine Mills Field area . . . . .   | 22 |
| 7.  | Cross section A-B through Pine Mills East and Pine Mills Fields . . . . .   | 23 |
| 8.  | Structure map on the base of the 2nd Sub-Clarksville sand at the<br>Pine Mills, Pine Mills East, and Pine Mills West Fields . . . . . | 24 |
| 9.  | Production decline for the Pine Mills Field, 2nd Sub-Clarksville reservoir . . . . .  | 25 |
| 10. | Production decline for the Pine Mills Field, Orr reservoir . . . . .  | 29 |
| 11. | Structure map on the top of the Woodbine Group and Pine Mills and<br>Pine Mills East Fields . . . . .                                 | 30 |
| 12. | Production decline for the Pine Mills Field, Woodbine reservoir . . . . .   | 31 |
| 13. | Production decline for the Pine Mills Field, Woodbine Wagoner reservoir . . . . .   | 32 |
| 14. | Structure map on the top of the Paluxy Formation at the Pine Mills Field . . . . .  | 33 |
| 15. | Production decline for the Pine Mills Field, Paluxy reservoir . . . . .   | 34 |
| 16. | Production decline for the Pine Mills East Field,<br>2nd Sub-Clarksville reservoir . . . . .  | 36 |
| 17. | Structure map on the top of the Woodbine producing zone at the<br>Deupree North and Deupree Fields . . . . .                          | 37 |
| 18. | Cross section B-C through Pine Mills and Deupree North Fields . . . . .   | 38 |
| 19. | Production decline for the Deupree Field, Woodbine reservoir . . . . .  | 39 |
| 20. | Production decline for the Deupree North Field, Woodbine reservoir . . . . .  | 40 |
| 21. | Typical geophysical log for the Hawkins and Hawkins Northeast Fields . . . . .  | 42 |
| 22. | Structure map on the top of the Woodbine Group at Hawkins and<br>Hawkins Northeast Fields . . . . .                                   | 43 |
| 23. | Production decline for the Hawkins Field, Woodbine reservoir . . . . .  | 44 |
| 24. | Production decline for the Hawkins Field, Rodessa reservoir . . . . .   | 45 |
| 25. | Production decline for the Hawkins Field, Woodbine reservoir . . . . .  | 46 |
| 26. | Production decline for the Hawkins Northeast Field,<br>Sub-Clarksville reservoir . . . . .  | 48 |

## Tables

1. Well statistics for all wells in the proposed Big Sandy reservoir site . . . . . 12
2. Example of procedure for estimating remaining oil  
that is available to secondary and tertiary recovery in a given reservoir . . . . . 26
3. Operating companies and pipe sizes of pipelines that cross  
the proposed Big Sandy reservoir site . . . . . 50

## Plate

1. Locations of wells in the proposed Big Sandy reservoir site. . . . . in pocket

## INTRODUCTION

This report documents the mineral resources in the proposed Big Sandy reservoir area (fig. 1), referred to in this report as the contract area. The proposed reservoir is located on the Big Sandy Creek floodplain extending northward from 3 mi north of Big Sandy, in Upshur County, to about 2 mi south of East Point in Wood County. The boundary of the study area is the 360-ft ground level contour (fig. 1, plate 1). The contract boundary is the 340-ft ground level contour. In addition, the area up to the 360-ft ground level contour was evaluated at the request of the Sabine River Authority.

The evaluated resources include oil and gas, sand and gravel, and lignite. No other mineral resources are known to occur in the contract area in amounts significantly greater than the background levels present in all rocks.

## GEOLOGY

Cenozoic strata of Eocene and Quaternary age crop out in the reservoir site. Units include the Eocene Queen City, Weches, and Sparta Formations of the Claiborne Group (figs. 1 and 2), as well as Quaternary fluvial terraces and alluvium. The Queen City and Sparta Formations are composed of fluvial-deltaic and shore-zone clays, silts, and sands. Weches strata are of marine origin and are characterized by shelf and prodelta muds and sands. The Quaternary fluvial terraces and alluvium are also composed of sand and mud.

Subsurface units of proven economic importance within the contract area are the Rodessa Member of the Lower Glen Rose Formation, the Paluxy Formation, the Woodbine Group, and the Sub-Clarksville Member of the Eagle Ford Group (fig. 2). Hydrocarbons are produced from these units. The Rodessa Member consists of interbedded shale, anhydrite, limestone, and sandstone (Wood and Guevara, 1981). The Paluxy Formation is composed of sandstone interbedded with shale and mudstone. In Wood and Upshur Counties, these sediments represent coastal-barrier facies of a deltaic system (Caughey, 1977). Woodbine

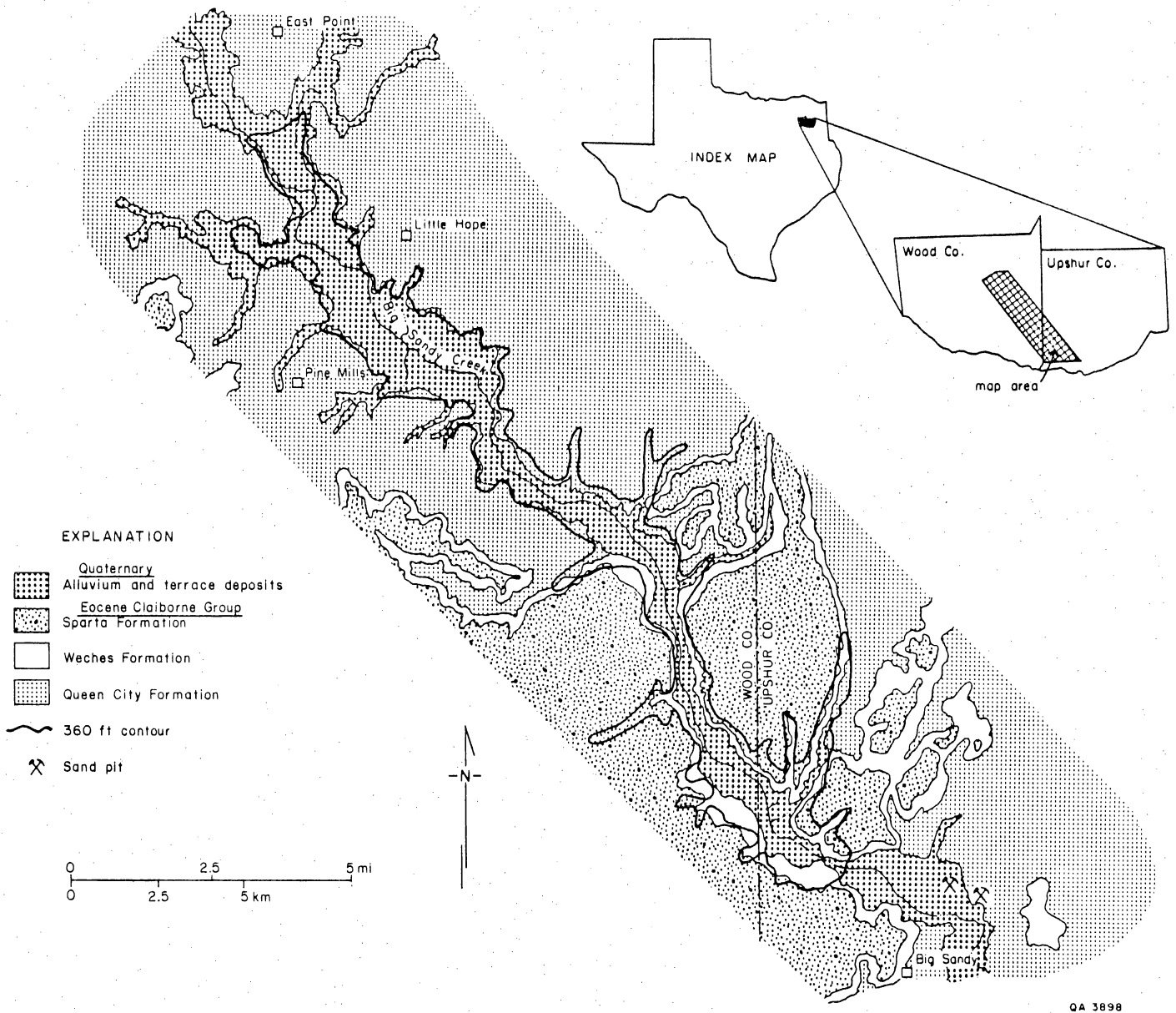


Figure 1. Geologic map of the proposed Big Sandy reservoir site, Wood and Upshur Counties (from Barnes, 1975).



Group sandstones and interbedded shales are distinguished by two members. The lower Dexter Member is of fluvial origin, and the upper Lewisville Member is of shelf-strandplain origin (Oliver, 1971). The Sub-Clarksville Member contains sandstones in the upper part of the predominantly shaly Eagle Ford Group (Wood and Guevara, 1981). Subsurface strata within the contract area that have potential economic importance are Louark Group limestones and Cotton Valley Group sandstones (fig. 2). Hydrocarbons are produced from these units in this northern part of the East Texas Basin. Wilcox Group lignites that are interbedded with sandstones, siltstones, and claystones also have potential economic importance (fig. 2).

## OIL AND GAS

### Introduction

Hydrocarbon accumulation in the East Texas Salt Dome Province has been controlled by structures formed by mobilization of the Jurassic Louann Salt during the evolution of the East Texas Basin. The structural history of the East Texas Basin was discussed in detail by Seni and Jackson (1984). The Jurassic Louann Salt was deposited on Triassic rift fill and Paleozoic basement. Salt began to move during the early period of basin formation (Jurassic to early Cretaceous); as salt mobilization continued, a variety of structures formed.

A three-stage model of dome growth (fig. 3) developed by Trusheim (1960) for the Zechstein Salt Basin of North Germany is also appropriate for salt dome growth in the East Texas Basin (Seni and Jackson, 1984). The first stage is represented by the development of nonpiercing salt-pillow anticlines (figs. 3B and 3C). Synclines also form in adjacent areas of salt withdrawal and are filled with thick accumulations of sediments. During the subsequent diapir stage, deflation of the salt-pillow anticline occurs as salt flows into the central growing diapir (fig. 3D). As collapse of the pillow flanks progresses, the thickened



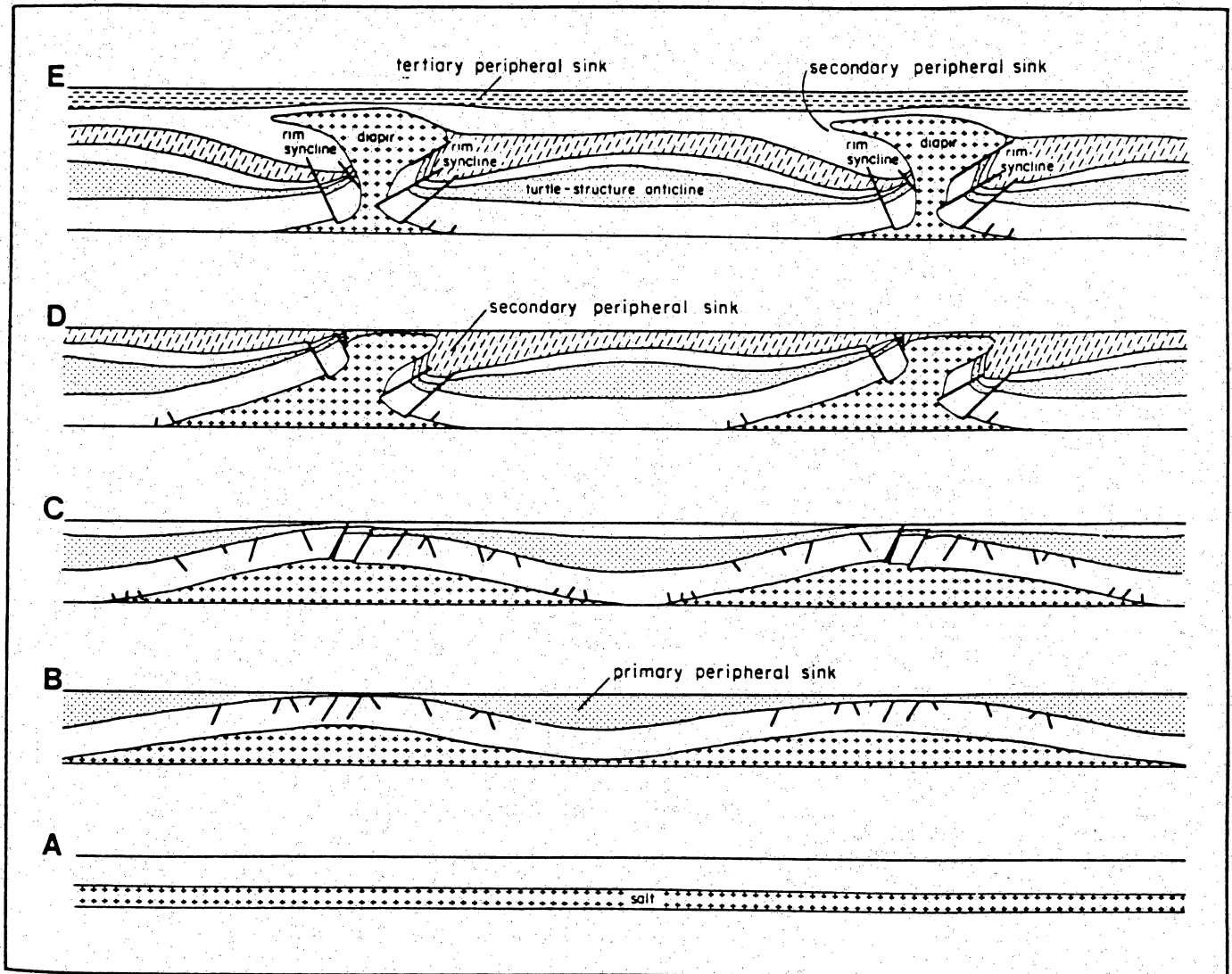


Figure 3. Schematic evolution of salt structures from original salt layer (A), through pillow stage (B and C), diapir stage (D), and postdiapir stage (E) (from Seni and Jackson, 1984; modified from Trusheim, 1960).

strata within the interdomal synclines undergo a structural inversion to form anticlines. Trusheim (1960) named these structures "turtle-structure anticlines." During the third stage, following rapid diapir growth (fig. 3E), domes stay near the sediment surface despite continued regional subsidence and deposition (Seni and Jackson, 1984).

The hydrocarbon production from salt-pillow anticlines, turtle-structure anticlines, and diapirs in the East Texas Basin was described by Wood and Giles (1982). Deep-seated, salt-pillow anticlines have accounted for almost 76 percent of the oil and 78 percent of the gas produced from the central East Texas Basin (Wood and Giles, 1982). Hydrocarbons are trapped by structural closure and associated crestal faults in the salt-pillow anticlines. Production from turtle-structure anticlines comprises about 22 percent of the oil and more than 7 percent of the gas in the central East Texas Basin (Wood and Giles, 1982). In turtle-structure anticlines, hydrocarbons are commonly trapped in arching strata with associated normal faults; however, stratigraphic and lithologic variations in porosity and permeability also serve to trap hydrocarbons in these structures. Salt diapir structures account for less than 1 percent of the oil and about 5 percent of the gas production in the central basin areas (Wood and Giles, 1982).

The contract area in Wood County overlies the northeastern flank of the Hawkins salt-pillow anticline and the northern part of the Earl-Lee turtle-structure anticline (fig. 4). Several oil and gas fields are associated with these structures. Within the contract area overlying the Earl-Lee turtle-structure anticline are the Pine Mills, Pine Mills East, Deupree, and Deupree North Fields. The Hawkins and Hawkins Northeast Fields, associated with the Hawkins salt-pillow anticline, are also in the study area. In addition, many dry holes have been drilled within the contract area boundary. Figure 5 and plate 1 show the location of all wells within the potential reservoir site; producing wells are indicated. Sixty-eight wells have been drilled within the 360-ft ground elevation boundary, and only one well is producing within the 340-ft ground elevation boundary. Legal location, total depth, and producing zones of these wells are listed in table 1. All

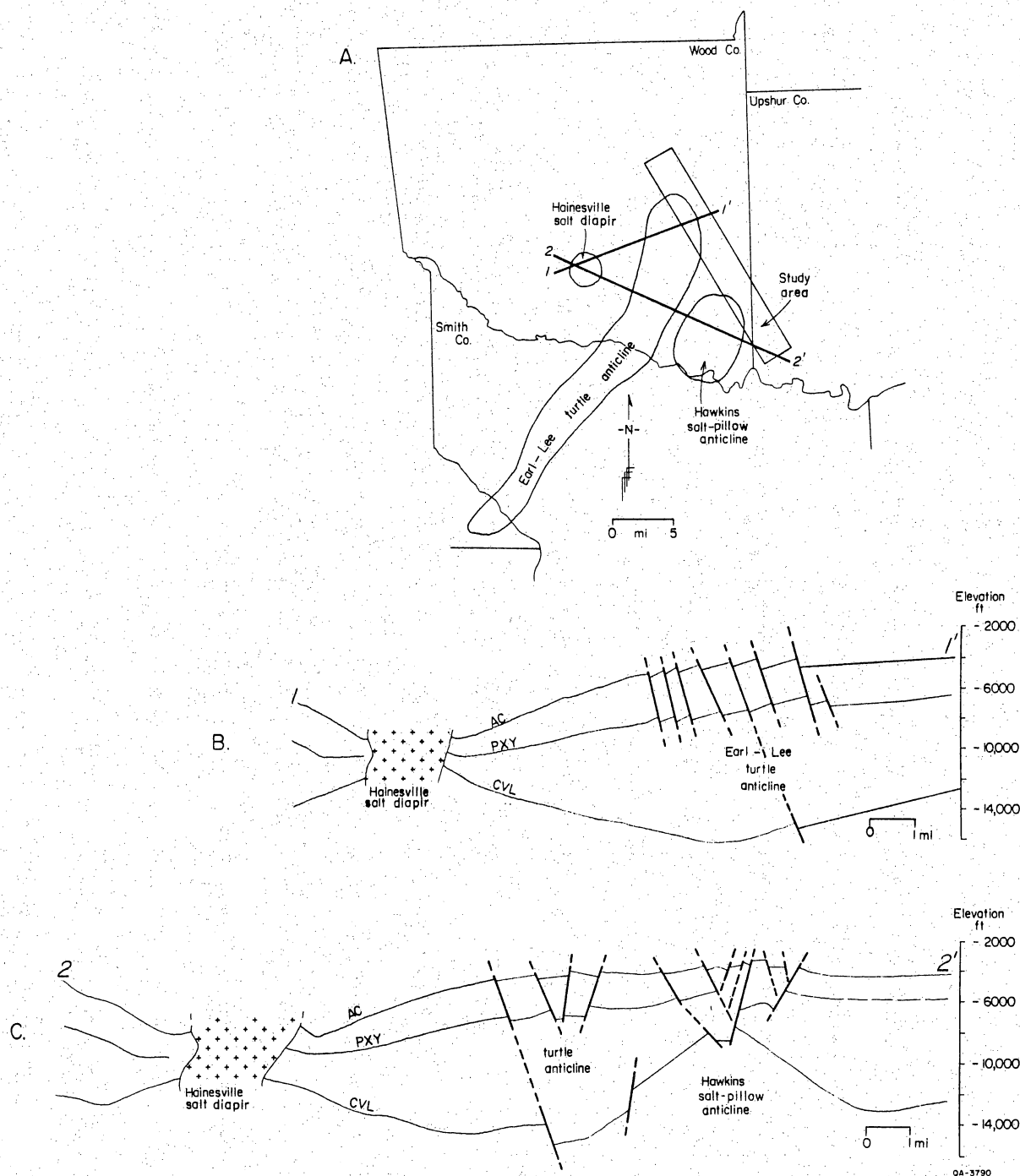


Figure 4. A. Location of study area, Hawkins salt-pillow anticline, Earl-Lee turtle-structure anticline, and Hainesville salt diapir. B. Cross section through northern part of Earl-Lee turtle-structure anticline, showing the Earl-Lee structure to be a westward-dipping monocline at this northern part of the structure. The structure has an asymmetric, anticlinal form in the area south of the cross sections. C. Cross section through the Hawkins salt-pillow anticline. AC-Austin Chalk; PXY-Paluxy Formation; CVL-Cotton Valley Limestone.

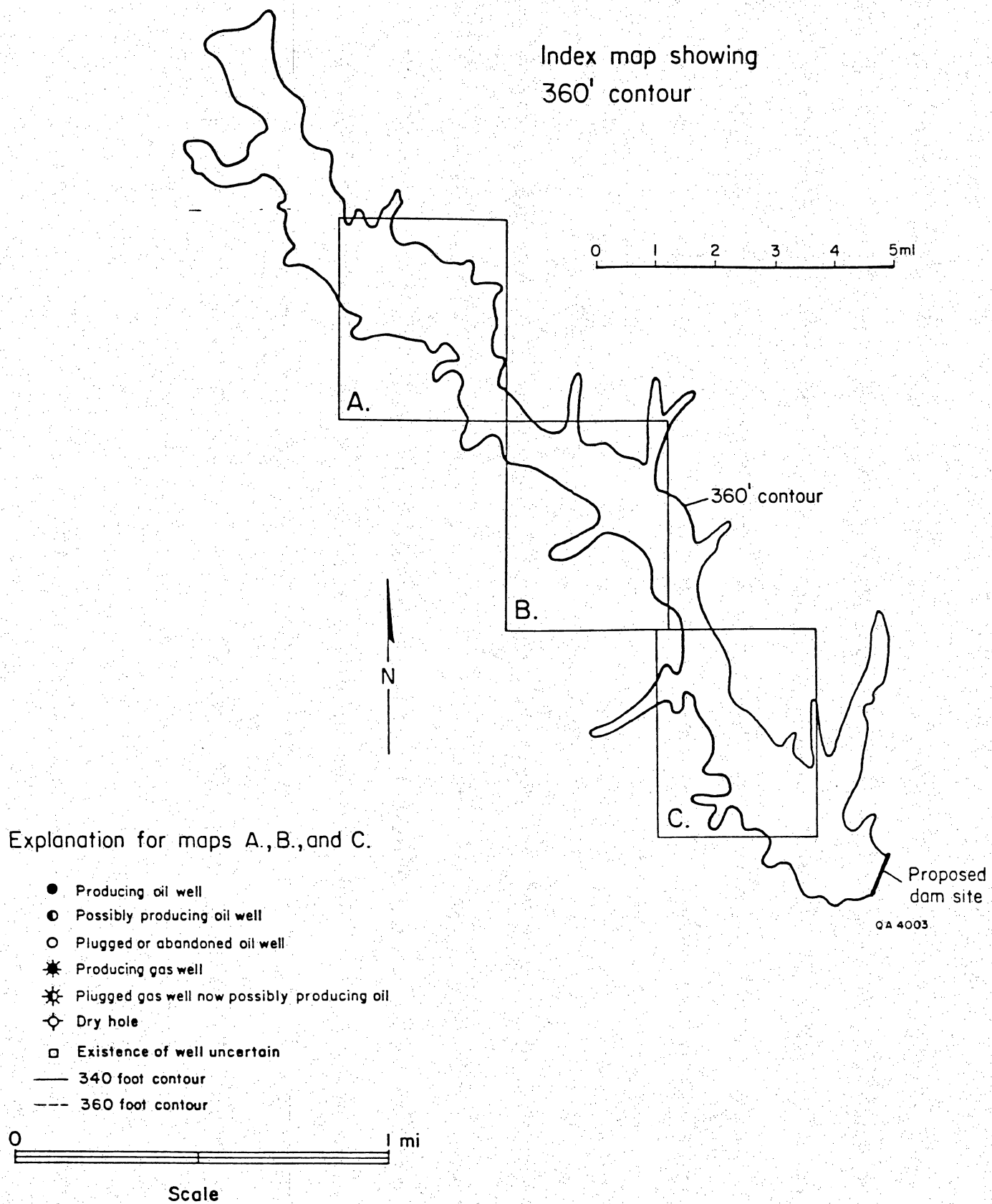


Figure 5. Location map of all wells within the study area.

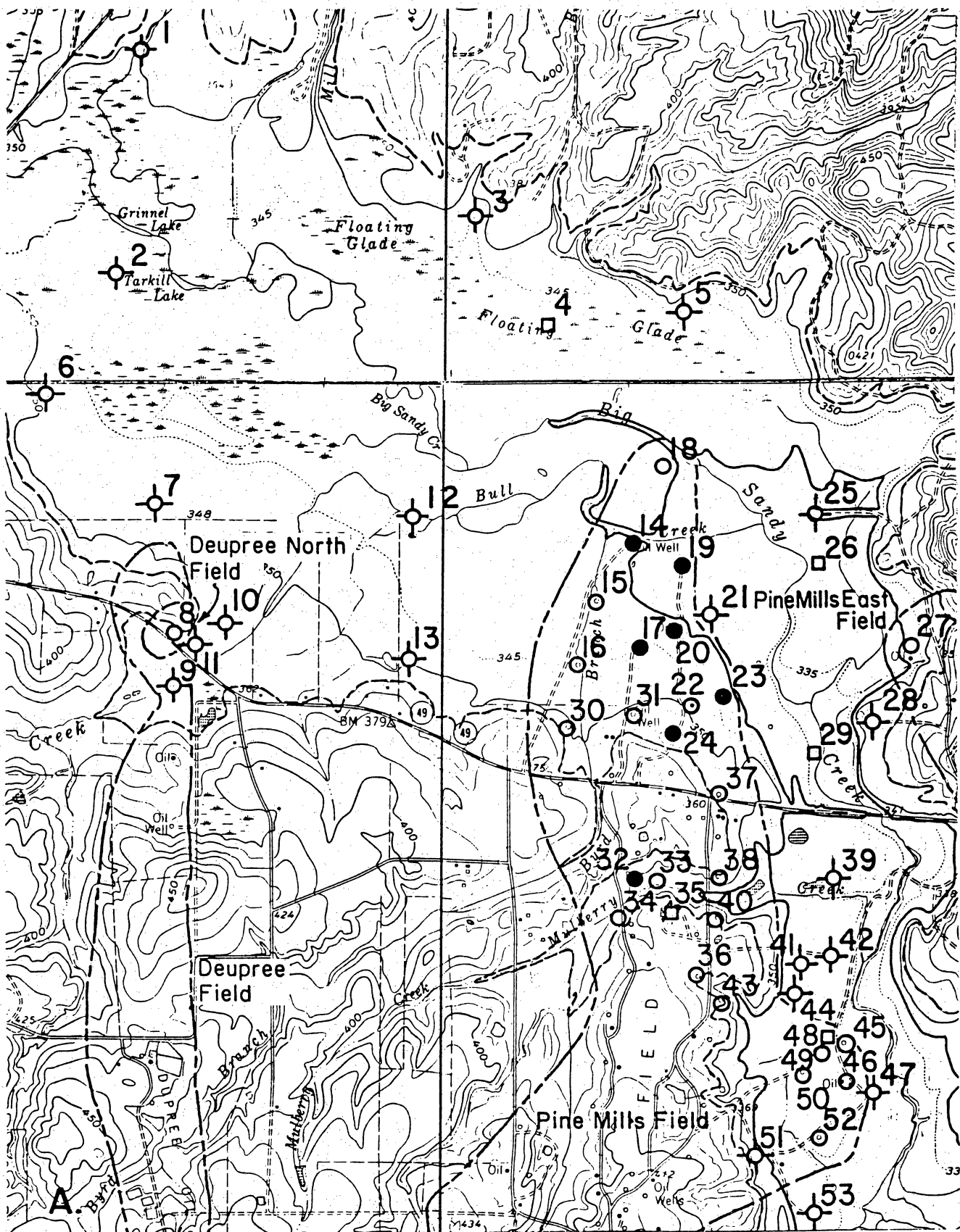


Figure 5 (continued)

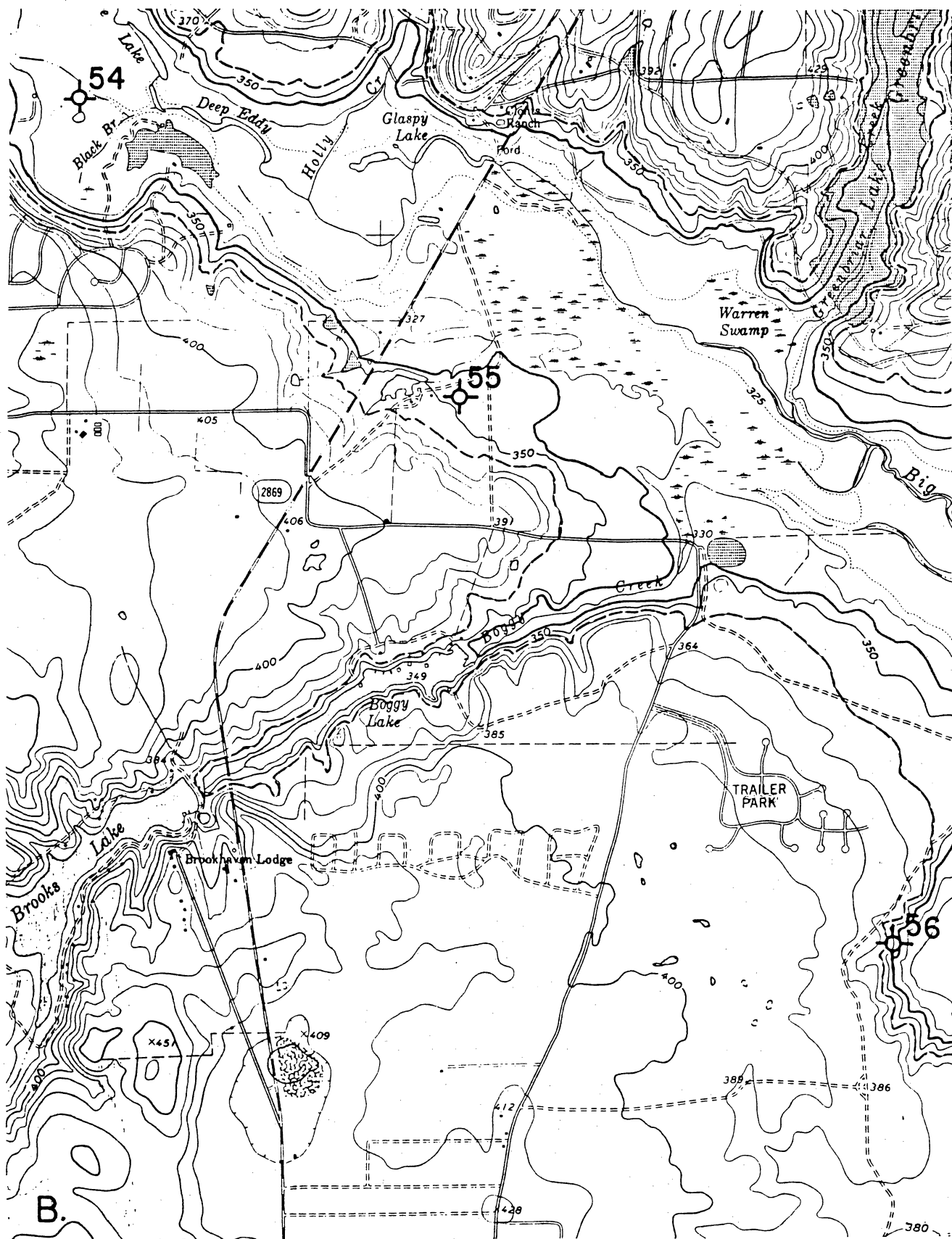


Figure 5 (continued)

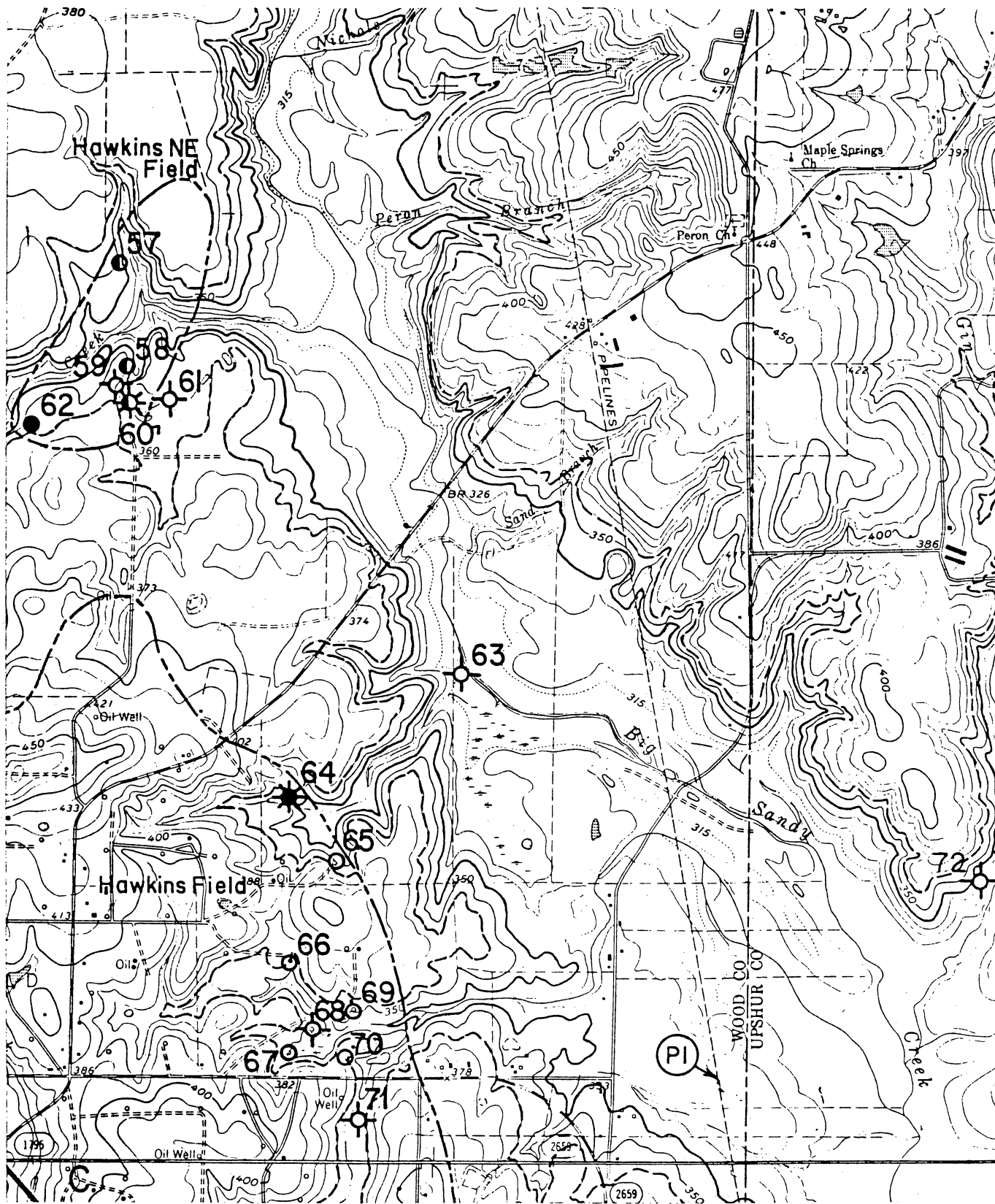


Figure 5 (continued)

Table 1. Well statistics for wells in 340-ft and 360-ft proposed reservoir areas. Dates shown are dates of completion except where indicated. Ground elevations estimated from U.S. Geological Survey topographic maps. Past operators listed in parentheses, most recent first. Map number refers to figure 5 and plate 1; + indicates wells on or below 340-ft contour; - indicates wells between 340-ft and 350-ft contours.

| Map no. | Present (and past) operators                           | Well no. | Lease/Date                              | Type | Status *         | Ground elevation (ft) |                      | Legal description  | Prod. zones | T.D. (ft) | Misc.  |
|---------|--|----------|---|------|------------------|-----------------------|----------------------|--|-------------|-----------|--|
|         |  |          |   |      |                  | Field/Co.             | Location Survey      |  |             |           |  |
| 1-      | Robbins Petroleum Corp. & Ralph E. Fair                | 1        | Sallie Lucy Old & L. W. Murphy 10-12-64 | Dry  | Plugged 10-12-64 | Wildcat Wood Co.      | Mathew Dial A-676    | 467' FWL of Dial survey and 317' FNL of C. J. Bullock survey | --          | 6,542     | --   |
| 2-      | Robbins Petroleum Corp. & Ralph E. Fair                | 2        | Sallie Lucy Old & L. W. Murphy 11-27-64 | Dry  | Plugged 11-27-64 | Wildcat Wood Co.      | Mathew Dial A-676    | 1700' F most southerly WL and 290' FSL of survey             | --          | 6,440     | --   |
| 3-      | R. J. Caraway, Allen Guiberson & Danciger Oil Refining | 1        | Sallie Lucy Old 5-24-50                 | Dry  | Plugged 5-24-50  | Wildcat Wood Co.      | M. B. Burnett A-87   | 330' FWL and 330' FNL of survey                              | --          | 8,086     | --   |
| 4-      | Humble   | 1        | Sallie Lucy Old --                      | --   | --               | Wildcat Wood Co.      | M. B. Burnett A-87   | 950' FEL and 1,000' FSL of survey                            | --          | --        | Legal description approximate; existence uncertain |
| 5-      | R. J. Caraway et al.                                   | 1        | Sallie Lucy Old 10-3-51                 | Dry  | Aband.           | Wildcat Wood Co.      | W. S. Armstrong A-16 | 660' FSL and 330' FEL of 40 ac. lease                        | --          | 6,135     | --   |
| 6-      | Sabine Exploration                                     | 1        | A. L. Dobbs 10-11-80                    | Dry  | Plugged 10-13-80 | Wildcat Wood Co.      | A. J. Odom A-448     | 540' FWL and 1,830' FNL of survey                            | --          | 5,940     | --   |
| 7-      | Ralph E. Fair  | 1        | Clint Collins et al. 3-17-65            | Dry  | Plugged 3-17-65  | Deupree, N. Wood Co.  | A. J. Odom A-448     | 200' FSL and 1,400' FEL of survey                            | --          | 6,350     | --   |
| 8       | Ralph E. Fair  | 1        | W. A. Byers 10-9-64                     | Oil  | Plugged 8-30-67  | Deupree, N. Wood Co.  | S. H. Davis A-164    | 330' FSL and 150' FEL of survey                              | Woodbine    | 6,333     | Discovery well                                     |
| 9       | Robbins Petroleum Corp.                                | 2        | E. A. Byers 11-6-64                     | Dry  | Plugged 11-6-64  | Deupree Wood Co.      | B. G. Ramsay A-492   | 330' FEL and 400' FNL of survey                              | --          | 5,900     | --   |



Table 1. (cont.)

| Map no. | Present (and past) operators                      | Well no. | Lease/Date                      | Type | Status*                | Ground elevation (ft) |  | Field/Co.                  | Location Survey         | Legal description  | Prod. zones                 | T.D. (ft) | Misc.                           |
|---------|---|----------|---------------------------------|------|------------------------|-----------------------|--|----------------------------|-------------------------|--|-----------------------------|-----------|---------------------------------|
|         |   |          |                                 |      |                        |                       |  |                            |                         |  |                             |           |                                 |
| 10      | The Long Trusts                                   | 1        | W. I. English<br>8-21-82        | Dry  | Plugged<br>8-22-82     | 358                   |  | Deupree<br>Wood Co.        | J. B. West<br>A-703     | 162' FWL and 700' F most<br>northerly SL of survey                         | --                          | 5,912     | Deepened to<br>6,205            |
| 11      | F. R. Jackson                                     | 1        | W. I. English<br>10-30-51       | Dry  | Plugged<br>11-26-51    | 355                   |  | Deupree<br>Wood Co.        | J. B. West<br>A-703     | 150' F most westerly WL<br>and 150' F most northerly SL<br>of survey       | --                          | 6,317     | --                              |
| 12-     | Robbins Petroleum Corp.                           | A-1      | Sallie Lucy Old<br>10-27-83     | Dry  | Plugged<br>10-27-83    | 343                   |  | Wildcat<br>Wood Co.        | W. S. Armstrong<br>A-16 | 190' FSL and 1,940' FEL<br>of lease  | --                          | 5,625     | --                              |
| 13      | Robbins Petroleum Corp.                           | 1        | Kepley<br>8-17-83               | Dry  | Plugged<br>11-10-83    | 350                   |  | Pine Mills, W.<br>Wood Co. | Thomas Hunt<br>A-314    | 467' FSL of survey,<br>467' FEL of lease                                   | --                          | 4,810     | --                              |
| 14-     | Robbins Petroleum Corp.<br>(Superior Oil Co.)     | 7        | J. M. Byrd<br>et al.<br>7-7-51  | Oil  | Prod.<br>above<br>340  | <1'                   |  | Pine Mills<br>Wood Co.     | Thos. Hunt<br>A-314     | 330' FEL and 355' FNL<br>of survey   | Sub-<br>Clarksville         | 5,700     | --1                             |
| 15-     | Robbins Petroleum Corp.<br>(Superior Oil Co.)     | 8        | J. M. Byrd<br>et al.<br>8-8-51  | Oil  | Aband.                 | 342                   |  | Pine Mills<br>Wood Co.     | Thos. Hunt<br>A-314     | 840.9' FEL and 1,142' FNL<br>of survey                                     | Sub-<br>Clarksville         | 4,925     | --1                             |
| 16-     | Robbins Petroleum Corp.<br>(Superior Oil Co.)     | 9        | J. M. Byrd<br>et al.<br>8-12-51 | Oil  | Aband.                 | 345                   |  | Pine Mills<br>Wood Co.     | Thos. Hunt<br>A-314     | 2,090.4' FNL and 1,127.2'<br>FEL of survey                                 | Sub-<br>Clarksville         | 4,775     | --1                             |
| 17-     | Robbins Petroleum Corp.<br>(Superior Oil Co.)     | 5        | J. M. Byrd<br>et al.<br>5-28-51 | Oil  | Prod.                  | 345                   |  | Pine Mills<br>Wood Co.     | Thos. Hunt<br>A-314     | 230' FEL of survey and<br>933' from Superior<br>#2 Byrd                    | Sub-<br>Clarksville,<br>Orr | 5,650     | Dual<br>completion <sup>1</sup> |
| 18-     | Robbins Petroleum Corp.<br>(F. R. Jackson et al.) | 6        | Sallie Lucy Old<br>10-14-65     | Oil  | Aband.<br>above<br>340 | <1'                   |  | Pine Mills<br>Wood Co.     | W. S. Armstrong<br>A-16 | 700' F most easterly SL<br>of survey and 1,280' NNW<br>from Robbins #4 Old | Sub-<br>Clarksville         | 4,854     | --3                             |
| +19     | Robbins Petroleum Corp.<br>(F. R. Jackson)        | 4        | Sallie Lucy Old<br>8-30-51      | Oil  | Prod.                  | 338                   |  | Pine Mills<br>Wood Co.     | W. S. Armstrong<br>A-16 | 330' FWL of survey and<br>933' NF Robbins #4 Old                           | Sub-<br>Clarksville         | 5,525     | --3                             |

Table 1. (cont.)

| Map no. | Present (and past) operators  | Well no. | Lease/Date                             | Type | Status*            | Ground elevation (ft)      |                         | Legal description                                       | Prod. zones                      | T.D. (ft) | Misc.   |
|---------|---|----------|--|------|--------------------|----------------------------|-------------------------|---|----------------------------------|-----------|---|
|         |   |          |  |      |                    | Field/Co.                  | Survey                  |   |                                  |           |   |
| 20-     | Robbins Petroleum Corp.<br>(F. R. Jackson)  | 3        | Sallie Lucy Old<br>6-18-51             | Oil  | Prod.              | Pine Mills<br>Wood Co.     | W. S. Armstrong<br>A-16 | 330' FWL and 1,823' F<br>most northerly SL<br>of survey | Orr,<br>Woodbine                 | 5,520     | Recompleted<br>1-12-82 to<br>Woodbine <sup>2</sup>  |
| +21     | Robbins Petroleum Corp.   | 7        | Sallie Lucy Old<br>10-9-83             | Dry  | Plugged<br>10-9-83 | Pine Mills<br>Wood Co.     | W. S. Armstrong<br>A-16 | 3,550' FWL and 1,225' FEL<br>of lease                   | --                               | 5,574     | --  |
| 22-     | Robbins Petroleum Corp.<br>(F. R. Jackson)  | 1        | Sallie Lucy Old<br>10-23-50            | Oil  | Plugged<br>3-28-53 | Pine Mills<br>Wood Co.     | W. S. Armstrong<br>A-16 | 330' FWL and 890' F<br>most northerly SL<br>of survey   | Sub-<br>Clarksville,<br>Woodbine | 5,603     | Dual<br>completion <sup>3</sup>   |
| 23-     | Robbins Petroleum Corp.<br>(F. R. Jackson)  | 5        | Sallie Lucy Old<br>8-24-60             | Oil  | Prod.              | Pine Mills<br>Wood Co.     | W. S. Armstrong<br>A-16 | 930' FWL and 1,080' F<br>most southerly SL<br>of survey | Woodbine                         | 5,700     | -- <sup>2</sup>   |
| 24      | Robbins Petroleum Corp.<br>(F. R. Jackson)  | 2        | Sallie Lucy Old<br>3-28-51             | Oil  | Prod.              | Pine Mills<br>Wood Co.     | W. S. Armstrong<br>A-16 | 230' FWL and 230' F<br>most northerly SL<br>of survey   | Sub-<br>Clarksville,<br>Woodbine | 5,581     | Dual<br>completion;<br>recompleted<br>6-19-56 to<br>Woodbine and<br>12-10-79 to<br>Sub-Clarksville <sup>3</sup> |
| 25-     | A. O. Phillips<br>et al.  | 1        | Mary Saner<br>3-28-52                  | Dry  | Aband.             | Wildcat<br>Wood Co.        | M. Polk<br>A-454        | 330' FWL and 3,649' FSL<br>of survey                    | --                               | 8,250     | --  |
| +26     | L. A. Grelling  | 1(A)     | Mary Saner<br>permitted<br>date 2-4-52 | --   | --                 | Pine Mills<br>Wood Co.     | M. Polk<br>A-454        | 3,019' FSL and 5,077' FEL<br>of survey                  | --                               | --        | Proposed<br>depth<br>8,500';<br>existence<br>uncertain  |
| 27-     | Largo Oil Co.<br>(Production Lease<br>Service, Inc.)<br>(B. M. Lloyd)<br>(L. A. Grelling) | 6        | Mary Saner<br>3-4-56                   | Oil  | Aband.             | Pine Mills, E.<br>Wood Co. | M. Polk<br>A-454        | 1,610' FWL and 1,757' FSL<br>of survey                  | Sub-<br>Clarksville              | 5,777     | Plugged back<br>7-20-60 for<br>salt-water<br>disposal   |

Table 1. (cont.)

| Map no. | Present (and past) operators   | Well no. | Lease/Date                             | Type | Status *            | Ground elevation (ft) | Location                   |                             | Legal description   | Prod. zones                 | T.D. (ft) | Misc.  |
|---------|--|----------|--|------|---------------------|-----------------------|----------------------------|-----------------------------|---|-----------------------------|-----------|--|
|         |  |          |  |      |                     |                       | Field/Co.                  | Survey                      |   |                             |           |  |
| 28      | L. A. Grelling   | 4        | Mary Saner<br>12-21-54                 | Dry  | Plugged<br>12-27-54 | 352                   | Pine Mills, E.<br>Wood Co. | M. Polk<br>A-454            | 660' FSL and 930' FWL<br>of survey                        | --                          | 8,168     | --   |
| 29      | L. A. Grelling   | 2(A)     | Mary Saner<br>permitted<br>date 2-4-52 | --   | --                  | 335                   | Pine Mills<br>Wood Co.     | M. Polk<br>A-454            | 330' FWL and 330' FSL<br>of survey                        | --                          | --        | Proposed<br>depth<br>8,500';<br>existence<br>uncertain                                 |
| 30      | Robbins Petroleum Corp.<br>(Superior Oil Co.)                              | 6        | J. M. Byrd<br>et al.<br>6-26-51        | Oil  | Plugged<br>3-16-77  | 350                   | Pine Mills<br>Wood Co.     | West Walker<br>A-642        | 378.4' FNL and approx-<br>imately 1,260' FEL<br>of survey | Sub-<br>Clarksville         | 6,203     | --1  |
| 31      | Robbins Petroleum Corp.<br>(Superior Oil Co.)                              | 2        | J. M. Byrd<br>et al.<br>9-5-50         | Oil  | Aband.              | 352                   | Pine Mills<br>Wood Co.     | West Walker<br>A-642        | 330' FEL and approx-<br>imately 100' FNL of<br>survey     | Sub-<br>Clarksville         | 5,700     | --1  |
| 32      | Largo Oil<br>(Production Lease<br>Service)<br>(B. B. Orr)                  | 1        | O. M. Childress<br>4-15-50             | Oil  | Prod.               | 350                   | Pine Mills<br>Wood Co.     | West Walker<br>A-642        | 330' FEL and 220' FSL<br>of survey                        | Sub-<br>Clarksville,<br>Orr | 5,558     | Plugged back<br>to Sub-<br>Clarksville   |
| 33-     | Largo Oil<br>(Production Lease<br>Service)<br>(B. B. Orr)                  | 2        | O. M. Childress<br>12-20-50            | Oil  | Plugged<br>5-12-63  | 345                   | Pine Mills<br>Wood Co.     | West Walker<br>A-642        | 100' FEL and 100' FSL<br>of survey                        | Orr                         | 4,811     | --   |
| 34      | Largo Oil<br>(Production Lease<br>Service)<br>(B. M. Lloyd)<br>(B. B. Orr) | 1        | J. W. Stagner<br>5-20-50               | Oil  | Prod.               | 352                   | Pine Mills<br>Wood Co.     | J. Morrison<br>A-409        | 330' FEL and 100' FNL<br>of survey                        | Sub-<br>Clarksville,<br>Orr | 5,490     | Discovery well<br>for Orr;<br>plugged back<br>from Orr to<br>Sub-Clarksville<br>3-8-51 |
| 35      | Robbins Petroleum Corp.<br>(Superior Oil Co.)                              | 2        | D. Wagoner<br>--                       | --   | --                  | 360                   | Pine Mills<br>Wood Co.     | David<br>Gilliland<br>A-229 | 330' FWL and 214' FSL<br>of West Walker survey            | --                          | --        | existence<br>uncertain   |

Table 1. (cont.)

| Map no. | Present (and past) operators                  | Well no. | Lease/Date                  | Type | Status *           | Ground elevation (ft) |  | Location               | Legal description                                  | Prod. zones | T.D. (ft) | Misc.   |
|---------|---|----------|-----------------------------|------|--------------------|-----------------------|--|------------------------|--|-------------|-----------|---|
|         |   |          |                             |      |                    |                       |  | Field/Co.              |  |             |           |   |
| 36      | Robbins Petroleum Corp.<br>(Superior Oil Co.) | 8        | D. Wagoner<br>1-26-51       | Oil  | Aband.             | 360                   |  | Pine Mills<br>Wood Co. | 594' FSL and 150' FEL<br>of lease                  | Woodbine    | 5,650     | --4   |
| 37      | Robbins Petroleum Corp.<br>(Superior Oil Co.) | 14       | D. V. Wagoner<br>5-25-51    | Oil  | Plugged<br>2-25-77 | 358                   |  | Pine Mills<br>Wood Co. | 1,774.8' FEL and 330' FNL<br>of survey             | Woodbine    | 5,650     | Also used as<br>an injection<br>well; reperfor-<br>ated for oil<br>in 1975 <sup>4</sup> |
| 38      | Robbins Petroleum Corp.<br>(Superior Oil Co.) | 12       | D. V. Wagoner<br>4-19-51    | Oil  | Aband.             | 359                   |  | Pine Mills<br>Wood Co. | 286' FSL and 150' FWL<br>of lease                  | Woodbine    | 5,444     | --4   |
| +39     | Superior Oil Co.                              | 16       | D. V. Wagoner<br>3-28-52    | Dry  | Aband.             | 336                   |  | Wildcat<br>Wood Co.    | 330' FSL and 330' FEL<br>of lease                  | --          | 8,162     | --  |
| 40      | Robbins Petroleum Corp.<br>(Morris N. Palmer) | 3        | O. M. Childress<br>1-21-51  | Oil  | Prod.              | 360                   |  | Pine Mills<br>Wood Co. | 150' FWL and 1,305' FSL<br>of survey               | Woodbine    | 5,441     | --5   |
| +41     | Morris N. Palmer                              | 4        | O. M. Childress<br>8-53     | Dry  | Aband.             | 338                   |  | Pine Mills<br>Wood Co. | 675' FEL and 880' FSL<br>of survey                 | --          | 7,885     | Legal<br>description<br>approximate   |
| +42     | L. A. Grelling<br>(J. L. Phillips Co.)        | 1        | Florence<br>4-11-50         | Dry  | Aband.             | 337                   |  | Pine Mills<br>Wood Co. | 250' FEL and 940' FSL<br>of survey                 | --          | 7,875     | Legal<br>description<br>approximate <sup>7</sup>  |
| 43      | Robbins Petroleum Corp.<br>(Morris N. Palmer) | 1        | O. M. Childress<br>10-22-50 | Oil  | Shut-in            | 360                   |  | Pine Mills<br>Wood Co. | 150' FWL and 150' FSL<br>of survey                 | Woodbine    | 5,450     | Wellhead<br>pressure<br>60 psi on<br>2-18-85 <sup>5</sup>                               |
| +44     | Scurlock Oil Co.                              | 4        | O. M. Childress<br>8-3-53   | Dry  | Aband.             | 338                   |  | Pine Mills<br>Wood Co. | 330' FSL of survey and<br>330' FEL of 20 ac. lease | --          | 7,885     | --  |

Table 1. (cont.)

| Map no. | Present (and past) operators                   | Well no. | Lease/Date                         | Type | Status *        | Ground elevation |                     | Legal description     | Prod. zones   | T.D. (ft)    | Misc.   |
|---------|--|----------|------------------------------------|------|-----------------|------------------|---------------------|-----------------------|---|--------------|---|
|         |  |          |                                    |      |                 | (ft)             | Field/Co.           | Survey                |   |              |   |
| +45     | R. McKay Moore (M. L. Mayfield) (Ralph Massad) | 1        | D. B. Clounts 10-19-54             | Oil  | Plugged 5-17-83 | 335              | Pine Mills Wood Co. | L. B. Henderson A-279 | 100' FWL and 350' F most westerly NL of 40 ac. lease            | Paluxy 7,875 | --  |
| +46     | R. McKay Moore (M. L. Mayfield)                | 1        | J. P. Hester 4-5-56                | Oil  | Plugged 5-23-83 | 336              | Pine Mills Wood Co. | L. B. Henderson A-279 | 1,850' FSL and 150' FWL of survey                               | Paluxy 7,871 | --  |
| +47     | R. McKay Moore (M. L. Mayfield) (Sohio)        | 1-W      | J. P. Hester 6-30-52               | Dry  | Plugged 5-14-83 | 335              | Pine Mills Wood Co. | L. B. Henderson A-279 | 330' F westerly WL and 2,350' FSL of survey                     | -- 8,275     | Plugged back 7-8-69 for injection in Woodbine; salt-water disposal well |
| +48     | F. A. Adair                                    | 1        | McCallister permitted date 8-30-54 | --   | --              | 337              | Pine Mills Wood Co. | David Gilliland A-229 | 32.5' FEL and 475' F most easterly NL of survey                 | --           | existence uncertain   |
| +49     | Clemco (R. P. Lewelling) (L. A. Grelling)      | 4        | O. M. Childress 3-12-55            | Oil  | Aband.          | 337              | Pine Mills Wood Co. | David Gilliland A-229 | 230' FEL and 475' F most easterly NL of survey                  | Paluxy 7,928 | Drilled diagonally to the northeast                                     |
| +50     | Clemco (R. P. Lewelling) (L. A. Grelling)      | 1        | O. M. Childress 1-5-52             | Oil  | Plugged 2-17-77 | 337              | Pine Mills Wood Co. | David Gilliland A-229 | 514' FEL and 740' F most easterly NL of survey                  | Paluxy 7,902 | Discovery well  |
| +51     | Clemco? (L. A. Grelling)?                      | 5        | O. M. Childress 1-7-60             | Dry  | Aband.          | 340              | Pine Mills Wood Co. | David Gilliland A-229 | 1,760' F most easterly NL and 500' F most easterly WL of lease  | -- 2,408     | Salt-water disposal well  |
| +52     | Clemco? (L. A. Grelling)?                      | 2        | O. M. Childress 3-10-52            | Oil  | Aband.          | 336              | Pine Mills Wood Co. | David Gilliland A-229 | 1,560' F most easterly NL and 330' FEL of survey                | Paluxy 7,997 | --  |
| +53     | L. A. Grelling                                 | 3        | O. M. Childress 4-19-52            | Dry  | Aband.          | 337              | Pine Mills Wood Co. | David Gilliland A-229 | 2,600' F most easterly NL and 330' F most easterly EL of survey | -- 8,028     | --  |

Table 1. (cont.)

| Map no. | Present (and past) operators       | Well no. | Lease/Date                       | Type      | Status *       | Ground elevation (ft) | Location                |                      | Legal description                     | Prod. zones              | T.D. (ft) | Misc.  |
|---------|------------------------------------|----------|----------------------------------|-----------|----------------|-----------------------|-------------------------|----------------------|---------------------------------------|--------------------------|-----------|--|
|         |                                    |          |                                  |           |                |                       | Field/Co.               | Survey               |                                       |                          |           |  |
| +54     | F. R. Jackson                      | 1        | Don Roberts 6-3-54               | Dry       | Plugged 6-3-54 | 327                   | Wildcat Wood Co.        | B. Hearn A-309       | 330' FNL and 330' FWL of 20 ac. lease | --                       | 5,942     | --   |
| 55      | Jack W. Trantham                   | 1        | T. J. Bailey 2-6-67              | Dry       | Plugged 2-6-67 | 348                   | Wildcat Wood Co.        | William Dobson A-170 | 467' FNL and 467' FEL of survey       | --                       | 5,150     | --   |
| 56      | Hedge Oil Co.                      | 1        | Welby and Carlock et al. 6-21-73 | Dry       | Aband.         | 350                   | Wildcat Wood Co.        | Wiley Davis A-171    | 467' FNL and 403' FEL of survey       | --                       | 5,500     | --   |
| 57      | Clemco                             | 3        | Paul H. McKnight 4-2-80          | Oil       | --6            | 349                   | Hawkins, N. E. Wood Co. | W. R. James A-335    | 150' FWL and 2,200' FSL of survey     | Sub-Clarksville          | 4,750     | --   |
| 58      | Clemco                             | 2        | Paul H. McKnight 11-26-78        | Oil       | --6            | 345                   | Hawkins, N. E. Wood Co. | W. R. James A-335    | 467' FWL and 1,000' FSL of survey     | Sub-Clarksville          | 4,700     | --   |
| 59      | E. Hollandsworth                   | 1        | Paul H. McKnight 11-21-49        | Dry       | Aband.         | 350                   | Hawkins, N. E. Wood Co. | W. R. James A-335    | 800' FSL and 467' FWL of survey       | --                       | 4,815     | --   |
| 60      | Clemco (Humble Oil & Refining Co.) | 1-R (1)  | Paul H. McKnight et al. 7-18-47  | Oil (Gas) | --6            | 349                   | Hawkins, N. E. Wood Co. | W. R. James A-335    | 467' FWL and 467' FSL of lease        | Rodessa, Sub-Clarksville | 14,629    | Gas well plugged 1965; re-entered 3-15-77 as #1-R for oil discovery in Sub-Clarksville |
| 61      | Clemco                             | 1        | Paul H. McKnight 2-23-77         | Dry       | Plugged        | 349                   | Hawkins, N. E. Wood Co. | W. R. James A-335    | 1,000' FWL and 467' FSL of survey     | --                       | 5,330     | --   |
| 62      | Clemco                             | 1        | Richey-Davis 4-6-80              | Oil       | Prod.          | 355                   | Hawkins, N. E. Wood Co. | A. V. Sharp A-567    | 950' FWL and 150' FSL of survey       | Sub-Clarksville          | 4,950     | --   |

Table 1. (cont.)

| Map no. | Present (and past) operators                       | Well no. | Lease/Date                            | Type | Status *            | Ground elevation (ft) |  | Field/Co.           | Location Survey       | Legal description   | Prod. zones | T.D. (ft) | Misc.  |
|---------|--|----------|---------------------------------------|------|---------------------|-----------------------|--|---------------------|-----------------------|---|-------------|-----------|--|
|         |  |          |                                       |      |                     |                       |  |                     |                       |   |             |           |  |
| +63     | Millican Oil                                       | 1        | Allar Co. et al.<br>10-26-71          | Dry  | Plugged<br>10-26-71 | 313                   |  | Wildcat<br>Wood Co. | G. D. Tucker<br>A-589 | 1,330' FNL and 970' FEL<br>of survey                            | --          | 5,398     | --   |
| 64-     | E Exxon<br>(Humble Oil &<br>Refining Co.)          | 1        | Florence M.<br>Farmer<br>7-24-60      | Gas  | Prod.               | 345                   |  | Hawkins<br>Wood Co. | J. B. Crain<br>A-137  | 330' FWL and 330' FSL<br>of lease                               | Woodbine    | 4,963     | Location<br>uncertain <sup>8</sup>   |
| 65      | Harry Harrington, Jr.<br>(R. W. Fair)<br>(Hal Co.) | 2        | Tom B.<br>Blackstone<br>5-31-58       | Oil  | Plugged<br>8-10-65  | 350                   |  | Hawkins<br>Wood Co. | J. B. Crain<br>A-137  | 330' FSL and 1,260' FWL<br>of lease                             | Woodbine    | 4,850     | --   |
| 66      | E Exxon<br>(Humble Oil &<br>Refining Co.)          | 10       | J. C. Snow<br>3-8-52                  | Oil  | Shut-in             | 360                   |  | Hawkins<br>Wood Co. | J. B. Crain<br>A-137  | 2,050' FEL and 1,600' FSL<br>of survey                          | Woodbine    | 4,928     | Hawkins Field<br>Unit #0310  |
| 57      | E Exxon<br>(Texaco)<br>(The Texas Co.)             | 3        | R. F. Green<br>tract 2 & 3<br>5-29-44 | Oil  | Aband.              | 350                   |  | Hawkins<br>Wood Co. | J. B. Crain<br>A-137  | 467' FSL and 1,763' FWL<br>of tract 2                           | Woodbine    | 4,855     | #2203; plugged<br>back 9-14-73<br>to 4758  |
| 68      | E Exxon<br>(Texaco)<br>(The Texas Co.)             | 1        | R. F. Green<br>tract 2 & 3<br>4-7-59  | Dry  | Plugged<br>10-20-76 | 350                   |  | Hawkins<br>Wood Co. | J. B. Crain<br>A-137  | 1,702' FWL and 794' FSL<br>of tract 2                           | --          | 2,660     | Salt-water<br>disposal well<br>#2201   |
| 69      | The Texas Co.<br>(now W. & L. Oper. #2)            | 4        | R. F. Green<br>8-14-44                | Oil  | Plugged<br>2-6-50   | 351                   |  | Hawkins<br>Wood Co. | J. B. Crain<br>A-137  | 550' F most southerly<br>NW corner and 1,001' FSL<br>of tract 3 | Woodbine    | 4,965     | --   |
| 69      | W. & L. Operators<br>(The Texas Co.)               | 2        | R. F. Green<br>10-30-51               | Oil  | Plugged<br>11-10-63 | 351                   |  | Hawkins<br>Wood Co. | J. B. Crain<br>A-137  | top of hole at Texas #4<br>Green                                | Woodbine    | 4,826     | Drilled on<br>same site as<br>Texas #4<br>Green; drilled<br>diagonally to<br>the southwest |
| 70      | W. & L. Operators                                  | 1        | R. F. Green<br>10-8-50                | Oil  | Plugged<br>11-5-63  | 360                   |  | Hawkins<br>Wood Co. | J. B. Crain<br>A-137  | 275' FSL and 330' FWL<br>of tract 3                             | Woodbine    | 4,827     | --   |

Table 1. (cont.)

| Map no. | Present (and past) operators      | Well no. | Lease/Date                       | Type | Status *           | Ground elevation (ft) | Location              |                         | Legal description   | Prod. zones | T.D. (ft) | Misc. |
|---------|-----------------------------------|----------|----------------------------------|------|--------------------|-----------------------|-----------------------|-------------------------|---|-------------|-----------|-------|
|         |                                   |          |                                  |      |                    |                       | Field/Co.             | Survey                  |   |             |           |       |
| 71      | Key Production Co.                | 1        | J. M. Green<br>5-17-72           | Dry  | Plugged<br>5-17-72 | 357                   | Hawkins<br>Wood Co.   | John P. Mosley<br>A-384 | 467' F westerly NL and<br>6,100' F westerly WL<br>of survey | --          | 4,900     | --    |
| +72     | Trumter Petroleum<br>Corp. et al. | 1        | Wanie Green<br>et al.<br>7-30-59 | Dry  | Aband.             | 330                   | Wildcat<br>Upshur Co. | M. Caffey<br>A-116      | 90' FEL and 330' FNL<br>of survey                           | --          | 5,353     | --    |

\* Aband. = abandoned or shut-in; Prod. = producing

1 Current lease is 2nd Sub-Clarksville Formation Unit 3

2 Current lease is Woodbine Wagoner Formation Unit 2

3 Current lease is 2nd Sub-Clarksville Formation Unit 2

4 Current lease is Woodbine Wagoner Formation Unit 18

5 Current lease is Woodbine Wagoner Formation Unit 19

6 A maximum of two and a minimum of one of the Cleimco McKnight wells are producing

7 Recompleted 1-23-55 to 6,010-ft, drilled diagonally to the south

8 Current lease is Hawkins Field Unit, well no. 2171; Hawkins Oil Unit no. 44, Hawkins Gas Unit no. 13



production and well statistics in this report are from Railroad Commission of Texas records and Railroad Commission of Texas (1982).

### Pine Mills Field

The Pine Mills Field was discovered in 1949 and has produced oil from the 2nd Sub-Clarksville sand, Orr sand (sometimes referred to as the 3rd Sub-Clarksville sand), Woodbine Group sands (the major producing sand is the Woodbine Wagoner), and upper Paluxy Formation sands (fig. 6). The regional dip of the producing strata is about 300 ft per mi westward, and a normal fault provides the primary trap (fig. 7). Stratigraphic pinch-outs of some of the upper Woodbine Group sands are also trapping mechanisms. Normal fault traps and stratigraphic pinch-outs are typical of the other fields associated with the northern part of the Earl-Lee turtle-structure anticline. The drive mechanism for the Pine Mills Field is probably water, solution gas, or a combination of the two.

Figure 8 shows the structure on the base of the 2nd Sub-Clarksville sand for the Pine Mills Field within the contract area. Only one producing well from this reservoir (well no. 19, table 1) occurs below the 340-ft ground elevation contour. Four additional wells produce from Sub-Clarksville sands within the 360-ft contour boundary.

The production history of the Pine Mills 2nd Sub-Clarksville reservoir is summarized in figure 9. Production rose after 1965 due to secondary recovery; the reservoir has decreased in production since 1970. The estimated value of the 4,988,953 barrels (bbl) of oil produced from this reservoir as of December 1984 is \$134,701,731 (all dollars in this report are 1985 dollars unless otherwise noted). This amount represents the total amount of oil produced from the reservoir multiplied by the 1985 price of oil per bbl, about \$27. Because oil has been produced over many years, this value does not represent the price at which the oil was sold. These assumptions were made for all calculations in this report.

Table 2 provides the procedure for estimating remaining oil that is available for secondary and tertiary recovery. Estimates for the Pine Mills 2nd Sub-Clarksville

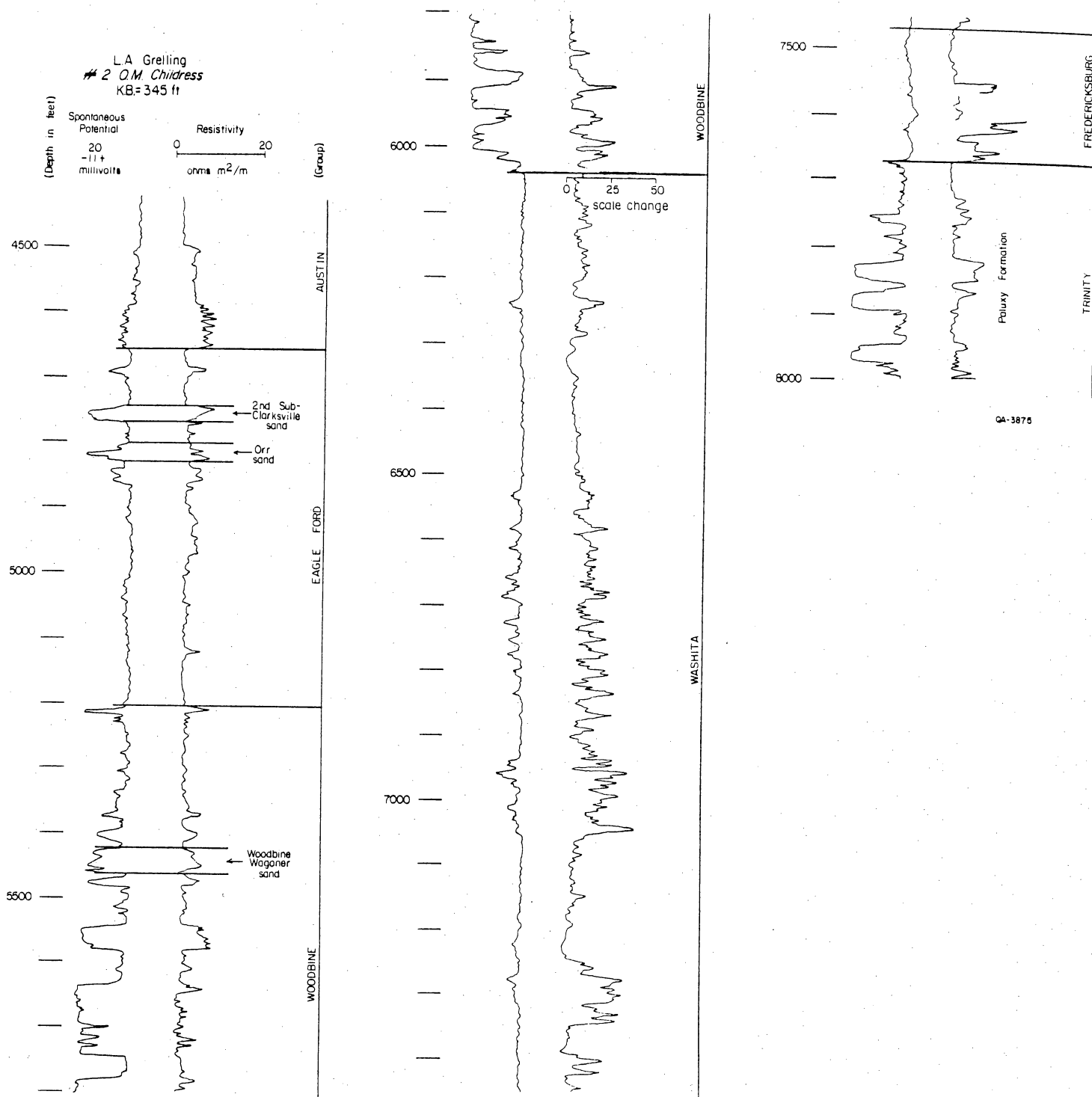


Figure 6. Typical geophysical log for the Pine Mills Field area, Wood County, Texas. K.B. = Kelly bushing; Depth = depth of well below Kelly bushing. Oil production in the Pine Mills and nearby fields is from Paluxy Formation sands (7,670-ft depth on log), the Woodbine Wagoner Unit (5,420-ft depth on log) as well as other younger Woodbine Group sandstones, and the Eagle Ford Group Orr sand (4,805-ft depth on log) and 2nd Sub-Clarksville sand (4,745-ft depth on log).

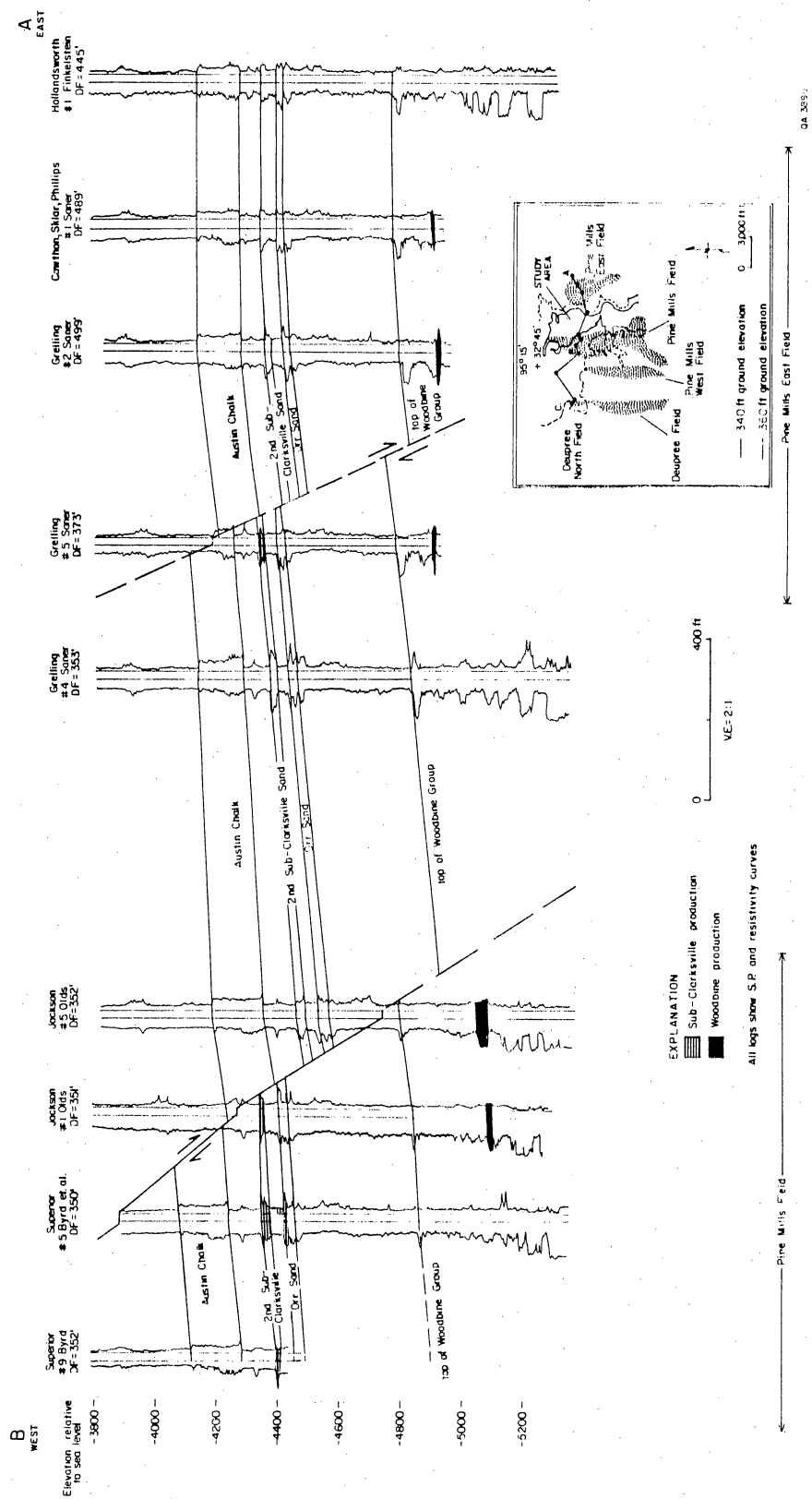


Figure 7. Cross section A-B through the Pine Mills East and Pine Mills Fields.

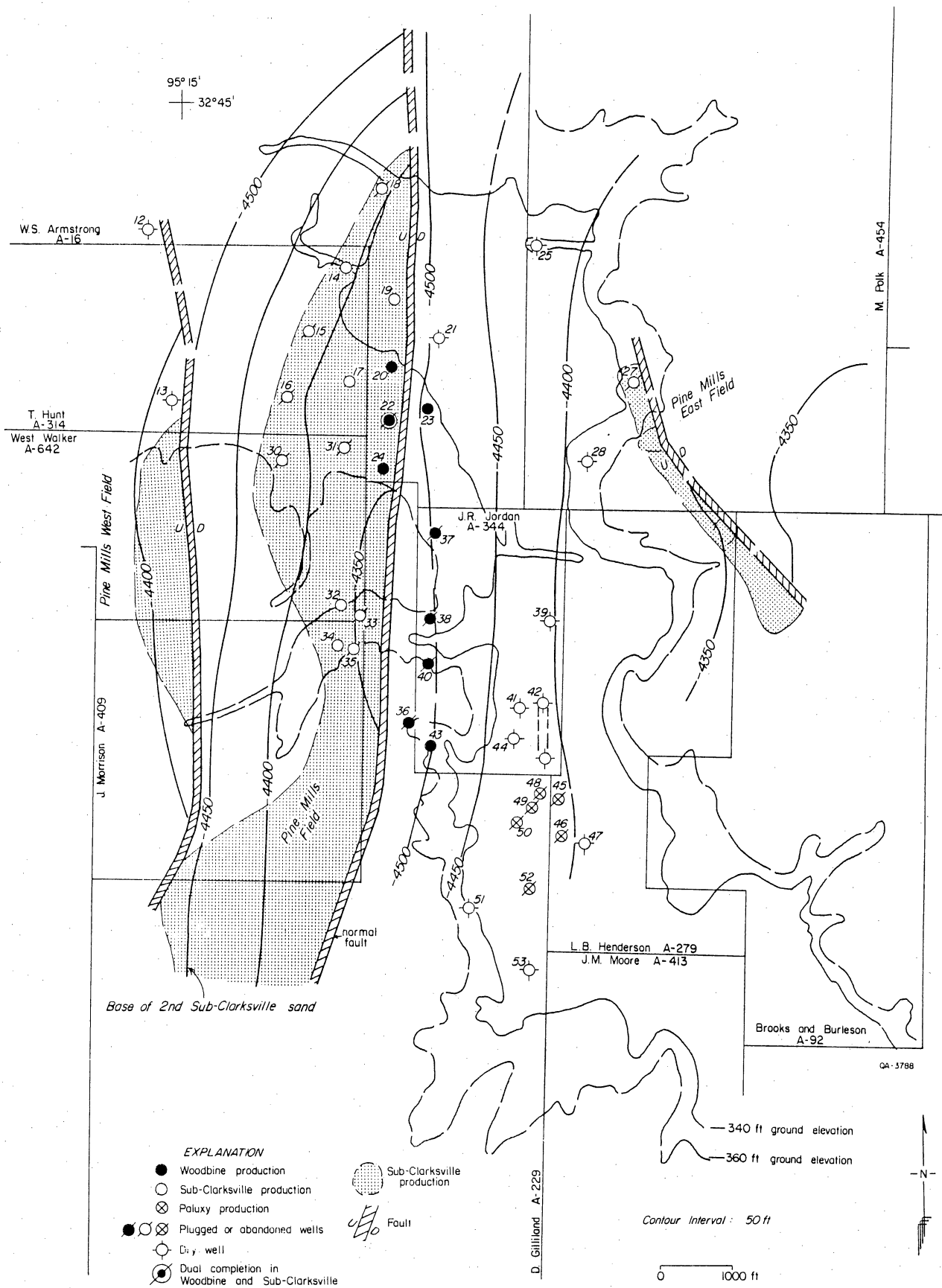


Figure 8. Structure map on the base of the 2nd Sub-Clarkville sand at the Pine Mills, Pine Mills East, and Pine Mills West Fields. Structure contours are at sub-sea-level elevations. Wells shown are within the study area, and well numbers correspond to numbers in table 1. Data are from Moore (1951), Railroad Commission of Texas files, and selected geophysical logs.

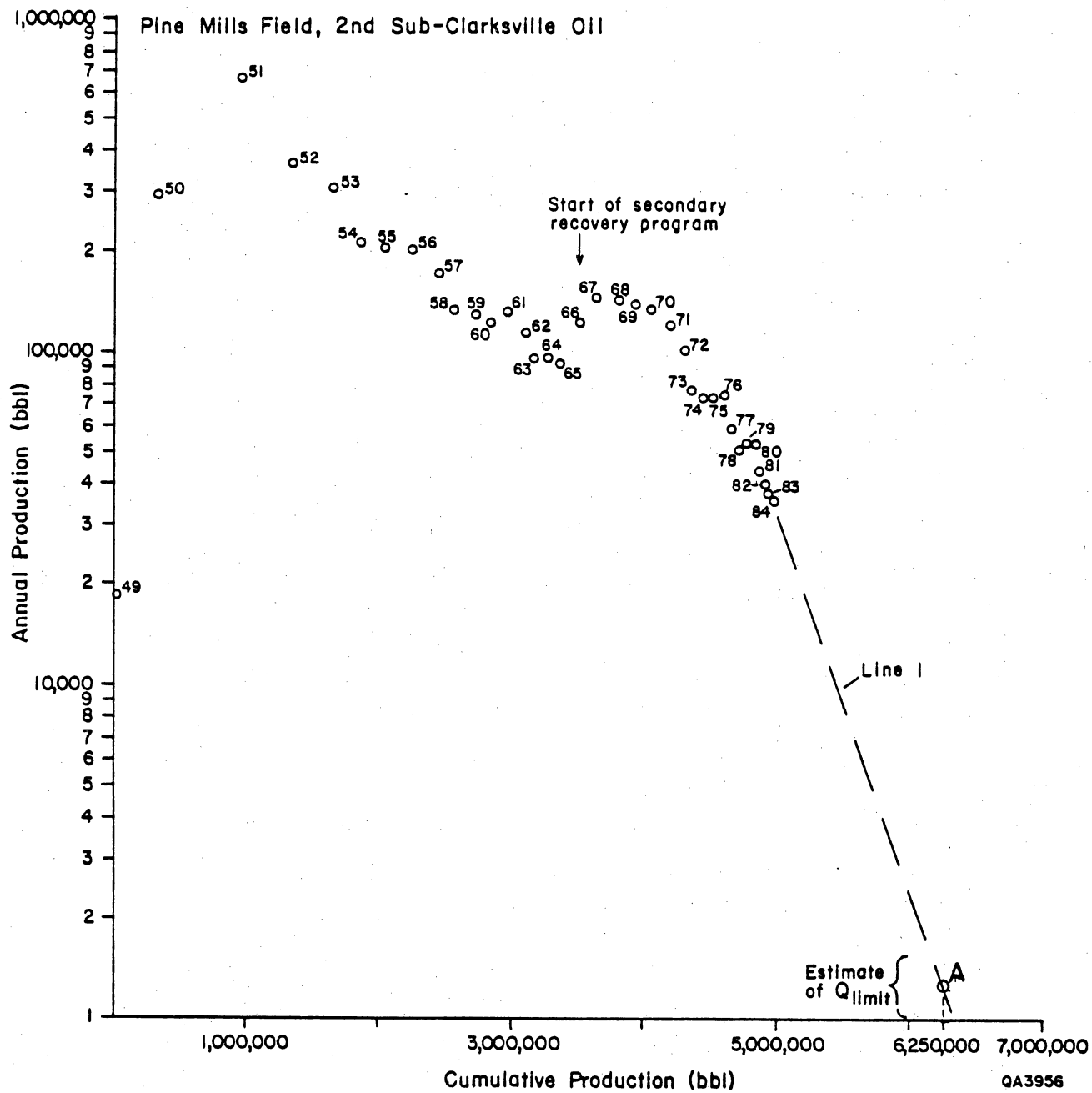


Figure 9. Production decline for the Pine Mills Field, 2nd Sub-Clarksville reservoir. For further explanation of graph see table 2.

Table 2. Example of procedure for estimating remaining oil that is available to secondary and tertiary recovery in a given reservoir.

Estimation of remaining oil involves three steps, outlined below.

1. Estimation of the economic limit of production.

$$Q_{\text{limit}} = \frac{C}{(P)(W)(1-T)}$$

where

$Q_{\text{limit}}$  = value of bbl/yr below which it is not economically feasible to operate a well

$C$  = operating cost of a well per year

$P$  = current price of oil per bbl, estimated at \$27

$W$  = working interest, about 0.75

$T$  = State tax rate, 0.41

2. Estimation of remaining oil available to secondary recovery methods (ultimate recovery).

An estimate of the remaining oil in a reservoir is made on production decline graphs (annual production vs. yrs) by extending a straight line from the trend in production down to the x-axis (here designated "line 1"). Then an estimate of  $Q_{\text{limit}}$  from step 1, above, is measured on the y-axis (annual production). A point of intersection (A) of the  $Q_{\text{limit}}$  value with line 1 is chosen in the middle of the  $Q_{\text{limit}}$  range to represent an average value. A straight line extended down from point A hits the x-axis at a certain value. This value is an estimate of ultimate recovery from the reservoir using secondary recovery methods.

3. Estimation of oil available to tertiary recovery methods (target and residual oil).

$$\begin{array}{lcl} \text{a. amount left} & = & \text{ultimate recovery} \\ \text{in reservoir} & & \text{(from step 2)} \\ \text{(secondary} & & - \text{ amount produced to date} \\ \text{recovery)} & & \end{array}$$

Table 2 (continued)

b. OOIP (original oil in place) =  $\frac{\text{ultimate recovery}}{\text{recovery efficiency}}$   
(estimated from Galloway and others, 1983)

c. target oil =  $(\% \text{ unrecovered oil} - \frac{\% \text{ residual oil}}{1 - W_s}) \times \text{OOIP}$

where

% unrecovered oil =  $1 - \text{recovery efficiency}$

% residual oil and  $W_s$  (% water saturation) are estimated from Galloway and others (1983)

d. total movable oil = target oil + ultimate recovery

e. residual oil = OOIP - total movable oil

f. Target oil and residual oil are both available to tertiary recovery methods. From 25 to 50 percent of this oil might be recovered; however, it is likely that less than 10 percent could be recovered.

g.  $(\text{target oil} + \text{residual oil}) (\$/\text{bbl}) =$  the cost of oil available to tertiary recovery  
(see step 1)

reservoir are not shown because only one of the Sub-Clarksville producing wells (well no. 19, table 1) occurs within the +340-ft contour boundary. Production data was not available for this well.

Production history of the Pine Mills Orr reservoir is summarized in figure 10. The Orr reservoir has experienced a sharp decline in production in the past 7 years; however, a slight increase occurred in 1984. There has been no secondary recovery in this reservoir. The estimated cost of the 845,108 bbl of oil produced from this reservoir as of December 1984 is \$22,817,916.

Figure 11 shows the structure on the top of the Woodbine Group at the Pine Mills Field. Currently no wells are producing from Woodbine sands in the contract area below the 340-ft ground elevation, although there are four active wells below the 360-ft ground level contour.

The production history of the Pine Mills Woodbine and Woodbine Wagoner reservoirs is summarized in figures 12 and 13. The Woodbine Wagoner reservoir was officially separated from the Woodbine reservoir in 1966, coincident with the start of the secondary recovery program. Production has been generally declining since then. Production totaled 1,330,150 bbl of oil at the end of 1984, with an estimated value of \$35,914,050. Production from the Woodbine reservoir appears to have stabilized since 1978. The estimated value of the 5,463,321 bbl of oil produced from this reservoir as of December 1984 is \$147,509,667.

The structure on the top of the Paluxy Formation is shown in figure 14. The entire Paluxy reservoir is within the contract area; however, all of the producing wells have been plugged or abandoned. The production history of the Pine Mills Paluxy reservoir is shown in figure 15. Rise in production in 1966 indicates a secondary recovery program; however, no official record of secondary recovery has been found in data from the Railroad Commission of Texas.



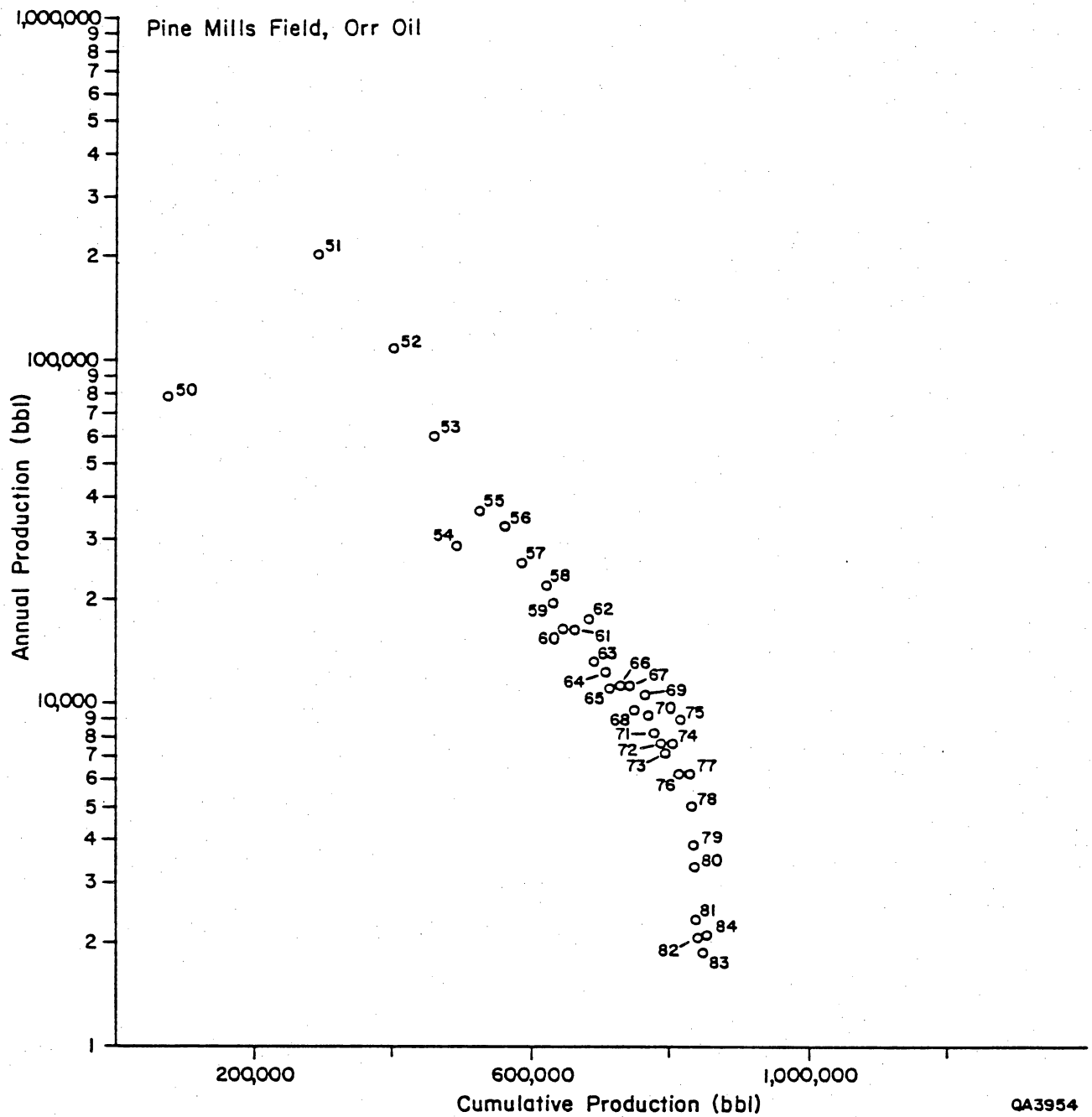


Figure 10. Production decline for the Pine Mills Field, Orr reservoir.

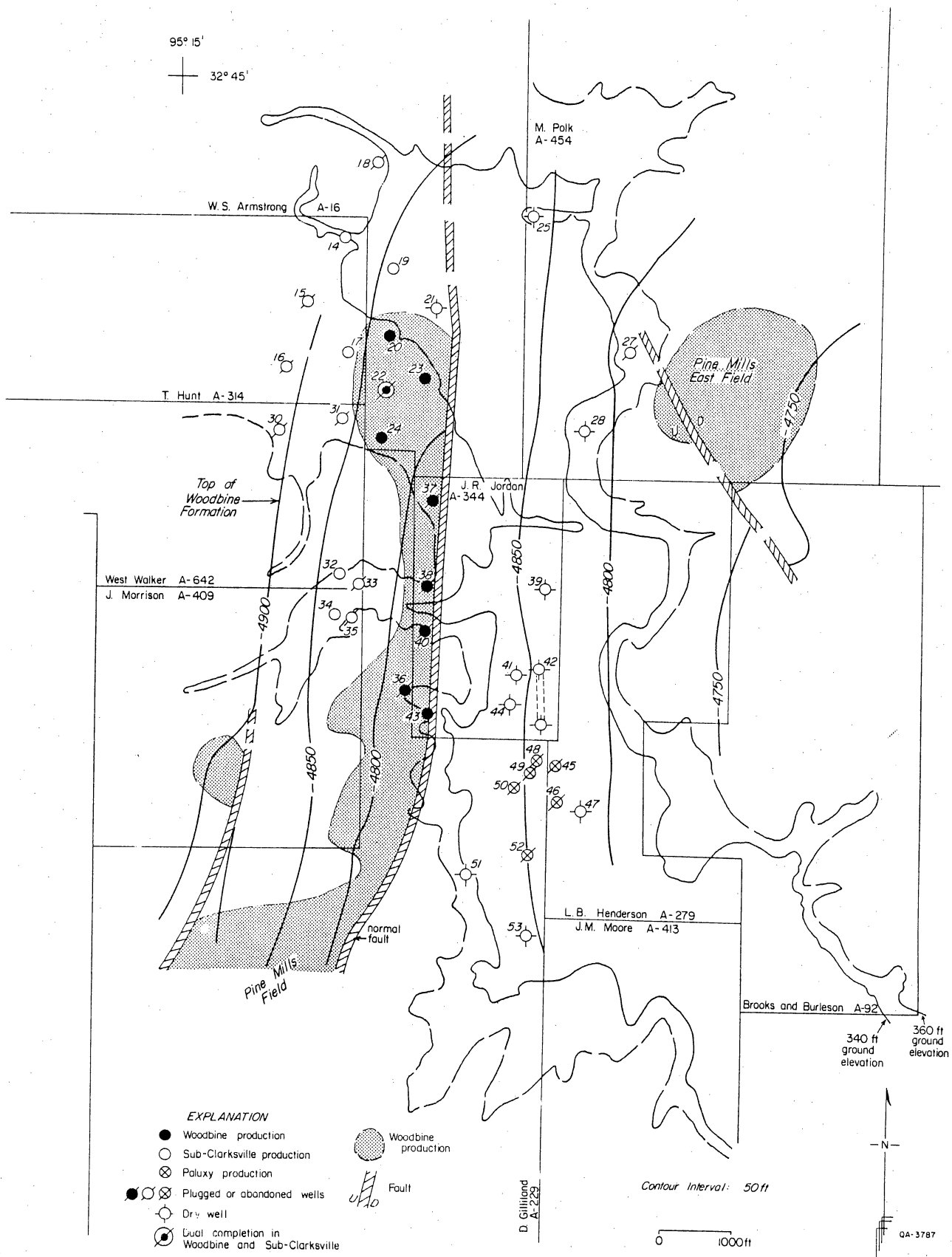


Figure 11. Structure map on the top of the Woodbine Group and Pine Mills and Pine Mills East Fields. Structure contours are at sub-sea-level elevations. Wells shown are within the study area, and well numbers correspond to numbers in table 1. Data are from Moore (1951), Railroad Commission of Texas files, and selected geophysical logs.

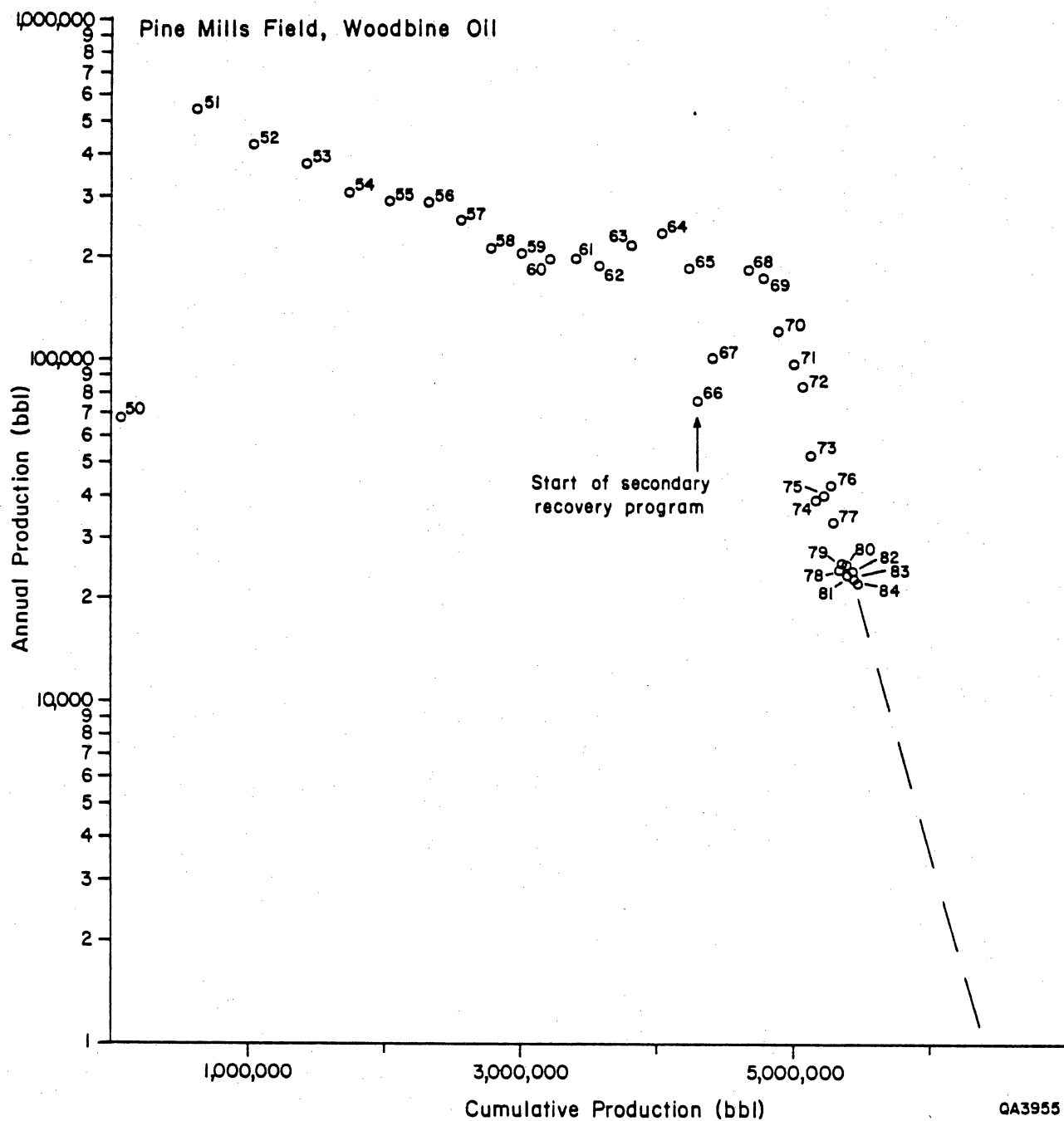


Figure 12. Production decline for the Pine Mills Field, Woodbine reservoir.

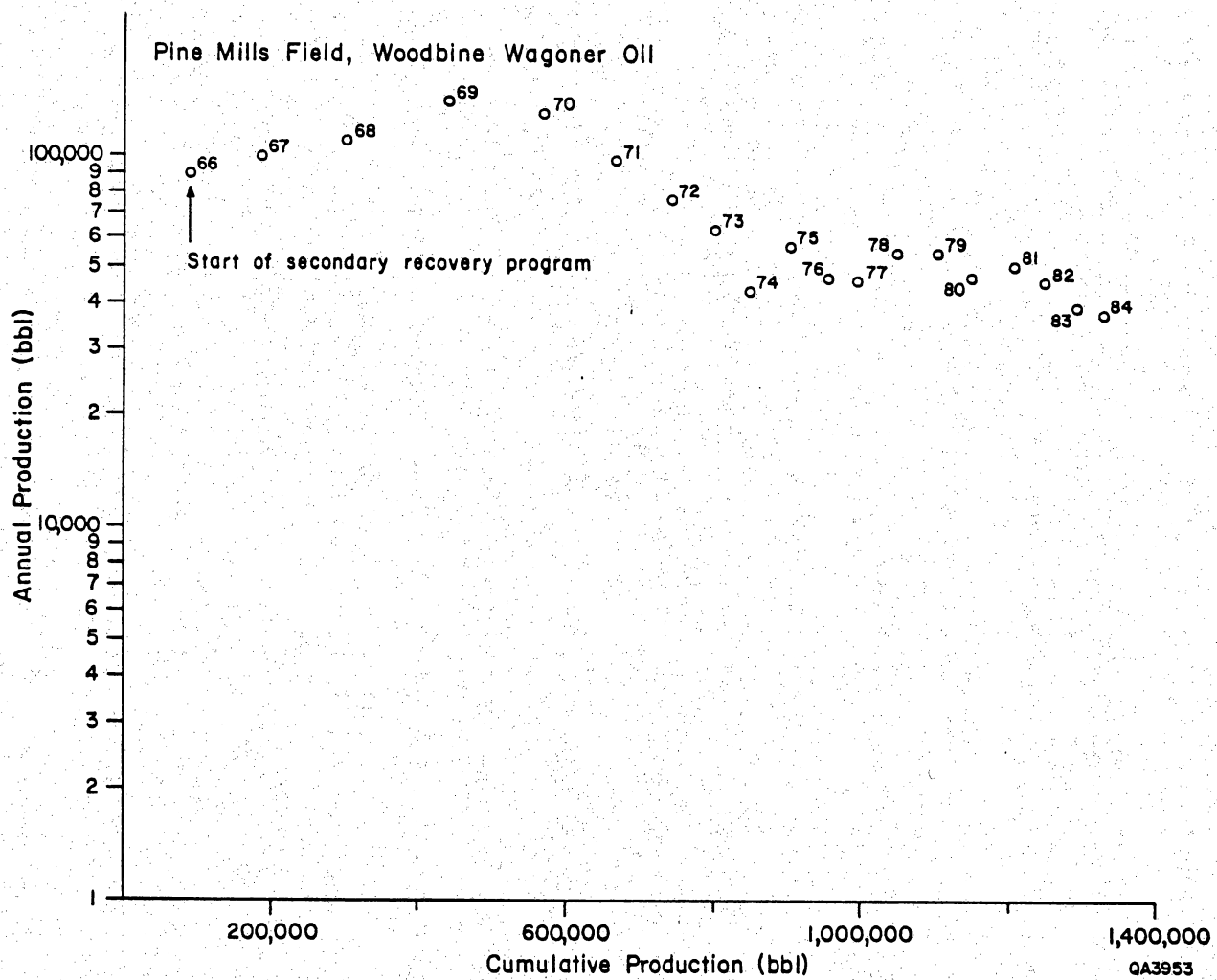


Figure 13. Production decline for the Pine Mills Field, Woodbine Wagoner reservoir. The Woodbine Wagoner reservoir was officially separated from the Woodbine reservoir in 1966, coincident with the start of the secondary recovery program.

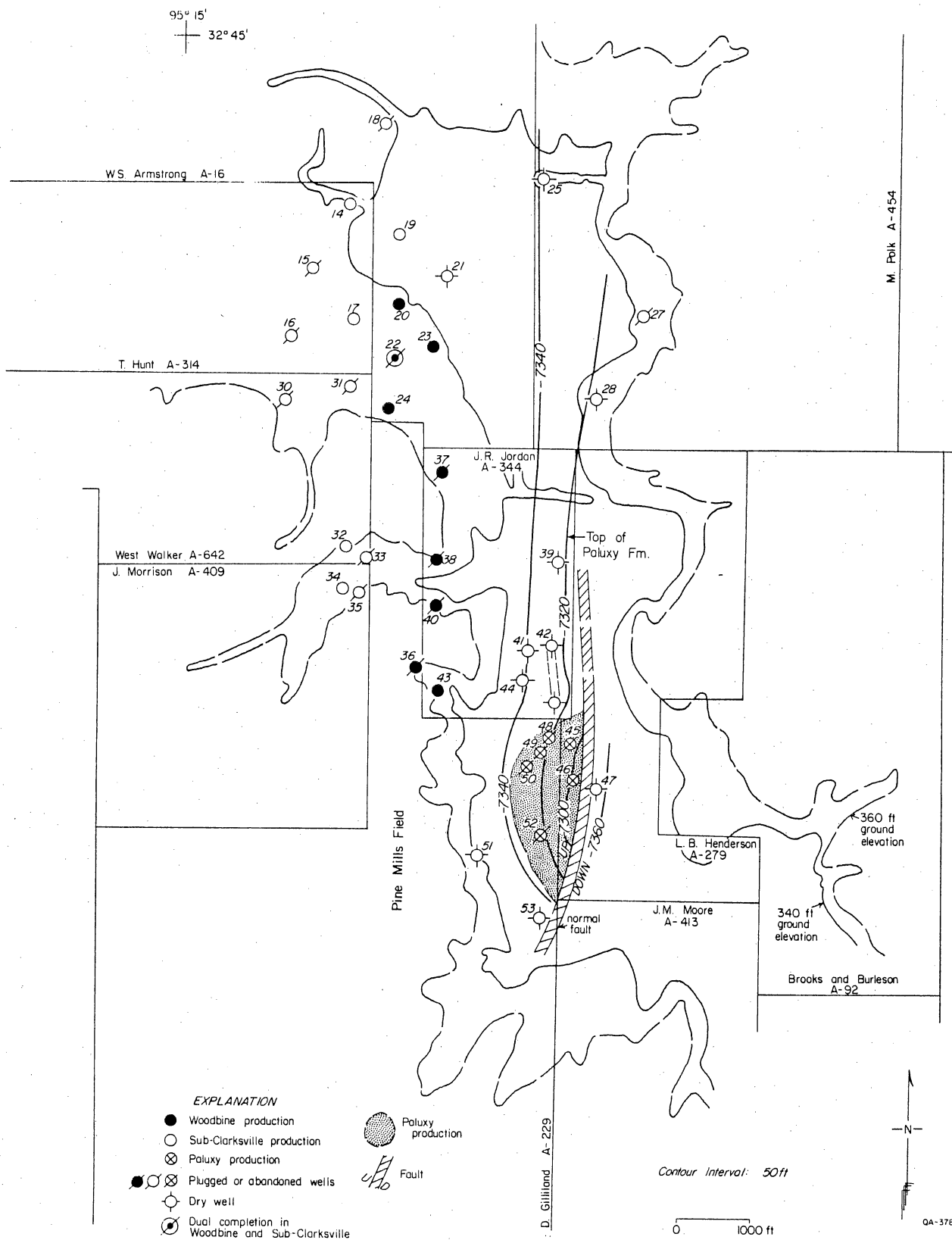


Figure 14. Structure map on the top of the Paluxy Formation at the Pine Mills Field. Structure contours are at sub-sea-level elevations. Wells shown are within the study area, and well numbers correspond to map numbers in table 1. Data are from Railroad Commission of Texas files and selected geophysical logs.

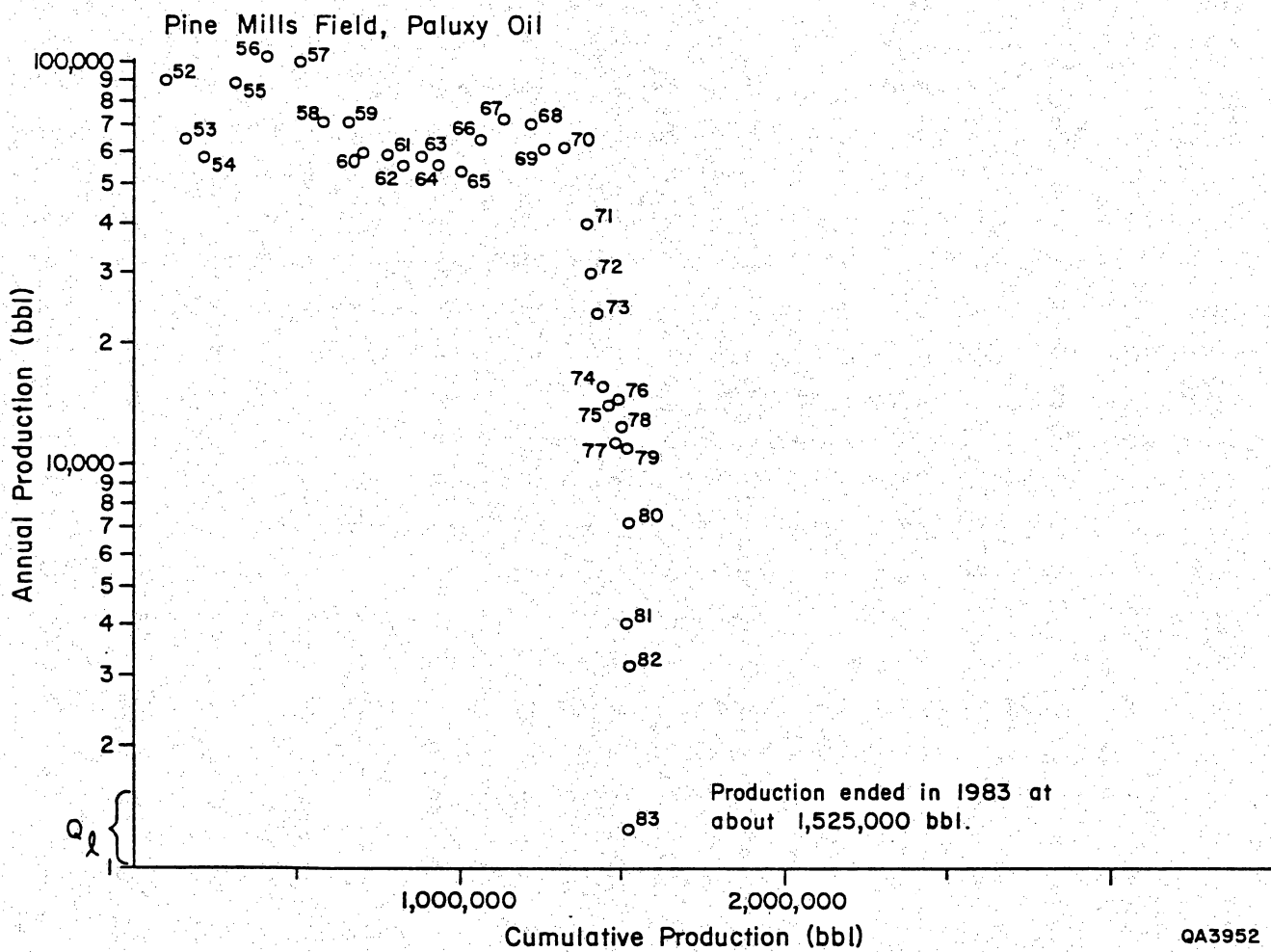


Figure 15. Production decline for the Pine Mills Field, Paluxy reservoir.

### Pine Mills East Field

The Pine Mills East Field was discovered in 1952 and has produced oil from the 2nd Sub-Clarksville sand and Woodbine Group sands (fig. 6). Several wells east of the potential reservoir site still produce from Woodbine strata, but Sub-Clarksville production has almost ceased. The field is above the 340-ft ground elevation, and only one plugged well that previously produced from the 2nd Sub-Clarksville sand is below the 360-ft contour elevation. The trapping mechanism and drive for this field are similar to those in the Pine Mills Field (fig. 7). Production in the Pine Mills East Sub-Clarksville reservoir has declined rapidly in recent years and is near the economic limit of production (fig. 16). Production totaled 259,986 bbl at the end of 1984, with an estimated value of \$7,019,622.

### Deupree and Deupree North Fields

The Deupree and Deupree North Fields were discovered in 1951 and 1964, respectively. The Deupree Field is above the 360-ft study site boundary and produces from Sub-Clarksville and Woodbine sands (fig. 6). The Deupree North Field had only one producing well, which is at a ground elevation of 360 ft. It produced from Woodbine sands until it was plugged in 1967. In the early 1980's two wells were drilled several hundred feet north of the Deupree North discovery well; however, Railroad Commission of Texas files list the wells in the Deupree Field. These two wells produce from Woodbine sands but they are outside the study site boundary. The structure at the top of the Woodbine producing zone is shown in figure 17. A normal fault acts as the trapping mechanism (fig. 18), and the drive mechanism is probably similar to that of the Pine Mills Field.

Production history of the Deupree and Deupree North Woodbine reservoirs is shown in figures 19 and 20. The estimated value of the 22,013 bbl of oil produced from the Deupree North Field as of December 1984 is \$594,351.

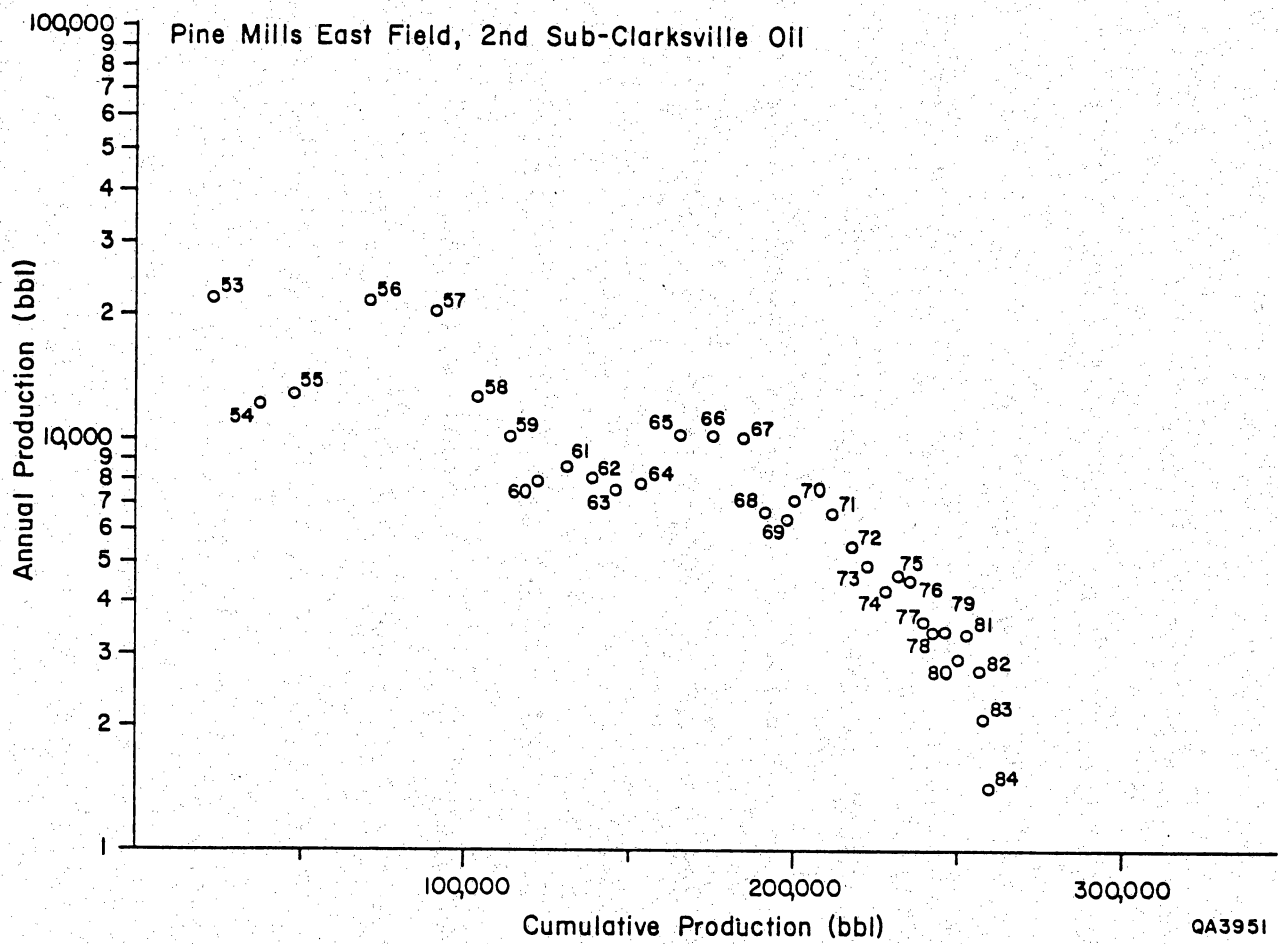


Figure 16. Production decline for the Pine Mills East Field, 2nd Sub-Clarksville reservoir.



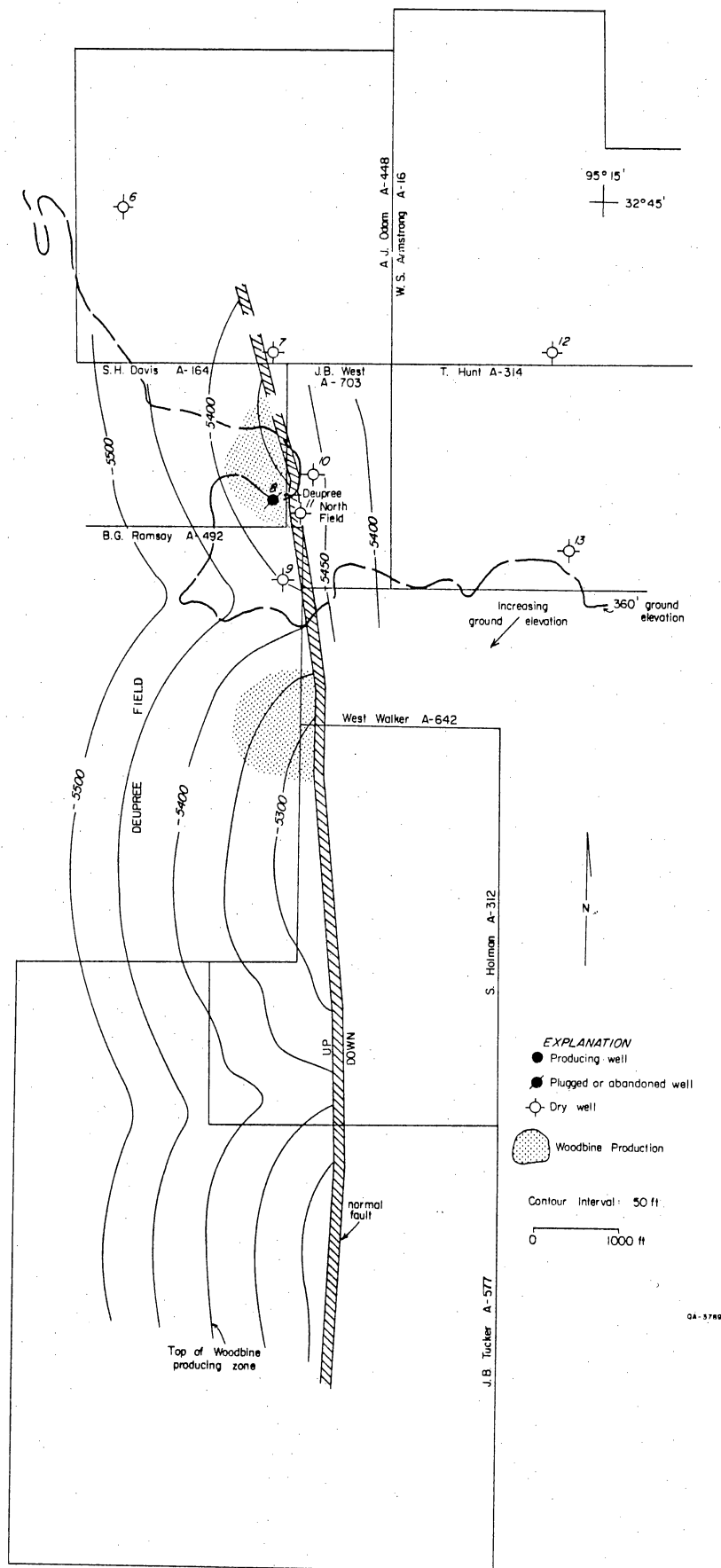


Figure 17. Structure map of the Deupree North and Deupree Fields. Sub-sea-level contours are on top of the Woodbine producing zone. Wells shown are within the study area, and well numbers correspond to map numbers in table 1. Data are from Railroad Commission of Texas files and selected geophysical logs.

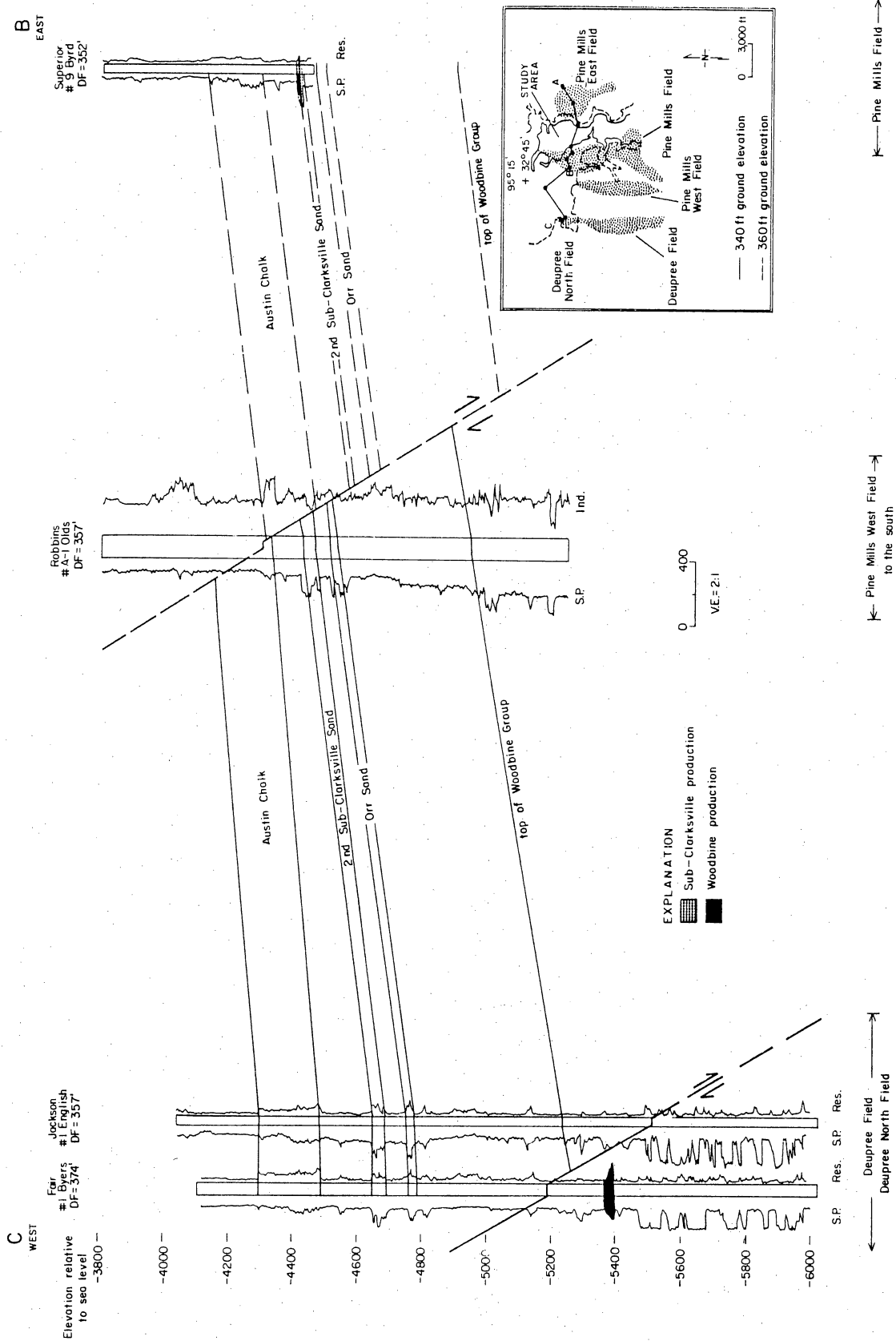


Figure 18. Cross section B-C through Pine Mills and Deupree North Fields.

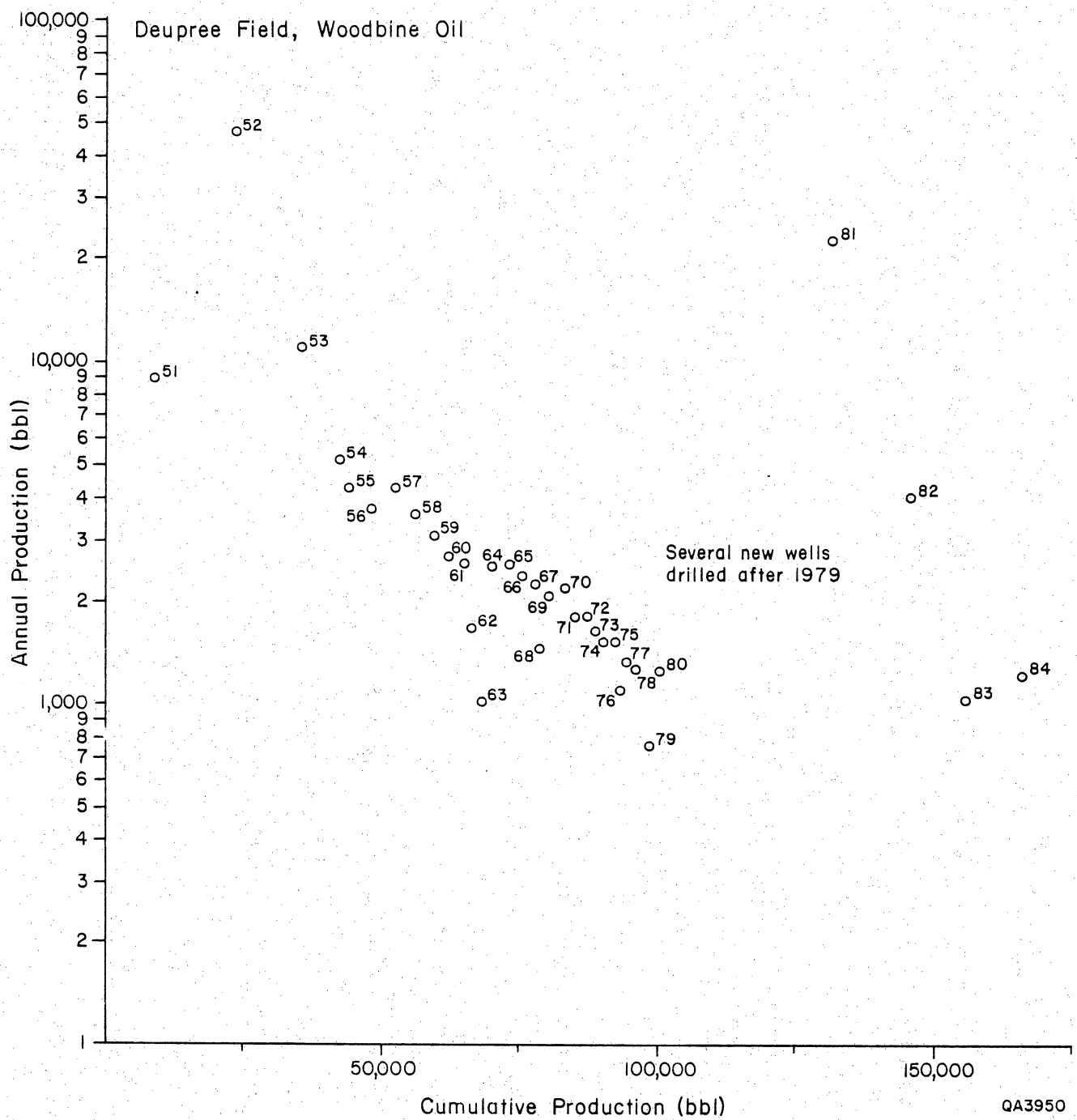


Figure 19. Production decline for the Deupree Field, Woodbine reservoir.

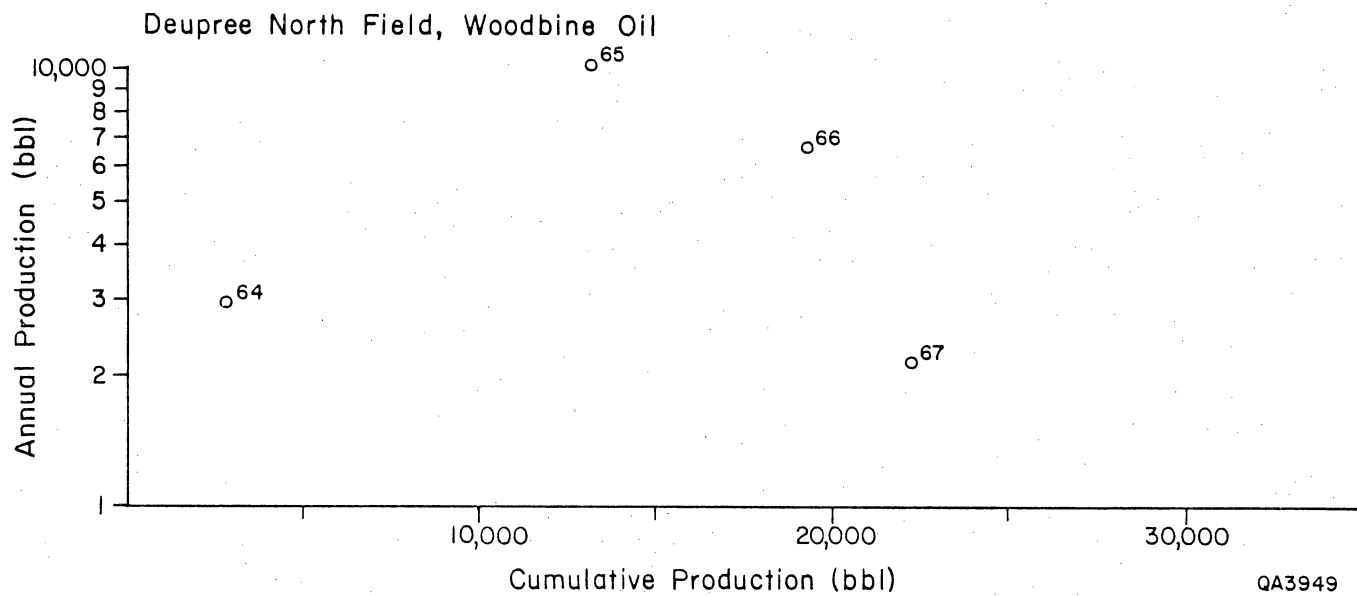


Figure 20. Production decline for the Deupree North Field, Woodbine reservoir.

## Hawkins Field

Oil was discovered at the Hawkins salt pillow in 1940. Oil is produced from Woodbine and Paluxy sands, whereas gas production is from Woodbine and Rodessa sands (fig. 21). The Hawkins Field is above the 340-ft contract area boundary, however the northeastern part of the field is within the 360-ft contour interval (fig. 22, plate 1). Paluxy production is outside the contract site. Hydrocarbons are trapped primarily by structural closure (fig. 22) and driven out by (1) water drive plus solution gas and (2) gravity drainage (Galloway and others, 1984).

The oil production history of the Hawkins Woodbine reservoir is summarized in figure 23. Estimated value of the 767,529,086 bbl of oil produced from this reservoir as of December 1984 is \$20,723,285,322. Secondary recovery began in 1969.

Figure 24 shows the Hawkins Woodbine gas production history. Production has declined slightly in recent years. Production from the Woodbine gas reservoir has totaled 8,636,083 thousand cubic feet (Mcf) as of December 1984, with an estimated value of \$22,885,619. Hawkins Rodessa gas production increased somewhat in the late 1970's and has moderately declined since then (fig. 25). The estimated value of the 2,202,417 Mcf of gas produced from the Rodessa reservoir as of December 1984 is \$5,836,405.

## Hawkins Northeast Field

The Hawkins Northeast Field, discovered in 1977, is located at the northern flank of the Hawkins salt pillow. Production is from Sub-Clarksville sands (fig. 21). The producing wells of this field are above the 340-ft ground elevation, however four wells are below the 360-ft ground elevation boundary (fig. 22 and plate 1). The trapping mechanism appears to be a fault along the flank of the anticline. Drive for this reservoir may be similar to that of the Hawkins Field.

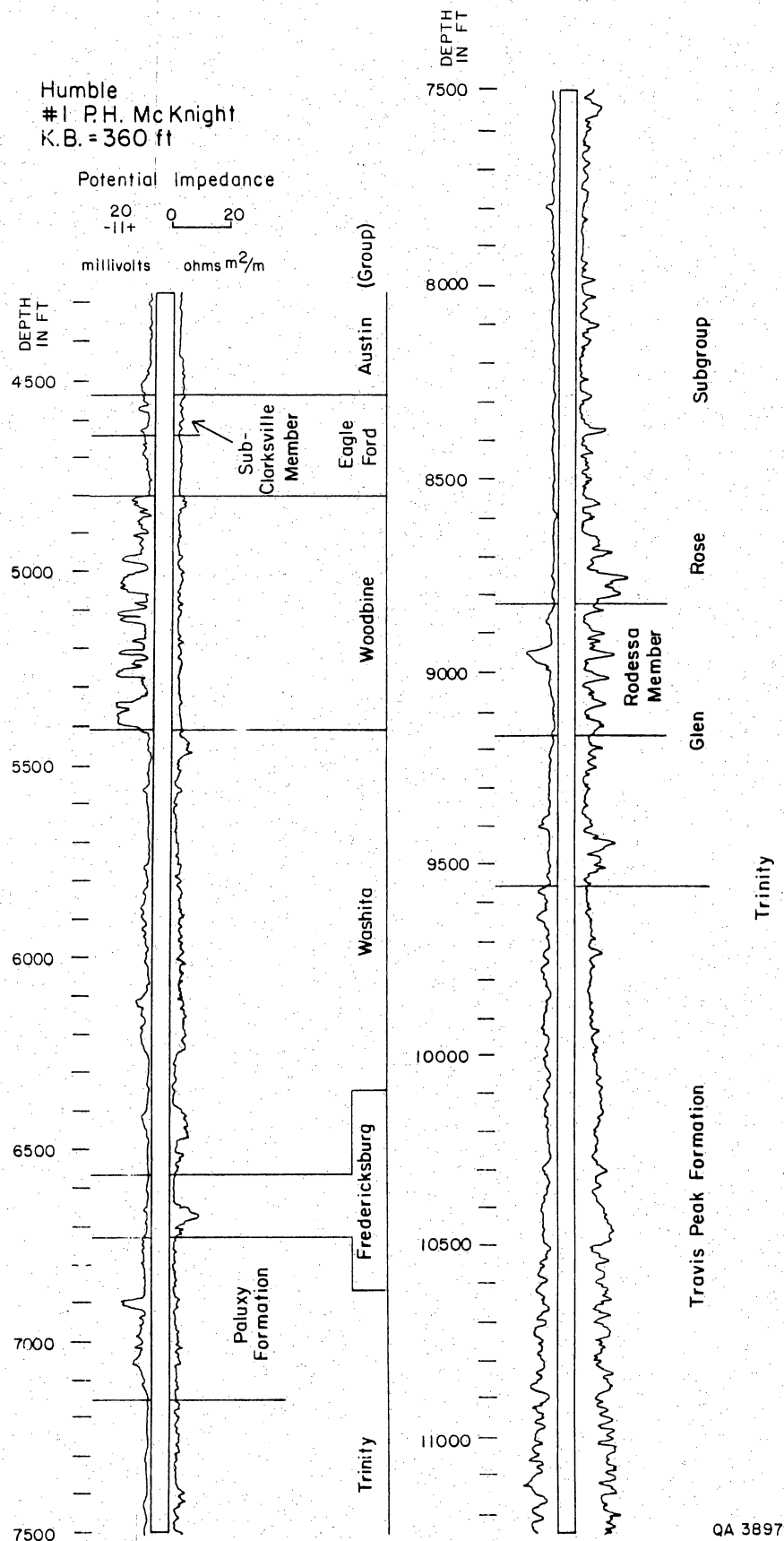


Figure 21. Typical geophysical log for the Hawkins and Hawkins Northeast Fields, Wood County, Texas. K.B. = Kelly bushing; Depth = depth of well below Kelly bushing. Oil production at the Hawkins field is primarily from Woodbine Group sands (4,800- to 5,400-ft depth on log) although Paluxy sands have also produced lesser amounts of oil. Gas production at Hawkins Field is from Woodbine Group sands and Rodessa sands (8,950-ft depth on log). Oil production at the Hawkins Northeast Field is from Sub-Clarksville sands (4,570-ft depth on log).

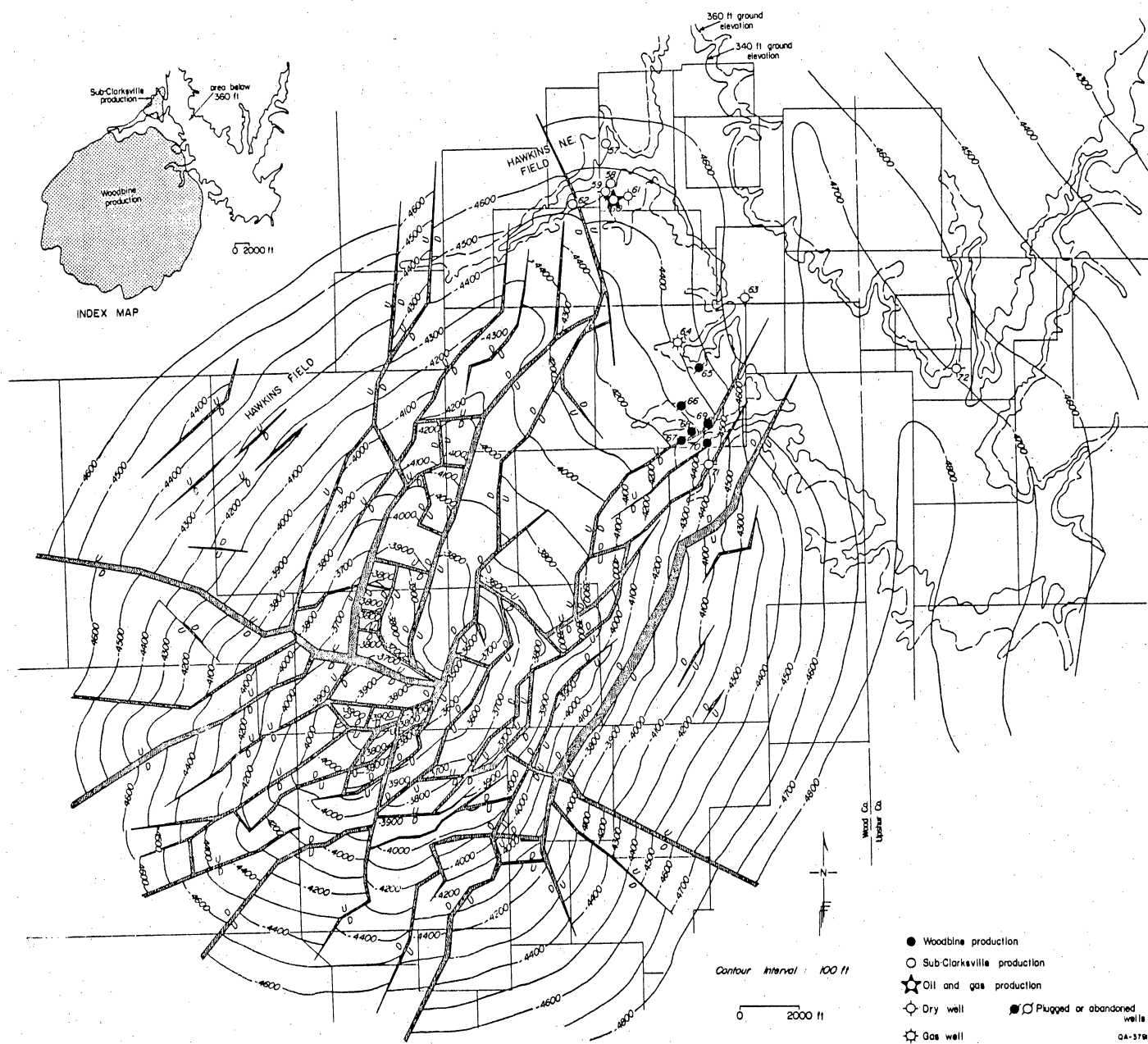


Figure 22. Structure map on the top of the Woodbine Group at Hawkins and Hawkins Northeast Fields. Structure contours are at sub-sea-level elevations. Wells shown are within the study area, and well numbers correspond to map numbers in table 1. Data are from map by Wendlandt (1951), Railroad Commission of Texas files, and selected geophysical logs.

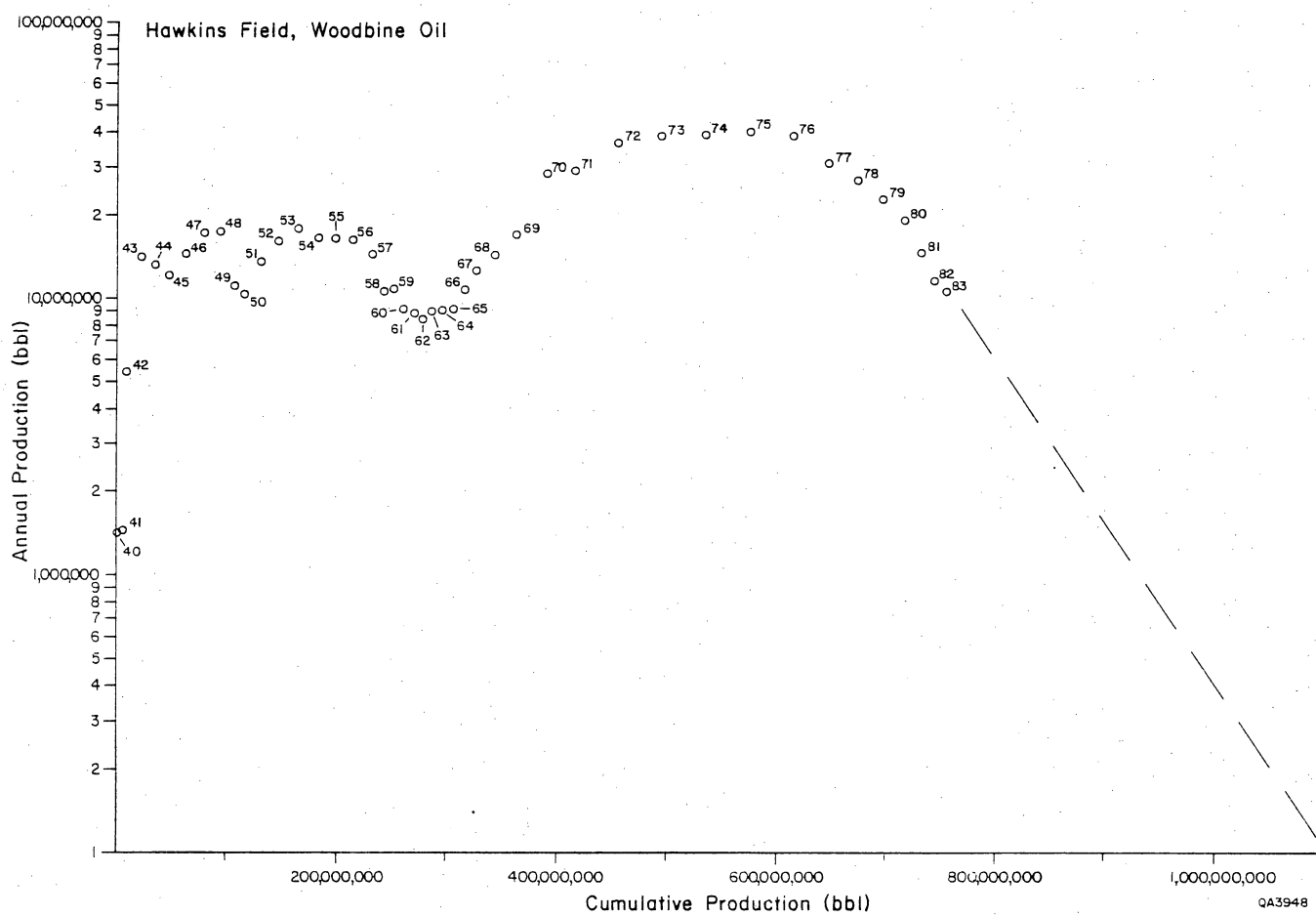


Figure 23. Production decline for the Hawkins Field, Woodbine reservoir.



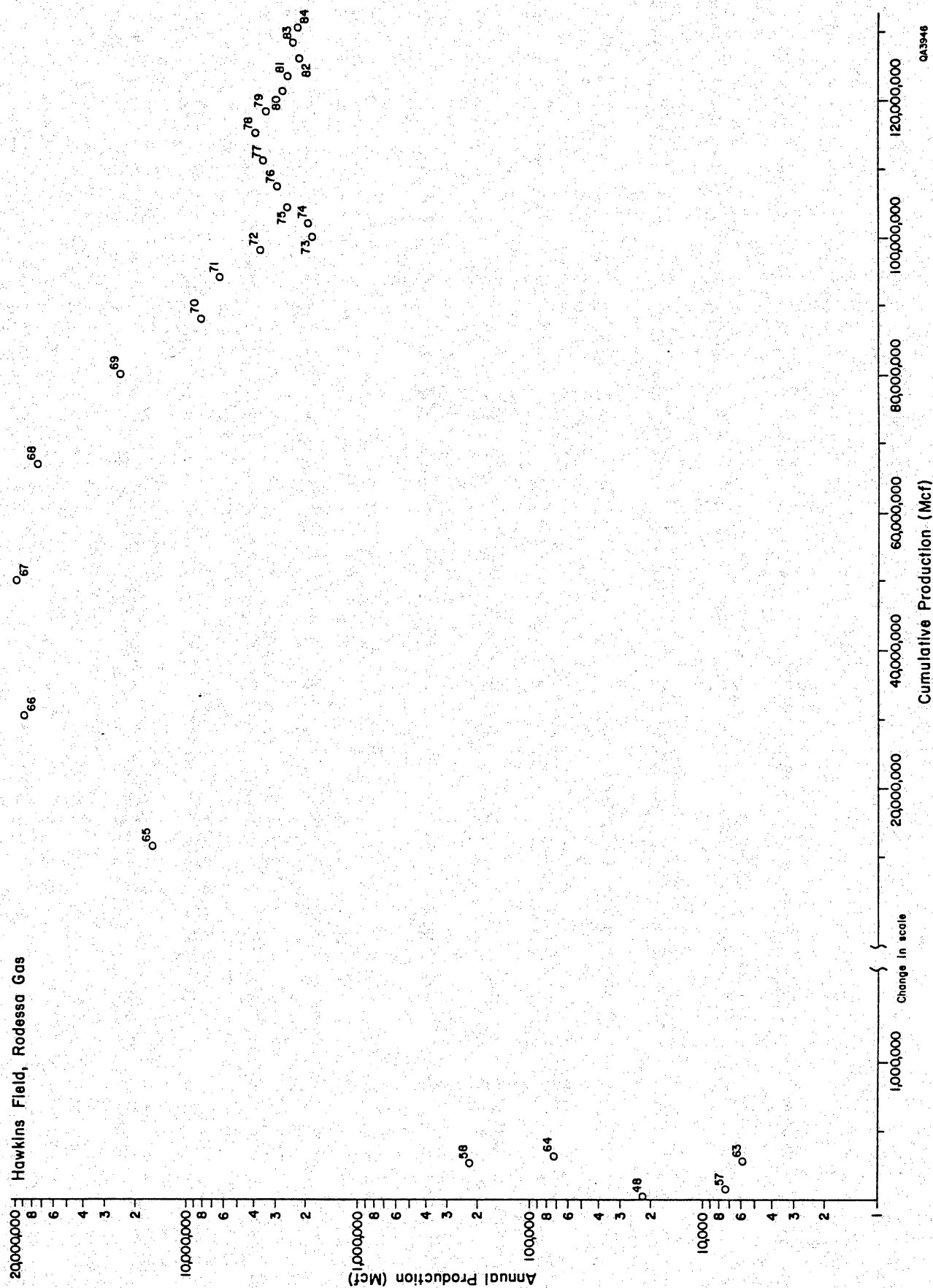


Figure 24. Production decline for the Hawkins Field, Rodessa reservoir.

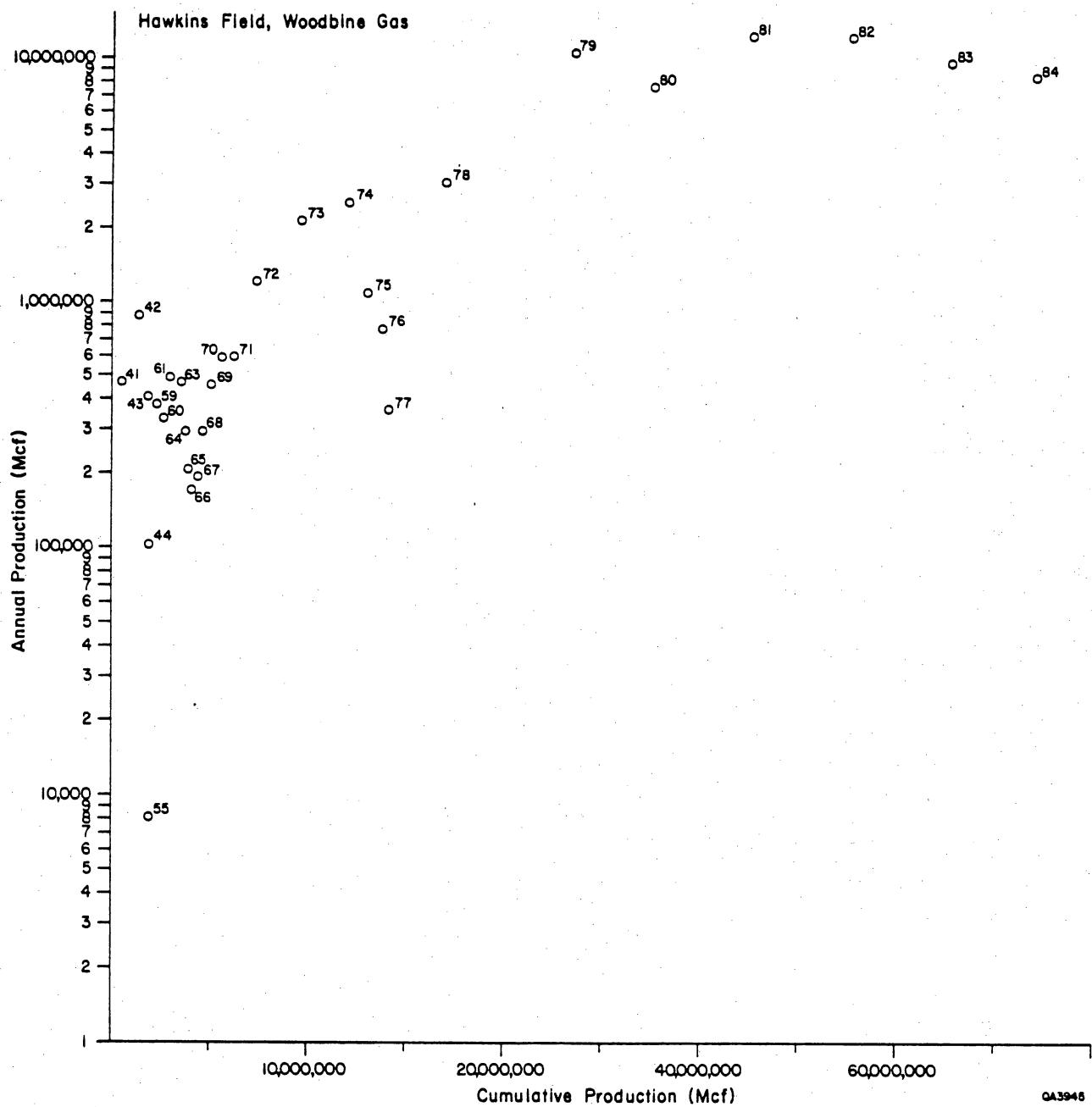


Figure 25. Production decline for the Hawkins Field, Woodbine reservoir.

Production in the Hawkins Northeast Field increased in the late 1970's and is now declining (fig. 26). Production totaled 24,251 bbl at the end of 1984, with an estimated value of \$654,777.

### Hydrocarbon Potential

Woodbine and Sub-Clarksville strata appear to have been thoroughly tested for hydrocarbons within parts of the contract area that coincide with the Hawkins salt-pillow anticline and the Earl-Lee turtle-structure anticline. The most recent discovery near the contract area is the Pine Mills West Field in 1982. In this field, production from Woodbine and Sub-Clarksville sands occurs immediately south of the contract area and west of the Pine Mills Field. Away from the regional anticlines, several dry holes have been drilled to Woodbine strata, which suggests low hydrocarbon potential in those areas.

Paluxy sands appear to have been thoroughly tested only in the Pine Mills Field. Few wells have been drilled to the Paluxy or other deeper strata in the contract area. Since 1979, the significant hydrocarbon discoveries made in the northern part of the East Texas Basin have been associated with the Smackover Formation and Cotton Valley Limestone of the Louark Group, Cotton Valley Group sandstones, the Rodessa Member of the Lower Glen Rose Formation, and the Paluxy Formation (Tsoukalas and others, 1984; Cambre and others, 1983; Cambre and others, 1982; Cambre and others, 1981; Collins and others, 1980). The economic potential of these deeper strata in the contract area will remain uncertain until they are tested for hydrocarbons.

### Lease Values

Private sources indicate a possible lease value of up to \$300 to \$500 per acre in the vicinity of the Hawkins and Pine Mills Fields in southwestern Wood County. Lease values depend upon several factors, including the production history of an area and the existing market values of hydrocarbons as well as other minerals.

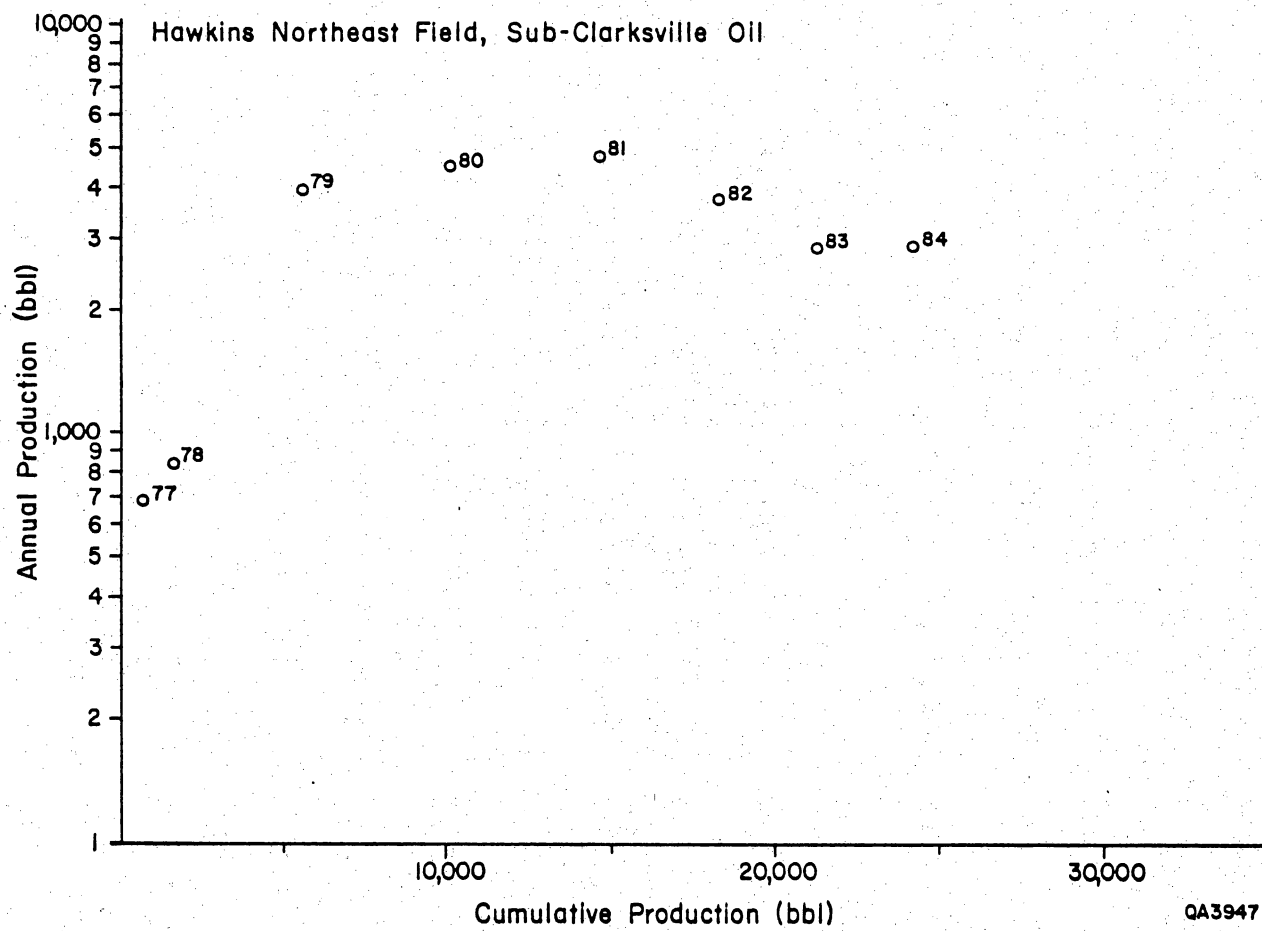


Figure 26. Production decline for the Hawkins Northeast Field, Sub-Clarksville reservoir.

## Pipelines

Two principal pipelines cross the contract area (plate 1). Table 3 lists the operating companies, addresses, phone numbers, and pipe sizes. Scurlock Oil Company operates three 8-inch-diameter pipes that trend approximately north-south across the contract area. Exxon Gas System operates an east-west-trending, 20-inch-diameter pipeline that crosses the contract area.

## Estimates for Slant and Raised Drilling

The cost of drilling a well in the vicinity of the study area (excluding completion costs) is approximately \$90 per ft (Railroad Commission of Texas). Slant hole drilling can cost up to twice as much per hole as vertical drilling; the steeper the slant angle, the higher the cost. Slant angles drilled to a target beneath the proposed Big Sandy reservoir would not be more than 30 degrees from vertical for a 5,000-ft well drilled on the perimeter of the reservoir. All areas under the proposed reservoir are accessible by slant drilling technology in use today. No estimate for the cost of raised drilling was available. Platforms built would be 30 ft tall at the most.

## SAND AND GRAVEL

No sand and gravel mining operations exist in the contract area. However, sand is mined near the proposed reservoir site at localities 2 mi northeast of Big Sandy and 6 mi north of the town of Hawkins. Production costs are determined partly by the following factors: (1) size and type of operation, (2) location and availability of power, water, and labor, as well as length of haul from the pit, (3) nature of the raw material, and (4) miscellaneous factors such as royalties, taxes, and environmental regulations (Fisher, 1965).

Table 3. Operating companies and pipe sizes of pipelines that cross the proposed Big Sandy reservoir site.

| Map Number | Operator         | Address/Phone  | Number of pipelines and pipe sizes |
|------------|------------------|--|------------------------------------|
| P1         | Scurlock Oil Co. | P. O. Box 4648<br>Houston, Texas 77210<br>(713) 228-9561 | Three 8-inch pipes                 |
| P2         | Exxon Gas System | P. O. Box 2180<br>Houston, Texas 77001<br>(713) 224-0429 | One 20-inch pipe                   |

## LIGNITE

The Wilcox Group contains lignite of economic thickness (equal to or greater than 5 ft) in northeast Texas; however, no near-surface resources of economic value have been identified by Kaiser and others (1980) in the study area. Forty-four electric logs in and adjacent to the proposed reservoir site were examined and showed no lignite seams as thick as 5 ft. One to two lignite seams underlie the Pine Mills East Field in the M. Polk survey. To the southwest, one to two seams underlie the Pine Mills Field in the Gilliland survey and adjacent surveys to the north. Available logs on the northeastern edge of the Hawkins Field show two to four seams in this region. All seams are deep-basin resources, lying at depths below 200 ft but above 2,000 ft. Prediction of the extent of these seams across the small size of the contract area is unreliable with the sparse well control available.

With current technology, there is no economically mineable lignite in the contract area. The current market price of lignite is about \$14 a ton for surface-mined lignite. Deep-basin lignite recovery methods and products vary; expenses are considerably higher, and recovery is less than for near-surface mining. Development of deep seams less than 6 ft thick is impractical with present in situ gasification technology because of the excessive heat loss that would be encountered and the difficulty of completion in thin seams. No deep-basin resources are currently mined in Texas.

## SUMMARY

1. Sixty-eight wells have been drilled within the 360-ft ground elevation boundary of the proposed Big Sandy reservoir site. All of these oil, gas, and dry wells, plus five wells of uncertain status, are shown in plate 1 and described in table 1.

2. Only one well is producing within the 340-ft ground elevation boundary of the contract site. Within the 360-ft ground elevation are 12 producing oil wells (including the well below 340 ft), 2 shut-in wells, 22 plugged or abandoned oil wells, 1 producing gas well,

1 plugged gas well, 30 dry holes, and 5 wells for which the status is unknown, except that they are not producing wells (table 1).

3. The 360-ft ground elevation boundary for the proposed reservoir site crosses five oil and gas fields. They are the Pine Mills, Pine Mills East, Deupree North, Hawkins, and Hawkins Northeast Fields. The Pine Mills Field has produced oil from the 2nd Sub-Clarksville sand, Orr sand, Woodbine Group sands, Woodbine Wagoner sand, and upper Paluxy Formation sands (fig. 6). The production history for these units is summarized in figures 9, 10, 12, 13, and 15. The Pine Mills East Field has produced oil from the 2nd Sub-Clarksville sand and Woodbine Group sands although Woodbine production is outside of the contract area. The 2nd Sub-Clarksville production history is shown in figure 16. The Deupree North Field had only one well, which produced from the Woodbine before it was plugged in 1967. The production history of this field is described in figure 20. In the Hawkins Field, oil is produced from the Woodbine and Paluxy sands (fig. 21), although only the Woodbine production is within the contract area (fig. 23). Gas production in the Hawkins Field is from Woodbine and Rodessa sands (fig. 21), and production from these reservoirs is shown in figures 24 and 25. Oil production history from the Hawkins Northeast Field (Sub-Clarksville reservoir, fig. 21) is analyzed in figure 26.

4. The one producing well below the 340-ft ground elevation is Robbins Petroleum Corp. no. 4 Sallie Lucy Old; it is in the Pine Mills Field (table 1, plate 1). The production is from the 2nd Sub-Clarksville; secondary recovery began after 1965.

5. Private sources indicate possible oil and gas lease values of up to \$300 to \$500 per acre in the vicinity of the contract area.

6. Two principal pipelines cross the contract area (plate 1, table 3). One pipeline system comprises three 8-inch-diameter pipes that are operated by Scurlock Oil Company. The other pipeline, operated by Exxon Gas System, is a 20-inch-diameter pipe.

7. Any potential hydrocarbon reservoirs beneath the proposed Big Sandy reservoir site are believed to be accessible by slant drilling techniques available today. Slant hole



drilling can cost up to twice as much per hole as vertical drilling; the steeper the slant angle, the greater the cost. The average cost to drill a vertical well in the vicinity of the study area is estimated to be \$90 per ft. This does not include completion costs.

8. No sand and gravel mining operations exist in the contract area.

9. Available electric logs show that no lignite seams greater than 5 ft in thickness underlie the study area. Several seams exist at depths below 200 feet; these are deep-basin resources. No deep-basin lignite is now being mined in Texas.

#### ACKNOWLEDGMENTS

This work was funded by the Sabine River Authority. Javier Meneses-Rocha assisted in data collection and processing. C. D. Henry and J. R. DuBar reviewed the manuscript. Word processing was by Dorothy C. Johnson, under the supervision of Lucille C. Harrell, and drafting of figures was by John T. Ames, Jana Brod, Annie Kubert, Nan Minchow, and Ted Samsel, under the direction of R. L. Dillon.

## REFERENCES

- Barnes, V. E., project director, 1964, Tyler sheet: University of Texas, Austin, Bureau of Economic Geology Geologic Atlas of Texas, scale 1:250,000.
- Cambre, D., Murphy, A. G., and Brundrett, J., 1982, Oil and gas developments in Arkansas, Northern Louisiana, and East Texas in 1981: American Association of Petroleum Geologists Bulletin, v. 66, no. 11, p. 1944-1954.
- Cambre, D., Murphy, A. G., and Core, E., 1981, Arkansas, Northern Louisiana, and East Texas: American Association of Petroleum Geologists Bulletin, v. 65, no. 10, p. 1862-1868.
- Cambre, D., Murphy, A. G., and Wright, A. E., 1983, Oil and gas developments in Arkansas, North Louisiana, and East Texas in 1982: American Association of Petroleum Geologists Bulletin, v. 67, no. 10, p. 1672-1678.
- Caughey, C. A., 1977, Depositional systems in the Paluxy Formation (Lower Cretaceous), Northeast Texas -- oil, gas, and ground-water resources: The University of Texas at Austin, Bureau of Economic Geology Geological Circular 77-8, 59 p.
- Collins, D. A., Murphy, A. G., and Core, E. H., 1980, Developments in Arkansas, North Louisiana, and East Texas in 1979: American Association of Petroleum Geologists Bulletin, v. 64, no. 9, p. 1490-1500.
- Fisher, W. L., 1965, Rock and mineral resources of East Texas: University of Texas, Austin, Bureau of Economic Geology Report of Investigations No. 54, 439 p.
- Galloway, W. E., Ewing, T. E., Garrett, C. M., Tyler, N., and Bebout, D. G., 1983, Atlas of major Texas oil reservoirs: The University of Texas at Austin, Bureau of Economic Geology Special Report, 139 p.
- Kaiser, W. R., Ayers, W. B., Jr., and LaBrie, L. W., 1980, Lignite resources in Texas: The University of Texas at Austin, Bureau of Economic Geology Report of Investigations No. 104, 52 p.

- Moore, H., 1951, Pine Mills, Wood County, Texas, in Herald, F. A., ed., Occurrence of oil and gas in Northeast Texas: University of Texas, Austin, Bureau of Economic Geology Publication No. 5116, p. 301-303.
- Oliver, W. B., 1971, Depositional systems in the Woodbine Formation (Upper Cretaceous), Northeast Texas: The University of Texas at Austin, Bureau of Economic Geology Report of Investigations No. 73, 26 p.
- Railroad Commission of Texas, 1982, A survey of secondary and enhanced recovery operations in Texas to 1982: Bulletin 82, 608 p.
- Seni, S. J., and Jackson, M.P.A., 1984, Sedimentary record of Cretaceous and Tertiary salt movement, East Texas Basin: times, rates, and volumes of salt flow and their implications for nuclear waste isolation and petroleum exploration: The University of Texas at Austin, Bureau of Economic Geology Report of Investigations No. 139, 89 p.
- Trusheim, F., 1960, Mechanism of salt migration in northern Germany: American Association of Petroleum Geologists Bulletin, v. 44, no. 9, p. 1519-1540.
- Tsoukalas, D., Murphy, A. G., and Ferguson, J. C., 1984, Oil and gas developments in Arkansas, North Louisiana, and East Texas in 1983: American Association of Petroleum Geologists Bulletin, v. 68, no. 10, p. 1377-1382.
- Wendlandt, E. A., 1951, Hawkins Field, Wood County, Texas, in Herald, F. A., ed., Occurrence of oil and gas in Northeast Texas: University of Texas, Austin, Bureau of Economic Geology Publication No. 5116, p. 153-158.
- Wood, D. H., and Giles, A. B., 1982, Hydrocarbon accumulation patterns in the East Texas salt dome province: The University of Texas at Austin, Bureau of Economic Geology Geological Circular 82-6, 36 p.
- Wood, D. H., and Guevara, E. H., 1981, Regional structural cross sections and general stratigraphy, East Texas Basin: The University of Texas at Austin, Bureau of Economic Geology Cross Sections, 21 p.