ANNUAL REPORT
MAY 12, 1982

SUMMARY OF HYDROLOGIC MONITORING PROGRAM
EMPIRE RANCH AND ROSEMONT AREAS, ARIZONA
ANAMAX MINING COMPANY

HARGIS & MONTGOMERY, INC.
CONSULTANTS IN HYDROGEOLOGY
TUCSON, ARIZONA
May 12, 1982

Mr. John A. Frankovich
Chief Counsel
ANAMAX MINING COMPANY
P. O. Box 127
Sahuarita, Arizona 85629

Dear Mr. Frankovich:

Enclosed please find three copies of our annual report:

SUMMARY OF HYDROLOGIC MONITORING PROGRAM
EMPIRE RANCH AND ROSEMONT AREAS, ARIZONA
ANAMAX MINING COMPANY

which has been prepared in accordance with your request. It is recommended that collection of baseline hydrologic data on the Empire Ranch and in the Rosemont area continue, and that the current minimal monitoring program be maintained. The monitoring program should continue to include the following:

- Annual water level measurements in exploration wells on the Empire Ranch, and monitor wells in the Rosemont and Singing Valley Ranch areas.
- Monthly measurement of streamflow at the two stations on Cienega Creek, and maintenance of the water level recorder.

Because of the lack of development in the area, and the stable hydrologic conditions, it is suggested that the routine summary report of the hydrologic monitoring program be compiled every two years instead of every year. It is also suggested that future assessment or exploration drilling be coordinated as much as possible with the hydrologic monitoring program to provide additional monitoring wells.

If you have any questions, or wish further discussion, please contact me.

Yours truly,

HARGIS & MONTGOMERY, INC.

[Signature]

Dr. David R. Hargis

Enclosures.
CONTENTS

CONCLUSIONS ................................................................. 1

INTRODUCTION ............................................................... 2

EMPIRE RANCH AREA ......................................................... 3
  Water Levels .......................................................... 3
  Water Level Contours ................................................. 5
  Streamflow ............................................................ 6

ROSEMONT AREA ............................................................. 7
  Water Levels .......................................................... 7
  Water Level Contours ............................................... 9

ROSEMONT ADDENDUM AND SINGING VALLEY RANCH AREAS ............. 10

REFERENCES CITED .......................................................... 12

TABLES

Table
1 WATER LEVELS IN MONITOR WELLS, EMPIRE RANCH
2 NET CHANGES OF WATER LEVEL ELEVATIONS IN MONITOR WELLS,
   EMPIRE RANCH, 1974-1981
3 WATER LEVELS IN MONITOR WELLS, ROSEMONT AREA
4 NET CHANGE OF WATER LEVEL ELEVATIONS IN MONITOR WELLS,
   ROSEMONT AREA, 1975-1981
5 WATER LEVELS IN MONITOR WELLS, ROSEMONT ADDENDUM AREA
6 WATER LEVELS IN RANCH WELLS, SINGING VALLEY RANCH
ILLUSTRATIONS

Figure

1. WATER LEVEL CONTOURS, EMPIRE RANCH, JANUARY 1982
2. WATER LEVEL CONTOURS, ROSEMONT AREA, JANUARY 1982

APPENDICES

Appendix

A. WATER LEVEL HYDROGRAPHS FOR MONITOR WELLS, EMPIRE RANCH
B. HYDROGRAPH OF STREAMFLOW ON CIENEGA CREEK
C. WATER LEVEL HYDROGRAPHS FOR SELECTED MONITOR WELLS, ROSEMONT AREA

*in pocket
ANNUAL REPORT

SUMMARY OF HYDROLOGIC MONITORING PROGRAM
EMPIRE RANCH AND ROSEMONT AREAS, ARIZONA
ANAMAX MINING COMPANY

CONCLUSIONS

Water levels measured in monitor wells on the Empire Ranch have generally declined since 1974. The average water level decline for wells in the Empire Ranch area has been about 1.5 feet for the period 1974 to 1982. Only minor changes in water levels have occurred since 1980.

Water levels measured in monitor wells in the Rosemont area indicate no significant change in water level elevations over most of the area since 1975. Water levels in the Rosemont area have generally declined since 1980. Water levels measured in monitor wells in the Rosemont addendum area have declined since June 1981.

Streamflow measurements obtained in the Cienega Creek indicate that the creek is a gaining stream as it flows northward from the Empire Ranch. The average minimum flow ranges from less than 100 gpm (gallons per minute) at station no. 1, to about 550 gpm at station no. 2.
ANNUAL REPORT

SUMMARY OF HYDROLOGIC MONITORING PROGRAM
EMPIRE RANCH AND ROSEMONT AREAS, ARIZONA
ANAMAX MINING COMPANY

INTRODUCTION

Pursuant to a request from Mr. John Frankovich, Chief Counsel, ANAMAX Mining Company, an annual summary report of the results of hydrologic monitoring for the Empire Ranch and Rosemont areas has been prepared. The contents include streamflow data collected at two gaging stations, water levels measured in 15 monitoring wells in the Empire Ranch area, and water level or water quality data collected from 58 monitor wells in the Rosemont area. Water level measurements were also obtained in 17 monitor wells in the Rosemont addendum area, and water level or water quality data were collected from stock and domestic wells in the vicinity of Singing Valley Ranch (formerly Thurber Ranch).

The objective of the monitoring program is to establish hydrologic baseline data for the Empire Ranch and Rosemont areas. Streamflow measurements have been obtained monthly since September 1976 at two stations on Cienega Creek. Water level measurements on the Empire Ranch were obtained in most wells in 1974, 1977, 1979, 1980, and 1982. Water level measurements in the Rosemont area were obtained in 1975, 1979, 1980, and 1982. Water level measurements were obtained with a steel tape or an electrical sounder. Water levels in the Weir Well on the Empire Ranch were obtained with an automatic continuous water level recorder.
EMPIRE RANCH AREA

A program of drilling and testing 14 exploration wells and one pilot production well was conducted by the ANAMAX Mining Company in 1974 and 1975. The purpose of the program was to evaluate the groundwater development potential of the Empire Ranch as a source of water supply to accommodate proposed mining operations in the Rosemont area. Results of this program were reported by Harshbarger & Associates, Inc. (1975), who recommended that a monitoring program be established to obtain quarterly water levels in the exploration wells, and monthly streamflow measurements at two stations along the Cienega Creek (Figure 1).

Groundwater occurs in two aquifers on the Empire Ranch: (1) an unconfined system in the recent floodplain alluvium along Cienega Creek and in the upper part of the basin-fill unconsolidated deposits, and (2) a quasi-artesian system in the basin-fill deposits (Harshbarger & Associates, Inc., 1975). The exploration wells were completed with slotted casing in the upper portion and open hole in the lower portion of the borehole. The water levels measured in these wells generally represent a composite level of both the shallow unconfined system, and the deeper quasi-artesian system. The Weir Well (D-19-17,3dd) is 50 feet deep and taps only the shallow unconfined aquifer system.

WATER LEVELS

Water levels in the exploration wells were initially measured during the testing program in 1974. Water levels were measured again in February 1977, December 1979, December 1980, and January 1982. The most recent data are presented in Table 1. Water level hydrographs for the monitor wells, pilot production well, and
Weir Well are plotted on Figures A-1 through A-5 (Appendix A). A comparison of the most recent water level data with data obtained in 1974 and 1977 is presented in Table 2. These data indicate that a net water level decline has occurred in all wells, except for monitor well E-1. An apparent water level rise of 24 feet has occurred in well E-1.

Comparison of water level measurements obtained in 1977 and 1979 indicate that a net water level rise occurred in all wells, except for the four monitor wells (E-6, E-2, E-4, E-7) located along the Oak Tree Canyon drainage (Figure 1). Between 1979 and 1980, water level data indicate a decline of water level in nine of the monitor wells. The water level decline ranged from 0.1 foot in well E-2, to 2.0 feet in well E-10. Six wells exhibited a water level rise ranging from 0.1 foot in well E-9 to 7.5 feet in well E-6.

During the period 1974 to 1980, all but five of the monitor wells have exhibited a net decline in water level ranging from 0.1 foot in well E-9 to 5.8 feet in wells E-11 and E-4. The water level rise in the other five wells ranged from 0.3 foot in well E-5 to 23.65 feet in well E-1. These long-term water level trends might result from local variations in the pattern of groundwater recharge to the aquifer system, or might represent adjustment to long-term regional climatic changes.

The Weir Well (D-19-17, 3dd) taps the shallow unconfined alluvial aquifer in the floodplain of Cienega Creek (Figure 1). A continuous water level recorder was installed in this well in August 1976. Maximum water levels occur annually in late spring in response to winter and spring precipitation (Figure A-5). Minimum water levels occur annually in late summer in response to winter and spring precipitation (Figure A-5). Minimum water levels occur annually in late summer in response to maximum evapotranspiration by phreatophytes in the summer months. The annual
water level fluctuation has ranged from about 4.8 feet in 1976-77, to about 1.2 feet in 1979-80 (Figure A-5). The annual water level fluctuation in 1980-81 amounted to 1.0 foot (Figure A-5).

The most recent water levels obtained from monitor wells in the Empire Ranch area were measured on the 21st and 22nd of January 1982. Comparison of water level measurements obtained in December 1980 and January 1982 indicate little change in water level elevations in most wells, although changes of greater than one foot are evident in some wells (Table 1). With the exception of well E-10 (D-19-17,23add), the water level data for all monitor wells in the Empire Ranch indicate fluctuations of water level elevations on the order of 1.0 foot or less. The water level data for well E-10 indicate a rise of 2.45 feet since December 1980. Of the remaining monitor wells, ten wells exhibited rises in water level elevation ranging from 0.02 foot in well E-2 (D-19-16,12aac) to 1.12 feet in well E-12 (D-19-17,1ccd). Four wells exhibited declines in water level elevations ranging from 0.26 foot in well E-4 (D-19-17,8bac) to 1.17 feet in well E-3 (D-19-17,20acb).

During the period 1974 to 1982, only well E-1 (D-19-17,19bac) has exhibited a significant net rise in water level elevation (Table 2). Excluding data developed from well E-1, the long-term water level trends of all wells indicate an average decline in water level elevation of about 1.5 feet since 1974.

WATER LEVEL CONTOURS

A water level contour map based on the January 1982 water level data for the Empire Ranch area is presented on Figure 1. The contours indicate that groundwater flows to the northeast through the area. Comparison of the water level contour maps for 1975 (Harshbarger & Associates, Inc., 1975), 1979, 1980, and 1982 indicates no significant change in water levels or flow direction.
STREAMFLOW

Streamflow measurements have been obtained monthly at two stations along the Cienega Creek (Figure 1). The purpose of obtaining these measurements is to determine the baseflow of Cienega Creek near the northern and southern boundaries of the Cienega Ranch. Streamflow hydrographs for each station are presented in Figure B-1 (Appendix B). Maximum annual flows tend to occur during January and July in response to seasonal precipitation. The Cienega Creek is a perennial stream at both gaging stations. The lowest flow measured at the upstream station no. 1 (Figure 1) is about 50 gpm (gallons per minute), while the minimum flow measured in the downstream station no. 2 is about 400 gpm (Figure B-1).
ROSEMONT AREA

Water levels in the Rosemont area were first measured in 1975 as part of a detailed environmental inventory of the area (J. W. Harshbarger and D. R. Hargis, 1976). The purpose of the monitoring program is to collect baseline hydrologic data in the Rosemont area before mining operations begin.

Groundwater occurs in the unconsolidated floodplain alluvium along Barrel and Schoolefield Canyons, in the fractured and faulted Mesozoic and Paleozoic sedimentary rocks, and in the Quaternary-Tertiary basin-fill deposits in the southern portion of the area (J. W. Harshbarger and D. R. Hargis, 1976). Two potential aquifers occur in the area: (1) the fractured Paleozoic and Cretaceous sedimentary rocks in the central and northern portion of the area, and (2) the basin-fill deposits in the southern portion of the area. Water levels measured in the drillholes and wells generally represent a composite level of both aquifer systems.

WATER LEVELS

A water level inventory of 48 monitor wells was conducted in 1975. Additional water levels were measured in December 1979, and December 1980. In January 1982, the inventory included 58 monitor wells. The most recently developed data are presented in Table 2. Water level hydrographs for 14 selected monitor wells are presented in Figures C-1 through C-7 (Appendix C). A comparison of the most recent water level data and data collected in 1974 is presented in Table 4.
A comparison of the January 1982 water levels and the December 1980 water levels indicates a net water level decline in most of the monitor wells, although some wells did show significant water level rises during the period (Table 2). The water level data indicate a net water level decline in 36 monitor wells, and net water level rise in 13 monitor wells. There was insufficient data to compute the water level changes of the remaining wells.

The water level decline ranged from 0.03 foot in monitor well DH-1490 (D-18-16,27adb) to 8.72 feet in monitor well DH-1431 (D-18-16,21cab). The average water level decline of the 36 monitor wells which registered a decrease in water level elevation since December 1980 was 1.54 feet. The monitor wells located in the northeastern portion of the Rosemont area experienced the greatest declines.

The water level rises ranged from 0.20 foot in wells DH-1442 (D-18-16,17acd), and DH-1423 (D-18-16,33aaa) to 9.28 feet in well DH-1455 (D-18-16,21acb). Two monitor wells, A-825 (D-18-16,31bba), and DH-1584 (D-18-16,32ccb), showed anomalously large water level rises of 28.36 and 34.17 feet, respectively. The magnitude of the water level rise in DH-1584 and A-825 are not consistent with regional water level trends. These large increases may result from surface runoff into the borehole, or may be indicative of boreholes which are not in communication with the regional aquifer. The average water level rise since December 1980 in those wells showing increases in water level elevation (excluding A-825 and DH-1584) was 2.60 feet. The average change in water level since December 1980 in all wells in the Rosemont area (excluding A-825 and DH-1584) is a decline of 0.55 feet.
The net change in the water level elevations of monitor wells in the Rosemont area since 1975 is shown in Table 4. The data indicate a net rise in water level in 18 wells, a net decrease in 14 wells, and no change in water level in six monitor wells. The net change in water level of the remaining monitor wells could not be calculated due to a lack of data. The water level declines ranged from 1.0 foot in several wells to 15 feet in monitor well DH-1495 (D-18-16,22acc). The net water level increases ranged from 1.0 foot in several wells to 19 feet in monitor well DH-1407 (D-18-16,32dbc). The average change in water level for all wells in the Rosemont area since 1975 is a rise of about 0.05 foot.

WATER LEVEL CONTOURS

A water level contour map based on water levels measured in January 1982 is presented as Figure 2. Groundwater generally moves northeast through the area from the ridge of the Santa Rita Mountains. Comparison of the water level contour maps prepared for 1975 (J. W. Harshbarger and D. R. Hargis, 1976) and 1982 indicates no change in the general flow direction. However, a slight increase in the flow gradient has occurred. The water levels have risen over most of the area, although several wells in the northeastern part of the area have shown a decline of water level. This trend is probably a response to variations in seasonal recharge. The monitor wells penetrate one or both of the potential aquifers in the area, and the water level contours probably represent composite water levels of both aquifer systems.
ROSEMONT ADDENDUM AND
SINGING VALLEY RANCH AREAS

The Rosemont addendum area comprises sections 7 and 8, T. 18 S., R. 16 E.; the east half of section 11 and all of section 12, T. 18 S., R. 15 E.; and the north half of section 1, T. 19 S., R. 15 E. (Figure 2). The groundwater resources of the Rosemont addendum were first documented by Hargis & Montgomery, Inc. (1981). The area has been incorporated into the regional groundwater monitoring program.

Water levels have been measured in ANAMAX drillholes in June 1981 and January 1982 in the addendum study area and vicinity (Table 5). Most of the drillholes in the addendum area were constructed along major drainages and probably penetrate a few feet of alluvium, and several tens to several hundreds of feet of Mesozoic and Paleozoic sedimentary rocks. Groundwater occurs in joints and fractures in the Mesozoic and Paleozoic sedimentary rocks, generally under confined conditions.

In general, water levels measured in wells in the addendum area indicate a net decline in water levels of a few feet since June 1981. As was the case in both the Empire Ranch and Rosemont areas, several monitor wells in the addendum area indicate large changes in water level which probably do not reflect regional conditions.

Pursuant to a request by Mr. W. McCurry, ANAMAX Geologist, a water well inventory of the Singing Valley Ranch (formerly Thurber Ranch) was conducted in conjunction with the annual water level measurements in the Empire Ranch and Rosemont areas (Table 6).

The Singing Valley Ranch is located south of the Rosemont area, and west of the Empire Ranch area. Where possible, the location and water level elevation of wells in the Thurber Ranch area
have been plotted on Figure 2. The water level elevation data developed in the Singing Valley Ranch area provide a tentative connection of water level contours in the Empire Ranch area and the Rosemont area (Figures 1 and 2). It is recommended that the feasibility of developing additional water level measuring points in the vicinity be investigated. The development of additional water level elevations, and the refinement of measuring point elevations in the Singing Valley Ranch area, may define water levels between the Rosemont area and the Empire Ranch.
REFERENCES CITED


