Technical Completion Report A-078-IDA

PRELIMINARY ASSESSMENT OF GROUND WATER MANAGEMENT ALTERNATIVES FOR IDAHO

by

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Idaho Water and Energy Resources Research Institute
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ABSTRACT

Many if not most of Idaho's ground water basins may be presently pumped at rates that exceed natural recharge. The general objective of this project is to provide a preliminary assessment of alternative management schemes for problems of overdraft of ground water basins.

Four study basins were selected to represent the range of ground water development problems and the various stages of present resource management. Ground water development in the Moscow Basin has resulted in a steady rate of water level decline in what is likely a "mining" situation. Local areas of water level decline have resulted from recent development of ground water in the Mountain Home area. A portion of this area is presently declared critical under present statutes. Water levels are slowly declining in the Camas Prairie area as a result of changing from dry land to irrigated agriculture. Impacts from pumpage in this area may interfere with prior downstream surface water rights. The Raft River Basin was declared critical in 1963. Impacts from ground water development include more than 100 feet of water level decline and some indications of land subsidence.

Management factors have been divided into three groups: hydrologic, development and legal guidelines. Hydrologic factors of importance to management are the water level response of a basin to pumpage and the effects that water level declines have on recharge and discharge amounts. The development factors, the pumpage rate in relation to recharge, the depth to water and annual rate of decline and the potential for increased pumpage. The important legal guidelines are

limits on adverse impacts on other users, a no-mining limit on pumpage and a limit on reasonable pumping lifts.

A basin classification system has been presented as a first step in a state wide management program. The classification system includes four factors reflecting management factors.

INTRODUCTION

Statement of the Problem

The economy of Idaho is strongly dependent upon the State's extensive ground water resources either directly by means of ground water pumpage or indirectly by means of surface water utilization. Impacts from ground water development to date have taken the form of water level decline, decreased spring and stream flow and in some areas reported land subsidence. It is possible that, contrary to State law, many if not most of Idaho's ground water basins are presently being pumped at rates exceeding natural recharge.

The Idaho Water Resource Board and the Idaho Department of Water Resources have recognized the magnitude of ground water management problems facing the State. Their interest in this subject resulted in a ground water management workshop held in Boise on October 18-19, 1982, and in a series of local meetings on ground water management held during October and November, 1982. This research project parallels the State interest and is intended to provide technical input into anticipated ground water management decisions.

Purpose and Objectives

The purpose of this project is to provide technical input for decisions on ground water management within the State of Idaho. The general objective is to provide a preliminary assessment of alternative management schemes for problems of overdraft of ground water basins.

The specific objectives are as follows.

1. Select four ground water basins within Idaho as representative of the type of overdraft problems that exist.
2. Use existing data to describe the magnitude and physical controls of ground water recharge and discharge and the characteristics of ground water flow in these basins.
3. Use existing data to describe the pattern and magnitude of pumpage and the impacts from pumpage.
4. Review the hydrologic, developmental and legal factors that impact ground water management with specific reference to these basins.
5. Prepare a report providing a preliminary assessment of ground water management alternatives for these basins.

Method of Study

Research on this project was conducted by two graduate students in hydrology at the University of Idaho under the direction of the senior author. Candidate ground water basins were selected and evaluated with input for the Idaho Department of Water Resources and the U. S. Geological Survey. Data on the hydrogeology of these basins were assembled and evaluated from existing reports and records at the University of Idaho, the Idaho Department of Water Resources and the U. S. Geological Survey. Data on pumpage magnitudes and patterns were obtained from existing reports and from electrical consumption records from local utilities. Short summaries describing the hydrogeology, water use and associated impacts were written for each basin. Data from the four basins were assembled in an evaluation of management factors. Information gained from the water management workshop held in Boise was utilized. The final step in this study was the preparation of the report of findings.

SELECTION OF STUDY BASINS

Criteria

Three criteria were used in the selection of study basins:

1. Representation of various aspects of ground water development problems.
2. Representation of various stages of water resource management.
3. Data availability.

The specific ground water problems resulting from basin development are dependent upon the hydrogeologic characteristics of the basin under study. Specifically, the location and characteristics of recharge, the location and characteristics of discharge and the spatial distribution of aquifer properties within the basin are important. The level of ground water development with respect to the magnitude of the resources is also important. Basins were selected to represent both confined and unconfined conditions, significant and insignificant recharge quantities and limited and extensive surface water interconnection.

Idaho ground water law allows formal management under several schemes. The selection of ground water basins included consideration of historic management efforts such as designation of management or critical areas.

Consideration was also given to the availability of hydrogeologic data and water use data. Particular emphasis was placed on candidate basins with recent hydrogeologic evaluations.

Study Basins

Four basins were selected for evaluation as part of this research effort: 1) Moscow Basin, 2) Mountain Home area, 3) Camas Prairie and 4) Raft River Valley (Figure 1). Ground water development of the deep aquifers in the Moscow Basin began in the mid 1960's. Water levels have declined steadily at rates of 2 to 5 feet per year to the present. The two primary users of the deep aquifer are the City of Moscow and the University of Idaho. The aquifer is basalt in nature under confined conditions and probably represents a situation where pumpage exceeds recharge. No administrative management designation has occurred in this area. The Moscow Basin is part of the larger Moscow-Pullman Basin that extends across the state line into Washington.

The desert area south and west of Mountain Home has undergone major ground water development in recent years. The aquifers are primarily composed of basalt and have been developed almost exclusively for irrigation. Water level declines have occurred in recent years. A portion of the area was declared critical in 1981. The entire Mountain Home area was designated as a ground water management area in 1982.

The Camas Prairie near Fairfield has also undergone a major increase in ground water pumpage in recent years as a result of a change from dry land to irrigated agriculture. Localized areas of water level decline have occurred in a basalt-sediment aquifer system. Pumpage is believed to be much less than annual recharge. Impacts from pumpage probably will take the form of decreased stream flow and possible interference

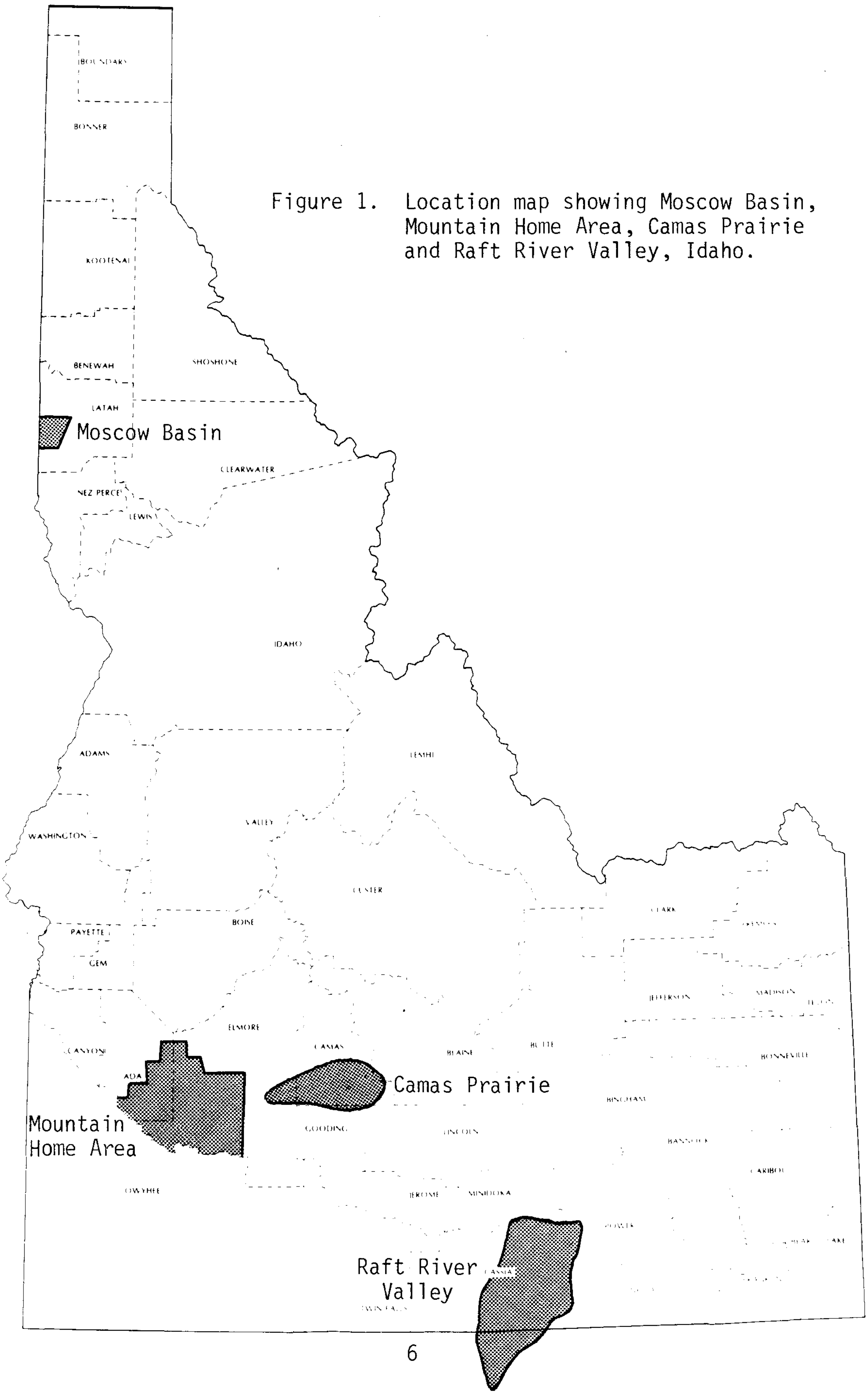


Figure 1. Location map showing Moscow Basin, Mountain Home Area, Camas Prairie and Raft River Valley, Idaho.

with prior downstream surface water rights. No management action has been yet taken in this area.

The fourth study area is the Raft River Valley in southern Idaho. The confined and unconfined sedimentary aquifers were developed for irrigation primarily in the 1950's and 1960's. The basin was declared critical in 1963 and closed for additional ground water permits. The impacts of development have included water level declines of over 100 feet, some indication of land subsidence and a change in surface water flow patterns.

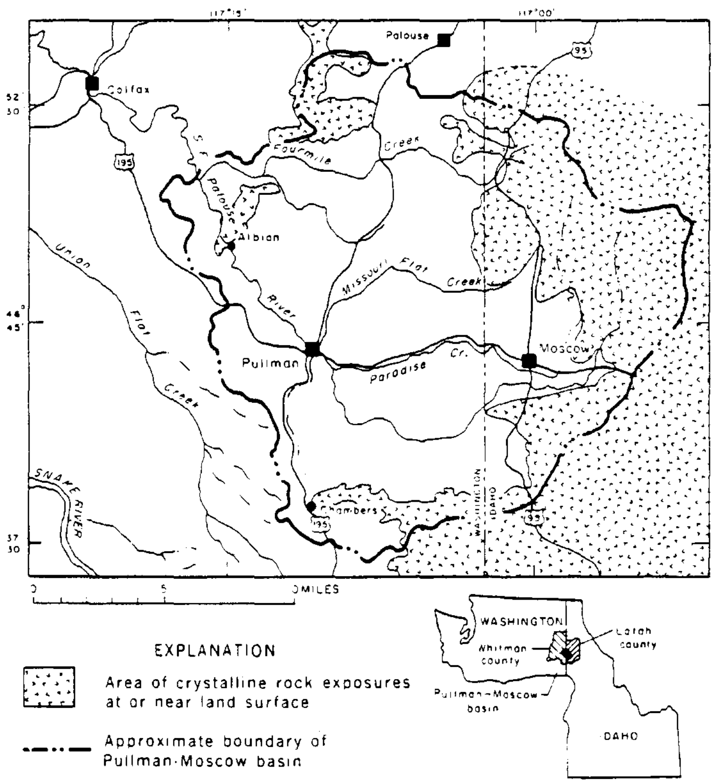
REVIEW OF STUDY BASINS

Moscow Basin

Hydrogeologic Setting

The Moscow Basin is underlain by a sequence of basalts and sediments of the Columbia River Group to a maximum depth of about 1300 feet (Figure 2). The basalts are bounded on the north, east and south and are underlain by granitic and metamorphic rocks that have much lower hydraulic conductivity. The western boundary of the Moscow Basin is assumed at the state line with Washington. A number of investigators have indicated that the basin continues to the west and is the primary source of water supply for the City of Pullman and Washington State University.

The major water yielding zones in the Moscow Basin are referred to as the upper, middle and lower aquifers. All of the aquifers are under confined conditions. The upper aquifer consists of basalts and sediments and was initially developed for water supply by the City of Moscow and the University of Idaho. The original water level in wells in this zone were above land surface. Ground water levels declined throughout the first half of the twentieth century into the mid 1960's when the city constructed wells into what is known as the lower aquifer. Deep wells were constructed because of water level declines and poor water quality in the upper aquifer. The two deep city wells drilled at that time penetrated the full sequence of basalts and sediments to the granitic basement at about 1300 feet. The water level in the lower aquifer is approximately 150 to 200 feet lower than the water level in



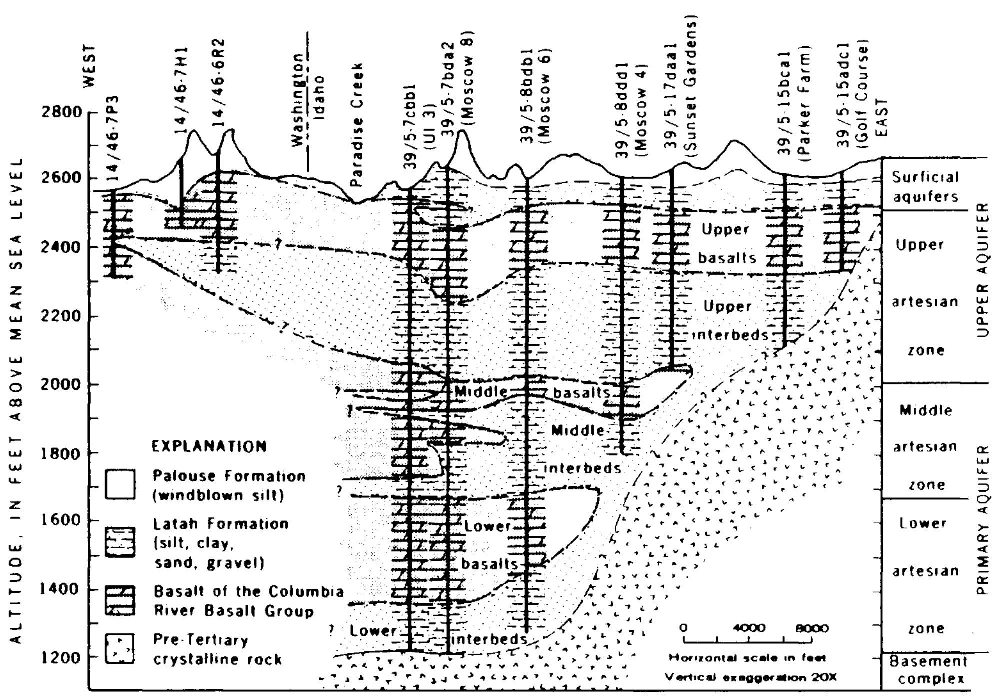


Figure 2. Plan map and cross-section for the Moscow Basin.

the upper aquifer. Well development has continued in the deeper aquifers in the Moscow Basin with the construction of two wells by the University of Idaho into what is termed the middle aquifer (700-1000 feet). These wells, constructed in the 1970's, have similar water levels as the city wells in the deep aquifer and are believed to represent a system connected with the deep aquifer. The City of Moscow completed the fifth deep well into both the middle and lower aquifers in 1982. All of these wells produce more than 1,000 gpm (gallons per minute) with several wells producing more than 2,000 gpm.

The magnitude and characteristics of recharge to the deep aquifers in the Moscow Basin are subjects of considerable argument. Some investigators have indicated that recharge occurs primarily along the contact between the granitic and metamorphic hills and the basalt lowlands (Jones and Ross, 1972). Other investigators have indicated the the primary mechanism of recharge is downward leakage from the upper aquifer (Barker, 1979). The volume of recharge to the deep aquifers in the Moscow Basin is not known. Barker (1979, p. 88) estimated that the downward rate of leakage from the upper aquifer to the lower aquifers was about 4,900 acre feet per year for 1975 as part of a research effort to develop a mathematical model of the Moscow-Pullman Basin. Ground water discharge is believed to occur naturally as ground water outflow west of the City of Pullman.

<u>Impacts from Development</u>

Development of ground water resources in the deep aquifers in the Moscow Basin has resulted in a continual pattern of water level decline. Average pumpage by the City and the University is about 3700 acre feet per year (Crosby, 1982). Decline ranges from 1 to 4 feet per year depending upon the well measured and the rate of annual pumpage (Figure 3). The water level decline has had little impact upon the ground water basin or the users within the basin. Land surface subsidence has not been noted in the basin because of the rigid nature of the basalt aquifers. Water quality within the deep aquifers in the basin is uniformly good and no change in quality is evident or anticipated from ground water pumpage. Decreases in ground water outflow from the Moscow-Pullman Basin have not been documented. The primary impact of development of ground water in the Moscow Basin has been a continual and steady decline in ground water levels. The model results presented by Barker (1979) predict a gradual decrease in the rate of water level decline in the Moscow-Pullman Basin. However, the model results are suspect; present (1982) water levels are lower than those predicted by Barker (1979, p. 96-98) for the year 2000. Barker's estimation of 4,900 acre feet per year of downward leakage to the lower aquifer is also suspect. The decline in ground water levels probably will continue indefinitely into the future. This decline probably represents the mining or continual withdrawal of ground water from storage from an aquifer system that receives very little recharge.

Management Needs and Plans

The Moscow Basin has not received formal administrative attention of the Idaho Department of Water Resources in spite of the Idaho statute that specifically prohibits the pumpage of ground water at a rate that

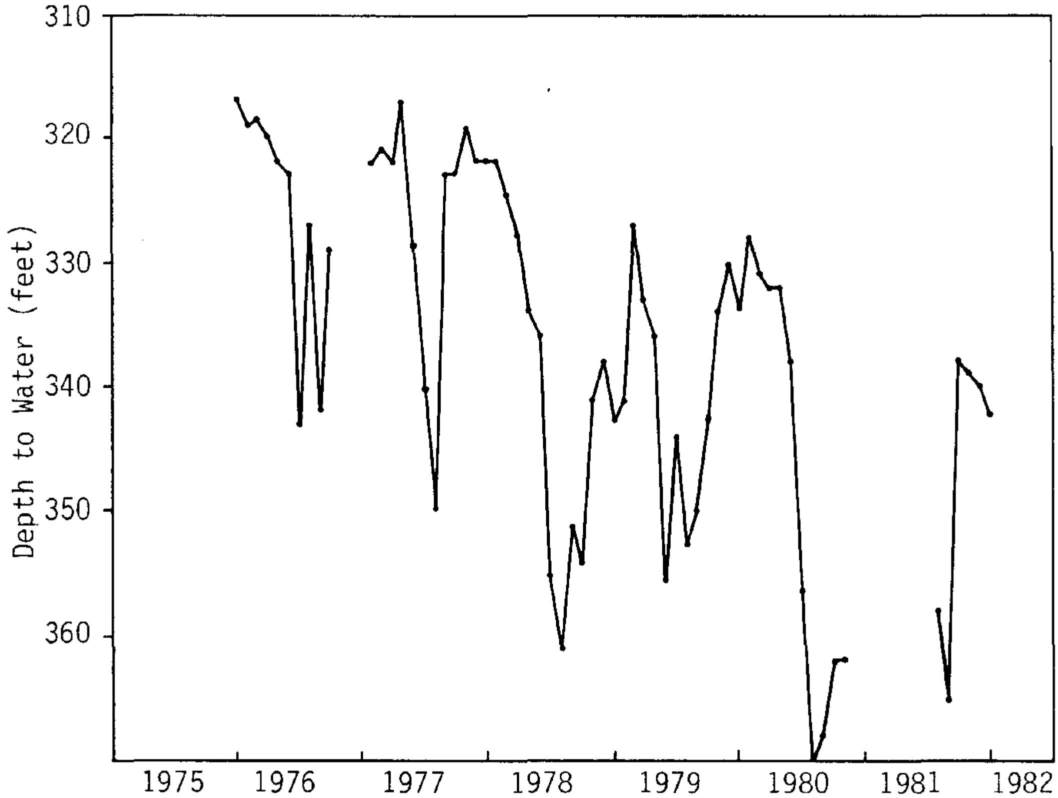


Figure 3. Hydrograph of well 39N 5W 8ba1 in the lower aquifer of the Moscow Basin.

exceeds the "reasonably anticipated average rate of future natural recharge" (Ralston and others, 1974). Development to date has been limited by the water needs of the two primary users of the deep aquifer within the basin. The two users, the City of Moscow and the University of Idaho, have a relatively stable demand for water with a limited projected increase in demand for the remainder of the century. The relatively large capital cost required for the construction of a well to penetrate the deep aquifers in the Moscow basin plus the availability of the upper aquifer probably will limit new users. Little interest has been expressed in development of new large uses of water such as irrigated agriculture.

The primary management consideration is thus the continued use of what is probably a stock resource. Interest has been expressed in both water conservation and methods by which artificial recharge can be implemented. The City of Moscow reinitiated the use of the upper aquifer in the late 1970's with the construction of a water treatment plant to reduce the problem of high iron and manganese contents. Water from the sewage treatment plant has been utilized to irrigate the university golf course for the past several years in a water conservation measure.

The life of the ground water resource in the Moscow Basin is dependent upon the volume of water pumped, the volume of water in storage and the annual rate of recharge. The water supply for the city and the university is probably suitable for a period of at least 50 years based upon present rates of pumpage and present rates of decline.

Mountain Home

Hydrogeologic Setting

The Mountain Home study area is a broad plateau located on the western Snake River plain in Elmore and Ada counties in southwestern Idaho (Figure 4). The area is underlain by a relatively flat lying sequence of basalts and sediments to a considerable depth. Rocks of lower conductivity form the higher mountain areas to the north and northeast. The southern boundary is formed by the Snake River and the east and west boundaries are arbitrary.

Ground water in the Mountain Home area occurs in the basalt sedimentary aquifers primarily under unconfined conditions. Recharge is believed to occur from precipitation directly on the basalts and from losing streams originating in the mountain highlands. Additional recharge occurs from surface irrigation using water from Canyon Creek and imported water from Camas Creek on the north and from pumped water from the Snake River on the south. Natural ground water discharge is poorly understood. Several small springs occur along the Snake River. Ground water flow conditions near the river are generally unknown. Surface irrigation near Mountain Home has resulted in the creation of a perched aquifer (Norton and others, 1982). Most ground water pumpage is from a lower regional aquifer.

Norton and others (1982) present a rough water balance for the Mountain Home study area for 1980 conditions (Table 1). The inputs reflect a runoff from the mountains and import of water from Camas Creek and pumpage from the Snake River. The outputs or uses are predominantly

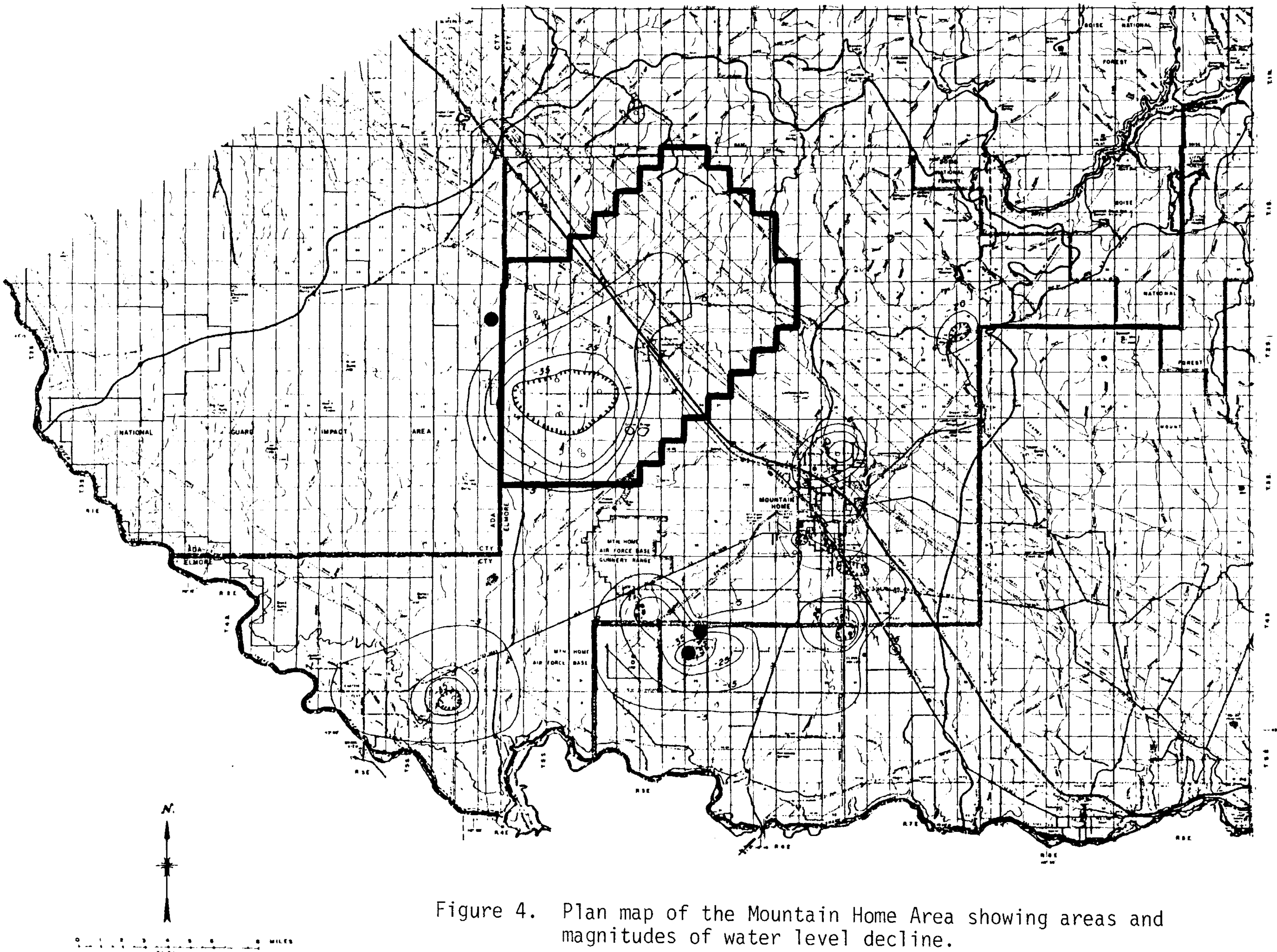


Figure 4. Plan map of the Mountain Home Area showing areas and magnitudes of water level decline.

Table 1. Water balance for Mountain Home study area, 1980 conditions (from Norton and others, 1982)

	Supply/Use	Total (rounded) (ac/ft/yr)
Source		
Canyon Creek Yield	19,000	
Little Camas Creek (imported)	9,500	
Rattlesnake Creek yield	3,460	
Ditto Creek and Adjacent Areas	3,800	
Snake River Pumping	37,800	
Precipitation on Plateau Rocky Areas	4,400	
		78,000
Use		
Loss to Snake River	1,900	
Use by Crops	74,250	
Use by Municipal, Air Base Irrigation	2,500	
		78,600
Source Less Use		-600

irrigation. The water balance as presented by Norton and others indicates that the inputs of water very nearly equals consumptive use. However, the area is considerably out of balance if the irrigation from the Snake River in the extreme southern portion is excluded from consideration. This water balance indicates that ground water pumpage exceeds recharge by approximately 9000 acre feet per year.

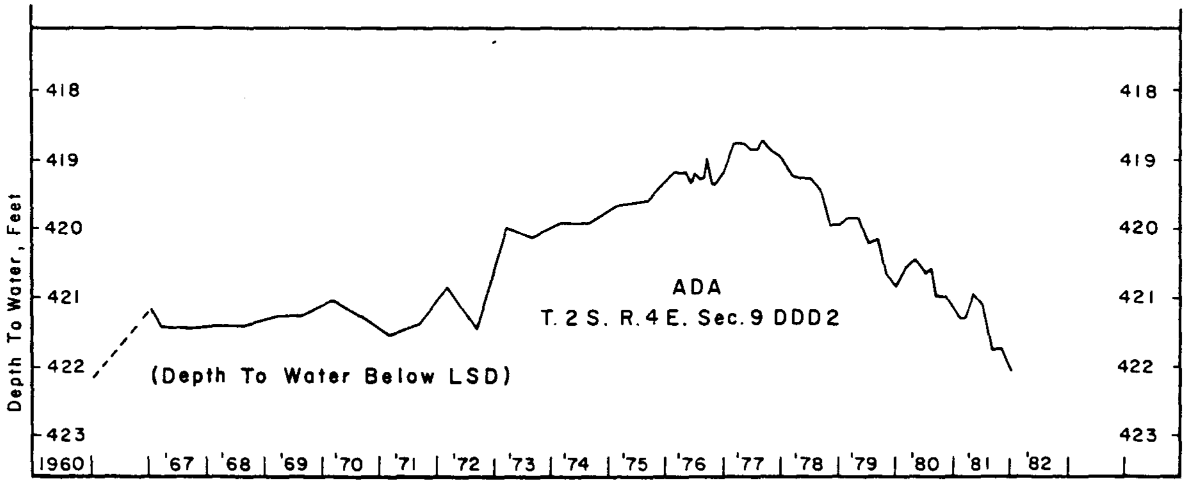
Impacts from Development

Three major areas of ground water decline have occurred south and west of Mountain Home coinciding with local areas of ground water pumpage (Figure 4). These areas are distant from both the areas of natural recharge and the areas of recharge from application of surface water. The complex history of water level rise from surface water application and subsequent water level decline from ground water pumpage is shown by the hydrograph of well 25 4E 9ddd2 presented in Figure 5. The other two hydrographs reflect water level changes in areas of exclusive ground water pumpage.

Impacts from ground water development in the Mountain Home area have apparently been limited to water level decline. Land subsidence has not been reported, probably because of the rigid nature of the basalt. Water quality changes have also not been noted. Natural ground water discharge is poorly understood and decreases resulting from pumpage would be difficult to document.

Management Needs and Plans

The Cinder Cone Butte portion of the Mountain Home study area was declared critical by the Idaho Department of Water Resources in 1981



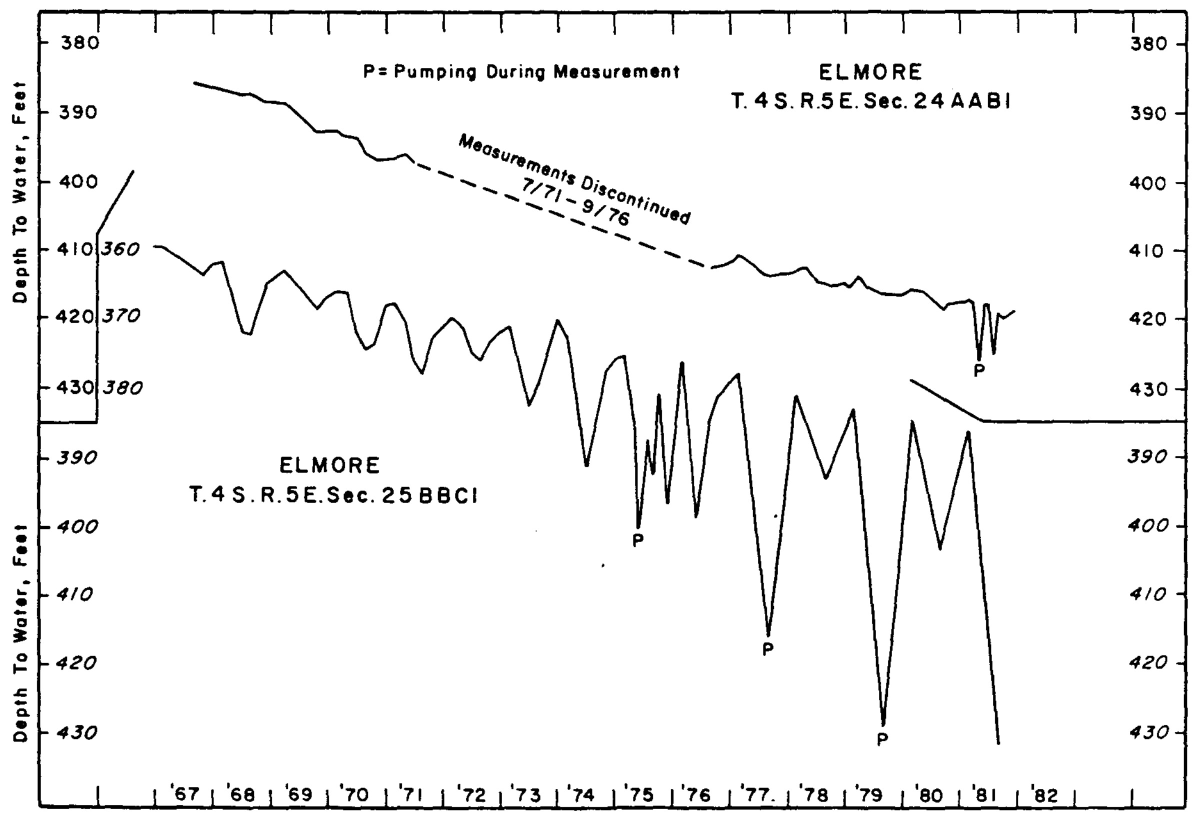


Figure 5. Hydrographs of wells T2S R4E 9ddd2 and T4S R5E 25bbc1 for the Mountain Home Area.

(Figure 4). The remainder of the Mountain Home area was declared as a management area in 1982. Permits have been approved for more than 15,000 acres of irrigation or an estimated 27,500 acre feet per year of pumpage in addition to that reported in Table 1 for 1980 (Norton and others, 1982, p. 46). In addition, ground water applications currently pending, if approved, would allow another approximately 20,000 acre feet per year of pumpage. The magnitude of existing pumpage, approved pumpage and pending pumpage illustrates the seriousness of the ground water management problem in the Mountain Home area.

Camas Prairie

Hydrogeologic Setting

The Camas Prairie includes about 730 square miles in Camas County and parts of Elmore, Gooding, and Blaine counties in southcentral Idaho (Figure 6). The valley, which includes about 250 square miles, is a gently undulating feature underlain by sediments and basalts. The surrounding highlands consist of older sedimentary and igneous rocks that have much lower hydraulic conductivity than the valley materials.

Wells in the area obtain water primarily from water table and artesian aquifers in the valley fill deposits and the basalts. The unconfined aquifer extends from about 10 to 40 feet below land surface and is separated from underlying artesian aquifers by a thick clay layer. The lower of two artesian flow systems has sufficient head to allow wells to flow at land surface in portions of the area.

Recharge to the ground water systems occurs from direct precipitation and percolation of stream runoff into the alluvial material. Young

EXPLANATION

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Potentiometric surface, September 1977--Dashed where approximately located. Contour interval is variable. Datum is mean sea level

Generalized direction of ground-water movement

Drainage-basin divide

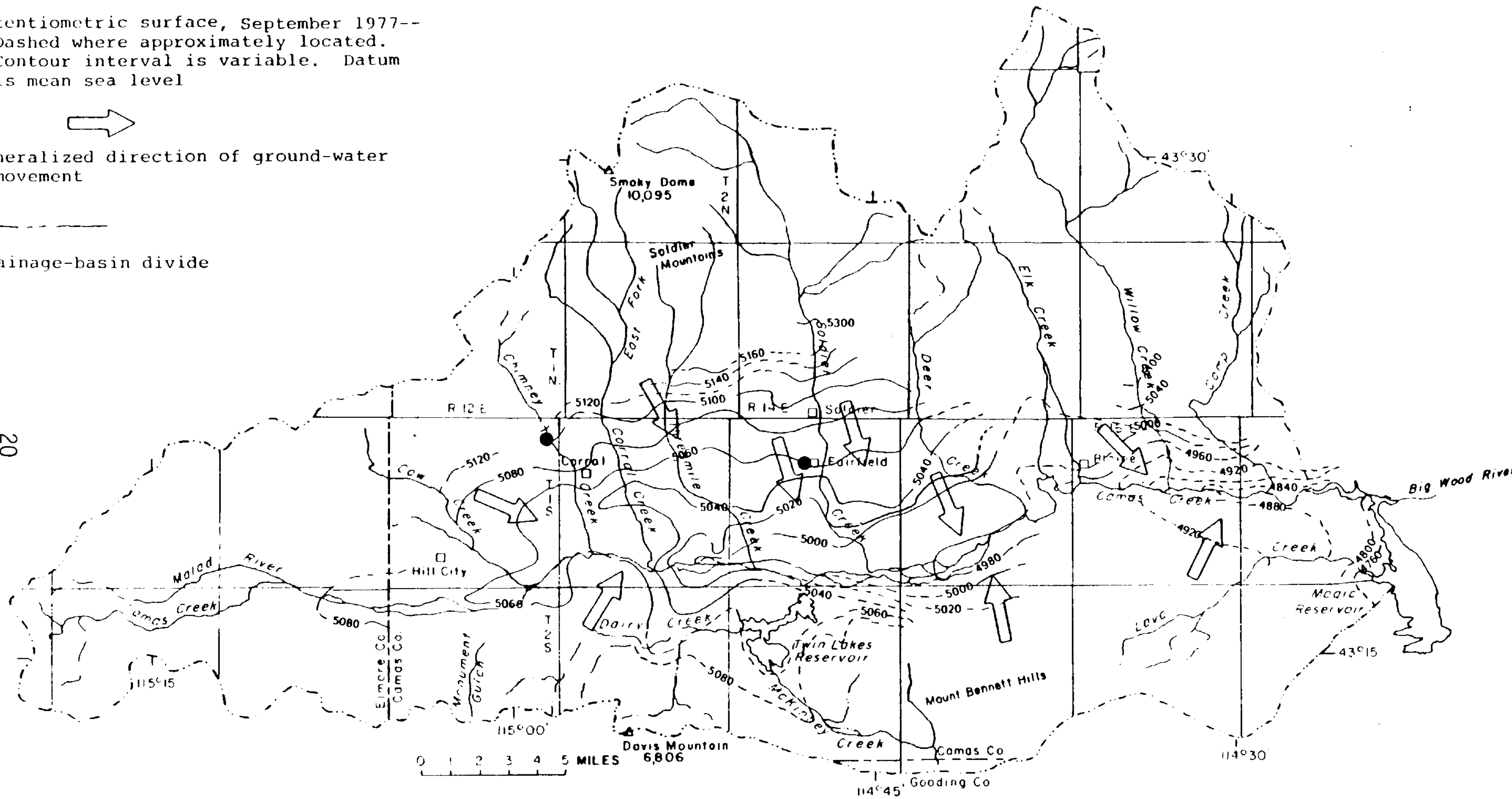


Figure 6. Location map of Camas Prairie showing water level contours.

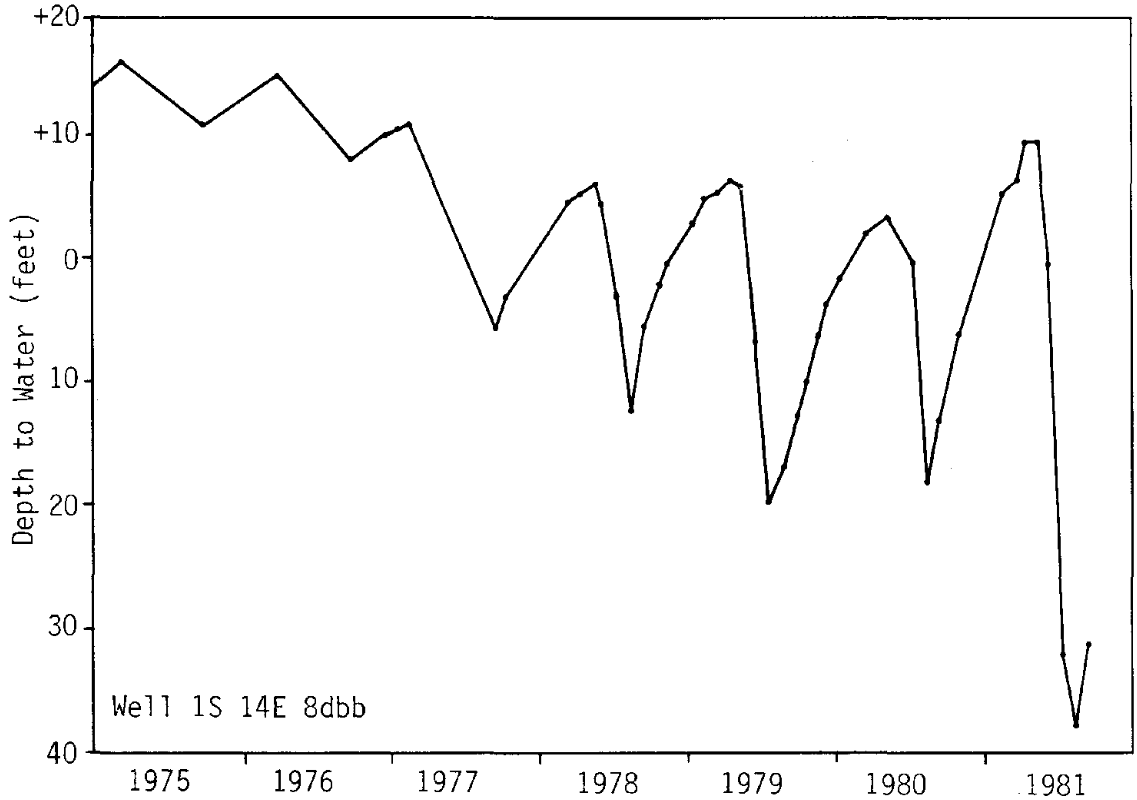
(1978) indicated recharge to the artesian system is about 37,000 acre feet per year. Natural discharge from the artesian system is by upward leakage into the overlying confined system and direct discharge into Camas Creek which is the primary surface water discharge in the basin. In addition ground water discharges as underflow east out of the basin.

Young (1978) estimated total pumpage for irrigation and municipal use was about 9500 acre feet in 1977. Power consumption records for 1981 indicate a pumpage of about 9800 acre feet. There was an increase in the number of irrigation wells from 28 wells in 1977 to about 51 wells in 1981.

Impacts from Development

Ground water withdrawal has resulted in a general decline in the piezometric surface of the confined system and the water table in the unconfined system and possibly the flow of Camas Creek. Hydrographs for selected observation wells are shown in Figure 7 and indicate a gradual decline. The decline averages slightly less than one foot per year.

Indirect impacts of ground water pumpage such as water quality degradation and land subsidence have not been noted in the Camas area. Portions of the basin underlain totally by sedimentary materials may be subject to subsidence. Ground water pumpage appears to have decreased the flow of Camas Creek. Additional research is needed to fully document the magnitude of the decreased stream flow resulting from ground water pumpage.



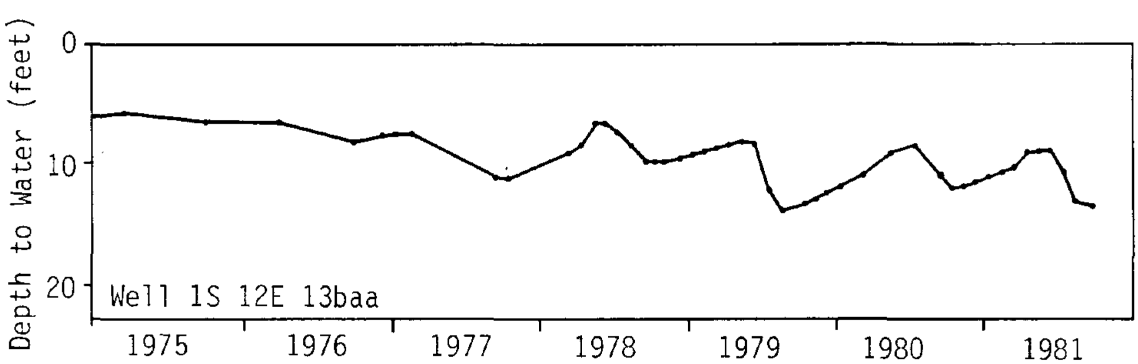


Figure 7. Hydrographs for wells 1S 14E 8dbb and 1S 12E 13baa in the Camas Prairie area.

Management Needs and Plans

The Idaho Department of Water Resources has not presently placed any constraints on the development of ground water within the Camas Prairie. Annual ground water pumpage is clearly less than annual ground water recharge. Water level decline rates are measureable but are not large in relation to decline rates in other portions of the state. The primary management problem is potential decreases of flow in Camas Creek resulting from ground water pumpage in the Camas Prairie. The low flow of Camas Creek is fully appropriated from downstream irrigation uses. An additional problem is the decrease in water levels in shallow wells that penetrate the unconfined aquifer. Continued ground water development will also result in a reduction in the area of flowing artesian wells. This will lead to questions of whether artesian pressure above land surface is a part of a water right.

Raft River Valley

Hydrogeologic Setting

The Raft River Valley is a large intermontane area located in Cassia County in southcentral Idaho (Figure 8). Major aquifers in the valley are sedimentary in nature and extend to considerable depths. The valley is bounded on the west, south and east by less permeable older rocks. The northern portion of the valley has a surface covering of basalt and joins with the Snake River Plain.

The primary aquifer system in the valley is under unconfined water table conditions. Ground water flow is from south to north with a gradient of approximately 15 feet per mile.

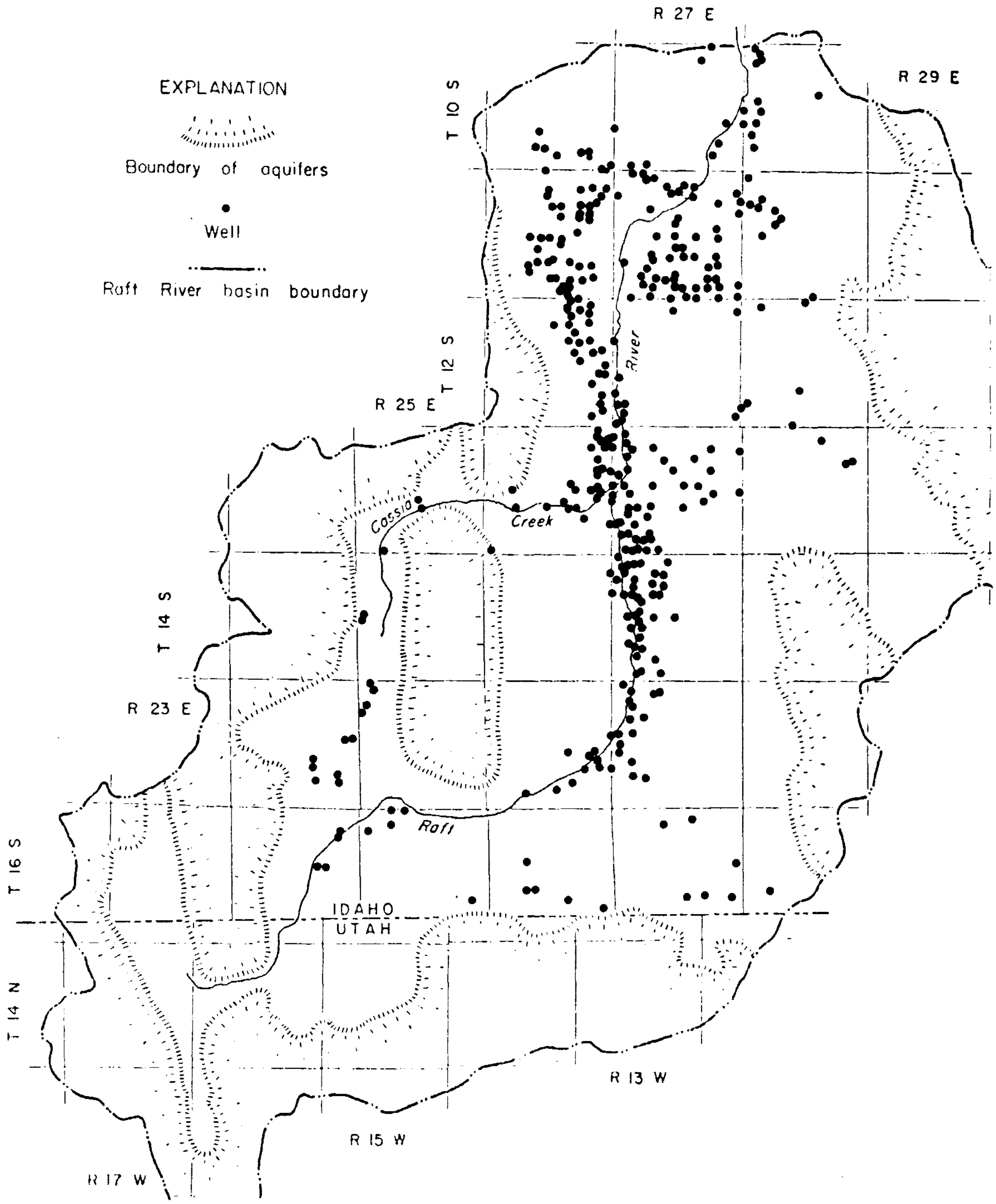


Figure 8. Location map of the Raft River Valley showing location of irrigation wells.

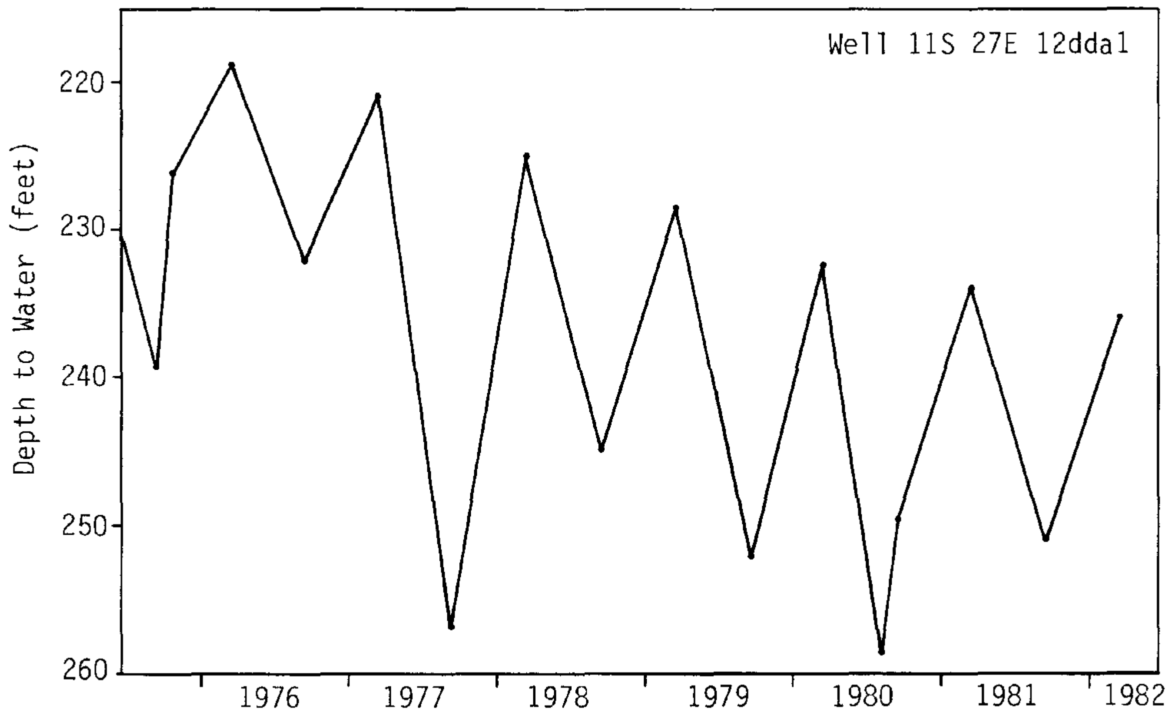
Recharge occurs primarily as a result of precipitation on the highlands area and stream loss into coarse alluvial fans. Some recharge probably also occurs by precipitation directly on the valley floor. Total recharge to the basin was estimated in 1970 to be 130,000 acre feet per year (Walker and others, 1970).

Natural ground water discharge prior to water resource development was by ground water outflow and by baseflow in the Raft River. Ground water and surface water development has resulted in a marked decrease in surface water outflow. Ground water outflow remains essentially unchanged at approximately 80,000 acre feet per year.

Pumpage is primarily for irrigation and totaled about 235,000 acre feet per year in 1966 (Walker and others, 1970). This figure represents total pumpage and is not consumptive pumpage. Irrigation water applied in excess of consumptive use probably recharges back to the unconfined aquifer.

Impacts from Development

Ground water pumpage in the Raft River Valley has resulted in localized areas of major ground water level decline. More than 100 feet of water level decline have been documented in an area of localized pumpage in the northern portion of the basin (Ralston and others, 1974). Hydrographs from selected observation wells are shown in Figure 9. Major water level declines are restricted primarily to the northern portion of the valley (hydrograph for well 11S 27E 12dda1). Most ground water recharge occurs in the southern portion (hydrograph for well



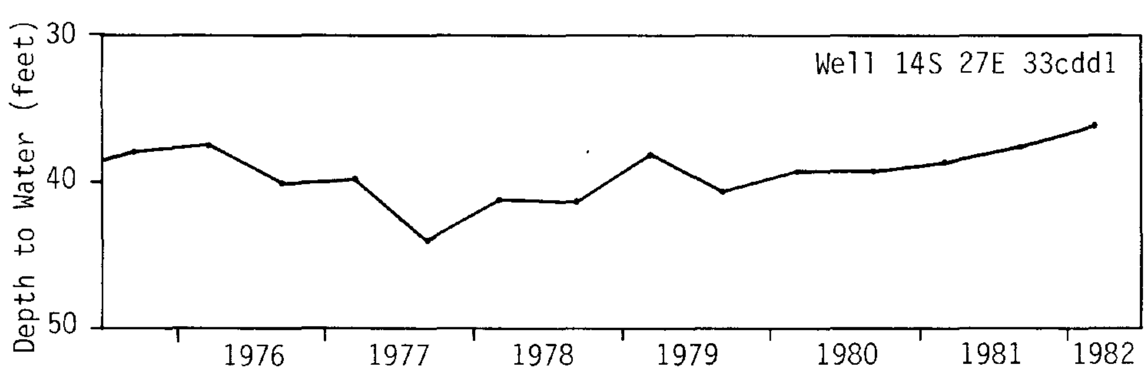


Figure 9. Hydrographs of wells 11S 27E 12dda1 and 14S 27E 33cdd1 in the Raft River Valley.

14S 27E 27cdd1). The areas of water level decline are relatively localized because of the nature of the ground water resource.

Limited land surface subsidence has been reported in portions of the northern half of the Raft River Valley. The full magnitude of this problem is not known. Water level declines to date have not apparently caused any decreases in water quality. Ground water pumpage has decreased the flow of Raft River but has not yet decreased the ground water outflow. Walker and others (1970) predicted that it would require several hundered years of pumpage at the 1966 rate to decrease the ground water outflow by one-half.

Management Needs and Plans

The Raft River Valley was declared a critical ground water area under Idaho statutes in 1963. This declaration resulted in the closure of the valley with respect to the approval of new permits. Ground water pumpage increased from the closure time in 1963 to a peak in about 1966 because of outstanding permits. Essentially no new pumpage has been allowed since that time. Several boundary changes have occurred to modify the original critical designation, particularly, in the northern portion of the valley.

One of the dominant factors that influences water management in the Raft River is the large areal extent of the valley and the unconfined ground water conditions. The unconfined conditions result in localized areas of ground water decline and slow propagation of these decline areas throughout the basin. Similarly, recharge events have caused water level rises in the southern portion of the basin. The increases and variations in recharge have not significantly affected the areas of water level decline to the north.

MANAGEMENT FACTORS

Introduction

Management factors that are of importance with respect to ground water may be divided into several groups: hydrologic, development and legal guidelines. Hydrologic factors include the physical characteristics of the basin such as the nature and extent of the aquifers, the aquifer parameters, the locations and characteristics of recharge and discharge and the response characteristics of the basin to pumpage. Development factors include the relative quantity of ground water pumpage in relation to annual recharge and water in storage, the severity of the impacts from ground water pumpage and the potential for growth in ground water pumpage in the basin. The legal guidelines are stated in the Idaho law and interpreted in terms of court cases.

Hydrologic Factors

The characteristic response of a basin to ground water pumpage is an important factor in the analysis of management alternatives. The extremes are shown by the Moscow Basin and by the Raft River Valley. The deep basalt aquifers in the Moscow Basin respond very quickly to ground water pumpage because of high transmissivity values and low storativity values. Water level decline is thus relatively uniform across the small basin. Contrarily, the medium transmissivity and high storativity of the aquifers in the Raft River Valley create localized areas of ground water decline near pumpage centers. These decline areas are relatively separated from areas of recharge in the large valley. The water level change map for the Mountain Home area also shows localized areas of water level decline distant from recharge areas.

Pumpage of ground water necessarily results in water level decline as the mass of water within the aquifer system is changed. Continued ground water pumpage must be balanced by either an increase in recharge or a decrease in discharge if equilibrium is to occur. Changes in recharge and/or discharge can only result from decreases in water levels in the respective areas. It is thus important to understand as management factors not only the locations of recharge areas and discharge areas but also how recharge and/or discharge will be changed as a result of water level decline. The extremes in this situation are shown by the Raft River Valley and the Camas Prairie area. Discharge from the Raft River Valley occurs as ground water outflow and as surface water flow into the Snake River. This discharge will not be significantly affected for a very long period of time because of the large distances involved and the unconfined nature of the valley. In the Camas Creek area, discharge occurs primarily as underflow and inflow into Camas Creek relatively near the areas of pumpage. Pumpage in the Camas Prairie area has already decreased the natural ground water discharge to the stream. Recharge to ground water systems is often relatively unaffected by decreases in ground water levels. Downward leakage from the upper aquifer to the lower aquifers in the Moscow Basin is controlled by an existing difference in potential of more than 200 feet. A decrease in ground water levels in the deep aquifer will not significantly increase downward flow.

Development Factors

The Idaho Code indicates that ground water pumpage shall be limited to less than the "reasonably anticipated average rate of future natural recharge". It is thus important to examine the consumptive ground water pumpage in relation to the natural recharge to the aquifer system. Available data indicate that the consumptive pumpage in the Moscow Basin exceeds natural recharge. However, natural recharge is very difficult to document in this area. Data from the Mountain Home area have been interpreted to indicate that ground water pumpage approximately equals replenishment (Norton and others, 1982). However, evaluation of the data shows that ground water pumpage is probably considerably greater than recharge. The consumptive pumpage in the Raft River Basin appears to be roughly equal to what has been estimated to be natural recharge. Finally, the ground water pumpage in the Camas Prairie area is estimated to be less than one fourth of the annual recharge. The relationship of consumptive pumpage to anticipated recharge is an important factor by which ground water basins may be classified.

The severity of ground water impacts is another developmental factor of importance in evaluating management alternatives. The rate of water level decline in the four study areas varies from less than one foot per year in the Camas Prairie area to more than five feet per year in the Mountain Home area. A ground water impact on surface water systems and potential downstream users is indicated only in the Camas Prairie area. A portion of the Raft River Valley is the only area that has been subject to noticeable ground subsidence. None of the areas have undergone water quality problems created because of water level decline. The Idaho code also includes a restriction that ground water pumping levels should not be lowered below that which is deemed reasonable. Ground water levels presently range from above land surface in the Camas Prairie to more than 400 feet in the Mountain Home area. Ground water management plans can and should be based upon a classification of basins with respect to depth to water and the rate of water level decline.

A third major development factor relates to the potential growth of ground water use within the basin. The two primary users in the Moscow Basin, the City of Moscow and the University of Idaho, probably will have a slow but steady increase in water use for the remainder of the decade. It is improbable that significant new users will enter into the basin because of lack of incentive for large scale irrigation and a limited potential for water use oriented industry. Conversely, approved permits and applications for permits would allow a four-fold increase in pumpage in the Mountain Home area. The potential for increased ground water pumpage in the Raft River Basin and the Camas Prairie range between the extremes formed by the Moscow Basin and Mountain Home area.

Legal Guidelines

The legal guidelines for ground water management have been researched extensively by Grant (1975, 1980). Two grounds exist for shutting down an existing well: 1) when withdrawals from an aquifer exceed the "reasonably anticipated average rate of future natural recharge" and 2) when a junior well affects a senior well (Idaho Code, sec. 237a(g)) (Grant, 1975, p. 20). Each of these constraints are important with respect to ground water management.

The Idaho court held in a recent case (Baker v. Ore-Idaho Foods, Inc.) that the first of the above noted constraints forbids mining of an aquifer (Grant, 1975). The court defined mining as perenially withdrawing ground water at rates beyond the recharge rate. However, Grant noted that considerable uncertainty exists with respect to quantification of the recharge limitation as defined in the Idaho Code. Questions center on the meaning of <u>average</u>, <u>future</u> and <u>natural</u>.

Grant (1975, p. 28) divided possible adverse consequences to others from the operation of a well into five classes: 1) interference with other wells, 2) interference with surface water rights, 3) compaction and land subsidence, 4) water quality impairment and 5) depletion of storage to the detriment of future generations. The first four of these consequences can occur even without mining of ground water as defined by the Idaho court. All of these can occur with ground water mining.

The 1980 paper by Grant deals with reasonable ground water pumping levels, an additional management tool noted in the Idaho code. Ground water pumpage must necessarily be accompanied by a lowering of ground water levels. This legal constraint pertains to the extent to which a senior ground water user will be protected against excessive water level declines. Grant noted that this management tool is also subject to considerable uncertainty. The primary question pertains to the definition of what is reasonable.

Discussion

Ground water basins may be classified utilizing selected management factors from those discussed in the previous sections as a first step in the formulation of a state-wide management program. A classification system is proposed in this section based upon the legal guidelines and the hydrologic and development factors.

The first factor in the classification system is the ratio of annual ground water pumpage to annual recharge to the aquifer system. This factor provides an indication of whether a basin presently violates the no-mining guideline in the Idaho code.

The second factor is the ratio of the maximum static depth to water in the basin to the maximum annual rate of water level decline. This factor provides an indication of the "reasonableness" of ground water levels and the severity of water level declines caused by development.

The third factor is the ratio of potential pumpage to present pumpage. This factor provides a measure of the need for management action in a basin.

The fourth factor is a rating of the present and anticipated adverse consequences from ground water development. Three types of adverse consequences are considered: interference with prior surface water rights, compaction and land subsidence and water quality impairment.

Initial classification of the four study basins is presented in Table 2 as an example. Much of the data needed for accurate classification of these basins are missing. However, a review of the four factors

Table 2. Initial classification of study basins using selected management factors

Basins	FACTOR I Ratio of Annual Pumpage to Annual Recharge	FACTOR II Ratio of Maximum Static Depth to Water to Maximum Annual Rate of Water Level Decline	FACTOR III Ratio of Potential Pumpage to Present Pumpage	FACTOR IV Rating of Severity of Potential Adverse Consequences: Interference with Prior Ground Water Rights	Compaction and Land Subsidence	Water Quality Impairment
Moscow Basin	3,700 ac ft/yr / very small	@300 ft / 4 ft/yr	3,700 ac ft/yr / @5,000 ac ft/yr	none	none	none
Mountain Home	40,000 ac ft/yr / 31,000 ac ft/yr	@400 ft / 5 ft/yr	40,000 ac ft/yr / @90,000 ac ft/yr	none	none	none
Camas Prairie	9,500 ac ft/yr / 37,000 ac ft/yr	@200 ft / 1 ft/yr	9,500 ac ft/yr / @30,000 ac ft/yr	medium	low	none
Raft River Valley	230,000 ac ft/yr / 130,000 ac ft/yr	@400 ft / 4 ft/yr	230,000 ac ft/yr / 230,000 ac ft/yr	low	low	low

allows identification of the basin problems. Moscow Basin, for example, has primarily a problem of ground water mining with few other adverse consequences. The Camas Prairie has potential adverse consequences without mining as defined in the Idaho code.

CONCLUSIONS

Four basins were selected as representative of the various aspects of ground water development problems in Idaho: Moscow Basin, Mountain Home area, Camas Prairie and Raft River Valley. Ground water levels are declining in all of the basins at rates ranging from one to five feet per year. Pumpage exceeds estimates of recharge in three of the four basins. Two of the basins have been declared as management areas.

Management factors have been divided into three groups: hydrologic, development and legal guidelines. Hydrologic factors of importance to management are the water level response of a basin to pumpage and the effects that water level declines have on recharge and discharge amounts. The development factors are the pumpage rate in relation to recharge, the depth to water and annual rate of decline and the potential for increased pumpage. The important legal guidelines are limits on adverse impacts on other users, a no-mining limit on pumpage and a limit on reasonable pumping lifts.

A basin classification system has been presented as a first step in a state-wide management program. The classification system includes four factors reflecting management factors.

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16. Abstract

Many if not most of Idaho's ground water basins may be presently pumped at rates that exceed natural recharge. The general objective of this project is to provide a preliminary assessment of alternative management schemes for problems of overdraft of ground water basins.

Four study basins were selected to represent the range of ground water development problems and the various stages of present resource management. Ground water development in the Moscow Basin has resulted in a steady rate of water level decline in what is likely a "mining" situation. Local areas of water level decline have resulted from recent development of ground water in the Mountain Home area. A portion of this area is presently declared critical under present statutes. Water levels are slowly declining in the Camas Prairie area as a result of changing from dry land to irrigated agriculture. The Raft River Basin was declared critical in 1963.

Management factors have been divided into three groups: hydrologic, development and legal guidelines.

A basin classification system has been presented as a first step in a statewide management program. The classification system includes four factors reflecting management factors.

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