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SUMMARY OF GROUND WATER CONDITIONS AT THE CURREN TUNNEL NEAR HAGERMAN, IDAHO

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INTRODUCTION

Spring discharge in the Hagerman area has shown decline in recent years. Decreased canal diversions, increased ground water pumpage, conversion from flood to sprinkler irrigation, and the recent drought have contributed to this decline in spring flow. Spring flow from the Curren Tunnel (also referred to as the Martin-Curren Tunnel), has been monitored by the Idaho Department of Water Resources (IDWR) with a continuous recorder for the past 18 months. This data, information compiled during this study, and previous work has provided insight into the relationship between canal diversions, ground water trends, and spring flow in the immediate area.

Purpose and Scope

The scope of study included a review of previous investigations, well driller reports, ground water hydrographs, water level measurements of local wells, a review of spring flow measurements from both the Curren Tunnel and the Hagerman National Fish Hatchery, and a review of the local geology.

The purpose was to compile and interpret data collected over the past two years at and upgradient from the Curren Tunnel in order to provide some insight into causes for fluctuations in spring discharge.

Site Description

The study area is located in Gooding County in south-central Idaho approximately three miles southeast of Hagerman, Idaho (see Figure 1, Site Location Map"). It is bounded by the Snake River to the south and west, and by the Eastern Snake River Plain to the east and north. Numerous springs emerge from the canyon walls as flow from the Snake River Plain Aquifer becomes tributary to the Snake River.

Agriculture, including dairy farming, and aquaculture (fish farming) are the primary industries in the study area. Major crops include potatoes, beans, sugar beets, cereal crops, alfalfa, and pasture. Fish farming is highly dependent on spring flow, while other farming practices use spring flow along with ground and surface water for irrigation.

Irrigation on the basalt plateau of the Snake River Plain northeast of the Hagerman Valley is accomplished almost exclusively by sprinkler systems. Flood irrigation is relatively minor. Sources of water are canal diversions from the Snake River and the pumpage of ground water.

Within the Hagerman Valley itself, sprinkler and flood irrigation are both practiced. Spring flow is the major source of water.

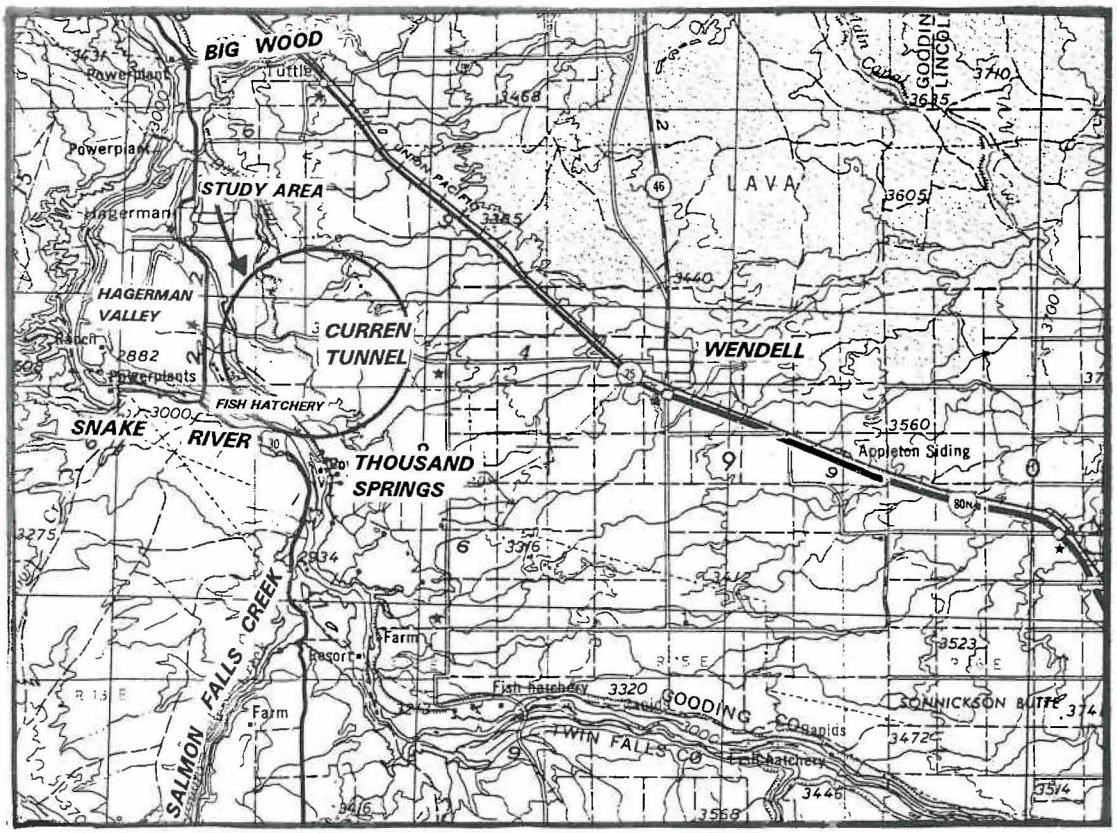


Figure 1. Site Location Map

The Curren Tunnel is located on the face of a basalt cliff 60 to 70 feet below the western edge of the Eastern Snake River Plain. The spring was developed by tunneling into the basalts to intercept the water table and produce additional flow. The spring water is used for aquaculture and irrigation. Water rights for the spring pre-date 1900.

Lying below the Curren Tunnel and approximately at the same elevation as the Snake River, numerous other springs emerge from other basalt cliffs. This spring water is used at the Hagerman National Fish Hatchery.

Climate in the area is arid with precipitation averaging approximately 10 inches per year. Evapotranspiration for crops exceeds this value, ranging from 18 to 34 inches.

HYDROLOGIC REGIME

Geology

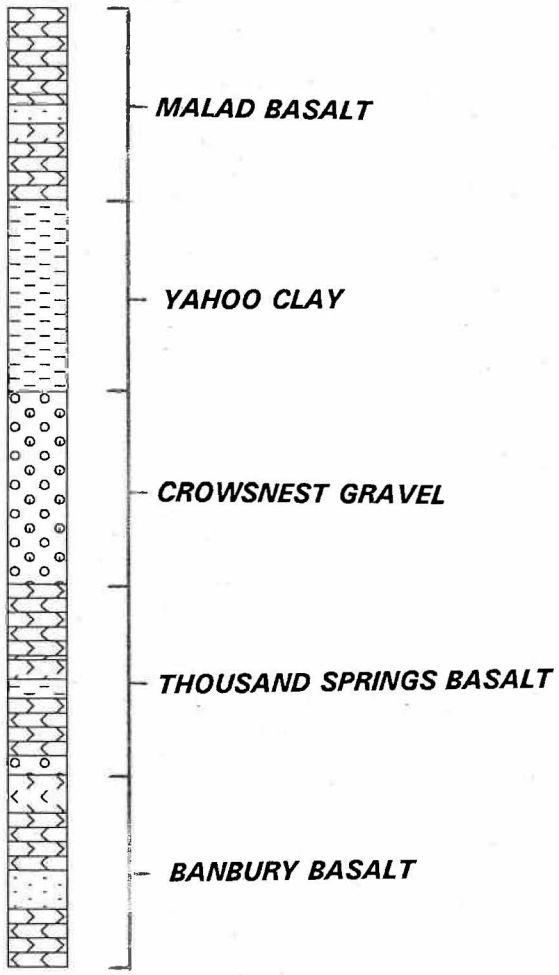
Regionally, the area can be generalized as basalts interlayered with sediments. Typically, a basalt flow is 20 to 25 feet thick and covers an area 50 to 100 mi^2 (Whitehead, 1992). As a result, individual basalt flows cannot be correlated over any great distance.

Locally, the area has been geologically mapped by the U.S. Geological Survey (USGS). Figure 2, "Stratigraphic Column" presents an idealized interpretation of the local geology. The Banbury Basalt lies at the base of the spring producing units which are overlain by the Thousand Springs Basalt which is again overlain by the alluvial deposits Crowsnest Gravel and Yahoo Clay. These deposits are again overlain by the Malad basalt. Interlayered are multiple tuff and ash flows along with sands, clays, and gravels. Therefore, even locally, the area's geology can be described as complex, and based on well driller reports, trying to correlate rock units is not only difficult, but often highly speculative.

Occurrence and Movement of Ground Water

Figure 3, "Geologic Cross Sections" presents two cross sections A-A′ and B-B′ along with their orientation shown on an inset map. Lithologies are from well drillers' reports. Water levels are from USGS and IDWR measurements and well drillers' reports. Correlating rock units is difficult, but some inferences can be made from water levels and water first encountered in the wells.

Three possibly separate potentiometric heads or semi-separate aquifer systems are present. Section A-A′ shows that the water level elevations in the upper system or



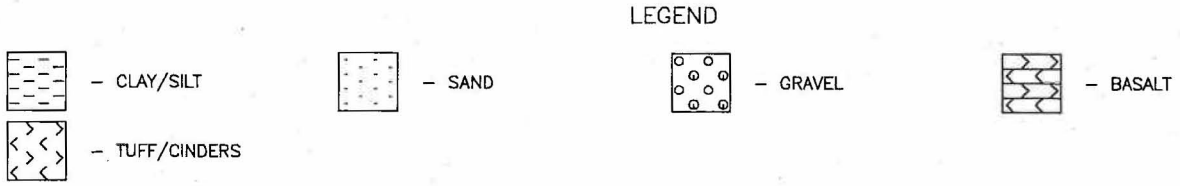
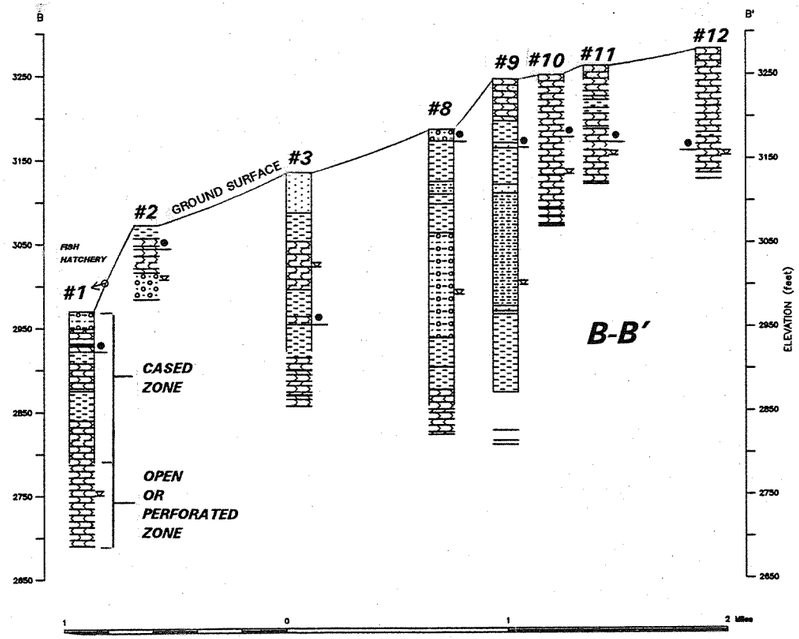
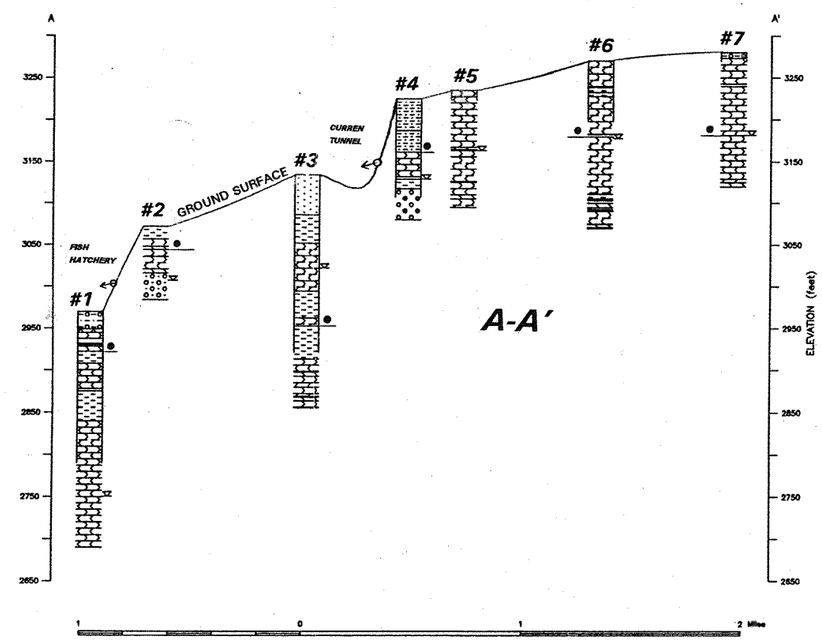
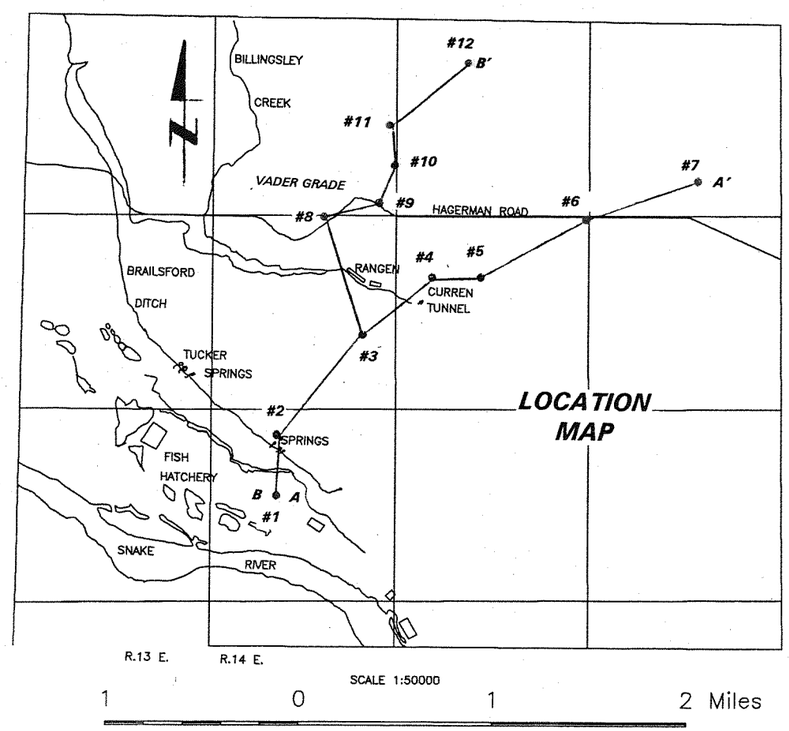


Figure 2. Stratigraphic Column







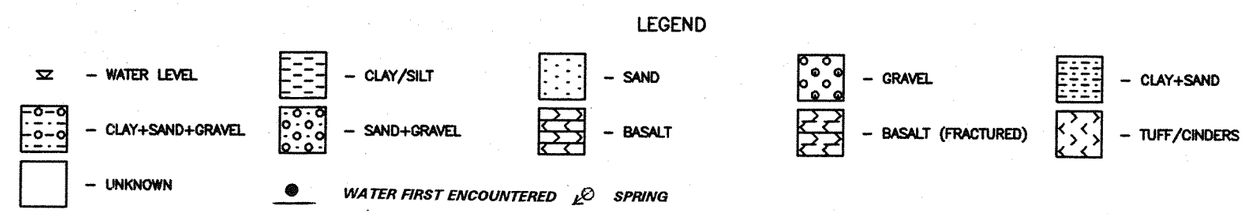


Figure 3. Geologic Cross Sections

upper wells (#4, #5, #6, & #7) correspond to spring flow at the Curren Tunnel which emerges from the Malad Basalt. Well #4 does show a static water level below the elevation of the spring, but the measurement is based on a well driller's report and therefore is only approximate. This upper system also appears to be unconfined based on the static water levels and where water was first encountered.

The water level or potentiometric head in well #3 corresponds to spring flow at the Hagerman National Fish Hatchery which emerges from the Thousand Springs Basalt. This middle or deeper system appears to be confined based on the static water level and where water was first encountered. Well #2 is too shallow to draw any type of conclusion, but the water level is probably associated with local recharge.

The water level in well #1 does not correlate with the elevation of the Snake River (2880 ft). But water was first encountered at approximately the same elevation as the Snake River. This zone was cased or sealed off and therefore the static water level is not representative of the river, but representative of the zone in which the well is open. This deeper system, lying below the Snake River, also appears to be confined.

Cross section B-B' contains three of the same wells (#1, #2, & #3) and five other wells on the plain. Well #8 is located about half way down Vader Grade. The upper system is again seen in wells #10, #11, and #12. Wells #8 and #9 show that water was encountered in the borehole at the same elevation as the upper system, but in fine grained clays and silts. Probably due to poor production, these sections were cased off and the borehole continued until more permeable zones were encountered. Static water levels correlate with well #3 and spring flow at the Hagerman National Fish Hatchery. Note also that no major springs emerge in the area of wells #8 and #9. The finer grained or less permeable material is probably restricting or forcing the flow north to northwest.

These separate potentiometric heads could also be explained by head changes associated with flow resistance or hydraulic conductivity. But wells #8 and #9, the two with enough depth to penetrate more than one system, suggest multiple systems. The static water levels in these two wells also suggest that flow between the systems may be unsaturated (i.e., the hydraulic head in the lower system is not equal to or above the upper system). Therefore a head change in one system may not affect the head or water level in the other.

Figure 4, "Ground Water Contours" presents generalized contours for the upper and deeper system lying below it. Spring heads, or the elevation at which the springs emerges from the basalt cliffs, are also included. The gradient south of the Curren Tunnel in the upper system also suggests the systems are merging. Both systems

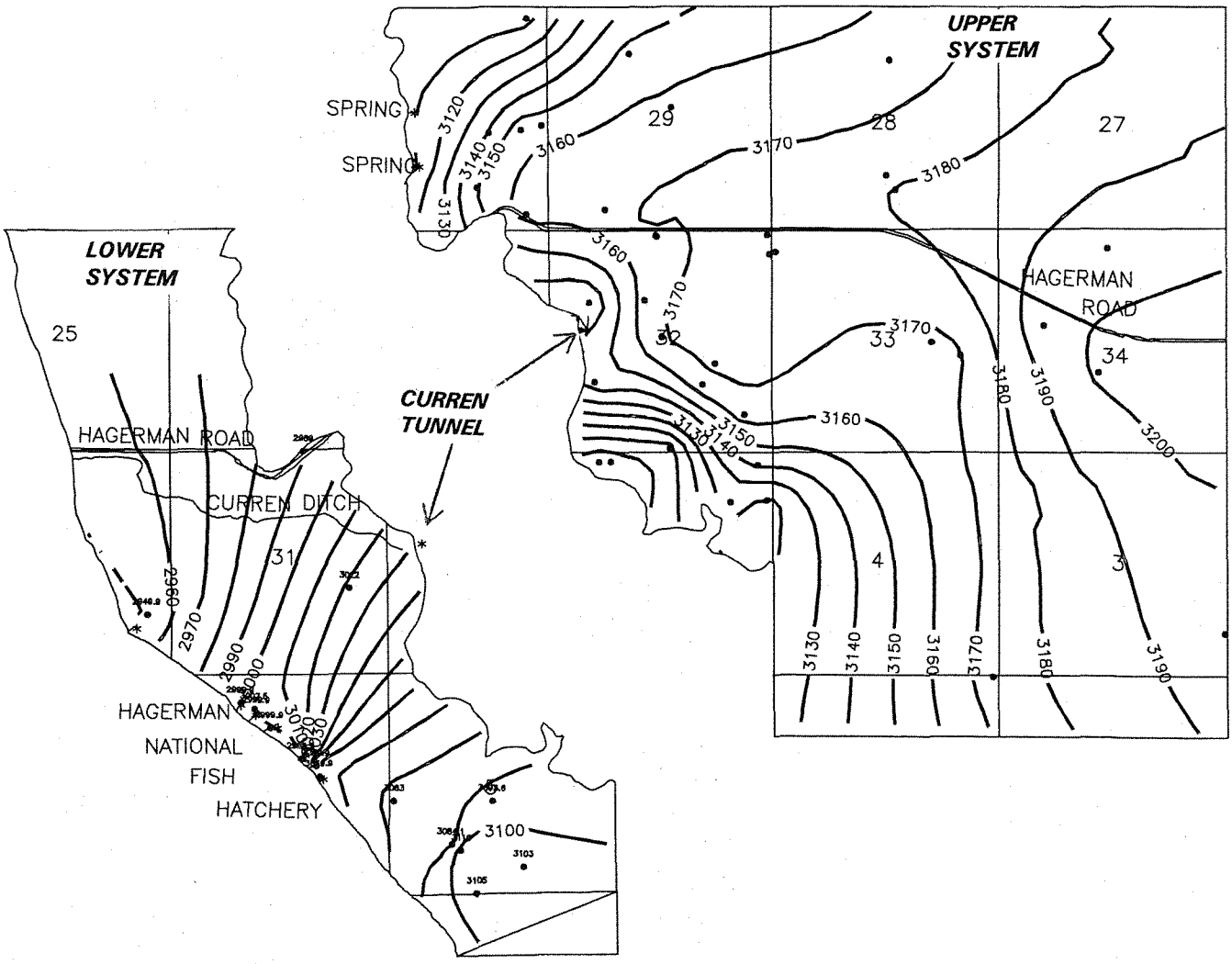


Figure 4. Ground Water Contours

have a strong western component which correlates with the overall regional system. Data were not available to contour the deep system lying below the Snake River.

Figure 5, "Seasonal Ground Water Levels", presents monthly ground water levels for well 07S 14E 33BBB1 (located two miles east of the Curren Tunnel). Also shown is the 1978-93 monthly average for the North Side canal. As would be expected, seasonal fluctuations show the same pattern.

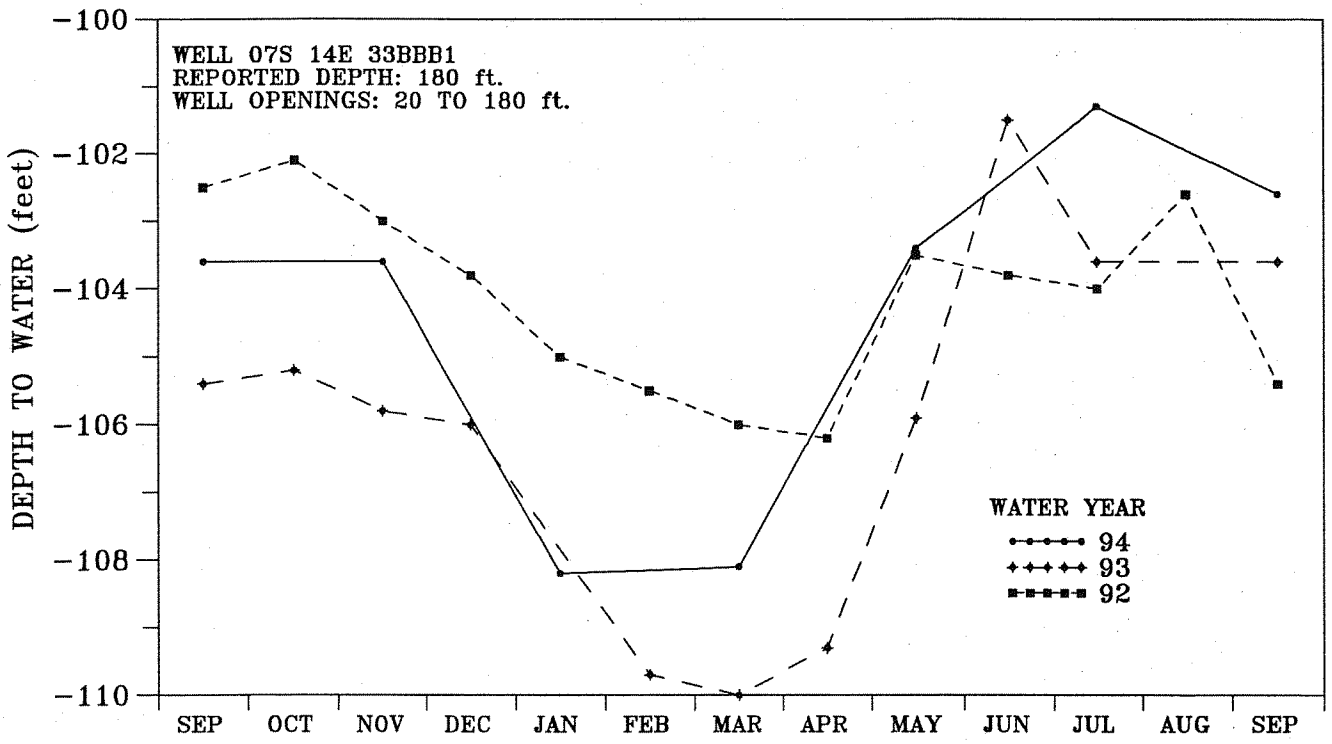
Figure 6, "Spring Discharge", presents flow for the Curren Tunnel and the #15 Spring at the Hagerman National Fish Hatchery for the period September 1993 to November 1994. Also presented are flow measurements for the #15 spring and the Bickle Lake Weir at the National Fish Hatchery for the period October 1991 to December 1994. Flow at the Curren Tunnel is based on daily averages from a continuous recorder while flow at the fish hatchery is based on monthly measurements. Both the Curren Tunnel and springs at the Hagerman National Fish Hatchery show the same fluctuations as seen with ground water levels and North Side canal diversions: decreasing flow from mid-winter until mid-summer with increasing flow throughout the fall. The deeper system though, (the National Fish Hatchery springs), lags or does not respond as fast as the upper system (the Curren Tunnel) to canal diversions and pumpage. Moreland (1976) observed and documented these same patterns for other springs discharging from the North Side of the Snake River.

Recharge vs. Discharge

Figure 7, "Local Ground Water Hydrographs", presents data from three wells currently monitored by the USGS and data from several other wells previously measured by the USGS and measured again by the IDWR during the winter of 1994-95. Hydrographs #1, #2, #3, and #4 correlate with flow at the Curren Tunnel. Hydrographs #5, #6, and #7, are out of the study area, but do reflect the area's trends. Hydrograph #8 is from the deeper system associated with spring flow at the Hagerman National Fish Hatchery (well #8, Figure 2). Long term records are only available for #1 and #7.

Hydrographs for wells upgradient from the Curren Tunnel suggest water levels have only declined approximately seven feet since 1949. This is based on a measurement for #1 made in 1949 and 1994 in December of both years. Hydrographs #2, #3, and #4 suggest the same trend.

Hydrograph #8 (the deep system) suggests water levels are the same as they were in the late 1970's.



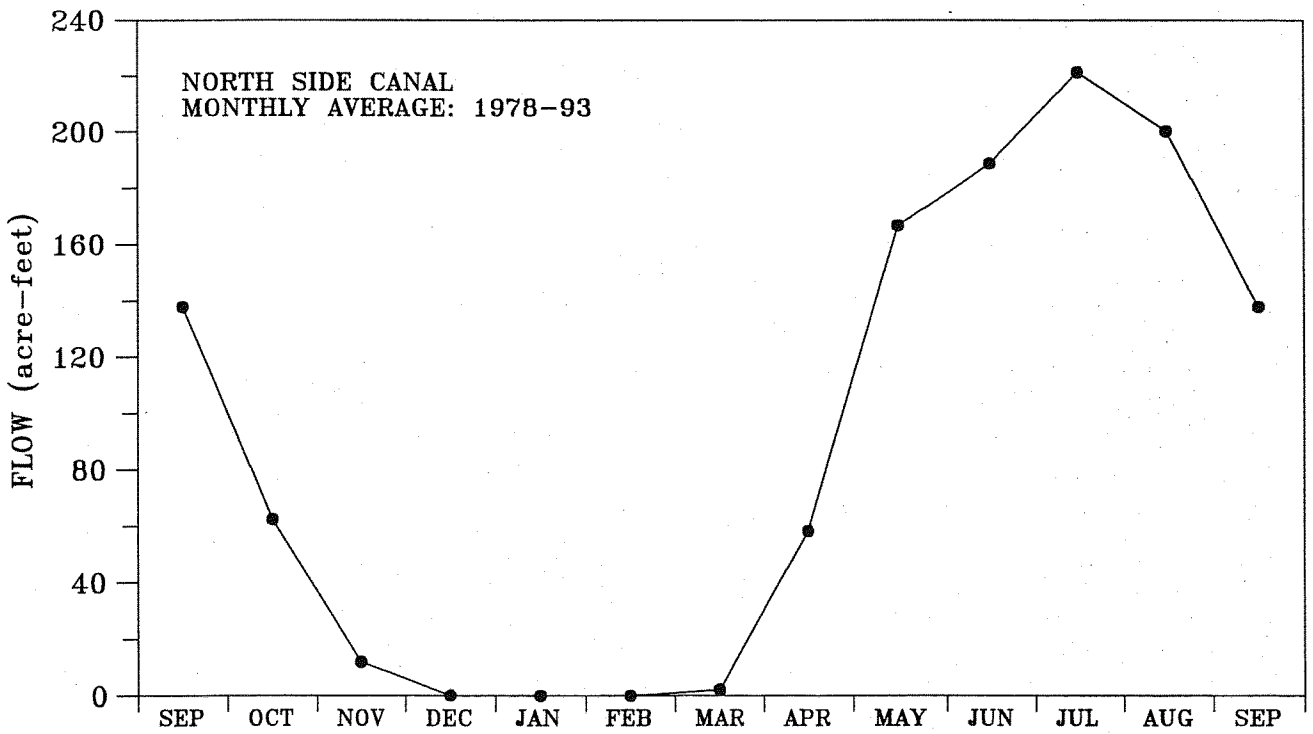
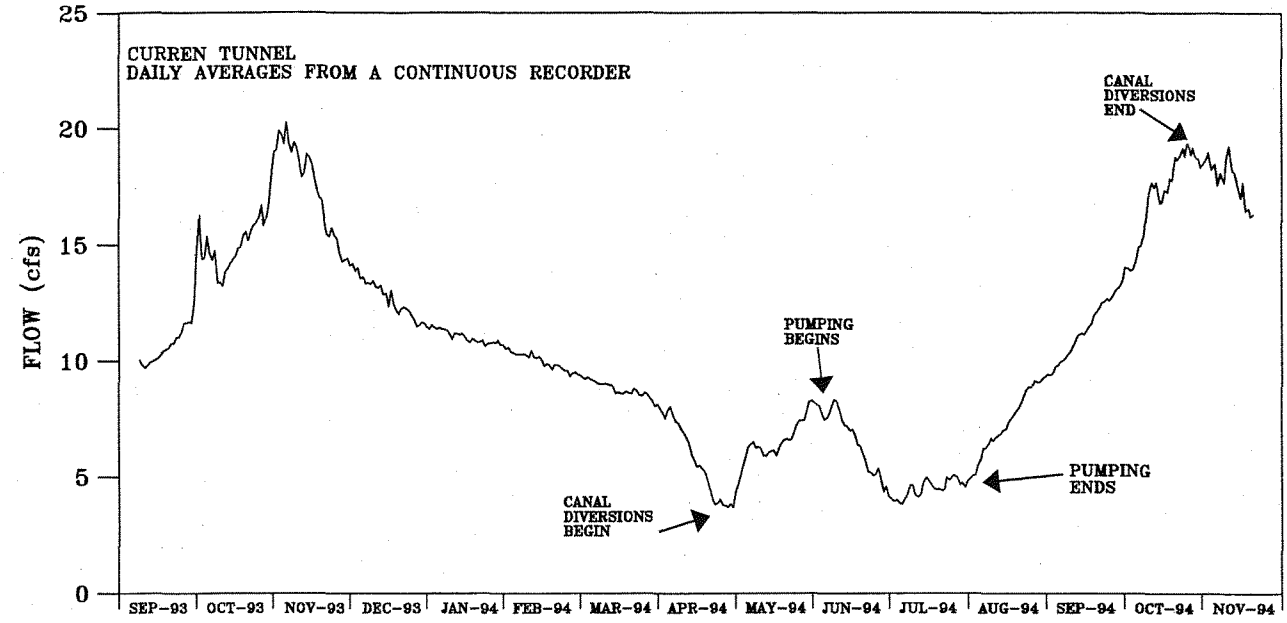


Figure 5. Seasonal Ground Water Levels



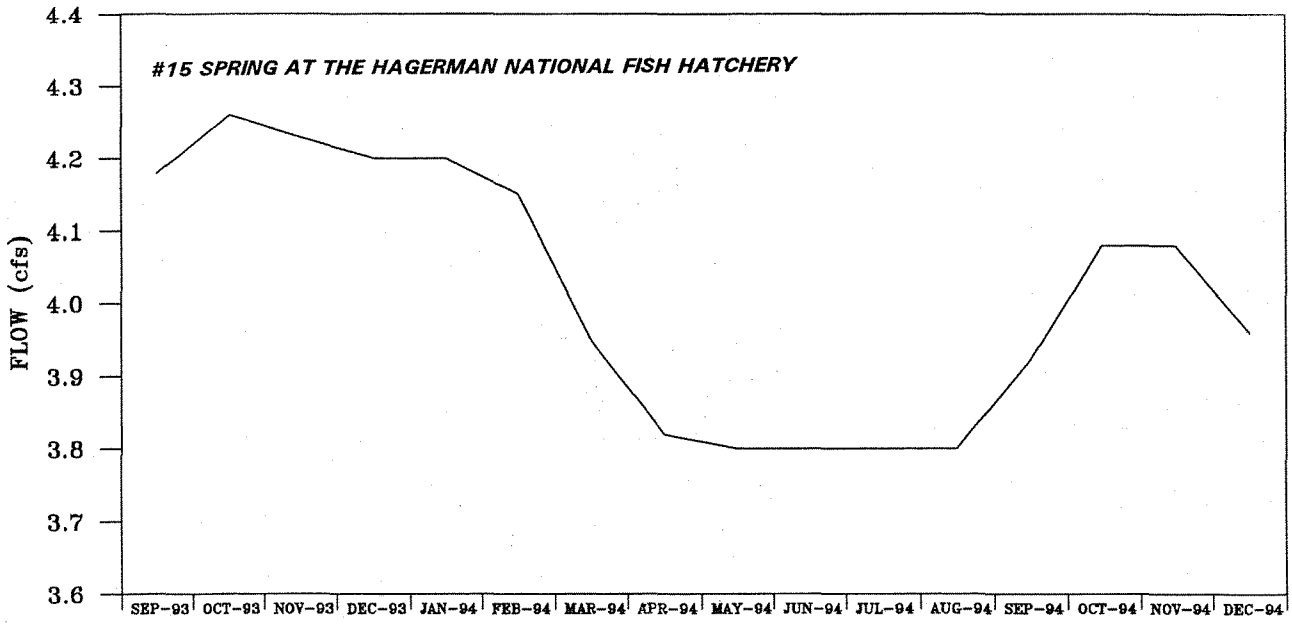
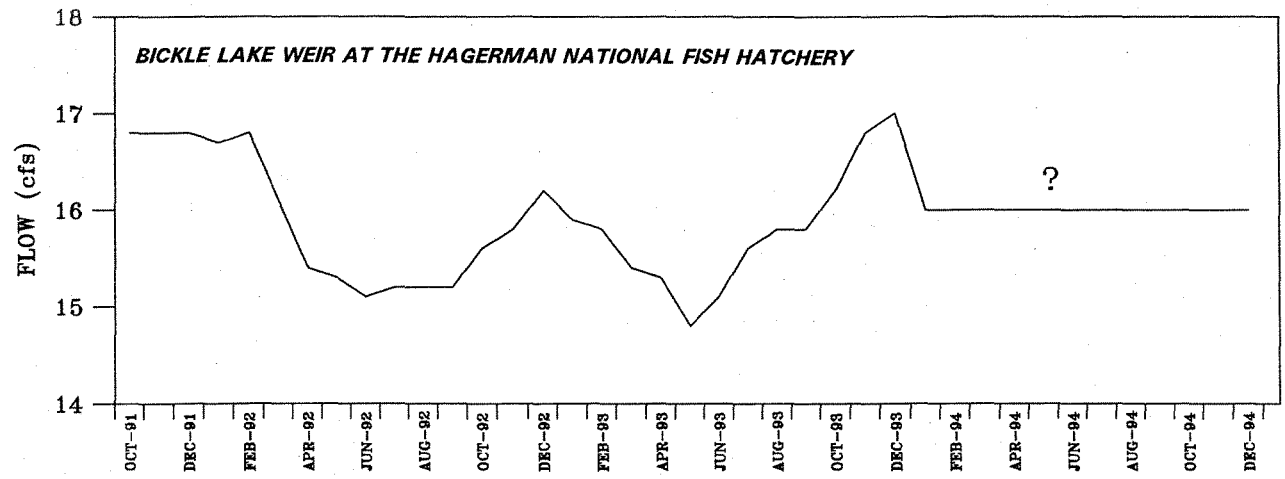


Figure 6. Spring Discharge



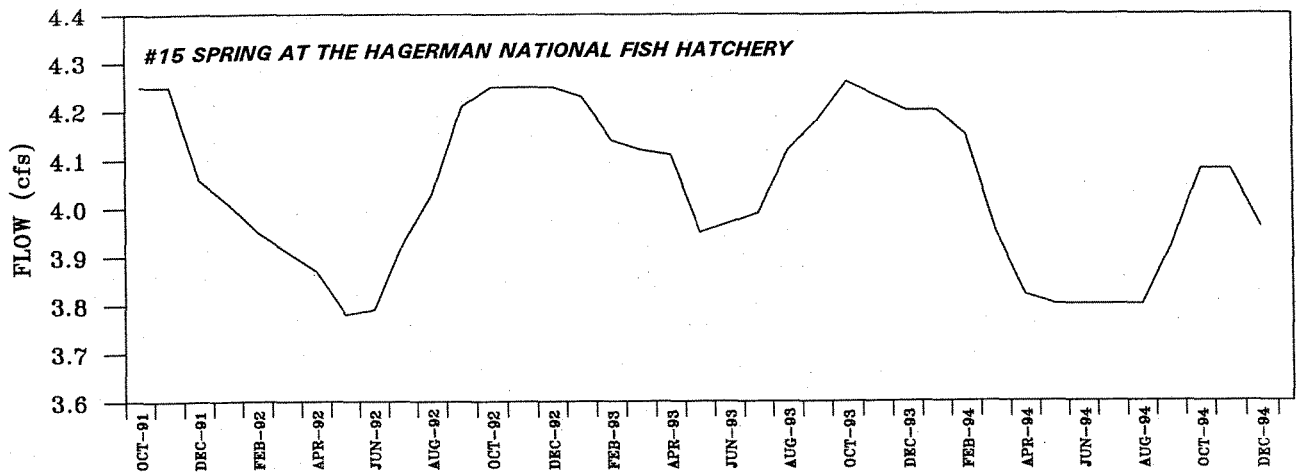
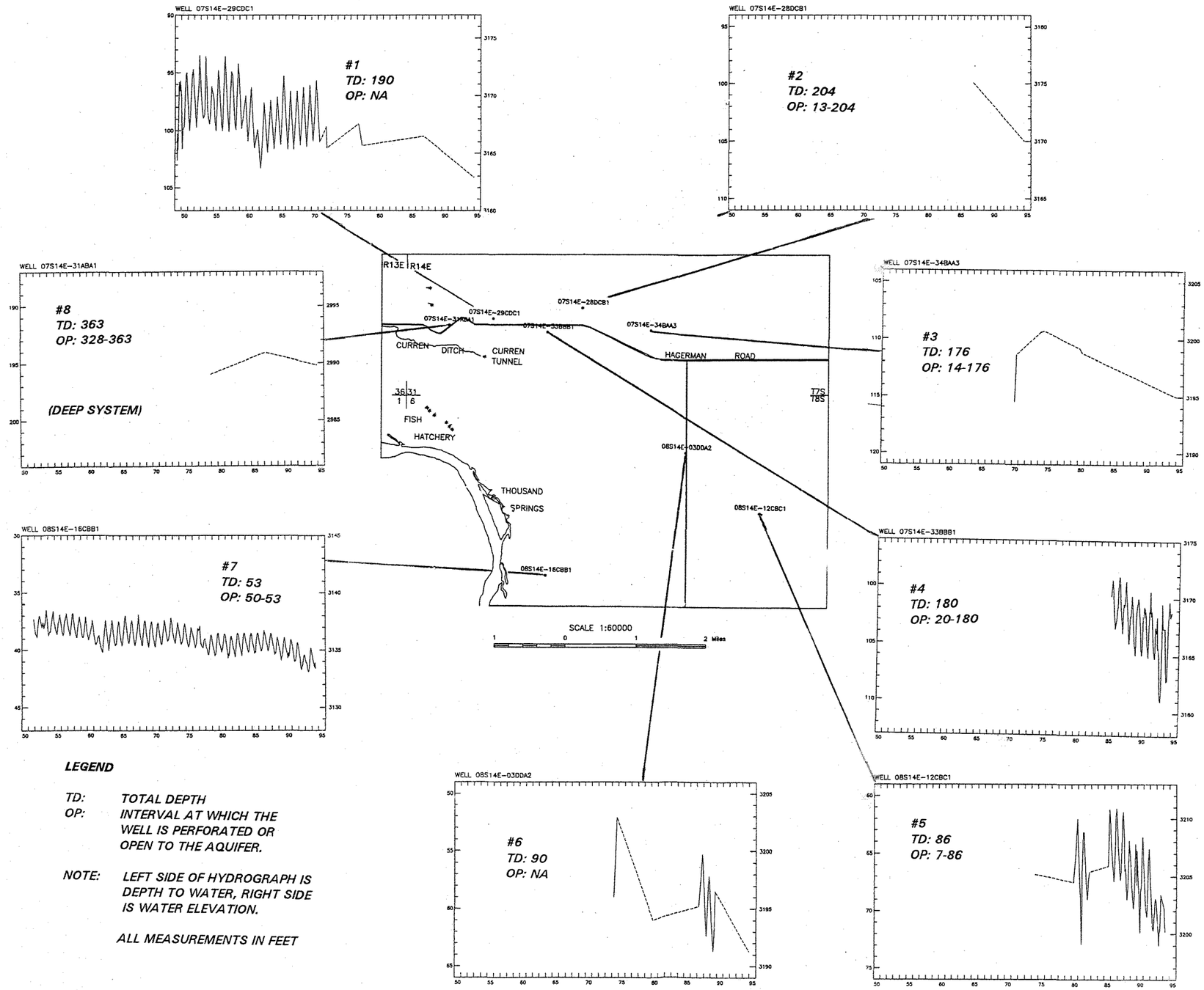


Figure 6. cont.



LEGEND

TD: TOTAL DEPTH
OP: INTERVAL AT WHICH THE WELL IS PERFORATED OR OPEN TO THE AQUIFER.

NOTE: LEFT SIDE OF HYDROGRAPH IS DEPTH TO WATER, RIGHT SIDE IS WATER ELEVATION.

ALL MEASUREMENTS IN FEET

Figure 7. Local Ground Water Hydrographs

Hydrographs #5 and #6 suggest an approximate 10 foot decline south of the study area probably associated with the 1987-1994 drought (i.e., increased pumpage and less recharge). Hydrograph #7 shows very little decline since the 1950's.

Figure 8, "Regional Ground Water Hydrographs" presents hydrographs for wells monitored by the USGS and may be used to assess regional impacts on spring flow in the Hagerman Valley. Plots are made with differing scales and time periods to emphasize trends. Water levels are decreasing, but not to any large degree. Note the trends for the long term hydrographs date back to the 1950's. The increasing and decreasing water levels result from climatic effects associated with dry and wet periods, varying recharge from surface irrigation, and the amount of ground water pumped.

Figure 9, "North Side Canal Flow" presents how water diverted increased until approximately 1955, stayed relatively steady until the late 1960's, dropped dramatically until the mid 1970's, and has been relatively stable ever since.

Figure 10, "Billingseley Creek Flow", presents flow data from which the Curren Tunnel is tributary and therefore representative of flow from the Curren Tunnel. When compared to the long term well hydrographs previously presented, the decrease is more dramatic, but similar trends are seen. The largest decrease from 1972 to 1981, also fits well with diversions to the North Side Canal (Figure 9).

Moreland (1976) analyzed spring flow using a two dimensional finite difference model. Six alternatives were used to test the effects on spring flows. Two involved less canal diversions while the other four involved increased pumping from certain areas. Reduced diversions to the Twin Falls North Side, North Gooding Main, South Gooding Main, and Milner Gooding canals produced the largest decreases in spring flow involving surface diversions. Increased pumpage southwest of Jerome produced the largest decreases in spring flow for increased withdrawals.

A comparison of land use from 1975 (IDWR, 1978) to 1993 (landsat data), showed that land use since 1975 has increased less than 10 percent. The 1975 data also showed that approximately 50 percent of the land irrigated then was with private ground water diversions.

As a point of interest, it is seen that minor fluctuations in the spring flow from the Curren Tunnel during the winter months cannot be explained by pumping or canal diversions (see figure 7). Some fluctuations (November, 1994) were approximately as much as two cubic feet per second (cfs). While barometric pressure influences ground water levels as much as few tenths of a foot, the effects on spring flow were not known. A barometric pressure recorder was therefore installed at the site.

Figure 11, "Spring Flow vs. Barometric Pressure", presents the results. While not a

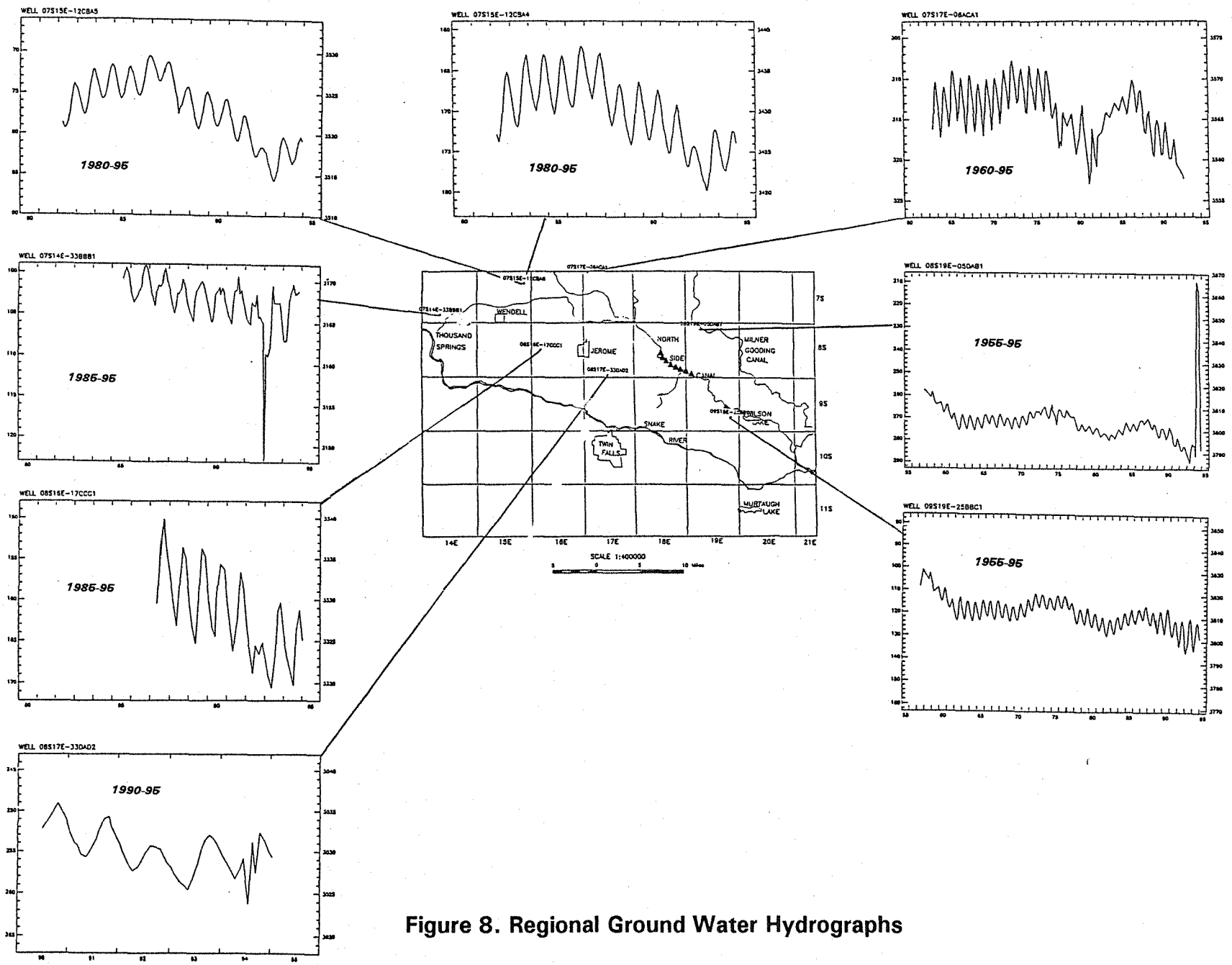


Figure 8. Regional Ground Water Hydrographs

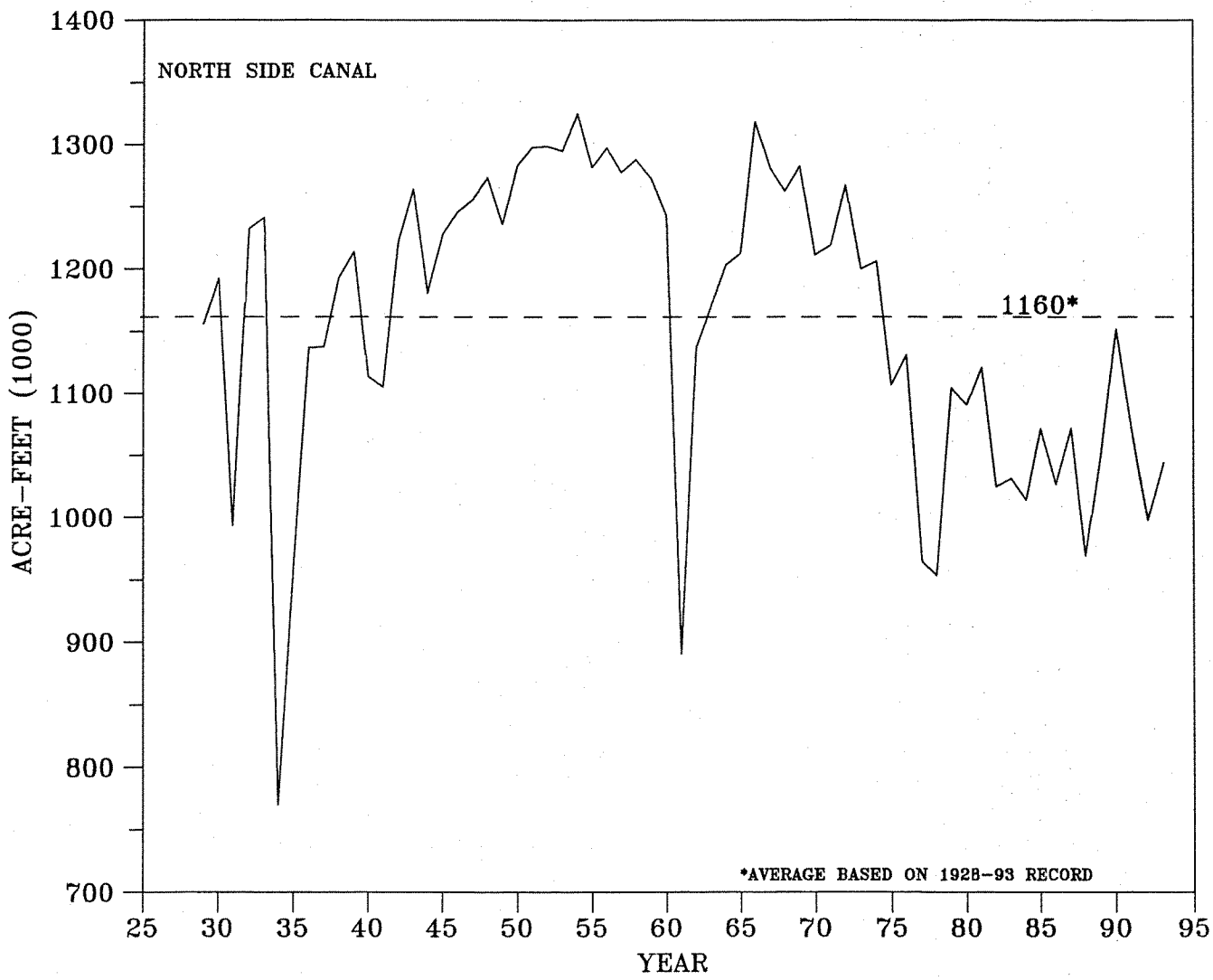


Figure 9. North Side Canal Flow

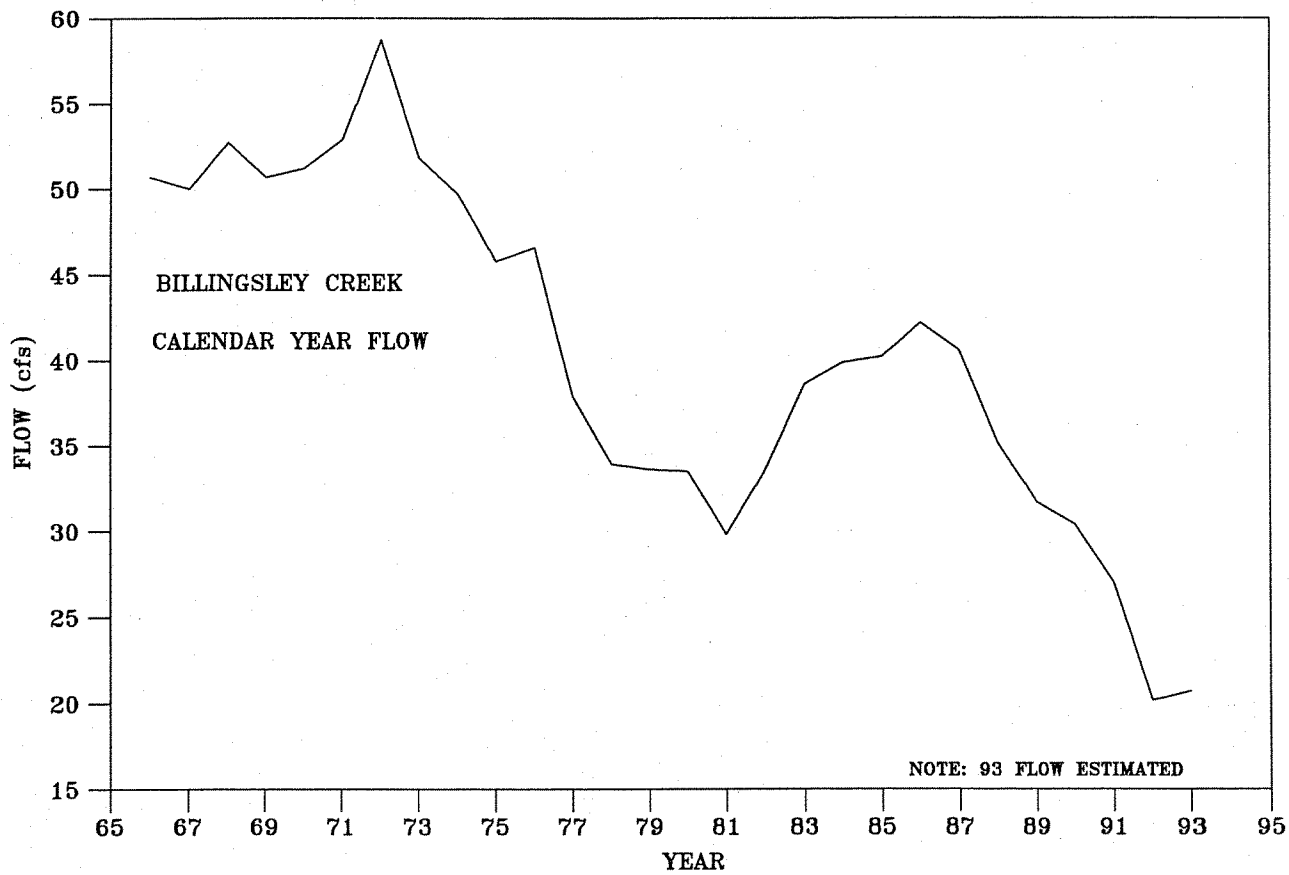
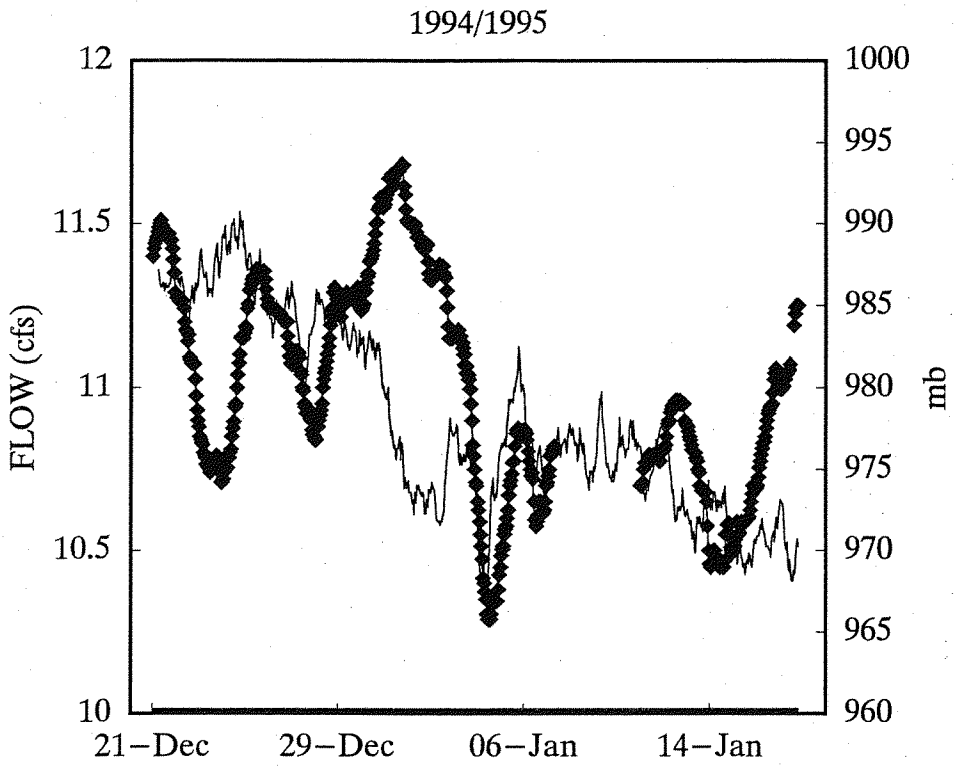
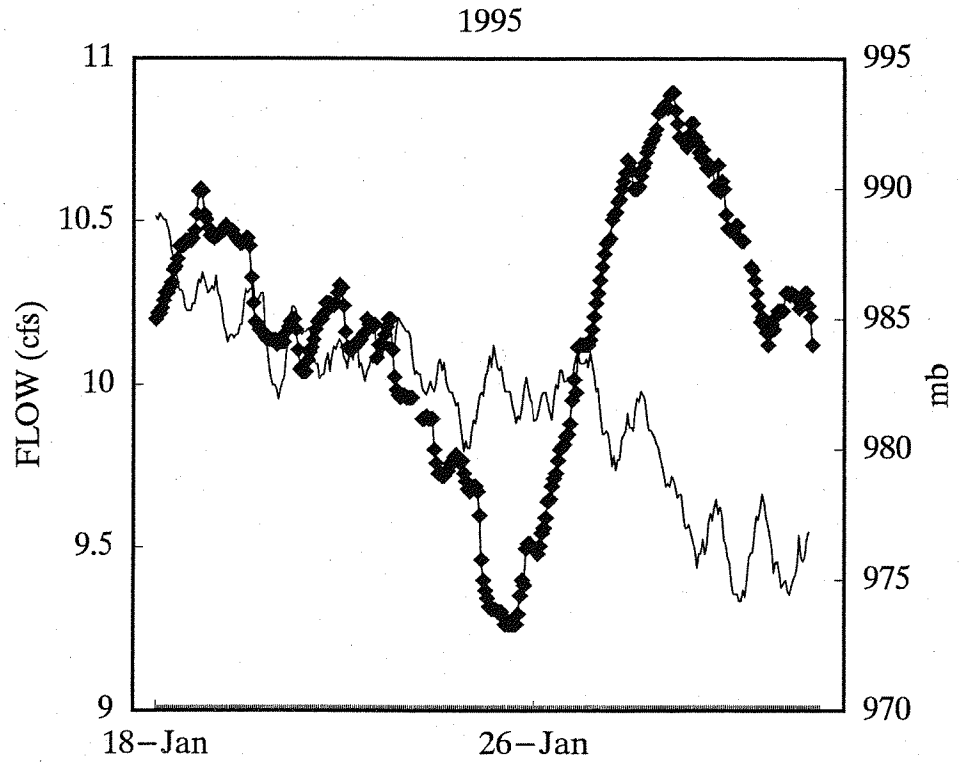


Figure 10. Billingsley Creek Flow





SPRING DISCHARGE: CFS (13 point weighted average)

CHANGE IN BAROMETRIC PRESSURE (millibars)

Figure 11. Spring Flow vs. Barometric Pressure

perfect correlation, it is seen that as barometric pressure decreases, spring flow either increases or stays relatively constant. The inverse is also true. Note that the data were collected during the winter and spring of 1994-1995 when spring flow was decreasing. Both graphs have different scales for time and data to emphasize the effects of barometric pressure.

CONCLUSIONS

Springs at the Curren Tunnel and Hagerman National Fish Hatchery respond in the same way as Moreland (1976) described other springs in the area. Long term and seasonal fluctuations in spring flow are in response to canal diversions, climatic effects, and ground water pumping.

Ground water in the immediate area appears to be in semi-separate aquifers not hydraulically connected. Pumping of the deeper system may therefore not affect water levels in upper system(s).

Ground water levels in the upper system are approximately seven feet lower than they were in the early 1950's. Ground water levels in the deeper system(s) appear to be the same as they were in the late 1970's.

Spring flow in the Curren Tunnel responds directly to very minor (tenths of a foot) ground water level fluctuations related to barometric pressure. This shows how sensitive the flow is to changes in ground water levels.

RECOMMENDATIONS

Monitoring of flow in the Curren Tunnel should continue. Ground water levels in several of the wells near the Curren Tunnel should also be measured at least once a year. This would provide direct data on ground water changes near the Curren Tunnel.

If possible, the Hagerman National Fish Hatchery should install a continuous recorder for monitoring spring flow. This would provide a better comparison between spring flow from the lower and upper systems.

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