TECHNICAL COMPLETION REPORT

CALIBRATION OF THE SNAKE PLAIN AQUIFER GROUND-WATER FLOW MODEL

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RESEARCH TECHNICAL COMPLETION REPORT

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ABSTRACT

The Snake Plain aquifer ground-water flow model is operated by the Idaho Department of Water Resources as a tool for management of the aquifer and the hydraulically connected Snake River. Data made available by the 1980 U.S. Geological Survey RASA program is being used to recalibrate the model. This project provided technical assistance for the assembly and interpretation of the hydrologic data necessary to recalibrate the model.

INTRODUCTION

The regional Snake Plain aquifer underlies most of the 10,800 mi^2 eastern Snake River Plain (figure 1). It is a major water source for agricultural, municipal, domestic, and industrial uses. Proper management of this resource is essential to the prosperity of southern Idaho.

The Snake Plain aquifer is recharged primarily by percolation from irrigation and by runoff from the mountains to the north and east. Regional ground-water flow is in a southwesterly direction. The aquifer discharges about 6.3 million acre feet per year to the Snake River in the vicinity of American Falls reservoir and in the Twin Falls to Hagerman reach (Kjelstrom, 1984). Discharge also occurs as ground-water pumpage for irrigation of about 1,064,000 acres on the Snake River Plain.

A ground-water flow model of the aquifer has been developed by the University of Idaho and applied by the Idaho Department of Water Resources as a tool for determining the effects of changes in water use on the aquifer and the Snake River. Application of the model as a management tool must be preceded by calibration to the Snake Plain aquifer. The purpose of this recalibration is to refine estimates of aquifer transmissivity and storage coefficient to provide the best possible match between simulated and measured values of water table elevations. The calibration should be performed for a time period in which water table elevation and recharge and discharge are determined by extensive field measurements.

The model has been used by the Idaho Department of Water Resources (IDWR) for the past several years based on calibration using data

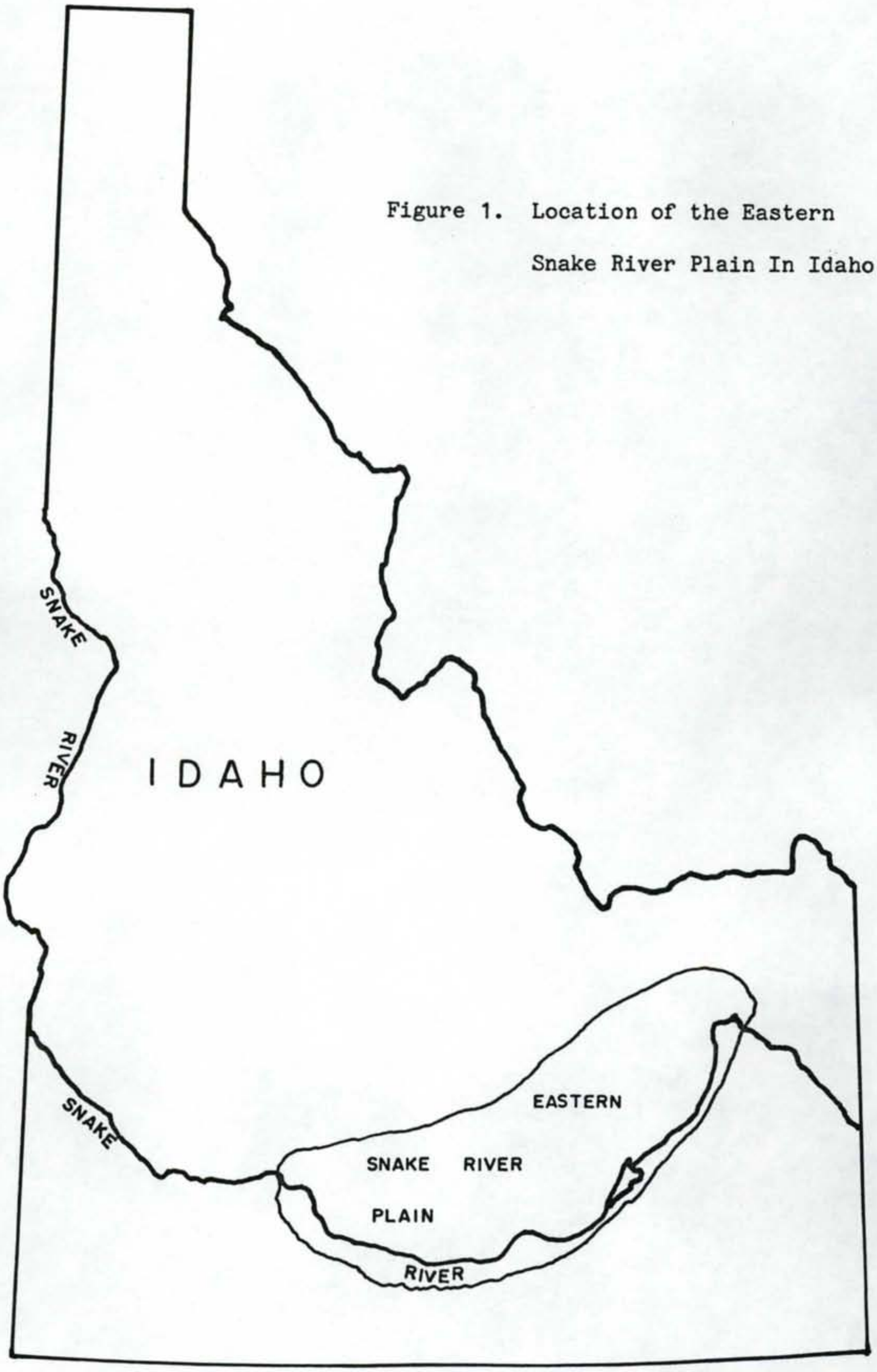

Figure 1. Location of the Eastern Snake River Plain In Idaho.

collected in 1966. The U. S. Geological Survey gathered extensive hydrologic data on the Snake River Plain in 1980, including water table elevations necessary for model calibration, as part of the Regional Aquifer Systems Analysis (RASA) program. Recalibration of the model, using the more extensive 1980 data, will result in a model which will more accurately and reliably predict water table elevations and ground-water discharge.

The hydrologic data are reduced into a single value of recharge or discharge for every model grid cell. The data are processed using the RECHARGE program described by Johnson and Brockway (1983). Data were assembled and prepared by staff of the Idaho Department of Water Resources with assistance from the University of Idaho. Completion of model calibration at the time of preparation of this report was not possible due to heavy workloads encountered by IDWR. Substantial progress has been made, however, and the calibration effort is continuing. Funds contributed by this project were used to assemble and process hydrologic data required for input to the RECHARGE program and for model calibration.

PURPOSE AND OBJECTIVES

The purpose of this project is to provide technical assistance to IDWR for calibration of the Snake Plain aquifer ground-water flow model. The objectives were to:

1) Accelerate the calibration process by the addition of technical support;
2) Minimize potential for errors by introducing additional personnel for consultation and verification;

3) Improve procedures by supplying additional technical input.

RECHARGE PROGRAM ALTERATIONS

The RECHARGE program was modified for application to the eastern Snake River Plain from that documented by Johnson and Brockway (1983). The program alterations include the following:

1. Elimination of reading and writing to scratch disk and associated EQUIVALENCE statements.
2. Changing dimensions of arrays to accommodate the 55 x 40 grid size. Loop limits were adjusted accordingly.
3. Changing output options to minimize unnecessary output of trial runs.

A listing of the program as applied to the eastern Snake River Plain is given in Appendix A.

MODEL GRID DESCRIPTION

The finite difference ground-water model used by IDWR employs a rectangular grid superimposed over the study area. The Snake Plain aquifer model (1980) uses a square grid with an interval of 5000 meters. The grid origin is located at 42^{o} 14' 48" latitude and 115^{o} 04' 21" longitude. The ordinate (y-axis) is oriented parallel to the central meridian of zone 12 of the Universal Transverse Mercator (UTM) grid (111^{o} 00' 00" longitude). The grid is shown in figure 2.

Previous IDWR models of the Snake Plain aquifer used a similar grid. However, the exact location of the origin and orientation of the axis are unknown. A relationship between the model developed by deSonneville (1974) and the present model grid was determined by linear regression of the grid coordinates of 24 wells used by deSonneville. The resulting relationships are as follows:

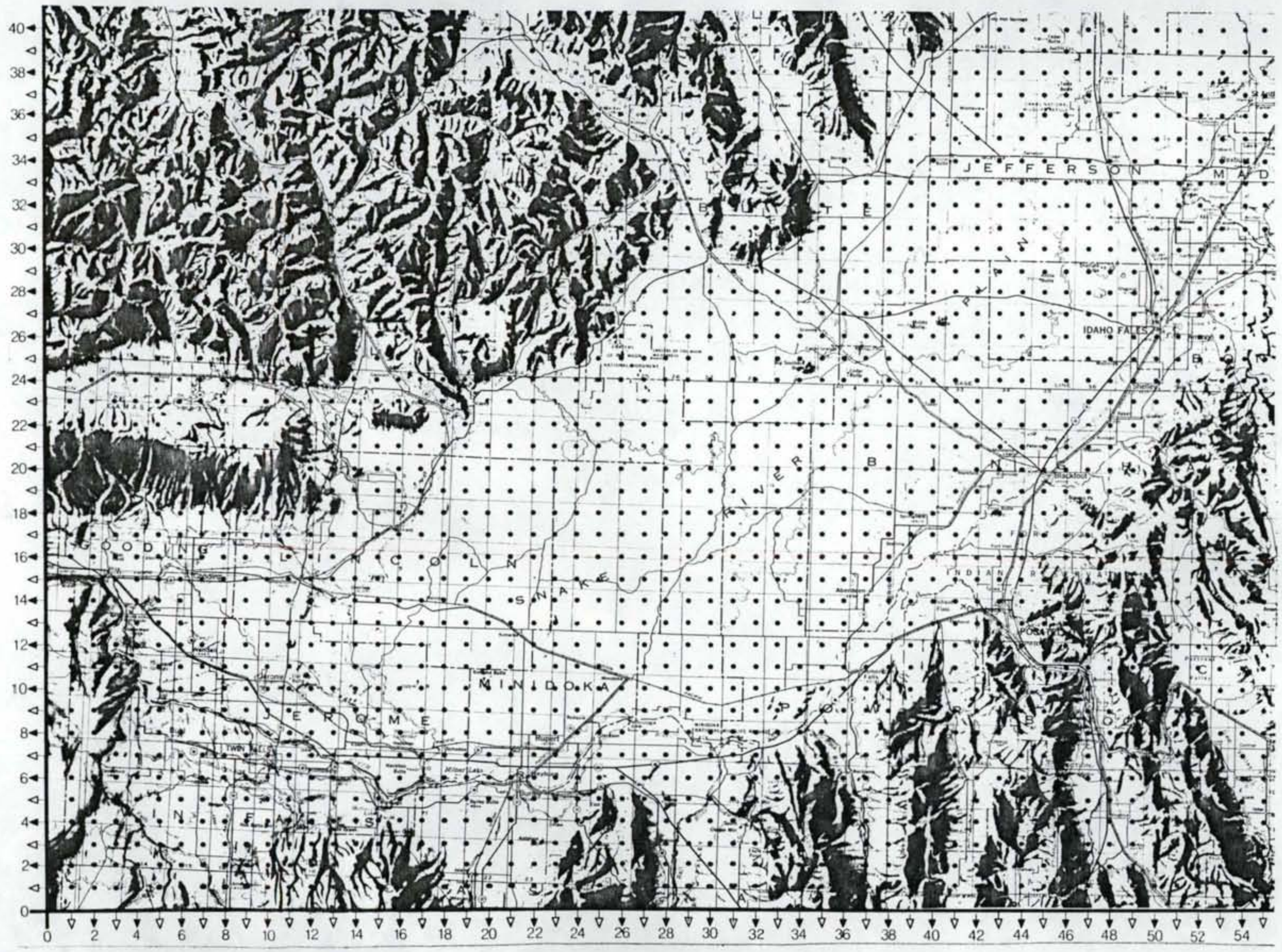

Figure 2. Snake Plain Aquifer Model Grid.

$$X_{1980} = 0.7859 + 1.0086 * X_{1966}$$

$$Y_{1980} = 2.9262 + 1.0103 * Y_{1966}$$

where:

X_{1980} = x-coordinate for 1980 data set,

Y_{1980} = y-coordinate for 1980 data set,

X_{1966} = x-coordinate of deSonneville (1974),

Y_{1966} = y-coordinate of deSonneville (1974).

The UTM zone 12 coordinates can be exactly converted to the model grid by the following relationships:

$$X_{1980} = -32.80 + 2.00 * X_{UTM}$$

$$Y_{1980} = -937.00 + 2.00 * Y_{UTM}$$

where:

X_{UTM} = (x-coordinate, UTM zone 12)/100,000

Y_{UTM} (y-coordinate, UTM zone 12)/1,000,000

The UTM coordinates for zone 11 cannot be easily converted into model grid coordinates. In zone 11, latitude and longitude of a point should be specified and then converted to model grid. A program written by Garth Newton of the U. S. Geological Survey can be used to determine model grid from the latitude and longitude (Newton, in review).

Portions of the eastern Snake River Plain have been recently modeled in two separate studies. The Mud Lake area was modeled by Johnson, Brockway, and Luttrell (1984) and the Henry's Fork-Rigby area was modeled by Wytzes (1980). Grid conversions for the Henry's Fork model are as follows:

$$X_{1980} = 48.2516 + 0.3219 * X_{HF}$$

$$Y_{1980} = 26.1368 + 0.3219 * Y_{HF}$$

and for the Mud Lake model:

$$X_{1980} = 42.7347 + 0.2748\, X_{ML} - 0.1677\, Y_{ML}$$

$$Y_{1980} = 28.8364 + 0.1677\, X_{ML} - 0.2748\, Y_{ML}$$

where:

X_{HF} = x-coordinate, Henry's Fork model,

Y_{HF} = y-coordinate, Henry's Fork model,

X_{ML} = x-coordinate, Mud Lake model,

Y_{ML} = y-coordinate, Mud Lake model.

MODEL TIMESTEP DESCRIPTION

The Snake Plain aquifer model is calibrated by comparison of simulated to measured water table elevations at three times during the one year period. The calibration year runs from May 1, 1980 through April 30, 1981. The period is divided into 20 timesteps. The first sixteen timesteps are 15.2 days duration, and the final four are 30.4 days duration. The month and day of the simulation start and the duration of the timesteps are identical to those used by Newton (1978) and deSonneville (1974).

DETERMINATION OF AQUIFER RECHARGE AND DISCHARGE

The major effort in model calibration usually involves obtaining and processing recharge and discharge data. Recharge resulting from irrigation percolation, tributary valley underflow, stream, and canal seepage, and precipitation on rangeland are generally independent of aquifer head and can be determined externally from the model in the RECHARGE program. Aquifer discharge by ground-water pumpage for irrigation is also determined in the RECHARGE program. Spring flows and hydraulically connected river gains and losses are dependent on aquifer head and are therefore determined in the model.

Treatment of the Henry's Fork Area

Ground water in the Henry's Fork area in the eastern extreme of the Snake River Plain was modeled by Wytzes (1980) and Johnson, Brockway and Luttrell (1985). The water table aquifer occurs mostly in alluvium and is not considered part of the underlying northeastern edge of the regional Snake Plain aquifer. This localized system is recharged primarily by irrigation percolation and discharges mostly by downward leakage to the Snake Plain aquifer.

The overlying alluvial aquifer temporally and areally redistributes recharge from irrigation and river and canal seepage, ultimately discharging it in the form of leakage to the Snake Plain aquifer. Leakage from the overlying alluvial aquifer is calculated by the Henry's Fork-Rigby ground-water model and is included in the RECHARGE program as recharge wells at the appropriate Snake Plain model nodes. Since the recharge is included as leakage it must not be included directly as irrigation and seepage inputs to the RECHARGE program. Irrigation, precipitation, evapotranspiration and stream losses are all set equal to zero in the Henry's Fork-Rigby area to avoid double accounting.

Treatment of the Mud Lake Area

The Snake Plain aquifer is under water table conditions throughout most of the Mud Lake area. The exception is a small arcuate area around the lake where the Snake Plain aquifer is overlain by groundwater in the alluvium. The impact of this area on the Snake Plain aquifer, however, is minimal and is neglected in inputs to the Snake Plain aquifer model. Recharge and discharge inputs in the Mud Lake area are treated in the same manner as the rest of the Snake Plain. The input values were obtained from the model effort of Johnson, Brockway, and Luttrell

(1984), converted to the Snake Plain aquifer grid, and merged into the RECHARGE program input data set.

Recharge Program Input Data

Final runs of the RECHARGE program using the 1980 data set are not yet complete. It is premature to release input data until completion since input values are still subject to change

SUMMARY

The recharge and discharge information and water table elevations assembled for the Snake Plain aquifer model form the basis of calibration. Care and effort were expended to develop hydrologic data representative of the actual situation. The 1980 data represent a substantial improvement in knowledge of the Snake River Plain hydrology. The resulting model calibration will consequently produce more accurate and reliable simulations than previous calibrations.

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