Groundwater Conditions in Scott Valley, California

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ACRONYMS

CDEC- California Data Exchange Center

DEM – Digital Elevation Models

DRG – Digital Raster Graphics

DWR – California Department of Water Resources

FGDC – Federal Geographic Data Committee

GIS – Geographic Information Systems

NRCS – National Resource Conservation Service

NWIS – National Water Information Service

Siskiyou RCD – Siskiyou Resource Conservation District

SWRCB- California State Water Resources Control Board

SSPA – S. S. Papadopulos & Associates, Inc.

USGS – U.S. Geological Survey

1.0 INTRODUCTION

This report describes groundwater conditions in the Scott Valley (Figure 1.1), located in Siskiyou County, California, and the development of a groundwater model representing the alluvial aquifer that can be used to investigate groundwater/surface-water interactions. The goal of this work is to improve understanding of the relationship between land and water use on flow conditions in the Scott River.

The groundwater model is applied to examine groundwater conditions given recent levels of groundwater use, and under an alternative water use condition representing partial build-out of the existing groundwater capacity. The partial build-out case, in comparison to the recent condition case, provides a mechanism for examining the impacts of groundwater pumping on the aquifer and on the Scott River. Many other scenarios can be evaluated through specification of alternative conditions to the model input packages. For example, scenarios may be structured to examine how the location and timing of groundwater diversion and use, or how managed recharge, might enhance late season flows of the Scott River.

This work is based on extensive data presently available in the public record, including over 1,000 well logs, soil and geologic data, groundwater elevations, well tests, high-resolution land surface elevation data, crop and riparian vegetation mapping, climatological data and stream gage records. The groundwater model provides a reasonable representation of existing conditions and is a useful tool for examining broad questions related to groundwater use in the Scott Valley. The groundwater model may be updated and refined as additional information is obtained. Focused data investigations may be particularly useful for improved assessment of specific scenarios or improved understanding of localized conditions.

2.0 SUMMARY OF AVAILABLE DATA

As part of this study, existing studies, reports and data sets were compiled and reviewed. These are summarized below.

2.1 Geologic Setting

The Scott Valley is underlain by younger alluvium, including stream channel, floodplain and alluvial fan deposits (Figure 2.1, from USGS, 2005). The water-bearing characteristics of the alluvial deposits are well-characterized by Mack (1958), and are discussed further in Section 3.0. Older alluvium is present along some of the valley margin; upland areas surrounding the valley are comprised of schist and various intrusive rocks (Figure 2.1).

The USDA NRCS SSURGO national soil inventory identifies several soil types within the valley and tributary areas (Figure 2.2). Diyou and Settlemeyer Loam dominate in the valley area; and, Stoner Gravelly Sandy Loam dominates in the tributary areas.

Water well driller's reports for 1,089 wells within eleven townships including the Scott Valley and interconnected tributary areas were obtained from the DWR under a confidentiality agreement for purposes of evaluating hydrogeologic conditions within the valley. These reports provide the driller's description of subsurface materials encountered during drilling, the well depth, and information on well yield, if available.

2.2 Groundwater Elevations

Depth-to-water data was obtained for wells in the Scott Valley from two primary databases: the USGS/NWIS and DWR/CDEC. Table 2.1 identifies wells in the Scott Valley for which data were found in the NWIS or CDEC databases noted above, and shows the well depth, construction date, use and surface elevation. Data obtained from NWIS consists of 84 depth-to-water measurements for 120 wells lying within the Scott Valley. Many of the listed wells have only one depth-to-water measurement taken during a regional inventory performed in 1953 by the USGS (Mack, 1958). One well has a series of 25 measurements over approximately a 15-year period. Of these wells, 22 were monitored approximately weekly from mid-July to mid-October in 1953; these data are not reflected in NWIS but are provided in Mack (1958), Table 9. Data in the CDEC database consists of depth-to-water data for 9 wells, from the early 1950s (1 well), the mid-1960s (4 wells), the mid-1990s (1 well), and the early 2000s (3 wells). These wells provide a long-term record of groundwater levels ranging over a period from one to five decades.

The wells for which multiple depth-to-water measurements are available are identified on Table 2.2 and shown on Figure 2.3. Hydrographs for these wells are provided in Appendix A.

Other data will be evaluated, as possible, during later phases of this study. Monthly depth-to-groundwater measurements have been collected as part of the Scott Valley Community Groundwater Measuring Program, established by the Scott River Watershed Council and with subsequent involvement of the Natural Resource Conservation Service, the Siskiyou RCD and the Klamath Forest Service. These data, including approximately 42 wells enrolled voluntarily by landowners, have been sampled since early 2006, and are being evaluated as part of the Siskiyou County Groundwater Study (Harter and Hines, 2008). These monthly data were requested at the initiation of this study in June of 2011. A representative of the Siskiyou RCD responded that the data would not be made available to this study at that point in time. Should the Siskiyou RCD share these data at a later date, the information will be reviewed to supplement understanding of spatial groundwater conditions over these recent years.

2.3 Specific Capacity

Specific capacity, an indicator of the aquifer's ability to transmit water (discussed further in Section 3.0), can be calculated from a well's pumping rate and the drawdown observed over a short pumping period, typically over a period of an hour to a few hours. Values for specific capacity calculated from data on well logs are tabulated on Table 2.3.

2.4 Streamflow

The USGS and DWR maintain gaging stations within the Scott Valley that provide information regarding river and tributary flows. Figure 2.4 shows surface water features and gages within the Scott Valley. Gaging stations are identified on Table 2.4.

2.5 Agricultural Water Use and Distribution

Figure 2.4 shows the spatial distribution of agricultural lands and major crop classes from the 2000 Siskiyou County Land Use Survey prepared by the DWR. Pasture and alfalfa are the primary crop classes, comprising over 90% of the irrigated lands. Also included in the DWR survey is information at the parcel scale on water source (groundwater, surface water or both) and irrigation method. The 2010 DWR land use survey data were not yet available at the time of this assessment.

The DWR estimates annual irrigated crop acreages, crop evapotranspiration, evapotranspiration of applied water, effective precipitation and applied water for 20 crop categories for sub-watershed areas identified as Detailed Analysis Units (DAU). These estimates reflect reference evapotranspiration, crop coefficients, soil characteristics, rooting depths and the quantity and timing of precipitation and are published for selected years by the DWR (http://www.water.ca.gov/landwateruse/anaglwu.cfm#). Table 2.5 provides DWR estimates for the year 2000 for applied water, the consumed fraction and evapotranspiration of applied water. The difference between applied water and the portion of this consumed or lost through evapotranspiration by plants or soil is also shown on Table 2.5 as *excess applied water*. Excess applied water is typically returned to the surface water system as tailwater or to groundwater by deep percolation.

Water sources for irrigated lands include surface water, groundwater or both surface water and groundwater. The Scott Valley Adjudication Decree (1980) identifies adjudicated points of diversion, associated acreages and allotments. These are summarized on Table 2.6. Major ditches diverting natural flows of the Scott River include: the Farmer's Ditch at Diversion No. 183, serving 1,236 acres in the southeast area of the Valley; and the Scott Valley Irrigation District (SVID) Ditch, serving 5,131 acres along the eastside of the Valley from Diversion No. 223 (between French and Etna Creek). The Scott Valley Irrigation District (SVID) Ditch served 1,630 acres from Diversion No. 576 at the northern end of the Valley, downstream of the confluence with Moffett Creek in the past; this ditch is presently unused. Under the adjudication, wells serving 12,975 acres are identified, including lands served by groundwater only or combined groundwater and surface water. Other points of diversion include direct diversions from creeks, springs and collection reservoirs generally located on the west or northwest sides of the valley, and from ditches or pipelines conveying water from these sources; diversions from Moffett Creek, and diversions from the eastside gulches to lands located above the Scott Valley Irrigation District Ditch. The DWR (Table 2.5) estimates that approximately 31,800 acres were irrigated in the Scott Valley in the year 2000.

Estimated canal losses are reported by DWR (1991) based on canal flow measurements. Farmer's Canal was reported to have minimal losses; the SVID Canal was reported to lose 7.4 cfs in the first 40,000 feet of the ditch in June 1990 (measurements by DWR in June 1990 with diversion averaging 38 cfs); and, 7 cfs in the lower 36,000 feet of the ditch (measurements by SCS, date unspecified).

2.6 Riparian Vegetation Water Use

Figure 2.5 shows the extent of wetland vegetation as mapped by the FWS National Wetland Inventory, consisting of approximately 7,100 acres of Emergent, Forested/Shrub, Riverine and Freshwater Pond wetlands. Table 2.7 identifies wetland classes in the Scott Valley. Some portion of this acreage coincides with areas designated by DWR in 2000 as cropland (Section 4.6).

2.7 Groundwater Wells

Over 1,000 well logs obtained from the DWR were reviewed to identify numbers of domestic, public, stock and irrigation wells; and to characterize their spatial distribution and depth of completion. Because well logs and data provided by the DWR only are located with respect to township, range and section, without precise coordinates or location by quarter or quarter-quarter section, a mechanism for filtering wells that are not within the alluvial aquifer was applied, as some sections include adjacent bedrock areas. For this purpose, 243 wells that encountered bedrock within 50 feet of land surface were excluded as either minor producers or beyond the primary alluvial aquifer area. A few wells were also excluded that were located outside of the study area. Of the remaining wells, the following were identified: 550 domestic, 169 irrigation, 2 public supply and 8 stock wells. Table 2.8 shows the number and well depth range for domestic wells by section; and, Table 2.9 shows the number and well depth range for irrigation wells by section. Table 2.10 summarizes the number of wells drilled by date ranges.

2.8 Land Surface and Channel Elevation

Light Detection and Ranging (LiDAR) data were collected by Watershed Sciences in November of 2010 to characterize land surface elevations at a fine resolution. This survey covered most of the Scott Valley (121,160 acres), with the exception of some upland tributary areas on the east side including Hamlin, Hurd, Heartstrand and Upper McConaughy Gulches. The Scott Valley LiDAR survey resulted in an accuracy with error of less than 0.1 foot (<0.03 meter RMSE) compared to ground-based RTK surveys. Bare earth or last return values are used in calculating land surface elevations. In areas beyond that of the LiDAR survey, the LiDAR-based elevations are supplemented with USGS 10-meter National Elevation Data (NED/DEM) coverages obtained from the USDA NRCS Geospatial Gateway.

3.0 HYDROGEOLOGIC CONDITIONS

3.1 Hydrogeologic Setting

In the 1950s, the U.S. Geological Survey undertook a comprehensive study of geology and groundwater conditions in the Scott Valley (Mack, 1958). This study, which included an inventory of existing wells, a review of driller's logs and well yields, and monitoring of depth to groundwater and water quality, provides a reasonably clear understanding of the hydrogeologic setting of the Scott Valley. Mack describes water bearing deposits in the Scott Valley as consisting of stream channel, flood-plain and alluvial-fan deposits within the valley area and along valley margins. Bedrock penetrated by wells in the upland or valley margin areas provides small amounts of water, in some cases sufficient for domestic use, but generally not significant in terms of the overall basin water supply. Data obtained since the Mack study provide opportunity to further refine the understanding of hydrogeologic conditions; these data consist of driller's logs, groundwater elevations and well yields for additional wells.

The alluvial material constituting the valley fill aquifer consists of a combination of clay, sand and gravel which appear to range from well-sorted to poorly-sorted in driller's logs provided by Mack and as reflected on DWR well logs for wells drilled subsequent to Mack's study. Mack describes the flood plain alluvium underlying the east side of the valley between Etna and Ft. Jones as being the most permeable; also of note are alluvial fan deposits on the west side, which contain both coarse channel deposits and layers of fine sediments. Numerous springs and wetlands are located along the valley margin on the west side between Etna and Greenview at or near the base of the fans; these discharge areas indicate the interception of the water table with the land surface or, in cases of springs or flowing wells, suggest that the interspersed fine-grained layers are sufficient to create localized confining conditions.

The California State Water Resources Control Board prepared a report on hydrogeologic conditions (SWRCB, 1975) in the Scott Valley to support the Scott River water rights adjudication. As part of this study, well logs were reviewed and cross-sections prepared denoting the alluvial materials as described by drillers, and, an area of highly permeable floodplain deposits was delineated (Figure 3.1).

California's Groundwater Bulletin 118 (2004) summarizes conditions of the Scott River Valley Groundwater Basin, based largely on information developed by Mack (1958) and SWRCB (1975). The average irrigation well yield is reported as 794 gpm based on 27 well completion reports. As part of this study, well completion reports available through 2010 were reviewed. Based on 204 irrigation well completion reports, 116 of which report yield, the average irrigation well yield is 524 gpm; the median yield is 250 gpm.

Harter and Hines (2008) further summarize the geologic setting, also largely as understood by Mack, but reflecting review of additional water level and well log data; and, provide comprehensive background on the Scott Valley's physical setting, including climate, temperature, precipitation; soils; and, watershed characteristics.

Figure 3.1 shows the well depth for specific wells where identified in the NWIS and CDEC databases (Table 2.1) and shows the range of well depths within each section as tabulated by the DWR based on driller's logs on file with the DWR. Most valley wells do not fully penetrate the alluvial fill, therefore, in composite, the alluvial fill is generally as deep as or deeper than the maximum depth shown. In some cases, the wells have reached bedrock, providing spatial control on the depth of the valley alluvium. These data are discussed further in Section 4.2.

3.2 Aquifer Properties

The report on hydrogeologic conditions prepared by the California State Water Resource Control Board (SWRCB,1975) provides estimates of hydraulic conductivity (permeability) based on specific capacity for wells in various regions of the valley. Specific capacity can be influenced by the length of the pumping period, aquifer storage properties and well efficiency. The method and adjustments employed by the SWRCB to convert from specific capacity to permeability are not identified in the 1975 report. Nevertheless, specific capacity provides insight into the transmissive properties of the aquifer. SWRCB concluded that the floodplain deposits have a hydraulic conductivity of about 134 ft/day (1,000 gpd/ft^2) and describes fan deposits or other alluvial sediments as "non-floodplain" deposits where the hydraulic conductivity was inferred to be less than about 40 ft/day (300 gpd/ft^2).

As part of this study, the evaluation of specific capacity was extended to the present, including all well test data reported on well logs filed with the DWR. Specific capacity, calculated for over 90 wells from test data provided on driller's logs, is shown on Table 2.3. Values range from less than one gpm/foot to over 100 gpm/foot. These data are generally consistent with the SWRCB's description of high transmissivity with the valley floodplain, and within the area outlined by SWRCB (1975) as the area of interconnected groundwater, although some data suggest that the aquifer is significantly less transmissive in the area south of Etna Creek and west of the Scott River. Also as described by SWRCB, specific capacity is generally lower in areas beyond the floodplain; however, some exceptions are noted.

Well yield, as reported on driller's logs, also was examined as a general indication of aquifer transmissivity. The spatial distribution of well yield suggests that areas of high or moderate transmissivity may be present beyond the area delineated by SWRCB, including the Moffett Creek alluvium, some parts of the area identified as "discharge zone" by Mack (1958), and in some areas of the Scott River floodplain in the southern and northern reaches of the Scott River. Lower well yields in the Oro Fino Valley, along valley margins and on the west mountain fans are consistent with generally lower specific capacity values in those areas.

3.3 Groundwater Elevations and Trends

Groundwater measurements have been made as part of several monitoring programs. In composite, these data provide a reasonably good understanding of the groundwater conditions in the Scott Valley. Mack (1958) and the DWR (1990, as represented in the 1991 Flow Augmentation Study) have developed groundwater elevation contour maps depicting the general configuration of the water table within the valley. Based on measurements at 38 wells, the DWR 1990 map shows the water table sloping from upland areas towards the Scott River and towards the downgradient (north) end of the Scott Valley, sloping at approximately 0.0015 foot/foot in the valley area. Mack similarly maps groundwater elevations, reflects a similar pattern, and observes a hydraulic gradient of about 7.5 feet per mile, which is comparable that observed in 1990 by the DWR. These data reflect a system which receives recharge from the surrounding mountainous areas, as well as recharge from stream and creek beds, and from the conveyance and application of irrigation water within the valley. The Scott River is the dominant discharge feature within the valley, and drains both run-off and intercepted groundwater from the valley when the hydraulic gradient is towards the river, as is reflected by these water table maps. However, there may be times of the year when particular river reaches lose water to groundwater, in lieu of gains, depending on the combination of local groundwater conditions, stream stage and the stream bed channel elevation.

Figure 3.2 shows the depth to water for wells monitored in October 1953. Groundwater levels are very shallow in the valley bottom, generally less than 10 feet to water. As would be expected, the depth to water increases towards the valley margins, generally reflecting the higher land surface elevations. While this same general condition might be expected today, inspection of hydrographs of the five wells monitored over a period of many decades (Appendix A) indicates that late summer or fall groundwater elevations have experienced declines over the decades. The long-term monitored wells (Table 2.2) are:

- **42/09-02A2:** This shallow well is located less than a mile east of the Scott River in the central area of the Scott Valley. The well appears sensitive to precipitation and appears also influenced by local factors. While the noise in the hydrograph may obscure trends, a number of years in the latter half of the record reflect elevations lower than seen in the earlier period.
- **42/09-27N1**: This is a shallow well located east of Etna, near Etna Creek and about a mile west of the Scott River. More recent dry season water levels are about 4 feet lower than in previous decades.
- **43/09-23F1**: This unused well is located just north of the airport, and about one half mile west of the Scott River. Low water levels in the past decade have been approximately 2 feet lower than those generally observed prior to 1980.
- **43/09-24F1**: This irrigation well is 204 feet deep and is located about a mile east of the Scott River. Water levels are erratic with some measurements apparently influenced by pumping. However, a decline of a few feet over recent decades is suggested by the seasonal lows where pumping influence is not suspected.
- **44/09-28P1**: This unused well is 65 feet deep, located near Scott River Road along Tyler Gulch at the downstream end of the Scott Valley. Late summer/fall water levels appeared to have declined from the mid 1960s to the present; recent low water levels appear to be 5 to 10 feet below the low water levels seen in the late 1960s.

Harter and Hines (2008) examined the groundwater trends at these same wells and concluded: "the minimum groundwater level measurements observed have shown a decline in almost all cases, when taking into account fluctuations due to differences in precipitation. This trend in declining minimum levels of groundwater measured in these wells corresponds to a period when an increase in the number of groundwater wells installed within Scott Valley has been observed. Surface flows have likely been impacted by this decrease in groundwater levels during critical times." Figure 3.3 provides a cumulative mass plot of precipitation from 1950 to the present at Ft. Jones. While some multi-year periods have experienced lower precipitation and precipitation likely influences short-term groundwater fluctuations and trends, a sustained decline in precipitation that would explain the apparent declines in low season groundwater elevations is not apparent. Van Kirk and Naman (2008a, b) analyzed snow water equivalent (SWE) data and a decline in base flow of the Scott River, considering also data and trends for other tributaries of the Klamath Basin. Noting that SWE decreased corresponding to cool and warm phases of the Pacific Decadal Oscillation for the periods 1942-1976 and 1977-2005, respectively, they concluded that 39% of the decline in late summer discharge of the Scott River is explained by regional scale climatic factors, with the remainder (about 23 cfs of the 37 cfs late summer decline) attributable to local or watershed factors such as changes in consumptive use.

A tally of wells drilled (based on DWR logs complied in June 2011 and Mack, 1958), and filtered to exclude those falling outside of the alluvial valley, indicates that whereas about 80 wells existed in the mid-1950s, about 400 existed by 1980, over 600 existed by 2000. Since 2000, an additional 168 well have been drilled (Table 2.10). While some of the drilling may simply replace older wells, nevertheless, more wells are in use today than in previous decades. The withdrawal of groundwater from wells has the potential to not only impact groundwater elevations but also to impact surface water flows, discussed further in Section 4.0.

Another factor which may have influenced declining low-season groundwater elevations is the reduction in irrigation-related recharge to the valley. Irrigation efficiency was reported to be about 55 % in the mid-fifties (Mack, 1958, based on Horn and others, 1954). In 2000, an irrigation efficiency of approximately 73% was achieved (Table 2.5, DWR, 2000). If the same amount of water is diverted and applied, improved irrigation efficiency may increase the quantity of water consumptively used and reduce the quantity of water that returns to groundwater through deep percolation and/or directly to surface water as tailwater. However, if diversions and applied water are reduced commensurate with the increased efficiency, then changes in efficiency would have little effect on the basin water budget, although changes in local hydrologic conditions may occur. Other factors also may have influenced agricultural consumptive use and return flow, and their trends, over the past 50 years. These factors include the timing of available surface water, the occurrence of shortage (fewer cuttings) and the availability of groundwater as a supplemental water supply, particularly later in the season. Harter and Hines (2008) note: "Considering the changes in crops, acreage and the factors above, the amount of water likely used by crops has increased from 1958 to 2000 by between 15 percent (10,000 more acre feet) and 30 percent (20,000 acre feet) depending on the date when surface irrigation stops, i.e. July 15, Aug 1 or Aug 15."

If crop yields have increased over time, either through an extended season or through more effective irrigation methods, consumptive water use would similarly have increased. Increased consumptive use has the potential to impact groundwater elevations, through a reduction of the percolation of excess applied water to the shallow aquifer and as a result of increased groundwater pumping. Watershed and river channel conditions may also impact groundwater elevations and associated surface water flows. Groundwater conditions, trends, and influencing factors can be further examined with the groundwater model, the development of which is described in the next section.

4.0 GROUNDWATER MODEL DEVELOPMENT

4.1 Model Code and Approach

The Scott Valley Groundwater Model uses a modified version of MODFLOW2000 (Harbaugh et. al., 2000) which incorporates the ET-RIP Package (Baird and Maddock, 2005; Maddock and Baird 2003) with capabilities for enhanced representation of riparian plant communities. In this phase of model development, exchanges between rivers or creeks and groundwater are represented using the River Package. This package does not explicitly model surface water flow; rather, it represents user-specified surface water conditions for model stress periods, i.e., seasonally specified stream stage and channel width, and tracks groundwater-surface water exchanges accordingly. The model simulates groundwater elevations within the aquifer and stream gain/loss associated with simulated groundwater conditions; for example, the model can simulate changes in groundwater elevations and stream gain/loss due to changes in recharge conditions, pumping, irrigation efficiency, stream channel conditions, or other model inputs.

4.2 Model Structure

The Scott Valley Groundwater Model is structured to represent groundwater flow and surface water interactions in the alluvial aquifer of the Scott Valley. Figure 4.1 shows the location of the groundwater model domain (active model area) and the streams, drains and canals that are explicitly represented in the model. The alluvial aquifer is bounded on all sides by bedrock of upland mountainous areas. Bedrock has limited capacity to transmit water and is excluded from the active model area. However, mountain-front recharge from bedrock to the alluvial aquifer is included as a boundary condition. The vertical extent of the alluvial aquifer was characterized from examination of well logs and geologic cross-sections. Model details are further described below.

4.2.1 Model Grid

The model grid is composed of 553 rows and 280 columns, with cell size uniformly equal to 200 by 200 feet. The model grid is oriented north-south, with principal flow towards the basin outlet generally oriented along columns south of Ft. Jones, and oriented along rows northwest of Ft. Jones. The model origin (lower left corner) is located 500,564.86E and 4,576,828.15N, UTM Zone 10N NAD83 horizontal datum (meter).

4.2.2 Model Elevations and Layer Thickness

Land surface elevations are assigned to each model cell based on LiDAR elevation data, supplemented by10-meter DEMs on the east side of the valley where LiDAR was not available (Figure 4.2). The bottom of the model represents the bottom of the alluvial aquifer. Two model layers are defined. Analyses conducted to delineate the model layer elevations and thicknesses are described below.

4.2.2.1 Delineation of Alluvial Aquifer

The lateral boundaries of the alluvial aquifer are readily apparent from inspection of geologic and topographic maps, generally corresponding to the bounding upland bedrock areas. Over 1,000 well logs were inspected to identify the thickness of alluvium. Because the wells are located only by section on well logs and within the database provided by the DWR, this analysis was directed towards identifying, for each section, the maximum observed alluvial thickness (Table 4.1). Where bedrock is encountered in wells, the depth to bedrock often corresponds to the bottom of the alluvial aquifer. However, some well logs reflect a significant thickness of clay or cemented material above bedrock. In these cases, the bottom of the alluvial aquifer is identified as the lowermost elevation at which alluvial material with reasonable capacity to store or transmit water, including gravels, sands and/or silts, are identified on well logs. For sections in which no well penetrates to bedrock, the maximum well depth was identified and the alluvial thickness is characterized as "greater than" this value (also shown on Table 4.1). The values shown on Table 4.1 formed the basis for the alluvial aquifer thickness represented in the groundwater model, shown on Figure 4.3. Active model cells along the model boundary were assigned a minimum alluvial thickness of 50 feet.

The alluvial aquifer thickness assigned to each cell was subtracted from the average land surface elevation to determine the elevation at the bottom of the alluvial aquifer as represented in the groundwater model. Figure 4.4 shows the elevation of the modeled alluvial aquifer bottom. The bottom slopes down from adjacent upland areas, reaching greatest depths in the central area of the Scott Valley.

4.2.2.2 Layer Thickness

Two model layers are designated in the Scott Valley Groundwater Model. Layer 1 represents the uppermost saturated portion of the aquifer, including the horizon commonly referred to as the "water table". In this layer, water storage is characterized by *specific yield*, a storage parameter largely reflecting the occurrence of gravity drainage (or pore space filling) at the top of the saturated zone. Layer 2 constitutes deeper sediments in the main valley and within the more prominent tributary aquifers where a thickness of sediments greater than 25 feet is present below the bottom of Layer 1. In this layer, water storage is characterized by a *storage coefficient*, a storage parameter reflecting the release of stored water that results from matrix and fluid compaction.

Layer 1 is present throughout the model domain, as shown on Figure 4.1. The bottom elevation of Layer 1 is set at 50 feet below the riverbed elevation along the Scott River, and at 50 feet below the streambed elevation along major tributaries. In the central valley, the bottom elevation is maintained at the same elevation across model rows within valley floor, then, gradually sloped upwards towards the western basin margins. In Quartz Valley, Oro Fino Valley and the Moffett Creek area, the bottom elevation is generally maintained across rows or columns (depending on orientation of the valley) and corresponds to the row/column riverbed elevation, with some smoothing to handle transitions to neighboring zones or other local spatial conditions. The bottom elevation of Layer 1 is shown on Figure 4.5. Layer 1 encompasses the entire alluvial thickness in several upland gulch areas, as well as in upland alluvial areas of tributary "arms" including those defined by Etna Creek, Kidder Creek, Mill and Shackleford Creeks and most of the Oro Fino Valley. The saturated thickness of Layer 1 is approximately 50 feet along much of the Scott River. The thickness of Layer 1 increases towards the basin boundaries in varying amounts, depending on topography, subsurface and recharge conditions.

Layer 2 extends from the bottom of Layer 1 (Figure 4.5) to the bottom of the alluvial aquifer (Figure 4.4). In the central valley area, Layer 2 ranges from 80 to 210 feet in thickness. Layer 2 is thin towards valley margins and is absent in most of the upland gulches and valleys. The areal extent of Layer 2 is shown on Figure 4.1.

4.3 Hydraulic Properties

4.3.1 Hydraulic Conductivity

Initial values for horizontal hydraulic conductivity are based on data and analyses described in Section 3, including specific capacity computed from well tests (Table 2.3) and literature-based values (Mack, 1958; DWR, 1975). Hydraulic conductivity values were initially associated with sub-regions corresponding to Mack's (1958) storage units, tributary watersheds and the DWR (1975) report on hydrogeologic conditions. These sub-regions are shown on Figure 4.6. Because the available data are based on short-term pumping tests and tend to reflect localized conditions, the initial hydraulic conductivity values are also evaluated in a basin-wide context and adjusted in model calibration. Resulting model horizontal conductivity values within sub-regions are summarized on Table 4.2. The ratio of horizontal to vertical hydraulic conductivity is specified as 200:1 between layers 1 and 2.

4.3.2 Storage Terms

The uppermost sediments within the Scott Valley alluvial aquifer are under water table (unconfined) conditions; therefore, the storage term in Layer 1 is assigned a value for specific yield, whereby water is stored or released from storage via the process of gravity drainage. The specific yield for Layer 1 was set by sub-regions based on estimates developed by Mack (1958), ranging from 7 to 15%[1]; values are shown on Table 4.2. The top of Layer 2 of the model is situated below the water table; accordingly, a specific storage value of 1×10^{-5} is specified for preliminary model runs; this value is multiplied by layer thickness within MODFLOW to obtain a storage coefficient for Layer 2.

4.4 Pumping

Groundwater withdrawals for domestic, municipal and irrigation use are distributed into the model using the MODFLOW Well Package.

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[1] For computational efficiency in model development, the hydraulic parameters are not varied as a function of saturated thickness. As implemented in MODFLOW, this requires specification of a dummy "specific storage" which functions as a "multiplier" to achieve the intended value for specific yield. The dummy specific storage value is selected such that when multiplied by layer thickness, the desired specific yield is obtained.

4.4.1 Domestic and Municipal Pumping

Groundwater withdrawal for domestic use is estimated at a total value of 136 acre-feet per year for 544 wells, assuming an average withdrawal of ¼ acre-foot per year per well (Section 2.7). In areas where the wells are widely dispersed, the impacts of these withdrawals will have little impact on modeled conditions. However, areas in which wells are clustered have the potential for a noticeable combined impact, and these are represented in the model. To this end, sections containing more than 10 wells were identified. In these sections, the estimated combined domestic pumping is distributed within the section and represented in the Well Package. The greatest concentration of domestic wells is located within the upper Kidder Creek drainage and in the general area between Greenview and Cheeseville (186 wells). Additional domestic well clusters represented in the model include the Etna area with 39 wells, Heartstrand Gulch with 16 wells, and the Ft. Jones/Moffett area with 31 wells. Pumping from the domestic well clusters is assigned to Layer 2 except in basin margin areas where only Layer 1 is represented. Municipal pumping by the Town of Ft. Jones is represented at the location of WW-2 in T43N/09W-02. Pumpage from this well is estimated at 50 acre-feet per year.

4.4.2 Groundwater Pumping for Irrigation

Groundwater use for irrigation is based on DWR Agricultural Water Use tables for DAU 3, an area used in DWR land and water use analyses, roughly corresponding in area to the Scott Valley watershed above the USGS gage near Ft. Jones. Detailed monthly reports were obtained from the DWR for the years 2000 and 2002 to 2005. The monthly reports tabulate irrigated acreage, evaporation of applied water (ETAW), the consumed fraction, unit applied water, applied water, evapotranspiration (ET) and effective precipitation (EP) for alfalfa, corn, grain, meadow pasture, other field and other truck crop categories. These quantities are separately identified based on water source, that is, surface water and groundwater. Supply-limited acreages of alfalfa and meadow pasture are also included as alfalfa-X and meadow pasture-X. The data table for the year 2000 is provided in Appendix C.

Groundwater pumped for irrigation use is represented in the groundwater model for two cases representing different points in the historic period with differing capacity for groundwater extraction. One case represents “recent conditions”; a second case represents "partial build-out" of groundwater capacity. While pumping and water use vary somewhat from year to year, depending on cropped acreage, crop distribution, weather and water supply conditions, these two cases are taken as representative of two distinct development conditions and provide a basis for examining hydrologic conditions and relationships within the alluvial aquifer. These cases are identified for illustrative purposes and can be modified or refined in future scenario evaluations.

4.4.2.1 Recent Condition

For the recent condition, irrigation pumpage is taken as the monthly quantity of applied irrigation groundwater for major crop categories (alfalfa, corn, grain and meadow pasture/pasture) as tabulated by the DWR for the year 2000 (Appendix C). These values are summarized on Table 4.3a by model season for the four major crop categories. The total quantity of groundwater withdrawal for irrigation under this condition is about 40,530 acre-feet per year for lands within DAU3 (Scott Valley). Applied as a unit withdrawal per irrigated acre for each crop category, the irrigation pumpage is spatially distributed into irrigated lands within the groundwater model in proportion to the percent coverage of each crop category within each model cell[2]. In this process, the distribution of crops is based on the GIS crop coverage from the 2000 DWR land use survey (*00SK*, http://www.water.ca.gov/landwateruse/lusrvymain.cfm, accessed 5/27/2011). The fact that lands planted with different crops tend to use surface water and groundwater in different proportions is preserved by this method. While actual cropped acreage and water sources will differ to some degree from the 2000 DWR land use survey in any particular year, this survey is believed adequate to capture the general nature of spatial cropping patterns in the valley.

4.4.2.2 Partial Build-Out Condition

The partial build-out condition differs from the recent condition in that groundwater capacity is specified at 60% of the 2000 condition. This case is not intended to represent a specific historic year; rather, it is structured to provide a point of comparison

[2] The modeled quantity of groundwater withdrawal is not exactly equal to the total applied groundwater for DAU3 due to the fact that some DAU3 irrigated areas are located outside of the active model grid. However, because most of the DAU3 irrigated lands located outside of the model grid are pasture, and groundwater is not a significant percentage of the water source to pasture, the difference between modeled groundwater irrigation withdrawals and DWR's estimated groundwater irrigation withdrawals for DAU3 is relatively small.

that will provide insight on impacts of incremental levels of groundwater pumping. While structured as a hypothetical, this pumping condition would have occurred at some point in the past. Based on drilling dates of the well logs available to this study, this condition would likely have occurred in or around the early 1980s. In addition to varying pumped groundwater for irrigation, this case correspondingly reduces the recharge from excess applied groundwater (see Section 4.5, below) that would have been associated with reduced pumping levels. Changes in cropping patterns or efficiency are not incorporated into this groundwater usage condition.

A review of monthly records of applied groundwater suggests that a 60% reduction in well capacity would potentially limit the application of irrigation water from wells in the months of June through September, but have little impact on groundwater usage in May. In the “partial build-out” case, the amount of applied groundwater is limited to 60% of the maximum monthly value from the “recent condition” values for each crop category. The resulting quantities of applied groundwater by season, for each crop category, are shown on Table 4.3b. The corresponding total groundwater withdrawal for irrigation in DAU3 under this condition is about 27,960 acre-feet per year. As for the “recent condition”, the groundwater withdrawal for irrigation is spatially distributed into irrigated lands within the model grid in proportion to the percent coverage of each crop category within each model cell.

4.5 Recharge

Recharge to the groundwater system includes mountain-front recharge, recharge from percolation of applied irrigation water, and recharge due to seepage from canals and farm laterals.

4.5.1 Mountain-Front Recharge

Mountain-front recharge (subsurface flow into the valley along the mountain front) is distributed along model boundaries (Figure 4.7) using the Well Package, at values identified on Table 4.4. Mountain-front recharge is estimated using a water balance approach for 13 watersheds tributary to the Scott River. This method involves computing available water in the upland watersheds as a function of evapotranspiration and precipitation over the mountainous areas. These quantities are developed over an 800-

meter gridded area using climate data developed by the PRISM Group, Oregon State University for the 1971 to 2000 period, with elevation and slope data from digital elevation models. Gaged stream records were reviewed to develop a preliminary allocation of available water between runoff and mountain-front recharge. This method, further described in Appendix D, provides a preliminary, physically-based, range of values for the distribution of recharge into the groundwater model along the valley margins. Mountain-front recharge was adjusted in model calibration; the resulting estimates are shown on Table 4.4. These estimates may be refined in future study phases if additional information becomes available. Additionally, subsurface inflow associated with the Scott River is included in an amount of 346 acre-feet per year, based on flux calculated by Darcy's Law at the cross-section where the valley is intersected by the southern model boundary.

4.5.2 Canal Seepage

Recharge through canal seepage during the irrigation season is estimated from limited field observations, as discussed in Section 2. Canal seepage is handled through the Well Package, as it is not expected to vary substantially as a function of water table elevations. Based on field observations (DWR, 1991), seepage is represented as 1 cfs per mile for the SVID Ditch below Young's Dam. The Farmer's Ditch, diverting at approximately Sugar Creek, is reported to have minimal to no seepage losses (DWR, 1991). However, some areas of seepage from this canal are inferred from the presence of vegetation and grassy or seep areas along the canal. Seepage from this ditch is represented at 0.5 cfs per mile.

4.5.3 Irrigation Season Recharge through Deep Percolation of Applied Water on Irrigated Lands

Recharge via infiltration from irrigated lands, or, on-farm deep percolation, is calculated using monthly, crop-specific, agricultural water use tables developed by the DWR (Appendix C). The on-farm deep percolation is simulated in the groundwater model as recharge using MODFLOW's Recharge Package, with distribution according to the number of acres of each crop type within each model cell.

On-farm deep percolation is taken as the difference between the total applied water and total evapotranspiration of applied water (ETAW), where the total represents the combination of applied surface water and groundwater. These values are computed monthly from the DWR table for DAU3 (Scott Valley) for 2000, then, grouped to correspond to the seasonal periods represented in the groundwater model. Resulting seasonal values for on-farm deep percolation are shown on Table 4.5a for the "recent condition" and on Table 4.5b for the "partial build-out condition". As noted earlier, for the partial build-out condition, the only change simulated is a reduction in groundwater capacity. In this case, the change in groundwater pumping of about 12,550 acre-feet per year is associated with a change in recharge of applied irrigation water of about 2,750 acre-feet per year, reflecting a consumed fraction of 78% for groundwater. That is to say, approximately 22% of the pumped groundwater returns to the aquifer or stream system; therefore, pumping 12,550 acre-feet per year would have a net impact of approximately 9,800 acre-feet per year given the agricultural water use assumptions reflected in the farm water budget (Appendix C). As noted for the pumping distribution, modeled quantities are based on unit rates per crop class acreage as mapped to each model cell[3].

4.5.4 Non-Irrigation Season Recharge

Recharge during the non-irrigation season is represented using MODFLOW's Recharge Package. During the non-irrigation season, available water, after satisfying evapotranspiration demand, is estimated to be about 10 inches (from water balance methods as described in Appendix D). This amount will partition between run-off and infiltration. Infiltration is estimated as 3 inches over the non-irrigation season (October through April) in the valley, including cropped and non-cropped land; this quantity is included in the Recharge Package.

4.6 Evapotranspiration

The ET-RIP Package is used to represent water use by riparian vegetation. Table 2.7 identifies the wetland groups and corresponding National Wetland Inventory (NWI) classification codes; Figure 2.5 shows the distribution of the wetland groups including emergent wetland, forested/shrub/wetland, pond and riverine for the Scott Valley. The ET-RIP package supports specification of percent cell coverage by each plant group, and assignment of a time-dependent ET curve for each plant group. The percent cell coverage

[3] Deep percolation associated with all irrigated acreage in DAU3 is summarized on Table 4.5, including approximately 2,500 acres of pasture that lie beyond the model boundary Model input, developed from the unit values shown on Table 4.5, excludes deep percolation associated with acreage that falls outside the model boundary.

for the wetland classes shown on Figure 2.5 are mapped into each cell of the the Scott Valley Groundwater Model. Of approximately 7,100 NWI mapped wetland acres, 6,776 acres fall within the model boundaries. A comparison of NWI mapped wetlands with DWR mapped crop acreage within the Scott Valley indicates that 4,341 acres of the NWI mapped wetlands classes coincide with mapped crop acres. For these lands, the crop classification is applied as the primary land use in the groundwater model, effectively reducing the number of wetland acres falling within the model grid from 6,776 to 2,438 acres.

Analyses conducted by the U.S. Bureau of Reclamation (2003) of ET demand by wetland classes, including northern climate salt grass, willows, cottonwoods, rushes/sedges and tules/cattails in the Upper Klamath Basin, illustrate a relatively close correspondence on a seasonal scale to the ET curve for alfalfa for that location. Assuming a similar relationship for the Scott Valley, the monthly evapotranspiration demand for alfalfa in the Scott Valley is used to approximate wetland ET demand, at an annual value of 2.21 feet, distributed as 0.68 feet in the May-June season and 1.53 feet in the July-September season. As structured, the ET-RIP Package can readily be updated to reflect class-specific rates if this information becomes available. The ET-RIP Package also offers the option of implementing a depth-specific evapotranspiration rate, which may be useful in some future model applications.

4.7 Gains/Losses to the Scott River

Gains and losses to the Scott River and major tributaries (Figure 4.1), including Shackleford Creek, Mill Creek, Oro Fino Creek, Kidder Creek, Patterson Creek, Moffett Creek, Big Slough, Etna Creek and French Creek are calculated within MODFLOW as a function of aquifer head, the specified stage within the river or stream, and a river conductance term. For ease in comparing simulated gains/losses to observed gains/losses, the modeled river cells have been grouped into reaches, as shown on Figure 4.8 and identified on Table 4.6.

The MODFLOW River Package is used to specify creek and river conditions that allow for the computation of groundwater-stream interactions. River bottom elevations are specified for each model cell crossed by a creek or river. LiDAR data were used in developing the river bottom elevations in a process involving identification of topographic lows, followed by a smoothing and reasonable adjustment. Stage for river segments is specified according to time-dependent flow conditions, representative of conditions to be simulated in a given scenario. River conductance is a lumped term reflecting the hydraulic conductivity of river bed material and the approximate river width. Grain size composition, reflected by D50 values reported by Sommarstrom et al. (1990) and subsequent studies, were considered in identifying a range for initial values.

Three prominent drainage channels are represented in the model: Big Slough, East Slough and West Slough. For purposes of this study, Big Slough is identified as including both the upper section, between Patterson and Kidder Creeks, and its continuation into the north-south trending reach of lower Kidder Creek. Big Slough is represented in the River Package, discussed above. Two other prominent drainage channels, identified for purposes of this study as East and West Slough, are represented in the Drain Package. The West Slough intercepts shallow groundwater, tailwater and runoff from an area west of the river in the upper valley, and flows into the Scott River at the French Creek confluence. The East Slough similarly intercepts shallow groundwater and/or surface water. It originates between the Eastside Road and the Scott River, about a mile north of Eller Lane, and intercepts the Scott River about a half mile north of Scarface Road. These channels intercept some of the shallow groundwater in areas of high water table, augmenting the drainage of low lying valley areas and returning flows to the Scott River.

4.8 Model Calibration

Initial model files were prepared based on data inputs as described in the previous sections. During model calibration, model parameters were adjusted to achieve a reasonable match to observed conditions, while maintaining consistency with information reflected in well logs, including lithology, well yield and specific capacity.

Data available for model calibration include groundwater elevations collected from a set of wells over a period of decades and periodic elevations collected at a larger number of wells, as described in Section 3.3. Valley-wide elevation surveys were undertaken in the mid-1950s (Mack, 1958) and again in August 1990 (DWR, 1991). Published information from these survey events provides a means of judging the general correspondence of simulated to observed groundwater levels. Wells with long-term hydrographs that continue to the present suggest that under recent conditions, late summer/early fall groundwater elevations may be up to a few feet lower than early values in some locations (Section 3.3 and Appendix A); and, winter/early spring groundwater elevations appear to have experienced minimal long-term declines. The multi-decadal records were used to evaluate the reasonableness of the model simulations with respect to long-term trends and seasonal fluctuations; and, these records provided guidance in extrapolating from past, valley-wide monitoring events to subsequent conditions on a valley-wide scale. Model results are discussed in Sections 5.0 and 6.0.

5.0 STEADY-STATE OSCILLATORY MODEL, PARTIAL BUILD-OUT

The steady-state oscillatory model (SSO model) provides a means of simulating seasonally-variable groundwater conditions corresponding to user-specified water use and water supply conditions, typically selected as representative of historical or existing conditions. The SSO model provides initial heads for subsequent transient runs that may look at seasonal or annual variation in greater detail or that may be used as a point of comparison for scenario analysis. The SSO model consists of an initial steady-state stress period followed by transient stress periods. Oscillations, composed of annual cycles of seasonal stresses, are repeated until there is minimal net change in storage over the course of two consecutive years. Aside from its value as a starting point for transient simulations, the SSO model is useful in characterizing the groundwater environment and surface water interactions under long-term average conditions and evaluating the general reasonableness of the model.

Two SSO model simulations were developed with alternate water use conditions; one simulating partial build-out conditions, and one simulating recent conditions. The SSO model of partial build-out conditions, described below, supported an initial calibration process and served to initialize a subsequent transient run. The SSO model of recent conditions and a transient simulation to evaluate the timing of stream depletion impacts associated with groundwater withdrawals are discussed in Section 6.0.

5.1 Seasonal Input for the SSO Models

The SSO models consist of a one-year, four-stress period transient simulation that is repeated for a 25-year period. Two seasonal stress periods are defined for the non-irrigation months and two periods are defined for the irrigation months. The non-irrigation periods are identified as Period A, spanning October through November, post-irrigation months with limited recharge and relatively low river flow; and, Period B, spanning December through April, months in which precipitation and run-off significantly increase river and tributary flows. The irrigation periods are identified as Period C, spanning May through June, a period with continuing high river and stream flows and good surface water availability for irrigation; and, Period D, July through September, characterized by low river flow, greater likelihood of dry stream reaches or creeks, decreasing availability of surface water supplies for irrigation, and increased amounts of groundwater pumping. The average flow of the Scott River at the USGS gage near Ft. Jones over the years 1971 to 2000 for the seasonal periods A through D was 212, 1,038, 902 and 96 cfs, respectively, with an average annual flow of 642 cfs (Appendix B).

Water supply conditions for the SSO model are taken from the 1971 to 2000 period. Stream stage is based on the long-term average flow per season, as noted above. Mountain-front recharge is based on conditions reflected in PRISM climate data for the period 1971 to 2000 (Appendix D).

Water use in the valley is dominated by irrigated agriculture; as such, assumptions for groundwater pumping and recharge from on-farm deep percolation are specified according to scenario, partial build-out or recent conditions. The partial build-out condition is described in Section 4.4.2.2 and 4.5.3 wherein groundwater capacity is limited to 60% of the recent condition (year 2000) values.

5.2 SSO Model Results, Partial Build-Out Condition

Simulated groundwater contours for the SSO model, partial build-out condition, are shown on Figure 5.1[4], for the end of the irrigation season. Spatial groundwater elevations were reviewed for overall reasonableness when compared to groundwater elevation maps from the historic period (Mack, 1958; DWR, 1991). A review of time-trend data at selected wells (Appendix A) indicates that over the multi-decadal historical period, groundwater declines tend to be on the order of a few feet; that is, declines in groundwater elevations are small enough to not greatly impact a comparison of this type. Model adjustments were made as part of an initial calibration process to attain general consistency of simulated to observed conditions, with respect to the magnitude, direction and slope of the water table.

Figure 5.2 shows simulated and observed heads over a 10-year period at five locations with monitoring records available for the 1980s. The simulated heads are influenced by seasonally variable water use and recharge rates over the 10-year period, resulting in higher water levels in winter/spring than in late summer/fall. Year-to-year

[4] Simulated groundwater elevations are mapped for the portions of the model area where LiDAR elevation data were available; simulated results in areas beyond the LiDAR survey extent are subject to greater uncertainty.

fluctuations are not represented in this simulation, nor are localized pumping impacts that cause additional inter-annual variability and "noise" in the observed water levels. The comparison provides a means of examining the reasonableness of the model, as the SSO output should bear reasonable resemblance to what is understood to be average hydrologic conditions in the basin for the partial build-out condition. Due to imprecision in well measuring point elevations, topographic variation across grid cells, the resolution of model stress periods and local pumping influences, the goal of this comparison is to obtain a reasonable, overall, correspondence to spatial conditions and trends rather than a precise match. Shallow wells located very close to the model boundaries (42/09-02A2 and 44/09-28P1) were given less weight in this exercise, as localized conditions on model edges can be difficult to capture in a basin-scale model. In addition to consideration of well responses, the model calibration was guided by depth-to-water maps; the spatial distribution of specific capacity and well yield; and, lithology reported on well logs.

Figure 5.3 compares simulated groundwater elevations at the end of the irrigation season to groundwater elevations measured in the fall of 1953 at fifty-six wells. Because the amount of pumping represented in the partial build-out simulation is greater than that occurring during 1953, the correspondence is expected to result in simulated values, on average, lower than observed values. While the difference is expected to vary depending on location, the available data (Appendix A) suggest that the difference is relatively low; thus, the comparison should be informative for checking reasonableness of the model. The average residual, or difference in simulated and observed elevations, is approximately 7 feet; that is, the simulated values on average are somewhat lower than the observed values, as expected. The simulated results are generally consistent with elevations and trends reflected in available data[5], particularly within the interior of the basin. Larger deviations are noted in areas of higher elevation, typically, along the model edges. The upland valley margin areas may be more sensitive to increased pumping over time, and a greater residual may reflect differences in pumping conditions. On the other hand, the valley margin areas are subject to greater uncertainty due to several factors, including, accuracy of reported,

[5] Water elevations were measured in the late-1980s by the DWR (1991) at 38 wells, and formed the basis for a published groundwater contour map representing that period of time, as noted above. Efforts were made to obtain the underlying data for use in the comparison. However, the data could not be located by the DWR staff in Red Bluff, nor are the data recorded in the NWIS or CDEC databases. If these data should be located, they will be considered in future model updates/refinements.

map-interpolated well elevations in areas of higher relief; the greater concentration of shallow or dug wells; and, the sensitivity of water levels along thin valley margins to localized lithology and recharge conditions. Despite these uncertainties, the valley margin points-of-comparison are retained as they provide potentially useful information that can be further explored at later time, if relevant to specific model applications.

Simulated to observed comparisons, as displayed on Figures 5.1, 5.2 and 5.3, were evaluated during the course of preliminary model calibration, along with other information including depth-to-water maps; the spatial distribution of specific capacity and well yield; and, lithology reported on well logs. Seasonal fluctuations at well locations with shorter term records (Appendix A) were also examined for general consistency with model-simulated seasonal fluctuations. During this process, model parameters including hydraulic conductivity, stream conductance, and mountain-front recharge were adjusted to achieve a reasonable representation of observed conditions, as reflected in available data.

Table 5.1 provides a summary of the annual groundwater budget obtained from the SSO model output. Under the simulated partial build-out conditions, on average, the Scott River receives inflow from groundwater amounting to about 33 cfs. This amount is variable in time and spatially. Greater inflows are simulated between Young's Dam and Eller Lane, although significant inflow also occurs as the valley narrows towards Ft. Jones and again as it narrows above the USGS gage. During winter months, several reaches are simulated as recharging water to the aquifer, as a result of increased river stage during the wetter periods. Several of the tributary creeks also intercept groundwater (stream gains), particularly at lower elevations; although Kidder, Patterson and Etna Creeks recharge water to the aquifer during winter/early spring. The Big Slough functions as a drain, intercepting on average about 9 cfs from groundwater, in addition to collecting run-off draining from Kidder and Patterson Creeks. The simulated water balance represents the average of simulated seasonal conditions. While actual values may vary from year to year, and simulated values may be refined if additional data become available, these values provide a general indication of expected pattern and trends under the partial build-out condition.

6.0 EVALUATION OF GROUNDWATER PUMPING IMPACTS

Two simulations were developed to provide insight on the impacts of groundwater withdrawals on the stream system. These include a SSO model of the recent condition, generally reflecting water use as characterized by DWR for the year 2000; and, a transient simulation, which also models the recent condition but initiates with the partial build-out condition. Results of the transient simulation are used to characterize the timing of stream depletion impacts associated with an incremental increase in groundwater pumping beyond the partial build-out levels. For both the SSO model and the transient model, the recent condition is as described in Section 4.4.2.1 and 4.5.3, and consists of a net increase in groundwater use of approximately 9,800 acre-feet per year as compared to the partial build-out condition. This net increase reflects an increase in groundwater pumping of about 12,550 acre-feet per year, offset by an increase in recharge from applied irrigation water of about 2,750 acre-feet per year.

6.1 SSO Model Results, Recent Condition

The SSO model of the recent condition was structured as that described for the partial build-out condition in Section 5.1, with the exception of irrigation pumping and deep percolation, which are set at levels as noted above. As for the partial build-out condition, the underlying assumptions for recharge and seasonal stream flow are based on long-term average conditions for the period 1971-2000.

Table 6.1 provides a summary of the annual groundwater budget obtained from the SSO model output for this simulation. This table shows the long-term distribution of impacts of increased groundwater pumping/increased irrigation recharge on stream gains/losses. While most streams continue to gain on an average annual basis as previously described for the partial build-out system, the magnitude of gains decreases. Similarly, reductions in inflow to gaining tributaries occur; and, increased seepage losses are seen in losing reaches. These changes, whether decreases in river gains, or increases in seepage losses, result in a net reduction to surface water flow from that which would occur under the partial build-out condition. These differences are examined more fully with the transient model, described below.

6.2 Transient Simulation, Change from Partial Build-Out to Recent Condition

A transient simulation was developed to examine the impacts of a change in groundwater pumping on groundwater elevations and on groundwater-stream interactions. The 25-year partial build-out SSO model provides the initial condition for the 25-year transient model, which initiates with 5 years of "partial-buildout" conditions (described in Section 4.4.2.2), and then transitions with a single-step increase[6] in pumping levels. Water use assumptions for the final 20 years of the transient simulation reflect the "recent condition" as described in Section 4.4.2.1 and 4.5.3, that is, a net increase in groundwater use of approximately 9,800 acre-feet per year. This net increase reflects an increase in groundwater pumping of about 12,550 acre-feet per year, offset by an increase in recharge from applied irrigation water of about 2,750 acre-feet per year.

The transient simulation illustrates the progression of groundwater impacts to the aquifer and stream system from the additional increment of groundwater pumping beyond the partial build-out levels. With some limitations, the results can be scaled to approximate impacts for other magnitudes of increase or decrease in groundwater pumping, assuming a similar spatial layout of wells. For example, a change of half the simulated change (i.e., decrease or increase of 4,900 acre-feet per year from the simulated increase of about 9,800 acre-feet per year) would modify the results by a similar proportion from those shown with this simulation; however, large changes from those simulated would merit examination in an alternate scenario.

Figure 6.1 maps the change in groundwater elevations as compared to the initial (partial build-out) heads after a period of 20 years, at the conclusion of the irrigation season. Overall, groundwater elevation changes resulting from the simulated increase in pumping from partial build-out to recent levels are relatively small. With the exception of valley margins where the alluvial material thins and is typically less transmissive, greatest simulated differences (end of the irrigation season), generally fall in the range of one to four feet. The simulated difference shown on Figure 6.1 is the incremental change due to the increase in pumping that would gradually develop over the period of years between the

[6] The change from partial build-out to recent conditions is simulated as a step-increase to support characterization of a stream depletion curve that can be used to assess stream depletion impacts under a variety of pumping schedules and amounts; for example, the results can be used to prepare a curve of gradual depletion impacts due to incremental changes over a period of years.

partial build-out and recent condition. This gradual decline would be superimposed on seasonal or annual fluctuations that otherwise occur.

Figure 6.2 shows the simulated change as it progresses seasonally for a 10-year period due to the step-change increase in pumping at selected well locations with long-term records. Minimum differences occur at the end of the non-irrigation/recharge season, with declines within a range of about 0.5 to 1.5 feet. Declines of this magnitude would be difficult to detect, particularly with the pumping increase occurring gradually over a decade or more, and considering inter-annual climate fluctuations. Declines during late summer months are more pronounced, largely because of the timing of irrigation pumping. Simulated, incremental, summer declines range from under 2 feet to about 4 feet at the locations shown. Declines increase over the first few years following the step-change in pumping, and then reach an oscillatory steady-state condition, with minimal change from year to year. In the historical period, assuming that a transition occurred from the partial build-out to the recent condition over a period of one or two decades, the change would have been more gradual, but the end result, essentially as shown. As noted before, these pumping-induced declines would be superimposed on seasonal or annual fluctuations that otherwise occur.

The range of incremental declines simulated, and as shown on Figure 6.1 and 6.2, are within a range expected based on review of long-term trends reflected in the data available to this study. Additional data exist for wells monitored in recent years under a voluntary monitoring program. A request to review and consider these data for this study was declined by the Siskiyou RCB in June 2011. If these data are made available to this study at a later date, they will be considered in model updates/refinements.

Figure 6.3 shows average annual stream depletion to the Scott River and tributaries in acre-feet per year, and as a percentage of the net pumping increase, resulting from the step-change from partial build-out to recent water use conditions. Most of the simulated depletion results from reduced groundwater inflow to the streams (reduced "gains"). This depletion relationship can be used to examine lagged impacts of a gradual increase in pumping or other pumping schedules with the same spatial distribution of groundwater use. Conversely, the stream depletion relationship can be viewed as a stream accretion relationship by reversing signs, if impacts of increasing recharge are to be considered[7].

Figure 6.4 shows the stream depletion in late summer (Period D, July through September) as reduction in Scott River flow and tributaries that feed the Scott River above the USGS gage due to the simulated change. Higher stream depletion impacts occur during the summer than during the winter/early spring period, reflecting the seasonal occurrence of irrigation pumping. The simulated net increase in pumping between the partial build-out condition (approximately, 1980s) and the recent condition (2000) indicates a corresponding stream depletion impact of approximately 16 cfs during the late summer season, July through September. The stream depletion is a change that would be superimposed on surface water flows resulting from the combination of other inflows and outflows, including run-off, ambient stream gains/losses, surface diversion and return flow. The stream depletion impact resulting from changes in groundwater use prior to the partial build-out condition, i.e., from the 1950s to the 1980s is not quantified as part of this exercise.

[7] If the spatial distribution of enhanced recharge is to be localized or otherwise different than the assumed pumping distribution, then, a scenario-specific accretion curve should be developed rather than using the depletion curve shown on Figure 6.3.

7.0 DISCUSSION AND FUTURE DIRECTIONS

A preliminary groundwater model of the Scott Valley has been prepared, suitable for general characterization of valley-wide groundwater conditions and groundwater/surface water interactions. Simulations reflecting two distinct water use conditions have been made. A simulation of water use under partial build-out of well capacity sets groundwater pumping at an amount reflecting 60% of the well capacity available in the year 2000, and adjusts irrigation recharge accordingly. A simulation of water use under a more recent condition sets groundwater pumping at the amounts estimated and summarized by the DWR for the year 2000. Pumping and irrigation-related recharge are pro-rated based on crop classes and spatially assigned to the model in accordance with mapped GIS coverages. Other sources of recharge, including mountain-front recharge and winter stream flows, are based on average conditions for the period 1971 to 2000. The groundwater model, as presently configured, tracks changes to groundwater elevations and surface water/groundwater interactions through four distinct seasons, although monthly or other time intervals could be incorporated in future scenarios.

The models were applied to identify differences in groundwater elevations and to quantify stream depletion impacts associated with the net change in groundwater use between the partial build-out and recent water use condition, within the context of average water supply/climate inputs. Simulation results are generally consistent with observed water-level data. Long-term groundwater elevations declines are minimal in winter, and greater in late summer, on the order of a few feet, depending on location. Groundwater declines are limited in the valley area due to the presence of groundwater connected streams; however, the streams can be and have been impacted by increased levels of groundwater pumping. The models have been applied to generate a stream depletion relationship, which shows that, on average, increases in groundwater pumping are entirely conveyed to equivalent reductions in streamflow within approximately five years, with the bulk of the impact occurring in the first year or two. This relationship has been developed for the existing distribution of irrigated lands and crop classes; alternate stream depletion relationships can be determined for pumping from specific areas within the valley.

Similarly, stream accretion curves can be developed corresponding to enhanced recharge or groundwater storage scenarios.

The simulations assume average water supply/climate conditions. While the results are generally applicable to wet or dry years, some questions may warrant more specific examination of wet or dry conditions, particularly where river drying or extensive flooding is anticipated. These changes can be incorporated into specific scenario analysis.

The models may be applied to evaluate scenarios that might offset stream depletion impacts. Scenarios might involve recharge ponds, modification of pumping locations or schedules, alternate irrigation application methods or other approaches for increasing aquifer recharge. In some cases, model refinement may be appropriate, particularly if new data is generated, offering opportunity to fine tune the model in areas relevant to management alternatives. Finally, the release and sharing of all existing water elevation data is encouraged, along with any anecdotal information relating to hydrologic conditions that water users have observed.

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Figures

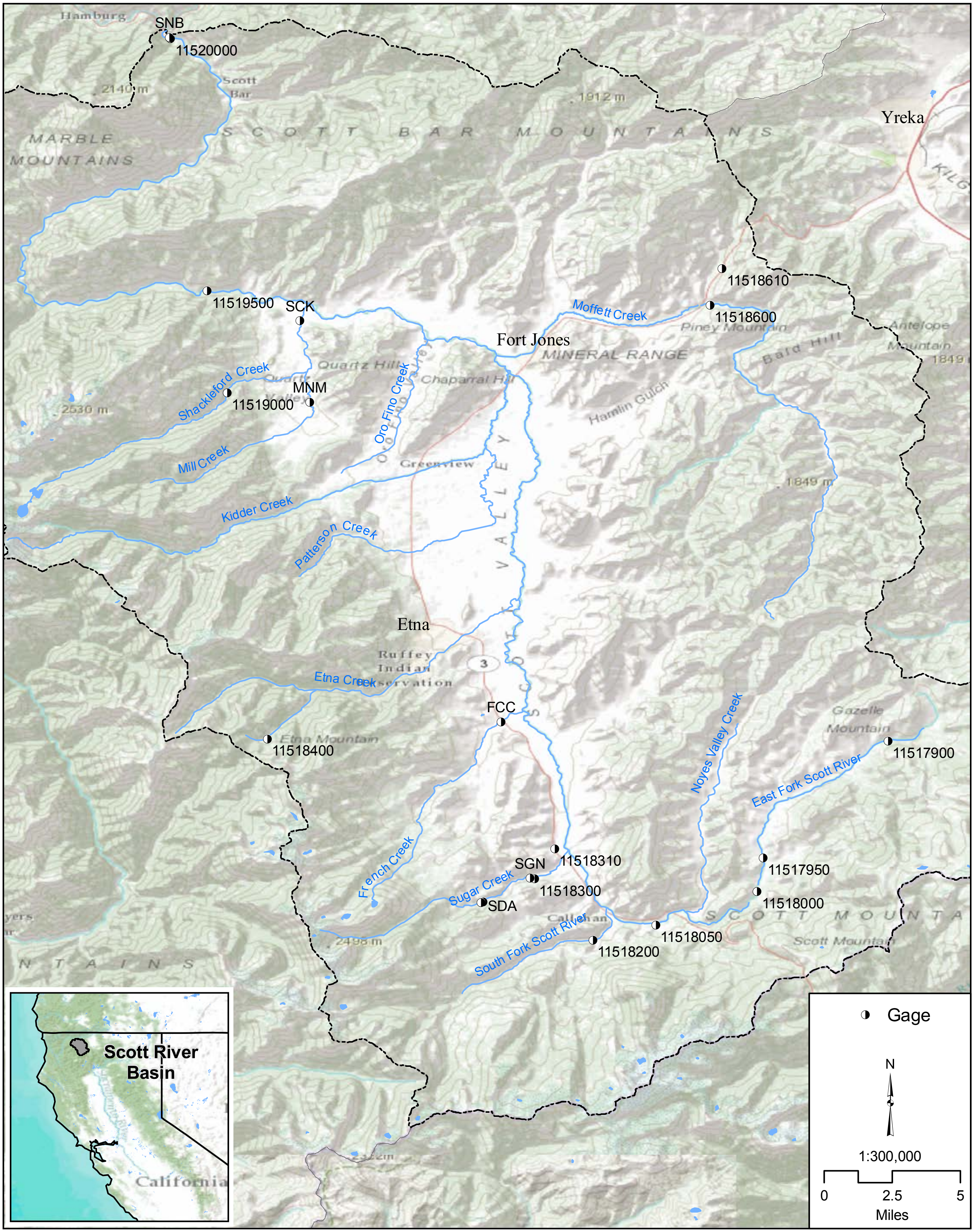

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Figure 1.1 Scott River Sub-Basin

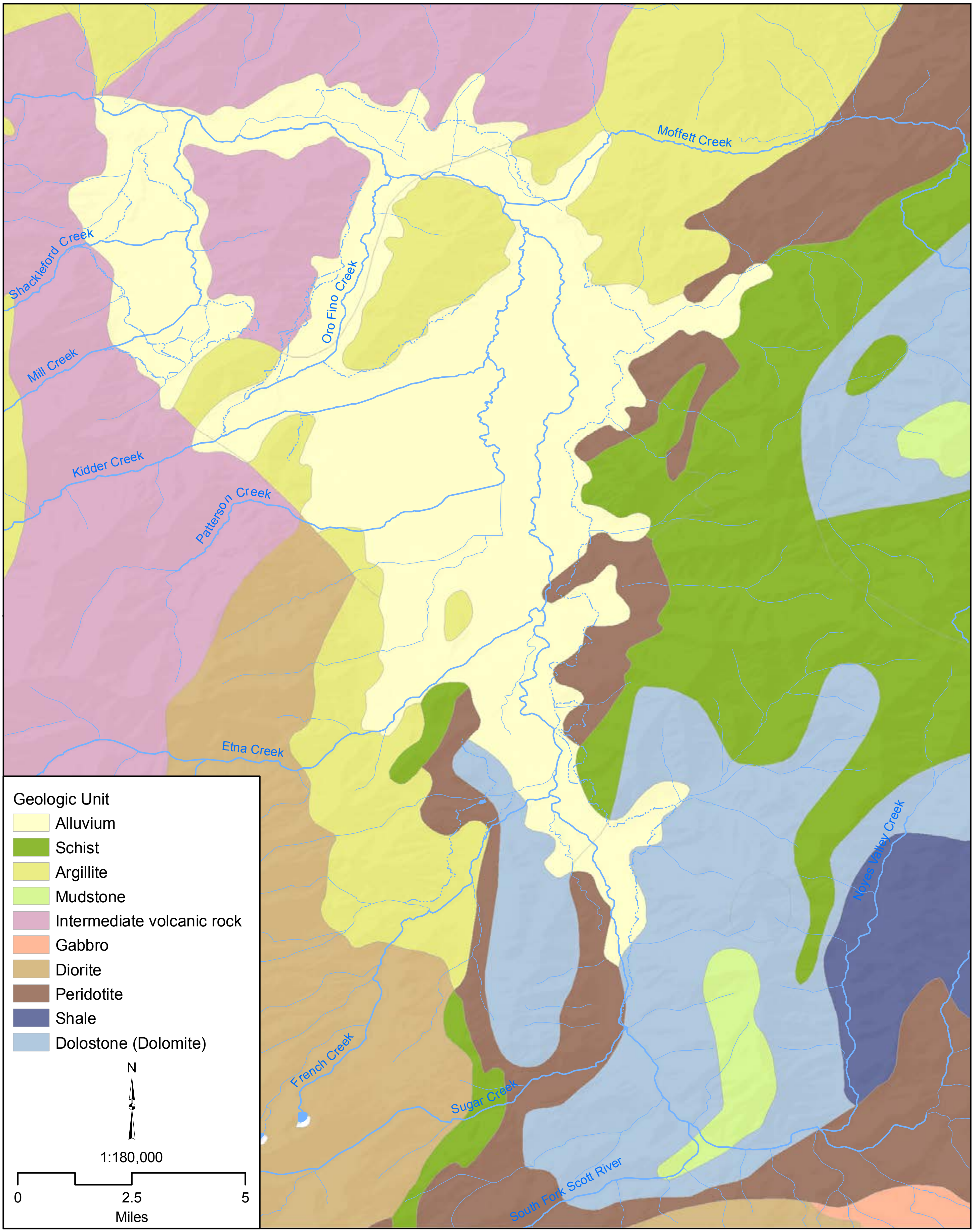

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Figure 2.1 Geologic Units

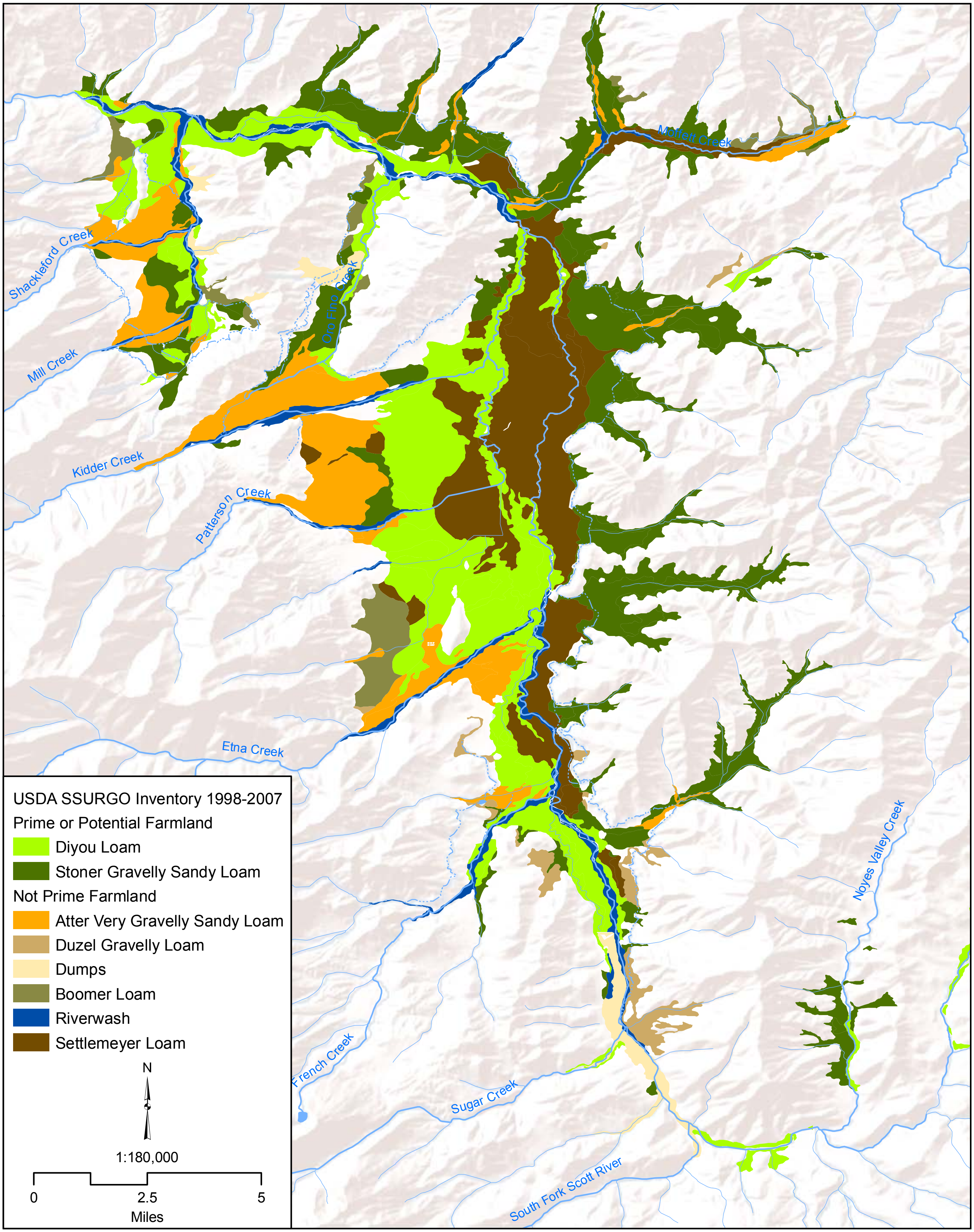

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Figure 2.2 Soils

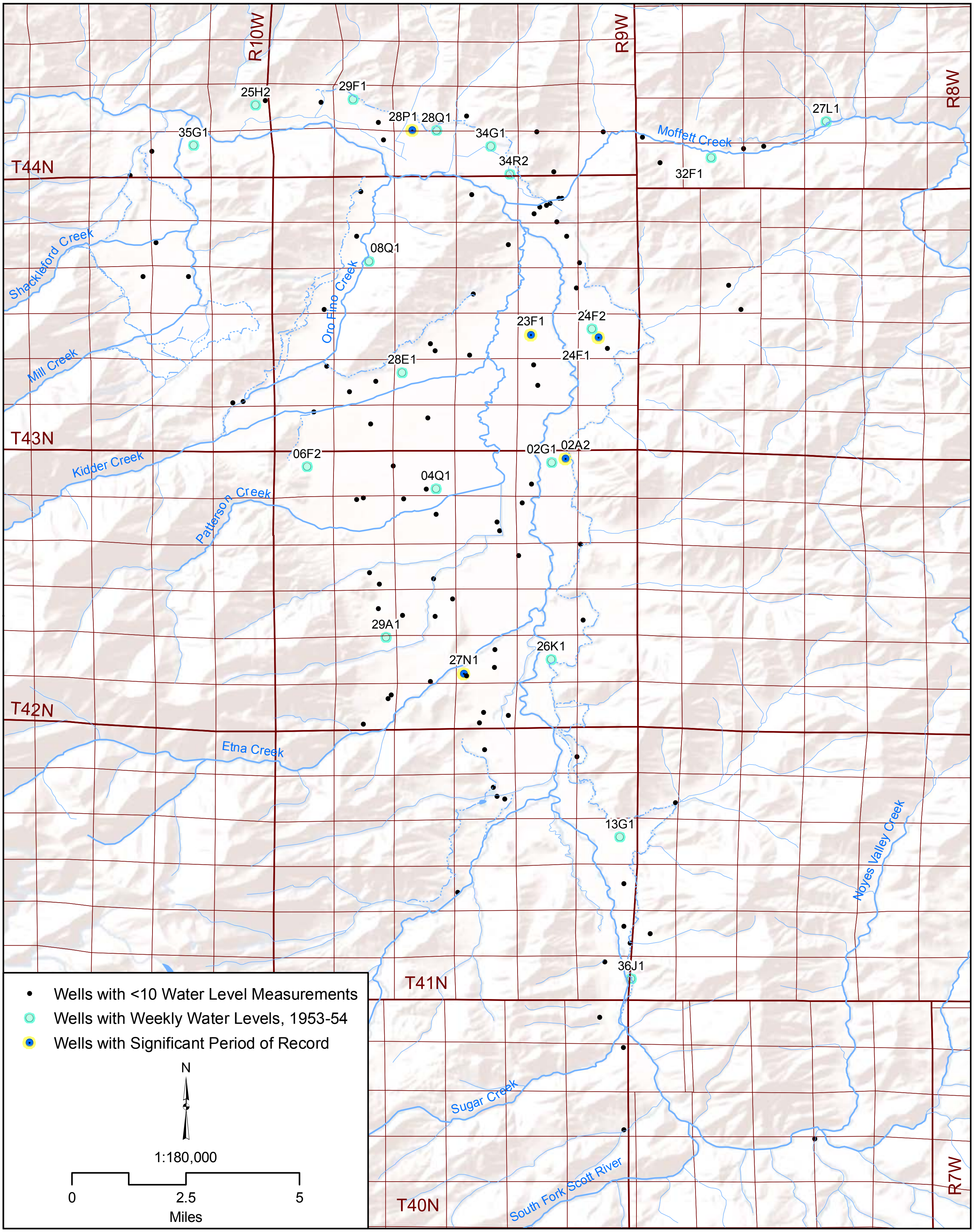

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Figure 2.3 Wells with Groundwater Elevation Measurements

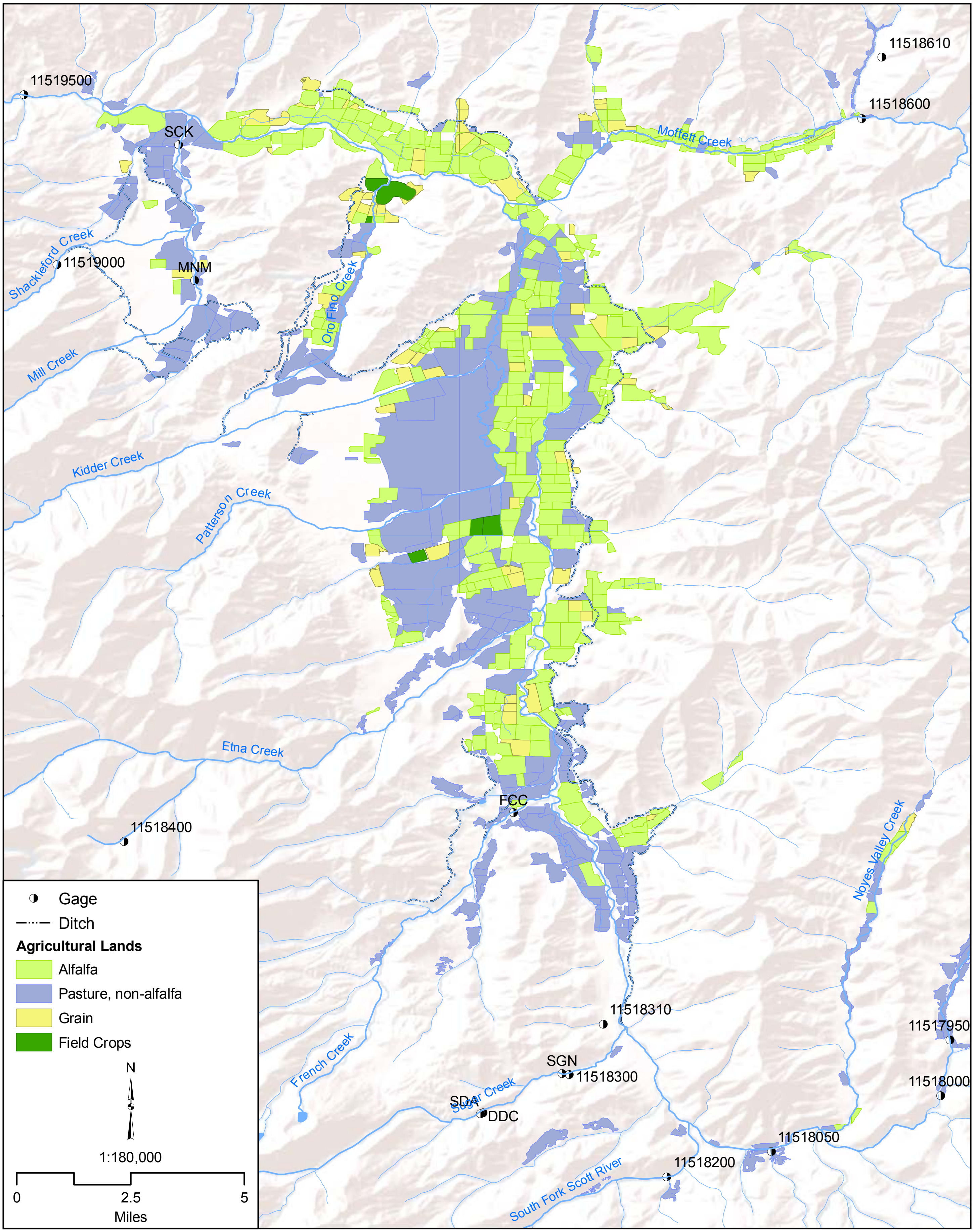

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Figure 2.4 Agricultural Lands and Selected Canals

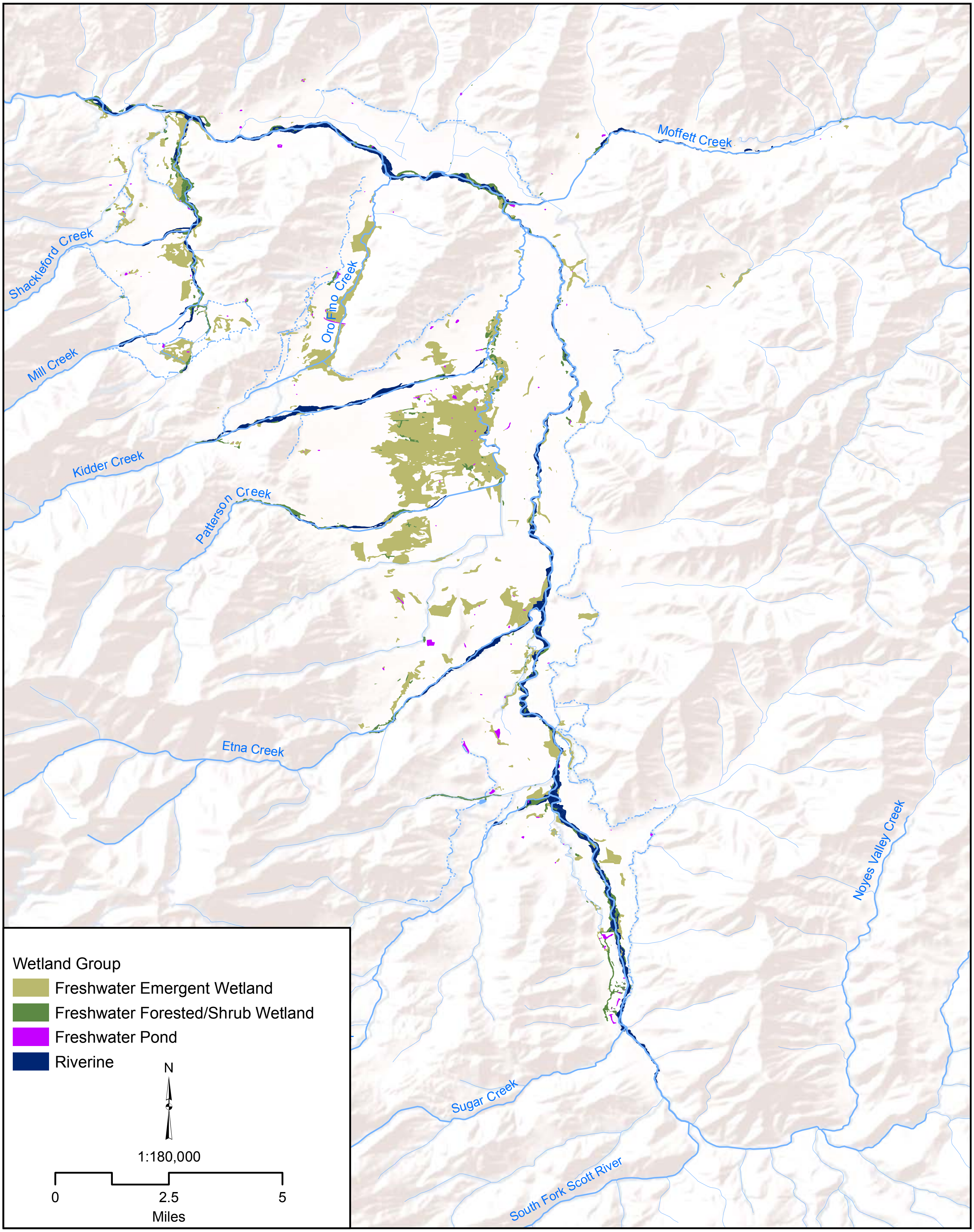

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Figure 2.5 Wetland Groups

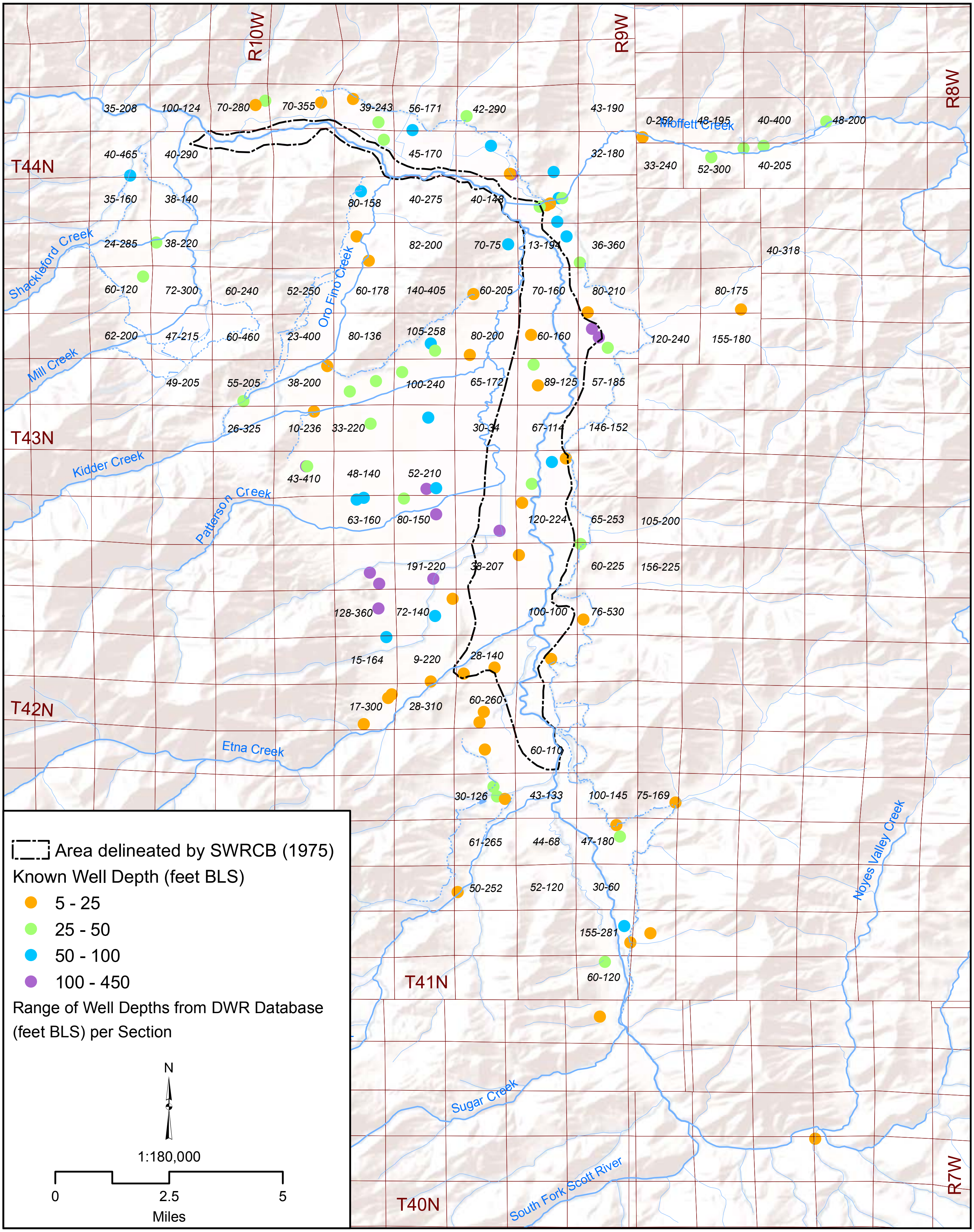

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Figure 3.1 Well Depth

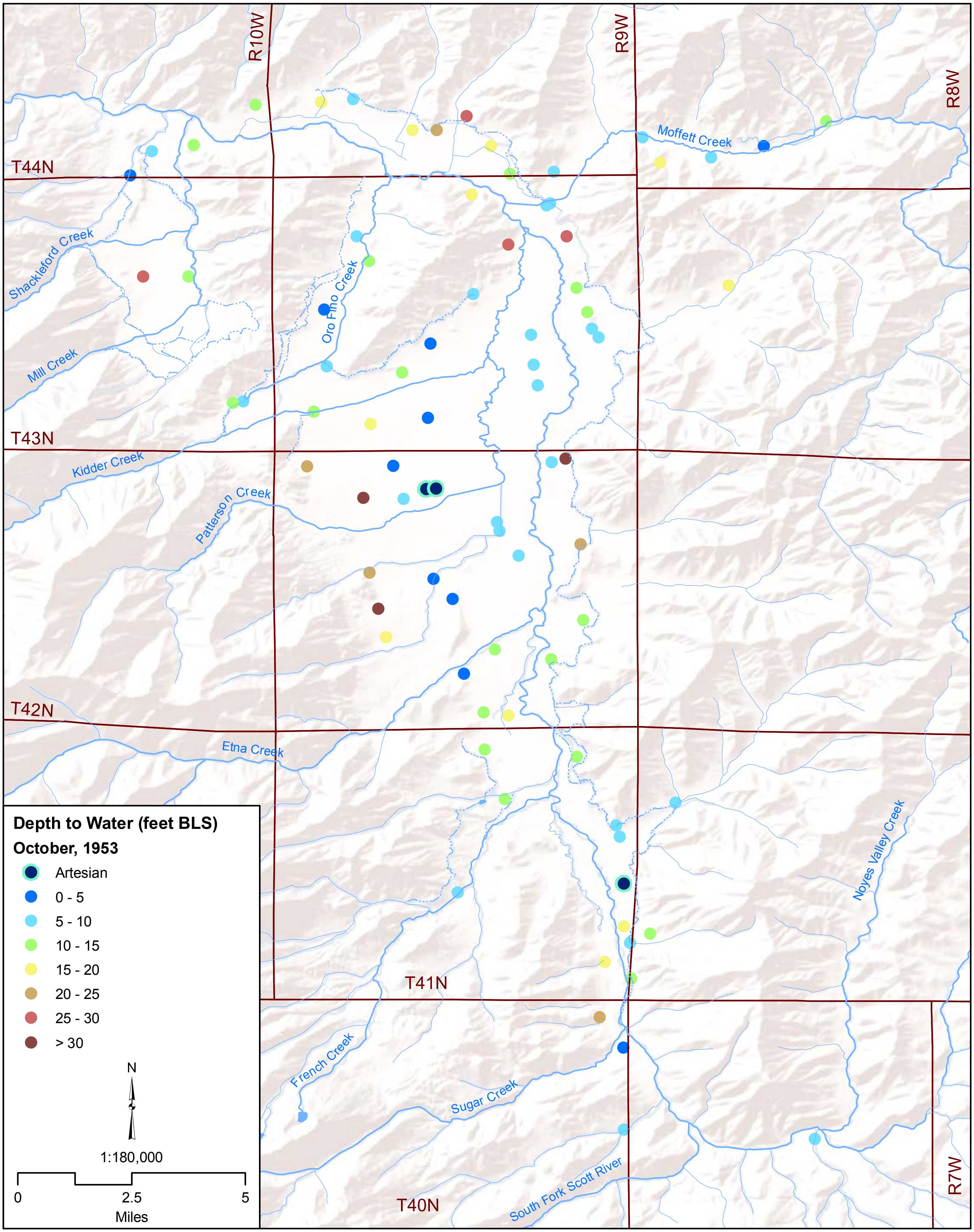

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Figure 3.2 Depth To Water

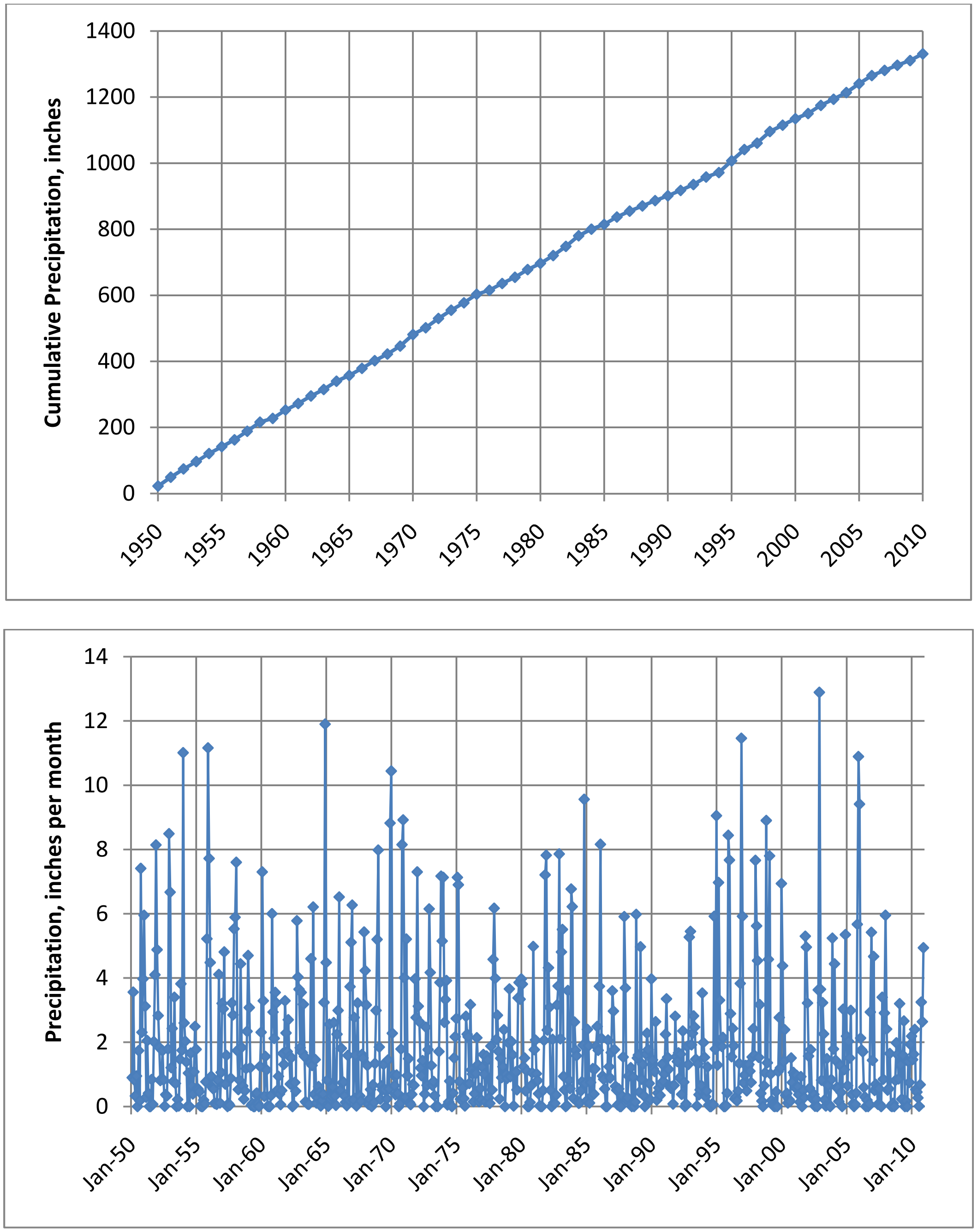

Figure 3.3. Cumulative Mass Plot, Precipitation at Ft. Jones, 1950 to 2010

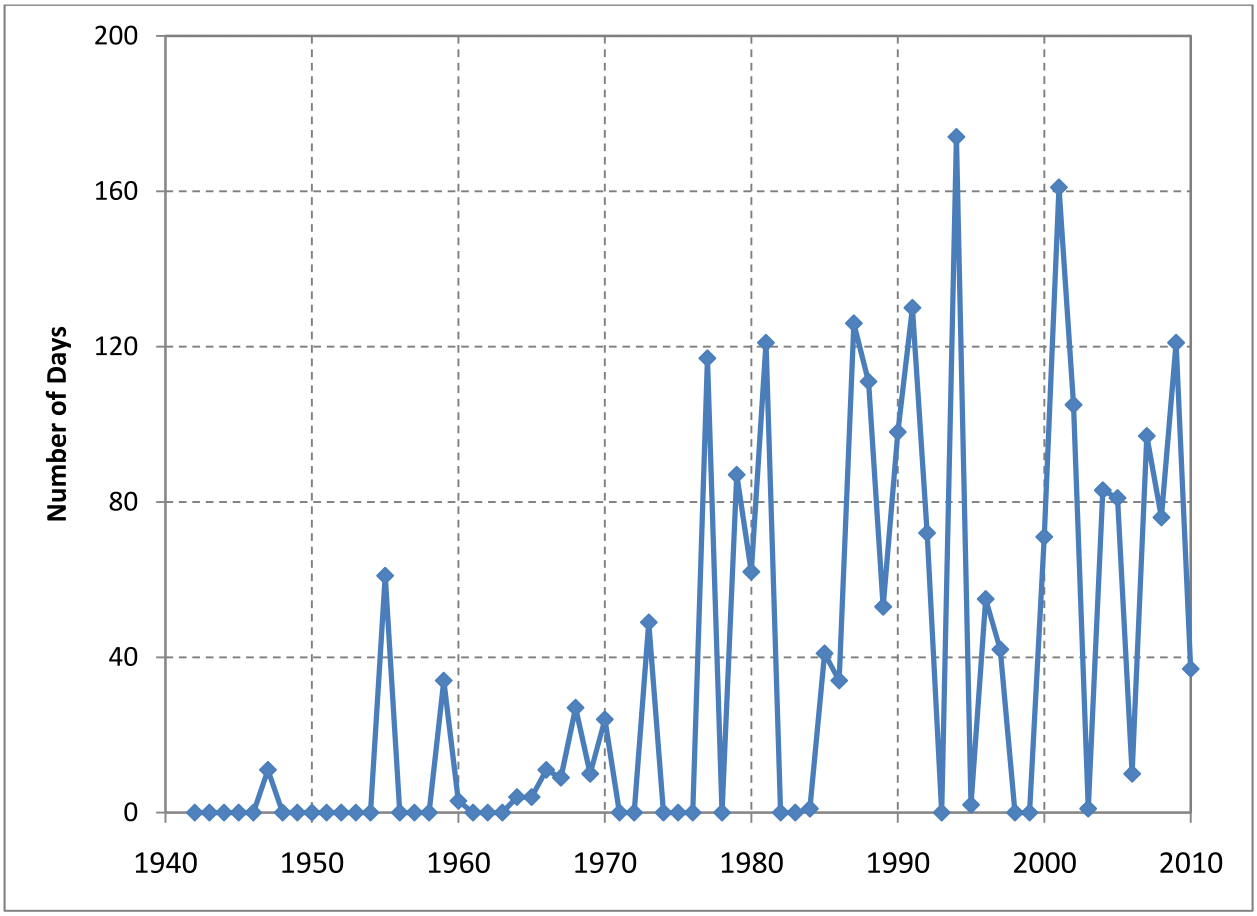

Figure 3.4. Number of Days with Flow at Ft. Jones below 40 cfs

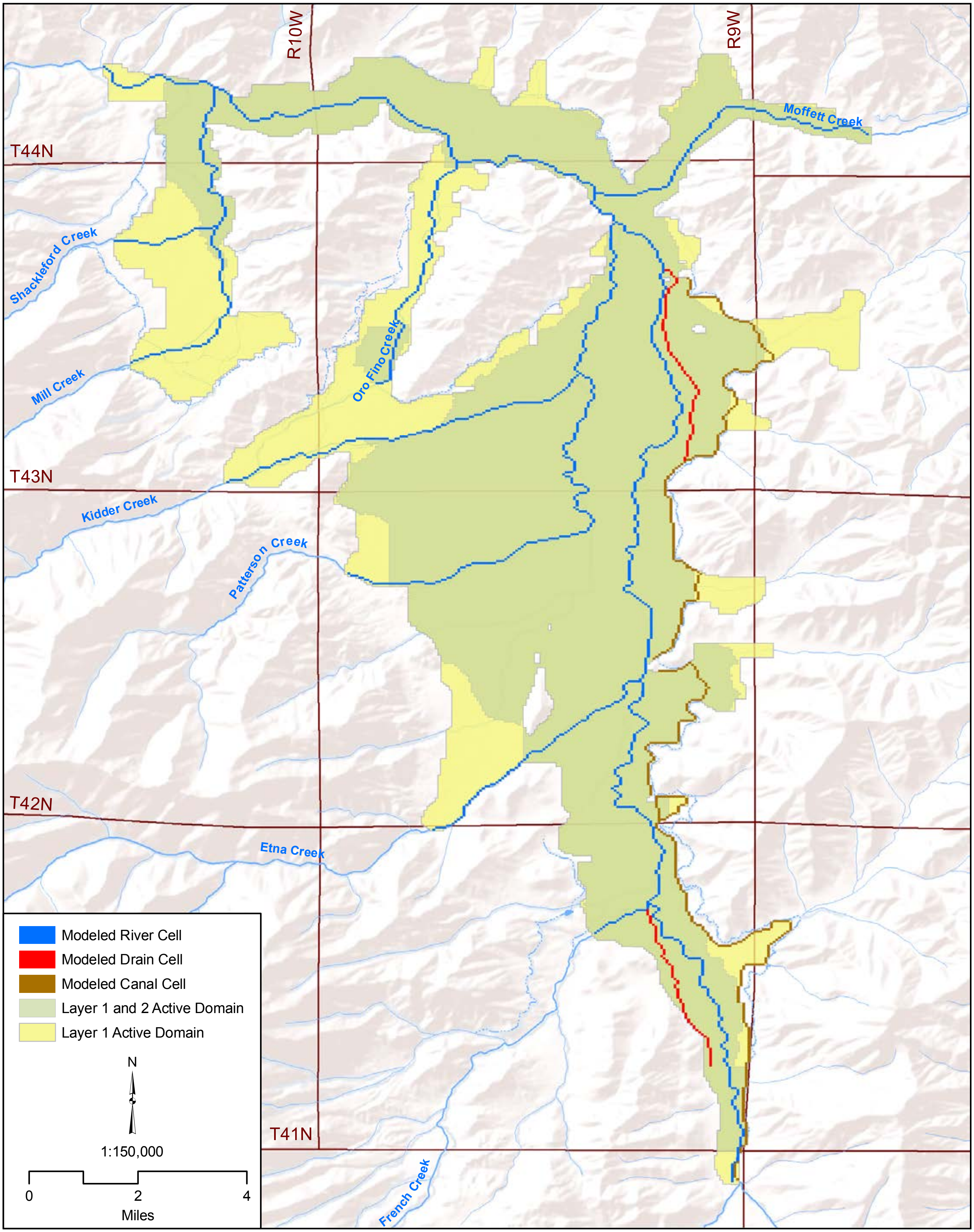

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Figure 4.1 Groundwater Model Features

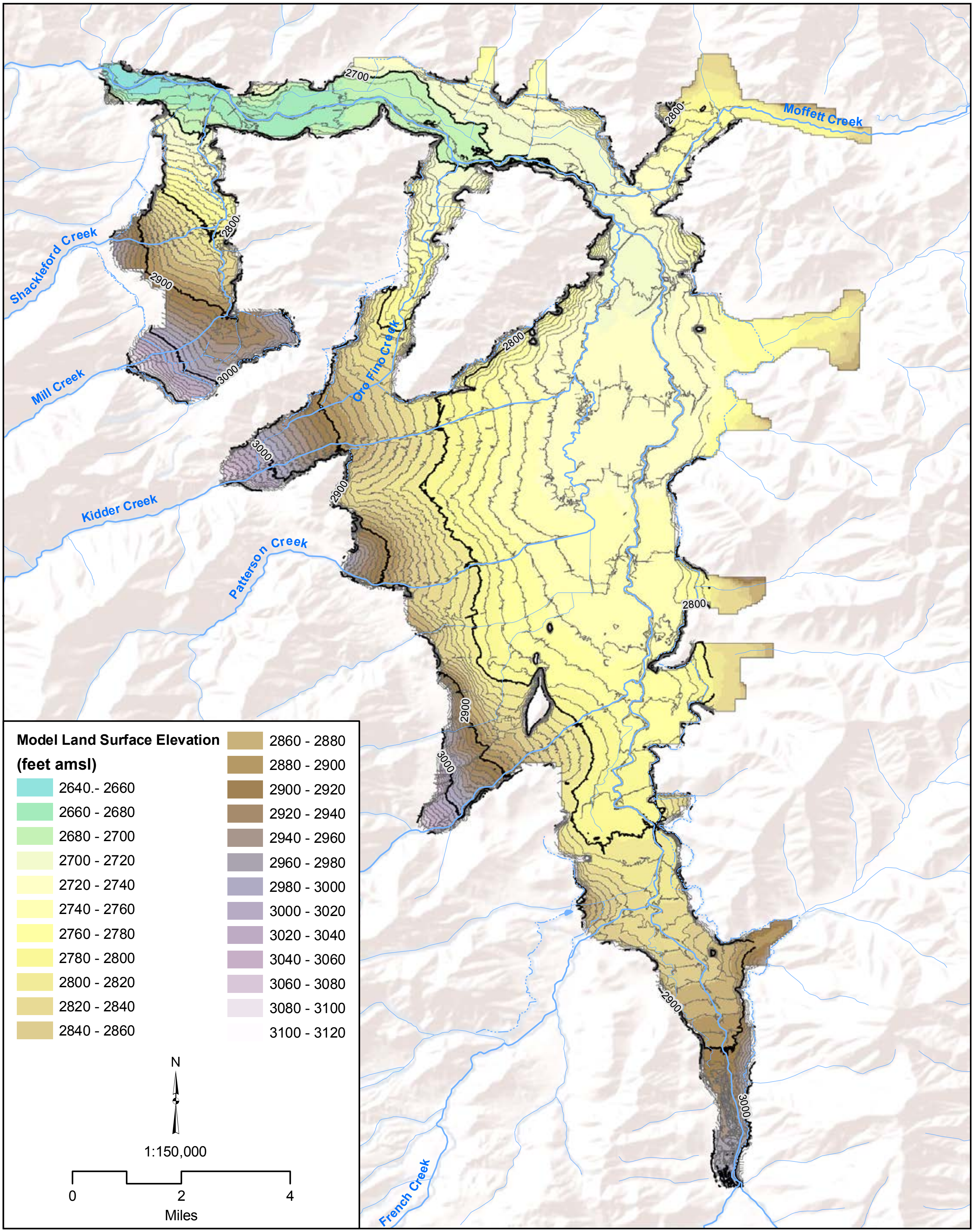

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Figure 4.2 Land Surface Elevation

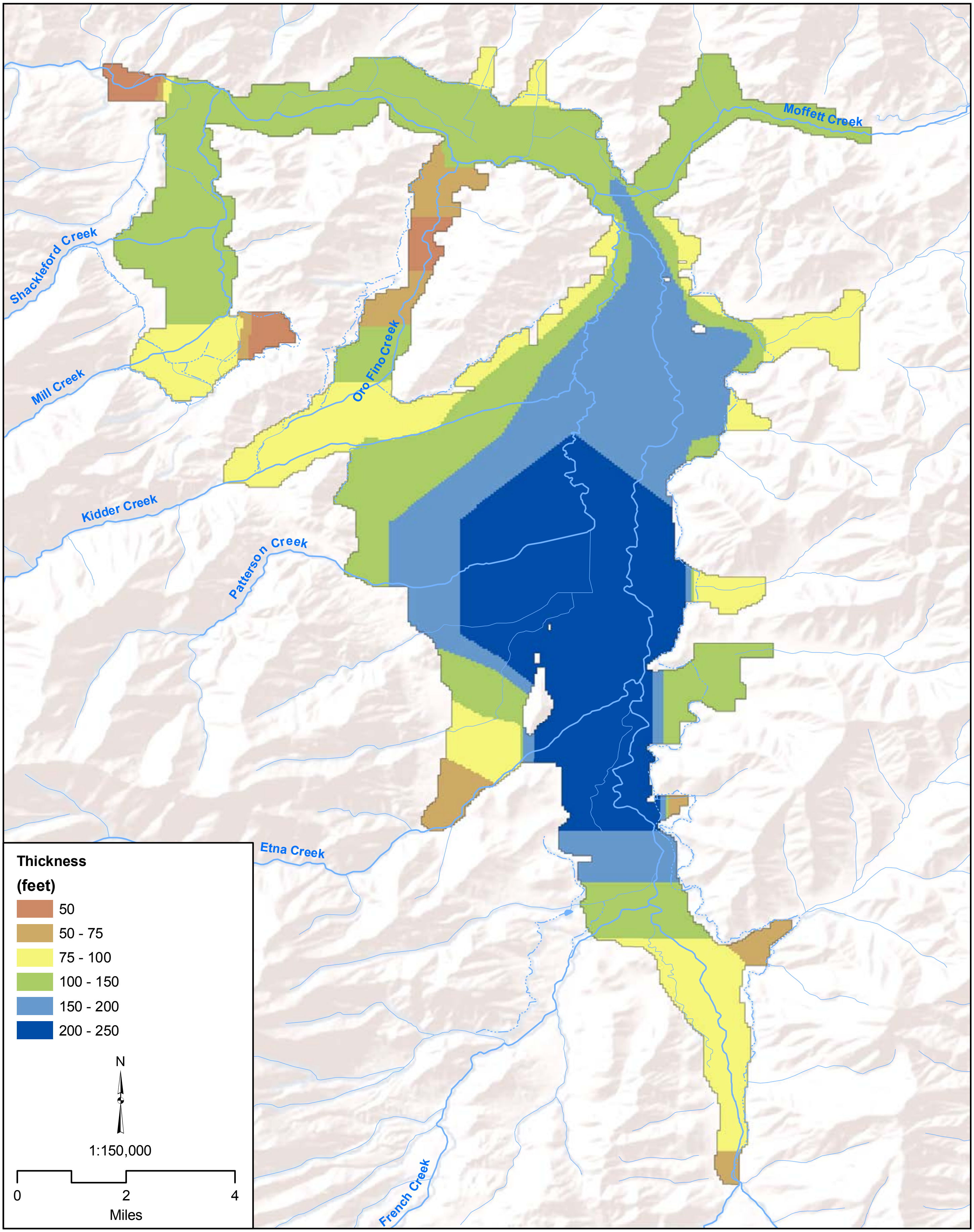

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Figure 4.3 Alluvial Aquifer Thickness Represented in the Groundwater Model

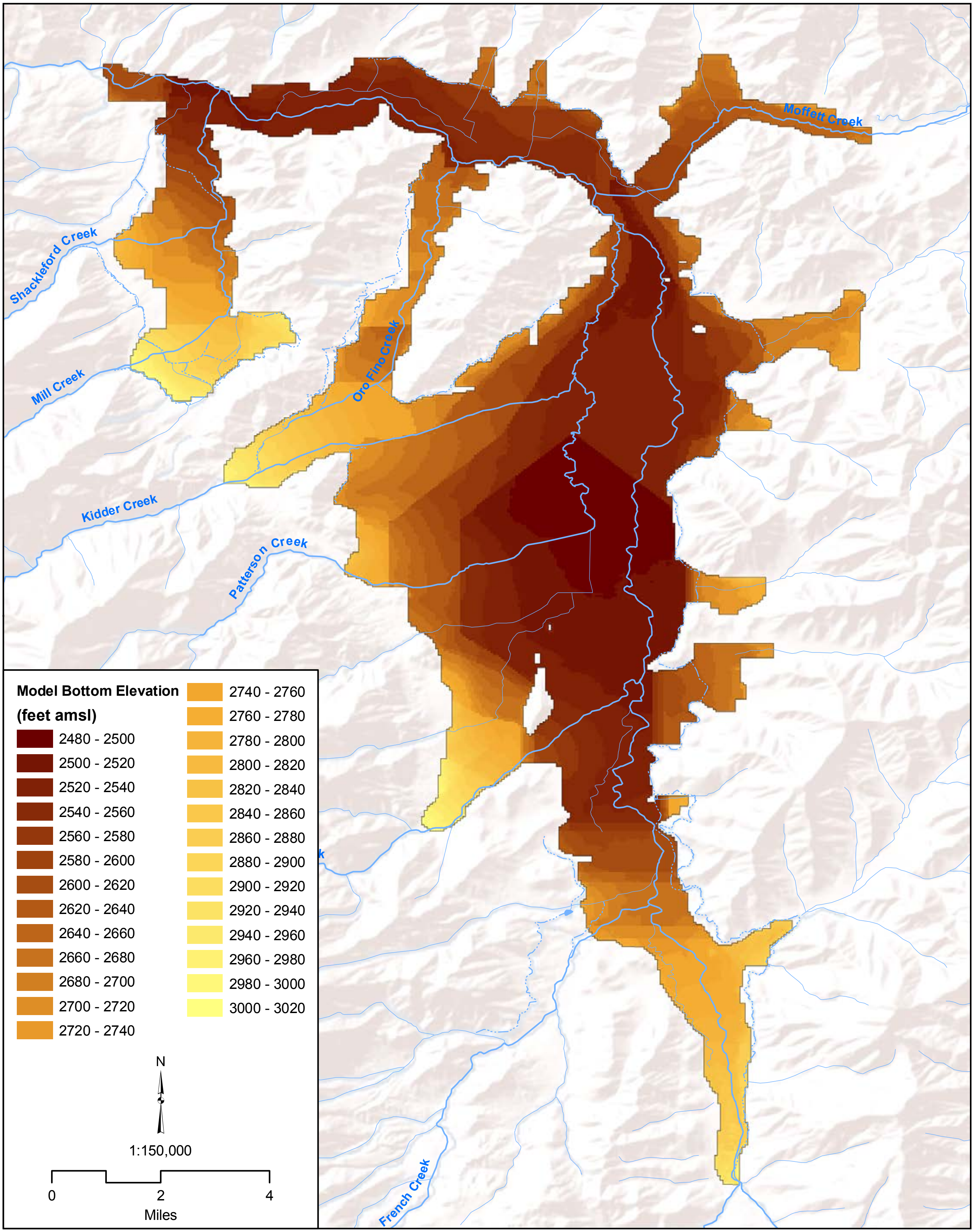

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Figure 4.4 Model Bottom Elevation

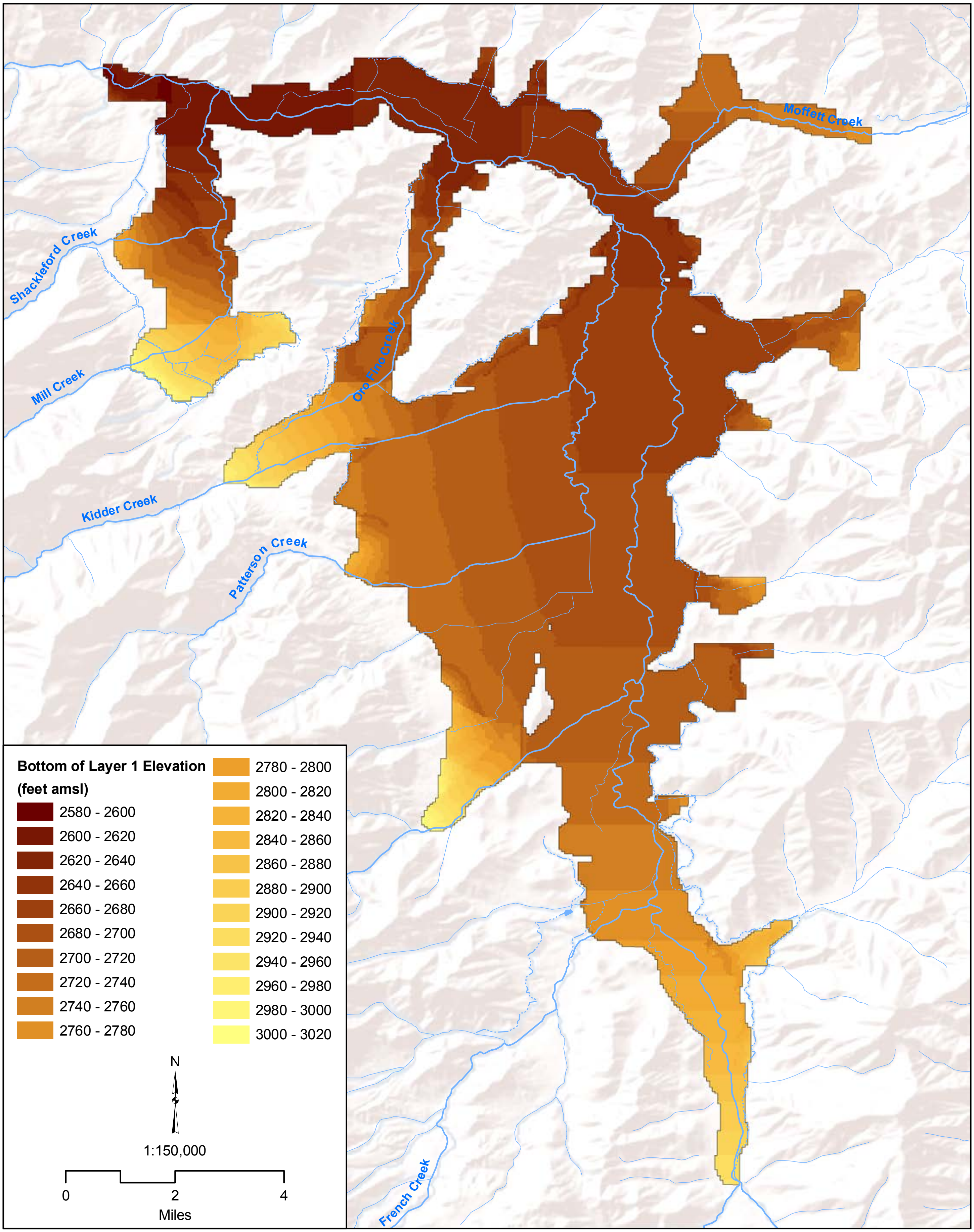

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Figure 4.5 Layer 1 Bottom Elevation

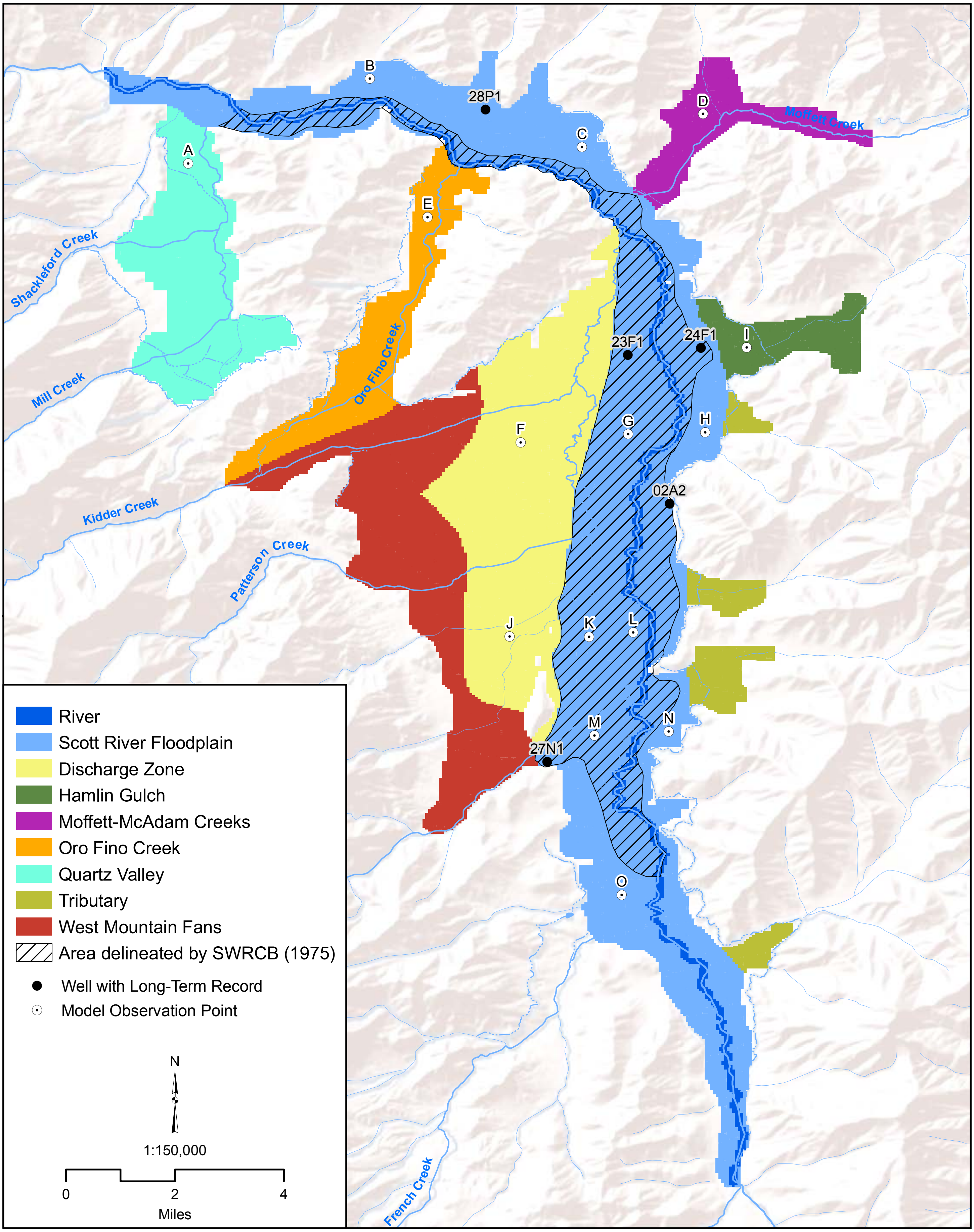

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Figure 4.6 Groundwater Model Sub-Regions and Selected Observation Locations

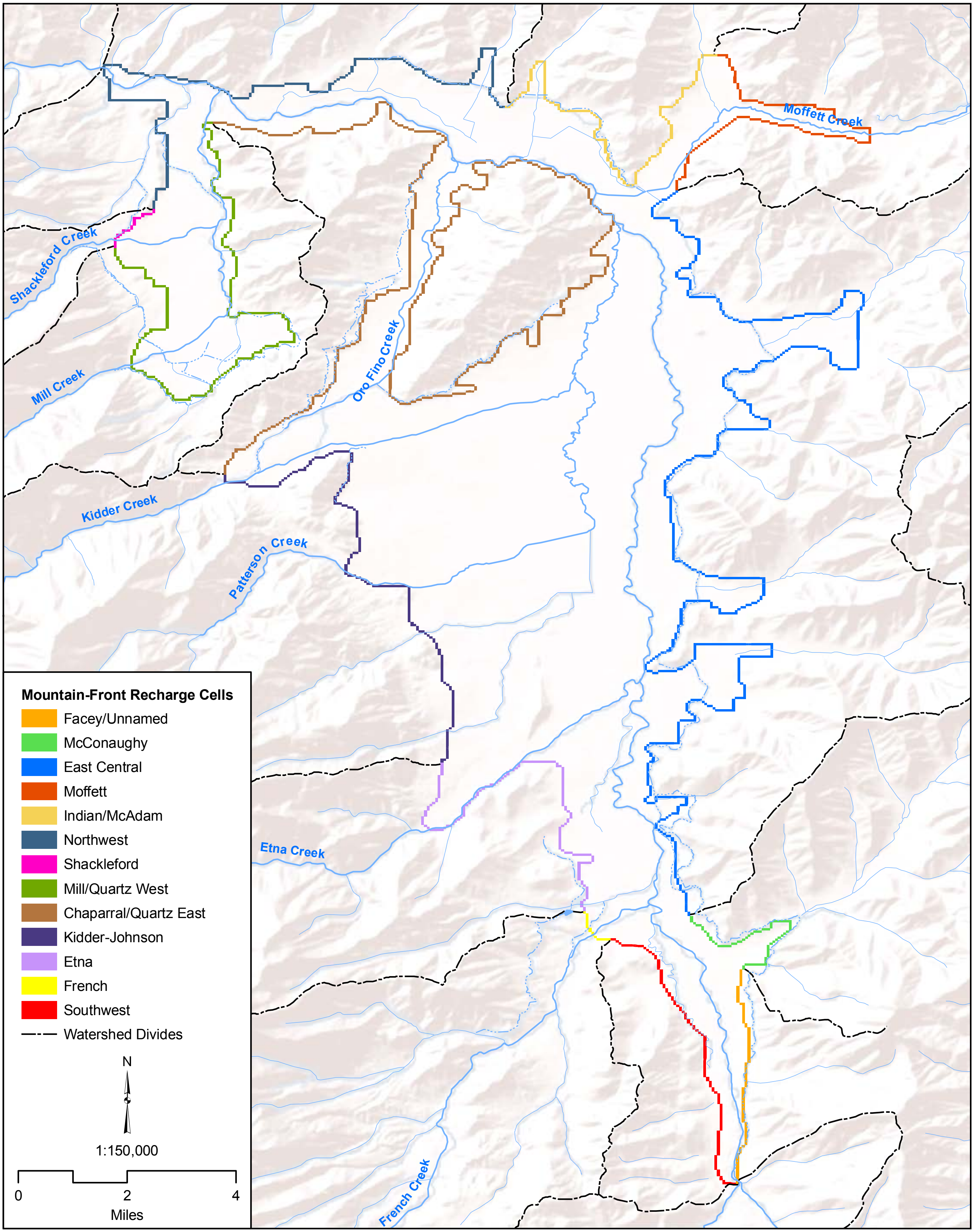

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Figure 4.7 Mountain-Front Recharge Cells

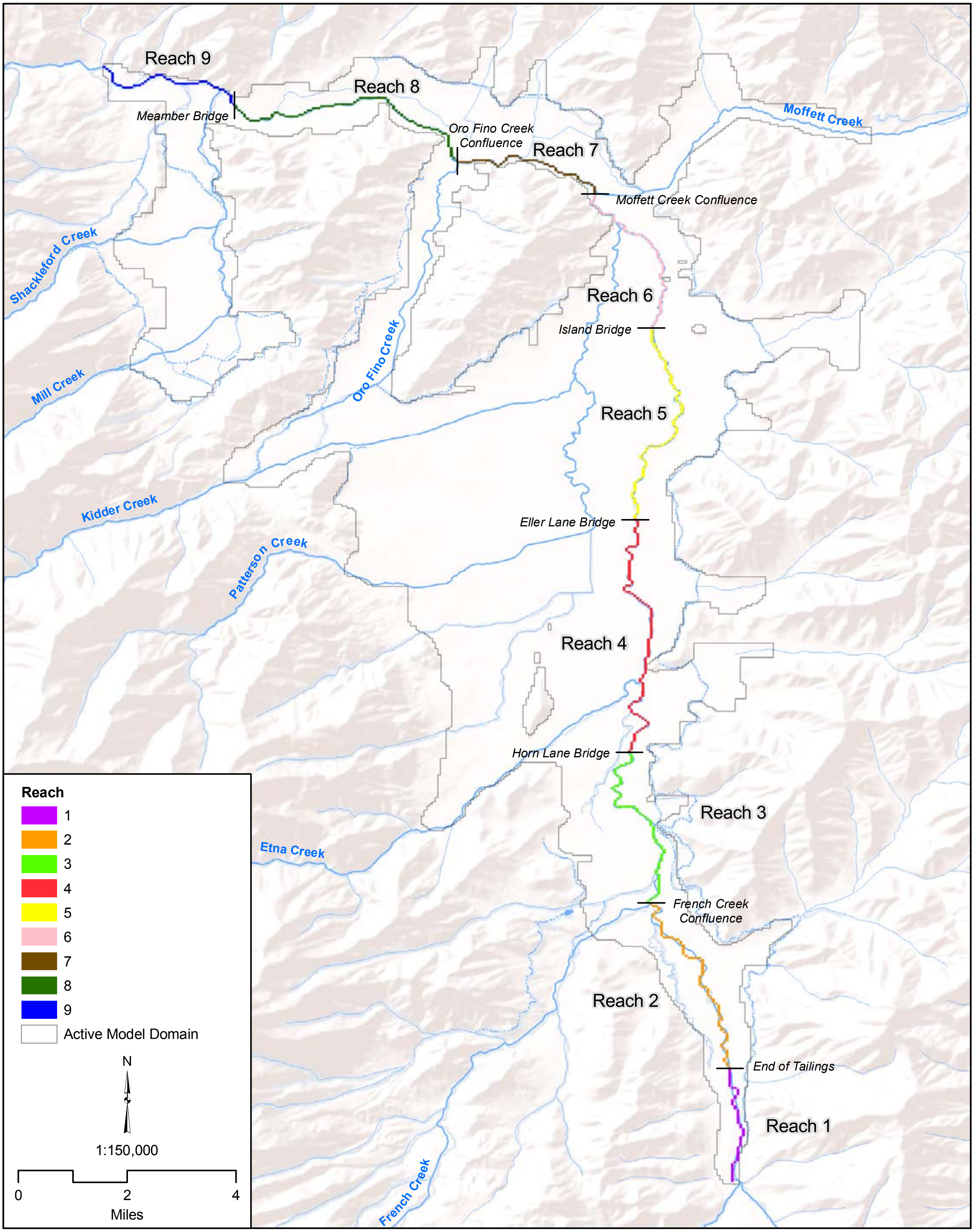

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Figure 4.8 Modeled Reaches, Scott River

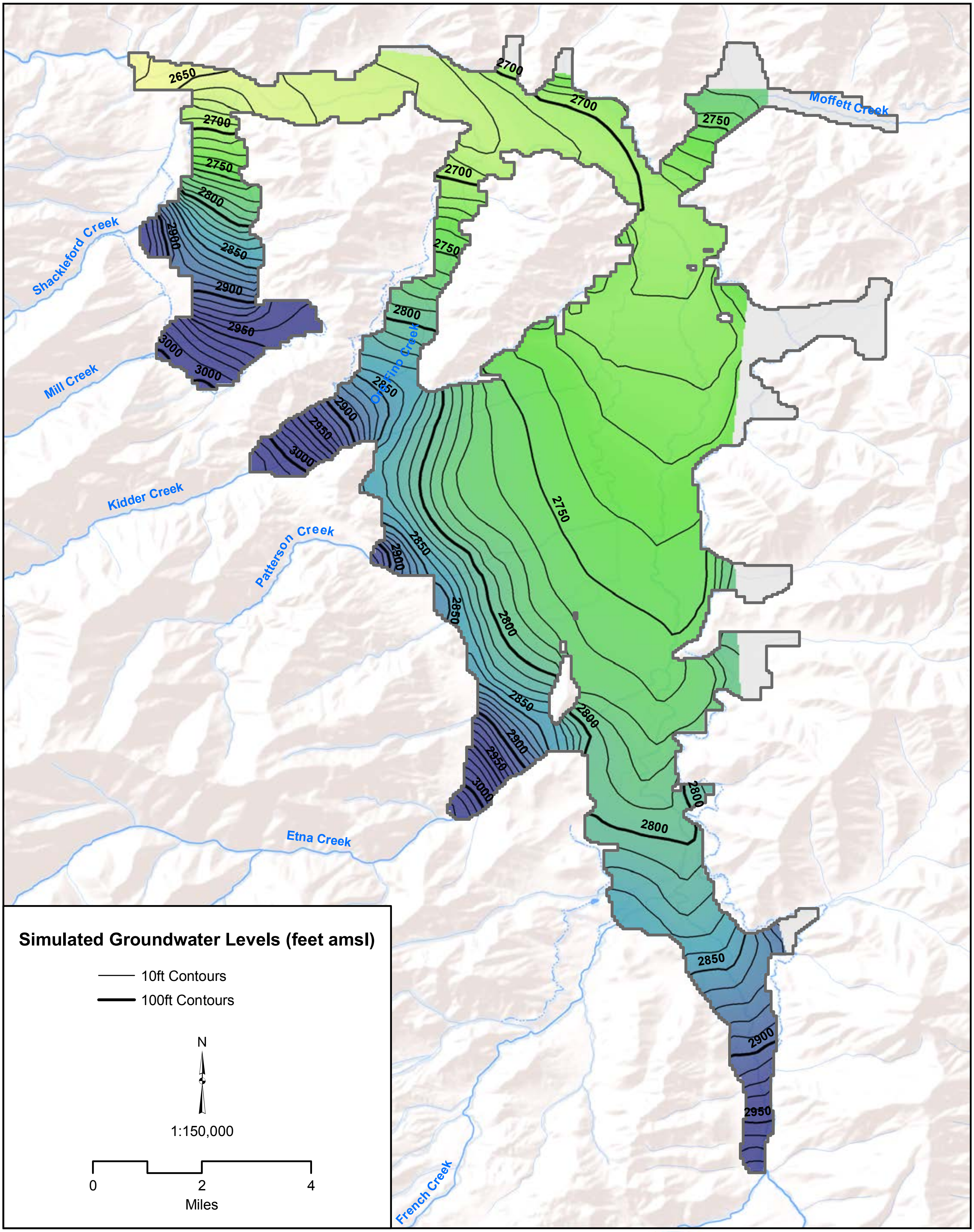

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Figure 5.1 Simulated Groundwater Contours at End of Irrigation Season, Partial Build-Out

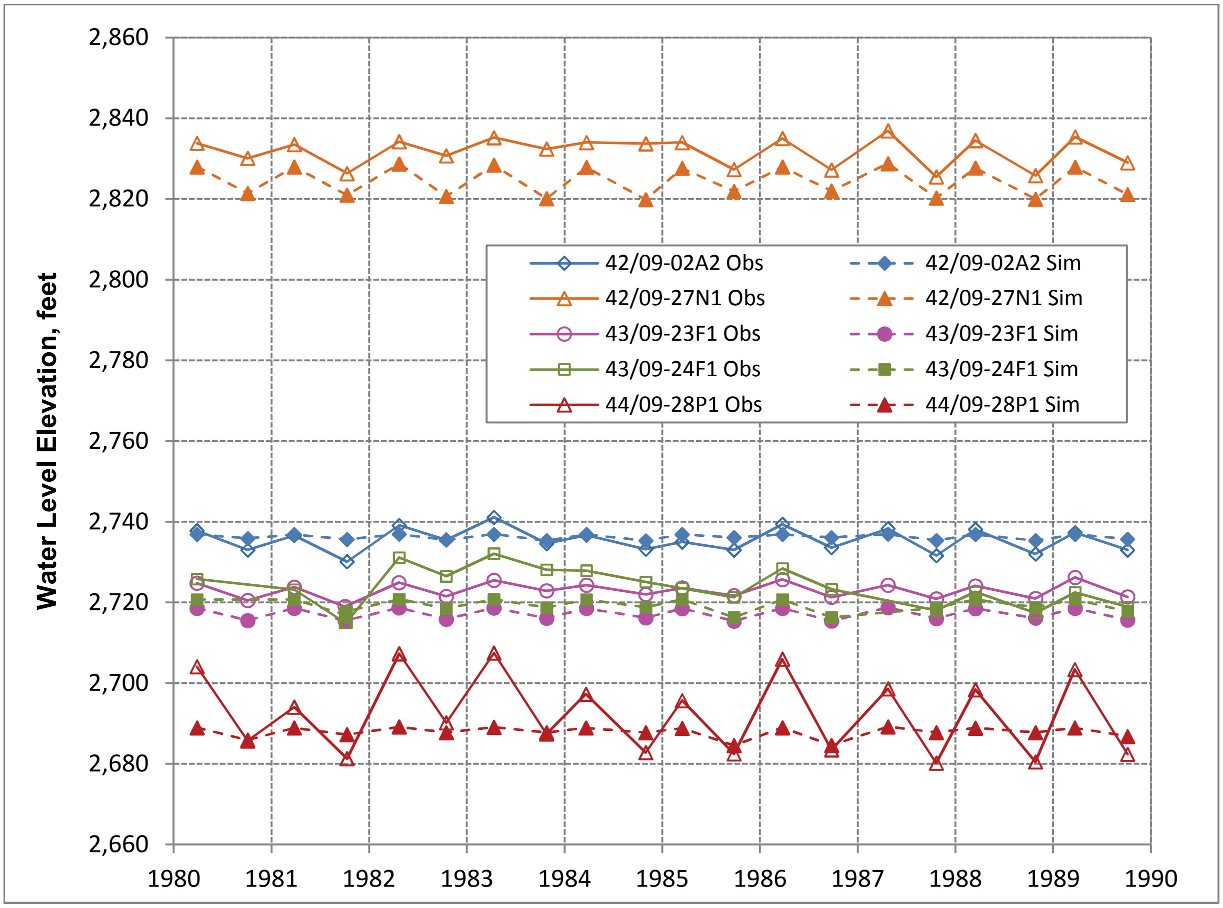


Figure 5.2 Simulated and Observed Groundwater Elevations at Selected Locations, Partial Build-Out

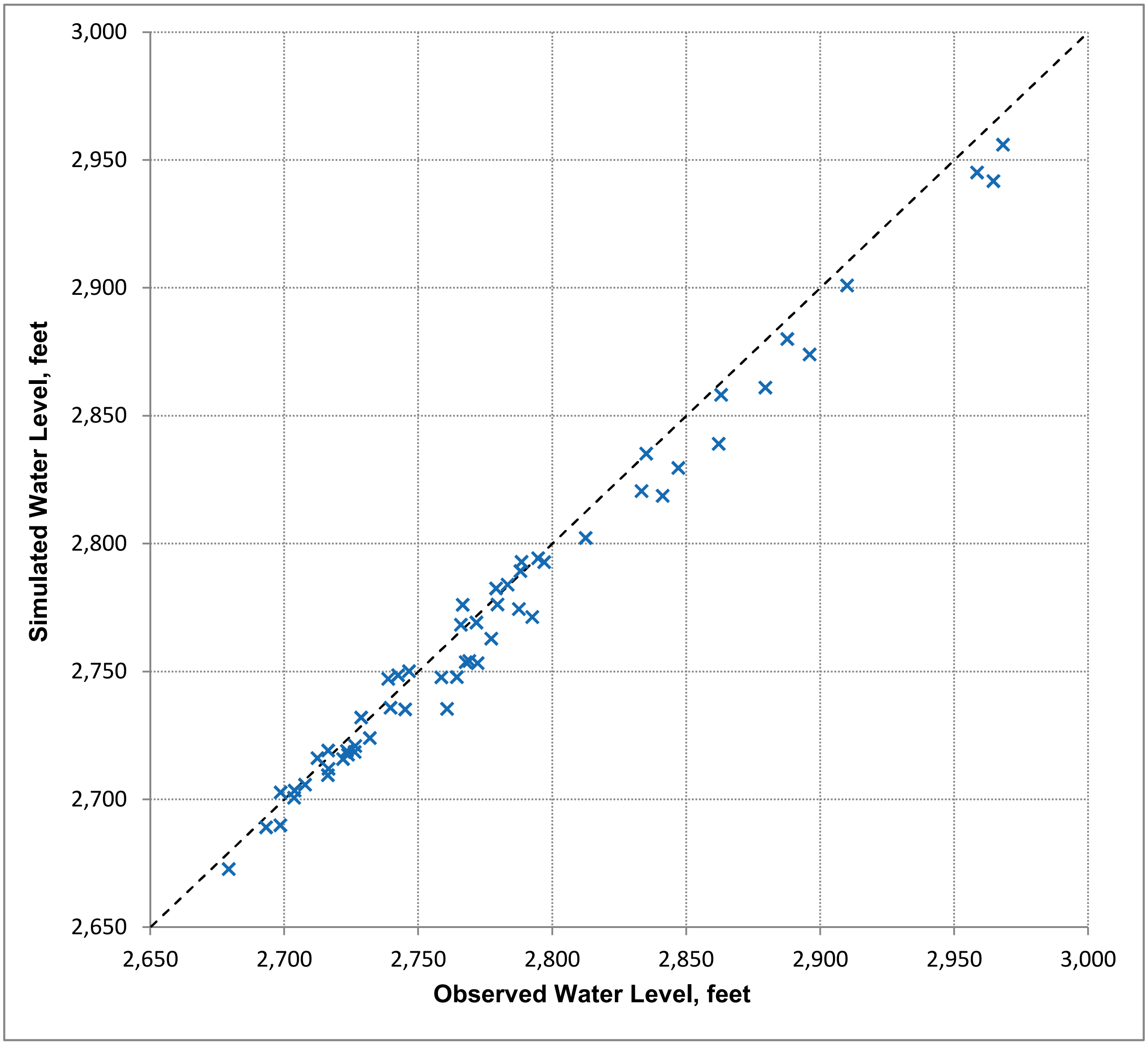
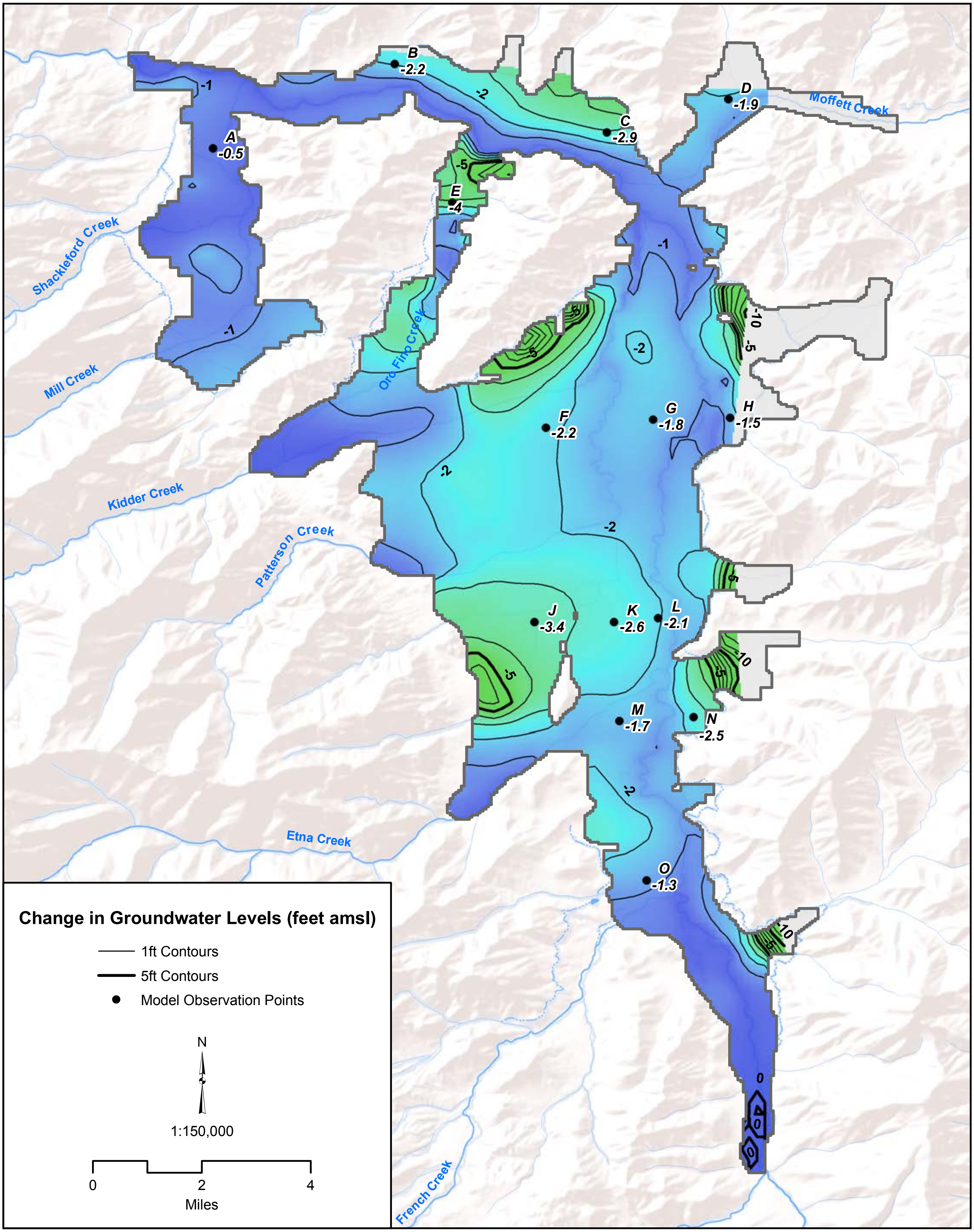


Figure 5.3 General Comparison of Simulated and Observed Groundwater Elevations



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6.1 Change in Simulated October Groundwater Levels due to Change in Pumping from Partial Build-Out to Recent Condition

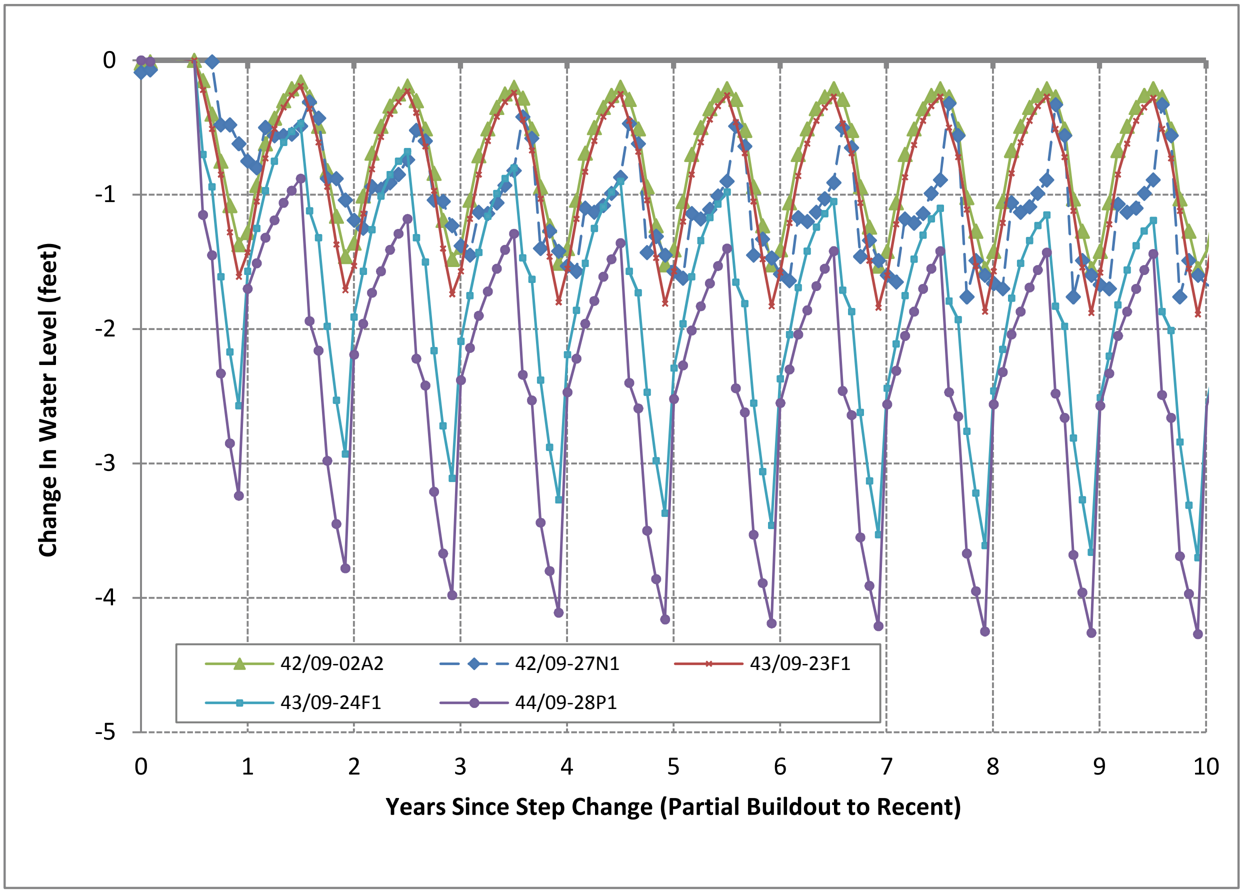
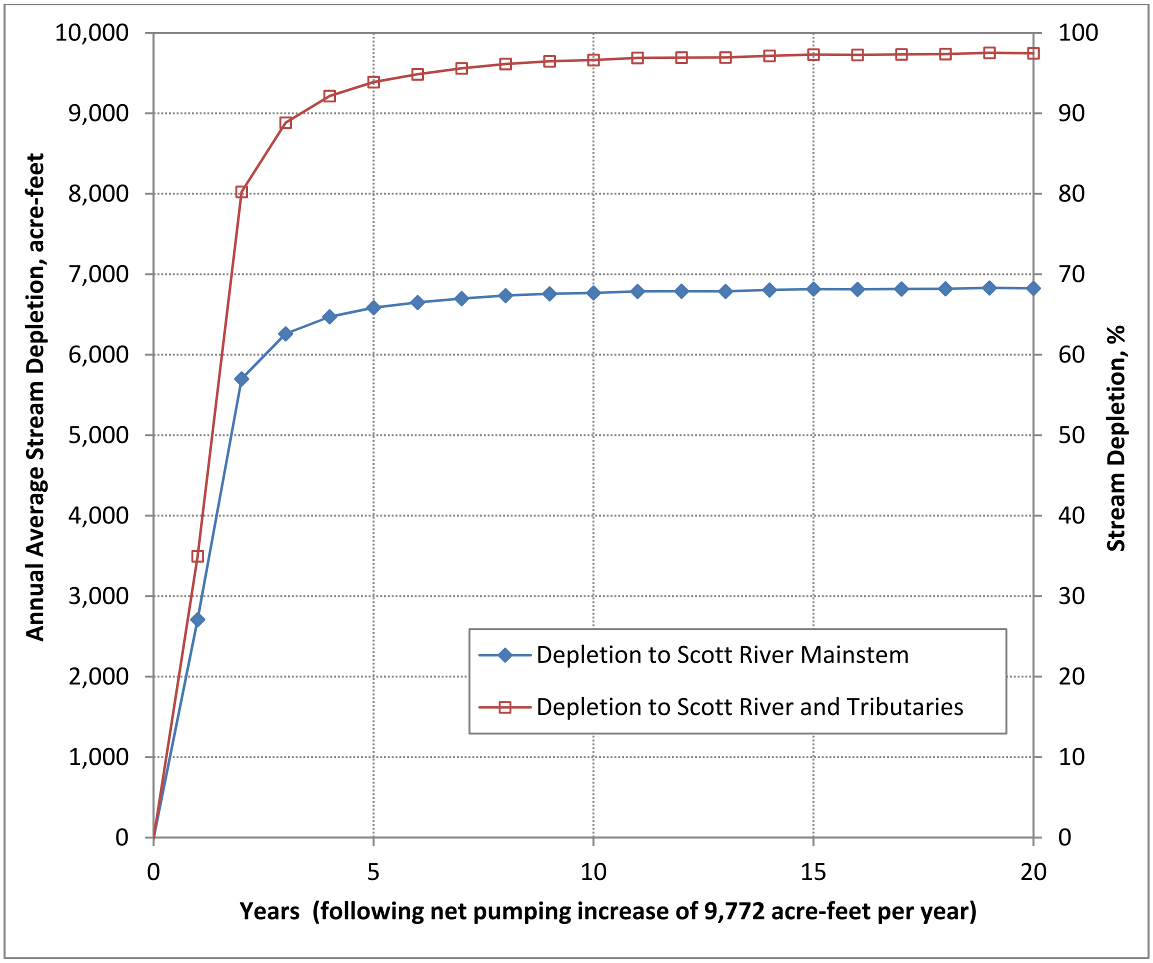
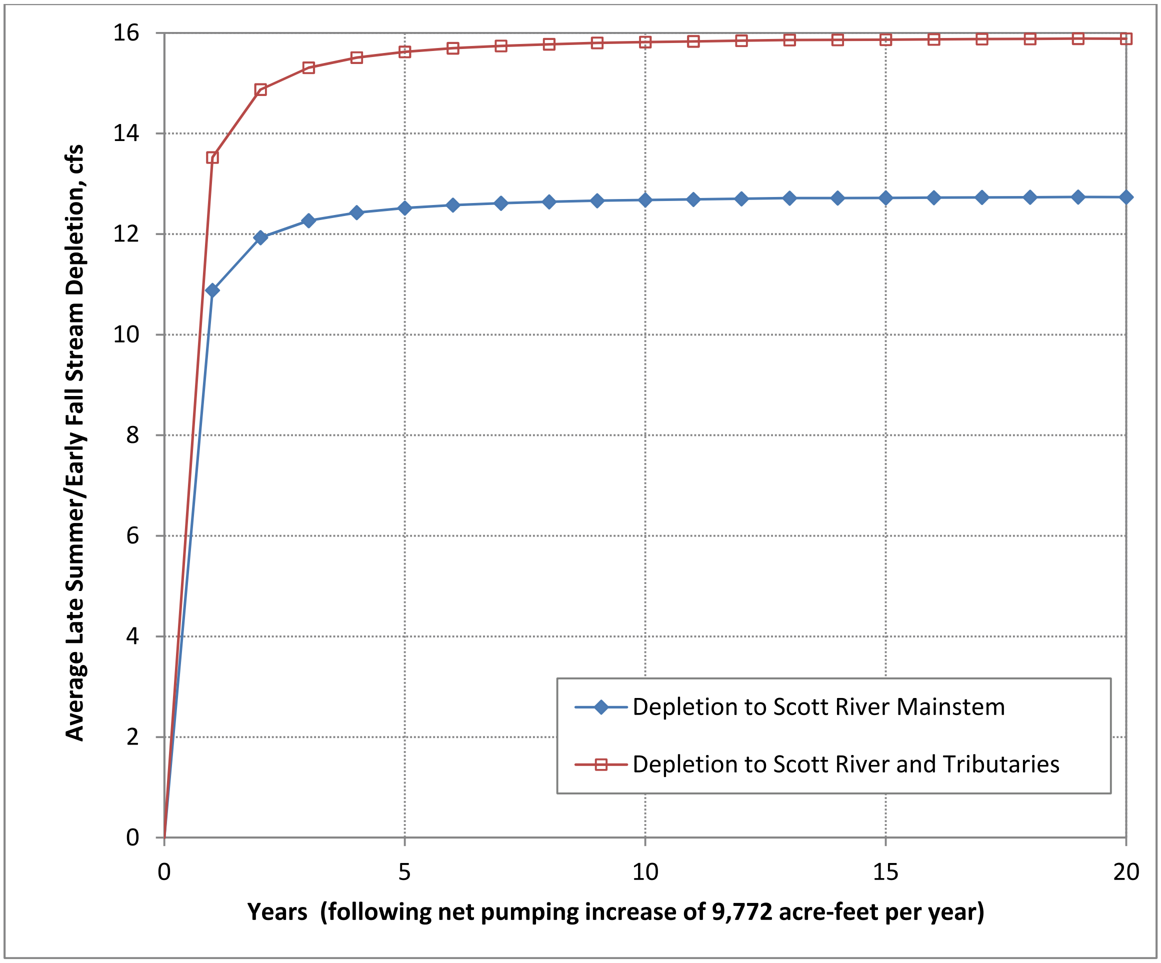


Figure 6.2 Change in Simulated Groundwater Elevations at Selected Locations due to Step-Change in Pumping from Partial Build-Out to Recent Condition



Note: The net increase in pumping is simulated as occurring as a single step; the resulting curve can be used to identify lagged depletion impacts from a gradual change in pumping

Figure 6.3 Average Annual Stream Depletion to Scott River and Tributaries from Increased Groundwater Use, Partial Build-Out to Recent Pumping Levels



Note: The net increase in pumping is simulated as occurring as a single step; the resulting curve can be used to identify lagged depletion impacts from a gradual change in pumping

Figure 6.4 Late Summer/Early Fall Stream Depletion to Scott River and Tributaries from Increased Groundwater Use, Partial Build-Out to Recent Condition

Tables

Table 2.1
Wells with One or More Depth to Water Measurements

Short Well Name	State Well Number	USGS Site Number	Construction Date	Well Depth	Use	Elevation, feet, NGVD29
40/09-01G1	040N009W01G001M	412048122494901		20		3,019
40/09-12A1	040N009W12A001M	412013122492201				3,050
40/09-13R1	040N009W13R001M	411839122492101	1937			3,183
40/08-14N1	040N008W14N001M	411828122454201		16		3,256
41/09-02J1	041N009W02J001M	412547122501501				2,828
41/09-03L1	041N009W03L001M	412555122520101	1949	25		2,827
41/08-07J1	041N008W07J001M	412454122482201	1900	22		2,951
41/09-10G1	041N009W10G001M	412512122515101	1949	30		2,880
41/09-10J1	041N009W10J001M	412501122514701		50		2,872
41/09-10J2	041N009W10J002M	412458122513801	1938	25		2,859
41/09-13B1	041N009W13B001M	412428122493001	1930	18		2,889
41/09-13G1	041N009W13G001M	412415122492601	1900	32		2,889
41/09-22M1	041N009W22M001M	412311122523201	1952	15		2,958
41/09-24H1	041N009W24H001M	412321122492101				2,896
41/09-25H1	041N009W25H001M	412232122492101	1949	65		2,928
41/09-25R1	041N009W25R001M	412213122491401		14		2,697
41/08-30L1	041N008W30L001M	412224122485101	1923	18		3,089
41/09-36B1	041N009W36B001M	412151122494301		28		2,980
41/09-36J1	041N009W36J001M	412132122491301				2,973
42/09-02A2	042N009W02A002M	413129122502801		22	Domestic	2,746
42/09-02G1	042N009W02G001M	413125122504401	1948	76		2,750
42/09-02N1	042N009W02N001M	413100122510701	1952	28		2,741
42/09-04P1	042N009W04P001M	413054122530801	1951	156		2,769
42/09-04Q1	042N009W04Q001M	413055122525701	1936	60		2,767
42/09-05H1	042N009W05H001M	413121122534601				2,783
42/09-06F1	042N009W06F001M	413120122552601		111		2,852
42/09-06F2	042N009W06F002M	413120122552501	1953	26		2,852
42/09-08C1	042N009W08C001M	413044122542001	1950			2,831
42/09-08C3	042N009W08C003M	413042122542801		66		2,836
42/09-09D1	042N009W09D001M	413043122533401	1948	32		2,805
42/09-09G1	042N009W09G001M	413025122525701	1950	450		2,750
42/09-10K1	042N009W10K001M	413016122514701	1952			2,744
42/09-10Q1	042N009W10Q001M	413006122514401	1953	120		2,748
42/09-11D1	042N009W11D001M	413038122511801	1951	22		2,746
42/09-13D1	042N009W13D001M	412951122501101	1925	35		2,773
42/09-14E1	042N009W14E001M	412938122512201	1942	20		2,756
42/09-16Q1	042N009W16Q001M	412911122530001	1951	150		2,769
42/09-17K1	042N009W17K001M	412918122541301	1952	200		2,863
42/09-17Q1	042N009W17Q001M	412905122540201	1952			2,843
42/09-20G1	042N009W20G001M	412837122540301	1925	145		2,946
42/09-21A1	042N009W21A001M	412848122523801	1924	10		2,780

Table 2.1
Wells with One or More Depth to Water Measurements, continued

Short Well Name	State Well Number	USGS Site Number	Construction Date	Well Depth	Use	Elevation, feet, NGVD29
42/09-21K1	042N009W21K001M	412828122525801	1940	100		2,800
42/09-21M1	042N009W21M001M	412829122533501				2,867
42/09-24M1	042N009W24M001M	412824122500801		20		2,784
42/09-26K1	042N009W26K001M	412739122504501	1860	20		2,779
42/09-27G1	042N009W27G001M	412750122514901	1948			2,794
42/09-27K1	042N009W27K001M	412729122515001	1940	23		2,800
42/09-27N1	042N009W27N001M	412722122522501	1933	19	Unused	2,840
42/09-27N2	42N09W27N002M				Domestic	
42/09-29A1	042N009W29A001M	412804122535401	1950	65		2,917
42/09-32H1	042N009W32H001M	412654122535201	1951	25		2,955
42/09-32H2	042N009W32H002M	412658122534801	1951	25		2,953
42/09-32P1	042N009W32P001M	412624122542001	1863	5		3,080
42/09-33B1	042N009W33B001M	412713122530301	1952	18		2,910
42/09-34L1	042N009W34L001M	412638122520201		20		2,803
42/09-34P1	042N009W34P001M	412626122520701	1910	18		2,804
42/09-35Q1	042N009W35Q001M	412634122513401	1860			2,806
43/09-02G1	043N009W02G001M	413628122503601	1924	65		2,760
43/09-02G2	043N009W02G002M	413628122503201	1931	45		2,727
43/09-02K1	043N009W02K001M	413620122505001		25		2,725
43/09-02K2	043N009W02K002M	413622122504601		19		2,725
43/09-02L1	043N009W02L001M	413618122505801	1950	42		2,728
43/09-02P2	43N09W02P002M				Domestic	
43/09-02Q1	043N009W02Q001M	413601122503801	1949	56		2,723
43/09-02Q2	43N09W02Q002M				Domestic	
43/09-03F1	043N009W03F001M	413632122521601				2,724
43/09-05F1	043N009W05F001M	413636122542301	1947	65		2,737
43/09-08F1	043N009W08F001M	413544122542801		19		2,753
43/09-08Q1	043N009W08Q001M	413516122541401	1948	25		2,773
43/09-10J2	043N009W10J002M	413535122513401	1949	72		2,743
43/10-11E1	043N010W11E001M	413537122581801	1962	40		2,845
43/09-11H2	043N009W11H002M	413544122502701	1946	51		2,736
43/09-12N1	043N009W12N001M	413514122501201	1913	42		2,750
43/09-13E1	043N009W13E001M	413445122501601				2,724
43/09-13N2	043N009W13N002M	413417122500301		18		2,735
43/10-14B1	043N010W14B001M	413458122574101				2,875
43/10-15A1	043N010W15A001M	413458122583301	1945	35		2,914
43/09-15L1	043N009W15L001M	413438122521401	1934	23		2,785
43/08-17F1	043N008W17F001M	413448122472101				2,853
43/08-17Q1	043N008W17Q001M	413420122470701	1905	20		2,845
43/09-18R1	043N009W18R001M	413420122550501	1951			2,801
43/09-21K1	043N009W21K001M	413341122530301	1940	100		2,762

Table 2.1
Wells with One or More Depth to Water Measurements, continued

Short Well Name	State Well Number	USGS Site Number	Construction Date	Well Depth	Use	Elevation, feet, NGVD29
43/09-21Q1	043N009W21Q001M	413333122525801		32		2,761
43/09-22P1	043N009W22P001M	413328122521801		6		2,735
43/09-23F1	043N009W23F001M	413351122510801	1952		Unused	2,728
43/09-24F1	043N009W24F001M	413348122495001	1953	204	Irrigation	2,735
43/09-24F2	043N009W24F002M	413358122495801	1953	146		2,734
43/09-24Q1	043N009W24Q001M	413336122494001	1900	40		2,740
43/10-25P1	043N010W25P001M	413235122563801	1951	30		2,974
43/10-25P2	043N010W25P002M	413233122565001				2,980
43/09-26C2	043N009W26C002M	413317122510501	1952	27		2,732
43/09-26L1	043N009W26L001M	413253122510001	1943	24		2,737
43/09-28E1	043N009W28E001M	413308122533601	1950	41		2,784
43/09-29G2	043N009W29G002M	413258122540601	1958	42		2,800
43/09-29M1	043N009W29M001M	413246122543601	1936	27		2,829
43/09-30A1	043N009W30A001M	413315122550201	1915	16		2,842
43/09-31B1	043N009W31B001M	413223122551701	1948	20		2,873
43/09-32G1	043N009W32G001M	413209122541201	1924	30		2,806
43/09-33G1	043N009W33G001M	413216122530601	1941	100		2,766
44/08-08A1	044N008W08AS01M	414000122470001				4,745
44/09-12K1	044N009W12K001M	414000122490001	1988	80		2,989
44/10-25H1	044N010W25H001M	413820122561301	1952	32		2,703
44/10-25H2	044N010W25H002M	413815122562401	1949	17		2,694
44/09-25R1	44N09W25R001M				Domestic	
44/08-27L1	044N008W27L001M	413756122452901		30		2,908
44/09-27M1	044N009W27M001M	413802122522201	1900	45		2,743
44/09-28P1	044N009W28P001M	413746122532401	1949	65	Unused	2,711
44/09-28Q1	044N009W28Q001M	413746122525601	1949			2,721
44/09-29F1	044N009W29F001M	413822122543201	1920	19		2,704
44/09-29Q1	044N009W29Q001M	413755122540301	1948	36		2,710
44/09-30G1	044N009W30G001M	413818122550901	1917	25		2,695
44/08-30P1	044N008W30P001M	413738122490001	1945	15		2,789
44/08-31G1	044N008W31G001M	413709122484001				2,893
44/09-32A1	044N009W32A001M	413735122535701	1949	30		2,702
44/08-32F1	044N008W32F001M	413715122474101	1935	27		2,825
44/08-33C1	044N008W33C001M	413728122464101	1953	35		2,848
44/08-33D1	044N008W33D001M	413725122470401	1950	40		2,831
44/09-34G1	044N009W34G001M	413728122515401	1952	97		2,721
44/10-34H1	044N010W34H001M	413722122582301				2,707
44/10-34Q1	044N010W34Q001M	413654122584801		90		2,824
44/09-34R1	044N009W34R001M	413655122513001	1951	120		2,720
44/09-34R2	044N009W34R002M	413656122513201	1860	20		2,717
44/10-35G1	044N010W35G001M	413729122573501				2,683
44/09-35Q1	044N009W35Q001M	413658122504201	1945	70		2,735

Table 2.2
Wells with Multiple Depth to Water Measurements

Short Well Name	DWR State Well Number	USGS Site Number	Well Use	Number of Records	Period of Record	
Long-term, multi-year records						
42/09-02A2	42N09W02A002M	413129122502801	Domestic	94	Aug-1953	Aug-2004
42/09-27N1	42N09W27N001M	412722122522501	Unused	83	May-1953	Mar-2001
42/09-27N2	42N09W27N002M	-	Domestic	44	Oct-1994	Apr-2011
43/09-02P2	43N09W02P002M	-	Domestic	16	Mar-2004	Apr-2011
43/09-02Q2	43N09W02Q002M	-	Domestic	16	Sep-2003	Apr-2011
43/09-23F1	43N09W23F001M	413351122510801	Unused	119	May-1953	Apr-2011
43/09-24F1	43N09W24F001M	413348122495001	Irrigation	112	Mar-1953	Apr-2011
44/09-25R1	44N09W25R001M	-	Domestic	27	Jul-2002	Apr-2011
44/09-28P1	44N09W28P001M	413746122532401	Unused	94	Oct-1953	Apr-2009
Short-term, greater than 3 records						
41/09-13G1	-	412415122492601	Domestic	15	Jul-1953	Oct-1953
41/09-36J1	-	412132122491301	Domestic	14	Jul-1953	Oct-1953
42/09-02A2	42N09W02A002M	413129122502801	Domestic	9	Aug-1953	Oct-1953
42/09-02G1	-	413125122504401	Irrigation	15	Jul-1953	Oct-1953
42/09-04Q1	-	413055122525701	Domestic	6	Jul-1953	Oct-1953
42/09-06F2	-	413120122552501	Unused	10	Aug-1953	Oct-1953
42/09-26K1	-	412739122504501	Unused	14	Jul-1953	Oct-1953
42/09-27N1	42N09W27N001M	412722122522501	Unused	15	Jul-1953	Oct-1953
42/09-29A1	-	412804122535401	Domestic	15	Jul-1953	Oct-1953
43/09-08Q1	-	413516122541401	Domestic	14	Jul-1953	Oct-1953
43/09-23F1	43N09W23F001M	413351122510801	Unused	14	Jul-1953	Oct-1953
43/09-24F1	43N09W24F001M	413348122495001	Irrigation	14	Jul-1953	Oct-1953
43/09-24F2	-	413358122495801	Irrigation	15	Jul-1953	Oct-1953
43/09-28E1	-	413308122533601	Stock	15	Jul-1953	Oct-1953
44/08-27L1	-	413756122452901	Domestic	15	Jul-1953	Oct-1953
44/08-32F1	-	413715122474101	Domestic	9	Aug-1953	Oct-1953
44/09-28Q1	-	413746122525601	Domestic, Stock	15	Jul-1953	Oct-1953
44/09-29F1	-	413822122543201	Unused	14	Jul-1953	Oct-1953
44/09-34G1	-	413728122515401	Unused	12	Aug-1953	Oct-1953
44/09-34R2	-	413656122513201	Unused	14	Jul-1953	Oct-1953
44/10-25H2	-	413815122562401	Domestic	15	Jul-1953	Oct-1953
44/10-35G1	-	413729122573501	Domestic	14	Jul-1953	Oct-1953

Table 2.3
Well Test Data and Calculated Specific Capacity

Well	Completed Well Depth, feet	Discharge, gpm	Drawdown, feet	Specific Capacity, gpm/foot	DWR File
41/08-07	157	6	120	0.1	64784
41/09-11	65	150	8	19	61391
41/09-11	85	500	55	9	66135
41/09-11	85	500	55	9	66136
41/09-11	133	141	92	2	62895
42/08-07	103	20	60	0.3	60393
42/08-18	156	250	71	4	62890
42/09-02	120	1,500	12	125	65841
42/09-02	180	1,700	2	850	89635
42/09-04	111	48	10	5	59484
42/09-04	92	8	45	0.2	61785
42/09-06	100	20	20	1	64780
42/09-06	117	15	20	1	64783
42/09-08	63	60	20	3	63980
42/09-09	81	80	15	5	58384
42/09-10	171	3,000	144	21	63975
42/09-11	224	2,000	83	24	83455
42/09-12	170	186	64	3	62084
42/09-13	60	27	1	27	58399
42/09-13	60	760	39	19	59899
42/09-13	93	400	74	5	59902
42/09-16	191	100	185	1	58575
42/09-16	220	4,000	60	67	58577
42/09-17	85	130	70	2	58595
42/09-17	170	500	120	4	64543
42/09-17	105	400	25	16	64766
42/09-23	100	1,200	8	150	66111
42/09-24	190	3	190	0.02	64792
42/09-26	210	1,600	100	16	66164
42/09-27	60	20	40	1	64709
42/09-28	170	15	170	0.1	64788
42/09-29	100	20	60	0.3	61403
42/09-32	270	23	80	0.3	62913
42/09-33	66	150	35	4	59198
42/09-34	67	400	46	9	59878
42/09-34	100	115	14	8	64725

From California Department of Water Resources Well Completion Records

Table 2.3
Well Test Data and Calculated Specific Capacity, continued

Well	Completed Well Depth, feet	Discharge, gpm	Drawdown, feet	Specific Capacity, gpm/foot	DWR File
43/08-17	130	400	40	10	83801
43/09-02	80	40	1	40	62908
43/09-02	159	550	61.2	9	64279
43/09-04	85	8	53	0.2	61617
43/09-05	115	7	85	0.1	61616
43/09-05	158	250	140	2	64546
43/09-10	70	800	30	27	59766
43/09-11	80	40	62	1	59679
43/09-11	120	600	60	10	64746
43/09-12	110	20	110	0.2	64793
43/09-13	180	700	111	6	83454
43/09-14	101	120	2	60	61408
43/09-14	70	400	21	19	61604
43/09-14	160	1,500	50	30	83495
43/09-15	200	100	100	1	62984
43/09-15	105	350	65	5	64504
43/09-18	175	50	140	0.4	86648
43/09-24	220	300	210	1	60406
43/09-25	100	60	5	12	63959
43/09-25	185	1,000	160	6	64762
43/09-26	125	1,750	110	16	60405
43/09-27	172	900	150	6	64761
43/09-28	100	600	70	9	64734
43/09-30	200	80	170	0.5	66169
43/09-32	75	29	1	29	62906
43/09-35	67	550	11	50	59410
43/09-35	114	160	80	2	61827
43/09-36	146	1,600	60	27	80086
43/10-02	72	50	5	10	60357
43/10-11	165	400	85	5	64520
43/10-13	83	20	48	0.4	59407
43/10-13	190	30	100	0.3	64702
43/10-14	203	350	98	4	59411
43/10-15	60	24	10	2	59404
43/10-15	60	24	18	1	59406
43/10-22	62	6	6	1	62069

From California Department of Water Resources Well Completion Records

Table 2.3
Well Test Data and Calculated Specific Capacity, continued

Well	Completed Well Depth, feet	Discharge, gpm	Drawdown, feet	Specific Capacity, gpm/foot	DWR File
43/10-22	73	10	4	3	62070
43/10-22	67	9	7	1	62071
43/10-22	64	10	3	3	62072
43/10-36	100	60	20	3	62980
44/08-29	65	600	57	11	59413
44/08-30	76	45	55	1	59409
44/09-25	80	300	56	5	59412
44/09-25	80	3	61	0.05	61625
44/09-27	67	100	1	100	61627
44/09-28	100	460	15	31	58265
44/09-28	165	20	165	0.1	64703
44/09-28	171	250	110	2	66124
44/09-28	171	250	110	2	66125
44/09-29	243	400	40	10	59622
44/09-29	73	7	68	0.1	61615
44/09-30	100	5	63	0.1	61407
44/09-32	100	1,500	25	60	65856
44/09-33	104	120	4	30	58336
44/09-36	80	25	75	0.3	64785
44/09-36	180	1,200	100	12	65358
44/10-34	69	18	52	0.3	58344
44/10-34	113	25	20	1	64781

From California Department of Water Resources Well Completion Records

Table 2.4
Summary of Stream Gages and Flow Data

CDEC Station ID	USGS Station ID	DWR Station ID	Station Name	Elevation, feet	Operator	Period of Record (Discharge)		Number of Measurements
SNB	11520000	F25040	Scott River near Scott Bar	1,560	USGS	10/1/1911	9/30/1913	731
					CA DWR	10/01/2004	9/30/2007	619
SFJ	11519500		Scott River near Fort Jones	2,624	USGS	10/1/1941	Present	25,365
SCK	11519000	F25484	Shackleford Creek near Mugginsville	2,690	USGS	10/1/1956	9/30/1960	1,461
					CA DWR	6/24/2004	9/1/2010	1,621
-	11518600		Moffett Creek near Fort Jones	-	USGS	10/1/1958	9/30/1967	3,287
-	11518610		Soap Creek Tributary near Fort Jones	-	USGS	1961	1973	11
MNM		F25480	Mill Creek near Mugginsville	2,840	CA DWR	11/10/2004	9/29/2005	322
-	11518400		Etna Creek above Lunch Creek near Etna	-	USGS	2/10/1961	4/27/1973	13
FCC	-	F25650	French Creek at HWY 3 near Callahan	2,840	CA DWR	6/24/2004	9/30/2009	1,774
-	11518310		Cedar Gulch near Callahan	-	USGS	2/1/1966	9/30/1973	2,799
SGN	11518300	F25890	Sugar Creek near Callahan	3,130	USGS	9/1/1957	9/30/1960	1,126
					CA DWR	10/01/2009	9/30/2010	363
DDC	-		Darbee Ditch near Callahan	3,400	CA DWR	9/20/2010	Present	375
SDA			Sugar Creek below Darbee Ditch near Callahan	3,400	CA DWR	5/12/2010	Present	471
-	11518200	F28100	South Fork Scott River near Callahan	3,270	USGS	10/1/1958	9/30/1960	731
					CA DWR	6/29/2002	Present	1,911
-	11518050	F26050	East Fork Scott River near Callahan	3,120	USGS	10/1/1959	9/30/1974	5,479
					CA DWR	6/28/2002	9/30/2010	2,066
-	11518000		East Fork Scott River near Callahan	-	USGS	10/1/1910	9/30/1911	365
-	11517950		East Fork Scott River above Kangaroo Creek near Callahan	-	USGS	9/1/1970	7/6/1973	1,040
-	11517900		East Fork Scott River below Houston Creek near Callahan	-	USGS	8/30/1970	7/6/1973	1,042

Table 2.5
Land and Water Use Data, 2000

	Grain	Corn	Alfalfa	Pasture	Total	Acreage Weighted Average, acre-feet/acre
Irrigated Crop Area (acres)	2,000	300	13,000	16,500	31,800	--
Applied Water (acre-feet/acre)	1.56	1.92	2.78	3.13	--	2.88
Consumed Fraction (percent)	0.77	0.73	0.79	0.67	--	0.73
Evapotranspiration of Applied Water (acre-feet/acre)	1.2	1.4	2.2	2.1	--	2.08
Excess Applied Water (acre-feet/acre)	0.36	0.52	0.58	1.03	--	0.80

Source: DWR, Land and Water Use, DAU 003 (Scott Valley), <www.water.ca.gov/landwateruse/docs/annualdata/2000/ag_dau_2000.xls>

Table 2.6
Irrigated Acreage and Allotments under Scott River Decree

Sub-Area	Schedule[1]	Area Served, acres	Priority 1 Allotment, cfs	Total Amount[2], cfs
Upper Tributaries, East Fork, Scott River	B1	146	5.20	6.32
Rail Creek and Tributaries	B2	368	6.58	10.33
Middle Tributaries, East Fork, Scott River	B3	279	3.36	8.91
Lower Tributaries, East Fork, Scott River	B4	626	6.72	21.29
East Fork, Scott River above Rail Creek	B5	779	0.16	35.67
East Fork, Scott River - Rail Creek to Gouse Creek	B6	420	0.17	19.44
East Fork, Scott River - Grouse Creek to Confluence with South Fork, Scott River	B7	119	0.08	7.77
Tributaries of South Fork, Scott River	B8	108	8.29	9.58
South Fork, Scott River	B9	99	6.07	8.05
Wildcat Creek and Tributaries	B10	290	1.73	7.49
Sugar Creek and Tributaries	B11	525	1.28	25.58
Messner Gulch, Cedar Gulch, Facey Gulch (aka Luddy Gulch), and other Tributaries of Scott River	B12	293	1.64	4.70
McConaughy Gulch and Tributaries	B13	220	3.57	3.57
Wolford Slough and Tributaries	B14	282	5.65	6.62
Clark Creek	B15	710	2.50	15.06
Tributaries of Etna Creek	B16	124	2.09	2.29
Upper Etna Creek including the Etna Mill Ditch	B17	732	2.41	13.72
Lower Etna Creek Downstream from the Etna Mill Ditch	B18	1,250	6.52	36.40
Shell Gulch, Hurds Gulch, Hamlin Gulch and their Tributaries	B19	292	1.53	4.19
Johnson Creek and Tributaries	B20	1,148	2.50	18.70
Crystal Creek	B21	884	2.10	11.30
Patterson Creek (West)	B22	3,251	5.62	35.48
Big Slough and Tributaries	B23	2,398	17.62	37.82
Tributaries of Kidder Creek	B24	326	2.17	6.53
Upper Kidder Creek	B25	4,514	17.91	91.93
Lower Kidder Creek	B26	3,352	32.66	53.04
Upper Moffett Creek and Tributaries	B27	797	9.37	12.10
Duzel Creek and Tributaries	B28	169	1.27	2.76
Lower Moffett Creek	B29	1,491	18.92	26.26
Soap Creek and Tributaries	B30	71	1.20	1.42
Tributaries of Lower Moffett Creek	B31	180	3.36	3.36
McAdam Creek and Tributaries	B32	761	0.05	14.68
Indian Creek and Tributaries	B33	641	0.15	12.58
Oro Fino Creek and Tributaries	B34	1,457	0.12	21.74
Rattlesnake Creek and Tributaries	B35	105	0.08	6.14
Tyler Gulch and Tributaries	B36	53	0.06	0.96
Patterson Creek (North) and Tributaries	B37	106	0.03	2.03
Sniktaw Creek and Tributaries	B38	552	1.38	10.68
Lower Scott River Tributaries	B39	33	0.14	0.68
Graveyard Gulch, Meamber Creek and Meamber Gulch	B40	179	2.86	2.90

Table 2.6
Irrigated Acreage and Allotments under Scott River Decree, continued

Sub-Area	Schedule[1]	Area Served, acres	Priority 1 Allotment, cfs	Total Amount[2], cfs
Scott River from the Confluence of East Fork and South Fork to the Lower End of the Dredger Tailings	D1	1,654	6.16	49.25
Scott River from Lower End of Dredger Tailings to the Scott Valley Irrigation District Ditch Diversion No. 223	D2	7,946	26.44	128.16
Scott River from the Scott Valley Irrigation District Diversion No. 223 to Diversion No. 576	D3	4,463	4.27	71.56
Scott River from Diversion No. 576 to USGS Gaging Station	D4	1,115	9.89	20.58
Scott River from USGS Gaging Station to Confluence with Klamath River	D5	145	2.79	4.67
Subtotal, Independent Tributary Streams[3]	B1 - B40	30,130	185	620
Subtotal, Natural Flow of the Scott River[3]	D1 - D5	15,323	50	274
Total Surface Water [3]	**B1 - B40, D1 - D5**	**45,453**	**235**	**894**
Groundwater Interconnected with the Scott River[4]	**C**	**12,975**	**--**	**--**

Notes:

1. Schedule refers to Scott River Adjudication Decree (1980)
2. Total Allotment includes all priority classes and surplus
3. Irrigation to some acreage is permitted from more than one diversion point and may be included on multiple schedules; accordingly, this tally may include some “double-counting” and does not represent total acreage served by irrigation; rather, totals represent the sum of acreages potentially irrigated by the identified systems.
4. Groundwater acreage overlaps with acreage served by surface water for 4,649 acres.

Table 2.7
Riparian Wetland Classes in Scott Valley

System	Wetland Group	NWI Classification Code	Class	Water Regime	Special Modifier	Acres
Palustrine	Freshwater Emergent Wetland	PEMA	Emergent	Temporary Flooded	-	415.6
		PEMAh			Diked/Impounded	1.1
		PEMB		Saturated	-	2.8
		PEMC		Seasonally Flooded	-	3,997.3
		PEMCh			Diked/Impounded	21.5
		PEMCx			Excavated	7.4
		PEMF		Semi-permanently Flooded	-	3.9
		PEMFh			Diked/Impounded	0.2
		PEMFx			Excavated	0.8
	Total					**4,450.7**
	Freshwater Forested/ Shrub Wetland	PFOA	Forested	Temporary Flooded	-	2.4
		PFOC		Seasonally Flooded	-	249.3
		PSSA	Scrub/Shrub	Temporary Flooded	-	19.6
		PSSC		Seasonally Flooded	-	526.7
		PSSCx			Excavated	10.8
	Total					**808.9**
	Freshwater Pond	PABF	Aquatic Bed	Semi-permanently Flooded	-	12.2
		PABFh			Diked/Impounded	5.9
		PABFx			Excavated	33.9
		PABG		Intermittently Exposed (to drought)	-	5.2
		PABGh			Diked/Impounded	2.9
		PABGx			Excavated	16.7
		PABHh		Permanently Flooded	Diked/Impounded	0.9
		PABHx			Excavated	0.5
		PABKh		Artificially Flooded	Diked/Impounded	9.3
		PUBFh	Unconsolidated Shore	Semi-permanently Flooded	-	0.3
		PUBFx			-	2.0
		PUBHh		Permanently Flooded	-	9.4
		PUBHx			-	6.3
		PUSC		Seasonally Flooded	-	2.7
		PUSCh			-	1.0
		PUSCx			-	3.8
	Total					**113.1**
Riverine	Riverine	R2ABH	Lower Perennial	Aquatic Bed	Permanently Flooded	1.9
		R2UBH		Unconsolidated Bottom	Permanently Flooded	441.4
		R2USA		Unconsolidated Shore	Temporary Flooded	188.5
		R2USC			Seasonally Flooded	733.0
		R3USC	Upper Perennial		Seasonally Flooded	9.3
		R4USA	Intermittent		Temporary Flooded	92.7
		R4USC			Seasonally Flooded	255.2
		R4USCx			Seasonally Flooded, Excavated	5.8
	Total					**1,727.8**

NOTES:

Palustrine Special Modifier Codes : h = Diked/Impounded, x = Excavated
Riverine Special Modifier Codes : A = Temporarily Flooded, C = Seasonally Flooded, Cx = Seasonally Flooded & Excavated, H = Permanently Flooded

Table 2.8
Inventory of Domestic Wells

Location	Number of Wells	Minimum Depth, feet	Maximum Depth, feet	Median Depth, feet
41/08-07	4	120	169	150
41/08-30	1	115	115	115
41/09-02	1	60	60	60
41/09-03	3	100	196	100
41/09-10	2	110	126	118
41/09-13	4	47	185	60
41/09-14	1	68	68	68
41/09-15	4	64	265	128
41/09-36	2	65	110	88
42/08-07	3	105	184	123
42/09-02	1	50	50	50
42/09-04	2	52	220	136
42/09-05	32	48	140	103
42/09-06	53	50	405	150
42/09-07	1	95	95	95
42/09-08	5	63	160	100
42/09-09	2	80	81	81
42/09-12	3	65	140	132
42/09-13	1	240	240	240
42/09-15	2	125	153	139
42/09-17	3	56	320	105
42/09-20	1	405	405	405
42/09-21	1	72	72	72
42/09-24	16	76	190	105
42/09-25	1	205	205	205
42/09-26	3	30	50	50
42/09-27	5	28	100	70
42/09-28	12	20	220	75
42/09-29	9	90	164	135
42/09-32	27	29	300	65
42/09-33	1	187	187	187
42/09-34	2	60	80	70
43/08-17	2	80	109	95
43/08-18	1	387	387	387
43/08-20	1	180	180	180
43/09-02	13	40	135	80
43/09-03	5	40	100	72
43/09-04	1	85	85	85
43/09-05	1	115	115	115
43/09-08	1	40	40	40
43/09-09	1	105	105	105
43/09-10	1	76	76	76
43/09-11	7	64	200	80
43/09-12	6	60	120	88
43/09-13	4	80	210	95

Notes:

1. Excludes wells that encountered bedrock at depths less than 50 feet
2. Excludes wells with unknown depth

Table 2.8
Inventory of Domestic Wells, continued

Location	Number of Wells	Minimum Depth, feet	Maximum Depth, feet	Median Depth, feet
43/09-14	1	100	100	100
43/09-15	6	106	200	124
43/09-16	3	140	255	170
43/09-17	3	60	160	158
43/09-18	3	55	180	130
43/09-19	1	23	23	23
43/09-20	1	80	80	80
43/09-21	1	258	258	258
43/09-23	3	100	130	100
43/09-25	1	57	57	57
43/09-26	3	89	100	90
43/09-28	2	189	240	215
43/09-29	31	32	160	60
43/09-30	4	38	200	71
43/09-31	27	50	281	100
43/09-32	16	33	220	75
43/09-34	2	30	34	32
43/09-35	1	80	80	80
43/10-02	9	38	100	50
43/10-03	7	35	160	45
43/10-10	8	24	300	142
43/10-11	8	38	100	57
43/10-13	6	60	190	103
43/10-14	5	75	105	100
43/10-15	5	60	120	80
43/10-22	8	62	205	87
43/10-24	2	60	75	68
43/10-25	10	60	160	100
43/10-26	3	49	205	100
43/10-36	17	26	325	90
44/08-29	4	48	155	74
44/08-30	2	76	300	188
44/08-31	4	52	205	110
44/08-32	7	52	124	82
44/09-25	7	68	140	80
44/09-27	3	62	290	67
44/09-28	3	56	165	75
44/09-29	5	73	243	108
44/09-30	10	70	355	119
44/09-33	1	126	126	126
44/09-36	18	34	106	80
44/10-25	7	70	203	100
44/10-34	20	40	465	115
44/10-35	4	40	100	76

Notes:

1. Excludes wells that encountered bedrock at depths less than 50 feet
2. Excludes wells with unknown depth

Table 2.9
Inventory of Irrigation Wells

Location	Number of Wells	Minimum Depth, feet	Maximum Depth, feet	Median Depth, feet
41/08-18	1	75	75	75
41/09-02	2	97	110	104
41/09-03	1	110	110	110
41/09-11	6	43	133	85
42/08-18	1	156	156	156
42/09-02	3	120	180	150
42/09-04	2	60	111	86
42/09-05	3	100	107	104
42/09-08	1	115	115	115
42/09-09	2	120	150	135
42/09-10	1	171	171	171
42/09-11	3	120	235	200
42/09-12	1	170	170	170
42/09-13	3	60	100	65
42/09-14	1	142	142	142
42/09-15	3	104	207	150
42/09-16	2	191	220	206
42/09-17	1	180	180	180
42/09-21	2	125	141	133
42/09-23	1	110	110	110
42/09-24	2	150	275	213
42/09-26	3	140	240	210
42/09-28	5	14	108	30
42/09-32	2	47	92	70
42/09-33	2	66	70	68
42/09-34	9	67	260	118
43/08-17	3	102	130	102
43/08-20	2	165	185	175
43/09-02	5	91	100	100
43/09-03	1	55	55	55
43/09-04	3	193	275	255
43/09-05	2	90	158	124
43/09-10	1	70	70	70
43/09-11	8	20	145	101
43/09-12	1	36	36	36
43/09-13	2	170	185	178
43/09-14	5	71	160	101
43/09-15	1	105	105	105
43/09-17	2	63	63	63
43/09-19	1	400	400	400
43/09-21	2	105	146	126
43/09-22	2	80	200	140
43/09-23	3	60	160	120
43/09-24	3	120	250	195
43/09-25	5	80	185	140

Notes:

1. Excludes wells that encountered bedrock at depths less than 50 feet
2. Excludes wells with unknown depth

Table 2.9
Inventory of Irrigation Wells, continued

Location	Number of Wells	Minimum Depth, feet	Maximum Depth, feet	Median Depth, feet
43/09-26	1	125	125	125
43/09-27	2	81	172	127
43/09-28	3	100	215	138
43/09-29	2	80	220	150
43/09-30	1	67	67	67
43/09-31	2	100	100	100
43/09-32	1	126	126	126
43/09-35	2	69	115	92
43/09-36	2	146	152	149
43/10-10	1	120	120	120
43/10-11	3	60	220	165
43/10-14	3	110	203	126
43/10-23	1	47	47	47
44/08-29	1	66	66	66
44/08-30	2	60	85	73
44/08-31	1	84	84	84
44/08-32	2	100	110	105
44/09-25	1	65	65	65
44/09-27	1	89	89	89
44/09-28	4	57	171	136
44/09-29	1	105	105	105
44/09-30	3	100	147	112
44/09-32	1	100	100	100
44/09-33	3	104	170	135
44/09-34	1	123	123	123
44/09-36	5	32	180	68
44/10-26	1	100	100	100
44/10-27	1	35	35	35

Notes:

1. Excludes wells that encountered bedrock at depths less than 50 feet
2. Excludes wells with unknown depth

Table 2.10
Number of Wells Drilled, 1950 through 2010

Period	Wells Drilled during Period	Cumulative Wells Drilled	Irrigation Wells Drilled during Period	Cumulative Irrigation Wells
Prior to 1954	78	78	6	6
1955 - 1959	3	81	0	6
1960 - 1964	7	88	3	9
1965 - 1969	64	152	15	24
1970 - 1974	70	222	19	43
1975 - 1979	184	406	56	99
1980 - 1984	31	437	4	103
1985 - 1989	16	453	1	104
1990 - 1994	97	550	11	115
1995 - 1999	72	622	15	130
2000 - 2004	115	737	25	155
2005 - 2009	48	785	14	169
2010	5	790	3	172

Notes:

1. Wells prior to 1954 from Mack, 1958, Table 8, including those with unknown completion dates
2. Wells 1955-2010 from CaDWR well logs, excluding wells encountering bedrock at depths less than 50 feet
3. DWR wells exclude a total of 17 wells with unknown completion dates, 3 of which are irrigation wells
4. Inventory reflects wells with use specified as domestic, irrigation, public supply or stock

Table 4.1
Maximum Alluvial Thickness, by Section

Township	Range	Section	Number of Wells	Maximum Alluvial Thickness, feet
41N	08W	7	6	75
41N	08W	18	1	60
41N	08W	30	7	55
41N	09W	2	3	90
41N	09W	3	7	80
41N	09W	10	9	65
41N	09W	11	6	131
41N	09W	14	2	67
41N	09W	15	8	>265
41N	09W	36	5	90
42N	08W	18	1	148
42N	09W	2	5	>180
42N	09W	4	5	>220
42N	09W	5	37	>140
42N	09W	6	56	165
42N	09W	7	1	>95
42N	09W	8	8	>160
42N	09W	9	4	>150
42N	09W	10	1	166
42N	09W	11	3	>200
42N	09W	12	5	109
42N	09W	14	1	>142
42N	09W	15	7	>240
42N	09W	16	2	>220
42N	09W	17	6	>180
42N	09W	21	3	>141
42N	09W	23	2	>110
42N	09W	24	21	170
42N	09W	25	1	123
42N	09W	26	7	>240
42N	09W	27	6	>140
42N	09W	28	34	100
42N	09W	33	10	100
42N	09W	34	14	236
43N	08W	17	9	>130

Note: Sections included with wells reporting over 50 feet of alluvium.

Table 4.1
Maximum Alluvial Thickness, by Section, continued

Township	Range	Section	Number of Wells	Maximum Alluvial Thickness, feet
43N	08W	18	1	152
43N	08W	19	2	>120
43N	08W	20	3	100
43N	09W	2	25	>210
43N	09W	3	7	90
43N	09W	4	6	190
43N	09W	5	3	153
43N	09W	9	4	90
43N	09W	10	2	>76
43N	09W	11	19	128
43N	09W	12	11	>120
43N	09W	13	8	98
43N	09W	14	6	>160
43N	09W	15	12	140
43N	09W	17	7	75
43N	09W	18	11	95
43N	09W	19	4	140
43N	09W	20	3	70
43N	09W	21	6	>143
43N	09W	22	3	>200
43N	09W	23	6	>160
43N	09W	24	4	181
43N	09W	25	7	165
43N	09W	26	4	>125
43N	09W	27	3	>172
43N	09W	28	6	145
43N	09W	29	48	130
43N	09W	30	7	182
43N	09W	31	31	>185
43N	09W	32	20	180
43N	09W	35	3	>80
43N	09W	36	2	>152
43N	10W	2	13	>140
43N	10W	10	10	>146
43N	10W	11	12	200

Note: Sections included with wells reporting over 50 feet of alluvium.

Table 4.1
Maximum Alluvial Thickness, by Section, continued

Township	Range	Section	Number of Wells	Maximum Alluvial Thickness, feet
43N	10W	14	11	126
43N	10W	22	9	>205
43N	10W	23	3	175
43N	10W	24	6	60
43N	10W	25	14	90
43N	10W	26	4	>100
43N	10W	36	22	>128
44N	08W	29	6	85
44N	08W	30	6	70
44N	08W	31	14	>205
44N	08W	32	9	>124
44N	09W	25	13	136
44N	09W	27	5	>89
44N	09W	28	11	170
44N	09W	29	9	148
44N	09W	30	27	141
44N	09W	32	1	>100
44N	09W	33	5	130
44N	09W	34	1	>123
44N	09W	36	30	140
44N	10W	25	15	>100
44N	10W	26	4	92
44N	10W	35	8	>100

Note: Sections included with wells reporting over 50 feet of alluvium.

Table 4.2
Modeled Hydraulic Conductivity and Specific Yield

Sub-Region	Mean Hydraulic Conductivity, feet/day		Specific Yield, Layer 1
	Layer 1	Layer 2	
River	175	N/A	0.20
Scott River Floodplain			
Within area delineated by SWRCB	141	142	0.15
Outside area delineated by SWRCB	37	38	0.15
Discharge Zone	47	47	0.05
Hamlin Gulch	19	19	0.07
Moffett-McAdam Creeks	42	42	0.15
Oro Fino Creek	14	14	0.07
Quartz Valley	19	22	0.07
Tributary	13	21	0.07
West Mountain Fans	11	11	0.07

Table 4.3a
Groundwater Use for Irrigation, Recent Condition

Season	Alfalfa	Corn	Grain	Pasture	Total
	feet per acre per season (unless otherwise noted)				
May-June	0.87	0.26	0.55	1.07	-
July-September	1.96	1.70	0.98	1.83	-
Annual	**2.83**	**1.97**	**1.53**	**2.91**	**-**
Groundwater Acres	**11,206**	**292**	**1,807**	**1,878**	**15,183**
Annual, acre-feet	**31,721**	**574**	**2,767**	**5,469**	**40,531**

Note: Values represent applied groundwater as reported for DAU3 by the DWR for the year 2000.

Table 4.3b
Groundwater Use for Irrigation, Partial Build-Out

Season	Alfalfa	Corn	Grain	Pasture	Total
	feet per acre per season (unless otherwise noted)				
May-June	0.60	0.26	0.54	0.78	-
July-September	1.32	1.07	0.68	1.32	-
Annual	**1.91**	**1.33**	**1.22**	**2.10**	**-**
Groundwater Acres	**11,206**	**292**	**1,807**	**1,878**	**15,183**
Annual, acre-feet	**21,433**	**389**	**2,205**	**3,936**	**27,963**

Table 4.4
Estimated Mountain-Front Recharge

Zone Number	Zone Name	Area of Contributing Watershed, acres	Estimated Recharge, acre-feet per year	Number of Bounding Grid Cells
1	Facey/Unnamed	2,960	504	105
2	McConaughy	13,137	572	74
3	East Central	26,027	5,981	723
4	Moffett	59,675	2,514	169
5	Indian/McAdam	29,600	1,696	181
6	Northwest	20,172	1,578	301
7	Shackleford	12,374	1,354	27
8	Mill/Quartz West	11,201	2,038	293
9	Chaparral/Quartz East	9,432	1,236	659
10	Kidder-Johnson	29,883	6,065	226
11	Etna	19,925	4,859	171
12	French	21,097	3,197	18
13	Southwest	3,594	138	131
Sum		**259,079**	**31,732**	**3,078**

Table 4.5a
On-Farm Deep Percolation, Recent Condition

Season	Alfalfa	Corn	Grain	Pasture	Total
	feet per acre per season (unless otherwise noted)				
May-June	0.20	0.07	0.13	0.40	-
July-September	0.44	0.47	0.23	0.66	-
Total, feet	**0.64**	**0.54**	**0.35**	**1.06**	**-**
Irrigated Acres	**13,035**	**312**	**1,970**	**16,453**	**31,770**
Total, acre-feet	**8,326**	**169**	**691**	**17,465**	**26,651**

Note: Values represent difference between total applied water (surface water and groundwater) and evaporation of applied water, as reported for DAU3 by the CADWR for the year 2000.

Table 4.5b
On-Farm Deep Percolation, Partial Build-Out

Season	Alfalfa	Corn	Grain	Pasture	Total
	feet per acre per season (unless otherwise noted)				
May-June	0.15	0.07	0.12	0.39	-
July-September	0.32	0.34	0.16	0.65	-
Total, feet	0.47	0.41	0.29	1.04	-
Irrigated Acres	**13,035**	**312**	**1,970**	**16,453**	**31,770**
Total, acre-feet	**6,063**	**128**	**567**	**17,134**	**23,893**

Note: Values reflect the same quantities of applied surface water as for the recent condition, with lower quantities of applied groundwater as shown on Table 4.3b.

Table 4.6
Modeled Reaches, Scott River

Reach Number	Description	Number of Cells
1	Upstream end of model domain to the downstream end of the tailings (Tailings)	56
2	Tailings to French Creek	90
3	French Creek to Horn Lane Bridge	82
4	Horn Lane Bridge to Eller Bridge	119
5	Eller Bridge to Island Bridge	96
6	Island Bridge to Moffett Creek	73
7	Moffett Creek to Oro Fino Creek	56
8	Oro Fino Creek to Shackleford Creek	95
9	Shackelford Creek to End of Valley	55

Table 5.1
Simulated Annual Groundwater Budget, Partial Build-Out

	Groundwater Inflow	Groundwater Outflow
	acre-feet	
Net River/Creek Gains (-)/Losses (+)	**-**	**-37,624**
Scott River	-	-23,907
Shackleford Creek	-	-1,026
Mill Creek	-	-2,235
Oro Fino Creek	-	-662
Kidder Creek	1,403	-
Patterson Creek	24	-
Etna Creek	-	-522
French Creek	-	-830
Moffett Creek	-	-1,040
East Valley Slough	-	-1,095
West Valley Slough	-	-973
Big Slough	-	-6,761
On-Farm Percolation/Precipitation Infiltration	**32,219**	**-**
Evapotranspiration	**-**	**-5,387**
Mountain-Front Recharge, Canal Seepage	**38,819**	**-**
Groundwater Extraction from Wells	**-**	**-28,008**

Notes:

1. Signs: (-) represents flux out of groundwater model domain, (+) represents flux into groundwater model domain.
2. Budget represents the final year of the 4-season 25-year SSO simulation.
3. Values shown are net for year. River and creek gains/losses may vary substantially over different seasons and within sub-reaches.

Table 6.1
Simulated Annual Groundwater Budget, Recent Condition

	Groundwater Inflow	Groundwater Outflow
	acre-feet	
Net River/Creek Gains (-)/Losses (+)	**-**	**-27,876**
Scott River	-	-17,077
Shackleford Creek	-	-954
Mill Creek	-	-2,140
Oro Fino Creek	-	-338
Kidder Creek	1,688	-
Patterson Creek	173	-
Etna Creek	-	-343
French Creek	-	-777
Moffett Creek	-	-557
East Valley Slough	-	-771
West Valley Slough	-	-915
Big Slough	-	-5,865
On-Farm Percolation/Precipitation Infiltration	**34,972**	**-**
Evapotranspiration	**-**	**-5,387**
Mountain-Front Recharge, Canal Seepage	**38,819**	**-**
Groundwater Extraction from Wells	**-**	**-40,533**

Notes:

1. Signs: (-) represents flux out of groundwater model domain, (+) represents flux into groundwater model domain.
2. Budget represents the final year of the 4-season 25-year SSO simulation.
3. Values shown are net for year. River and creek gains/losses may vary substantially over different seasons and within sub-reaches.

Appendices

Appendix A

Groundwater Hydrographs

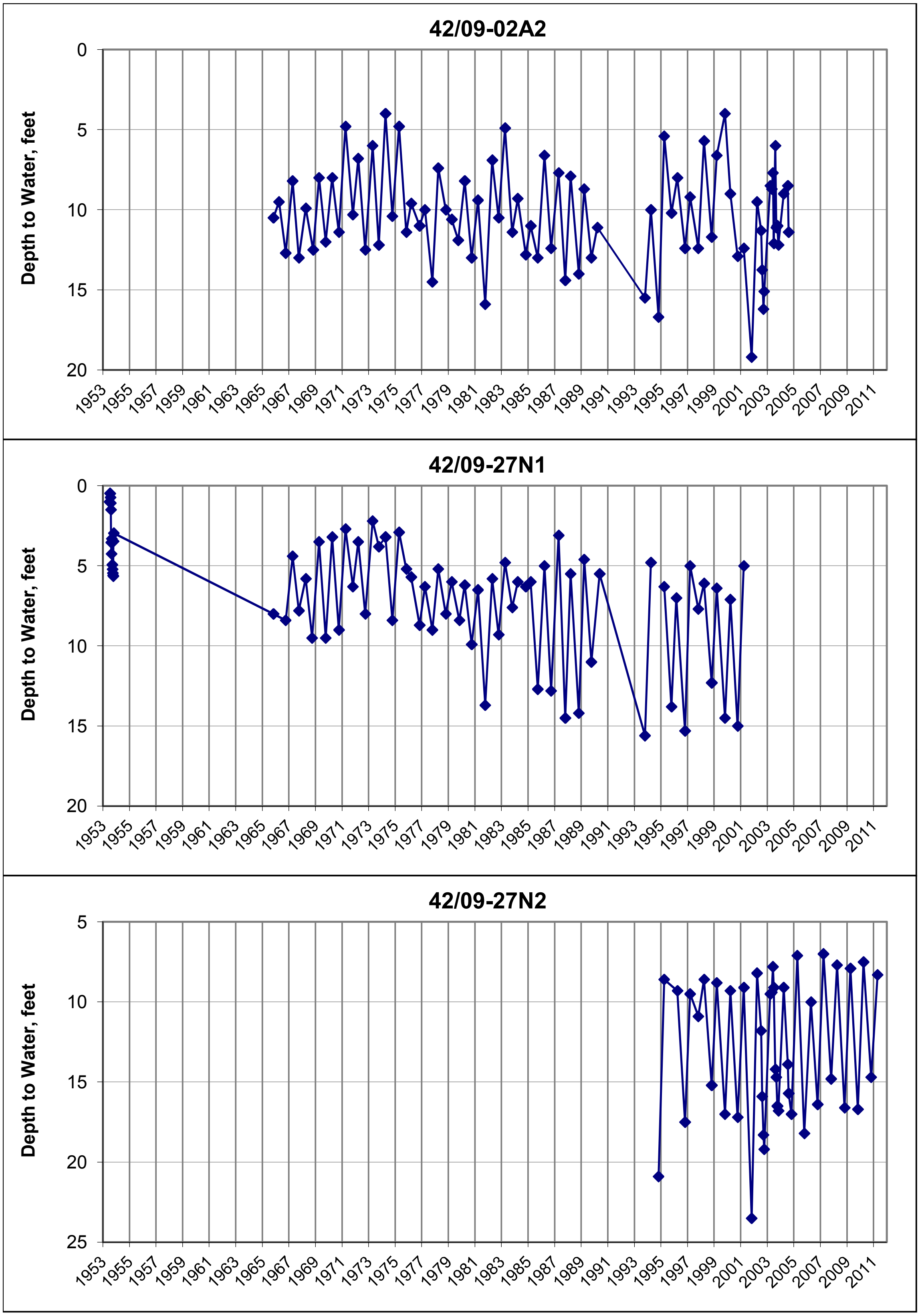


Figure A-1. Scott Valley Long-term Hydrographs

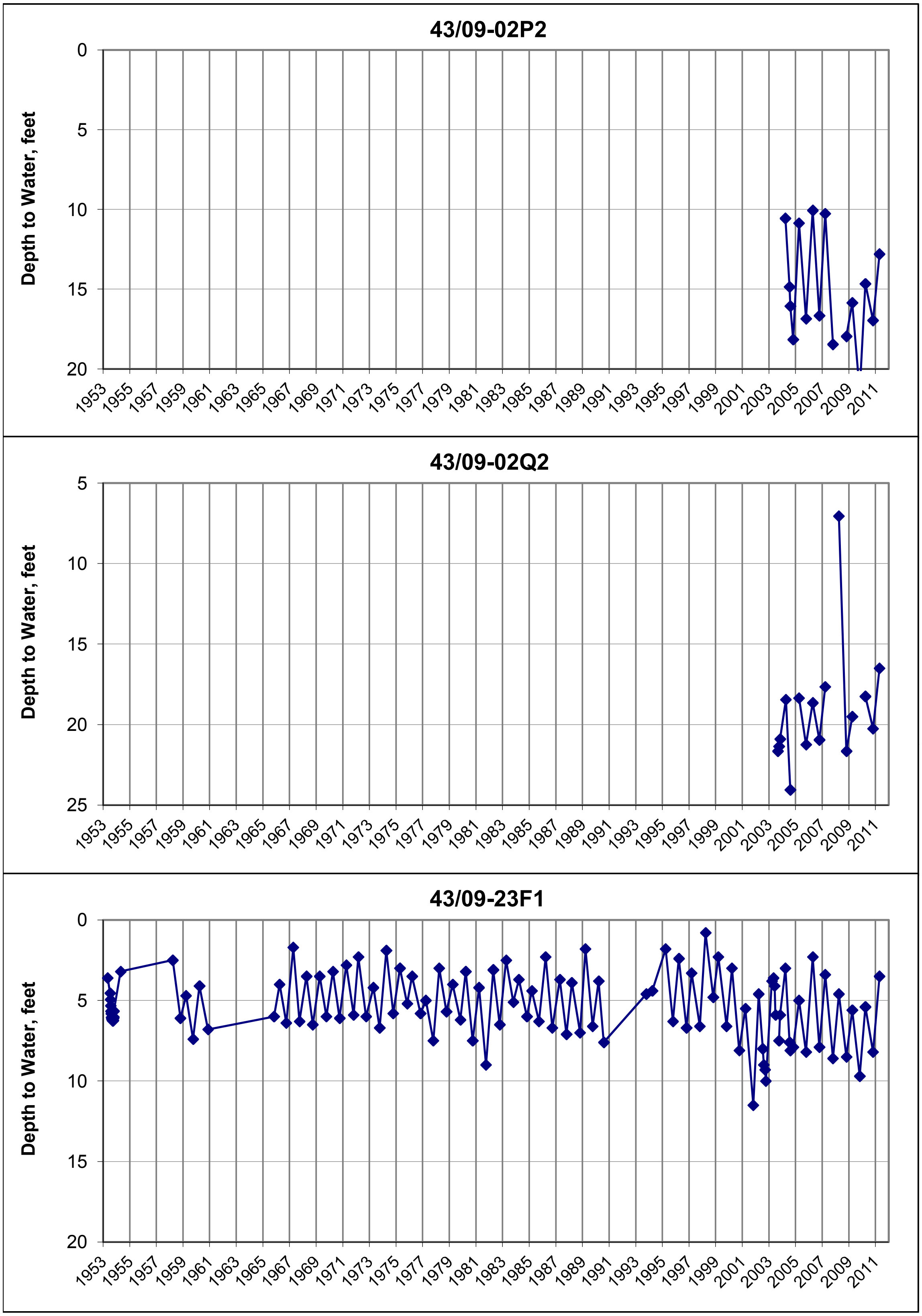
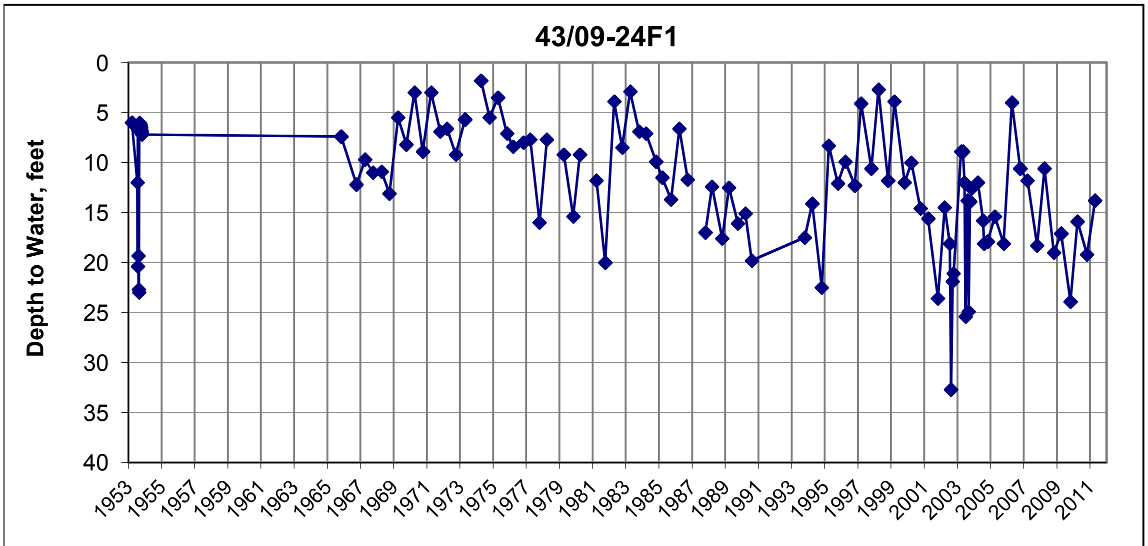
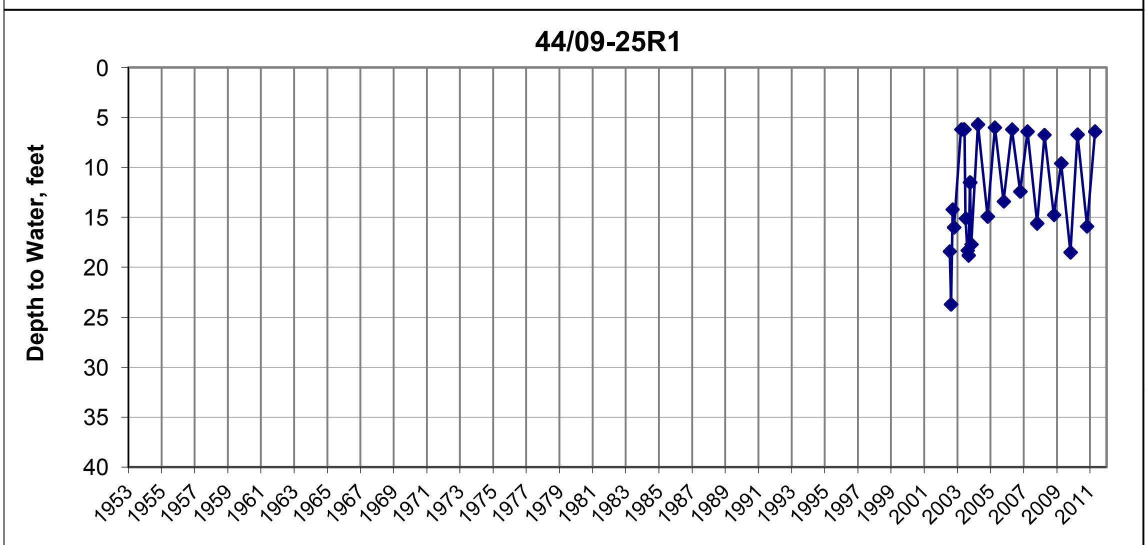


Figure A-1. Scott Valley Long-term Hydrographs, continued





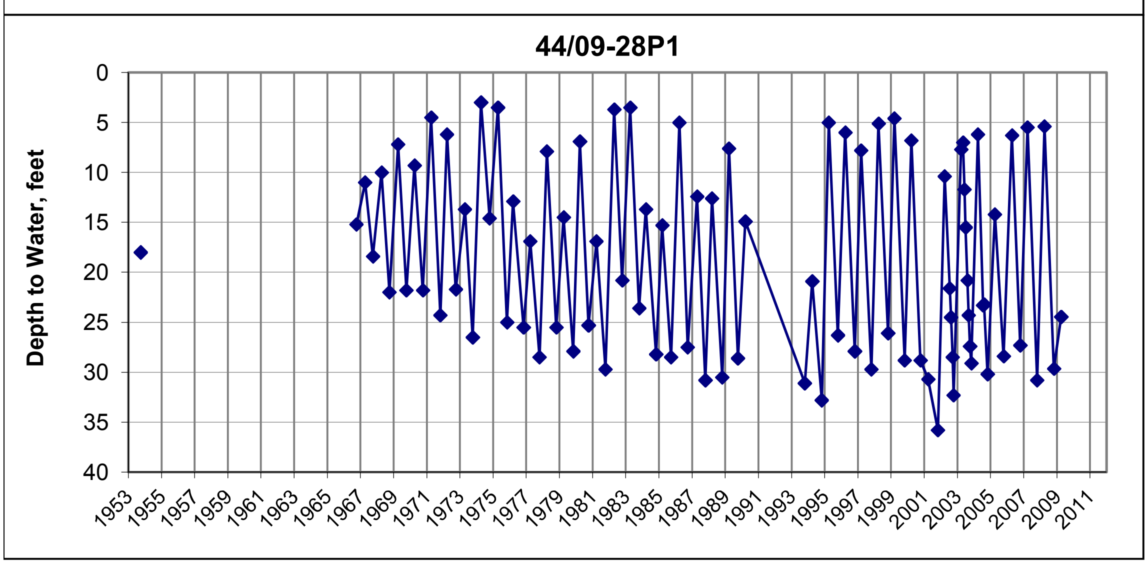


Figure A-1. Scott Valley Long-term Hydrographs, continued

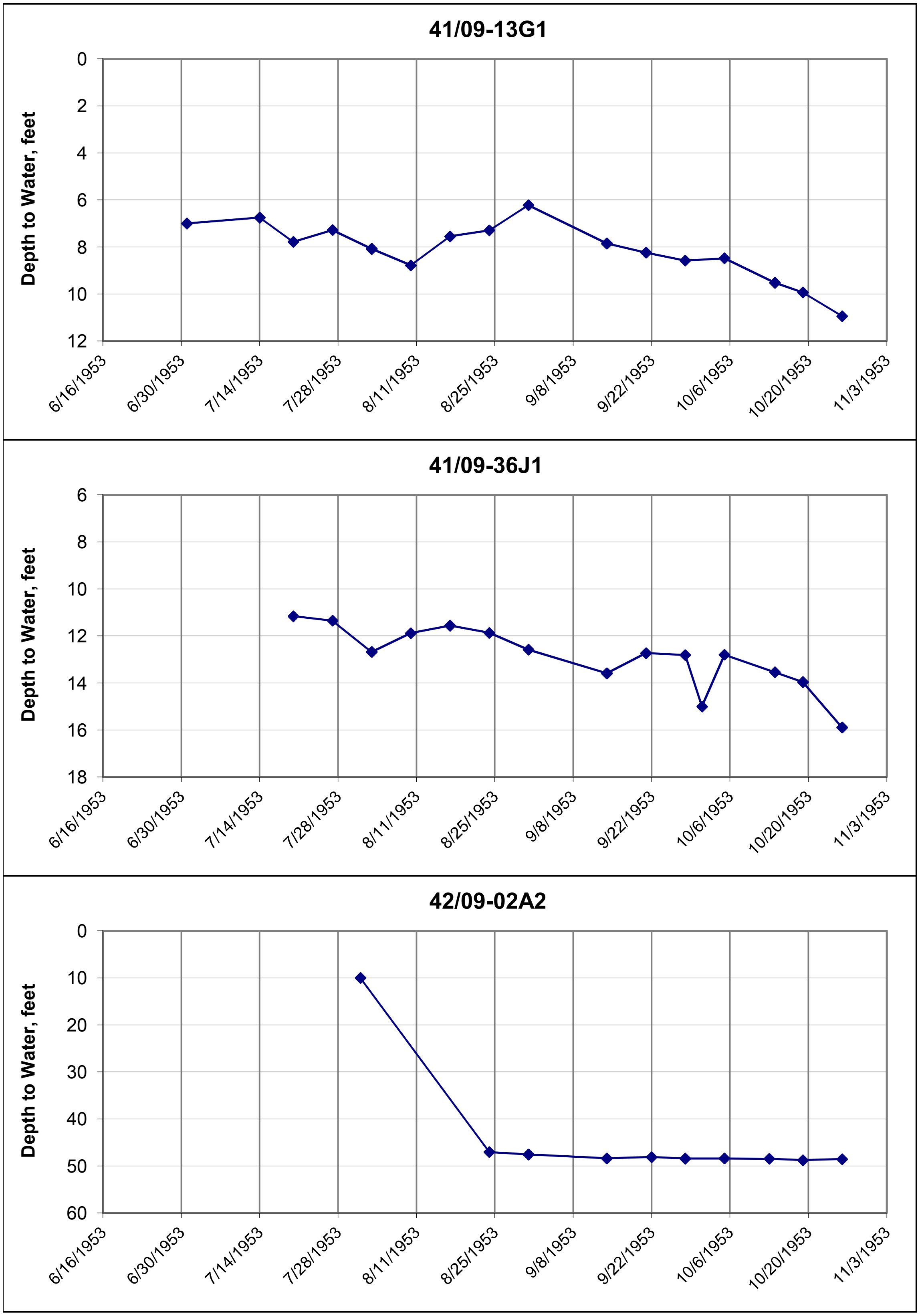
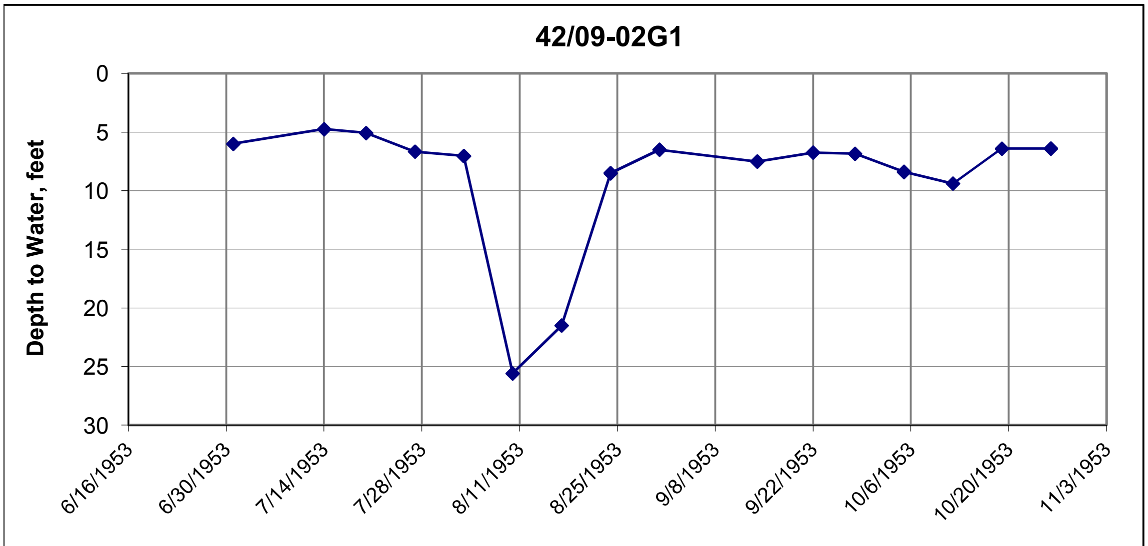
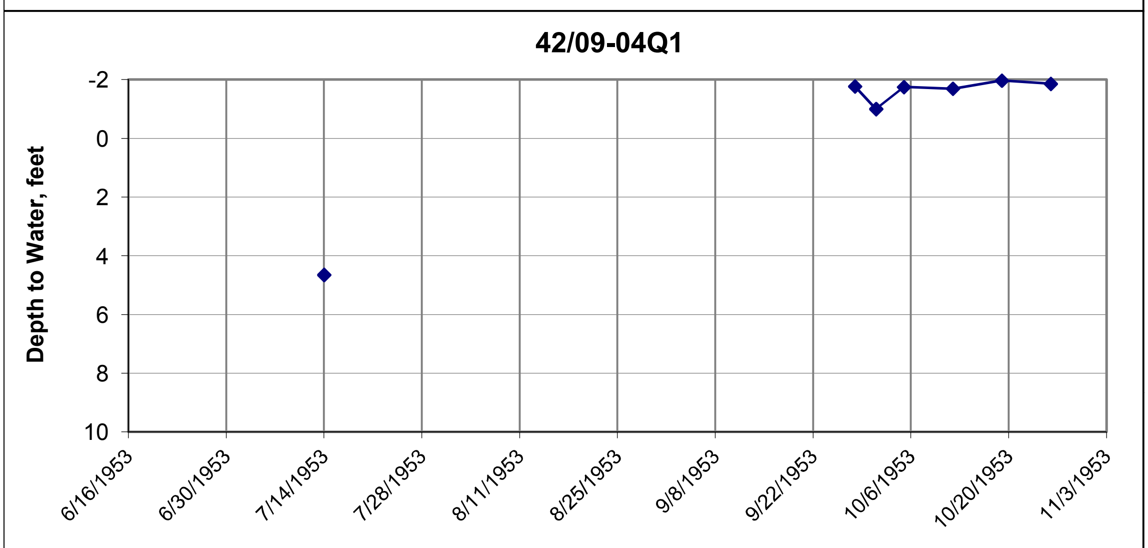


Figure A.2. Scott Valley Short-term Hydrographs (greater than 3 records)





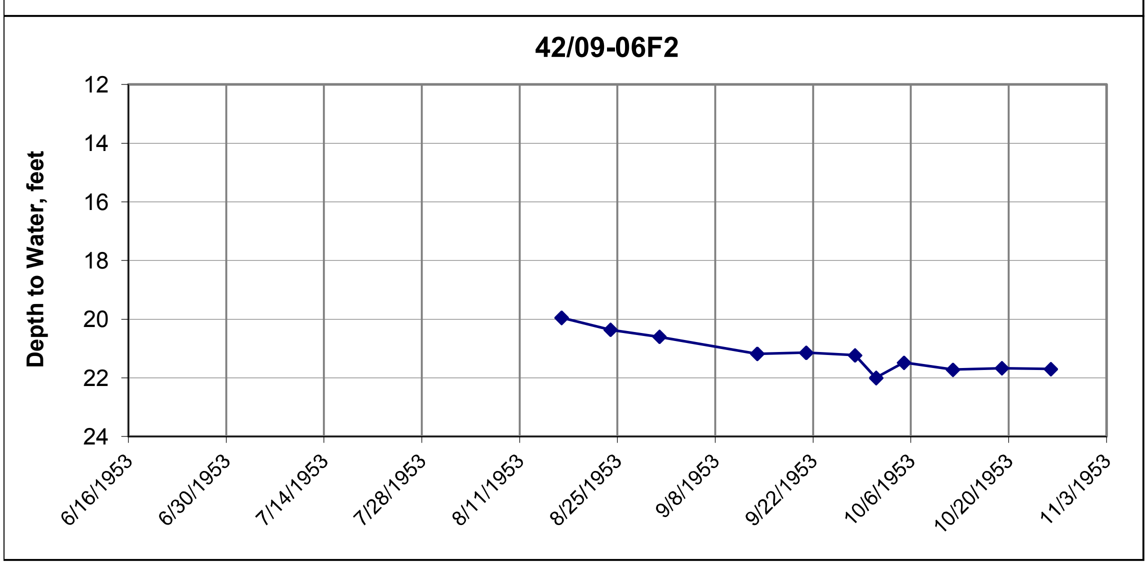


Figure A.2. Scott Valley Short-term Hydrographs (greater than 3 records), continued

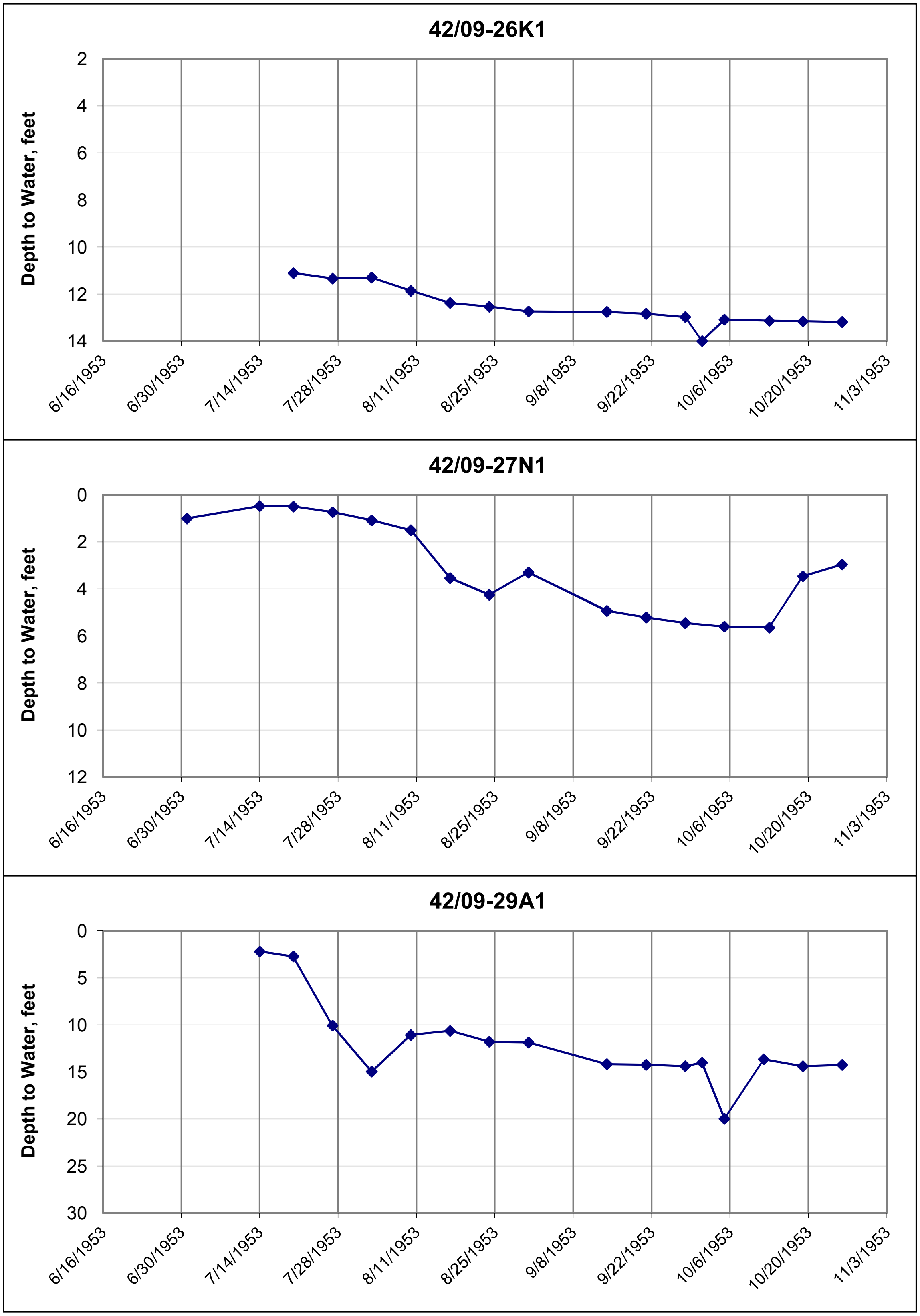


Figure A.2. Scott Valley Short-term Hydrographs (greater than 3 records), continued

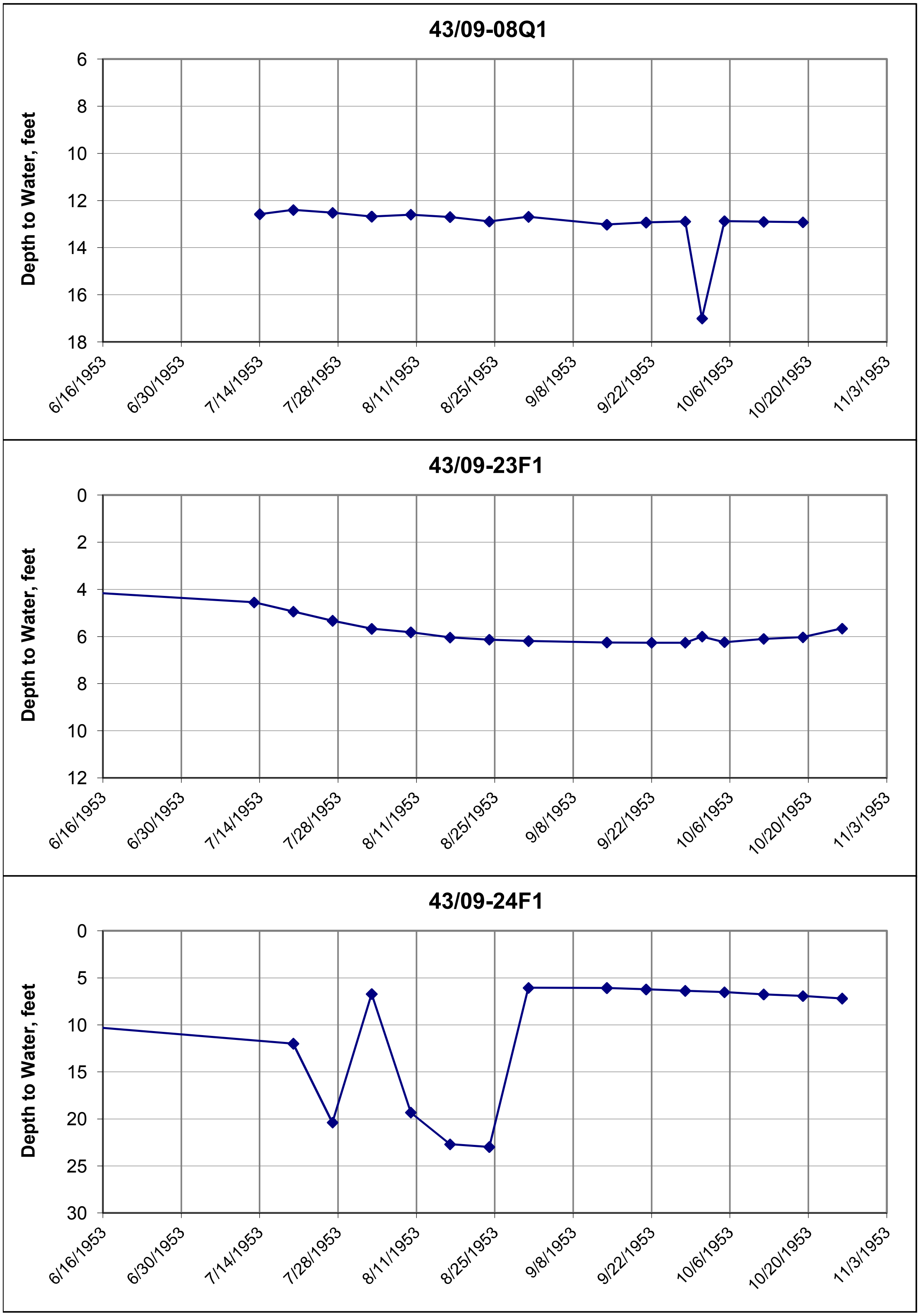


Figure A.2. Scott Valley Short-term Hydrographs (greater than 3 records), continued

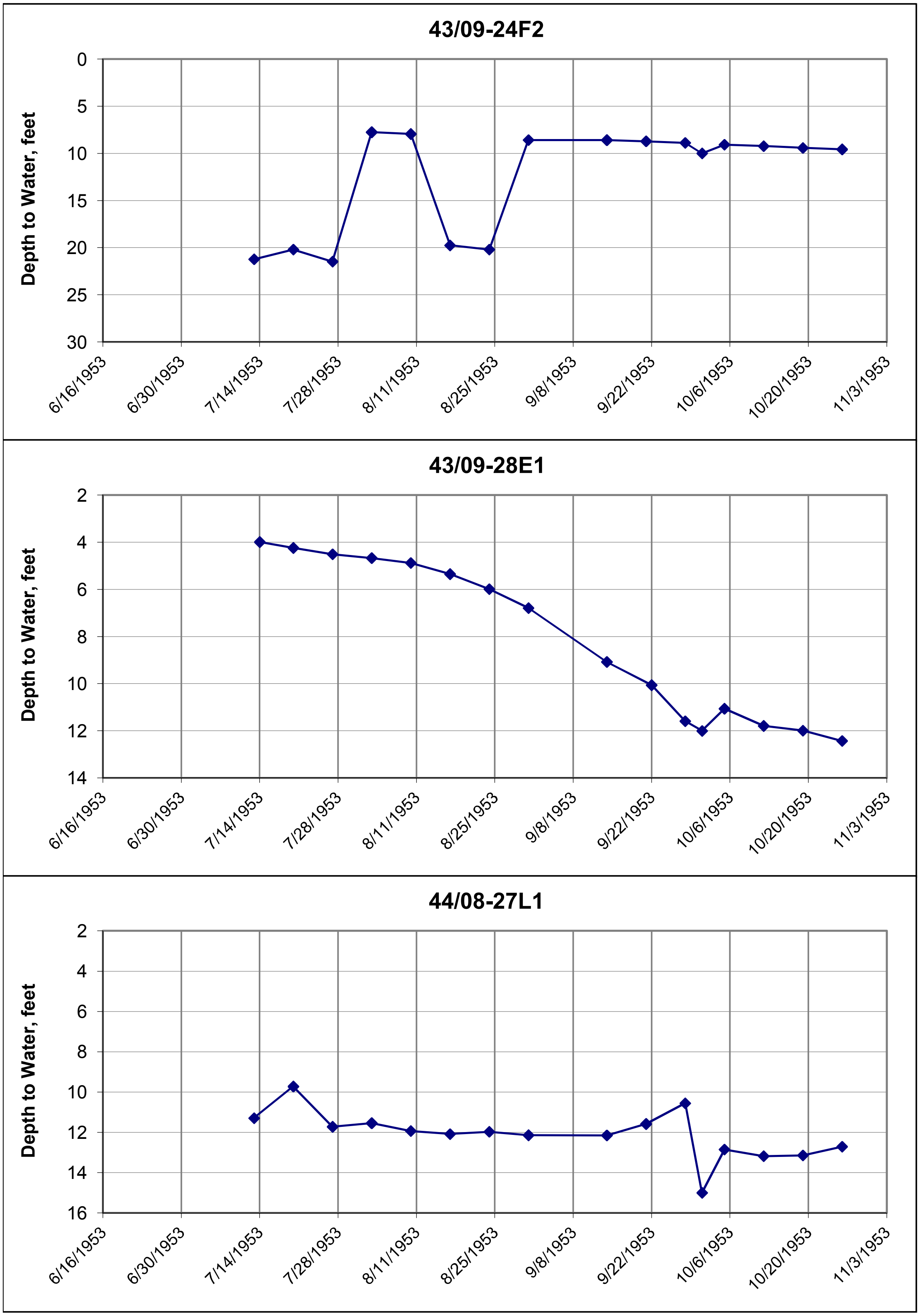
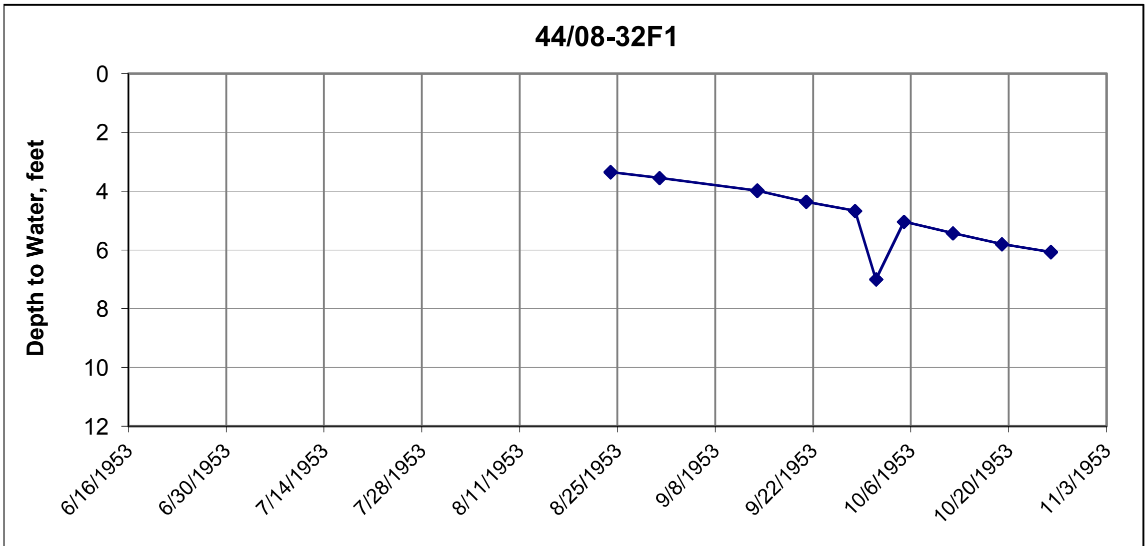
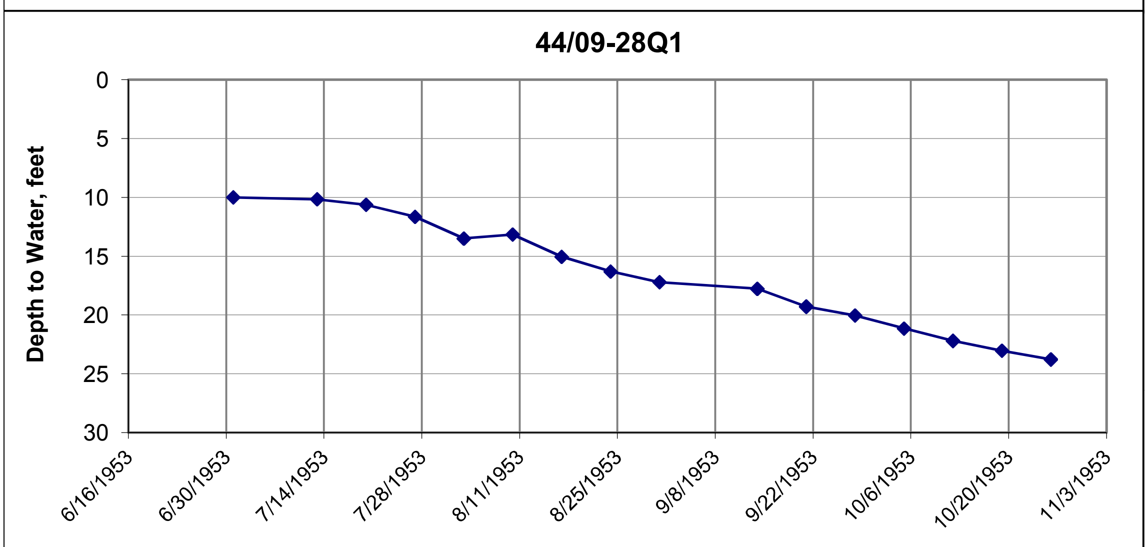


Figure A.2. Scott Valley Short-term Hydrographs (greater than 3 records), continued





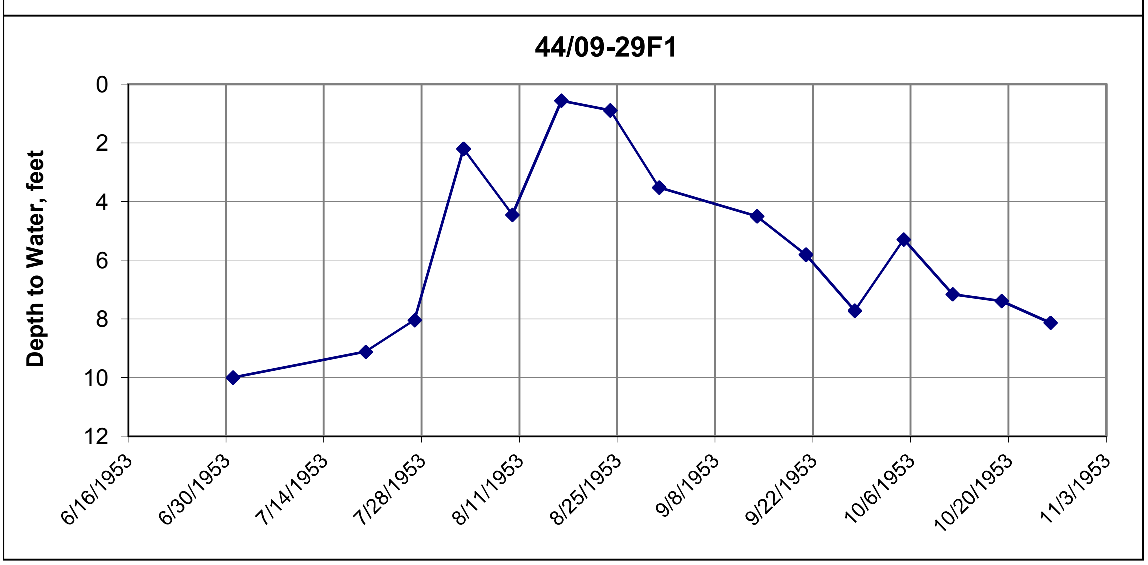
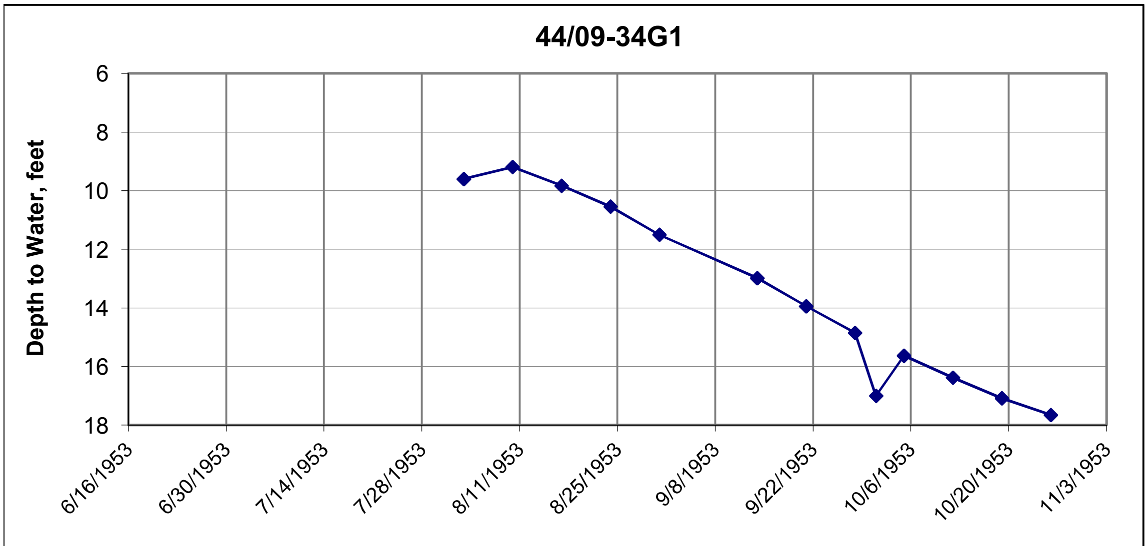
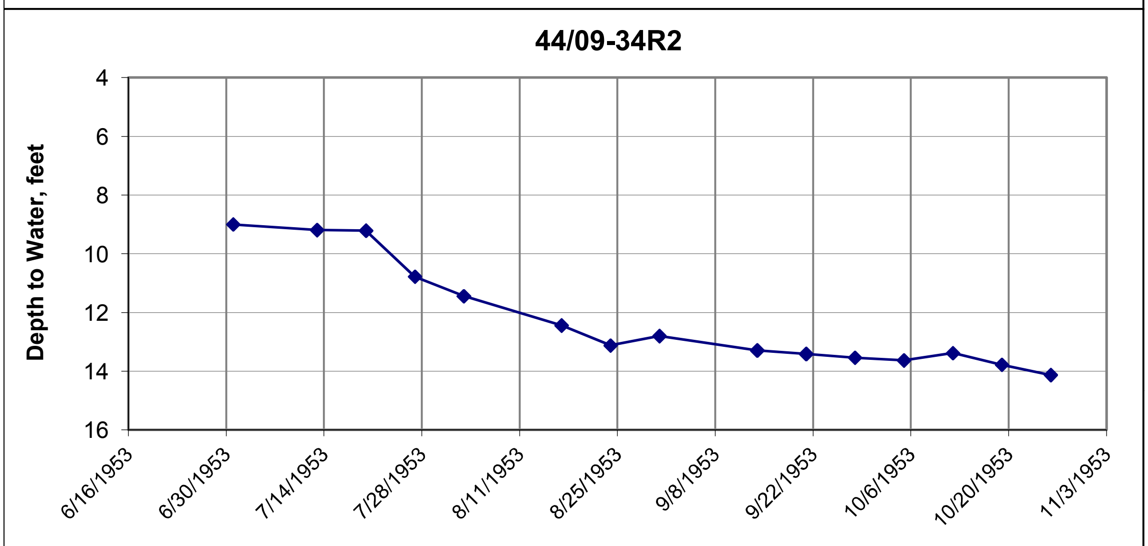


Figure A.2. Scott Valley Short-term Hydrographs (greater than 3 records), continued





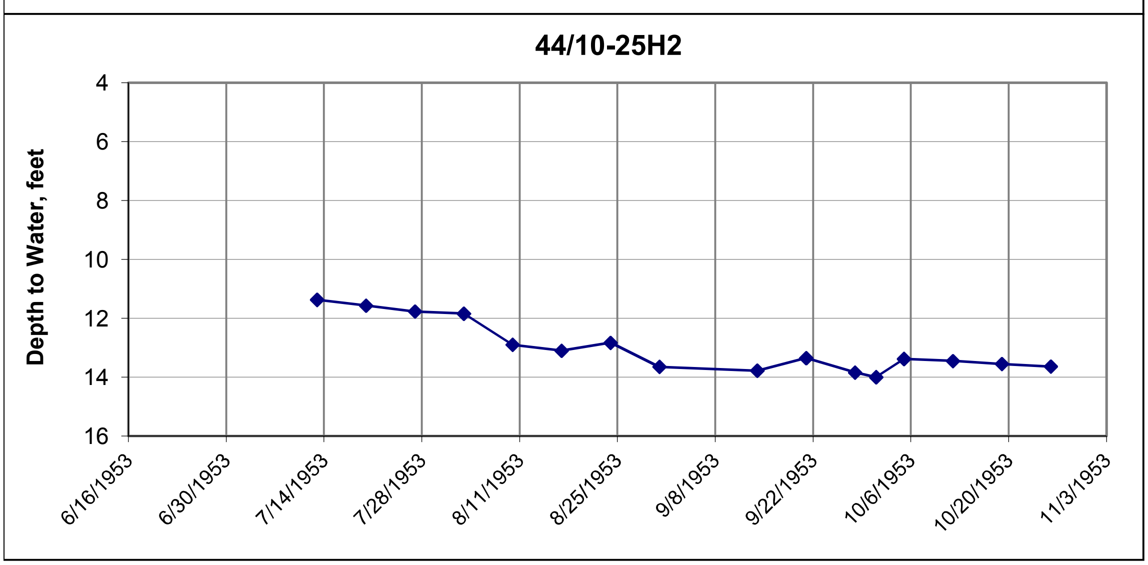


Figure A.2. Scott Valley Short-term Hydrographs (greater than 3 records), continued

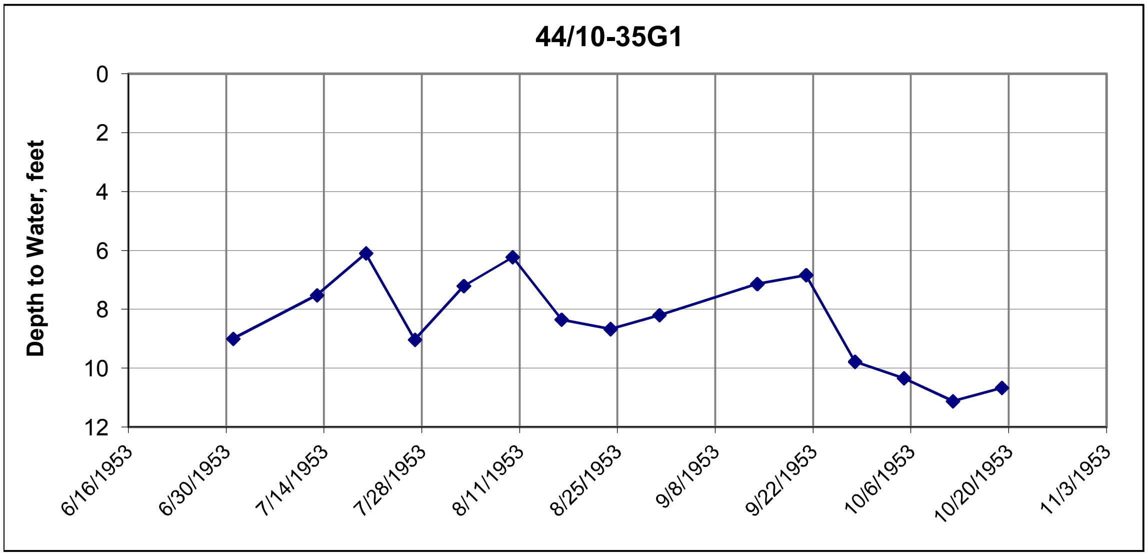


Figure A.2. Scott Valley Short-term Hydrographs (greater than 3 records), continued

Appendix B

Gaged Flow Summaries

Table B-1
Average Daily Flow, Scott River near Ft. Jones
USGS Station 11519500

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average	Water Year Average
1941	--	--	--	--	--	--	--	--	--	80	150	1,500	**--**	**--**
1942	1,156	1,480	609	785	1,275	1,058	294	90	68	67	616	1,429	**744**	**712**
1943	1,787	1,405	1,216	1,531	900	675	234	93	65	80	167	137	**691**	**835**
1944	161	248	401	390	636	332	115	75	49	46	153	233	**237**	**233**
1945	361	1,019	401	674	1,226	543	133	70	52	81	293	1,085	**495**	**409**
1946	1,254	588	794	1,100	1,359	669	189	94	64	69	329	292	**567**	**631**
1947	203	534	617	639	524	273	81	52	41	144	156	115	**282**	**305**
1948	1,238	366	314	695	1,201	1,235	222	88	76	90	140	296	**497**	**488**
1949	164	382	624	1,138	1,308	445	103	60	44	48	86	94	**375**	**400**
1950	521	634	1,132	1,119	1,131	667	145	71	53	706	1,036	2,048	**772**	**475**
1951	1,084	2,419	777	1,286	1,046	520	162	73	57	83	250	1,051	**734**	**935**
1952	726	2,118	1,219	2,217	2,270	1,580	521	167	104	88	99	394	**959**	**1,025**
1953	3,221	1,422	834	1,211	1,492	1,711	753	148	108	117	663	641	**1,027**	**957**
1954	1,141	1,716	1,493	1,614	1,333	590	184	97	89	91	220	225	**733**	**807**
1955	194	198	203	256	653	428	88	43	32	39	237	3,261	**469**	**219**
1956	3,120	1,509	1,485	1,761	1,880	1,202	318	103	80	144	276	362	**1,020**	**1,250**
1957	251	1,002	1,742	1,050	1,279	629	138	75	57	383	696	876	**681**	**584**
1958	1,570	4,793	1,515	1,565	2,426	1,483	407	133	97	100	183	174	**1,204**	**1,329**
1959	913	708	631	936	659	312	81	42	40	53	54	62	**374**	**398**
1960	97	953	937	818	841	682	103	61	48	59	224	486	**442**	**392**
1961	295	1,531	881	892	930	890	131	58	63	70	135	423	**525**	**536**
1962	279	711	541	1,136	793	486	128	64	56	941	756	1,747	**636**	**402**
1963	457	2,539	622	1,506	1,663	537	155	68	62	99	735	426	**739**	**921**
1964	810	651	493	567	650	574	123	59	49	54	129	5,003	**764**	**436**
1965	2,228	1,361	798	1,403	1,036	592	145	78	71	71	232	218	**686**	**1,075**
1966	758	383	796	1,460	1,152	458	101	48	47	61	374	803	**537**	**477**
1967	875	947	828	602	1,724	1,211	287	67	53	95	107	153	**579**	**653**
1968	497	2,056	954	574	556	295	64	44	43	51	210	463	**484**	**453**
1969	1,283	1,080	972	1,561	2,308	1,209	191	60	61	99	119	1,115	**838**	**787**
1970	4,186	1,460	1,061	584	920	596	108	51	48	64	1,016	1,295	**949**	**862**
1971	2,714	1,276	1,659	1,347	1,867	1,235	363	91	87	112	262	377	**949**	**1,084**
1972	1,405	1,024	2,825	945	971	728	136	63	69	84	126	571	**746**	**743**
1973	820	539	441	564	982	285	66	28	29	147	1,628	2,139	**639**	**378**
1974	4,417	1,264	2,128	2,174	1,854	1,595	381	113	70	74	121	196	**1,199**	**1,493**
1975	399	993	2,201	1,289	2,127	1,801	370	100	80	167	524	613	**889**	**813**
1976	380	430	605	607	945	322	90	73	62	79	87	84	**314**	**402**
1977	81	99	83	55	121	156	34	10	11	18	342	1,648	**221**	**75**
1978	1,814	1,302	1,272	1,017	936	727	264	65	139	94	103	148	**657**	**795**
1979	405	357	725	576	1,104	206	52	23	22	123	467	670	**394**	**318**

Note: Values shown are average daily flows, cfs, over period indicated.

Table B-1, Continued
Average Daily Flow, Scott River near Ft. Jones
USGS Station 11519500

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average	Water Year Average
1980	2,171	1,494	969	975	805	501	118	38	32	45	74	509	**644**	**697**
1981	440	986	539	488	398	135	23	7	8	21	1,077	3,246	**614**	**304**
1982	1,132	3,092	1,497	1,346	1,518	991	300	68	57	163	311	1,369	**987**	**1,195**
1983	1,359	2,226	2,747	1,703	2,379	1,720	769	269	228	195	960	2,086	**1,387**	**1,270**
1984	1,257	946	1,079	980	1,363	691	183	51	52	99	881	543	**677**	**820**
1985	331	549	439	1,138	655	374	67	31	39	66	100	188	**331**	**429**
1986	736	3,164	2,121	964	787	537	87	34	44	91	129	146	**737**	**736**
1987	257	559	861	843	681	152	40	13	14	20	38	750	**352**	**315**
1988	518	517	462	417	436	467	61	15	12	27	368	293	**300**	**310**
1989	308	323	1,695	1,477	917	367	74	21	32	140	137	159	**471**	**492**
1990	613	278	566	536	439	405	61	14	12	31	55	66	**256**	**280**
1991	120	233	381	296	473	256	41	13	11	18	43	140	**169**	**165**
1992	123	388	389	810	374	78	48	8	26	64	80	166	**213**	**204**
1993	515	647	1,931	1,252	1,938	1,365	219	57	48	61	76	154	**688**	**690**
1994	236	231	346	318	455	114	13	6	5	10	11	53	**150**	**168**
1995	1,719	2,029	2,285	1,549	1,803	1,352	506	92	49	66	86	1,075	**1,051**	**955**
1996	1,293	2,725	1,449	1,498	1,547	588	145	32	28	58	1,150	2,832	**1,112**	**878**
1997	3,709	1,134	800	894	633	252	74	28	37	82	178	235	**671**	**967**
1998	1,520	1,668	2,566	1,412	1,728	1,794	663	119	68	105	639	881	**1,097**	**1,003**
1999	1,120	1,610	1,552	1,295	1,664	1,244	243	71	58	71	180	237	**779**	**874**
2000	913	1,100	1,166	1,423	1,124	633	127	19	24	49	81	98	**563**	**585**
2001	99	127	386	276	401	50	8	6	4	4	60	384	**150**	**132**
2002	1,077	644	570	1,018	707	395	64	15	12	17	81	1,165	**480**	**412**
2003	2,051	1,106	1,200	1,199	1,502	1,047	181	88	49	67	111	379	**748**	**807**
2004	546	1,082	1,185	1,050	969	412	73	13	14	48	92	559	**504**	**492**
2005	554	492	549	649	1,453	656	134	22	16	35	224	2,965	**646**	**435**
2006	3,236	2,343	1,101	1,360	2,344	1,155	193	52	47	64	252	937	**1,090**	**1,255**
2007	696	524	1,074	634	539	142	38	8	7	104	113	270	**346**	**410**
2008	382	497	749	657	1,459	568	101	23	17	37	140	129	**396**	**411**
2009	235	287	613	497	929	309	36	11	7	18	48	74	**255**	**269**
2010	498	437	529	863	1,123	1,617	292	40	36	126	352	1,040	**580**	**465**
2011	1,017	540	696	--	--	--	--	--	--	--	--	--	**--**	**--**
Period of Record Average	**1,058**	**1,107**	**1,019**	**1,007**	**1,154**	**715**	**180**	**59**	**50**	**101**	**309**	**800**	**630**	**631**
Average, 1971-2000	**1,094**	**1,106**	**1,259**	**1,006**	**1,101**	**702**	**187**	**52**	**48**	**79**	**344**	**722**	**642**	**648**
Average, 1990-2010	**1,012**	**932**	**1,018**	**928**	**1,124**	**687**	**155**	**35**	**27**	**54**	**193**	**659**	**569**	**565**

Note: Values shown are average daily flows, cfs, over period indicated.

Table B-2
Average Daily Flow, Shackleford Creek near Mugginsville
CA DWR Station F25484

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average	Water Year Average
2004	--	--	--	--	--	--	--	--	--	4	8	54	**--**	**--**
2005	50	62	80	122	166	62	10	4	1	2	42	65	**55**	**52**
2006	--	--	--	--	--	103	18	7	4	4	39	108	**--**	**--**
2007	106	73	153	91	78	28	7	3	1	11	23	47	**52**	**58**
2008	53	54	107	105	180	91	16	1	1	3	24	25	**55**	**57**
2009	45	41	82	72	105	36	4	2	2	1	4	16	**34**	**37**
2010	85	73	72	95	111	106	25	4	3	--	--	--	**--**	**50**
Period of Record Average	**68**	**60**	**99**	**97**	**128**	**71**	**13**	**3**	**2**	**4**	**23**	**52**	**49**	**51**

Note: Values shown are average daily flows, cfs, over period indicated.

Table B-3
Average Daily Flow, Mill Creek near Mugginsville
CA DWR Station F25480

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average	Water Year Average
2004	--	--	--	--	--	--	--	--	--	--	3	12	--	--
2005	11	17	22	30	44	17	7	5	5	--	--	--	--	--
Period of Record Average	**11**	**17**	**22**	**30**	**44**	**17**	**7**	**5**	**5**	--	**3**	**12**	--	--

Note: Values shown are average daily flows, cfs, over period indicated.

Table B-4
Average Daily Flow, Moffett Creek near Ft. Jones
USGS Station 11518600

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average	Water Year Average
1958	--	--	--	--	--	--	--	--	--	2	3	3	**--**	**--**
1959	7	13	14	7	4	1	1	0	1	1	2	2	**5**	**5**
1960	1	19	32	15	5	2	1	0	1	3	4	20	**9**	**7**
1961	9	46	30	20	10	4	2	1	1	1	2	4	**11**	**12**
1962	5	19	17	14	7	3	1	1	1	5	11	50	**11**	**6**
1963	12	84	19	50	39	17	6	2	1	2	5	5	**20**	**25**
1964	29	27	22	23	10	4	2	0	0	0	1	80	**17**	**11**
1965	142	70	29	40	24	8	4	2	2	1	2	2	**27**	**34**
1966	27	13	29	27	6	3	0	0	0	0	2	20	**11**	**9**
1967	36	46	43	40	44	17	5	1	1	--	--	--	**--**	**21**
Period of Record Average	**30**	**37**	**26**	**26**	**16**	**7**	**2**	**1**	**1**	**2**	**3**	**21**	**14**	**14**

Note: Values shown are average daily flows, cfs, over period indicated.

Table B-5
Average Daily Flow, French Creek at HWY 3 near Callahan
CA DWR Station F25650

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average	Water Year Average
2004	--	--	--	--	--	--	--	--	--	5	11	43	**--**	**--**
2005	29	27	25	23	86	36	6	0	0	3	41	98	**31**	**24**
2006	126	96	56	60	117	61	7	2	1	3	24	51	**50**	**56**
2007	55	36	68	47	51	16	3	2	2	16	19	26	**28**	**30**
2008	32	34	42	34	87	49	6	1	0	3	19	16	**27**	**29**
2009	28	22	34	35	86	24	1	0	1	--	--	--	**--**	**23**
Period of Record Average	**54**	**43**	**45**	**40**	**85**	**37**	**5**	**1**	**1**	**6**	**23**	**47**	**34**	**32**

Note: Values shown are average daily flows, cfs, over period indicated.

Table B-6
Average Daily Flow, Sugar Creek near Callahan
CA DWR Station F25890

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average	Water Year Average
2009	--	--	--	--	--	--	--	--	--	3	5	6	**--**	**--**
2010	19	10	15	24	36	52	18	2	2	--	--	--	**--**	**16**
Period of Record Average	**19**	**10**	**15**	**24**	**36**	**52**	**18**	**2**	**2**	**3**	**5**	**6**	**--**	**16**

Note: Values shown are average daily flows, cfs, over period indicated.

Table B-7
Average Daily Flow, South Scott River near Callahan
CA DWR Station F28100

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average	Water Year Average
2002	--	--	--	--	--	42	16	5	3	7	24	55	**--**	**--**
2003	139	110	129	159	186	196	53	26	14	--	--	--	**--**	**91**
2004	--	--	--	--	--	--	--	--	--	--	23	58	**--**	**--**
2005	66	60	77	103	260	161	43	9	4	--	--	--	**--**	**--**
2007	--	--	--	108	110	35	10	6	5	28	28	39	**--**	**--**
2008	41	37	70	121	289	172	22	7	4	13	50	24	**71**	**71**
2009	46	52	116	155	238	76	11	5	4	15	16	18	**63**	**66**
2010	52	39	64	114	240	--	54	13	7	--	--	--	**--**	**58**
Period of Record Average	**69**	**60**	**91**	**127**	**220**	**114**	**30**	**10**	**6**	**16**	**28**	**39**	**67**	**72**

Note: Values shown are average daily flows, cfs, over period indicated.

Table B-8
Average Daily Flow, East Fork Scott River near Callahan
CA DWR Station F26050

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average	Water Year Average
2002	--	--	--	--	--	24	10	4	3	5	15	64	**--**	**--**
2003	242	142	154	236	324	161	35	22	9	--	--	--	**--**	**118**
2004	--	--	--	--	--	--	--	--	--	--	22	73	**--**	**--**
2005	89	103	128	141	262	147	44	8	6	--	--	--	**--**	**--**
2006	--	--	--	--	--	--	--	--	--	10	19	55	**--**	**--**
2007	42	79	150	104	91	19	5	3	3	16	14	30	**46**	**48**
2008	53	69	99	123	219	80	13	5	4	8	42	15	**61**	**60**
2009	19	39	113	124	166	57	10	4	3	19	16	22	**49**	**50**
2010	97	119	156	200	283	307	89	13	8	--	--	--	**--**	**111**
Period of Record Average	**90**	**92**	**134**	**155**	**224**	**113**	**29**	**8**	**5**	**12**	**21**	**43**	**52**	**77**

Note: Values shown are average daily flows, cfs, over period indicated.

Table B-9
Average Daily Flow, Shackleford Creek near Mugginsville
USGS Station 11519000

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average	Water Year Average
1956	--	--	--	--	--	--	--	--	--	19	37	44	**--**	**--**
1957	18	63	101	80	122	74	19	11	9	31	62	52	**53**	**50**
1958	60	159	58	85	187	161	50	15	11	7	35	23	**71**	**78**
1959	83	37	48	90	81	54	13	8	8	5	5	4	**36**	**41**
1960	6	38	75	81	116	115	20	13	7	--	--	--	**--**	**40**
Period of Record Average	**42**	**74**	**70**	**84**	**127**	**101**	**26**	**11**	**9**	**16**	**35**	**31**	**54**	**52**

Note: Values shown are average daily flows, cfs, over period indicated.

Appendix C

Monthly Agricultural Water Use, 2000, for DAU 003

State of California, Department of Water Resour

Monthly Ag Water Use by DAU Cou

Crops

	Area (Acres)			Unit ETAW (ft)	ETAW (Acre-feet)			Consumed Fraction			Unit Applied Water (feet)			Applied Water (Acre-fe	
	SW	GW	Total		SW	GW	Total	SW	GW	Tot	SW	GW	Tot	SW	GW

2000 Water Year

003 - Siskiyou

Alfalfa

	SW	GW	Total	Unit ETAW (ft)	ETAW SW	ETAW GW	ETAW Total	CF SW	CF GW	CF Tot	UAW SW	UAW GW	UAW Tot	AW SW	AW GW
Oct 99	1,420	11,191	12,611	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
Nov 99	1,420	11,191	12,611	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
Dec 99	1,420	11,191	12,611	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
Jan 00	1,420	11,191	12,611	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
Feb 00	1,420	11,191	12,611	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
Mar 00	1,420	11,191	12,611	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
Apr 00	1,420	11,191	12,611	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
May 00	1,420	11,191	12,611	0.1	173	1,362	1,535	0.73	0.78	0.77	0.2	0.2	0.2	237	1,746
Jun 00	1,420	11,191	12,611	0.6	789	6,220	7,009	0.73	0.78	0.77	0.8	0.7	0.7	1,081	7,975
Jul 00	1,420	11,191	12,611	0.6	811	6,388	7,199	0.73	0.78	0.77	0.8	0.7	0.7	1,110	8,190
Aug 00	1,420	11,191	12,611	0.6	812	6,398	7,210	0.73	0.78	0.77	0.8	0.7	0.7	1,112	8,202
Sep 00	1,420	11,191	12,611	0.4	553	4,356	4,909	0.73	0.78	0.77	0.5	0.5	0.5	757	5,584
Total	1,420	11,191	12,611	2.2	3,138	24,724	27,862	0.73	0.78	0.77	3.0	2.8	2.9	4,297	31,697

Alfalfa-X

	SW	GW	Total	Unit ETAW (ft)	ETAW SW	ETAW GW	ETAW Total	CF SW	CF GW	CF Tot	UAW SW	UAW GW	UAW Tot	AW SW	AW GW
Oct 99	409	15	424	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
Nov 99	409	15	424	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
Dec 99	409	15	424	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
Jan 00	409	15	424	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
Feb 00	409	15	424	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
Mar 00	409	15	424	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
Apr 00	409	15	424	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
May 00	409	15	424	0.1	50	2	52	0.74	0.92	0.74	0.2	0.1	0.2	68	2
Jun 00	409	15	424	0.6	227	8	235	0.73	0.76	0.73	0.8	0.7	0.8	311	11
Jul 00	409	15	424	0.6	233	9	242	0.73	0.78	0.73	0.8	0.7	0.8	320	11
Aug 00	409	15	424	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
Sep 00	409	15	424	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
Total	409	15	424	1.2	510	19	529	0.73	0.78	0.73	1.7	1.6	1.7	699	24

Corn

	SW	GW	Total	Unit ETAW (ft)	ETAW SW	ETAW GW	ETAW Total	CF SW	CF GW	CF Tot	UAW SW	UAW GW	UAW Tot	AW SW	AW GW
Oct 99	20	292	312	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
Nov 99	20	292	312	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
Dec 99	20	292	312	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
Jan 00	20	292	312	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
Feb 00	20	292	312	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
Mar 00	20	292	312	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
Apr 00	20	292	312	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
May 00	20	292	312	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
Jun 00	20	292	312	0.2	4	56	60	0.64	0.73	0.72	0.3	0.3	0.3	6	77
Jul 00	20	292	312	0.6	12	169	181	0.68	0.73	0.73	0.9	0.8	0.8	17	232

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Monthly Ag Water Use by DAU Cou

Crops

	Area (Acres)			Unit ETAW (ft)	ETAW (Acre-feet)			Consumed Fraction			Unit Applied Water (feet)			Applied Water (Acre-fe	
	SW	GW	Total		SW	GW	Total	SW	GW	Tot	SW	GW	Tot	SW	GW
2000 Water Year															
003 - Siskiyou															
Corn															
Aug 00	20	292	312	0.6	12	172	184	0.69	0.73	0.73	0.9	0.8	0.8	17	236
Sep 00	20	292	312	0.1	1	21	22	0.71	0.71	0.71	0.1	0.1	0.1	2	29
Total	20	292	312	1.4	29	418	447	0.68	0.73	0.73	2.1	2.0	2.0	42	574
Grain															
Oct 99	163	1,807	1,970	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
Nov 99	163	1,807	1,970	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
Dec 99	163	1,807	1,970	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
Jan 00	163	1,807	1,970	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
Feb 00	163	1,807	1,970	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
Mar 00	163	1,807	1,970	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
Apr 00	163	1,807	1,970	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
May 00	163	1,807	1,970	0.1	11	119	130	0.72	0.78	0.77	0.1	0.1	0.1	15	153
Jun 00	163	1,807	1,970	0.4	59	654	713	0.70	0.78	0.77	0.5	0.5	0.5	84	838
Jul 00	163	1,807	1,970	0.6	97	1,077	1,174	0.70	0.78	0.77	0.9	0.8	0.8	139	1,380
Aug 00	163	1,807	1,970	0.2	28	309	337	0.70	0.78	0.77	0.2	0.2	0.2	40	396
Sep 00	163	1,807	1,970	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
Total	163	1,807	1,970	1.2	195	2,159	2,354	0.70	0.78	0.77	1.7	1.5	1.5	278	2,767
Meadow Pasture															
Oct 99	7,964	0	7,964	0.0	193	0	193	0.63	0.00	0.63	0.0	0.0	0.0	306	0
Nov 99	7,964	0	7,964	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
Dec 99	7,964	0	7,964	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
Jan 00	7,964	0	7,964	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
Feb 00	7,964	0	7,964	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
Mar 00	7,964	0	7,964	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
Apr 00	7,964	0	7,964	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
May 00	7,964	0	7,964	0.2	1,958	0	1,958	0.63	0.00	0.63	0.4	0.0	0.4	3,108	0
Jun 00	7,964	0	7,964	0.5	4,101	0	4,101	0.63	0.00	0.63	0.8	0.0	0.8	6,511	0
Jul 00	7,964	0	7,964	0.5	4,354	0	4,354	0.63	0.00	0.63	0.9	0.0	0.9	6,911	0
Aug 00	7,964	0	7,964	0.5	4,314	0	4,314	0.63	0.00	0.63	0.9	0.0	0.9	6,847	0
Sep 00	7,964	0	7,964	0.4	2,814	0	2,814	0.63	0.00	0.63	0.6	0.0	0.6	4,466	0
Total	7,964	0	7,964	2.2	17,734	0	17,734	0.63	0.00	0.63	3.5	0.0	3.5	28,149	0
Meadow Pasture-X															
Oct 99	1,651	0	1,651	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
Nov 99	1,651	0	1,651	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
Dec 99	1,651	0	1,651	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
Jan 00	1,651	0	1,651	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0

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Monthly Ag Water Use by DAU Cou

Crops

	Area (Acres)			Unit ETAW (ft)	ETAW (Acre-feet)			Consumed Fraction			Unit Applied Water (feet)			Applied Water (Acre-fe	
	SW	GW	Total		SW	GW	Total	SW	GW	Tot	SW	GW	Tot	SW	GW

2000 Water Year

003 - Siskiyou

Meadow Pasture-X

Feb 00	1,651	0	1,651	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
Mar 00	1,651	0	1,651	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
Apr 00	1,651	0	1,651	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
May 00	1,651	0	1,651	0.2	406	0	406	0.63	0.00	0.63	0.4	0.0	0.4	644	0
Jun 00	1,651	0	1,651	0.5	850	0	850	0.63	0.00	0.63	0.8	0.0	0.8	1,350	0
Jul 00	1,651	0	1,651	0.2	384	0	384	0.63	0.00	0.63	0.4	0.0	0.4	609	0
Aug 00	1,651	0	1,651	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
Sep 00	1,651	0	1,651	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
Total	1,651	0	1,651	1.0	1,640	0	1,640	0.63	0.00	0.63	1.6	0.0	1.6	2,603	0

Other Field

Oct 99	0	46	46	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
Nov 99	0	46	46	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
Dec 99	0	46	46	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
Jan 00	0	46	46	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
Feb 00	0	46	46	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
Mar 00	0	46	46	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
Apr 00	0	46	46	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
May 00	0	46	46	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
Jun 00	0	46	46	0.2	0	7	7	0.00	0.78	0.78	0.0	0.2	0.2	0	9
Jul 00	0	46	46	0.4	0	20	20	0.00	0.71	0.71	0.0	0.6	0.6	0	28
Aug 00	0	46	46	0.7	0	30	30	0.00	0.73	0.73	0.0	0.9	0.9	0	41
Sep 00	0	46	46	0.2	0	7	7	0.00	0.70	0.70	0.0	0.2	0.2	0	10
Total	0	46	46	1.4	0	64	64	0.00	0.73	0.73	0.0	1.9	1.9	0	88

Other Truck

Oct 99	0	19	19	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
Nov 99	0	19	19	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
Dec 99	0	19	19	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
Jan 00	0	19	19	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
Feb 00	0	19	19	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
Mar 00	0	19	19	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
Apr 00	0	19	19	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
May 00	0	19	19	0.1	0	1	1	0.00	1.00	1.00	0.0	0.1	0.1	0	1
Jun 00	0	19	19	0.2	0	4	4	0.00	0.67	0.67	0.0	0.3	0.3	0	6
Jul 00	0	19	19	0.5	0	9	9	0.00	0.69	0.69	0.0	0.7	0.7	0	13
Aug 00	0	19	19	0.6	0	11	11	0.00	0.73	0.73	0.0	0.8	0.8	0	15
Sep 00	0	19	19	0.1	0	2	2	0.00	0.67	0.67	0.0	0.2	0.2	0	3
Total	0	19	19	1.4	0	27	27	0.00	0.71	0.71	0.0	2.0	2.0	0	38

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Monthly Ag Water Use by DAU Cou

Crops

	Area (Acres)			Unit ETAW (ft)	ETAW (Acre-feet)			Consumed Fraction			Unit Applied Water (feet)			Applied Water (Acre-fe	
	SW	GW	Total		SW	GW	Total	SW	GW	Tot	SW	GW	Tot	SW	GW
2000 Water Year															
003 - Siskiyou															
Pasture															
Oct 99	4,334	1,668	6,002	0.0	58	22	80	0.69	0.77	0.71	0.0	0.0	0.0	84	29
Nov 99	4,334	1,668	6,002	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
Dec 99	4,334	1,668	6,002	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
Jan 00	4,334	1,668	6,002	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
Feb 00	4,334	1,668	6,002	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
Mar 00	4,334	1,668	6,002	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
Apr 00	4,334	1,668	6,002	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
May 00	4,334	1,668	6,002	0.3	1,141	439	1,580	0.69	0.78	0.71	0.4	0.3	0.4	1,654	563
Jun 00	4,334	1,668	6,002	0.6	2,478	954	3,432	0.69	0.78	0.71	0.8	0.7	0.8	3,591	1,222
Jul 00	4,334	1,668	6,002	0.6	2,543	979	3,522	0.69	0.78	0.71	0.9	0.8	0.8	3,685	1,255
Aug 00	4,334	1,668	6,002	0.6	2,543	979	3,522	0.69	0.78	0.71	0.9	0.8	0.8	3,685	1,255
Sep 00	4,334	1,668	6,002	0.4	1,734	667	2,401	0.69	0.78	0.71	0.6	0.5	0.6	2,512	855
Total	4,334	1,668	6,002	2.4	10,497	4,040	14,537	0.69	0.78	0.71	3.5	3.1	3.4	15,211	5,179
Pasture-X															
Oct 99	626	210	836	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
Nov 99	626	210	836	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
Dec 99	626	210	836	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
Jan 00	626	210	836	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
Feb 00	626	210	836	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
Mar 00	626	210	836	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
Apr 00	626	210	836	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
May 00	626	210	836	0.3	165	55	220	0.68	0.78	0.70	0.4	0.3	0.4	242	71
Jun 00	626	210	836	0.6	358	120	478	0.68	0.78	0.70	0.8	0.7	0.8	526	154
Jul 00	626	210	836	0.2	151	51	202	0.68	0.78	0.70	0.4	0.3	0.3	222	65
Aug 00	626	210	836	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
Sep 00	626	210	836	0.0	0	0	0	0.00	0.00	0.00	0.0	0.0	0.0	0	0
Total	626	210	836	1.1	674	226	900	0.68	0.78	0.70	1.6	1.4	1.5	990	290
003 - Siskiyou															
Total	16,587	15,248	31,835	2.1	34,417	31,677	66,094	0.66	0.78	0.71	3.2	2.7	2.9	52,269	40,657
	0	0	0	Double Crop Acreage											
	16,587	15,248	31,835	Irrig. Land Area											
2000															
Total	16,587	15,248	31,835	2.1	34,417	31,677	66,094	0.66	0.78	0.71	3.2	2.7	2.9	52,269	40,657
	0	0	0	Double Crop Acreage											
	16,587	15,248	31,835	Irrig. Land Area											

Appendix D

Mountain-Front Recharge

Appendix D
Mountain-Front Recharge

SUMMARY

Mountain-front recharge for the Scott River Valley groundwater model is estimated through examination of available water in the bordering mountains and hills, and surface water runoff to the valley, in a water balance approach. Available water is calculated as the difference between average monthly precipitation and monthly evapotranspiration over the mountainous area adjacent to the valley. The method allows for carryover of a portion of unused available water during spring and early summer months, representing available water storage in snowpack. Available water is allocated between surface water run-off and mountain-front recharge at the valley margin.

The procedure is initiated with the delineation of watersheds contributing to surface and subsurface inflow to the valley (Figure D-1). For each watershed, precipitation and potential evapotranspiration are computed over PRISM grid cells (Prism Climate Group, www.prism.oregonsate.edu), with dimensions of approximately 600 meters on a side (at the latitude of the Scott River Valley). Precipitation and climatologic input are based on monthly averages from the period 1971 to 2000, as computed and distributed by the Prism Climate Group. Available water is computed using climatologic as well as physical data including slope, aspect, elevation for each PRISM grid cell, and solar radiation. Available water is that portion of water not consumed by evaporation or evapotranspiration in the mountainous area and that comprises natural basin inflow, including channel and overland flow, and subsurface mountain-front recharge.

Average annual available water for watersheds bordering the groundwater model boundary is estimated to be 266,291 acre-feet per year, distributed among the component watersheds as shown in Table D-1. Assuming that on average, 85% of this amount comprises run-off, the remainder, approximately 40,000 acre-feet per year, constitutes subsurface or mountain-front recharge. The distribution of available water between run-off and subsurface recharge will vary among watersheds; a range of values is shown on Table D-2 using alternate distributions between run-off and subsurface recharge ranging from 95% / 5% to 75% / 25%. The suitability of values within the range is examined in model calibration.

METHOD DETAIL

Available Water

For each of the watersheds sharing boundaries with the groundwater model, available water is calculated. Additional watersheds contributing surface water flow to the Scott River are also included in the analysis for general reference. The watersheds are shown on Figure D-1. Climatologic inputs for the watersheds are based on PRISM grid cell data.

Average annual available water is calculated using a methodology based on Sankarasubramanian and Vogel (2002), Fernandez et al. (2000), and communication with Dr. Vogel of Tufts

University. These papers developed methods for watershed-scale calibration of a watershed model based on a water-balance calculation. The principal equation solved for is:

$$Q = P - \Delta S - ET$$

Where:

- Q = average annual available water (acre-feet/year)
- P = average annual precipitation (acre-feet/year)
- ΔS = average annual change in storage (acre-feet/year)
- ET = average annual evapotranspiration (acre-feet/year)

Changes in storage are assumed to be negligible, leaving us to solve:

$$Q = P - ET$$

This can be rewritten as:

$$Q = P - P \times \left(\frac{ET}{P}\right)$$

Where ET/P is the Evaporation Ratio, the ratio of evapotranspiration (ET) to precipitation. The advantage of reframing the equation using the Evaporation Ratio is that extensive work has been conducted on empirical relationships between the Evaporation Ratio and the Aridity Index (PET/P), as relationships of this type provide approximations to ET from measurements of rainfall and potential ET (PET). In this work, the Evaporation Ratio is calculated using the following empirical equation from Sankarasubramanian and Vogel (2002), which takes into account soil moisture storage and therefore provides a better fit than earlier empirical relationships:

$$\frac{ET}{P} = \frac{1}{2}\left\{1 + \gamma(1-R) - \left[1 - 2\gamma(1-R) + \gamma^2(1 - 2R + R^2)\right]^{1/2}\right\}$$

where:

- $R = e^{(-\Phi/\gamma)}$
- Φ = PET/P, the aridity index; the ratio of potential evapotranspiration to precipitation
- γ = b/P, a soil moisture storage index
- b = model parameter; b= $\max(ET_t + S_t)$
- S_t = soil moisture holding capacity of the basin in units of length, which could be thought of as a depth

The value of b used in the soil moisture storage index is estimated using a physically based approach using the observed precipitation, potential ET, and maximum soil moisture holding capacity of the basin. In their model calibration, Sankarasubramanian and Vogel use the maximum value of b, the sum of the maximum actual ET and the maximum soil moisture holding capacity. The maximum soil moisture holding capacity, $\max(S_t)$, is obtained from

Dunne and Willmott, 1996. The maximum ET, $\max(ET_t)$, is precipitation, if precipitation is less than potential ET, or potential ET.

This equation is applied by first calculating potential ET (PET) using gridded maximum and minimum monthly temperature data for the 1971-2000 period obtained from the PRISM Group, Oregon State University (www.prism.oregonstate.edu). These data were used in conjunction with a digital elevation model and monthly average percent possible sunshine data (for Red Bluff, California; obtained from the Western Regional Climate Center, http://www.wrcc.dri.edu/htmlfiles/westcomp.sun.html) to calculate potential ET via the Jensen-Haise method (Jensen, 1973) using code adapted from Deep Percolation Model (Bauer and Vaccaro, 1987).

The Jensen-Haise method is an empirical equation for potential evapotranspiration (PET). The Jensen-Haise method was selected over other methodologies for two reasons: it requires only temperature and incident solar radiation data, both readily available for the region[1], and it is particularly suitable to arid and semi-arid climates. The Jensen-Haise PET is computed as a function of average daily temperature, daily incident solar radiation, and elevation:

$$\text{PET} = \frac{R_I T_x}{C_L + 13 * C_H}$$

where

R_I = incident solar radiation
$T_x = [T = 2.5 + 0.14(E_2 - E_1) + A/550]$
$C_L = (38 - 2A/305)$
$C_H = 50/(E_2 - E_1)$
T = mean air temperature in degrees C
A = land surface altitude in meters
E_1 and E_2 = saturation vapor pressure at the long-term mean minimum and maximum temperatures for the warmest month of the year, in millibars

In application, the monthly reference percent possible sunshine for the area (Red Bluff, California) is varied for slope and aspect to provide R_I for each grid cell. In mountainous areas, this type of adjustment is critical, given that south facing slope are often bare in mid-winter while north-facing slopes are fully snow-burdened.

Potential ET was calculated for the PRISM grid. The mean slope, aspect and elevation values of the cell centroids within the PRISM cells were used to represent the entire cell area. Gridded PRISM monthly precipitation data for the 1971 to 2000 period were then used, in conjunction with the calculated values of potential ET, to calculate available water using the Sankarasubramanian and Vogel (2002) empirical equation given above. This methodology results in available water, Q, remaining after ET is removed, where ET losses are somewhat less than potential ET.

[1] One of the principal strengths of the Jensen-Haise equation is its limited data requirements. The Penman-Monteith approach, a well known and regularly used approach to calculating evapotranspiration, requires specific humidity data. Though this data is readily available in many agricultural settings, it is generally unavailable over diverse topographic areas such as mountainous regions.

Computed monthly available water was adjusted to allow for evapotranspiration of available water stored in the snowpack from previous months, in addition to allowing for evapotranspiration of precipitation that accumulated during a given month. Adjustment factors reflecting monthly carryover storage of available water due to snow accumulation were identified using basin-wide water budget constraints, with annual outflow at the Scott River near Ft. Jones gage, plus upland and valley-wide water depletion, providing a limit on total annual available water. The adjustment factors allowed a percentage of unused available water from winter months to be accumulated and later used to satisfy upland evapotranspiration demand in late spring and early summer months in which precipitation was insufficient to meet demand, while maintaining consistency with the annual basin-wide water budget.

Allocation of Available Water between Run-Off and Mountain-Front Recharge

Available water represents that portion of precipitation remaining after watershed demand is satisfied; or, the sum of run-off and mountain front recharge. The allocation of available water between run-off and mountain front recharge is a function of watershed characteristics, the timing and quantity of precipitation and other factors. Where available, gaged streamflow data can be used in estimating mountain front recharge as the difference between available water and run-off. For the Scott Valley, records of tributary inflow for upland watersheds are typically limited to a period of a few years (Appendix B), and, detailed upstream diversion, water use and return flow records are not readily available; nevertheless, the existing records provide some insight. Records for French Creek and the South Fork of the Scott River, suggest that gaged run-off accounts for approximately 85 to more than 90 percent of available water. The network of diversions and ditches within the French Creek Basin adds complexity to the analysis that goes beyond the scope of this assessment; however, the occurrence of consumptive use within the basin supported by irrigation practices, beyond that accounted for in the PRISM analysis, argues for reducing the estimate of mountain-front recharge obtained using the PRISM-based available water and gaged record. Records for Shackleford Creek suggest that only minimal opportunity for subsurface recharge is present in this watershed. Historic records for Moffett Creek and more recent records for the East Fork of the Scott River were also examined, and it was noted that run-off represents a significantly lower percentage of available water than in the other watersheds examined. This difference might be associated with the size and complexity of these watersheds which may support higher levels of consumptive use.

Many of the sub-watersheds included in the analysis are not drained by perennial streams or are ungaged. In the case of ungaged watersheds with similar characteristics to that of French Creek or the South Fork, one may expect a similar allocation of run-off to subsurface recharge. Watersheds without significant streams may provide greater opportunity for subsurface recharge resulting in a higher percentage of available water being attributable to mountain front recharge. Table D-2 identifies a range of values for mountain-front recharge, assuming this quantity to be 5%, 15% and 25% of calculated available water.

Mountain-Front Recharge Input to the Scott Valley Groundwater Model

Table D-2 provides a starting point for assigning mountain-front recharge to the groundwater model based on the simplified watershed water balance analysis described above. An initial allocation of 15% of available water was taken as mountain-front recharge for each contributing watershed, amounting to total mountain-front recharge of 39,944 acre-feet. The recharge was assigned to the groundwater model for the winter/spring and early summer seasons during which mountain-front recharge is most likely to accrue to the valley margins. The initial values are adjusted in model calibration, considering localized aquifer conditions at and near the mountain-front for each watershed.

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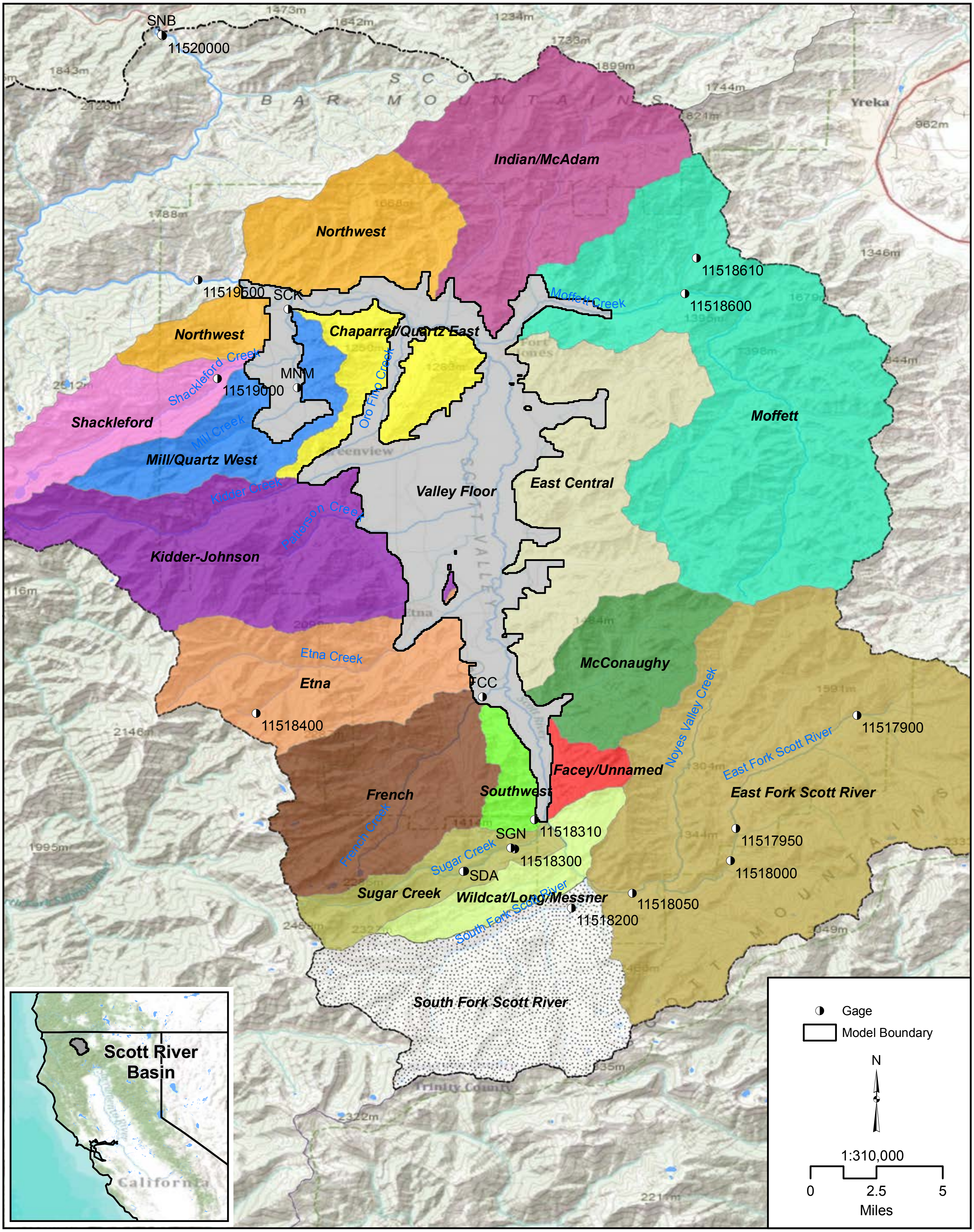

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Figure D-1 Sub-basin Designations for Mountain-Front Recharge Estimation

Table D-1
Average Annual Watershed Water Budget, 1971-2000 Period

Watershed	Area of Contributing Watershed, acres	Potential ET, acre-feet	ET, acre-feet	Precipitation, acre-feet	Available Water, acre-feet
Watersheds Bounding Groundwater Model					
Facey/Unnamed	2,960	12,090	4,595	6,275	1,680
McConaughy	13,137	55,638	21,443	29,076	7,632
East Central	26,027	111,771	42,593	52,561	9,967
Moffett	59,675	240,817	94,739	153,139	58,399
Indian/McAdam	29,600	119,588	46,764	69,370	22,607
Northwest	20,172	87,545	33,578	44,102	10,523
Shackleford	12,374	41,779	16,767	42,561	25,794
Mill/Quartz West	11,201	43,509	16,522	27,855	11,333
Chaparral/Quartz East	9,432	41,809	15,731	18,478	2,746
Kidder-Johnson	29,883	111,041	43,659	99,314	55,655
Etna	19,925	74,480	29,392	61,784	32,392
French	21,097	80,035	30,850	57,494	26,644
Southwest	3,594	15,740	5,914	6,831	917
Subtotal	**259,079**	**1,035,841**	**402,548**	**668,838**	**266,291**
Watersheds Upstream of Groundwater Model					
South Fork Scott River	28,139	89,604	35,929	96,776	60,847
Sugar Creek	8,504	30,519	11,919	24,039	12,120
Wildcat/Long/Messner	7,554	30,451	11,586	16,262	4,675
East Fork Scott River	73,844	272,352	109,210	269,396	160,186
Subtotal	**118,042**	**422,926**	**168,644**	**406,472**	**237,829**

Table D-2
Mountain-Front Recharge

Watershed	Available Water, acre-feet	Mountain-Front Recharge as Percent of Available Water, acre-feet		
		5%	15%	25%
Facey/Unnamed	1,680	84	252	420
McConaughy	7,632	382	1,145	1,908
East Central	9,967	498	1,495	2,492
Moffett	58,399	2,920	8,760	14,600
Indian/McAdam	22,607	1,130	3,391	5,652
Northwest	10,523	526	1,579	2,631
Shackleford	25,794	1,290	3,869	6,449
Mill/Quartz West	11,333	567	1,700	2,833
Chaparral/Quartz East	2,746	137	412	687
Kidder-Johnson	55,655	2,783	8,348	13,914
Etna	32,392	1,620	4,859	8,098
French	26,644	1,332	3,997	6,661
Southwest	917	46	138	229
Total	**266,291**	**13,315**	**39,944**	**66,573**