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UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
Albuquerque, New Mexico

Investigation of a water supply near Encino, New Mexico,
during the STARMET test

By

J. A. Basler

Open-file report

Prepared in cooperation with the Air Force Weapons
Laboratory (DEV-G), Kirtland Air Force Base, New Mexico

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Introduction

The U.S. Air Force has made tests using conventional explosives at a site near Encino, Torrance County, New Mexico (fig. 1) on a ranch owned by Mr. Gene Harvey. The initial high-energy detonation test was made at the site on October 3, 1968. Soon thereafter, Mr. Harvey expressed concern that the detonation may have adversely affected a nearby surface-water supply used for watering stock. The water supply is contained in two ponds that have formed in holes scoured in an arroyo about 250 feet south of the test site.

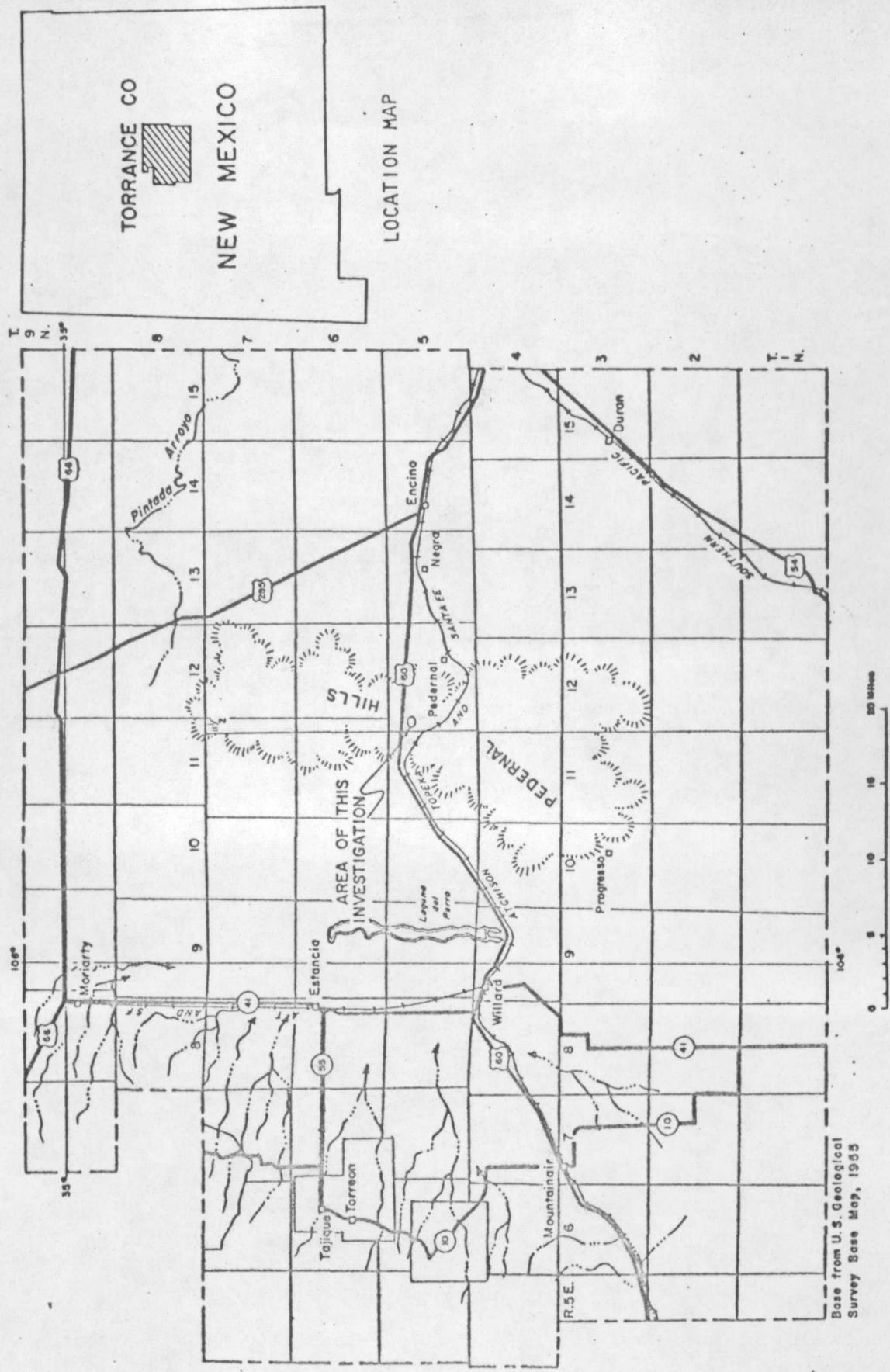


Figure 1.--Index map.

At the request of the Air Force, personnel of the U.S. Geological Survey and the Air Force visited the site on November 5, 1968 to make a reconnaissance and field inspection. Preliminary data collected by Geological Survey personnel were noted in a letter to the record transmitted to the Air Force on November 8, 1968. A more detailed investigation began during April 1969 and continued through October 1969. This investigation resulted in a report by F. C. Koopman, J. A. Basler, and E. G. Lappala, "Investigation of a water supply near Encino, New Mexico, in relation to nearby high-energy detonations," which was released to the open file in May 1970.

In 1970 the Air Force scheduled a second detonation test at the same site. The Geological Survey was again requested by the Air Force to monitor water levels in the ponds, before, during, and after the test to determine if the detonation caused any change in the amount of water stored in the ponds. The water level of the ponds, and precipitation at the site, were monitored from August 22 through November 9, 1970. The detonation test, named "STARMET", was activated at 1330 hours plus 30 seconds November 4, 1970.

Description of the ponds

For the purpose of this report the term "pond" is used to imply a permanent or temporary water supply that is impounded in holes scoured into the surface of hard rock.

The two ponds that furnish stock water for this section of the Harvey ranch are known as the "upper" and "lower" ponds. Details and location of the ponds are shown in figures 2, 3, and 4 of the earlier report by Koopman, Basler, and Lappala (1970).

During the period of this investigation it was observed that an average of more than 25 head of cattle and about six sheep were pastured within a fenced area around the ponds.

Instrumentation and test equipment

Strain-gage transducers were used to sense the water level in each pond. Once each hour a signal command device transferred in sequence the signal from each pond to a Sargent MR recorder. The reference datum for water-level measurements is a bench mark on a rock dam below the lower pool (Koopman, Basler, and Lappala, 1970, p. 29).

An Esterline-Angus single-pen recorder was modified and fitted with an event pen to record the time of receipt of each 0.12-inch of precipitation. This was done by capturing the precipitation in a standard tipping-bucket type precipitation gage equipped to transmit a signal when each increment of 0.12-inch of precipitation was received. Precipitation was noted by the event pen on the recorder and tallied on a counter that registered the total precipitation. The recorders were housed in a steel shelter.

The Sargent MR recorder and power supplies for the transducers were driven by a standard 12-volt car battery and a 12-volts direct current to 120-volts alternating current inverter that was actuated during signal-sampling intervals.

The recorded data were supplemented and checked at frequent intervals by field observations because frequent watering of livestock at the ponds disturbed placement of the transducers.

Fluctuation of water level

The relation of the water level in the two ponds to precipitation is shown in figure 2. Precipitation occurred at the test site during the periods, August 22 to October 4 (44 days), October 4 to 15 (12 days), and October 15 to 22 (8 days). Because rainfall was light, and because the gage used at the site recorded only increments of 0.12-inch, the individual days when precipitation occurred cannot be determined. Thus, the daily record of precipitation measured at the Weather Bureau station 4 miles east of Pedernal, and about 8 miles southeast of the test site was used in figure 2.

Over 0.50-inch of precipitation was recorded at Pedernal 4E on August 21. A like amount must have fallen at the test site, as both ponds were nearly filled with water when the investigation started on August 22. Only minor amounts of rainfall occurred between August 22 and October 4. This lack of precipitation, watering of livestock, and evaporation, caused both ponds to become dry.

Rainfall in the test area on October 4 (about 0.20-inch recorded at Pedernal 4E) caused the water level in the ponds to rise more than 0.50-inch; however, by the middle of October both ponds were again nearly dry. Rainfall totaling about 0.20-inch was recorded on October 15, 16, and 17 at Pedernal 4E. Again, rainfall must have fallen at the test site as the water level in both ponds on October 19 was higher than at the time of the previous measurement. Only traces of rainfall were recorded between October 17 and the end of the investigation on November 9. The lower pond dried up on November 2, and remained dry during the STARMET test.

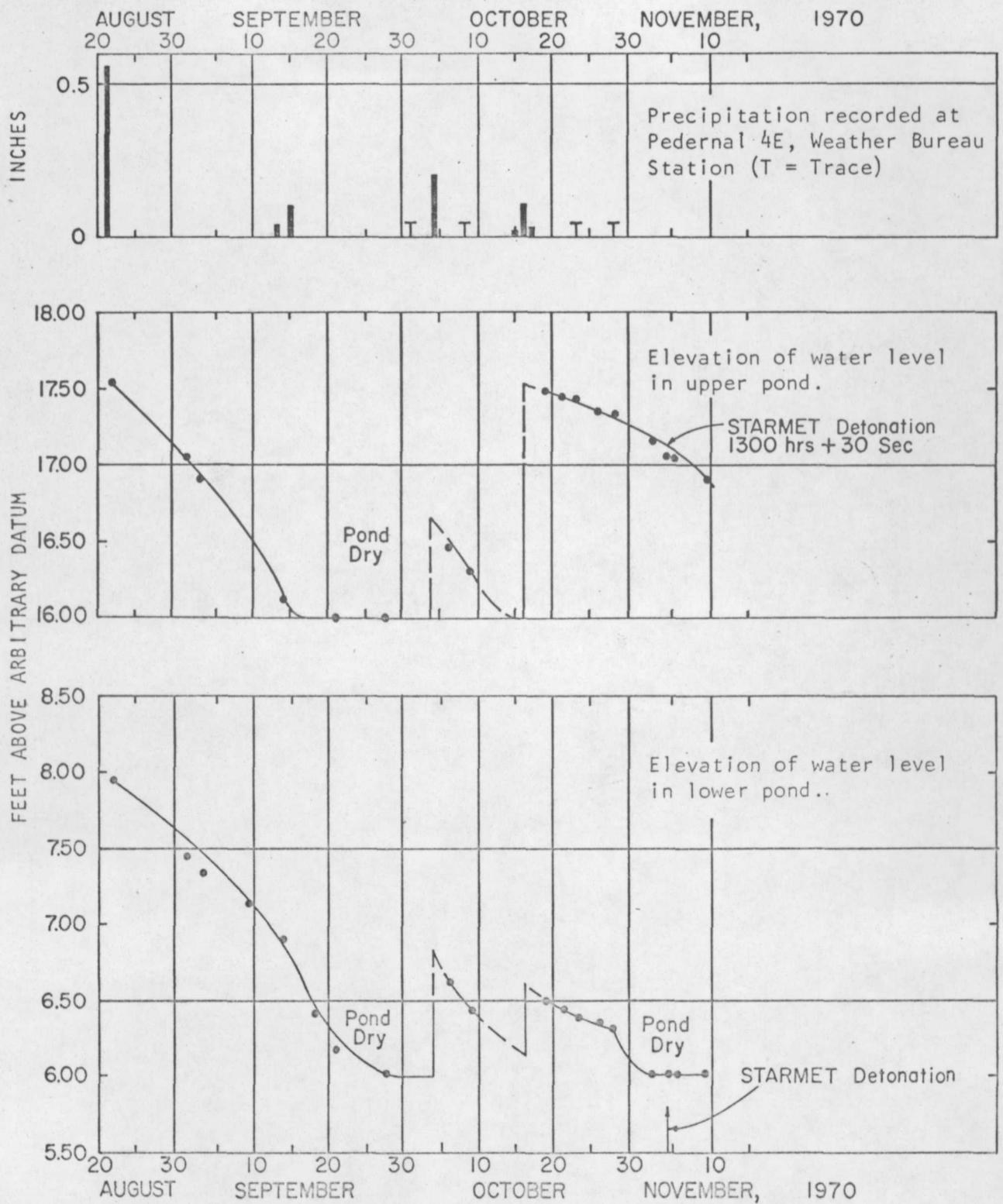


Figure 2.--Relation of water level in the two ponds to precipitation during period of investigation.

Water-level measurements were made in the upper pond before and immediately following the STARMET test on November 4, 1970.

These measurements follow:

<u>Hour</u>	<u>Elevation of water level (feet)</u>
1020	17.28
1200	17.28
1330	17.28
1330 + 30 seconds	STARMET detonation
1500	17.28

The measurements indicate that the water level in the pond was not noticeably affected by the detonation.

When investigations were begun on August 22, 1970, the two ponds contained about 700 cubic feet of water. During the period of the study (80 days) about 450 cubic feet of water was impounded from rainfall. At the end of the study, on November 9, the upper pond contained about 50 cubic feet of water and the lower pond was dry. Thus, about 1,100 cubic feet of water was lost from the ponds during the study.

According to the U.S. Department of Agriculture (1955, p. 17) range cattle will consume about 4 to 8 gallons of water per day, and sheep, $3/4$ to $1\ 1/2$ gallons per day. On the basis of the minimum figures quoted, it is estimated that the livestock observed watering at the ponds (25 cattle and six sheep) could have consumed the 1,100 cubic feet of water during the 80 days of the study.

In addition to water-level measurements of the ponds, an attempt was made to relate the changes in the volume of water stored in the ponds to the causes of the changes. Precipitation near the ponds causes a rapid fill-up of the ponds and a sharp rise in pond levels; evaporation and use of water by livestock cause gradual declines of water level and volume of water in the ponds.

The total volume of water in the ponds, when they are full, is about 80 cubic feet for the upper pond and about 645 cubic feet for the lower pond. The storage and surface areas of the ponds relative to the elevation of the water level in the ponds is shown graphically in figures 11 and 12 of the report by Koopman, Basler, and Lappala (1970).

The average rate of evaporation during the period August through November 1970, was about 0.16-inches per day. This figure was calculated from records of the National Weather Service (1970) for the station at Estancia, and is the average monthly evaporation rate based upon rates of measured evaporation at the station in August, September, and October 1970, plus the average of measured evaporation in November of 1968 and 1969. It is estimated that evaporation from the water surface of the ponds, and from the wetted land surface around the edges of the ponds, during the 80 days of the study could have amounted to as much as 400 cubic feet of water.

As only about 1,100 cubic feet of water was lost from the ponds during the study, the total estimated possible water loss of about 1,500 cubic feet of water is obviously too high. Either fewer livestock than those observed watered at the ponds, or the calculated evaporation rate is too high, or both.

The estimated possible water loss of 1,500 cubic feet of water does, however, point out that the actual loss of 1,100 cubic feet of water from the ponds is well within the limits of the estimated rates of evaporation and water loss attributed to livestock. It also supports the conclusion, indicated by water-level measurements, that the detonation caused no change in the amount of water stored in the ponds. If the detonation had damaged the strata beneath the ponds, the relatively small volume of water contained in the upper pond during the detonation would have been expected to diminish rapidly because of drainage into fractures.

Summary

Measurements made immediately before and after the STARMET test indicate that the water level in the upper pond was not affected by the detonation. The water-level declines observed during a period of several days after the detonation are regular in occurrence and are similar to declines observed for several days prior to the detonation. These declines are attributed to water losses caused by evaporation and stock watering.

The relation of the volume of water in the ponds to gains from precipitation, and losses from evaporation and from stock watering supports the conclusion, indicated by water-level measurements, that the detonation caused no change in the water supply in the ponds.

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