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ANTICIPATED EFFECT OF DISCHARGING
242-S EVAPORATOR COOLING WATER TO
THE GROUND

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By

M. D. Veatch

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ANTICIPATED EFFECT OF DISCHARGING
242-S EVAPORATOR COOLING WATER TO
THE GROUND

By
M. D. Veatch

Advance Process Development Section
Research and Development Department
Chemical Processing Division

September 17, 1971

ATLANTIC RICHFIELD HANFORD COMPANY
RICHLAND, WASHINGTON

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ANTICIPATED EFFECT OF DISCHARGING
242-S EVAPORATOR COOLING WATER TO
THE GROUND

INTRODUCTION

A cursory analysis of the anticipated effect of discharging cooling water from the 242-S Evaporator-Crystallizer to the ground on the Hanford water table is presented on the basis of the data that was readily available. The report addresses itself to the effect that the design cooling water discharge, approximately 1 - 1.2 billion gallons per year (bg/yr) over a three-year period, could have on the altitude* of the Hanford water table in the vicinity of the 200 West Area if it were discharged to the 216-U-10 pond. The effect of past discharges of water to the ground in the 200 West and 200 East Areas is shown graphically on an exaggerated geologic cross-section, Figure 3. Synthesis of the geologic cross-section, Figure 4, discharge hydrograph, Figure 2A, and well hydrographs, Figure 2B, clearly indicate the cause and effect relationships that exist between artificial recharge (disposal of water to the ground) and the altitude of the water table in and directly adjacent to the 200 West Area.

SUMMARY

The discharge of cooling water, in the amount of 1 - 1.2 billion gallons per year for a period of three years from the 242-S Evaporator-Crystallizer, to the groundwater system will have a measurable effect on the altitude of the water table beneath and directly adjacent to the 200 West Area. The probability is high that the water levels in well 299-W23-4 and well 699-35-78 adjacent to the 216-U-10 pond will rise from their present altitude of 478 feet to a minimum altitude of 500 feet, a water-table rise

*Altitude as used in this document refers to a mean sea level datum.

of 22 feet. Furthermore, a maximum water-table altitude of 510-515 feet may be realized in the above-mentioned wells because the sediments above a general altitude of 500 feet become finer textured and, therefore, possess a lower water transmitting capability. This resultant water-table rise is of a local nature when considered in relation to the physical boundaries of the regional groundwater system beneath the Hanford Reservation. Based on an average pore volume of 25 percent, total infiltration of three billion gallons and an average rise in the water table of one foot, the area affected would be described by a 4.3 mile radius circle; if a 25 foot rise resulted the radius of the area affected would be about 4500 feet.

A. Data Base

The historical rise of the water table beneath and adjacent to the 200 Area Chemical Separations Facilities has been monitored since 1944. This monitoring program has provided the hydrogeologic data--drillers' logs, bore hole samples, and water-level measurements--upon which the analysis is based. The quantity of water discharged to the ground from the Chemical Separations Facilities is reported in a number of documents which are referenced in Jacobs and Uebelacker (1970). Bierschenk (1957), and Bierschenk and McConiga (1957) discuss the changes in the Hanford water table that occurred prior to 1957, and Brown (1959) discusses the geology beneath the 200 Area Chemical Separations Facilities which controls the hydraulic behavior of the groundwater system. The post-1957 changes in the Hanford water table are known from water-level monitoring data which are summarized on an annual to biannual basis as a contour map of the Hanford water table. The configuration, water-table "topography", of the 1970 Hanford water table is shown in Figure 1 along with the location of the water level monitoring wells that provide the data upon which the map is based. The well numbers on the map prefixed with an E, E28-4, or a W, W15-2, are within the confines of the 200 East Area Chemical Separations Facilities and the 200 West Area Chemical Separations Facilities, respectively.

HANFORD PROJECT

B. Operating Criteria of the Analysis

The conclusions resulting from this analysis are based on several operating criteria:

1. The assumption that the past record of approximate discharge summarized in Figure 2A accounts for at least 90 percent of the reported water discharged to the ground in the 200 West Area.
2. An anticipated maximum discharge of 1.2 billion gallons per year from the 242-S Evaporator-Crystallizer (Hanson, 1971) for a period of three years.
3. An assumed reduction of discharge from the Redox plant evaporators in the amount of 0.25 billion gallons per year (Hanson, 1971).
4. It is assumed that between September 1951 and the time that the 242-S Evaporator-Crystallizer goes on line that the water table will not rise any higher than the April 1969 water-table altitudes recorded in well 699-35-78, 480.72 feet, and well 299-W23-4, 480.57 feet.

C. Approximate Quantity of Water Discharged to the Ground in the 200 West Area

The quantity of water discharged to the ground in the 200 West Area has varied through time. A first approximation of how this discharge has varied is given in Figure 2A. Inspection of the 200 West Area discharge hydrograph indicates that the groundwater system beneath the 200 West Area was artificially recharged at the approximate rate of 0.8 bg/yr from 1945 through 1950, 3.3 bg/yr from 1951 through 1955, 2.4 bg/yr declining to 1.5 bg/yr between 1956 and the end of 1959, and 1.5 bg/yr from 1960 through 1970.

WATER DISCHARGED
TO THE GROUND
(IN BILLIONS OF
GALLONS PER YEAR)

0 2 4

WATER-TABLE ALTITUDE ABOVE MEAN SEA LEVEL, IN FEET

380 400 420 440 460 480

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D. Analysis of the Water-Table Mound Beneath the 200 West Area

The development of the groundwater mound beneath the 200 West Area is characterized by well hydrographs in Figure 2B. A geologic cross-section, Figure 3, illustrates how the water table has risen beneath the 200 West and 200 East Areas with relation to other points beneath the Hanford Reservation along a west to east trending cross-section from the west boundary of the Hanford Reservation to the Columbia River a few miles south of the old Hanford townsite. It is self-evident from inspection of Figures 2A, 2B, and 3 that the water table adjacent to the 216-U-10 pond and 216-S-16 pond rose approximately 25 feet to an altitude of 422 feet between 1944 and 1951 in well 699-35-78. Between 1951 and the end of 1956 the water table rose an additional 55 feet to an altitude of 477 feet in well 699-35-78 due to a three-fold increase in discharge, approximately 1 bg/yr to 3 bg/yr. Since 1957 the water table has remained relatively stable, fluctuating between an altitude of 470 feet (September 1959) and 482 feet (March 1967) in well 699-35-78.

The geologic cross-section, Figure 3, possesses a vertical exaggeration of 52. This means that any length in the vertical direction is 52 times longer than it should be with respect to a horizontal length on the cross-section. Another way to visualize the effect of the vertical exaggeration is to increase the horizontal distance between any two wells on the cross-section by a factor of 52 to gain a true perspective of the actual slope, hydraulic gradient, of the water table. Furthermore, it should be emphasized that the groundwater mounds are relatively local features when the regional groundwater system beneath the Hanford Reservation as a whole is considered. Lastly, no attempt has been made to show the saturated column of sediments directly below the 216-U-10 pond and 216-S-16 pond on the cross-section because no monitoring wells exist near the perimeter of these ponds. However, in a technical sense, the water table is the surface water level of the ponds if the sediment column between them and the regional water table below is

saturated. The rise of the water table to the surface directly beneath the ponds is insignificant in a hydraulic sense because it represents an inundation of less than one one-hundredth of one percent of the volume of the regional unconfined Hanford aquifer.

E. Anticipated Effect of Discharging 242-S Evaporator-Crystallizer Cooling Water to the Ground on the Water Table Beneath the 200 Areas

The effect of discharging 242-S Evaporator-Crystallizer cooling water to the ground at a rate of 1 - 1.2 bg/yr for a period of three years will be measurable in the 200 West Area and adjacent areas that extend radially a distance of approximately 10 to 15 thousand feet from well 699-35-78. A good potential exists for the water level in well 299-W23-4 (adjacent to the 216-U-10 pond) and well 699-35-78 (about 500 feet southwest of the edge of the 216-U-10 pond and about 4500 feet northeast of the edge of the 216-S-16 pond) to attain an altitude of 500 feet. A maximum altitude of 510-515 may be realized since the sediments above an altitude of 500 feet become finer textured, Figure 3, and therefore, possess a relatively lower water transmitting capability. There should be little to no significant rise of the water table beyond the area outlined above due to the discharge of the 242-S Evaporator-Crystallizer. Based on an average pore volume of 25 percent, total infiltration of three billion gallons and an average rise of the water table of one foot, the area affected would be described by a 4.3 mile radius circle; if a 25 foot rise resulted the radius of the area affected would be about 4500 feet. The above conclusions are based on the following data:

1. An increase in discharge of approximately 2 - 2.5 bg/yr to the ground in the 200 West Area during a five-year period, 1951 through 1955, resulted in a total discharge of 3 - 3.5 bg/yr and a water-table rise of approximately 55 feet to an altitude of 477 feet at well 699-35-78 near the southwest corner of the 200 West Area. During the period 1956-1969, the water table has risen approximately 32 feet to an altitude of 477 feet, 7 feet to

an altitude of 479 feet, 28 feet to an altitude of 456 feet, and 17 feet to an altitude of 411 feet in wells 699-34-88, 699-35-78, 699-35-70, 699-25-55, respectively.

2. The water table in the 200 West Area has now attained an apparent equilibrium between the current discharge rate and the transmitting capacity of the groundwater flow system at wells 699-34-88, 699-35-78, and 699-35-70. However, one cannot be absolutely sure that equilibrium has been attained without several more years of water-level measurement. Equilibrium with the present discharge has definitely not been attained in well 699-25-55 where a one-half to one foot per year rate of rise of the water table is continuing.
5. The anticipated discharge from the 242-S Evaporator-Crystallizer would increase the present-day discharge, which is approximately 1.25 - 1.5 bg/yr, to the ground to a total of approximately 2.4 - 2.7 bg/yr in the 200 West Area: an increase of about 1.2 bg/yr. This increased discharge to the groundwater system will not have the effect that the 1951 through 1955 discharge of 3.3 bg/yr had on the water table because the discharge is smaller and of shorter duration. However, the effect will not necessarily be proportionately smaller, i.e., a three-fold increase in discharge between 1951 and 1955 resulted in a 55 foot rise of the water table at well 699-35-78 whereas a postulated increase in discharge 50 - 75 percent greater than the present should result in more than a 9 - 14 foot rise. This results because the former available storage capacity (unsaturated sediments that existed to the south and southwest of well 699-35-78 to the relatively impermeable hydrogeologic boundary known as Yakima Ridge, Figure 1) has been saturated, resulting in a nearly flat water table in this area.

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Although an incremental water-table rise of 55 feet is not anticipated at well 699-35-78 or well 299-W23-4, the empirical data suggest that there is a high probability that the 200 West Area groundwater mound could increase in altitude locally as much as 25 feet to a new altitude of 503 feet in wells 699-35-78 and 299-W23-4.

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