Chapter 2: The Existing Environment

2.0 Land Use: Irrigated Lands and Irrigation Practices

Irrigation is the largest use of water in the Smith River basin. DNRC analyzed aerial photographs from the late 1990s and found that about 36,000 acres of land is irrigated in the upper basin for alfalfa hay, grass hay, grain, and irrigated pasture. About two-thirds of this land is irrigated by flood irrigation and the remaining one-third is irrigated using sprinkler systems. In the lower basin below the Smith River Canyon, about 2,000 acres are irrigated.

Irrigation practices vary from water user to water user throughout the Smith River basin. Although there is some variance, a general pattern of irrigation practices does exist. The typical forage crops consist of grass hay and alfalfa while certain grain crops are sometimes harvested as forage crops. Small grains are usually grown on a rotational basis with alfalfa. Grains are cropped for 1 to 3 years and then alfalfa is grown for 6 to 10 or more years. The length of time alfalfa is grown depends on the alfalfa plant population or stand, which in turn is greatly impacted by the type of irrigation among other factors such as soil type. Flood irrigation tends to lessen the length of time a stand of alfalfa is viable.

Flood irrigation may begin as early as March in order to take advantage of low elevation snowmelt. This practice is typically limited to those areas where climatic conditions allow for the practice and where water availability is limited later in the irrigation season. Grass hay is cut or harvested once per year and alfalfa is typically cut twice per year. Flood irrigation of grass hay and alfalfa generally occurs once for each cutting of crop while flood irrigation of grain occurs typically only once. Flood irrigation also sometimes occurs in the fall at the end of the growing season when water is available and soil moisture conditions warrant it. The soil holds the moisture until needed by the crop early in the next growing season.

Sprinkler irrigation typically begins in late April or early May and not earlier because of the potential for damage to the sprinkler system from freezing. Sprinkler irrigation continues throughout the growing season as the crop demands water. The application of water is fairly continuous when compared to flood irrigation where larger volumes of water are applied during limited periods of time. Sprinkler irrigation sometimes continues into the fall for the same reason as fall flood irrigation.

Water stored in North Fork Smith Reservoir, Newland Creek Reservoir and several smaller reservoirs supplements irrigation later in the summer and fall when stream flow is not adequate. During times of drought these reservoirs often supply water earlier in the irrigation season.

The irrigation season in the more mountainous or foothills areas of the upper Smith River basin is shorter both in the spring and fall. Both climatic conditions and water availability further limit the irrigation season. Water becomes available later due to the dependence on higher elevation snowmelt that does not occur typically until mid to late May.

Producing forage crops such as alfalfa is the primary focus of irrigation in the upper Smith River basin. Comparing countywide production statistics with predicted yields indicates that alfalfa production does not reach the maximum potential production. This is likely due to a number of reasons. Much of the area is flood irrigated. Many of the soils in the area have a limited ability to hold sufficient water to meet the crop demand with only one irrigation per cutting. The crop runs out of water before it is harvested. Also, water availability is limited. Streamflows may not be sufficient to provide the water necessary for irrigation. This is particularly true of flood irrigation where larger diversion rates are needed to successfully operate the irrigation system.

2.1 Geology and Ground-Water Resources

Development of Intermountain Basins in Southwestern Montana

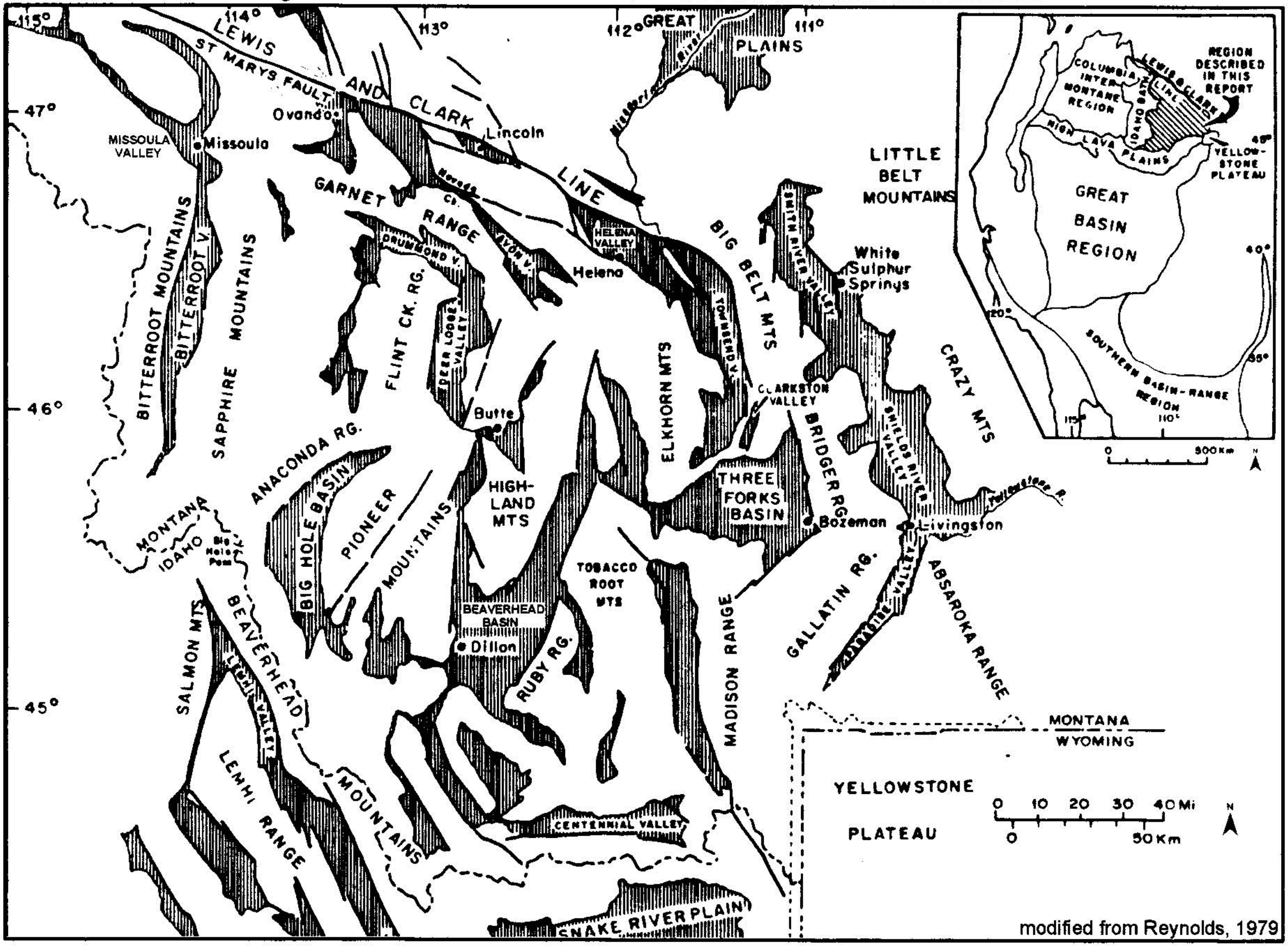
Intermountain basins of southwestern Montana (Figure 2.1-1), that include the Smith River Valley, share many geological similarities. These include extensional block faulting, seismic activity, volcanism, high heat flow and hydrothermal circulation, vertebrate fossil assemblages that serve to correlate strata among basins, and thousands of feet of continental sediments distinguished by four principal regionally-similar stratigraphic subdivisions (Fields and others, 1985; Thompson and others, 1982). The Tertiary-age (65-2 million years before present (mybp)) continental sediments include an early-Tertiary conglomerate and the mid-Tertiary Bozeman Group that includes two distinctive stratigraphic units (i.e. the Renova and Sixmile Creek formations). Quaternary-age (2-0 mybp) deposits include lakebed silt, glacial outwash and till, and alluvial gravel and sand.

The Bozeman Group strata represent a considerable thickness of Tertiary-age deposits in many of the intermountain basins. Deposition of the Renova Formation began about 50 mybp as erosional debris and air-borne volcanic ash from volcanic fields accumulated on an erosional topography. Basin subsidence and voluminous sedimentation disrupted through-flowing drainage basins to such an extent that thick lakebed, riverine, and wetland deposits accumulated virtually unbroken over southwestern Montana, which was then a region of broad, continuous basins with low topographic relief (Thompson and others, 1981). The Renova Formation is characterized in all basins of southwestern Montana by abundant volcaniclastics and air-fall ash, repeating lakebed claystone and tuffaceous siltstone, fine sandstone, local conglomerate, and wetland deposits (Fields and others, 1985). However, the distinguishing lithologic feature of the Renova Formation is its fine-grained nature (Kuenzi and Fields, 1971). Renova strata are the oldest widespread Tertiary-age rocks of southwestern Montana.

By about 20 mybp, renewed faulting and regional uplift, and a rapid climatic reversal to a wetter climate (Thompson and others, 1982) caused erosion of Renova sediments, pediment formation across tilted Renova rocks, and formation of a red tropical soil in southwestern Montana basins. A major angular unconformity across southwestern Montana marks this erosional event (Fields and others, 1985; Rasmussen, 1973).

Basin-and-range extensional tectonics began to significantly affect southwestern Montana beginning about 17 mybp. Regional uplift structurally delineated modern intermountain basins and imparted to southwestern Montana many of its geologic features, such as parallel mountain ranges bordered by steep range-front faults. Evidence for regional uplift and faulting across southwestern Montana includes mountain summits capped by "high-level gravels", tilting and faulting of Renova rocks, presence of a mid-Tertiary unconformity, and extensive pedimentation. Another climatic reversal to very arid conditions (Thompson and others, 1982) accompanied the regional uplift and contributed to another cycle of continental sedimentation known as the Sixmile Creek Formation. The distinguishing lithologic feature of the Sixmile Creek Formation is the coarseness of the sediments. Coarse clastic sediments were deposited as mud and debris flows and channel fills on alluvial fans (Fields and others, 1985). Lithologic and stratigraphic features, such as exclusive smectite clay mineralogy that forms only in arid environments, evaporites and carbonates that indicate playa deposition, and sedimentary structures that suggest transport over a desert-plain surface, infer a desert-like environment (Thompson and others, 1981). Reworked volcanic ash from the Renova Formation and externally-derived volcanic ash from active volcanic fields are also abundant in the sediments. The landscape of southwestern Montana exhibited low topographic relief in which mountains protruded as isolated peaks through the thick alluvial deposits as erosional products accumulated. Sixmile Creek sedimentation ended about 6 mybp as continuing uplift increased precipitation that caused another erosional cycle. The Tertiary Period closed about 2 mybp in which through-flowing streams again eroded hundreds of feet of basin sediments and produced extensive pediment surfaces on older Tertiary rocks.

Figure 2.1-1. Distribution of Intermountain Basins in Southwestern Montana



modified from Reynolds, 1979

Alluvial fans, glacial outwash and till, and floodplain alluvium of modern rivers constitute the principal coarse materials that have accumulated in the intermountain basins since the end of the Tertiary Period. Erosion continues today as streams remove remnant Tertiary deposits throughout southwestern Montana.

Tertiary- and Quaternary-Age Geology of the Smith River Valley

The Smith River Valley, which lies on the northeastern limit of the Montana basin-and-range region, exhibits geologic features consistent with other intermountain basins in Montana. Runkel (1986) conducted an investigation of Tertiary-age depositional systems, geologic structures, and fault movements in the northern Smith River basin. Runkel (1986) concluded that *"Tertiary basin-fill strata occur in the northern Smith River basin as a northeast-striking, southeast-dipping package. Maximum basin-fill thickness, based upon geophysical data, is 600 feet near Rabbit Creek and increases to 1500 feet near White Sulphur Springs"*. Reynolds (1979) also recognized the basin-range type of faulting that bounds the Smith River Valley near White Sulphur Springs and noted that these faults are coincident with the eastern-most occurrence of Tertiary strata in southwestern Montana.

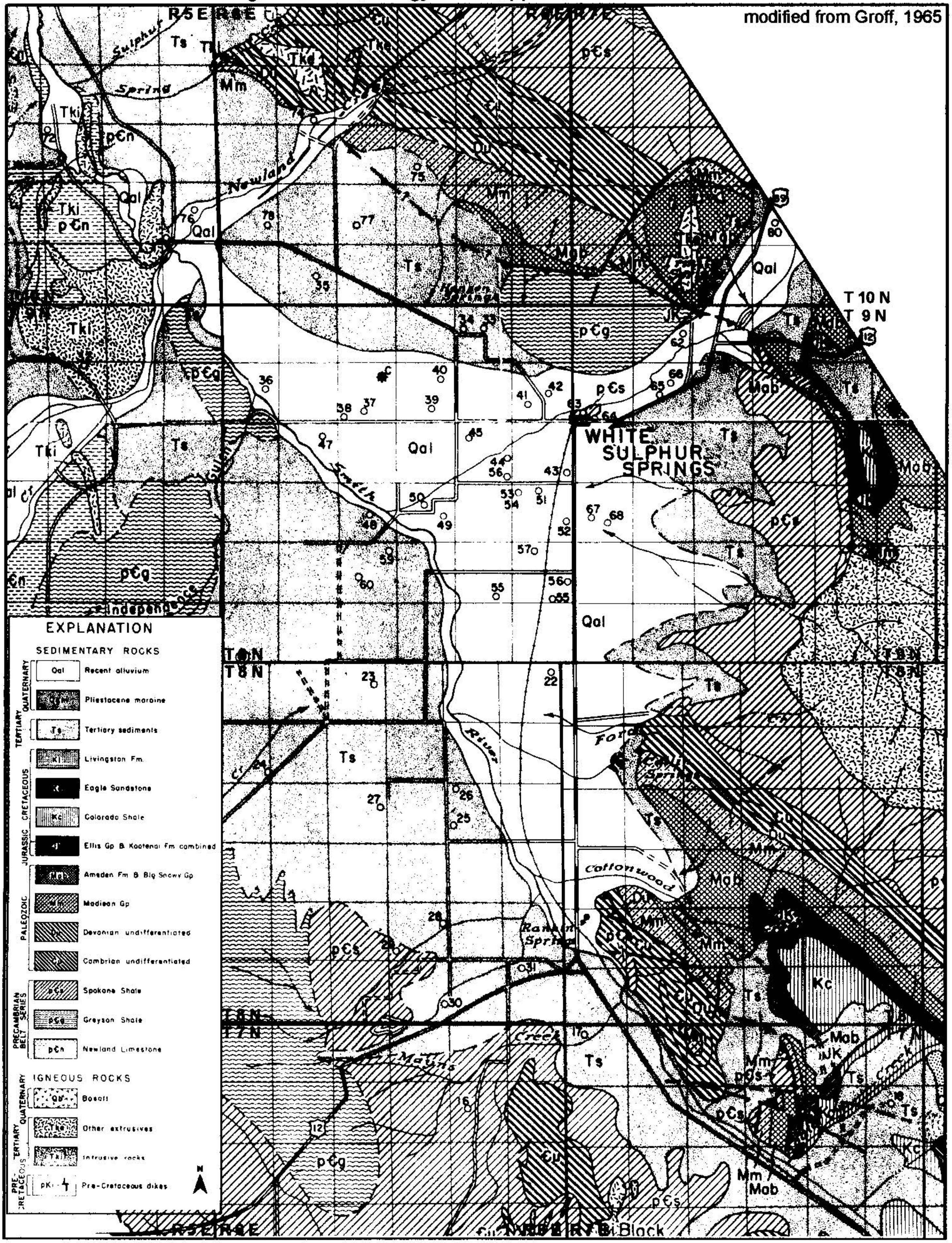
The magnitude of faulting can be demonstrated by elevational differences between remnant Tertiary strata that occur along the crests of mountain ranges and similar strata in adjoining basins. For example, Tertiary-age sediments occur in the Smith River basin at an elevation of about 5,000 feet and in the Helena/Townsend basin at an elevation of about 3,800 feet. The Smith and Helena/Townsend basins are separated by the Big Belt Mountains. Along the crest of the Big Belt Mountains near the summit of Magpie Gulch Pass at an elevation of about 6,600 feet, near Duck Creek Pass at an elevation of about 6,800 feet, and near Deep Creek Pass at an elevation of about 6,000 feet, east-dipping Tertiary-age strata also occur. These sediments appear identical in lithology with deposits in adjoining basins; therefore, the Tertiary strata on the top of the Big Belt Mountains and those in the Smith and Helena/Townsend basins are interpreted as having been deposited on an extensive, continuous depositional plain (Fields and others, 1985; Thompson and others, 1981; Reynolds, 1979). The elevational differences of Tertiary strata in the adjoining basins and along the crest of the Big Belt Mountains indicate a vertical throw of more than 2,000 feet for the faulting that elevated and tilted the Big Belt Mountains block with respect to the basin floors.

Other basin-and-range geological features, such as high heat flow and geothermal circulation, are expressed as thermal springs emerging in White Sulphur Springs along a normal fault, and geothermal artesian wells that are aligned along the eastern boundary of the basin-range faulting (Reynolds, 1979).

Distribution of lithologic units exposed at the land surface in the upper Smith River basin is illustrated in Figure 2.1-2. Quaternary alluvium (Qal) includes gravel, sand, silt, and clay deposited by running water on the floodplain and alluvial fans. Alluvium covers older rocks near the center of the valley and extends up tributary drainages. Tertiary sediments (Ts) lie topographically above the Quaternary alluvium and abut older bedrock in upland areas. Tertiary and Quaternary igneous rocks outcrop at various locations throughout the basin. Of particular interest is the Tertiary igneous sill (Tki) (i.e. horizontal igneous body intruding surrounding rock), located about 7 miles west of White Sulphur Springs, through which the Smith River is eroding. Older bedrock of various ages occurs as surface exposures at higher elevations in the basin.

The shallow subsurface geology of the upper Smith River valley may be described from water well drilling logs from the Montana Bureau of Mines and Geology Ground-Water Information Center (GWIC) database for various township-and-range areas. The shallow subsurface geology of three broad areas are summarized from the east side of the Big Belt Mountains across the Smith River Valley to the west side of the Castle Mountains.

Figure 2.1-2. Geology of the Upper Smith River Basin



The first area covers the southern Smith River Valley from Township 8 North, Range 5 East through Township 8 North, Range 7 East (see Figure 2.1-2). There are 2 drilling logs with lithologic descriptions for the east slope of the Big Belt Mountains in Township 8 North, Range 5 East. One drilling log describes shale to a depth of 203 feet. There are 18 drilling logs with lithologic descriptions for the southern Smith River Valley in Township 8 North, Range 6 East. Well depths range from 10 to 395 feet. Various-colored clay and shale are the predominant lithologies in these wells. Some drilling logs report gravel seams or stringers of fine sand interbedded with clay. There are 10 drilling logs with lithologic descriptions east of the South Fork Smith River along the west slope of the Castle Mountains in Township 8 North, Range 7 East. Well depths range from 17 to 200 feet. Lithologies include mostly clay with interbedded, loose or cemented gravel seams.

The second area covers the southern Smith River Valley from Township 9 North, Range 5 East through Township 9 North, Range 7 East. There are 6 drilling logs with lithologic descriptions for the east slope of the Big Belt Mountains in Township 9 North, Range 5 East. Well depths range from 49 to 500 feet. Lithologies are described as predominantly clay with interbedded sand and gravel layers overlying shale bedrock. There are 41 drilling logs with lithologic descriptions near the center of the southern Smith River Valley in Township 9 North, Range 6 East. Well depths range from 16 to 250 feet. Lithologies are described as sand and gravel either with interbedded clay layers or overlying thick sequences of clay. Shale is reported at depth for some upland wells. There are 49 drilling logs with lithologic descriptions for the northwest slope of the Castle Mountains in Township 9 North, Range 7 East, that includes the town of White Sulphur Springs and the North Fork Smith River. Well depths range from 15 to 415 feet. Lithologies are described as clay mixed with sand and gravel, interbedded clay and gravel, or mudstone/siltstone overlying either shale or limestone.

The third area covers the middle Smith River Valley from Township 10 North, Range 5 East west of White Sulphur Springs through the Park Hills to Township 10 North, Range 7 East in the North Fork Smith River valley. There are 17 drilling logs with lithologic descriptions for the area west of White Sulphur Springs in Township 10 North, Range 5 East. Well depths range from 10 to 350 feet. Lithologies are described as surficial clayey gravel underlain by clay or shale, and in some instances, the entire sequence is clay. There are 19 drilling logs with lithologic descriptions for the Park Hills area northwest of White Sulphur Springs in Township 10 North, Range 6 East. Well depths range from 20 to 340 feet. Lithologies in several wells are entirely clay or shale, but other lithologies may range from sand and gravel sequences to clay intervals interbedded with cemented gravel seams. There are 11 drilling logs with lithologic descriptions for the Park Hills area northeast of White Sulphur Springs in Township 10 North, Range 7 East. Well depths range from 10 to 396 feet. Lithologies include surficial clayey sand and gravel underlain by clay or shale, and clay interbedded with loose or cemented gravel.

The shallow subsurface geology of the Smith River basin, based on drilling-log lithologic descriptions, is characterized by clay and shale as the dominant lithologic components. These fine-grained materials and the interbedded sequences of clay and coarser sediments represent low-energy riverine and lakebed depositional systems that commonly occurred throughout the Tertiary Period. However, it is impossible to lithologically or stratigraphically correlate individual stratigraphic units on a valley-wide basis due to spatial and temporal variations in sediment deposition, the discontinuous nature of the deposits, the absence of marker beds, and the paucity of drilling logs and stratigraphic exposures in some parts of the basin.

Ground-Water Resources of the Smith River Valley

Aquifers

Ground water occurs in many lithologic units in the Smith River basin; however, aquifers include only those materials that can produce ground water in useable quantities. The most highly-appropriated aquifers in the Smith River basin are the Quaternary alluvium and Tertiary sediments that occur in the valley lowlands, tributary drainages, and adjacent lowland foothills/terraces. Quaternary alluvial aquifers, when comprised of gravel and sand, generally will have high permeability and water-storage coefficients that are capable of producing large well yields where the aquifer is extensive. Tertiary sediments, in contrast, are generally fine-grained with low permeability, and thus can usually provide only small yields suitable for domestic and stock use. Aquifer

properties are poorly known and commonly vary based on thickness and texture of the aquifer materials. Aquifers of secondary importance include igneous rock and shale.

The Quaternary alluvial aquifer consists of gravel, sand, and discontinuous clay layers. The thickness of the Quaternary alluvial aquifer is variable and often there is no clear, distinct boundary between the Quaternary alluvium and the underlying Tertiary-age sediments. Thick sequences of alluvial gravel and sand are limited in extent, and where present, may represent a depositional continuum that transcends geologic-time boundaries. An interpretation of lithologies on drilling logs suggests that a valley-wide, continuous clay layer does not exist within the Quaternary alluvial aquifer. The aquifer functions as a single, hydraulically-interconnected, unconfined system and laterally-discontinuous, localized clay lenses in the alluvial aquifer do not effectively function as barriers to vertical movement of ground water. Localized lenses and wedges of clay or silt may create perched water tables and impede, rather than prevent, ground-water exchange between interconnected water-bearing zones in the alluvial aquifer.

The Tertiary aquifer consists of thin to thick seams and lenses of loose or cemented gravel or sand interbedded with thick sequences of clay. These gravel and sand units are spatially discontinuous, interfinger horizontally and vertically with other sedimentary units, and are impossible to trace or correlate even across short distances. These water-bearing zones respond to pumping as localized, semi-confined aquifers. The thin, interbedded gravel seams and lenses are capable of producing only small yields to domestic and stock wells, and typically cannot sustain high yields to irrigation or municipal wells. Some of the proposed irrigation wells are completed in thicker gravel and sand sequences beneath clay deposits, and will initially show a confined response to pumping.

West and southwest of White Sulphur Springs in Township 9 North, Range 6 East, the thickness of the Quaternary alluvium appears to be variable. In places, a thin veneer of poorly sorted gravel-and-sand deposits may reach a thickness of about 15 feet, and in other places, may range in thickness up to 50 feet. Underlying the Quaternary alluvium is an unknown thickness of Tertiary-age clay interbedded with gravelly materials. Drilling log lithology descriptions suggest that the coarse alluvium may gradually thicken westward where the alluvial thickness may reach about 65 feet in Sections 4 and 9 of Township 9 North, Range 6 East, and in Section 32 of Township 10 North, Range 6 East. The alluvial thickness increases to about 120 feet in places in Section 31 of Township 10 North, Range 6 East. Thick sequences of coarse sand and gravel represent buried stream channel deposits that can produce large well yields. The alluvium thins considerably to the southwest toward the Smith River and overlies clay or siltstone at shallow depths, as suggested by the waterlogged soil and high water table along the Smith River.

East of White Sulphur Springs in the North Fork Smith River valley, the Quaternary alluvium is a thin, discontinuous sheet of poorly-sorted gravel and sand that may range in thickness from about 3 to 7 feet. Clay is reported at the land surface in many places in the valley of the North Fork Smith River. Thick clay deposits, gravelly or sandy clay, and clay interbedded with gravel or sand layers are common in this area. Area wells can produce yields that suffice for domestic and stock uses by extracting ground water from buried layers of gravel and sand. The thin alluvium is insufficient for large well yields.

South of White Sulphur Springs in the South Fork Smith River valley in Township 8 North, Range 6 East, the thickness of the Quaternary alluvium is variable and often discontinuous, with surface exposures of clay in many places. The alluvium thins from southwest of White Sulphur Springs to a thickness of about 12 feet in the southernmost part of the valley where Routes 12 and 89 merge. Clay, the predominant material in the southern Smith River Valley, underlies the thin alluvial cover as either thick, massive beds or interbedded with gravel or sand lenses. In Sections 2, 3, and 10 of Township 8 North, Range 6 East, thick, coarse gravel deposits, interpreted to represent buried stream channels, are found beneath thick clay sequences. Irrigation wells completed in these buried channel deposits can produce over 1,000 gallons per minute (gpm). Permeable buried stream-channel deposits are interpreted to occur along the southwest side of the valley lowlands that may produce high yields of ground water if large wells could consistently be completed in these deposits. However, the actual distribution of these buried channels is unknown and prediction of their locations is problematic.

The potential for future ground-water development for high-yield wells in the upper Smith River basin will be limited by the extent of thick gravel deposits in both the Quaternary and Tertiary aquifers.

Well Yields

Most of the ground water consumed for domestic and stock uses is produced at yields ranging from less than 5 gpm to about 50 gpm. There also are 14 ground-water diversions listed in the GWIC database for irrigation and municipal uses that have well yields greater than 250 gpm. Three irrigation diversions, all greater than 1,000 gpm, are located in Township 8 North, Range 6 East west of the South Fork Smith River. A 650-gpm irrigation diversion is located in Township 8 North, Range 7 East south of the South Fork Smith River. Six large irrigation diversions, ranging from 275 to 1,850 gpm, are located in Township 9 North, Range 6 East east of the South Fork Smith River. The town of White Sulphur Springs has a 1,000-gpm municipal diversion in Township 9 North, Range 7 East. Last, three large irrigation diversions, ranging from 570 to 670 gpm, are located in Township 10 North, Range 6 East north of the main stem of the Smith River.

Ground-Water Levels

Ground-water levels were monitored in selected wells (Figure 2.1-3) in the Smith River Valley during 2000 and 2001. Latitude, longitude, and elevation above mean sea level of these wells were measured with global positioning system (GPS) instrumentation. Representative ground-water hydrographs (Figure 2-1.4) illustrate that ground-water levels fluctuated about 3 feet in lowland wells along the Smith River and its tributaries in response to stream stage, recharge from seasonal precipitation, ditch seepage and, in some cases, irrigation return flow. Ground-water hydrographs for upland wells, such as the White Sulphur Springs airport and those on the southwest valley terraces, show water-level declines in response to redistribution of aquifer storage and low recharge. Ground-water hydrographs for mid-elevation wells, such as those located southwest and northwest of White Sulphur Springs, show seasonal fluctuations of ground-water levels due to recharge from ditch seepage and irrigation return flow.

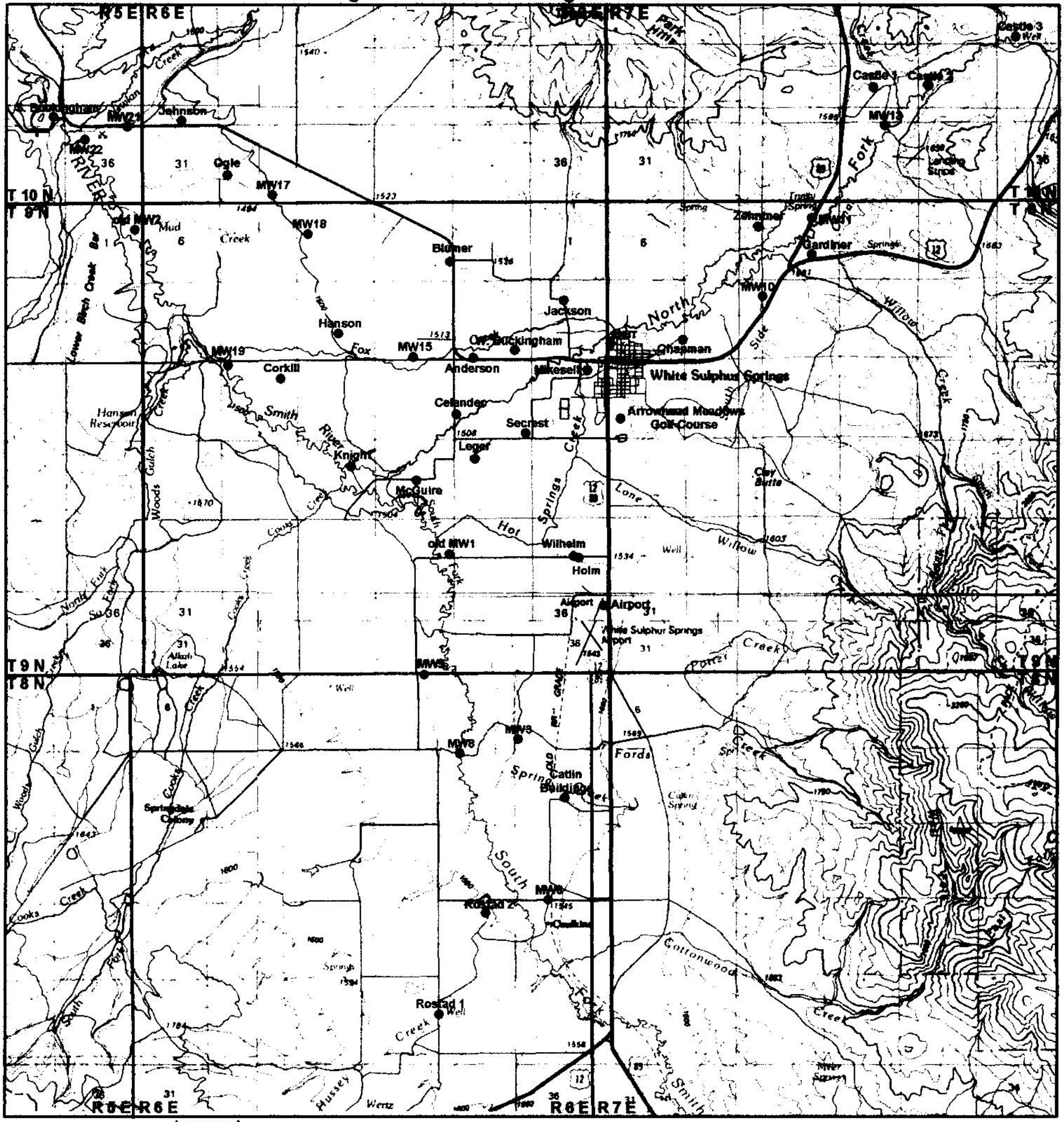
Ground-water levels in the Smith River Valley are relatively shallow because the alluvial aquifer is relatively thin and the Tertiary-age clay underlying the alluvial aquifer impedes downward percolation of ground water. Furthermore, the igneous sill in sections 26 and 35 of Township10 North, Range 5 East, in which the Smith River is eroding a bedrock channel, functions as a bedrock barrier to ground water flowing downvalley. The alluvial aquifer abuts the low-permeability sill, which not only prevents the continuing through-flow of ground water, but impounds it, thus causing ground-water levels to be high throughout much of the upper Smith River valley. Ground water must enter the Smith River as baseflow upriver of the sill as it continues downvalley as surface flow.

Ground-Water Movement and Flow Direction

The Smith River basin, like other intermountain basins of southwestern Montana, is surrounded by mountains that limit ground-water interactions to the basin. Most of the ground-water recharge to the basin originates locally as snowmelt and rainfall that occurs within the basin.

Ground-water flow begins in upland recharge areas and moves downward toward lowland discharge areas. In an unconfined aquifer, gravity is the primary driving force of ground-water movement and the direction of movement can be inferred from the land-surface topography. Because water-table elevations decrease in the downslope direction, ground-water flow converges on lowland areas from all parts of the basin. Basin symmetry creates vertical hydrologic boundaries beneath the valley lowlands across which ground-water flow cannot occur. As a result, ground water discharges at the land surface as springs and wetlands, through perennial stream channels and into lakes or ponds, and as recharge to adjoining floodplain aquifers. The water table in lowland discharge areas lies at or close to the land surface.

Figure 2.1-3. Monitoring Well Locations



Legend

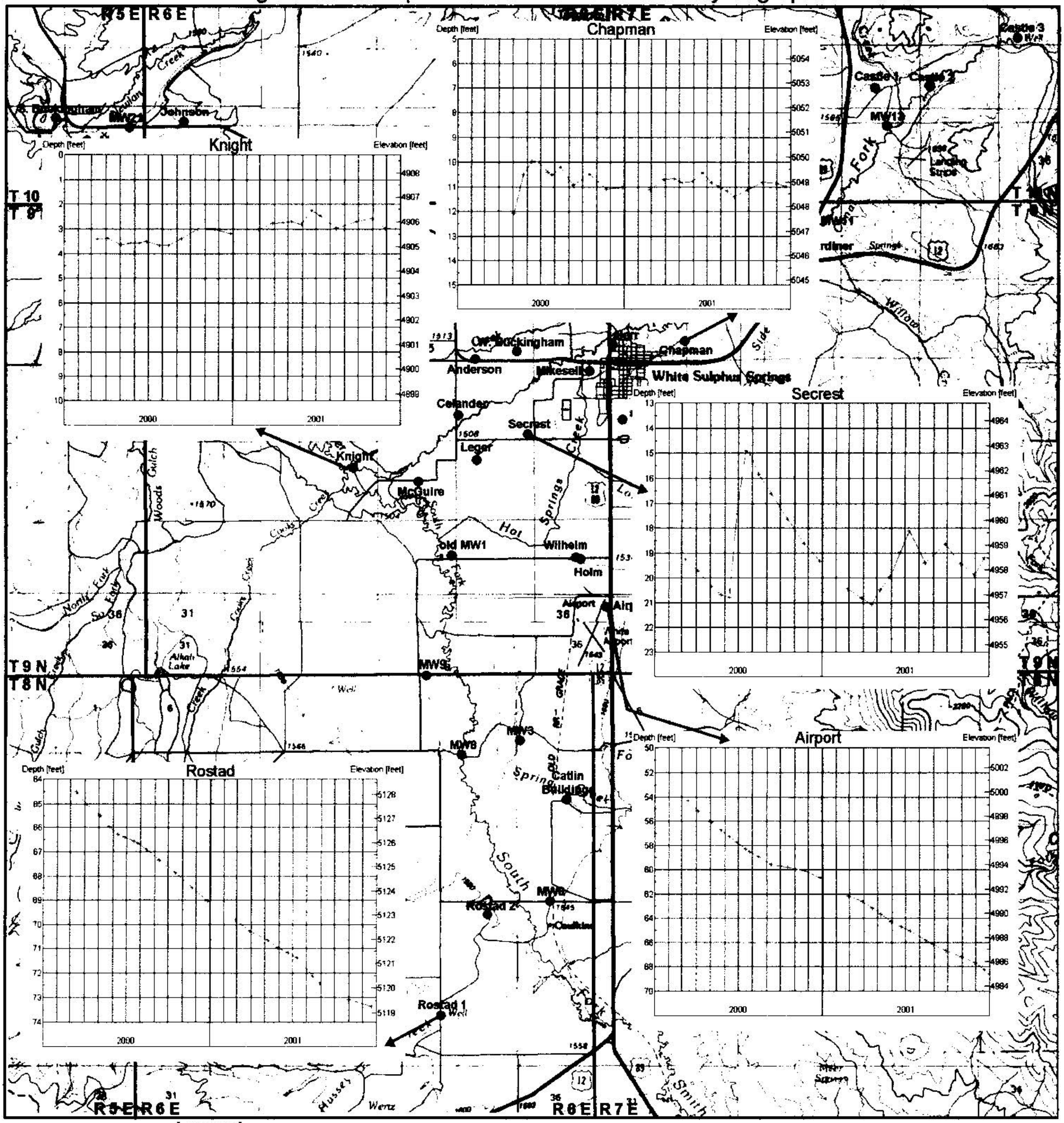
U.S. Geological Survey White Sulphur Springs
1:100,000 scale map; 50-meter contour interval

● monitoring well

scale: kilometer 0 1 2

scale: mile 0 1 2

Figure 2.1-4. Representative Ground-Water Hydrographs



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U.S. Geological Survey White Sulphur Springs
1:100,000 scale map; 50-meter contour interval

scale: kilometer 0 1 2

scale: mile 0 1 2

monitoring well

Ground-water levels were measured in domestic, stock, and monitoring wells and were plotted as water-table contour maps for May of 2000 and 2001, and for June of 2000 and 2001. Ground-water levels observed during late spring and early summer are representative of the times of year when the water table is commonly at its lowest and highest levels, respectively. Water-table contour maps for the Smith River Valley near White Sulphur Springs were plotted as Figures 2.1-5 through 2.1-8 on the U.S. Geological Survey White Sulphur Springs 1:100,000-scale topographic basemap. Because the unit of length on 1:100,000-scale topographic maps is the meter, the water-table contours are reported in meters.

The water-table contour maps are similar in appearance because the annual fluctuations of the water-table elevations in lowland areas were small. Based on the fact that the ground-water-flow direction is perpendicular in a downslope direction to the water-table contours, the water-table contour maps indicate that ground water flows down the South Fork Smith River valley in a northwesterly direction, down the North Fork Smith River valley in a southwesterly direction, and down the mainstem valley of the Smith River west of the confluence of the North and South forks in a general west-southwest direction. Streams that traverse lowland discharge areas are commonly effluent in nature (i.e. gains water from the subsurface). Given the absence of a continuous, valley-wide confining clay-layer barrier in the alluvial aquifer and the fact that ground-water elevations lie above the stage of the upper Smith River, ground water and surface water constitute a single hydrologic system and ground-water flow converges on and discharges to the upper Smith River or adjoining wetlands, thus characterizing the upper Smith River as an effluent or gaining stream.

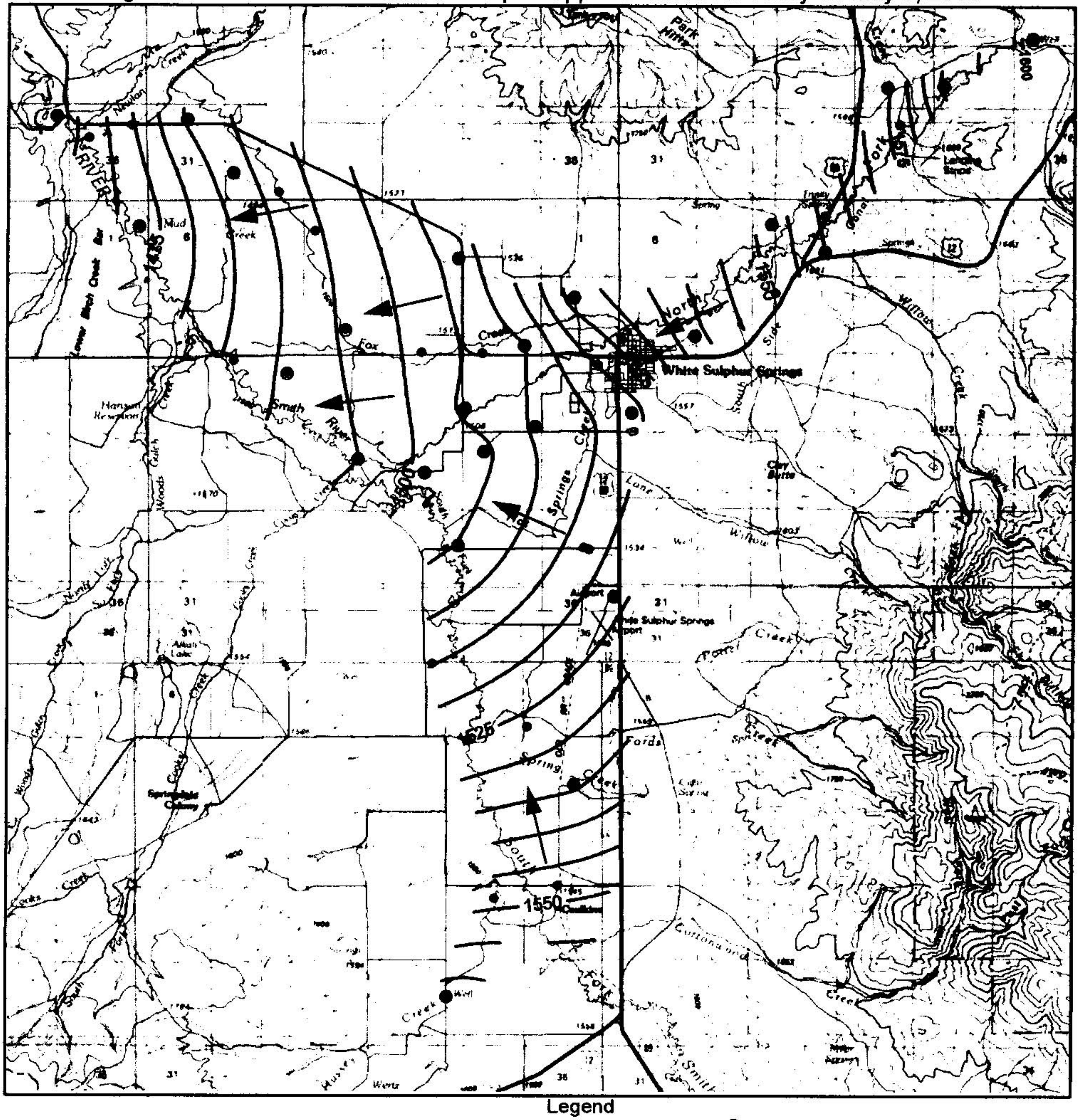
Mass Water Balance

Hydrogeologic principles are governed by the immutable laws of physics. In particular, the Law of Mass Conservation states that any change in mass of water recharging an aquifer must be balanced by a corresponding change in mass of water discharging from an aquifer, or by a change in the mass of water stored in the aquifer. A new ground-water appropriation represents water that is obtained from the basin's existing supply of water rather than "new" water created when a well is completed. The basin's water supply is replenished by recharge from precipitation and snowmelt, seepage from losing streams in the uplands, and ground-water underflow from tributary basins and surrounding bedrock. Ground water discharges from the basin as subsurface underflow, seepage to gaining streams and springs, evapotranspiration, and well discharge.

The mass water balance of the basin is in a state of dynamic equilibrium where the long-term average recharge equals the long-term average discharge. When some amount of the basin's ground-water supply is diverted for a consumptive use, such as irrigation, changes within the hydrologic system (Figure 2.1-9) occur to offset the new consumptive use (i.e. loss) of water from the system. The initial change is a diminishment of the volume of water in aquifer storage caused by ground-water level decline. Further hydrologic changes within the system include a decrease in ground-water discharge as the cone of depression from a pumping well captures ground water that would have discharged to surface water or been transpired by plants. Last, if a new consumptive diversion of water is still not balanced by capture of ground-water discharge or reduced evapotranspiration, aquifer recharge can occur as direct streamflow capture (i.e. induced streambed infiltration) by the cone of depression, thus further diminishing the availability of surface water.

The precise rate and timing of impacts to surface-water availability from new ground-water development in the Smith River basin are not known. However, new ground-water development will create additional or cumulative impacts to availability of the basin water supply.

Figure 2.1-5. Water-Table Contour Map of Upper Smith River Valley on May 3, 2000



Legend

U.S. Geological Survey White Sulphur Springs 1:100,000 scale map; 50-meter contour interval

scale: kilometer 0 1 2

scale: mile 0 1 2

N

groundwater flow direction

monitoring well

monitoring well data used in water-table contour map

1500 water-table contour in meters above mean sea level; 5-meter contour interval

Figure 2.1-6. Water-Table Contour Map of Upper Smith River Valley on June 28, 2000

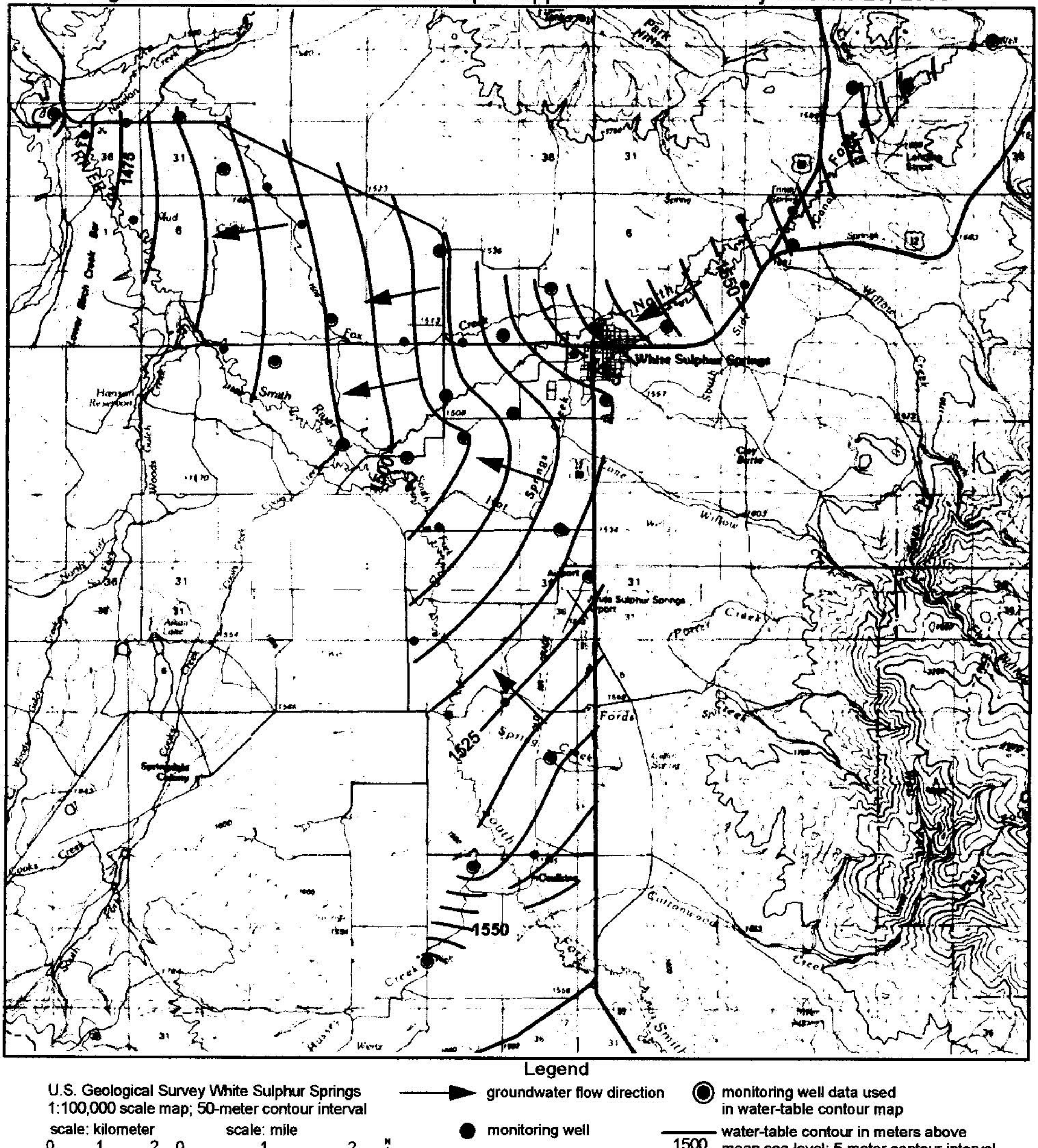
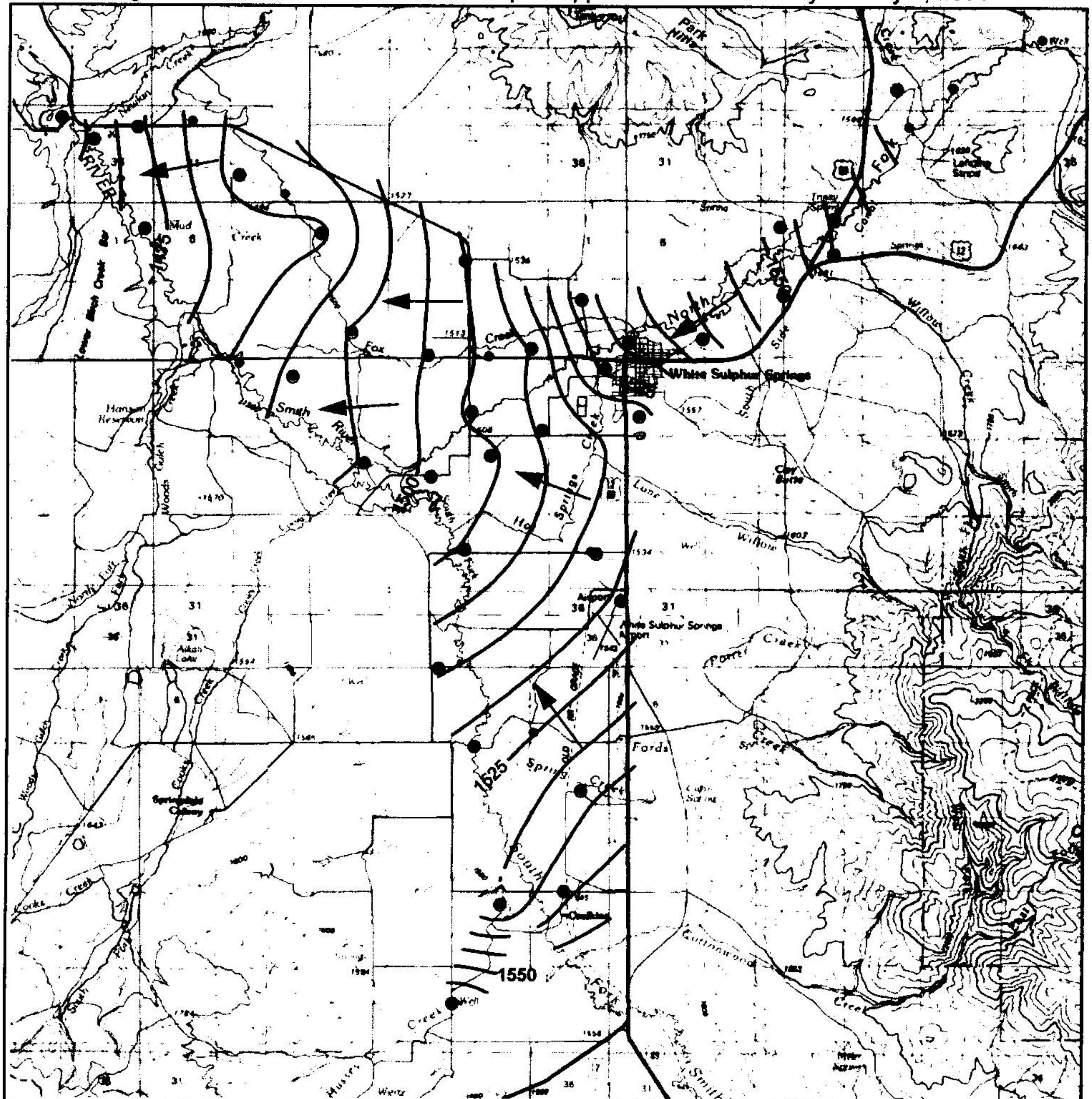


Figure 2.1-7. Water-Table Contour Map of Upper Smith River Valley on May 8, 2001



U.S. Geological Survey White Sulphur Springs 1:100,000 scale map; 50-meter contour interval

scale: kilometer 0 1 2

scale: mile 0 1 2

N

groundwater flow direction

monitoring well

monitoring well data used in water-table contour map

1500 water-table contour in meters above mean sea level; 5-meter contour interval

Figure 2.1-8. Water-Table Contour Map of Upper Smith River Valley on June 20, 2001

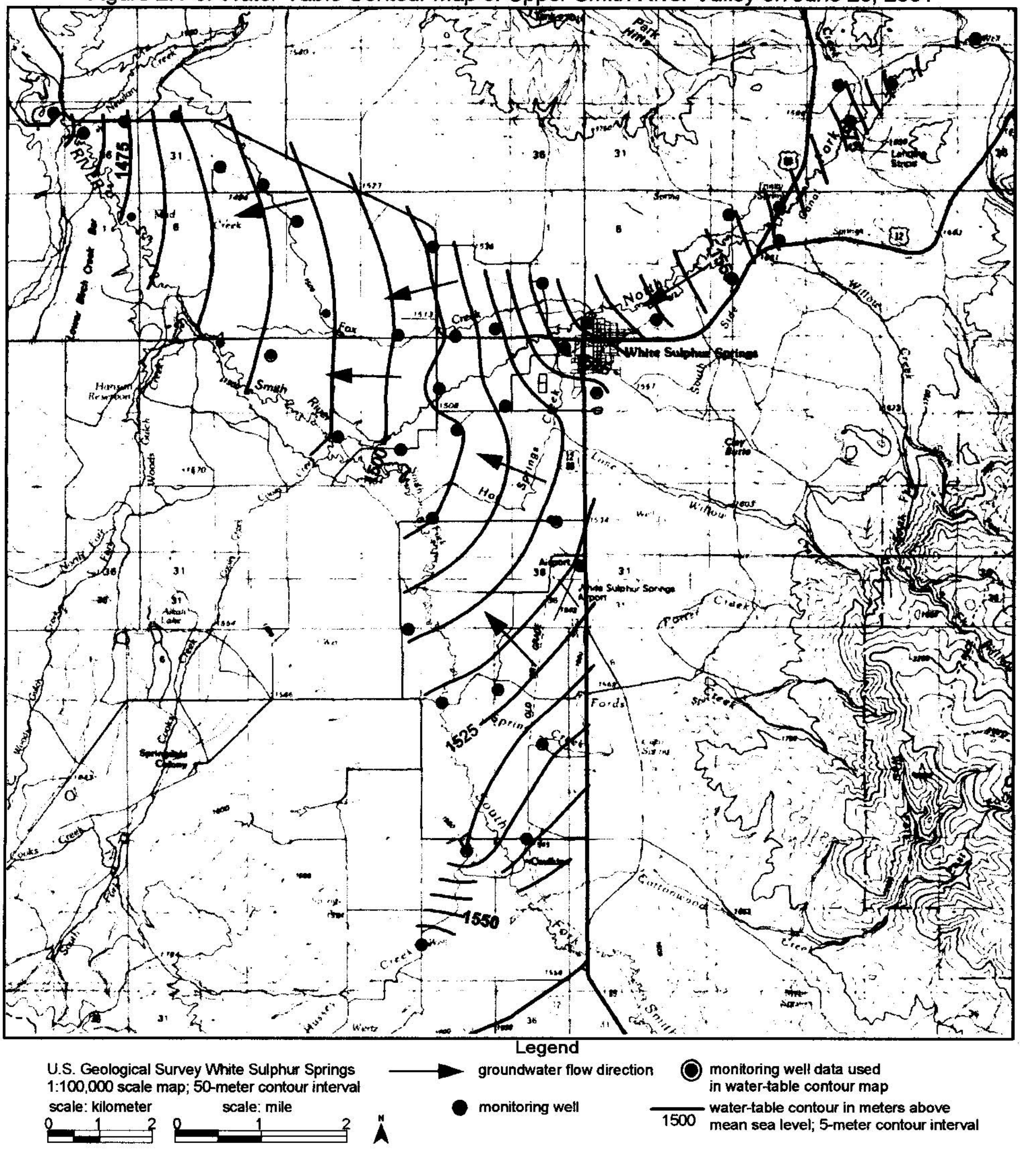
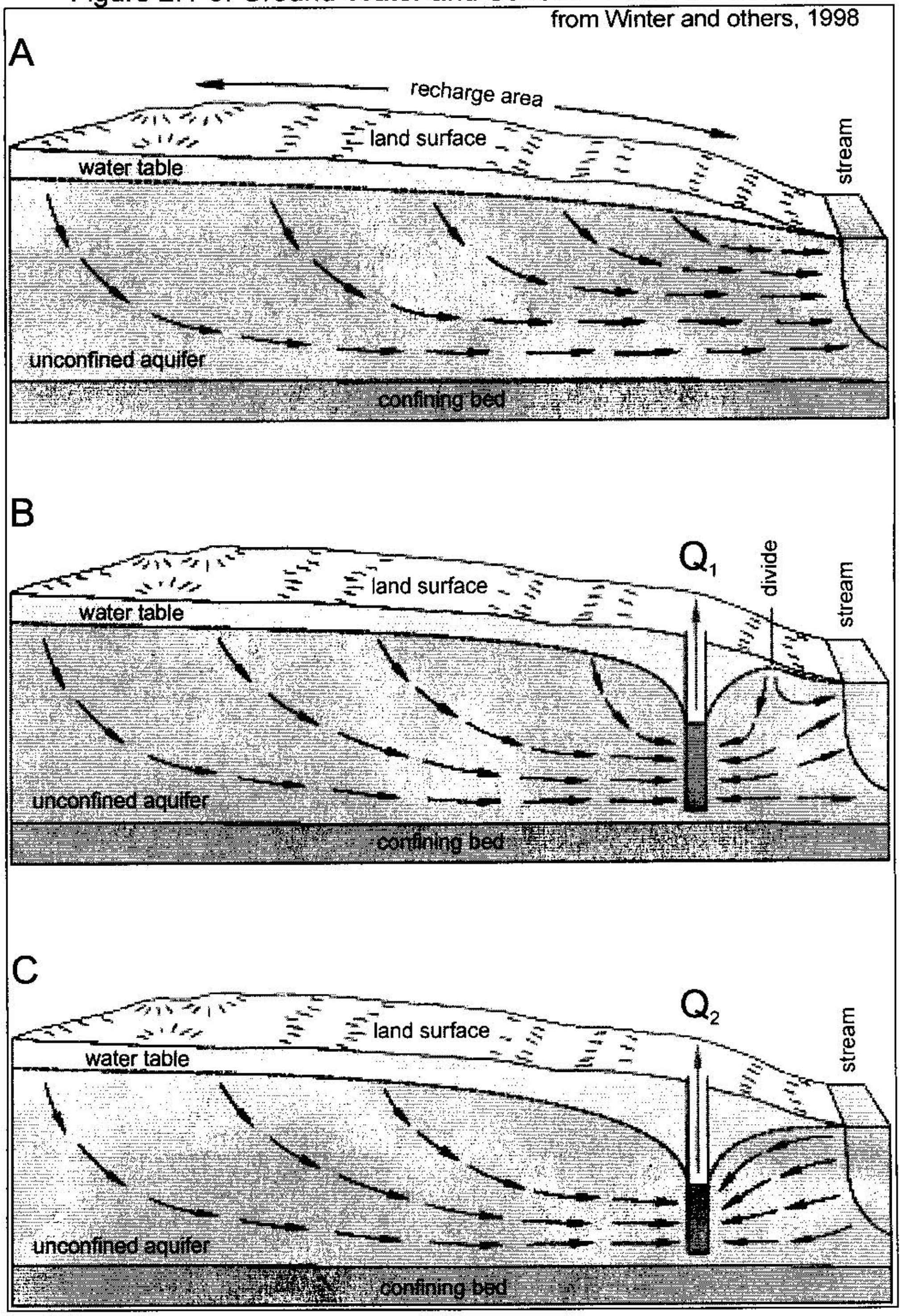


Figure 2.1-9. Ground-Water and Surface-Water Interactions



In a hydrologic setting where ground water discharges to a stream under natural condition (A), placement of a well pumping rate (Q1) near the stream will intercept part of the ground water that would have discharged to the stream (B). If the well is pumped at an even greater rate (Q2), it can intercept additional water that would have discharged to the stream in the vicinity of the well and can draw water from the stream to the well (C).

2.2 Surface-Water Resources

Streamflows in the Smith River basin originate from precipitation of rain or snow. Precipitation, which is strongly influenced by elevation, varies from about 14 inches per year in the lower portions of the valley to over 30 inches in the higher mountains. The mountains contribute a high proportion to the total basin water supply because the cooler mountains receive more precipitation, and accumulate more snow and retain it later in the season. Irrigation, ground-water storage and recharge, and water storage in reservoirs also affect the amount and timing of streamflows in the basin.

Stream gages have been operated by the U.S. Geological Survey (USGS) on the upper Smith River near Fort Logan (above the mouth of Sheep Creek) from 1977 to 1996, and just downstream below Sheep and Eagle Creeks from 1996 to present. A stream gage also has been operated on upper Sheep Creek from 1941 through present by the USGS and U.S. Department of Agriculture, Natural Resources Conservation Service (NRCS). Based on these flows records, trends in irrigated acres and system types, and other flow measurements, DNRC has estimated streamflows for the Smith River both above and below the mouth of Sheep Creek. These estimated monthly flows for different types of years are presented in Tables 2.2-1 and 2.2-2. Average monthly flows for these sites are plotted in Figure 2.2-1.

Table 2.2-1. Estimated average monthly flow rates for the Smith River above Sheep Creek in cubic feet per second (cfs).

Type of Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Very Wet	142	186	245	320	444	632	357	123	141	148	133	126
Wet	108	125	191	265	351	446	277	97	121	131	112	109
Middle	81	98	132	159	220	261	110	63	75	103	97	81
Dry	67	76	97	123	80	101	41	38	53	66	65	55
Very Dry	50	54	90	108	63	62	29	20	38	59	46	41

Note: based on 1978 through 2001 streamflow data

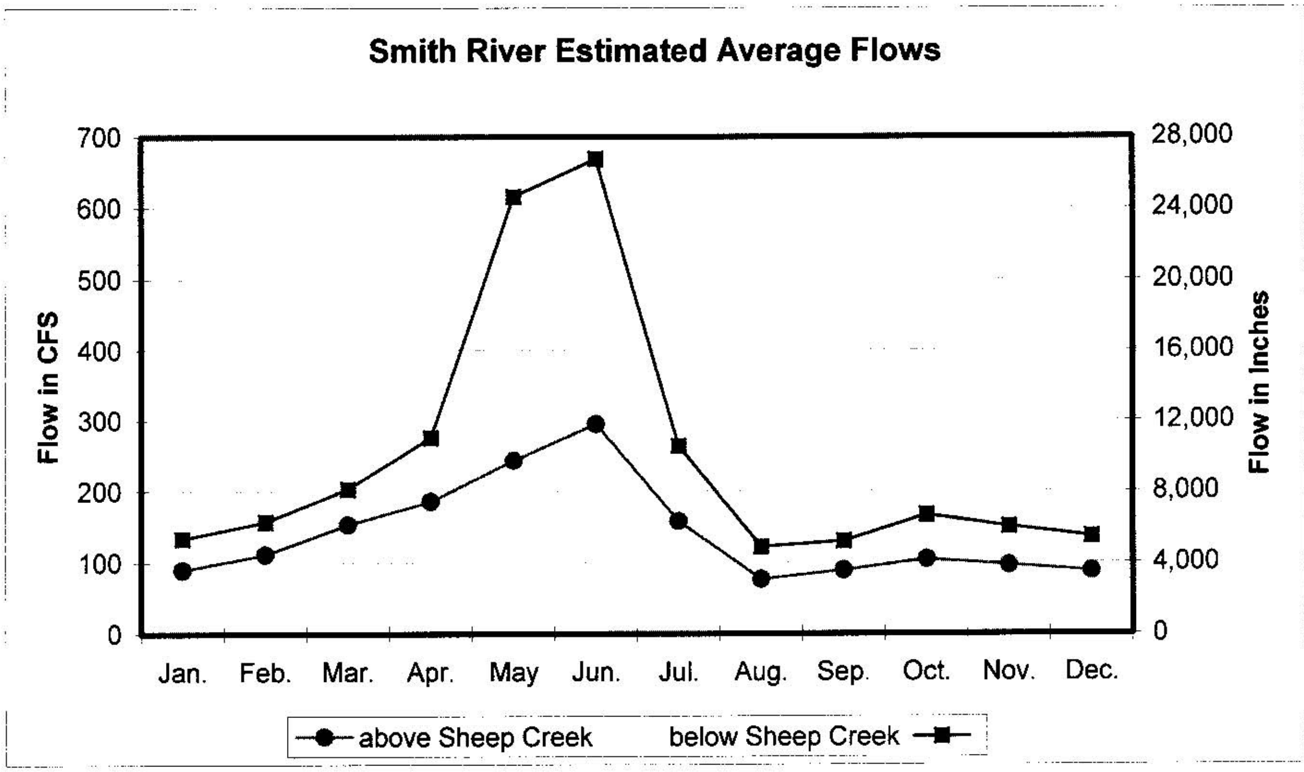
Table 2.2-2. Estimated average monthly flow rates for the Smith River below Sheep Creek in cubic feet per second (cfs).

Type of Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Very Wet	208	234	298	457	1,113	1,296	596	232	209	224	190	187
Wet	159	187	253	373	859	930	509	162	166	210	180	166
Middle	126	143	191	242	550	607	201	101	110	165	154	132
Dry	104	111	138	180	332	231	99	69	80	118	104	85
Very Dry	78	83	122	157	264	204	77	41	61	97	82	75

Note: based on 1978 through 2001 streamflow data

The area of the Smith River basin above Sheep Creek is about 860 square miles; below Sheep Creek it is about 1,080 square miles. Sheep Creek accounts for about 20 percent of the Smith River drainage area near Camp Baker, but appears to contribute a disproportionate share to the total flow, especially during the runoff season. One reason for this is because the Smith River watershed above Sheep Creek does not contain a large proportion of the higher elevation water-producing areas. Only about 25 percent of the basin above Sheep Creek receives more than about 2 feet (24 inches) of annual precipitation on average--24 inches of precipitation is approximately the amount of water that would be consumed in a season by an alfalfa crop under optimal conditions. In contrast, about 60 percent of the Sheep Creek watershed receives more than 2 feet of annual precipitation. Another factor is that, because about 90% of the irrigated lands in the upper Smith River basin are above Sheep Creek, much of the upstream flow that is produced initially is diverted for irrigation. Furthermore, about 11,500 acre-feet of runoff water from the North Fork of the Smith can be stored in Lake Sutherlin for release later in the season. All of these factors tend to substantially reduce spring peak flows in the Smith River basin upstream of Sheep Creek.

Figure 2.2-1. Estimated average flows for the upper Smith River (based on 1978-2001 streamflow data).



There is much less information on streamflows in the Smith River canyon and for the lower-most sections of the river. Streamflows are currently not gaged anywhere on the lower Smith River. However, a stream gage was operated on the River near the Eden Bridge from 1951 to 1969. Table 2.2-3 contains a summary of Smith River flows near Eden Bridge during this time period. These numbers are monthly average flows; the absolute lowest observed flow at the Eden Bridge gage during this period was 3.1 cfs on September 1, 1961.

Table 2.2-3. Monthly average flows for the Smith River near Eden Bridge in cubic feet per second (cfs).

Type of Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Very Wet	194	277	282	823	1,724	2,870	754	344	379	357	315	248
Wet	156	193	260	536	1,574	2,226	568	226	197	188	161	137
Middle	84	112	163	304	734	705	344	141	114	130	123	101
Dry	54	78	106	206	550	550	215	82	75	91	95	56
Very Dry	44	65	101	172	358	384	89	59	51	76	90	53

Note: based on 1951 through 1969 streamflow data

A gage was operated by the USGS near the mouth of the Smith River near Truly from 1905-1907, and again from 1929-1932. Average monthly flows for this gage are presented in Table 2.2-4 The lowest recorded flow at this gage was 0.2 cfs on September 10, 1931, and the lowest average monthly flow of 16.2 cfs occurred during August of that same year. These data indicate that very low flows and probably times of zero flow occurred in the lower river during earlier droughts.

Table 2.2-4. Average flows in cfs for the period of record for the USGS Smith River gaging station near Truly.

Type of Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average	75	166	195	447	709	912	194	66	68	104	92	83

During the late summers of 2000 and 2001, portions of the lower Smith River below the canyon were dry and very low flows were observed in the Smith River Canyon. The problems with no flow in the lower river during 2000 and 2001 started to occur when the flow at the USGS gage below the mouth of Sheep Creek dropped below about 40 cfs. What happened to this 40 cfs or so of water, along with any additional water that was added by tributaries in the Canyon, is not entirely known. There would be losses from the river due to evaporation and water use by riparian vegetation, but it is unlikely that these losses alone could account for so much water. Irrigators on the lower river also would have been diverting, but the river was already dry or very low before it reached the major downstream diversions. A possible explanation is that the lower Smith River is losing a substantial amount of water to ground water by seepage through the channel bottom.

Tributary Streams

There is not much information on the streamflows in Smith River tributaries. Tributaries that could be affected by the pending applications include the lower North Fork of the Smith River, the South Fork of the Smith River, Big Birch Creek, Sheep Creek, and Eagle Creek.

Flows in the lower North Fork of the Smith River are regulated by reservoir operations at Lake Sutherlin. DNRC gaged reservoir outflows from Lake Sutherlin during the irrigation seasons of 1966 through 1980. Average monthly flows for this period are presented in Table 2.2-5. These flows are not a good indication of what flows may be in the lower portions of the North Fork because most of this water is diverted for irrigation before it reaches the lower river. DNRC periodically measured flows on the lower portions of the North Fork during the drought years of spring, summer, and fall of 2000 and 2001. Measured flows ranged from 0 to about 90 cfs.

Table 2.2-5 Average flows for the North Fork of the Smith River below Lake Sutherlin in cfs (1966-1980 data).

	May	June	July	August	September
Average	69	100	74	61	38

DNRC measured flows on the South Fork during 2000 and 2001 that ranged from 0 to about 10 cfs in the upper portions of the stream near the turnoff for Highway 294, and from about 1 to 16 cfs in the lower portion near the confluence with the North Fork.

Flows in upper Big and Little Birch creeks were also monitored during 2000 and 2001, and the combined average monthly flows are summarized in Table 2.2-6.

Table 2.2-6. Estimated combined average monthly flows for Big and Little Birch creeks during the drought years of 2001 and 2002 in cfs.

Year	May	June	July	August	September	October
2000	34	73	20	8	8	12
2001	50	56	18	7	5	5

Flows were periodically measured on Big Birch Creek near the mouth during this same time. Measured streamflows near the mouth were almost always lower than upstream, and ranged from less than 0.5 cfs to 32 cfs.

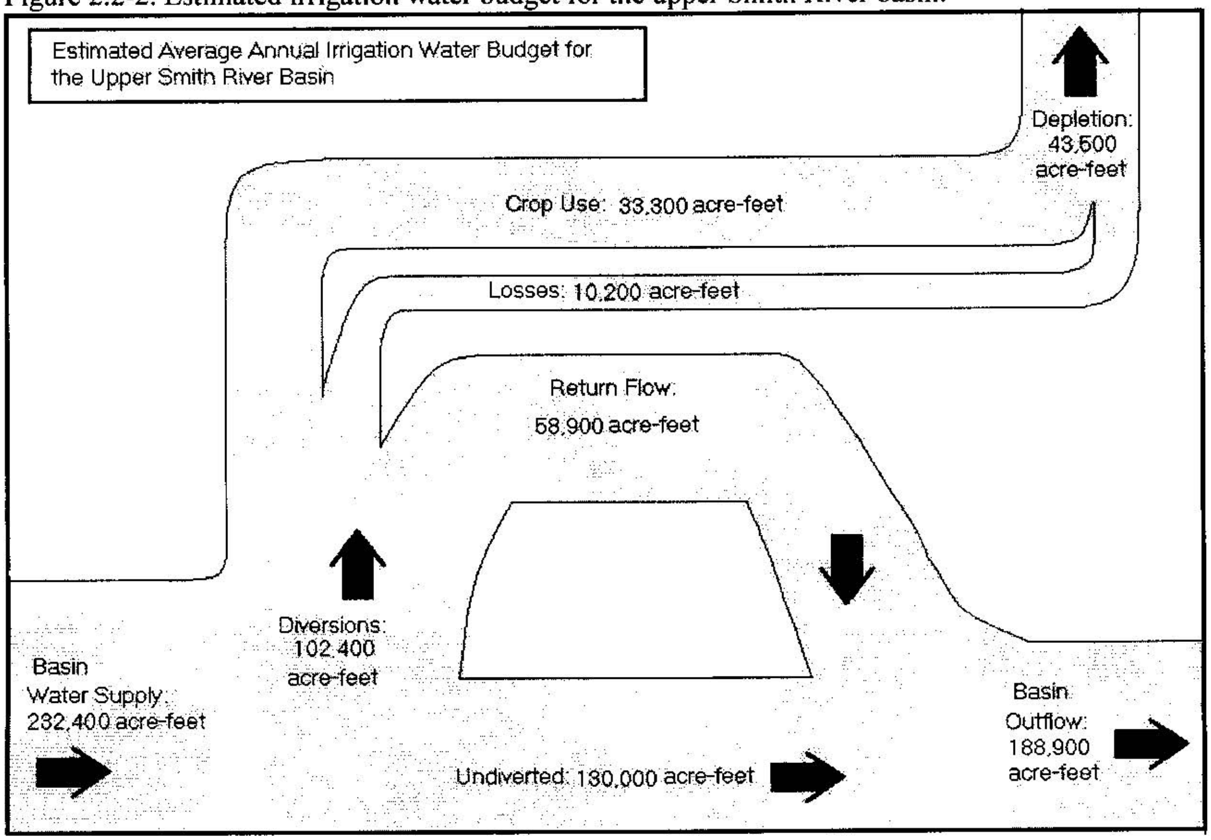
Water appropriations have been requested from Catlin Springs and a flowing well by the South Fork of the Smith River near the Junctions of Highway 89 and Highway 294. DNRC measured a flow of about 5.3 cfs from Catlin Springs on January 17, 1983. The flowing well near the South Fork was recently estimated to flow about 2.3 cfs.

Irrigation Effects on Streamflows

The largest use of water in the Smith River basin is for irrigation. By examining recent aerial photographs, DNRC estimates that about 36,000 acres of land is typically irrigated in the upper Smith River basin above the canyon for alfalfa hay, grass hay, grain, and pasture. About two-thirds of this land is irrigated by flood irrigation and the remaining one-third is irrigated using sprinkler systems. Irrigation affects both the amount and timing of streamflows. Figure 2.2-2 depicts the estimated effects of irrigation on the average annual water budget for the upper Smith River under present conditions.

Crops consume irrigation water through evapotranspiration. Further, irrigation water may be lost to evaporation during application or irrigation waste water may be consumed by riparian vegetation such as willows, cottonwoods, sedges, and rushes. But much of the water that is initially diverted for irrigation eventually will return to the stream. Excess applied water that runs off the surface of irrigated fields, sometimes called tail water, generally will return to a stream relatively quickly. Most of the rest of the water that seeps through the bottom of ditches or below the root zone in fields, will eventually reach a stream as ground-water return flow, but this water will return more slowly. More discussions on irrigation influences on streamflows will be presented in the surface-water resources section of Chapter 3, and in Appendix D.

Figure 2.2-2. Estimated irrigation water budget for the upper Smith River basin.



2.3 Water Quality

Water quality in Smith River basin streams is generally of fair to good quality. The amount of total dissolved solids (TDS) in water is an indication of the salinity. TDS concentrations could be considered moderate in the Smith River and North Fork and South Forks, and low in the tributaries such as Birch Creek and Sheep Creek. Water in the South Fork of the Smith River is usually higher in salts, probably due to soil types in the watershed and low precipitation. Recent water quality data for Smith River basin streams that could be affected by the applications are presented in Table 2.3-1.

Dissolved oxygen is needed to sustain aquatic life, and concentrations of over 7 mg/l are generally considered best for cold-water trout fisheries. Dissolved oxygen concentrations are somewhat controlled by water temperature because colder water can hold more dissolved oxygen. Measured dissolved oxygen levels in Smith River streams are generally near or above 7 mg/l, even during times of low flow.

Nitrogen and phosphorous are essential elements for aquatic plant growth. However, high nitrate and phosphorous concentrations in stream water can cause excessive algal growth, and the decomposition of this algae will deplete dissolved oxygen. Nitrogen concentrations of less than 5 mg/l are generally desirable in streams. Phosphorous usually is the limiting factor to eutrophication, because it is typically in shorter supply than nitrogen. To prevent excessive algal growth, phosphorus concentrations of less than 0.1 mg/l are desirable. Phosphorous concentrations above the 0.1 mg/l have been documented at times in the Smith River and some of its tributaries. Sources of the nutrients nitrogen and phosphorous include sediments, domestic sewage, animal wastes, and fertilizers.

Table 2.3-1. Water quality data summary for the Smith River basin.

	Total Dissolved Solids (mg/l)		Dissolved Oxygen (mg/l)		Nitrate (mg/l)	Phosphorous (mg/l)
Stream	middle	range	middle	range	range	range
Smith River near Ft. Logan	357	139-443	10	7.7-12.3	<0.05-0.23	<0.05-.35
South Fork Smith River	535	305-664	11	6.9-14.4	<0.05-0.31	<0.05-.62
North Fork Smith River	268	181-366	9.2	6.6-13.6	<0.05-.21	<0.05-0.23
Birch Creek	156	82-218	10	7.8-13.2	<0.05-0.16	<0.05-.0.25
Sheep Creek	168	86-226	11	8.9-12.9	<0.05-0.13	<0.05-0.19

Source: unpublished USGS water quality data 1982-1996 mg/l = milligrams per liter

The Smith River from the confluence of the North and South Forks to the mouth of Hound Creek is listed on the Montana Department of Environmental Quality (DEQ) 303d list as a stream for which a TMDL (total maximum daily load) non-point source pollution water quality plan needs to be developed. Identified problems include dewatering, flow alteration, nutrients, and pathogens. The rest of the Smith River, below the mouth of Hound Creek, is listed on the 303d list for similar reasons, and also due to warm water, bank erosion, and riparian and fish habitat degradation. The North Fork of the Smith River also is on the 303d list for reasons of algal growth and nutrient and pathogen problems.

2.4 Fisheries

The Smith River, a nationally known blue-ribbon trout fishery has been managed as a wild trout fishery since 1974 when all trout stocking was discontinued. Long-term population monitoring by the Montana Fish, Wildlife, and Parks (DFWP) indicates rainbow and brown trout as the dominant trout species in the drainage.

Westslope Cutthroat Trout, considered a sensitive species by the U.S. Forest Service, and recognized as a species of special concern by the State of Montana, occur in the Smith River mainstem. The U.S. Fish and Wildlife Service is presently under a court order to determine whether listing under the Endangered Species Act is warranted (American Wildlands vs. Norton, 2002). Other game species present in the Smith River drainage include brook trout, cutthroat trout, mountain whitefish, and burbot. Non-game species include stonecat, white, longnose, and mountain suckers, longnose dace, and mottled sculpins.

Several environmental factors and habitat conditions regulate the trout population levels and dynamics on the Smith River. During winter, periodic ice jams and flooding have caused substantial bedload transport of gravel, filled in pools, scoured brown trout redds, and greatly reduced reproduction. Likewise, drought conditions with warm summer water temperatures place fish under additional stresses that, combined with lower dissolved oxygen and other infectious agents, can cumulatively affect fish health

Based on data collected from the late 1970s-2002 by DFWP (Horton, pers comm 2003), trout population densities apparently respond to streamflow. Data suggest that in years where late summer discharge was below 100 cfs, the corresponding rainbow trout population levels of age 2 and age 3 fish from that year-class (2 and 3 years later respectively) were lower than in years that flows were above 100 cfs.

Streamflows ceased in sections of the Smith River during the extremely low water years between 1999 and 2001 (Figure 2.4-1). As a result, some fish kills were documented by DFWP. Table 2.4-1 lists recent documented dry sections of the river and associated fish kills.

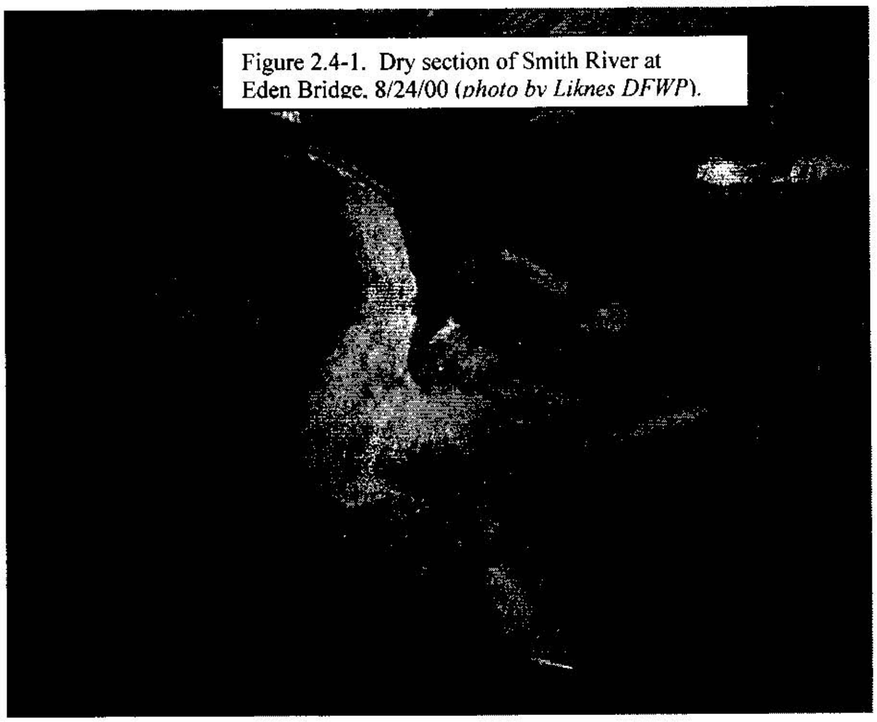


Figure 2.4-1. Dry section of Smith River at Eden Bridge. 8/24/00 (*photo by Liknes DFWP*).

Table 2.4-1. Documented dewatering and fish kills in Smith River between 1999-2001 (Liknes, personal communication, 2003)

Date	Location	Dry	Fish Kills
6/30/99-7/1/99	SF Smith River	x	
5/99	NF Smith River nr town	x	x
5/16/2000	NF Smith River nr town	x	
8/2/2000	SF Smith River near Moss Agate	x	x
8/23/2000-10/2000	Smith River nr Hound Cr	x	x
9/4/2001-10/2001	Smith River below Hound Cr	x	x

Habitat conditions vary among the different reaches of the river. In the upper reach of the Smith River, above the canyon, stream and riparian habitat is in relatively good condition for trout and coldwater aquatic life. The riparian zone in this area meanders through sedge and hay meadows with substantial willow stands in some areas. The floodplain is well developed in the broad upper valley, which helps to increase in-channel stability during periods of high flow events. Instream cover consists of rooted aquatic vegetation and undercut banks; some reaches develop substantial algal blooms during summer months and some reaches tend to be wide and shallow, which is undesirable for most fish. Some tributaries do not maintain year-round connectivity with the river in this reach. The river substrate consists of fines, with greater components of sand and gravel.

In the canyon reach, the river and the riparian zones are incised and confined between steep limestone walls, which grade into an area of foothill grasslands. Here, the river's course is much straighter than upstream and the woody shrub component of the riparian zone and bank cover is greatly reduced. Grasses dominate the riparian zone. Substrate includes greater percentages of gravel and cobble. Instream cover consists primarily of cliff walls and submerged boulders. Several tributary drainages from the Little Belt Mountains enter the river in this reach.

Below the canyon, the Smith River enters a valley dominated by agricultural uses that extends from the Eden Bridge area to the confluence with the Missouri River near Ulm. This lowest reach has limited riparian vegetation, a lower gradient, and some sections have high, steep banks that are highly erosive. Substrate composition changes from primarily gravel in the upper portion of this reach to sand and other fines in the lower end. Much of this reach has poor, marginal instream habitat for trout.

Smith River water temperature data were collected at eight stations between 1996-2001 (Horton, pers. comm., 2003). The stations were spaced between the North Fork Smith River (river mile 127.8) and Eden Bridge (river mile 22.4). Mean monthly temperatures at all sites were highest in July or August of each year and generally range from 60° to 65° F. Typically, tributaries add cooler water to the mainstem Smith River. Maximum summer temperatures were typically in the mid-to-high seventies at all stations with temperatures exceeding 80° F near Deep Creek and Eden Bridge in 2000 and 2001.

During the 1980s, DFWP applied for several water reservations on the Smith River and some of its tributaries. The purpose of the water reservation was to set aside a minimum river flow to protect fish habitat. Although these reservations have no force and effect as provided in the Board's Final Order because of the current Upper Missouri River Basin closure, they are an indication of flows needed for fishery habitat. Using the wetted perimeter inflection point method (Leathe and Nelson, 1989), DFWP has shown that the rate of habitat loss increased as flows decreased from 150 cfs to 80 cfs. Several water rights ("Murphy Rights") are held by DFWP with a priority date of 1970. Water reservation requests and Murphy water rights assigned to the Smith River for instream flows are displayed in Table 2.4-2.

Table 2.4-2. Smith River and tributary water rights and instream flow reservations.

Reach	Begin	End	Flow (cfs)	Type
Smith River				
Mouth (river mile 0.0) to Hound Cr (rm 25.4)	1/1	12/31	80	Water Reservation*
Hound Cr (rm 24.4) to Mud Gulch (rm 64.3)	5/1	5/15	372	Murphy Right
	5/16	6/15	400	Murphy Right
	6/16	6/30	398	Murphy Right
	7/1	4/30	150	Murphy Right
Hound Cr (rm 24.4) to Sheep Cr (rm 83.4)	*1/1*	12/31	150	Water Reservation*
Mud Gulch (rm 64.3) to Sheep Cr (83.4)	5/1	6/30	150	Murphy Right
	7/1	8/31	140	Murphy Right
	9/1	3/31	125	Murphy Right
	4/1	4/30	140	Murphy Right
Sheep Cr (rm 83.4) to Smith R, N FK (rm 123.4)	1/1	12/31	78.5	Water Reservation*
Sheep Cr (rm 83.5 to Rabbit Cr (rm 103.5)	5/1	6/30	150	Murphy Right
	7/1	4/30	90	Murphy Right
NF Smith River	1/1	12/31	9	Water Reservation*
SF Smith River	1/1	12/31	7	Water Reservation*
Big Birch Creek	1/1	12/31	11	Water Reservation*
Eagle Creek	1/1	12/31	2.5	Water Reservation*

* The Wetted Perimeter Inflection Point method was used to determine instream flows necessary to protect habitat in riffles.

2.5 Economics

The economic implications of changes in the allocation of water center on the trade-offs among the competing economic activities for which water is an input. Some of these activities are associated with goods and services that are traded in markets and allow for an assignment of a monetary value to the contribution of water in the production of the good or service. For other non-market economic activities, such valuations of water can not be discerned so readily (see Gibbons, 1986, National Research Council, 1997). Less direct impacts result as changes to these economic activities flow through the local economy due to altered production and consumption patterns. This section describes the water-related economic activities likely to be affected by the proposed action and the socioeconomic setting in which they occur.

Agriculture

Cash receipts from agricultural marketing in Meagher County in 2000 totaled $24.5 million and ranked 35th among Montana's 56 counties. Total cash receipts for the state were $2,305 million. Cash receipts in Meagher County included $21.1 million from livestock, $1.7 million from crops and $1.8 million in government payments. The primary crop in the county is irrigated hay. Total production expenses were estimated to be $18.3 million in 1997 (Montana Agricultural Statistics Service, 2003). Farm income in 2000 was $3.2 million, below the ten-year average of $3.7 million (U.S. Bureau of Economic Analysis, 2003a).

Recreation

Fishing

During the summer of 2001, fishermen logged an estimated 15,371 angling days on the Smith River from its headwaters to its confluence with the Missouri River (McFarland and Meredith, 2002). Montana residents and non-residents accounted for 9,671 and 5,700 of total angling days, respectively. Over the period 1991 to 2001, total angling days on the Smith averaged 18,378 per summer--12,451 and 5,927 for residents and non-residents, respectively. Duffield and others (1987) have estimated the net economic value of fishing per day at the Smith River to be $70.96 or $1.7 million for the 2001 summer season.

Floating

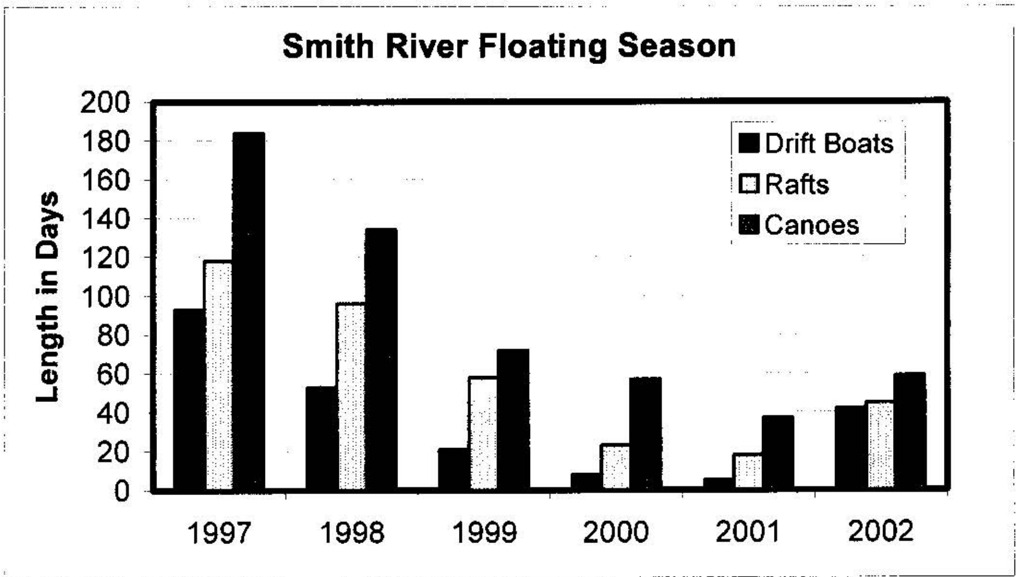
DFWP generally considers the flows listed in Table 2.5-1 to be necessary, as measured at the USGS gaging station below Sheep Creek at Camp Baker, for recreational floating on the Smith River between Camp Baker and the Eden Bridge.

Table 2.5-1. Flows in cfs that are considered to be the minimum needed at Camp Baker for recreational floating from Camp Baker to the Eden Bridge.

Type of Boat	Necessary Minimum Flow in cfs
Drift Boat	350
Raft	250
Canoe	150

Daily flows from the USGS Smith River gage at Camp Baker (below Sheep Creek) are available only for the 1997-2002 floating seasons. The times that the river was considered floatable at the above listed flow rates are summarized in Figure 2.5-1. During the higher flow years of 1997 and 1998, the river was floatable by all craft during much of the early season, by rafts and canoes during most of the summer, and could be canoed throughout most of the fall. During the later, drier years, the floating season was very short for rafts and drift boats, and ended by early summer for canoes. There were no fall floating opportunities during the years 1999 through 2002.

Figure 2.5-1. Approximate length of the floating season through the Smith River Canyon during recent years assuming the minimum flow rates specified in Table 2.5-1.



Proximity to recreational opportunities enhances property values and enables the development of recreation-related services. DFWP estimated that expenditures for shuttles, fuel, food, lodging, outfitting, and other expenses associated with fishing and floating on the Smith in 2002 totaled $1.4 million or $20,420 per day (DFWP, 2002).

Hydropower

As a tributary to the Missouri River, the Smith River contributes flows to the Missouri River basin hydropower plants owned by PPL Montana and the U.S. Army Corps of Engineers. PPL Montana's five plants downstream of the Smith River in the Great Falls area have a combined summer generating capability of 216 megawatts (MW) (DEQ, 2002). Generating capability at Fort Peck is 209 MW. Prices in the region have been quite volatile in recent years and tend to be higher in summer months.

Taxation

The total taxable value of property in Meagher County for the 2002 tax year was $7.8 million (0.45 percent of the state total). The taxable value of Class 3 agricultural land in the county was $1.6 million (21 percent of the taxable value of property in the county). Grazing ($0.96 million) and tillable irrigation ($0.36 million) comprised the largest portions of the taxable value of Class 3 agricultural land. In 2002, the tax rate on agricultural land was 3.46 percent and the average rural mill levy in Meagher County was 367.46. In 2002, the property tax per acre in the county for tillable irrigated land was $2.65, $2.13 for tillable non-irrigated land, $0.48 for grazing land, and $3.11 for wild hay (Montana Department of Revenue, 2002a).

Socioeconomics

Population

Similar to most rural counties in Montana, the population of Meagher County--the 48th most populous of the state's 56 counties--has been decreasing in number and increasing in age. From 1980 to 2000, Meagher County's population decreased by 10.3 percent to 1,932 despite a 6.2 percent increase during the 1990s. During the same period Montana's population increased by 15.6 percent to 909,453. The population of White Sulphur Springs was estimated to be 984 in 2000. The median age of Meagher County's population increased from 32.8 in 1980 to

42.8 in 2000. The median age for Montana's population increased from 29.0 to 37.5 during the same period (Montana Census and Economic Information Center, 2003).

Employment

In 2001, the unemployment rates for Meagher County and Montana were 5.9 percent and 4.6 percent, respectively. Between 1991 and 2001, employment in the county increased 8.6 percent to 939 jobs. During the same period, Montana's employment increased 17.4 percent to 443,904. In 2000, wage and salary employment (690) exceeded proprietors' employment (478) and nonfarm proprietors' employment (333) exceeded farm proprietors' employment (145). Industries employing the most workers in 2001 were services (293), farms (253), retail trade (152), and state and local government (139) (U.S. Bureau of Economic Analysis 2003a). Prominent components of the service sector include health care, professional services and lodging and recreational services.

Income

In 2000, Meagher County's per capita personal income of $20,461 ranked 24th and was lower than the state's average $22,518. Total personal income (TPI) consists of earnings from labor and proprietors' income; dividends, interest, and rent; and transfer payments received by county residents. Meagher County's TPI in 2000 was $39.5 million and ranked 46th in the state (0.2 percent of the state total). In 2000, earnings represented 53.4 percent of TPI; dividends, interest, and rent were 26.1 percent; and transfer payments were 20.5 percent. Between 1990 and 2000 earnings increased on average 3.8 percent per year; dividends, interest, and rent increased 2.1 percent on average; and transfer payments increased 5.2 percent on average.

Earnings of persons employed in Meagher County increased from $14.7 million in 1990 to $21.4 million in 2000, an average annual growth rate of 3.8 percent. The industries providing the largest shares of earnings were services (24.2 percent), farming (14.9 percent), and state and local government (14.2 percent). The slowest growing major industries between 1990 and 2000 were farming, which decreased at an average annual rate of 1.6 percent. The fastest growing industry was durable goods manufacturing which increased at an average annual rate of 14.8 percent (U.S. Bureau of Economic Analysis, 2003b).