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Technical Memorandum 1C- Groundwater Modeling Evaluation for Phase 1 Conjunctive Use and Enhanced Aquifer Recharge Project:

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Technical Memorandum 1C

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From: Matt Baillie and Michael Maley, Kennedy/Jenks Consultants

Subject: **Groundwater Modeling Evaluation** of Potential Conjunctive Use Projects
Santa Cruz County Conjunctive Water Use and Enhanced Groundwater recharge Study
K/J 0864005

1. Introduction

Kennedy/Jenks Consultants (Kennedy/Jenks) is pleased to provide the Santa Cruz County Health Services Agency (County) with Technical Memorandum 1C (TM1C) in support of the Conjunctive Use and Enhanced Groundwater recharge Project (Conjunctive Use Project). The Conjunctive Use Project is one of fifteen projects funded by a Proposition 50 Water Bond grant from the California State Water Resources Control Board to the Community Foundation of Santa Cruz County. The Conjunctive Use Project is Project #3 of the grant and is being administered by the County.

1.1. Conjunctive Use Project Overview

The objective of the Conjunctive Use Project is to assess the most appropriate approaches for coordinating water projects and increasing aquifer storage to improve the reliability of drinking water supplies primarily for the Scotts Valley Water District (SVWD) and San Lorenzo Valley Water District (SLVWD), mitigating declines in groundwater levels in the Santa Margarita Groundwater Basin (SMGB), and increasing stream baseflow in the lower San Lorenzo River Watershed. The Conjunctive Use Project evaluates the opportunities to use water exchanges, winter streamflow diversion, enhanced stormwater capture and recharge, and/or reclaimed wastewater to replenish aquifer storage.

The two goals of the Conjunctive Use Project are to increase the volume of groundwater in aquifer storage, and to increase summertime baseflow in streams by increasing groundwater levels. An understanding of the factors controlling the ability to recharge water to the aquifer in the Scotts Valley area is important for the Conjunctive Use Project. TM1C documents the use of the SMGB groundwater model to evaluate the effects on groundwater levels and summertime stream baseflow of potential Conjunctive Use Projects including water exchanges, winter streamflow diversion, enhanced stormwater capture and recharge, and/or reclaimed wastewater to replenish aquifer storage. The results of groundwater model analysis were incorporated into the screening analysis for selecting the preferred conjunctive use alternatives.

The study area is focused on the Scotts Valley area (Figure 1C-1). For the Conjunctive Use Project, the study area covers the portion of the Santa Margarita Groundwater Basin (SMGB) south of Bean Creek (Figure 1C-1).

1.2. Scope

TM1C summarizes the work performed as part of Task 1 – Mitigation Analysis of Potential Alternatives of the Conjunctive Use Project Scope of Work. A key element in evaluating the feasibility of a potential conjunctive use alternative is to determine the potential benefit or mitigation that may be achieved.

The objective of the groundwater model scenarios performed for this TM is to develop an initial basis for comparison of the potential effects on groundwater levels and summertime baseflow for use in the conjunctive use screening-level analysis. The use of the groundwater model allows for a more uniform analysis of the recharge potential and storage capacity that incorporates the geologic complexities known to exist in the basin. This is considered an initial screening-level groundwater modeling analysis to provide a basis for comparison for the alternatives screening analysis. It is anticipated that additional modeling will likely be conducted for future phases of the project that will incorporate site-specific data and evaluate operational performance as the Conjunctive Use Project advance from this initial screening phase to the planning and design stages.

1.3. General Approach

For this task, the existing SMGB Groundwater Model was used to perform a quantitative analysis to provide a method to evaluate the relative potential benefits and limiting factors for a range of potential conjunctive use projects. The potential projects evaluated using the SMGB groundwater model include groundwater recharge by surface ponds, injection wells, storm-water capture, or in-lieu recharge. The results of the groundwater model analysis provide a basis to compare the volume of recharge water that:

- goes into long-term aquifer storage,
- sustains baseflow (especially summertime baseflow) in the tributaries of the San Lorenzo River,
- is extracted from the aquifer by pumping at wells, or
- is discharged from the SMGB by other processes.

The results of this analysis are incorporated into the screening criteria for Task 5 - Feasibility Analysis of Potential Conjunctive Use Projects. The groundwater modeling results provide a mechanism to compare the relative potential benefit of these alternatives with respect to the project goals of increasing groundwater levels in the SMGB and helping to sustain summertime (dry season) baseflows in the San Lorenzo River Watershed.

2. Groundwater Model Background

The first step towards developing a sound, defensible numerical model is to insure consistency with the hydrogeological understanding or conceptual model of the basin. Because of the complexity of a natural system, assumptions are necessary to define the aquifer properties and boundary conditions required for the numerical model. Therefore, a model is a simplification of the natural system. The input data for the numerical model mathematically describe the hydrogeological conceptual model. The numerical model is a mathematical solution that solves the mass balance and motion equations that govern groundwater flow and chemical transport (Bear and Verruijt, 1987).

2.1. Groundwater Model

The SMGB covers over 30 square miles in the Santa Cruz Mountains. The SMGB forms a roughly triangular area that extends from Scotts Valley in the east, to Boulder Creek in the northwest, to Felton in the southwest (Figure 1C-2). The SMGB is a geologically complex area that was formed by the same tectonic forces that created the Santa Cruz Mountains.

The modeling was conducted using the existing groundwater model of the SMGB that was developed as part of a DWR Local Groundwater Assistance (AB303) grant. The SMGB Model was set up and calibrated for the 20-year interval from 1985 to 2004 (ETIC, 2006). A summary of the model construction is provided below. Additional information about the development of the groundwater model is presented in the original model report (ETIC, 2006).

2.2. Model Setup

The model was constructed using MODFLOW2000 (Harbaugh et al., 2000), a numerical groundwater modeling code developed by the United States Geological Survey (USGS). The model consists of 346 rows, 383 columns, and 4 layers. The rows and columns have a uniform spacing of 110 feet. The total number of model cells is just over 530,000, with about 180,000 of these as active cells. The number of active cells varies from layer to layer because not all the formations have the same areal extent in the subsurface. Cells not within the active model are represented as no-flow cells, which cannot exchange water with active cells.

The model is based on a conceptual model that is already summarized in Technical Memorandum 1A – Hydrogeology Evaluation, also presented in this report. The model is defined using four layers that represent the following geologic units:

- Santa Margarita Sandstone (Santa Margarita) – Model Layer 1
- Monterey Formation (Monterey) – Model Layer 2
- Lompico Sandstone (Lompico) – Model Layer 3
- Butano Formation (Butano) in the northern part of the SMGB and Locatelli Formation (Locatelli) in the southern part of the SMGB – Model Layer 4

Because of the marked seasonality of the climate of the area, the model was set up with quarterly (3 month) timesteps. The model is based on water years that run from October through September. The period of October through December represents the first timestep in each water year, with the remaining three timesteps running approximately three months each for the rest of the year. This construction allows the model to simulate the cause and effect of wintertime rain and subsequent groundwater pumping in the summer.

The model was originally constructed to simulate the 20-year period from 1985 through 2004, with a total 80 timesteps. The model is updated as part of the Scotts Valley Water District's annual groundwater management program, and the model updates are reported in annual reports (Kennedy/Jenks, 2008, 2009, and 2010).

2.3. Aquifer Properties

Aquifer properties represent the hydrogeologic characteristics within the basin. Specifically, aquifer properties describe the physical characteristics of the aquifer and the hydraulic properties that control groundwater flow. Aquifer properties must be assigned to each active grid cell in the model. The conceptual model provides the framework necessary to define aquifer properties. Reasonable value ranges for each aquifer property were developed and the values used in the model were based on the model calibration. Specific aquifer properties are summarized below.

Hydraulic conductivity represents the ability of the water to flow through the aquifer, and is defined horizontally within a model layer and vertically between adjacent model layers. Specific storage and specific yield define the ability of the aquifer to release water from storage. Specific storage is defined for confined conditions, whereas specific yield is defined for unconfined conditions. Each model layer represents a thick intervals composed of varying degrees of gravel, sand, silt and clay. Therefore, the hydraulic conductivity, specific storage and specific yield for each model layer represent average values in regionalized blocks for the entire interval, rather than for a specific sand and gravel zone.

The horizontal hydraulic conductivity values used in the groundwater model (ETIC, 2006) for Model Layers 1 through 4, respectively, are summarized as follows:

- Model Layer 1 (Santa Margarita) has the highest horizontal hydraulic conductivities in the model, ranging from 2 to 50 feet per day (ft/d). Model Layer 1 is represented as entirely unconfined; therefore, only specific yield was required by the model. Specific yield values ranging from 0.07 to 0.12 were used.
- Model Layer 2 (Monterey) has lower horizontal hydraulic conductivities that range from 0.001 to 0.75 ft/d. A uniform specific storage of 0.00001 per foot (ft^{-1}) and a uniform specific yield of 0.02 were used for Model Layer 2.
- Model Layer 3 (Lompico) has horizontal hydraulic conductivities that range from 0.6 to 3.5 ft/d. A uniform specific storage of 0.0001 ft^{-1} and a uniform specific yield of 0.06 were used for Model Layer 3.
- Model Layer 4 (Butano and Locatelli) has horizontal hydraulic conductivities that range from 0.04 to 1.25 ft/d. Specific storage ranged from 0.0001 to 0.00001 ft^{-1} and a uniform specific yield of 0.06 was used for Model Layer 4.

Vertical hydraulic conductivities were generally estimated based on lithologic descriptions. Vertical hydraulic conductivities are generally defined by the lowest permeability continuous layer that the water must pass through between model layers. In a heterogeneous geologic setting such as that found in the SMGB, vertical hydraulic conductivities can be several orders of magnitude lower than horizontal hydraulic conductivities. The vertical conductivities used in the model ranged from 0.00009 to 0.1 ft/d.

2.4. Boundary Conditions

In the model, water can enter or leave a model layer via a number of paths that are defined by boundary conditions. The boundary conditions used in the model (ETIC, 2006) represent the following physical processes:

- Groundwater pumping
- Precipitation recharge
- Flow in rivers, streams and springs
- Evapotranspiration
- Groundwater flow into and out of the basin

Existing pumping wells are included as analytical elements and well boundary conditions in the model. Well pumping is determined by records kept by well owners, or estimated based on the well type. Large pumping wells were updated to reflect actual data where available. The updated wells included the municipal wells in the area, as well as several privately-owned wells. Some wells do not have discharge information provided, and for these wells values from previous years are used. Most small wells are screened within the uppermost active model layer at that location, and these are represented as boundary conditions. Larger wells are represented as analytical elements, and are assigned to model layers based on their actual screened intervals. Domestic wells had an assumed pumping rate of about 0.3 acre-feet per year from the uppermost layer.

Recharge input to the model was calculated based on the actual amount of rainfall. Rainfall was modified based on relationships with land use and surface geology (ETIC, 2006) to estimate the amount of rainfall that contributed to recharge. Recharge is calculated in an Excel spreadsheet based on rainfall rates and known spatial patterns of rainfall variation, surface geology, and land use.

Stream and river boundary conditions were included to simulate surface water bodies throughout the model domain. These bodies exchange water with the aquifer depending on the gradient between the stream and the aquifer and the ability of the streambed to conduct water. Springs are represented as discharge points where groundwater is allowed to drain from the aquifer at a rate controlled by the hydraulic conductivity and the groundwater elevation.

Evapotranspiration (ET) is specified as a rate based on measured pan evaporation rates and vegetation mapping in the area. ET only applies over a specified depth (representing rooting depth), so it mostly affects Model Layer 1 only.

Constant and general head boundaries along the model layer peripheries were included to simulate the groundwater level in the areas bounding the model to allow groundwater to flow into and out of the model from areas outside the basin.

No-flow cells represent areas of the grid where the stratigraphic layer represented by a model layer is not present in the subsurface. The bottom of the lowest model layer is a no-flow boundary condition, representing the crystalline bedrock, which is assumed to be relatively impermeable.

2.5. Model Calibration Review

Model calibration is the process reducing uncertainty in the simulation by matching model results to observed data. The more extensive the calibration process, the more constrained the model becomes, thereby reducing uncertainty in the results. Typically, aquifer properties and water balance data are varied within the range prescribed by the conceptual model until the best obtainable fit of simulated versus measured data is achieved.

To determine the performance of the model, results must be compared with measured groundwater levels. Statistical measures of the residual (difference between simulated and measured groundwater levels at a given location) are the primary method for evaluating the model calibration. The primary statistical measures are the residual mean, absolute residual mean, and the residual standard deviation.

- The residual mean is computed by dividing the sum of the residuals by the number of residual data values. The closer this value is to zero, the better the calibration. For the original modeling period (1985 through 2004), the residual mean was 0.96 feet.
- The residual standard deviation evaluates the scatter of the data. A lower standard deviation indicates a closer fit between the simulated and observed data. For the original modeling period (1985 through 2004), the residual standard deviation was 27.44 feet.
- The absolute residual mean is a measure of the overall error in the model. The absolute residual mean is computed by taking the square root of the square of the residuals and dividing that by the number of residuals. For the original modeling period (1985 through 2004), the absolute residual mean was 18.52 feet.
- The ratio of the standard deviation of the mean error divided by the range of observed groundwater elevations provides another statistical measure of calibration. This ratio demonstrates how the model error relates to the overall range of groundwater elevations across the model. For the original modeling period (1985 through 2004), the ratio was 0.053.

The model is considered to be reasonably well calibrated to a base period which reflects a time frame within which the necessary array of data is available (ETIC, 2006). These data span a representative distribution of hydrologic conditions observed throughout the basin and over time. The calibrated model is available for application to a wide range of groundwater management scenarios.

Once calibration is achieved, the model is considered capable of forecasting future conditions with reasonable accuracy. Input parameters can be set to simulate a wide range of potential future groundwater use, water quality, or hydrogeologic scenarios. The results can be evaluated for overall trends and more localized effects. The horizontal and vertical resolution used to construct the model dictate the range of scales that the model can evaluate. For example, a regional or basin-wide model will not likely contain the site-specific details of a more localized model, but a regional model will better evaluate a local area within the broader regional context.

When evaluating model results, it is important to consider the limitations of the model. The quality of a model is highly dependent upon the accuracy of the conceptual understanding of the hydrogeology and the quality and quantity of the data. The conceptual model is based on the model report (ETIC, 2006).

2.6. Model-Based Water Budget

A model-based water budget provides a summary of how groundwater enters and exits the aquifer, either for the entire basin or for a specifically defined subarea. Water entering the aquifer is referred to as either inflow or recharge, whereas water exiting the aquifer is referred to as either outflow or discharge.

The SMGB groundwater model is updated annually as part of the Scotts Valley Water District's annual groundwater management program (Kennedy/Jenks, 2008, 2009, and 2010). A water budget is developed to evaluate change in aquifer storage. The water budget is summarized by grouping the various inflow and outflows into four key components. These components include:

- **Precipitation Recharge** - includes groundwater recharge from precipitation percolating through soil to the groundwater. The recharge rate varies across the area due to spatial variability in precipitation, soil conditions, geology, and land use.
- **Net Groundwater Flow -** includes the subsurface movement of groundwater within the aquifers and is an accounting of the total subsurface flows into and out of the Scotts Valley GW Subarea. Net groundwater flow is primarily influenced by changes in groundwater levels.
- **Groundwater-Surface Water Interactions -** includes interactions between the aquifer and streams, springs and evapotranspiration. Evapotranspiration and springs are outflows only. Streams have more complex interactions with the aquifer. The degree and direction of the exchange between streams and the aquifer can vary according to the relative difference between stream and groundwater levels.
- **Wells -** includes groundwater pumping from wells. The pumping rate for individual municipal wells and certain private wells is input into the model. Pumping from domestic and other wells is estimated based on past usage and/or approximated based on assumed usage.

The model-based water budget is summarized on Tables 1C-1 and 1C-2. Groundwater pumping by wells generally increased from 1985 through 2001; groundwater pumping is now the largest groundwater outflow (Figure 1C-3). Groundwater pumping has generally decreased since 2001. Total pumping in the Scotts Valley area for 2009 was 1,866 acre-feet.

Table 1C-1 – Model-based water budget for the Scotts Valley area

Water Supply (AFY)	1980's average	1990's average	2000's average	25-year average
Precipitation Recharge	4,510	4,946	4,957	4,863
Net Groundwater Flow	-51	567	757	519
Groundwater-Surface Water Interactions	-3,843	-3,094	-3,029	-3,218
Wells	-2,539	-2,968	-3,004	-2,896
Change in Aquifer storage	-1,881	-526	-289	-702

Table 1C-2 - Model-based water budget for the entire SMGB

Water Supply (AFY)	1980's average	1990's average	2000's average	25-year average
Precipitation Recharge	11,879	13,633	13,413	13,194
Net Groundwater Flow	-52	15	189	71
Groundwater-Surface Water Interactions	-11,126	-10,471	-10,640	-10,670
Wells	-3,419	-3,669	-3,880	-3,703
Change in Aquifer storage	-2,676	-469	-887	-1,078

Recharge, as determined by precipitation modified by land use and geology data, is a function mostly of fluctuations in annual rainfall. Historic recharge totals change with annual rainfall, reflected by, for example, the low precipitation totals for the late 1980's and early 1990's. Precipitation is the ultimate form of natural groundwater recharge in the basin even though it can enter the aquifer either as direct infiltration through the soil or as infiltration from the creeks. Reductions in groundwater recharge can occur either naturally through reduced precipitation during a drought, or as a result of man-made effects such as urbanization cutting off or intercepting potential groundwater recharge. When the precipitation recharge is reduced, it results in a reduction in either the net outflow of the basin or by a reduction in aquifer storage reflecting by lower groundwater levels.

The net natural flow decreased from an outflow of about 1,300 acre-feet per year (afy) in 1985 to about 500 AFY per year in 2007 (Figure 1C-3). This change was primarily related to declining groundwater levels in the Santa Margarita, since the deeper units of the Lompico and Butano have limited interaction with surface waters. The net natural flow in 2009 was an outflow of about 400 acre-feet.

The model-based water budget also provides a mechanism to evaluate the groundwater-surface water interactions. Initially, the groundwater-surface water exchange was a net gain into the streams from the aquifer. This gain has decreased over the model run from a high of more than 1,000 acre-feet in 1991 to lows of less than 300 acre-feet in 2001 and 2005. The net for 2009 was an outflow of 300 acre-feet.

To compensate for the increased pumping, the groundwater conditions have adjusted to a new equilibrium through the redistribution of the components of the water budget. In the Scotts Valley area, one key change is a reversal in the net groundwater flow. In 1985, the Scotts Valley GW Subarea water budget shows the net groundwater flow as an 800 AFY outflow. However, over the past 15 years, the net groundwater flow has reversed so that now there is an 800 to 1,000 AFY inflow of groundwater into the Scotts Valley area (Figure 1C-3). The net groundwater flow in 2009 was an inflow of about 800 acre-feet.

The difference between inflows and outflows to the model represents the change in storage. Because of the low rainfall total and sustained high pumping, the model calculated a net loss of storage of 24 acre-feet for 2009 (Figure 1C-3). This value is less than the 25-year average of 471 acre-feet of storage loss per year (1985-2009).

3. Conjunctive Use Scenario Development

The existing groundwater model was updated to determine the effect of various directed enhanced groundwater recharge systems. In total, 21 scenarios were created to cover different configurations, locations, and timing of recharge.

3.1. Objectives

The Conjunctive Use Model Scenarios are intended to provide a quantitative analysis to define the potential benefits and limiting factors for a range of potential conjunctive use projects including active groundwater recharge by surface ponds or injection wells, storm-water capture, or in-lieu recharge.

The Lompico has traditionally been heavily utilized for groundwater extraction, leaving it with the most available aquifer storage capacity. The Santa Margarita is conductive enough to transmit large quantities of recharged water. In areas where it is underlain by the Monterey, this water is likely to discharge to streams where it is would increase baseflow and leave the basin. The critical time to increase baseflow would be during the low-flow periods (i.e. summer and early fall). Groundwater discharge would also lower the temperature of streamflow which would be beneficial for the fishery. The primary benefit of the Conjunctive Use Project is to identify the groundwater recharge project that will achieve a balance between increases in aquifer storage and summertime stream baseflow. The modeling scenarios used to support the development of the screening criteria for Task 5 - Feasibility Analysis of Potential Conjunctive Use Projects are described below.

3.2. Modeling Scenarios

The SMGB model was used to evaluate the 21 potential groundwater recharge project scenarios using future conditions that assume a repeat of the natural hydrologic conditions from 1985 through 2005. The locations for recharge were chosen based on their expected ability to transmit water into the deep aquifer fairly quickly. Specifically, areas where the Santa Margarita directly overlies the Lompico were targeted. In these areas, the Monterey, which has relatively low permeability, is not present thus allowing direct communication between the Santa Margarita and Lompico. Figure 1C-4 shows the locations of recharge in the various scenarios.

For most of the model scenarios, the total aquifer recharge is assumed to be 1,000 afy. However, the in-lieu recharge scenarios were limited by the available reduction in groundwater pumping available for the chosen time interval. The goal of this analysis was to determine how the changes to the water budget created by the directed recharge varied with the recharge magnitude and location. The scenarios were set up as follows.

- **Base Case:** This scenario is essentially identical to the final model from ETIC (2006). No directed recharge is applied to the model. The results of this scenario were used as a comparative tool, to quantify the changes effected by the directed recharge systems.
- **Large-Scale Surface Recharge:** Four scenarios were created to simulate recharge applied in large percolation ponds. Recharge was applied to Model Layer 1 (the Santa Margarita) only.
- **Injection Wells:** Four scenarios were created to simulate injection wells completed within the Lompico (Model Layer 3).
- **Low Impact Development:** Two scenarios were created to simulate surface recharge in a more dispersed system to simulate the use of low-impact development on existing urbanized areas to capture and recharge stormwater to groundwater. This setup was intended to mimic numerous small recharge points, such as in a stormwater recharge system. Recharge was applied to Model Layer 1 only.
- **In-Lieu Recharge:** Three scenarios were created to simulate in-lieu recharge, which is accomplished by reducing pumping in existing groundwater wells rather than actively adding water to the basin. These scenarios assume that the water supply needs are met by utilizing another water source that is outside of the basin. In these scenarios, pumping in wells is decreased in specific areas, or from specific layers.
- **Bean Creek Wellfield:** Two scenarios were constructed to simulate the effect of pumping from the aquifer to capture wintertime groundwater discharges to Bean Creek when streamflows are high. The objective is to evaluate how much of an impact this type of pumping has on the aquifer and streams.

The aquifer recharge from the simulated Conjunctive Use Projects assumed that the recharge period would occur during the cool, wet months of the year, starting in mid-November and ending in mid-May. The SMGB model is subdivided into three-month-long stress periods that represent seasonal variations. For Surface Recharge, Lompico Injection, and Dispersed Surface scenarios, the project groundwater recharge was varied seasonally, with 25% of water recharged during the first quarter of the water year (October through December), 50% in the second quarter, 25% in the third quarter, and 0% in the fourth quarter. This distribution represents the proposed seasonal operation of a conjunctive use project to take advantage of the distribution of precipitation in the region, where winters are wet and summers dry.

3.3. Evaluation of Results

The SMGB model has been calibrated to historical conditions and is considered capable of forecasting these future case scenarios. The numerical model provides a quantitative tool to provide a relative comparison of the amount of water entering and exiting the basin to determine the potential change in aquifer storage and groundwater levels. However, in evaluating the model results, it is recommended for the evaluation to focus more on the relative differences and overall trends between the scenario and the baseline scenarios.

The modeling software automatically keeps track of the hydrologic budget over time. In order to track water levels throughout the basin, difference maps are developed to show the total change in groundwater levels over the 20-year model scenario. The results of the model scenarios include:

- Water balance summaries (Tables 1C-3 through 1C-7) given in percent of the Conjunctive Use Project recharge to aquifer storage, stream baseflow and other discharges, and the maximum buildup of groundwater levels in winter (active period) and summer (rest period).
- Changes in aquifer storage and summertime baseflow in relation to the base case scenario for each scenario (Tables 1C-3 through 1C-7).
- Detailed water balance summaries for each model scenario (Attachment A).
- The seasonal variations in the hydrologic budget relative to the base case scenario (Attachment B).
- Changes in groundwater levels (i.e. buildup) resulting from the groundwater recharge projects. Maps showing the distribution of groundwater buildup for the winter and summer are presented in Attachment C. The maps only show areas with greater than 10 feet of build-up. Please note that the maps show areas of buildup away from recharge area that should be ignored.

4. Conjunctive Use Scenario Results Summary

To meet the goals of the Conjunctive Use Project, a recharge system must increase the volume of groundwater in aquifer storage. In addition, the groundwater discharges to the rivers and streams in the SMGB should show increases in the summer.

A total of 16 Conjunctive Use Project scenarios (including the Base Case Scenario) were created to cover different enhanced groundwater recharge configurations, locations, and timings. An additional 5 scenarios were run as a sensitivity analysis to determine the effect that varying the volume of groundwater recharge would have on the basin. A summary of the results is presented below. More detailed tables showing the water balance information are presented in Attachment A, B and C.

Attachments B and C show the total change in groundwater levels over the 20-year model scenario relative to the initial conditions. The model results show the buildup of groundwater levels in the vicinity of the simulated Conjunctive Use Project. It should be noted that the model results also show changes in groundwater levels in areas away from the project area. These typically represent areas in the model that are sensitive to changes in groundwater levels such as near groundwater pumping wells and along outcrop areas especially in the Lompico. These outlying areas may or may not represent changes in groundwater levels that would be realized under actual project conditions. The groundwater model is planned to be updated in the near future and these areas will be evaluated more closely at that time to determine if the model parameters in these areas need to be adjusted. At this time, the model results are shown as they were produced by the SMGB Model.

4.1. Base Case Scenario

The base case represents the MODFLOW simulation of actual conditions for water years 1985 through 2004. The hydrologic budget for this case is presented in Attachment A.

4.2. Large-Scale Surface Recharge Scenarios

Four scenarios were created to simulate recharge applied in large percolation basins at the surface. These basins were simulated in the South Hanson Quarry, North Hanson Quarry, Mount Hermon Road, and Scotts Valley areas (Figure 1C-4). In each case, the percolation basin facility was modeled as an area of six by six cells (660 by 660 feet, or 10 acres). The total flow into the basin was 1,000 afy, so each cell carried approximately 28 afy, input into the model as 3,313 cubic feet per day (cfd). Recharge was applied to Model Layer 1 (the Santa Margarita) only. The facility is assumed to recharge 1,000 afy for 20 years. The recharge was varied seasonally, with 25% of water recharged during the first quarter of the water year (October through December), 50% in the second quarter (January through March), 25% in the third quarter (April through June), and 0% in the fourth quarter (July through September).

The results of the large-scale surface recharge scenarios are provided in Table 1C-3 and Figure 1C-5. Additional detailed information on the model results is provided in Attachments A, B and C. Below is a summary of the results of each of these scenarios.

Table 1C-3 – Large-scale surface recharge model scenario water budget results for the entire SMGB

Simulated Groundwater recharge area	**South Hanson Quarry**	**North Hanson Quarry**	**Mt Hermon Rd**	**Scotts Valley Dr**
Recharge Volume (acre-feet)	1,000	1,000	1,000	83
GW Storage Increase (percent)	14%	6%	33%	12%
Baseflow Increase (percent)	38%	54%	41%	85%
Loss to Springs and ET (percent)	49%	39%	26%	3%
Maximum Winter GW Buildup (feet)	68	50	186	120
Maximum Summer GW Buildup (feet)	45	26	188	60

4.2.1. South Hanson Quarry

Large-scale surface recharge at South Hanson Quarry targets an area where the Santa Margarita and Lompico are in direct contact. In this manner, surface recharge in the Santa Margarita would be anticipated to reach the Lompico. The site is associated with the Hanson Quarry because it represents a large area of potentially available land. However, the analysis applies to the adjacent areas as well. The Hanson Quarry represents an area that was excavated and then refilled with sand. It has been interpreted that the mining operations may have excavated down into Lompico. The model uses a conservative assumption to represent this condition. Future site-specific data from the South Hanson Quarry may show that this area may have a higher infiltration rate than is used in this simulation.

From the overall water budget, the SMGB model shows that approximately 14% of the total groundwater recharge from this location remains in aquifer storage after 20 years. About 38% ultimately discharges to the nearby streams, and about 49% is discharged to the nearby springs or is lost to ET (Table 1C-3). The springs simulated in the SMGB model are not differentiated as large springs that contribute to stream baseflow and small springs that are primarily consumed by ET. Therefore, these are shown separately. As a conservative assumption, the spring outflow is not counted as part of the stream baseflow. The buildup of groundwater levels in the South Hanson Quarry area at the end of the scenario is 68 feet in the winter (active recharge period) and 45 feet in the summer (rest period).

From Figure 1C-5, it can be seen that aquifer storage increases at a higher rate in the early years and then levels off. Of the 20,000 acre-feet of water added to the aquifer, it is estimated that less than 3,000 acre-feet remain in aquifer storage. The increases in groundwater levels show increases in summertime stream baseflow in the area. The model results show that in the summer months groundwater discharge to streams increases over the first 10 years and then stabilizes at about 0.55 cfs.

On average, an extra 324 acre-feet goes to storage during the three quarters of the year of recharge, and an additional 16 acre-feet is saved that would have been released during that period. An average of 217 extra acre-feet of storage is released in the summer. Losses from streams and rivers into the aquifer are reduced by 8 acre-feet per year, while gains to streams, rivers, and springs are increased by an average of 852 acre-feet per year. The distribution of increased surface water flow is fairly uniform through the seasons, with a low of 193 acre-feet per fall quarter and a high of 230 acre-feet per spring quarter. The increase in summer flows averages 209 acre-feet per quarter. Attachments B and C contain detailed information on the seasonal hydrologic budget of this scenario.

These model results indicate that most of the surface groundwater recharge in the South Hanson Quarry area stays in the Santa Margarita. In the Santa Margarita groundwater flow system, the recharge is directed towards the nearest spring or stream discharge. The SMGB has a vertical hydraulic conductivity between the Santa Margarita and Lompico that appears to be limiting the movement of groundwater between the two aquifers. Future evaluation is likely necessary to determine if the model is accurately representing groundwater movement between the Santa Margarita and Lompico, or the conductivity between the two formations is actually higher in which case a higher percentage of the recharge would stay in aquifer storage.

4.2.2. North Hanson Quarry

The North Hanson Quarry represents a large area of potentially available land. At this location, the Monterey is present below the Santa Margarita. In these areas, groundwater recharge from the surface is assumed to not to reach the Lompico. Therefore, this model scenario simulates large-scale surface recharge at the North Hanson Quarry that targets the Santa Margarita but not the Lompico.

From the overall water budget, the SMGB model shows that approximately 6% of groundwater recharge from surface recharge at the North Hanson Quarry remains in aquifer storage after 20 years. About 54% discharges to the nearby streams and about 39% is discharged to the nearby springs or lost to ET (Table 1C-3). The buildup of groundwater levels in the North Hanson Quarry area at the end of the scenario is 50 feet in the winter (active recharge period) and 26 feet in the summer (rest period).

From Figure 1C-5, it can be seen that aquifer storage increases at a higher rate in the early years and then levels off. Of the 20,000 acre-feet of water added to the aquifer, it is estimated that about 1,000 acre-feet remain in storage. The higher groundwater levels result in increased summertime stream baseflow in the area. The model results show that in the summer months groundwater discharge to streams increases over the first 10 years and then stabilizes at about 0.50 cfs.

On average, an extra 236 acre-feet goes to storage during the three quarters of the year of recharge, and an additional 16 acre-feet is released from storage during that period. An average of 168 extra acre-feet of storage is released in the summer. Losses from streams and rivers into the aquifer are reduced by 6 acre-feet per year, while gains to streams, rivers, and springs are increased by an average of 936 acre-feet per year. The increased surface water flow is seasonally variable, with the highest value in the winter (316 acre-feet per quarter) and lowest in the summer (162 acre-feet per quarter). Attachments B and C contain detailed information on the seasonal hydrologic budget of this scenario.

These model results indicate that surface recharge in the North Hanson Quarry area has low aquifer storage potential. Even though a high percentage of the groundwater recharge goes to stream baseflow, the timing is such that the summertime baseflow increase is lower than under either the South Hanson Quarry or Mt. Hermon Road area scenarios.

4.2.3. Mount Hermon Road

Large-scale surface recharge in the Mount Hermon Road area targets the area where the Santa Margarita has experienced the largest groundwater level declines. From the overall water budget, the SMGB model shows that approximately 33% of the groundwater recharge remains in aquifer storage after 20 years. About 41% discharges to the nearby streams and about 26% is discharged to the nearby springs or lost to ET (Table 1C-3). Large-scale surface recharge at Mount Hermon Road leads to build-up values of up to 186 feet in the winter (active recharge period) and 188 feet in the summer (rest period).

From Figure 1C-5, it can be seen that aquifer storage increases at a higher rate in the early years and then levels off. Of the 20,000 acre-feet of water added to the aquifer, it is estimated that about 6,000 acre-feet remain in aquifer storage. The increased groundwater levels result in increased summertime stream baseflow in the area. The model results show that in the summer months groundwater discharge to streams increases over the first 10 years and then stabilizes at about 0.65 cfs.

On average, an extra 432 acre-feet goes to storage during the three quarters of the year of recharge, and an additional 47 acre-feet is saved that would have been released during that period. An average of 187 extra acre-feet of storage is released in the summer. Losses from streams and rivers into the aquifer are reduced by 21 acre-feet per year, while gains to streams, rivers, and springs are increased by an average of 484 acre-feet per year. The distribution of increased surface water flow is fairly uniform through the seasons, with a low of 114 acre-feet per fall quarter and a high of 130 acre-feet per winter quarter. The increase in summer flows averages 115 acre-feet per quarter. Attachments B and C contain detailed information on the seasonal hydrologic budget of this scenario.

These model results indicate there is a high potential for surface aquifer storage in the Mount Hermon area. The Santa Margarita has the potential for aquifer storage due to the observed historical groundwater level declines in this area. Most of the losses to baseflow and springs will be directed towards nearby Bean Creek. Future evaluation is likely necessary to determine if the model is accurately representing the ability of the Santa Margarita for aquifer storage. However, historical data suggest that the potential exists for aquifer storage.

4.2.4. Scotts Valley Drive

Large-scale surface recharge along Scotts Valley Drive targets the area where the Santa Margarita and Lompico are in direct contact and have experienced significant historical groundwater level declines. The results of this scenario are affected by model cells going dry in the vicinity of the simulated recharge facility during the simulation. The MODFLOW model does allow for resaturation, but an annual average groundwater recharge of only 83 afy was achieved. Because of the dry cells, groundwater recharge was significantly less in the later timesteps. Model upgrades will be necessary to allow for a full model scenario of the Scotts Valley Drive area.

4.2.5. Assessment of Large-Scale Surface Recharge

These model results indicate that most of the groundwater recharge from the large-scale surface recharge facilities goes to stream baseflow, discharges to springs, or losses to ET. This is primarily a function of the complex geology of the SMGB. The recharge facilities are located on the Santa Margarita. The Santa Margarita is well-connected to the various springs and streams so recharge tends to leave the aquifer and discharge to nearby springs or streams. The model does not indicate that large-scale surface recharge is an efficient method of increasing the amount of groundwater stored in the Lompico.

As noted above, the SMGB model defines a vertical hydraulic conductivity between the Santa Margarita and Lompico that appears to limit the movement of groundwater between the two aquifers. Future evaluation is likely necessary to determine if the model is accurately representing groundwater movement between the Santa Margarita and Lompico, or if a higher percentage would actually stay in aquifer storage.

4.3. Injection Well Scenarios

Four scenarios were created to simulate injection wells drilled into the Lompico (Model Layer 3). Injection wellfields were simulated in the South Hanson Quarry, North Hanson Quarry, Mount Hermon Road, and Scotts Valley areas (Figure 1C-4).

This recharge bypasses the Santa Margarita. Wells were simulated as 12 cells within an area of six by seven cells. Each cell handled about 83 afy, input into the model as 9,939 cfd. The recharge was varied seasonally, with 25% of water recharged during the first quarter of the water year (October through December), 50% in the second quarter (January through March), 25% in the third quarter (April through June), and 0% in the fourth quarter (July through September).

The results of the injection well scenarios are provided in Table 1C-4 and Figure 1C-6. Additional detailed information on the model results is provided in Attachments A, B, and C. Below is a summary of the results of each of these scenarios.

Table 1C-4 – Injection well model scenario water budget results for the entire SMGB

Simulated Groundwater recharge area	**South Hanson Quarry**	**North Hanson Quarry**	**Mt Hermon Rd**	**Scotts Valley Dr**
Recharge Volume (acre-feet)	1,000	1,000	1,000	1,000
GW Storage Increase (percent)	47%	54%	61%	66%
Baseflow Increase (percent)	25%	22%	27%	25%
Loss to Springs and ET (percent)	28%	24%	12%	10%
Maximum Winter GW Buildup (feet)	125	109	118	196
Maximum Summer GW Buildup (feet)	129	113	117	141

4.3.1. South Hanson Quarry

Injection wells in the South Hanson Quarry target adding recharge water directly into the Lompico. The Lompico has the highest available potential aquifer storage capacity; therefore, there is an operational advantage in recharging the Lompico directly with respect to increasing aquifer storage. The site is associated with the South Hanson Quarry because it represents a large area of potentially available land. However, the analysis applies to the adjacent areas as well.

From the overall water budget, the SMGB model shows that approximately 47% of groundwater recharge remains in aquifer storage after 20 years. About 25% discharges to the nearby streams and about 28% is discharged to the nearby springs or lost to ET (Table 1C-4). The buildup of groundwater levels in the South Hanson Quarry area at the end of the scenario is 125 feet in the winter (active recharge period) and 129 feet in the summer (rest period).

From Figure 1C-6, it can be seen that aquifer storage increases at a relatively steady rate over the 20-year scenario. Of the 20,000 acre-feet of water added to the aquifer, it is estimated that nearly 10,000 acre-feet remain in storage. The increased groundwater levels results in increased summertime stream baseflow in the area. The model results show that in the summer months groundwater discharges to streams increases steadily over the 20-year scenario to about 0.48 cfs.

On average, an extra 484 acre-feet goes to storage during the three quarters of the year of recharge, and an additional 111 acre-feet is saved that would have been released during that period. An average of 157 extra acre-feet of storage is released in the summer. Losses from streams and rivers into the aquifer are reduced by 15 acre-feet per year, while gains to streams, rivers, and springs are increased by an average of 427 acre-feet per year. The distribution of increased surface water flow is fairly uniform through the seasons, with a low of 96 acre-feet per fall quarter and a high of 122 acre-feet per winter quarter. The increase in summer flows averages 99 acre-feet per quarter. Attachments B and C contain detailed information on the seasonal hydrologic budget of this scenario.

4.3.2. North Hanson Quarry

Injection wells in the North Hanson Quarry target adding recharge water directly into the Lompico including locations where Monterey is present. The Lompico has the highest available potential aquifer storage capacity; therefore, there is an operational advantage in recharging the Lompico directly with respect to increasing aquifer storage. The site is associated with the North Hanson Quarry because it represents a large area of potentially available land. However, the analysis applies to the adjacent areas as well.

From the overall water budget, the SMGB model shows that approximately 54% of groundwater recharge remains in aquifer storage after 20 years. About 22% discharges to the nearby streams and about 24% is discharged to the nearby springs or lost to ET (Table 1C-4). The buildup of groundwater levels in the South Hanson Quarry area at the end of the scenario is 109 feet in the winter (active recharge period) and 113 feet in the summer (rest period).

From Figure 1C-6, it can be seen that aquifer storage increases at a relatively steady rate over the 20-year scenario. Of the 20,000 acre-feet of water added to the aquifer, it is estimated that nearly 11,500 acre-feet remain in storage. The increased groundwater levels result in increases in summertime stream baseflow in the area. The model results show that in the summer month’s groundwater discharge to streams increases steadily over the 20-year scenario to about 0.48 cfs.

On average, an extra 556 acre-feet goes to storage during the three quarters of the year of recharge, and an additional 101 acre-feet is saved that would have been released during that period. An average of 153 extra acre-feet of storage is released in the summer. Losses from streams and rivers into the aquifer are reduced by 20 acre-feet per year, while gains to streams, rivers, and springs are increased by an average of 314 acre-feet per year. The distribution of increased surface water flow is fairly uniform through the seasons, with a low of 74 acre-feet per fall quarter and a high of 85 acre-feet per winter quarter. The increase in summer flows averages 75 acre-feet per quarter. Attachments B and C contain detailed information on the seasonal hydrologic budget of this scenario.

4.3.3. Mount Hermon Road

Injection wells in the Mount Hermon Road area target an area where the Lompico has experienced the largest groundwater level declines. From the overall water budget, the SMGB model shows that approximately 61% of groundwater recharge remains in aquifer storage after 20 years. About 27% discharges to the nearby streams and about 12% is discharged to the nearby springs or lost to ET (Table 1C-4). The buildup of groundwater levels in the Mount Hermon Road area at the end of the scenario is 118 feet in the winter (active recharge period) and 117 feet in the summer (rest period).

From Figure 1C-6, it can be seen that aquifer storage increases at a relatively steady rate over the 20-year scenario. Of the 20,000 acre-feet of water added to the aquifer, it is estimated that nearly 12,000 acre-feet remain in storage. The increased groundwater levels result in increased summertime stream baseflow in the area. The model results show that in the summer months groundwater discharges to streams increases steadily over the 20-year scenario to about 0.55 cfs.

On average, an extra 540 acre-feet goes to storage during the three quarters of the year of recharge, and an additional 116 acre-feet is saved that would have been released during that period. An average of 142 extra acre-feet of storage is released in the summer. Losses from streams and rivers into the aquifer are reduced by 29 acre-feet per year, while gains to streams, rivers, and springs are increased by an average of 310 acre-feet per year. The distribution of increased surface water flow is fairly uniform through the seasons, with a low of 74 acre-feet per fall quarter and a high of 80 acre-feet per winter quarter. The increase in summer flows averages 77 acre-feet per quarter. Attachments B and C contain detailed information on the seasonal hydrologic budget of this scenario.

4.3.4. Scotts Valley

Injection wells in the Scotts Valley Drive area target another area where the Lompico has experienced the largest groundwater level declines. From the overall water budget, the SMGB model shows that approximately 66% of groundwater recharge remains in aquifer storage after 20 years. About 25% discharges to the nearby streams and about 10% is discharged to the nearby springs or lost to ET (Table 1C-4). The buildup of groundwater levels in the Scotts Valley Drive area at the end of the scenario is 196 feet in the winter (active recharge period) and 141 feet in the summer (rest period).

From Figure 1C-6, it can be seen that aquifer storage increases at a relatively steady rate over the 20-year scenario. Of the 20,000 acre-feet of water added to the aquifer, it is estimated that nearly 13,000 acre-feet remain in storage. The increased groundwater levels result in increased summertime stream baseflow in the area. The model results show that in the summer month’s groundwater discharge to streams increases steadily over the 20-year scenario to about 0.45 cfs.

On average, an extra 526 acre-feet goes to storage during the three quarters of the year of recharge, and an additional 122 acre-feet is saved that would have been released during that period. An average of 132 extra acre-feet of storage is released in the summer. Losses from streams and rivers into the aquifer are reduced by 39 acre-feet per year, while gains to streams, rivers, and springs are increased by an average of 256 acre-feet per year. The increased surface water flow is seasonally variable, with the highest value in the winter (77 acre-feet per quarter) and lowest in the fall and summer (58 acre-feet per quarter). Attachments B and C contain detailed information on the seasonal hydrologic budget of this scenario.

4.3.5. Assessment of Injection Wells

These model results indicate that injection wells are a more efficient system for getting water into aquifer storage than large-scale surface facilities in all of the different areas evaluated. By getting the water directly into the Lompico, the water stays mostly in aquifer storage. The increases in summertime baseflow are also comparable to those for large-scale surface facilities. This is because the increases in baseflow are in response to regional increases in groundwater levels, which are better able to sustain baseflow throughout the year. With the large-scale surface facilities, a majority of the recharge reaches the streams at less-optimal times, so the increased discharge to the streams does not produce a significantly higher increase in summertime baseflow.

The results of the Injection Well Scenarios indicate that the aquifer storage potential is greatest at the Scotts Valley Drive site, followed closely by both the North Hanson Quarry site and Mount Hermon Road site. The South Hanson Quarry site had slightly lower aquifer storage potential than the others. For summertime baseflow, the model results were closely clustered, with the largest baseflow increase occurring due to recharge at the Mount Hermon Road site and the lowest occurring due to recharge at the South Hanson Quarry site.

The SMGB model provides a good quantitative tool. However, it should be noted that the results could vary if additional model simulations were run to optimize these systems. In addition, further site-specific investigations may find conditions that may affect the actual performance relative to the SMGB model, which is constructed on a regional scale. Therefore, the results for all of the injection well scenarios are considered close enough that the four sites are essentially of equal viability.

4.4. Low Impact Development Scenarios

Two scenarios were created to simulate surface recharge in a more dispersed system that was intended to mimic numerous small recharge points, such as in a stormwater recharge system. These scenarios evaluated the construction of low impact development style stormwater systems that would collect stormwater runoff into small percolation basins or other similar structures for groundwater recharge. These scenarios assume a large-scale retrofit of existing urbanized areas in Scotts Valley.

As with the large-scale surface recharge scenarios, recharge was to Model Layer 1 only. Scenarios were created in the Pasatiempo and Mount Hermon Road areas. The potential exists for a similar recharge system along Scotts Valley Drive, but the construction of a model scenario encountered similar issues as for the large-scale recharge facilities (see Section 4.2.4). Therefore, the Mount Hermon Road scenario was extended along Scotts Valley Drive as much as possible considering the constraints of the model.

In each case, recharge was applied to 100 model cells that were placed somewhat randomly around existing roads in the areas. The recharge cells lie within an area of approximately 50 rows by 60 columns. Each cell handled 10 afy, input into the model as about 1,193 cfd.

The results of the low impact development scenarios are provided in Table 1C-5 and Figure 1C-7. Additional detailed information of the model results if provided in Attachments A, B and C. Below is a summary of the results of each of these scenarios.

Table 1C-5 –Low impact development model scenario water budget results for the entire SMGB

Simulated Groundwater recharge area	**Pasatiempo area**	**Scotts Valley area**
Recharge Volume (acre-feet)	990	830
GW Storage Increase (percent)	18%	28%
Baseflow Increase (percent)	48%	59%
Loss to Springs and ET (percent)	34%	13%
Maximum Winter GW Buildup (feet)	52	145
Maximum Summer GW Buildup (feet)	45	137

4.4.1. Pasatiempo Area

Low impact development in the Pasatiempo area targets the area primarily west of Scotts Valley. This is primarily a suburban residential development. The model scenarios assume that a portion of the stormwater runoff from the streets and residences would be collected into small percolation basins or other similar structures for groundwater recharge.

From the overall water budget, the SMGB model shows that approximately 18% of groundwater recharge remains in aquifer storage after 20 years. About 48% discharges to the nearby streams and about 32% is discharged to the nearby springs or lost to ET (Table 1C-5). The buildup of groundwater levels in the Pasatiempo area at the end of the scenario is 52 feet in the winter (active recharge period) and 45 feet in the summer (rest period).

From Figure 1C-7, it can be seen that aquifer storage increases at a relatively steady rate over the 20-year scenario. Of the 20,000 acre-feet of water added to the aquifer, it is estimated that nearly 3,500 acre-feet remain in storage. The increased groundwater levels result in increased summertime stream baseflow in the area. The model results show that in the summer month's groundwater discharge to streams increases steadily over the 20-year scenario to about 0.60 cfs.

On average, an extra 271 acre-feet goes to storage during the three quarters of the year of recharge, and an additional 41 acre-feet is saved that would have been released during that period. An average of 190 extra acre-feet of storage is released in the summer. Losses from streams and rivers into the aquifer are reduced by 14 acre-feet per year, while gains to streams, rivers, and springs are increased by an average of 705 acre-feet per year. The increase in surface water flow is seasonally variable, with the highest increase in the winter (198 acre-feet per quarter) and lowest in the summer (156 acre-feet per quarter). Attachments B and C contain detailed information on the seasonal hydrologic budget of this scenario.

4.4.2. Mount Hermon Road and Scotts Valley

Low impact development in the Mount Hermon Road and Scotts Valley Drive areas of Scotts Valley targets commercial development with large shopping centers and extensive areas of large, paved parking lots. The model scenarios assume that a portion of the stormwater runoff from the roofs, parking areas and streets would be collected into small percolation basins or other similar structures for groundwater recharge.

From the overall water budget, the SMGB model shows that approximately 18% of groundwater recharge remains in aquifer storage after 20 years. About 59% discharges to the nearby streams and about 13% is discharged to the nearby springs or lost to ET (Table 1C-5). The buildup of groundwater levels in the Scotts Valley area at the end of the scenario is 145 feet in the winter (active recharge period) and 137 feet in the summer (rest period).

From Figure 1C-7, it can be seen that aquifer storage increases at a relatively steady rate over the 20-year scenario. Of the 20,000 acre-feet of water added to the aquifer, it is estimated that nearly 4,000 acre-feet remain in storage. The increased groundwater levels results increased summertime stream baseflow in the area. The model results show that in the summer month's groundwater discharge to streams increases steadily over the 20-year scenario to about 0.60 cfs.

On average, an extra 259 acre-feet goes to storage during the three quarters of the year of recharge, and an additional 65 acre-feet is saved that would have been released during that period. An average of 127 extra acre-feet of storage is released in the summer. Losses from streams and rivers into the aquifer are reduced by 51 acre-feet per year, while gains to streams, rivers, and springs are increased by an average of 539 acre-feet per year. The increased surface water flow is seasonally variable, with the largest increase in the winter (172 acre-feet per quarter) and lowest in the summer (96 acre-feet per quarter). Attachments B and C contain detailed information on the seasonal hydrologic budget of this scenario.

4.4.3. Assessment of Low Impact Development

These model results indicate that the dispersed recharge from low impact development style recharge facilities into the Santa Margarita has a limited potential for increasing groundwater in storage. This is primarily because of the dispersed nature of these types of facilities and the complex geology of the SMGB. Over much of this area, the Santa Margarita is underlain by the Monterey which limits recharge potential to the Lompico. Groundwater recharge is instead primarily directed to the nearest surface discharge point in the Santa Margarita.

The increases in summertime baseflow are also comparable to those for large-scale surface facilities and injection wells. This suggests that the implementation of low impact development would have a large beneficial affect on summertime baseflow in the area streams including Bean, Carbonera and Eagle Creeks.

4.5. In-Lieu Recharge Scenarios

Three scenarios were created to simulate in-lieu recharge, which is accomplished by replacing a portion of the pumping from the existing groundwater wells with water supply from an outside source. The groundwater recharge is achieved by reducing the pumping stress in the basin and allowing groundwater levels to recover by natural recharge.

In these scenarios, pumping in wells is decreased in specific areas, or from specific layers. The scenarios targeted wells in the San Lorenzo and Scotts Valley areas, with one scenario in the Scotts Valley area focusing on wells in the Butano and the other on wells in the Lompico.

The results of the in-lieu recharge scenarios are provided in Table 1C-6 and Figure 1C-8. Additional detailed information on the model results is provided in Attachments A, B, and C. Below is a summary of the results of each of these scenarios.

Table 1C-6 –In Lieu recharge model scenario water budget results for the entire SMGB

Simulated Groundwater recharge area	SLVWD Lompico Wells	SVWD Butano Wells	SVWD Lompico Wells
Recharge Volume (acre-feet)	436	891	543
GW Storage Increase (percent)	45%	71%	64%
Baseflow Increase (percent)	23%	23%	25%
Loss to Springs and ET (percent)	31%	6%	11%
Maximum Winter GW Buildup (feet)	107	73	100
Maximum Summer GW Buildup (feet)	110	99	93

4.5.1. SLVWD Lompico Wells

In-lieu recharge by the San Lorenzo Valley Water District (SLVWD) southern district located west of Scotts Valley targets an area where the Lompico has experienced historic groundwater level declines. From the overall water budget, the SMGB model shows that approximately 45% of groundwater recharge remains in aquifer storage after 20 years. About 23% discharges to the nearby streams and about 31% is discharged to the nearby springs or lost to ET (Table 1C-6). The buildup of groundwater levels in the area at the end of the scenario is 107 feet in the winter (active recharge period) and 110 feet in the summer (rest period).

From Figure 1C-8, it can be seen that aquifer storage increases at a relatively steady rate over the 20-year scenario. Of the 8,720 acre-feet of water added to the aquifer, it is estimated that nearly 4,000 acre-feet remain in storage. The increased groundwater levels result in increased summertime stream baseflow in the area. The model results show that in the summer month’s groundwater discharge to streams increases steadily over the 20-year scenario to about 0.15 cfs.

On average, an extra 63 acre-feet goes to storage during the three quarters of the year of recharge, and an additional 54 acre-feet is saved that would have been released during that period. Water released from storage in the summer is reduced by 55 acre-feet. Losses from streams and rivers into the aquifer are reduced by 6 acre-feet per year, while gains to streams, rivers, and springs are increased by an average of 168 acre-feet per year. The distribution of increased surface water flow is fairly uniform through the seasons, with a low of 36 acre-feet per fall quarter and a high of 55 acre-feet per winter quarter. The increase in summer flows averages 37 acre-feet per quarter. Attachments B and C contain detailed information on the seasonal hydrologic budget of this scenario.

4.5.2. SVWD Butano Wells only

In-lieu recharge by the Scotts Valley Water District (SVWD) considers the reduction in pumping only from wells that are currently pumping primarily from the Butano. From the overall water budget, the SMGB model shows that approximately 71% of groundwater recharge remains in aquifer storage after 20 years. About 23% discharges to the nearby streams and about 6% is discharged to the nearby springs or lost to ET (Table 1C-6). The buildup of groundwater levels in the area at the end of the scenario is 73 feet in the winter (active recharge period) and 99 feet in the summer (rest period).

From Figure 1C-8, it can be seen that aquifer storage increases at a relatively steady rate over the 20-year scenario. Of the 17,820 acre-feet of water added to the aquifer, it is estimated that nearly 13,000 acre-feet remain in storage. The increased groundwater levels result in increased summertime stream baseflow in the area. The model results show that in the summer months groundwater discharges to streams increase steadily over the 20-year scenario to about 0.25 cfs. The changes in groundwater levels are experienced regionally due to the lower storage capacity and confined aquifer conditions found in the Butano. Therefore, the changes in summertime baseflow represent a regional response to increased groundwater levels that generally reflect an incremental increase in streamflows across the SMGB rather than occurring in nearby streams as was seen in the scenarios focused on the Santa Margarita.

During the three quarters of the year of recharge (accomplished by decreasing pumping), 90 extra acre-feet of water is taken out of storage. However, an additional 213 acre-feet is saved that would have been released from storage during that period. Water released from storage in the summer is reduced by 141 acre-feet. Losses from streams and rivers into the aquifer are reduced by 55 acre-feet per year, while gains to streams, rivers, and springs are increased by an average of 156 acre-feet per year. The distribution of increased surface water flow is fairly uniform through the seasons, with a low of 36 acre-feet per summer quarter and a high of 43 acre-feet per winter quarter. Attachments B and C contain detailed information on the seasonal hydrologic budget of this scenario.

4.5.3. SVWD Lompico Wells only

In-lieu recharge by the SVWD considers the reduction in pumping only from wells that are currently pumping primarily from the Lompico. From the overall water budget, the SMGB model shows that approximately 64% of groundwater recharge remains in aquifer storage after 20 years. About 25% discharges to the nearby streams and about 11% is discharged to the nearby springs or lost to ET (Table 1C-6). The buildup of groundwater levels in the area at the end of the scenario is 100 feet in the winter (active recharge period) and 93 feet in the summer (rest period).

From Figure 1C-8, it can be seen that aquifer storage increases at a relatively steady rate over the 20-year scenario. Of the 10,860 acre-feet of water added to the aquifer, it is estimated that nearly 7,000 acre-feet remain in storage. The increased groundwater levels result in increased summertime stream baseflow in the area. The model results show that in the summer month's groundwater discharge to streams increases steadily over the 20-year scenario to about 0.25 cfs.

On average, an extra 21 acre-feet goes to storage during the three quarters of the year of recharge, and an additional 164 acre-feet is saved that would have been released during that period. Water released from storage in the summer is reduced by 101 acre-feet. Losses from streams and rivers into the aquifer are reduced by 21 acre-feet per year, while gains to streams, rivers, and springs are increased by an average of 149 acre-feet per year. The distribution of increased surface water flow is fairly uniform through the seasons, with lows of 35 acre-feet in both the summer and fall quarters and a high of 41 acre-feet per winter quarter. Attachments B and C contain detailed information on the seasonal hydrologic budget of this scenario.

4.5.4. Assessment of In-Lieu Recharge

These model results indicate that in-lieu recharge is a highly efficient method for getting water into aquifer storage. By getting the water directly into the Lompico or the Butano, the water stays mostly in aquifer storage. The increases in summertime baseflow are lower than for injection wells. This is because in-lieu recharge is limited to a percentage of the existing pumping. Therefore, groundwater level increases are less than for injection wells, resulting in smaller increases in summertime baseflow.

In-lieu recharge is limited by the volume of groundwater pumping that can be replaced. For these scenarios, it was assumed that 75% of the annual pumping was replaced by an outside source. This is likely higher than would be realistic; however, for the modeling, the scenario was set up to be more directly comparable to the other scenarios to evaluate the effects on aquifer storage and summertime baseflow. The actual in-lieu recharge volumes may well be significantly less than simulated in these scenarios.

The results of the In-Lieu Well Scenarios indicate that the highest aquifer storage potential is in the Butano. This is primarily because of the depth of the SVWD Butano Wells and the complex geology, as the Butano is a highly confined system at these locations.

4.6. Bean Creek Wellfield Scenarios

Two scenarios were constructed to simulate the effect of pumping that would essentially capture groundwater that would otherwise discharge to Bean Creek during the winter months when streamflow in Bean Creek is high. The goal of these scenarios is to use groundwater pumping similar to a surface water diversion. The model results evaluate the potential impacts of this approach on aquifer storage and summertime baseflow.

There are several potential options for a wellfield. The two model scenarios examined likely end members to provide a framework for evaluation. The first scenario considers a series of horizontal wells located underneath Bean Creek that pump 1,000 acre-feet annually. The assumption for this scenario is that there is new and additional groundwater pumping with no decrease in other groundwater pumping elsewhere in the basin to compensate. This scenario also reflects a worst-case scenario for impacts to the basin and isolates the effects of this type of pumping for evaluation.

The second scenario assumes a wellfield of vertical wells located adjacent to Bean Creek that pump at 400 acre-feet annually. The assumption for this scenario is that there is a reduction in groundwater pumping in the Lompico to compensate for the increased pumping from the Santa Margarita along Bean Creek. Pumping in the SVWD Lompico Wells is reduced by 400 acre-feet so that there is a no net increase in groundwater pumping in the basin. This scenario evaluates the combined effects of shifting pumping from the Lompico to the Santa Margarita in an area that is well recharged.

For both of these model scenarios, the pumping was varied seasonally, with 25% of the discharge occurring during the first quarter of the water year (October through December), 50% in the second quarter (January through March), 25% in the third quarter (April through June), and 0% in the fourth quarter (July through September).

The results of the Bean Creek wellfield scenarios are provided in Table 1C-7 and Figure 1C-9. Additional detailed information on the model results is provided in Attachments A, B, and C. Below is a summary of the results of each of these scenarios.

Table 1C-7 –Bean Creek wellfield model scenario water budget results for the entire SMGB

Simulated Groundwater recharge area	Horizontal Wells	Bean Creek Wellfield
Recharge Volume (acre-feet)	1,000	400
GW Storage Increase (percent)	<-1%	--
Baseflow Increase (percent)	-99%	--
Loss to Springs and ET (percent)	<-1%	--
Maximum Winter GW Buildup (feet)	--	--
Maximum Summer GW Buildup (feet)	--	--

4.6.1. Horizontal Well Scenario

The horizontal well scenario assumes that a series of horizontal wells are installed underneath Bean Creek to pump groundwater that would otherwise discharge to Bean Creek. A total of 10 well cells were placed along Bean Creek just below its confluence with Lockhart Gulch. The amount of pumping varied from well to well to prevent drying out of individual cells. Wells on the upstream end were able to handle greater pumping, as much as 220 afy, while downstream wells (where the upper layer is thinner) could only pump 20 afy. Most of the pumping (700 afy) occurs during the winter, which is the period of highest streamflow, with less pumping in the fall and spring (150 afy each).

From the overall water budget, the SMGB model shows that approximately 99% of the pumping is derived from groundwater that would otherwise have discharged to surface streams with less than 1% impact on aquifer storage or losses to springs or ET. From Figure 1C-9, it can be seen that aquifer storage is essentially unchanged over the 20-year scenario relative to the base case. This suggests that pumping from a Bean Creek Wellfield would have little impact on the overall groundwater conditions in the basin.

Surface water discharge is reduced in all seasons, although this reduction is by far greatest in winter (a loss of 527 acre-feet per quarter, as compared to losses of 209, 146, and 19 acre-feet per quarter in the spring, summer, and fall, respectively). Other than minor decreases in spring flow (average of 3 acre-feet per year change out of actual flows of over 4,500 acre-feet per year), all other components of the water budget are approximately unchanged. The model results show that in the summer months groundwater discharge to streams shows some variability during the first 7 years. with decreases in summertime baseflow ranging from 0.1 to 0.25 cfs; however, after this time this stabilizes at about 0.10 cfs.

Over the course of the year, the changes in storage induced by the pumping approximately equal out. In other words, the decrease in total storage of 116 acre-feet per quarter in the winter (caused by a decrease of 36 acre-feet per quarter in the water going into storage and an increase of 80 acre-feet per quarter in the water coming out of storage) is balanced by the 83 acre-feet (mostly in the spring) that go back into storage and the 30 acre-feet (majority in the summer) reduction in water coming out of storage over the spring through fall period. The total change in storage is a loss of only 3 acre-feet per year.

4.6.2. Bean Creek Wellfield Scenario

The Bean Creek Wellfield scenario assumes that a series of vertical wells are installed adjacent to Bean Creek to pump groundwater that would otherwise discharge to Bean Creek. A total of 400 afy is pumped from the wellfield, and pumping from the Lompico wells in Scotts Valley is decreased by the same amount. Therefore, there is no net change in groundwater pumping relative to the base case. Most of the pumping occurs during the winter, which is the period of highest streamflow, with less pumping in the fall and spring. There is no pumping in the summer.

Because there is no net change in pumping, the evaluation of the changes in the water budget is less straightforward. From Figure 1C-9, it can be seen that aquifer storage increases at a steady rate to an estimated cumulative increase of 1,500 acre-feet. This results from an 8,000 acre-feet reduction in pumping from the Lompico over the 20-year period, producing a net increase in aquifer storage. The increased groundwater levels result in a slight (less than 0.05 cfs) increase in summertime stream baseflow at the end of the scenario. During the first seven years, there is a decrease in summertime baseflow on the order of 0.05 to 0.1 cfs. However, after 7 years, the summertime baseflow rates increase to a positive after about 12 years. This scenario also results in increased groundwater levels in the Lompico.

4.6.3. Assessment of Bean Creek Wellfield

These model results indicate that the Bean Creek Wellfield is a potential Conjunctive Use alternative. Even though pumping is from the vicinity of Bean Creek, the wellfield takes advantage of the natural conditions that cause this area to be a major discharge area from the Santa Margarita. The model results suggest that there are minimal impacts on aquifer storage. There are impacts to summertime baseflow at Bean Creek. However, for the scenario where the Bean Creek Wellfield pumping is compensated by reduced pumping in the Lompico, there is a minor long-term benefit to summertime baseflow.

4.7. Sensitivity Analysis

A sensitivity analysis was created to determine the effect of increased or decreased recharge to the aquifer on the hydrologic budget. Five sensitivity simulations were run based on the Injection Well scenarios into the Lompico at South Hanson Quarry (see Section 4.3.1). Including the base case and the Lompico injection scenario itself (six scenarios total), recharge was varied from 250 to 1,500 afy in increments of 250 afy.

The objective of the sensitivity analysis was to provide a preliminary evaluation of the affect of the project scale on percentage of recharge staying in aquifer storage and the impact on summertime stream baseflows. The sensitivity analysis answers the question of whether a larger project has benefits over a smaller project or if there is a maximum level of benefit that can be realized.

The distribution of pumping was varied seasonally for all of these scenarios, similar to the other recharge scenarios. The pumping is distributed with 25% of water recharged during the first quarter of the water year (October through December), 50% in the second quarter (January through March), 25% in the third quarter (April through June), and 0% in the fourth quarter (July through September).

The results of the Bean Creek wellfield scenarios are provided in Table 1C-8 and Figure 1C-10. Additional detailed information on the model results is provided in Attachments A, B, and C. Below is a summary of the results of each of these scenarios.

From the overall water budget, the SMGB model shows that the percentage of injected water staying in storage shows a slight increasing trend from 42% for the 250 afy scenario to 49% for the 1,500 afy scenario. Conversely, the percentage discharged to stream baseflow shows a slight decreasing trend, from 28% for the 250 afy scenario to 22% for the 1,500 afy scenario.

From Figure 1C-10, it can be seen that aquifer storage increases proportionally to the amount of injected water. The injected groundwater remaining in storage ranges from about 2,000 acre-feet (of the 5,000 acre-feet of water added to the aquifer) for the 250 afy scenario to about 15,000 acre-feet (of the 30,000 acre-feet of water added to the aquifer) for the 1,500 afy scenario.

Similarly, summertime baseflow increases proportionally to the amount of injected water. Summertime baseflow increased by between about 0.15 cfs (for the 250 afy scenario) to about 0.70 cfs (for the 1,500 afy scenario). The progressively increasing summertime baseflow results from groundwater levels that increase with increasing project scale.

Table 1C-8 –Sensitivity analysis water budget results for the entire SMGB. Sensitivity analysis based on the South Hanson Quarry Injection Well Scenario.

Simulated Groundwater recharge area	250 AFY	500 AFY	750 AFY	1,000 AFY	1,250 AFY	1,500 AFY
Recharge Volume (acre-feet)	250	500	750	1,000	1,250	1,500
GW Storage Increase (percent)	42%	46%	48%	47%	49%	49%
Baseflow Increase (percent)	28%	25%	24%	25%	23%	22%
Loss to Springs and ET (percent)	30%	28%	28%	28%	28%	29%
Maximum Winter GW Buildup (feet)	90	105	115	125	135	143
Maximum Summer GW Buildup (feet)	98	108	119	129	138	147

5. Evaluation of Conjunctive Use Scenario Results

A total of 16 Conjunctive Use Project scenarios were created to cover different enhanced groundwater recharge configurations, locations, and timings. An additional 5 scenarios were run as a sensitivity analysis to determine the effect that varying the volume of groundwater recharge has on the basin. These model scenarios are considered as a screening-level analysis to help support the development of the screening criteria for Task 5 - Feasibility

Analysis of Potential Conjunctive Use Projects. A summary of the results is discussed above. More detailed tables showing the water balance information are presented in Attachments A, B, and C.

The goal of the modeling is to determine the ability of the recharge system simulated in each scenario to achieve the project goals of increasing groundwater levels in the SMGB and helping to sustain dry season baseflows in the San Lorenzo River Watershed.

- With respect to aquifer storage, the Injection Well and In-Lieu Scenarios showed the highest efficiency as defined by the percentage of enhanced recharge still present in the aquifer at the end of the simulation period. This is because the groundwater recharge is directed into the deeper Lompico and Butano.
  - Due to the complex geology of the SMGB, these formations occur at greater depths in the SMGB and have fewer outlets to surface water discharge than does the Santa Margarita.
  - The Lompico and Butano have experienced significant declines in groundwater levels historically, so they potentially have aquifer storage capacity available.
- The Large-Scale Surface Recharge and Low Impact Development scenarios show lower aquifer storage efficiencies.
  - The Santa Margarita has numerous springs and experiences direct groundwater-surface water interactions with several creeks in the area, primarily Bean Creek. Therefore, groundwater recharge added to the Santa Margarita will ultimately be discharged to streams or springs.
  - Groundwater recharge from the surface primarily affects the Santa Margarita; however, the Santa Margarita areas with historic groundwater declines are more limited to areas around Scotts Valley. In areas where the Santa Margarita has not experienced historic drawdowns, it is assumed that there is not sufficient capacity for additional aquifer recharge.
- With respect to summertime baseflow, the Large-Scale Surface Recharge, Low Impact Development, and Injection Well scenarios show increases.
  - This is because the Large-Scale Surface Recharge and Low Impact Development scenarios have a higher percentage of their stream discharge occurring during the winter and spring during higher flow conditions.
  - The Injection Well Scenarios are able to sustain more summertime baseflow because they result in higher groundwater levels which ultimately help sustain summertime baseflow.

  - Enhanced recharge under In-Lieu Recharge Scenarios is limited by the amount of pumping. Therefore, groundwater level increases are smaller than for injection wells, which results in less increase in summertime baseflows.

- The scenario results indicate that the aquifer storage potential, especially for injection wells and in-lieu recharge, is greatest at the Scotts Valley Drive, North Hanson Quarry and Mount Hermon Road areas. The South Hanson Quarry site has slightly less potential for aquifer storage than do the others; however, the model may need further refinement to better simulate interactions between in the Santa Margarita and Lompico in this area.
- For summertime baseflow, the model results were similar for all the sites, especially for surface recharge projects, with the largest increase in baseflow resulting from recharge at the Mount Hermon Road site, and the smallest from recharge at the South Hanson Quarry site; however, the large increase in spring discharge from the South Hanson Quarry would result in higher summertime baseflows in Camp Evers and Carbonera Creeks.
- These model results indicate that the Bean Creek Wellfield is a potential Conjunctive Use alternative. Even though pumping is from the vicinity of Bean Creek, the wellfield takes advantage of the natural conditions that cause this area to be a major discharge area from the Santa Margarita.
  - The model results suggest that there are minimal impacts on aquifer storage. There are impacts to summertime baseflow at Bean Creek.
  - However, for the scenario where the Bean Creek Wellfield pumping is compensated by reduced pumping in the Lompico, there is a minor long-term benefit to summertime baseflow.
- The sensitivity analysis results indicate that aquifer storage increases proportionally to the amount of enhanced recharge.
  - The total recharge remaining in storage at the end of the simulation period ranges from about 2,000 acre-feet (of the 5,000 acre-feet of water added to the aquifer) for the 250 afy scenario to about 15,000 acre-feet (of the 30,000 acre-feet of water added to the aquifer) for the 1,500 afy scenario.
  - Summertime baseflow increases proportionally to the amount of enhanced recharge. The increase in the summertime baseflow rate ranges from about 0.15 cfs for the 250 afy scenario to about 0.70 cfs for the 1,500 afy scenario. The progressively increasing summertime baseflow results from the groundwater levels that increase with increasing project scale.

The SMGB model provides a good quantitative tool. However, it should be noted that the results could vary if additional model simulations were run to optimize these systems. In addition, further site-specific investigations may find conditions that may affect the actual performance relative to the SMGB model, which is constructed on a regional scale. Therefore, the results for all of the injection well scenarios are considered close enough that the four sites are essentially of equal viability.

References

ESI, 2007, *Guide to Using Groundwater Vistas: Version 5*, Environmental Simulations, Inc., Reinholds, PA, 381p.

ETIC Engineering, 2006, *Groundwater Modeling Study of the Santa Margarita Groundwater Basin*, ETIC Engineering, Oakland, CA.

Harbaugh, A.W., E.R. Banta, M.C. Hill, and M.G. McDonald, 2000, *MODFLOW-2000, The U.S. Geological Survey Modular Ground-Water Model – User Guide to Modularization Concepts and the Ground-Water Flow Process*, U.S. Geological Survey Open-File Report 00-92, U.S. Geological Survey, Reston, VA, 130p.

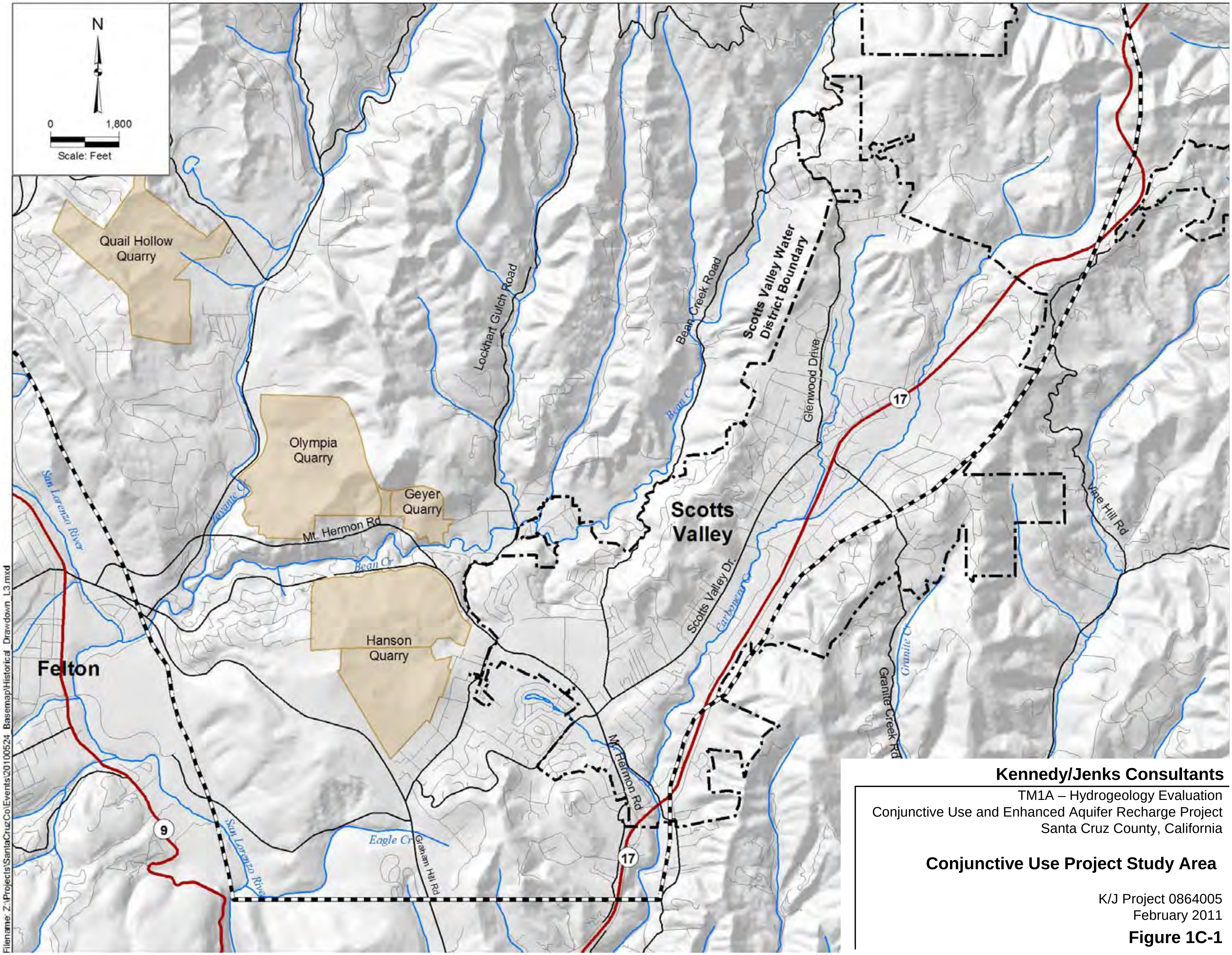
Kennedy/Jenks Consultants, 2008, *2007 Annual Report: Scotts Valley Water District Groundwater Management Program*, Kennedy/Jenks Consultants, San Francisco, CA.

Kennedy/Jenks Consultants, 2009, *2008 Annual Report: Scotts Valley Water District Groundwater Management Program*, Kennedy/Jenks Consultants, San Francisco, CA.

Kennedy/Jenks Consultants, 2010, *2009 Annual Report: Scotts Valley Water District Groundwater Management Program*, Kennedy/Jenks Consultants, San Francisco, CA.

Watkins-Johnson, 1993, *Santa Margarita Groundwater Basin Management Plan* (Prepared for Association of Monterey Bay Area Governments), Watkins-Johnson Environmental, Inc., Palo Alto, CA.

FIGURES



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Santa Cruz County, California

Conjunctive Use Project Study Area

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Figure 1C-1

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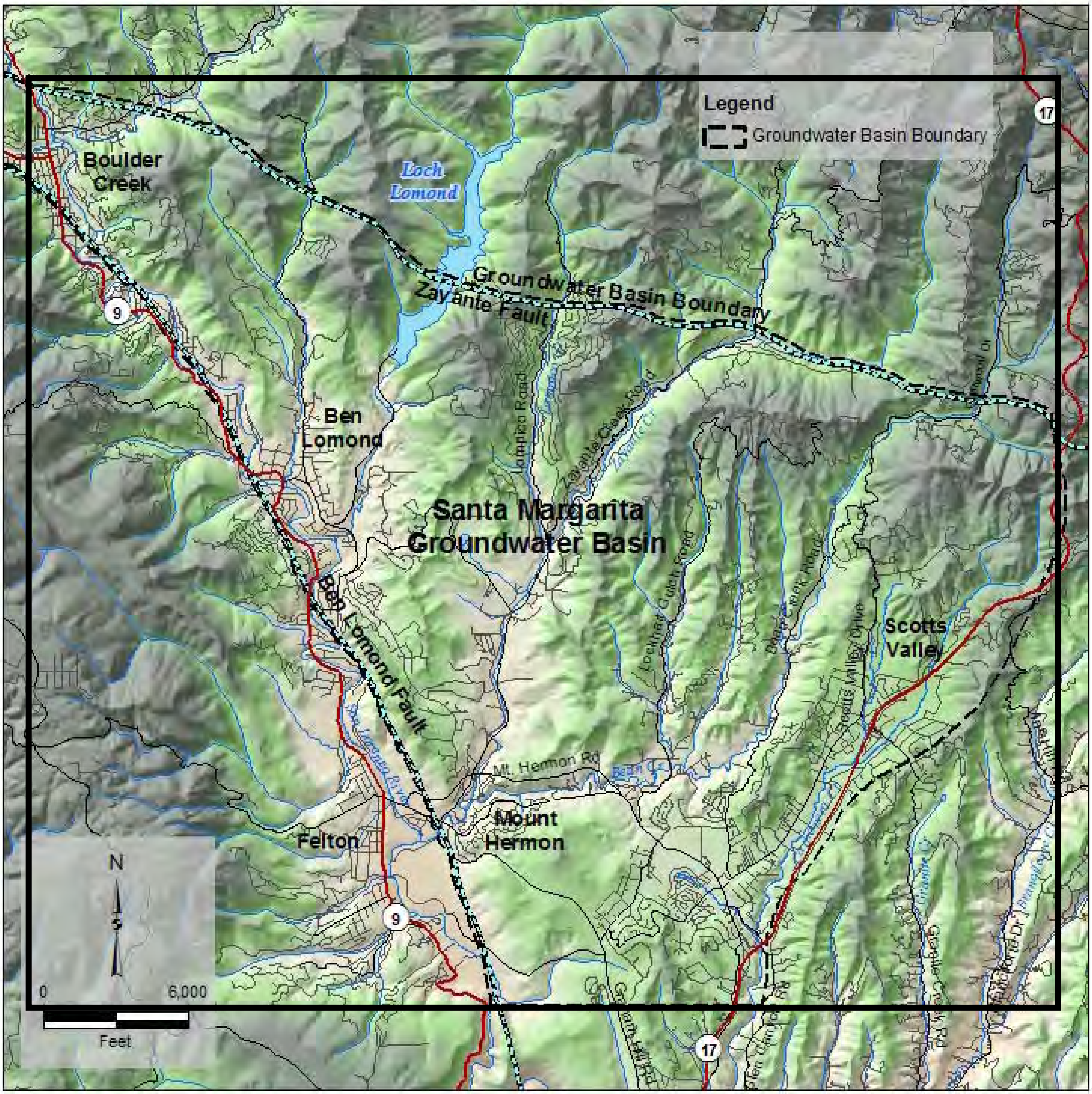

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Figure 1C-2

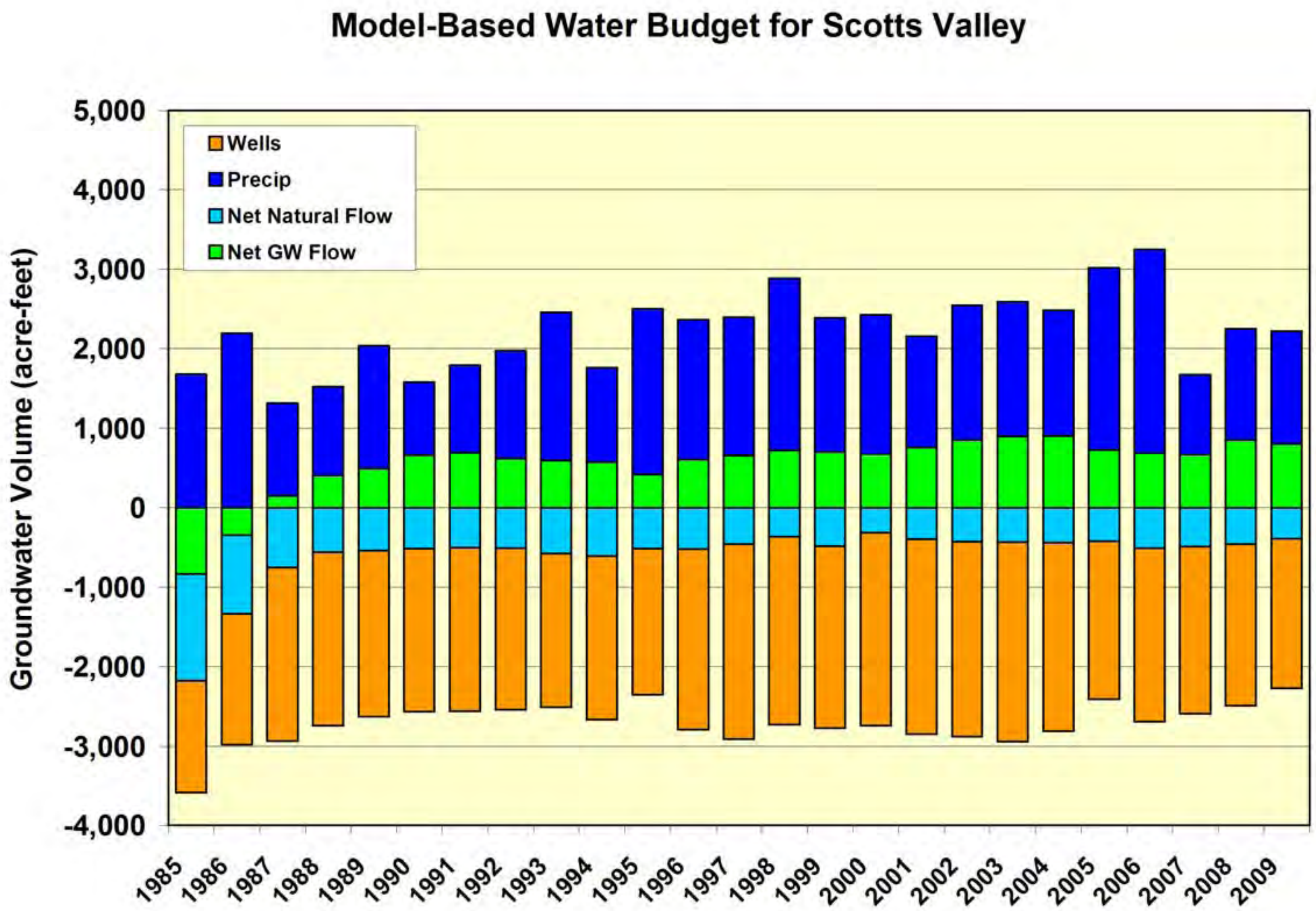

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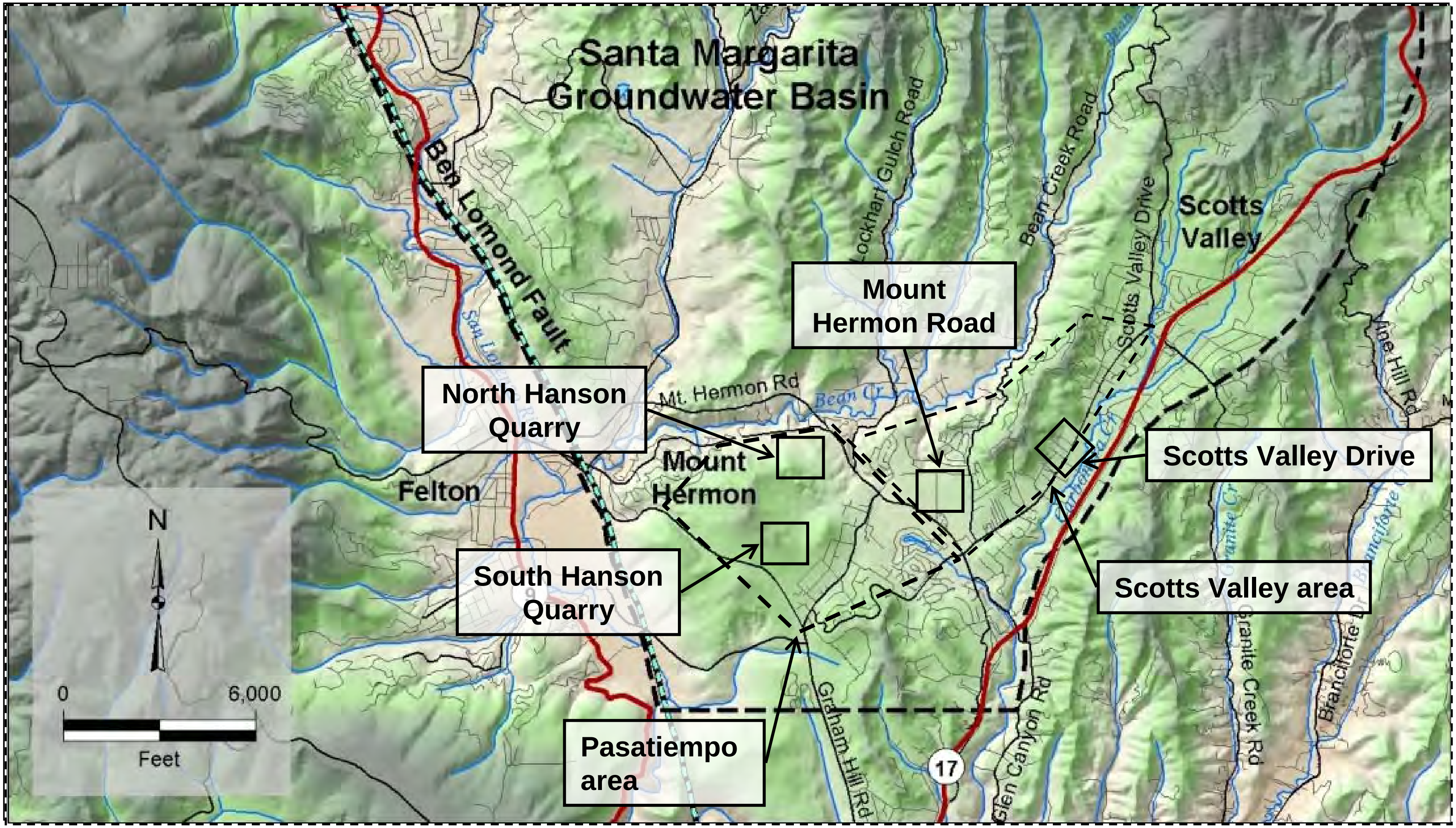
Figure 1C-3



Note that boxes representing individual areas are not representative of the actual model area over which recharge occurs.

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Figure 1C-4

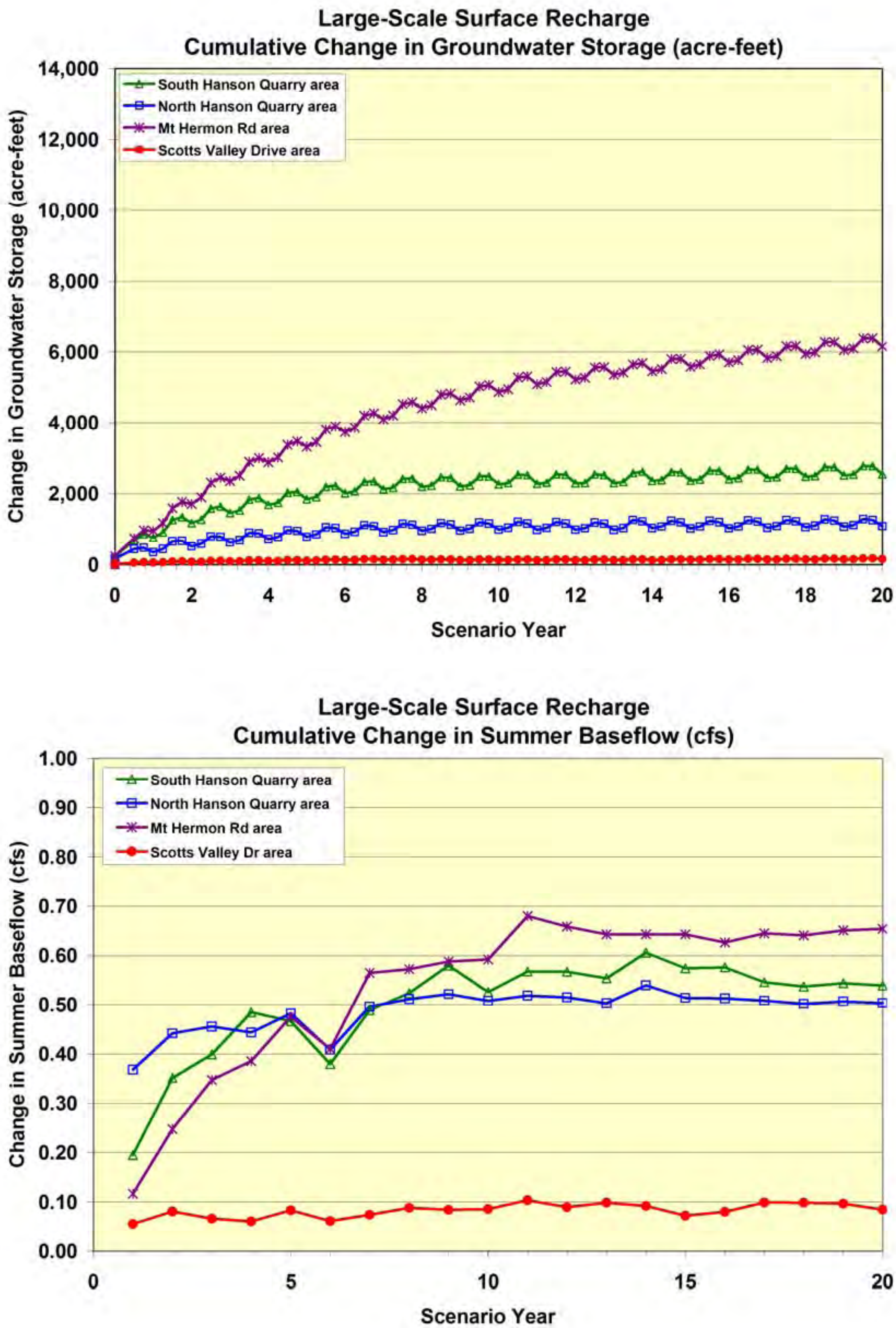

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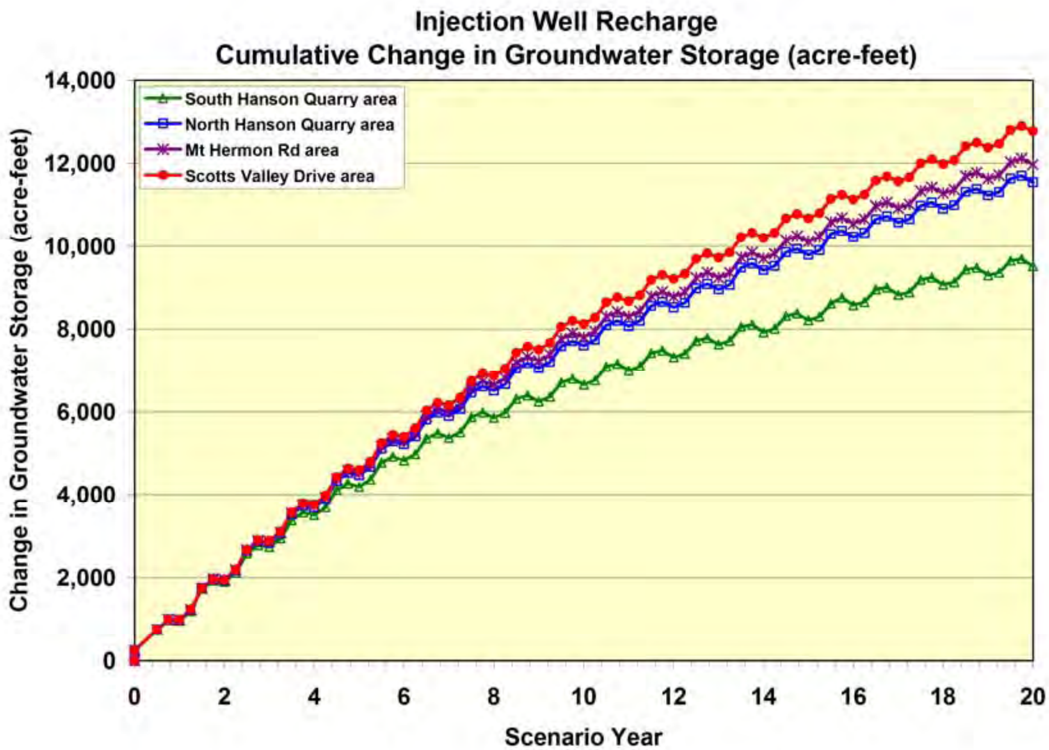
Figure 1C-5



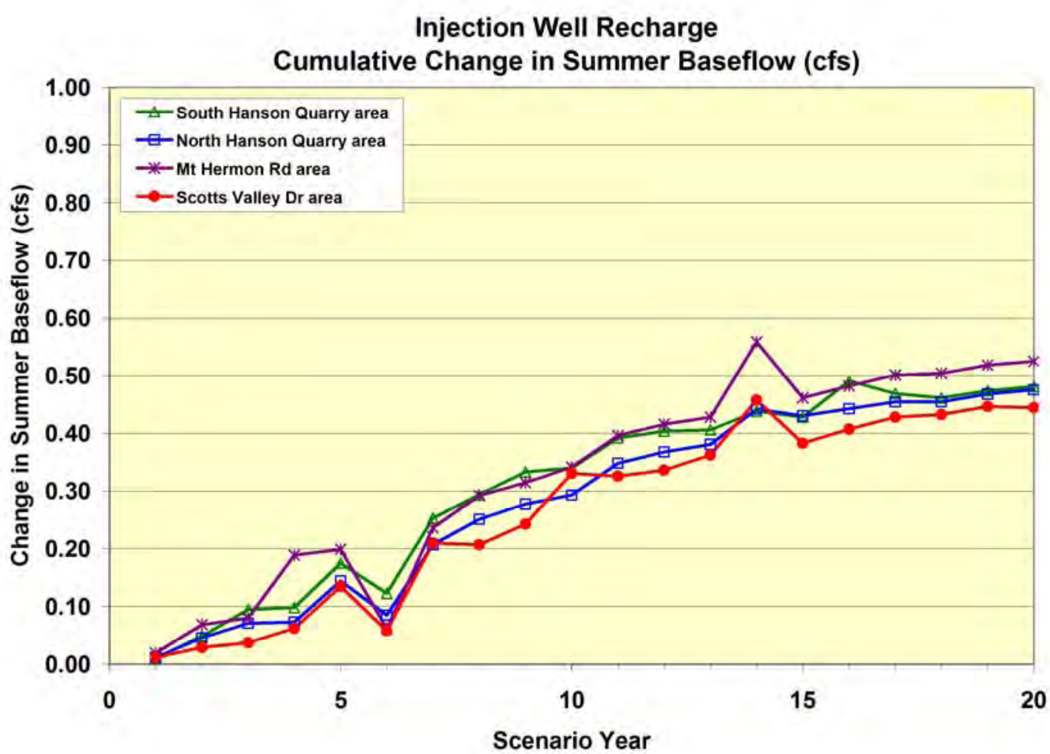


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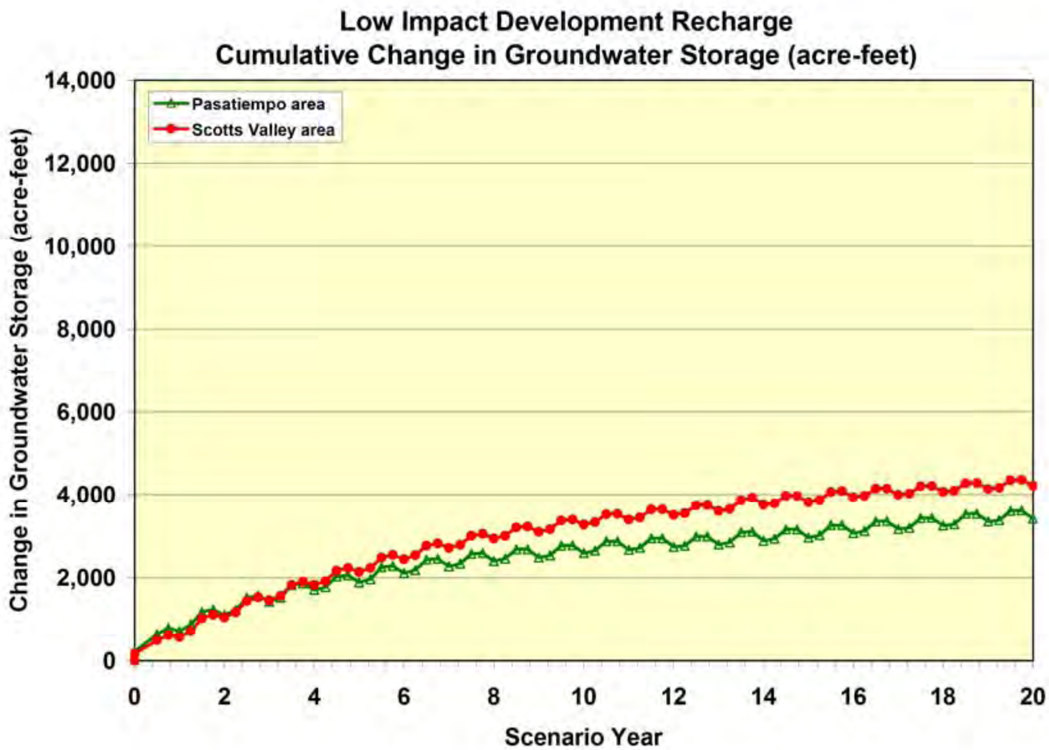
Figure 1C-6



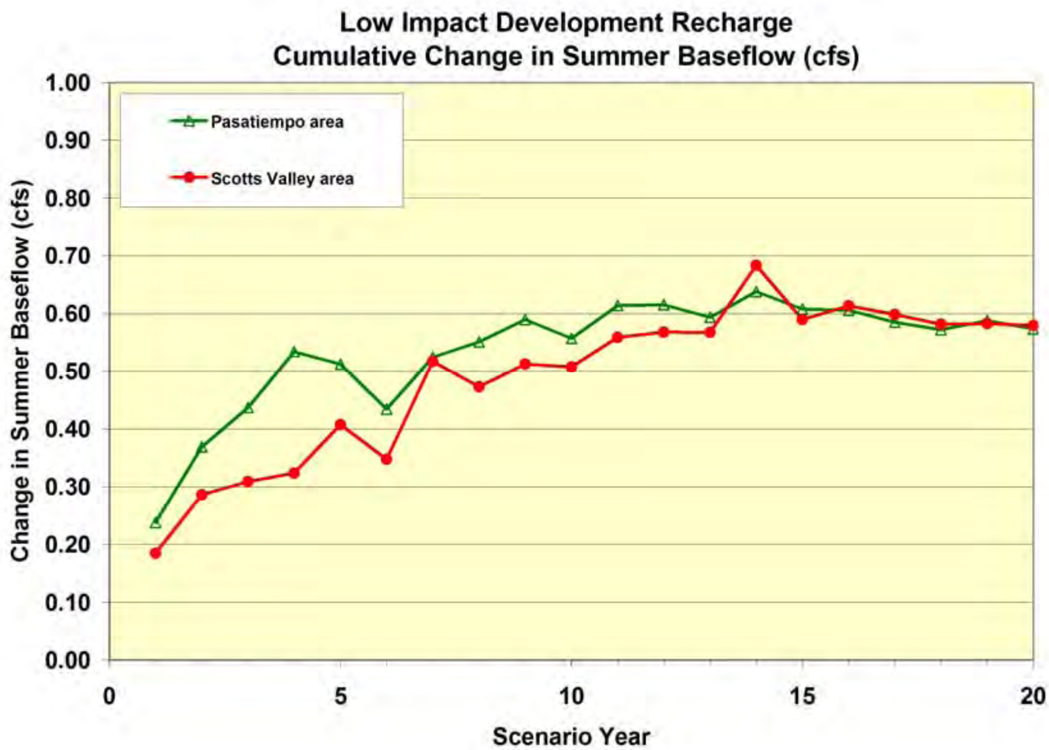


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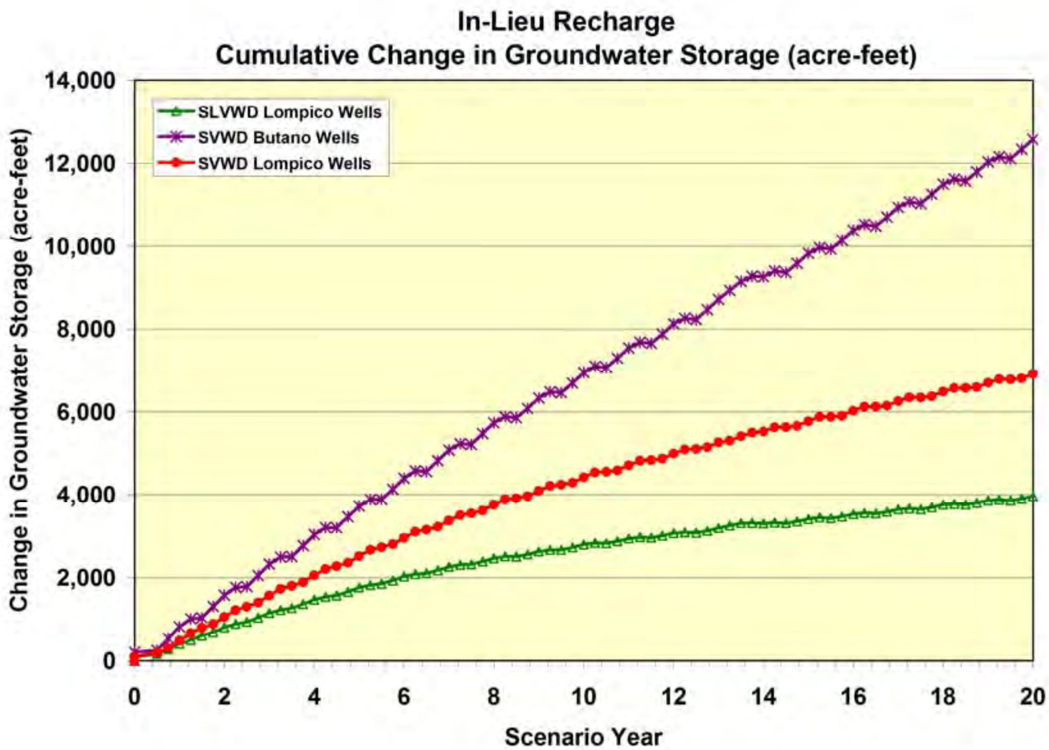
Figure 1C-7



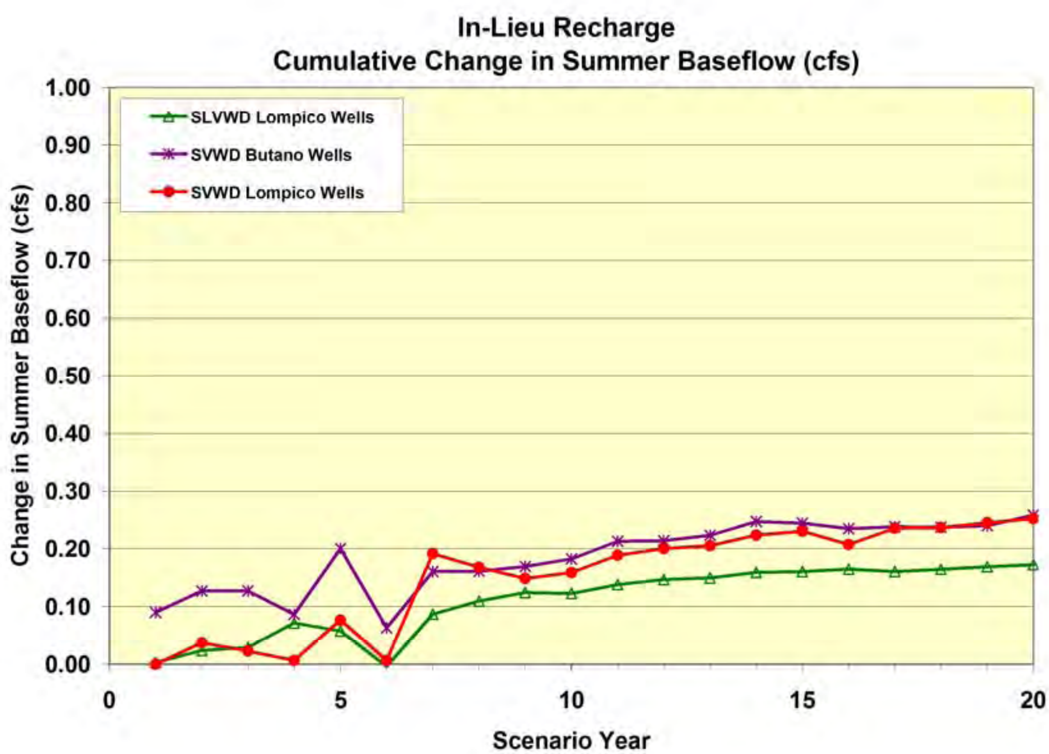


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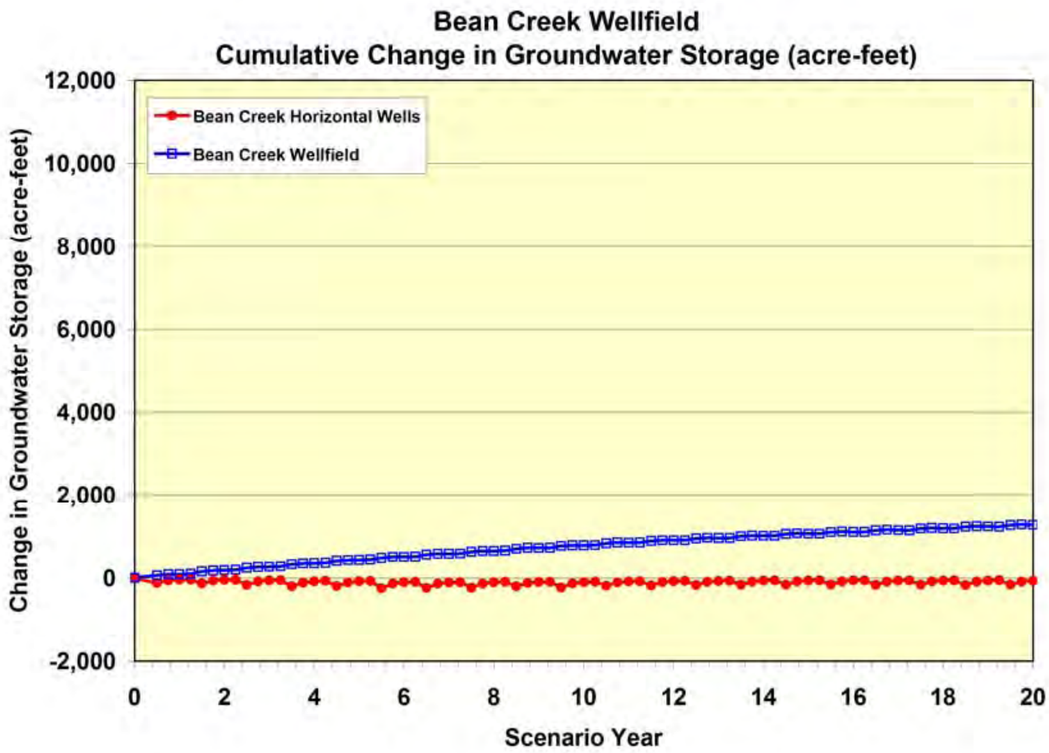
Figure 1C-8



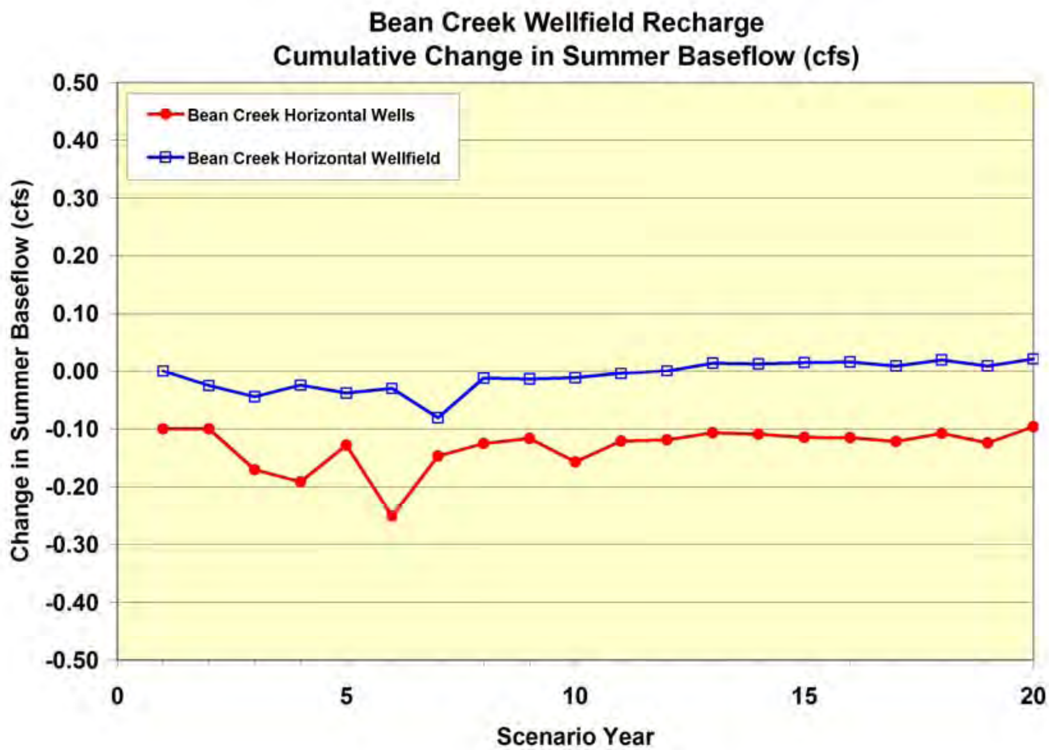


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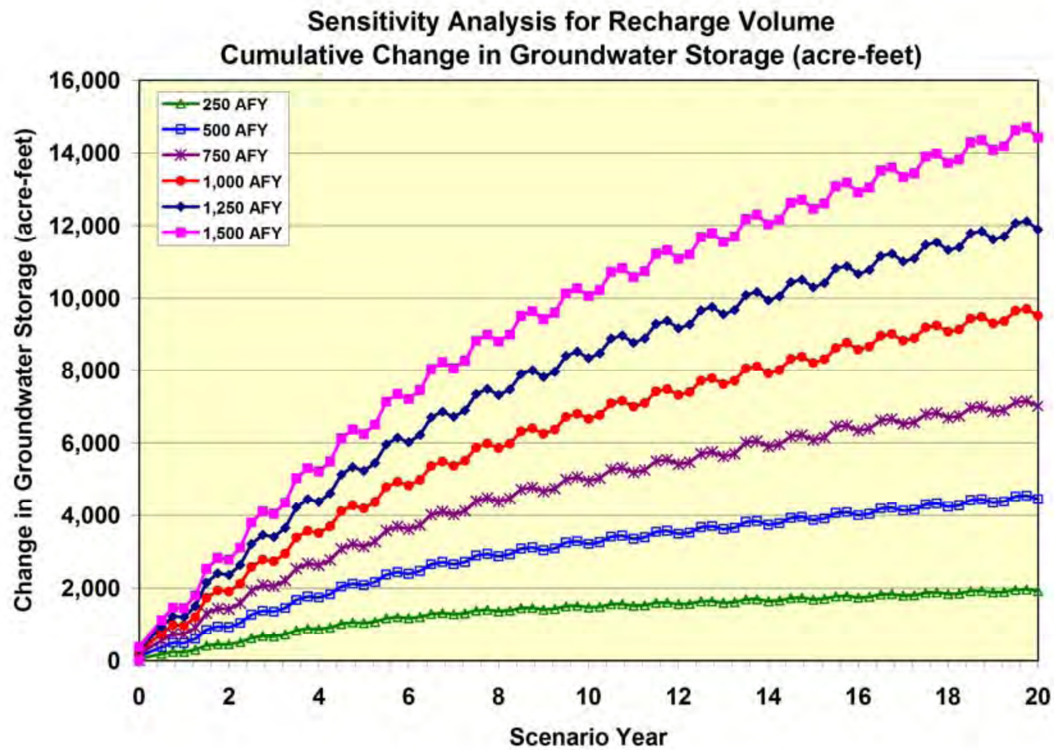
Figure 1C-9



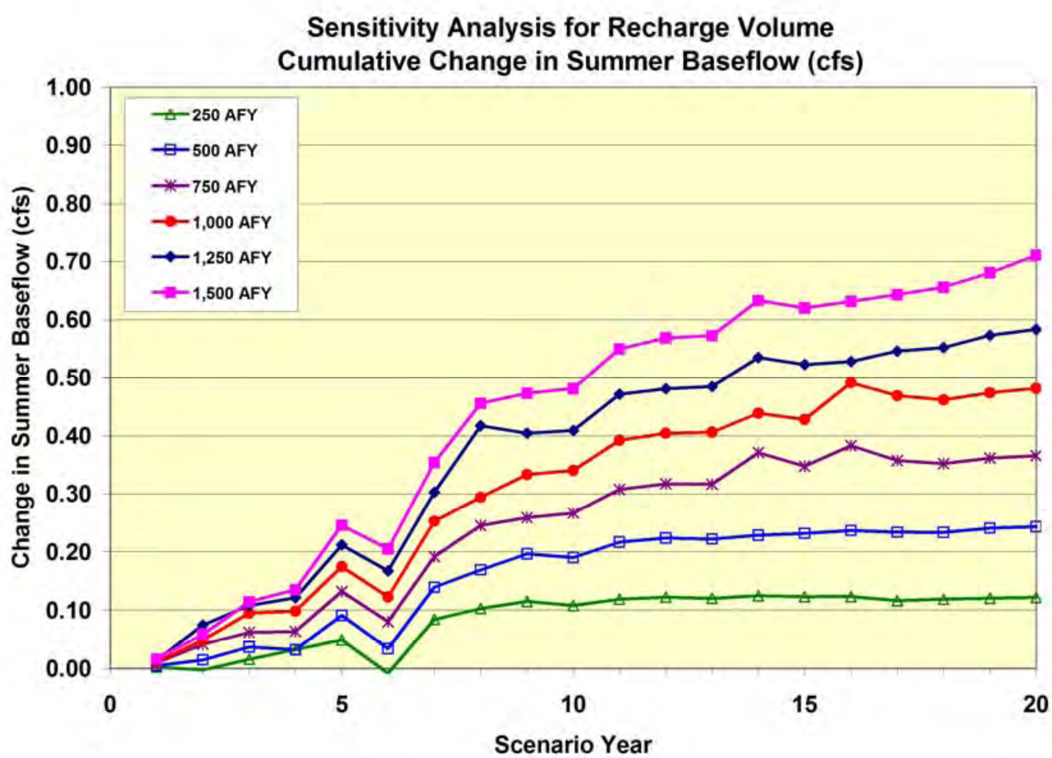


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Figure 1C-10

Attachment A: Detailed Water Balance Summaries for Each Model Scenario

Table 1C-A1: Seasonal Results for Scenar All Figures in acre-feet per quarter, averaged over 20 years of simulation

Table 1C-A1: Summary of results from Base Case scenario. All seasonal quantities are in acre-feet per quarter, and total quantities are in acre-feet. The "resaturation simulation" was run to compare the Surface Recharge - Scotts Valley scenario to a base case.

		Primary Base Case					Bean Creek Base Case				
		Fall	Winter	Spring	Summer	Total	Fall	Winter	Spring	Summer	Total
Inflows	From Storage	1,023	287	982	2,583	4,875	536	32	622	2,163	3,353
	Groundwater Inflow	423	412	420	429	1,684	423	413	420	429	1,685
	Directed Recharge	21	21	21	21	85	21	21	21	21	85
	Springs	--	--	--	--	--	--	--	--	--	--
	River Losses	149	128	162	188	627	152	129	163	188	632
	Evapotranspiration	--	--	--	--	--	--	--	--	--	--
	Head-Dep Bdy Inflow	178	171	175	183	708	188	181	184	190	743
	Recharge	3,763	6,457	4,049	1,826	16,095	3,763	6,457	4,048	1,826	16,094
	Stream Losses	909	1,090	733	416	3,147	905	1,095	729	422	3,151
Outflows	To Storage	865	2,484	333	99	3,781	791	2,421	330	73	3,614
	Groundwater Outflow	0	0	0	0	0	0	0	0	0	0
	Well Discharge	888	559	913	1,136	3,496	554	433	588	763	2,338
	Springs	1,107	1,325	1,200	1,046	4,677	1,108	1,327	1,200	1,042	4,677
	River Gains	1,059	1,253	1,110	942	4,365	1,057	1,255	1,114	946	4,373
	Evapotranspiration	327	385	673	406	1,791	324	384	677	410	1,795
	Head-Dep Bdy Outflow	334	342	329	304	1,309	333	343	342	329	1,347
	Recharge	--	--	--	--	--	--	--	--	--	--
	Stream Gains	1,887	2,217	1,986	1,716	7,806	1,821	2,163	1,938	1,679	7,601

Table 1C-A2: Summary of results from Surface Recharge: South Hanson Quarry scenario. All seasonal quantities are in acre-feet per quarter, and total quantities are in acre-feet. "Less Base Case" quantities represent the difference between the results for this scenario and the Base Case.

		Simulation Results (acre-feet)					Relative to Base Case (acre-feet)				
		Fall	Winter	Spring	Summer	Total	Fall	Winter	Spring	Summer	Total
Inflows	From Storage	1,016	276	984	2,800	5,076	-7	-11	2	217	201
	Groundwater Inflow	423	412	419	429	1,684	0	0	0	0	-1
	Directed Recharge	271	521	271	21	1,085	250	500	250	0	1,000
	Springs	--	--	--	--	--	--	--	--	--	--
	River Losses	149	127	162	188	626	0	0	0	0	0
	Evapotranspiration	--	--	--	--	--	--	--	--	--	--
	Head-Dep Bdy Inflow	178	171	175	183	707	0	0	0	0	-1
	Recharge	3,763	6,457	4,049	1,826	16,095	0	0	0	0	0
	Stream Losses	907	1,083	733	416	3,139	-2	-7	0	0	-8
Outflows	To Storage	910	2,744	351	100	4,106	46	260	18	1	325
	Groundwater Outflow	0	0	0	0	0	0	0	0	0	0
	Well Discharge	890	564	916	1,139	3,508	2	5	2	2	11
	Springs	1,215	1,450	1,331	1,163	5,159	108	125	131	118	482
	River Gains	1,059	1,254	1,111	943	4,367	1	1	1	1	3
	Evapotranspiration	329	383	677	411	1,800	2	-2	4	5	9
	Head-Dep Bdy Outflow	334	342	330	304	1,310	0	0	0	0	1
	Recharge	--	--	--	--	--	--	--	--	--	--
	Stream Gains	1,972	2,311	2,084	1,806	8,173	85	94	98	90	367
Summary	Enhanced Aquifer Recharge						250	500	250	0	1,000
	Change in Groundwater Storage						53	272	17	-215	127
	Change in Surface Water Baseflow						87	101	99	91	378
	Change in Springs and ET discharge						110	123	135	123	491

Table 1C-A3: Summary of results from Surface Recharge: North Hanson Quarry scenario. All seasonal quantities are in acre-feet per quarter, and total quantities are in acre-feet. "Less Base Case" quantities represent the difference between the results for this scenario and the Base Case.

		Simulation Results (acre-feet)					Relative to Base Case (acre-feet)				
		Fall	Winter	Spring	Summer	Total	Fall	Winter	Spring	Summer	Total
Inflows	From Storage	1,013	282	1,013	2,751	5,059	-10	-5	31	168	184
	Groundwater Inflow	423	412	420	429	1,684	0	0	0	0	0
	Directed Recharge	271	521	271	21	1,085	250	500	250	0	1,000
	Springs	--	--	--	--	--	--	--	--	--	--
	River Losses	149	128	162	188	626	0	0	0	0	0
	Evapotranspiration	--	--	--	--	--	--	--	--	--	--
	Head-Dep Bdy Inflow	178	171	175	183	707	0	0	0	0	0
	Recharge	3,763	6,457	4,049	1,826	16,095	0	0	0	0	0
	Stream Losses	907	1,088	731	415	3,142	-1	-2	-2	-1	-6
Outflows	To Storage	916	2,665	337	100	4,017	51	181	4	1	236
	Groundwater Outflow	0	0	0	0	0	0	0	0	0	0
	Well Discharge	889	564	915	1,138	3,506	1	5	2	2	10
	Springs	1,185	1,448	1,316	1,120	5,069	78	123	116	75	392
	River Gains	1,059	1,253	1,110	942	4,365	0	0	0	0	0
	Evapotranspiration	328	386	676	407	1,797	1	1	3	1	6
	Head-Dep Bdy Outflow	334	342	330	304	1,310	0	0	0	0	1
	Recharge	--	--	--	--	--	--	--	--	--	--
	Stream Gains	1,995	2,410	2,142	1,803	8,350	108	193	156	87	544
Summary	Enhanced Aquifer Recharge						250	500	250	0	1,000
	Change in Groundwater Storage						61	187	-27	-167	54
	Change in Surface Water Baseflow						109	194	158	88	550
	Change in Springs and ET discharge						78	125	119	76	398

Table 1C-A4+B158: Summary of results from Surface Recharge: Mount Hermon Road scenario. All seasonal quantities are in acre-feet per quarter, and total quantities are in acre-feet. "Less Base Case" quantities represent the difference between the results for this scenario and the Base Case.

		Simulation Results (acre-feet)					Relative to Base Case (acre-feet)				
		Fall	Winter	Spring	Summer	Total	Fall	Winter	Spring	Summer	Total
Inflows	From Storage	996	266	984	2,770	5,016	-27	-21	1	187	140
Inflows	Groundwater Inflow	423	412	420	429	1,684	0	0	0	0	0
Inflows	Directed Recharge	271	521	271	21	1,085	250	500	250	0	1,000
Inflows	Springs	--	--	--	--	--	--	--	--	--	--
Inflows	River Losses	149	127	162	187	626	0	0	0	0	-1
Inflows	Evapotranspiration	--	--	--	--	--	--	--	--	--	--
Inflows	Head-Dep Bdy Inflow	178	170	174	182	705	-1	-1	-1	-1	-3
Inflows	Recharge	3,763	6,457	4,049	1,826	16,095	0	0	0	0	0
Inflows	Stream Losses	903	1,083	729	412	3,127	-6	-7	-4	-4	-20
Outflows	To Storage	937	2,786	390	106	4,220	72	303	57	7	439
Outflows	Groundwater Outflow	0	0	0	0	0	0	0	0	0	0
Outflows	Well Discharge	892	567	918	1,141	3,518	4	8	5	5	22
Outflows	Springs	1,128	1,348	1,223	1,067	4,766	21	23	23	22	89
Outflows	River Gains	1,059	1,253	1,111	943	4,366	0	0	0	0	1
Outflows	Evapotranspiration	352	417	739	459	1,966	25	32	66	53	175
Outflows	Head-Dep Bdy Outflow	336	343	331	306	1,316	2	1	2	2	7
Outflows	Recharge	--	--	--	--	--	--	--	--	--	--
Outflows	Stream Gains	1,980	2,324	2,087	1,809	8,200	93	107	101	93	394
Summary	Enhanced Aquifer Recharge						250	500	250	0	1,000
Summary	Change in Groundwater Storage						101	326	58	-178	308
Summary	Change in Surface Water Baseflow						99	114	106	98	416
Summary	Change in Springs and ET discharge						46	55	89	75	264

Table 1C-A5+B196: Summary of results from Surface Recharge: Scotts Valley scenario. All seasonal quantities are in acre-feet per quarter, and total quantities are in acre-feet. "Less Base Case" quantities represent the difference between the results for this scenario and the Base Case.

		Simulation Results (acre-feet)					Relative to Base Case (acre-feet)				
		Fall	Winter	Spring	Summer	Total	Fall	Winter	Spring	Summer	Total
Inflows	From Storage	1,025	287	984	2,600	4,895	2	0	2	17	20
	Groundwater Inflow	423	412	420	429	1,684	0	0	0	0	0
	Directed Recharge	42	63	42	21	168	21	42	21	0	83
	Springs	--	--	--	--	--	--	--	--	--	--
	River Losses	149	128	162	188	627	0	0	0	0	0
	Evapotranspiration	--	--	--	--	--	--	--	--	--	--
	Head-Dep Bdy Inflow	178	171	175	183	708	0	0	0	0	0
	Recharge	3,763	6,457	4,049	1,826	16,095	0	0	0	0	0
	Stream Losses	903	1,086	728	409	3,125	-6	-4	-5	-7	-22
Outflows	To Storage	869	2,504	336	100	3,808	4	20	3	0	28
	Groundwater Outflow	0	0	0	0	0	0	0	0	0	0
	Well Discharge	888	559	914	1,137	3,498	0	1	0	0	2
	Springs	1,107	1,326	1,201	1,046	4,680	0	1	1	0	3
	River Gains	1,059	1,253	1,110	942	4,365	0	0	0	0	0
	Evapotranspiration	327	385	673	406	1,791	0	0	0	0	0
	Head-Dep Bdy Outflow	334	342	330	304	1,309	0	0	0	0	0
	Recharge	--	--	--	--	--	--	--	--	--	--
	Stream Gains	1,899	2,232	2,000	1,724	7,855	12	15	14	8	49
Summary	Enhanced Aquifer Recharge						21	42	21	0	83
	Change in Groundwater Storage						2	21	1	-16	8
	Change in Surface Water Baseflow						18	19	19	15	71
	Change in Springs and ET discharge						0	1	1	0	3

Table 1C-A6: Summary of results from Lompico Injection: South Hanson Quarry scenario. All seasonal quantities are in acre-feet per quarter, and total quantities are in acre-feet. "Less Base Case" quantities represent the difference between the results for this scenario and the Base Case.

		Simulation Results (acre-feet)					Relative to Base Case (acre-feet)				
		Fall	Winter	Spring	Summer	Total	Fall	Winter	Spring	Summer	Total
Inflows	From Storage	972	246	963	2,740	4,921	-50	-41	-20	157	46
	Groundwater Inflow	423	412	420	429	1,684	0	0	0	0	0
	Directed Recharge	271	521	271	21	1,085	250	500	250	0	1,000
	Springs	--	--	--	--	--	--	--	--	--	--
	River Losses	149	127	162	187	624	-1	-1	-1	-1	-3
	Evapotranspiration	--	--	--	--	--	--	--	--	--	--
	Head-Dep Bdy Inflow	177	170	174	182	703	-1	-1	-1	-1	-4
	Recharge	3,763	6,457	4,049	1,826	16,095	0	0	0	0	0
	Stream Losses	905	1,084	731	415	3,135	-4	-6	-2	-1	-13
Outflows	To Storage	942	2,805	419	122	4,288	77	321	86	23	507
	Groundwater Outflow	0	0	0	0	0	0	0	0	0	0
	Well Discharge	889	564	915	1,138	3,506	1	5	2	2	10
	Springs	1,150	1,371	1,246	1,090	4,857	43	47	46	44	180
	River Gains	1,062	1,256	1,113	945	4,376	3	3	3	3	11
	Evapotranspiration	345	407	710	434	1,895	17	22	37	28	104
	Head-Dep Bdy Outflow	336	344	332	306	1,319	2	2	2	3	10
	Recharge	--	--	--	--	--	--	--	--	--	--
	Stream Gains	1,938	2,290	2,046	1,768	8,042	51	73	60	52	236
Summary	Enhanced Aquifer Recharge						250	500	250	0	1,000
	Change in Groundwater Storage						131	366	109	-130	476
	Change in Surface Water Baseflow						58	82	66	56	262
	Change in Springs and ET discharge						60	69	83	72	284

Table 1C-A7: Summary of results from Lompico Injection: North Hanson Quarry scenario. All seasonal quantities are in acre-feet per quarter, and total quantities are in acre-feet. "Less Base Case" quantities represent the difference between the results for this scenario and the Base Case.

		Simulation Results (acre-feet)					Relative to Base Case (acre-feet)				
		Fall	Winter	Spring	Summer	Total	Fall	Winter	Spring	Summer	Total
Inflows	From Storage	975	244	972	2,736	4,928	-47	-43	-10	153	52
	Groundwater Inflow	423	412	420	429	1,684	0	0	0	0	0
	Directed Recharge	271	521	271	21	1,085	250	500	250	0	1,000
	Springs	--	--	--	--	--	--	--	--	--	--
	River Losses	148	126	161	186	621	-1	-1	-1	-1	-5
	Evapotranspiration	--	--	--	--	--	--	--	--	--	--
	Head-Dep Bdy Inflow	176	168	172	180	697	-3	-3	-3	-3	-11
	Recharge	3,763	6,457	4,049	1,826	16,095	0	0	0	0	0
	Stream Losses	903	1,086	729	415	3,133	-6	-4	-4	-1	-14
Outflows	To Storage	962	2,829	447	139	4,377	97	345	114	40	596
	Groundwater Outflow	0	0	0	0	0	0	0	0	0	0
	Well Discharge	891	565	917	1,140	3,513	3	7	4	4	17
	Springs	1,132	1,352	1,227	1,071	4,782	25	28	27	25	105
	River Gains	1,062	1,256	1,113	945	4,376	3	3	3	3	12
	Evapotranspiration	342	402	701	428	1,873	15	17	28	23	82
	Head-Dep Bdy Outflow	339	347	335	310	1,332	5	5	6	7	23
	Recharge	--	--	--	--	--	--	--	--	--	--
	Stream Gains	1,934	2,271	2,036	1,762	8,004	46	54	50	47	198
Summary	Enhanced Aquifer Recharge						250	500	250	0	1,000
	Change in Groundwater Storage						152	396	133	-104	577
	Change in Surface Water Baseflow						56	62	59	52	229
	Change in Springs and ET discharge						39	44	55	48	187

Table 1C-A8: Summary of results from Lompico Injection: Mount Hermon Road scenario. All seasonal quantities are in acre-feet per quarter, and total quantities are in acre-feet. "Less Base Case" quantities represent the difference between the results for this scenario and the Base Case.

		Simulation Results (acre-feet)					Relative to Base Case (acre-feet)				
		Fall	Winter	Spring	Summer	Total	Fall	Winter	Spring	Summer	Total
Inflows	From Storage	973	241	962	2,725	4,902	-50	-46	-20	142	26
	Groundwater Inflow	423	412	420	429	1,684	0	0	0	0	0
	Directed Recharge	271	521	271	21	1,085	250	500	250	0	1,000
	Springs	--	--	--	--	--	--	--	--	--	--
	River Losses	148	127	161	187	623	-1	-1	-1	-1	-4
	Evapotranspiration	--	--	--	--	--	--	--	--	--	--
	Head-Dep Bdy Inflow	175	167	171	179	692	-4	-4	-4	-4	-16
	Recharge	3,763	6,457	4,049	1,826	16,095	0	0	0	0	0
	Stream Losses	900	1,080	726	417	3,122	-9	-10	-7	0	-25
Outflows	To Storage	958	2,818	446	134	4,356	93	334	113	35	575
	Groundwater Outflow	0	0	0	0	0	0	0	0	0	0
	Well Discharge	892	566	918	1,141	3,516	4	7	4	4	19
	Springs	1,124	1,343	1,219	1,063	4,749	17	19	19	17	71
	River Gains	1,060	1,255	1,112	944	4,372	2	2	2	2	7
	Evapotranspiration	336	396	690	418	1,840	9	11	16	12	49
	Head-Dep Bdy Outflow	342	350	338	314	1,343	8	8	8	10	34
	Recharge	--	--	--	--	--	--	--	--	--	--
	Stream Gains	1,942	2,277	2,045	1,773	8,037	55	60	59	57	231
Summary	Enhanced Aquifer Recharge						250	500	250	0	1,000
	Change in Groundwater Storage						154	392	146	-93	598
	Change in Surface Water Baseflow						67	72	69	60	267
	Change in Springs and ET discharge						26	30	35	30	120

Table 1C-A9: Summary of results from Lompico Injection: Scotts Valley scenario. All seasonal quantities are in acre-feet per quarter, and total quantities are in acre-feet. "Less Base Case" quantities represent the difference between the results for this scenario and the Base Case.

		Simulation Results (acre-feet)					Relative to Base Case (acre-feet)				
		Fall	Winter	Spring	Summer	Total	Fall	Winter	Spring	Summer	Total
Inflows	From Storage	961	247	962	2,715	4,886	-62	-40	-20	132	11
Inflows	Groundwater Inflow	423	412	420	429	1,684	0	0	0	0	0
Inflows	Directed Recharge	271	521	271	21	1,085	250	500	250	0	1,000
Inflows	Springs	--	--	--	--	--	--	--	--	--	--
Inflows	River Losses	148	127	161	187	623	-1	-1	-1	-1	-4
Inflows	Evapotranspiration	--	--	--	--	--	--	--	--	--	--
Inflows	Head-Dep Bdy Inflow	171	164	168	176	678	-7	-7	-7	-8	-29
Inflows	Recharge	3,763	6,457	4,049	1,826	16,095	0	0	0	0	0
Inflows	Stream Losses	892	1,082	722	416	3,112	-16	-8	-11	0	-36
Outflows	To Storage	944	2,820	443	130	4,338	79	337	110	31	557
Outflows	Groundwater Outflow	0	0	0	0	0	0	0	0	0	0
Outflows	Well Discharge	892	566	918	1,141	3,516	4	8	4	4	20
Outflows	Springs	1,117	1,339	1,213	1,057	4,725	10	14	13	11	48
Outflows	River Gains	1,060	1,255	1,112	944	4,370	1	1	1	1	5
Outflows	Evapotranspiration	336	395	690	418	1,839	8	11	16	13	48
Outflows	Head-Dep Bdy Outflow	349	356	345	322	1,372	15	14	15	18	63
Outflows	Recharge	--	--	--	--	--	--	--	--	--	--
Outflows	Stream Gains	1,934	2,278	2,036	1,762	8,010	46	61	50	46	204
Summary	Enhanced Aquifer Recharge						250	500	250	0	1,000
Summary	Change in Groundwater Storage						163	398	153	-76	638
Summary	Change in Surface Water Baseflow						65	71	63	48	248
Summary	Change in Springs and ET discharge						18	25	29	24	96

Table 1C-A10: Summary of results from Dispersed Surface Recharge: San Lorenzo scenario. All seasonal quantities are in acre-feet per quarter, and total quantities are in acre-feet. "Less Base Case" quantities represent the difference between the results for this scenario and the Base Case.

		Simulation Results (acre-feet)					Relative to Base Case (acre-feet)				
		Fall	Winter	Spring	Summer	Total	Fall	Winter	Spring	Summer	Total
Inflows	From Storage	997	274	981	2,773	5,025	-26	-13	-1	190	149
	Groundwater Inflow	414	398	407	421	1,639	-10	-14	-13	-9	-45
	Directed Recharge	269	516	269	21	1,075	248	495	248	0	990
	Springs	--	--	--	--	--	--	--	--	--	--
	River Losses	149	127	162	188	626	0	0	0	0	0
	Evapotranspiration	--	--	--	--	--	--	--	--	--	--
	Head-Dep Bdy Inflow	178	171	175	183	707	0	0	0	0	-1
	Recharge	3,763	6,457	4,049	1,826	16,095	0	0	0	0	0
	Stream Losses	905	1,073	737	418	3,133	-4	-16	4	2	-14
Outflows	To Storage	899	2,714	339	101	4,053	34	231	6	1	272
	Groundwater Outflow	0	1	0	0	1	0	1	0	0	1
	Well Discharge	890	564	916	1,139	3,508	2	5	2	2	11
	Springs	1,163	1,392	1,266	1,103	4,924	56	67	66	57	247
	River Gains	1,062	1,256	1,113	945	4,376	3	3	3	3	11
	Evapotranspiration	340	402	712	429	1,884	13	18	38	23	93
	Head-Dep Bdy Outflow	334	342	330	304	1,310	0	0	0	0	1
	Recharge	--	--	--	--	--	--	--	--	--	--
	Stream Gains	1,987	2,345	2,108	1,812	8,253	100	128	122	96	447
Summary	Enhanced Aquifer Recharge						248	495	248	0	990
	Change in Groundwater Storage						71	259	21	-180	171
	Change in Surface Water Baseflow						107	147	121	97	472
	Change in Springs and ET discharge						69	85	105	80	339

Table 1C-A11: Summary of results from Dispersed Surface Recharge: Scotts Valley scenario. All seasonal quantities are in acre-feet per quarter, and total quantities are in acre-feet. "Less Base Case" quantities represent the difference between the results for this scenario and the Base Case.

		Simulation Results (acre-feet)					Relative to Base Case (acre-feet)				
		Fall	Winter	Spring	Summer	Total	Fall	Winter	Spring	Summer	Total
Inflows	From Storage	993	267	968	2,709	4,937	-30	-20	-15	127	62
	Groundwater Inflow	423	412	420	429	1,684	0	0	0	0	0
	Directed Recharge	229	436	229	21	915	208	415	208	0	830
	Springs	--	--	--	--	--	--	--	--	--	--
	River Losses	149	127	162	187	626	0	0	0	0	0
	Evapotranspiration	--	--	--	--	--	--	--	--	--	--
	Head-Dep Bdy Inflow	178	170	174	183	705	-1	-1	-1	-1	-3
	Recharge	3,763	6,457	4,049	1,826	16,095	0	0	0	0	0
	Stream Losses	894	1,078	721	404	3,097	-15	-12	-12	-12	-50
Outflows	To Storage	903	2,682	354	104	4,044	38	199	21	4	263
	Groundwater Outflow	0	0	0	0	0	0	0	0	0	0
	Well Discharge	893	568	919	1,142	3,522	5	9	6	6	26
	Springs	1,127	1,351	1,225	1,065	4,769	20	26	25	20	92
	River Gains	1,059	1,253	1,111	942	4,365	0	0	0	0	1
	Evapotranspiration	330	389	681	411	1,812	3	4	8	6	21
	Head-Dep Bdy Outflow	336	343	331	305	1,315	1	1	2	2	6
	Recharge	--	--	--	--	--	--	--	--	--	--
	Stream Gains	1,982	2,363	2,117	1,792	8,253	94	145	131	76	447
Summary	Enhanced Aquifer Recharge						208	415	208	0	830
	Change in Groundwater Storage						70	221	39	-119	211
	Change in Surface Water Baseflow						109	157	143	89	499
	Change in Springs and ET discharge						23	31	33	25	113

Table 1C-A12: Summary of results from In-Lieu Recharge: San Lorenzo scenario. All seasonal quantities are in acre-feet per quarter, and total quantities are in acre-feet. "Less Base Case" quantities represent the difference between the results for this scenario and the Base Case.

		Simulation Results (acre-feet)					Relative to Base Case (acre-feet)				
		Fall	Winter	Spring	Summer	Total	Fall	Winter	Spring	Summer	Total
Inflows	From Storage	1,001	279	959	2,528	4,766	-22	-9	-24	-55	-109
	Groundwater Inflow	423	412	420	429	1,684	0	0	0	0	0
	Directed Recharge	21	21	21	21	85	0	0	0	0	0
	Springs	--	--	--	--	--	--	--	--	--	--
	River Losses	149	127	162	187	625	0	0	0	-1	-2
	Evapotranspiration	--	--	--	--	--	--	--	--	--	--
	Head-Dep Bdy Inflow	178	170	175	183	705	-1	-1	-1	-1	-2
	Recharge	3,763	6,457	4,049	1,826	16,095	0	0	0	0	0
	Stream Losses	907	1,088	732	416	3,143	-2	-2	-1	0	-4
Outflows	To Storage	888	2,488	368	118	3,862	23	4	36	18	81
	Groundwater Outflow	0	0	0	0	0	0	0	0	0	0
	Well Discharge	792	492	789	1,005	3,078	-96	-66	-124	-132	-418
	Springs	1,124	1,344	1,219	1,063	4,750	17	19	19	17	72
	River Gains	1,060	1,255	1,112	944	4,370	1	1	1	1	6
	Evapotranspiration	339	397	695	424	1,855	12	13	21	18	64
	Head-Dep Bdy Outflow	335	343	331	305	1,314	1	1	1	1	5
	Recharge	--	--	--	--	--	--	--	--	--	--
	Stream Gains	1,905	2,251	2,005	1,734	7,896	18	34	19	18	90
Summary	Enhanced Aquifer Recharge						96	66	124	132	418
	Change in Groundwater Storage						47	14	61	76	198
	Change in Surface Water Baseflow						22	38	22	20	102
	Change in Springs and ET discharge						29	32	40	36	136

Table 1C-A13: Summary of results from In-Lieu Recharge: Scotts Valley (Butano) scenario. All seasonal quantities are in acre-feet per quarter, and total quantities are in acre-feet. "Less Base Case" quantities represent the difference between the results for this scenario and the Base Case.

		Simulation Results (acre-feet)					Relative to Base Case (acre-feet)				
		Fall	Winter	Spring	Summer	Total	Fall	Winter	Spring	Summer	Total
Inflows	From Storage	956	272	852	2,442	4,522	-67	-16	-130	-141	-353
	Groundwater Inflow	423	412	420	429	1,684	0	0	0	0	0
	Directed Recharge	21	21	21	21	85	0	0	0	0	0
	Springs	--	--	--	--	--	--	--	--	--	--
	River Losses	148	127	161	187	623	-1	-1	-1	-1	-4
	Evapotranspiration	--	--	--	--	--	--	--	--	--	--
	Head-Dep Bdy Inflow	162	155	159	167	644	-16	-16	-16	-17	-64
	Recharge	3,763	6,457	4,049	1,826	16,095	0	0	0	0	0
	Stream Losses	887	1,073	718	418	3,095	-21	-17	-15	2	-52
Outflows	To Storage	863	2,379	349	100	3,691	-2	-104	16	1	-90
	Groundwater Outflow	0	0	0	0	0	0	0	0	0	0
	Well Discharge	662	494	607	844	2,607	-226	-65	-307	-293	-890
	Springs	1,108	1,326	1,202	1,047	4,683	1	2	2	2	6
	River Gains	1,059	1,254	1,111	943	4,366	0	0	0	0	1
	Evapotranspiration	336	394	690	422	1,841	9	9	17	16	50
	Head-Dep Bdy Outflow	410	411	403	386	1,610	76	69	73	83	301
	Recharge	--	--	--	--	--	--	--	--	--	--
	Stream Gains	1,924	2,258	2,022	1,750	7,955	37	41	37	34	148
Summary	Enhanced Aquifer Recharge						226	65	307	293	890
	Change in Groundwater Storage						157	-4	236	241	629
	Change in Surface Water Baseflow						59	59	53	34	205
	Change in Springs and ET discharge						10	10	18	18	56

Table 1C-A14: Summary of results from In-Lieu Recharge: Scotts Valley (Lompico) scenario. All seasonal quantities are in acre-feet per quarter, and total quantities are in acre-feet. "Less Base Case" quantities represent the difference between the results for this scenario and the Base Case.

		Simulation Results (acre-feet)					Relative to Base Case (acre-feet)				
		Fall	Winter	Spring	Summer	Total	Fall	Winter	Spring	Summer	Total
Inflows	From Storage	924	254	950	2,482	4,610	-98	-33	-32	-101	-265
	Groundwater Inflow	423	412	420	429	1,684	0	0	0	0	0
	Directed Recharge	21	21	21	21	85	0	0	0	0	0
	Springs	--	--	--	--	--	--	--	--	--	--
	River Losses	149	127	162	187	624	-1	-1	-1	-1	-2
	Evapotranspiration	--	--	--	--	--	--	--	--	--	--
	Head-Dep Bdy Inflow	175	168	172	180	694	-3	-3	-3	-4	-14
	Recharge	3,763	6,457	4,049	1,826	16,095	0	0	0	0	0
	Stream Losses	902	1,083	728	416	3,129	-7	-7	-5	0	-19
Outflows	To Storage	875	2,482	346	116	3,819	10	-2	13	17	38
	Groundwater Outflow	0	0	0	0	0	0	0	0	0	0
	Well Discharge	722	466	805	964	2,957	-166	-92	-108	-173	-539
	Springs	1,115	1,334	1,209	1,054	4,711	8	9	9	8	33
	River Gains	1,060	1,254	1,111	943	4,368	1	1	1	1	4
	Evapotranspiration	332	391	683	413	1,819	5	6	9	7	28
	Head-Dep Bdy Outflow	341	349	337	312	1,338	7	7	7	9	29
	Recharge	--	--	--	--	--	--	--	--	--	--
	Stream Gains	1,914	2,248	2,014	1,742	7,918	27	31	28	26	112
Summary	Enhanced Aquifer Recharge						166	92	108	173	539
	Change in Groundwater Storage						119	41	56	130	346
	Change in Surface Water Baseflow						35	39	35	27	136
	Change in Springs and ET discharge						13	15	18	15	61

Table 1C-A15: Summary of results from Sensitivity Analysis - 500 afy scenario. All seasonal quantities are in acre-feet per quarter, and total quantities are in acre-feet. "Less Base Case" quantities represent the difference between the results for this scenario and the Base Case.

		Simulation Results (acre-feet)					Relative to Base Case (acre-feet)				
		Fall	Winter	Spring	Summer	Total	Fall	Winter	Spring	Summer	Total
Inflows	From Storage	994	260	967	2,662	4,884	-28	-27	-15	79	8
	Groundwater Inflow	423	412	420	429	1,684	0	0	0	0	0
	Directed Recharge	146	271	146	21	585	125	250	125	0	500
	Springs	--	--	--	--	--	--	--	--	--	--
	River Losses	149	127	162	187	625	0	0	0	0	-1
	Evapotranspiration	--	--	--	--	--	--	--	--	--	--
	Head-Dep Bdy Inflow	178	171	175	183	706	-1	-1	-1	-1	-2
	Recharge	3,763	6,457	4,049	1,826	16,095	0	0	0	0	0
	Stream Losses	907	1,087	732	415	3,142	-2	-2	-1	-1	-6
Outflows	To Storage	898	2,632	365	109	4,004	33	148	32	10	224
	Groundwater Outflow	0	0	0	0	0	0	0	0	0	0
	Well Discharge	889	563	915	1,138	3,506	1	5	2	2	10
	Springs	1,130	1,351	1,226	1,070	4,777	23	26	26	24	99
	River Gains	1,060	1,255	1,112	944	4,370	1	1	1	1	6
	Evapotranspiration	334	393	689	417	1,833	7	8	15	11	42
	Head-Dep Bdy Outflow	335	343	331	305	1,314	1	1	1	1	5
	Recharge	--	--	--	--	--	--	--	--	--	--
	Stream Gains	1,915	2,247	2,015	1,742	7,920	28	30	30	27	113
Summary	Enhanced Aquifer Recharge						125	250	125	0	500
	Change in Groundwater Storage						63	177	50	-68	222
	Change in Surface Water Baseflow						31	34	32	29	126
	Change in Springs and ET discharge						31	34	41	36	142

Table 1C-A16: Summary of results from Sensitivity Analysis - 1,500 afy scenario. All seasonal quantities are in acre-feet per quarter, and total quantities are in acre-feet. "Less Base Case" quantities represent the difference between the results for this scenario and the Base Case.

		Simulation Results (acre-feet)					Relative to Base Case (acre-feet)				
		Fall	Winter	Spring	Summer	Total	Fall	Winter	Spring	Summer	Total
Inflows	From Storage	954	237	966	2,820	4,977	-69	-50	-17	237	102
Inflows	Groundwater Inflow	423	412	420	429	1,684	0	0	0	0	0
Inflows	Directed Recharge	396	771	396	21	1,585	375	750	375	0	1,500
Inflows	Springs	--	--	--	--	--	--	--	--	--	--
Inflows	River Losses	148	127	161	187	623	-1	-1	-1	-1	-4
Inflows	Evapotranspiration	--	--	--	--	--	--	--	--	--	--
Inflows	Head-Dep Bdy Inflow	177	169	174	182	701	-2	-2	-2	-2	-6
Inflows	Recharge	3,763	6,457	4,049	1,826	16,095	0	0	0	0	0
Inflows	Stream Losses	903	1,082	731	416	3,132	-5	-8	-2	0	-15
Outflows	To Storage	993	2,979	473	138	4,583	128	495	141	39	802
Outflows	Groundwater Outflow	0	0	0	0	0	0	0	0	0	0
Outflows	Well Discharge	891	565	917	1,140	3,512	3	7	3	3	16
Outflows	Springs	1,167	1,391	1,265	1,108	4,931	60	66	65	62	254
Outflows	River Gains	1,063	1,257	1,115	946	4,381	4	4	4	4	17
Outflows	Evapotranspiration	356	423	735	453	1,967	29	38	62	47	176
Outflows	Head-Dep Bdy Outflow	337	345	333	308	1,323	3	3	3	4	14
Outflows	Recharge	--	--	--	--	--	--	--	--	--	--
Outflows	Stream Gains	1,959	2,295	2,064	1,790	8,108	71	78	78	74	302
Summary	Enhanced Aquifer Recharge						375	750	375	0	1,500
Summary	Change in Groundwater Storage						202	550	162	-193	721
Summary	Change in Surface Water Baseflow						82	91	86	80	338
Summary	Change in Springs and ET discharge						89	104	127	109	430

Table 1C-A17: Summary of results from Sensitivity Analysis - 250 afy scenario. All seasonal quantities are in acre-feet per quarter, and total quantities are in acre-feet. "Less Base Case" quantities represent the difference between the results for this scenario and the Base Case.

		Simulation Results (acre-feet)					Relative to Base Case (acre-feet)				
		Fall	Winter	Spring	Summer	Total	Fall	Winter	Spring	Summer	Total
Inflows	From Storage	1,008	272	975	2,625	4,879	-15	-15	-8	42	4
	Groundwater Inflow	423	412	420	429	1,684	0	0	0	0	0
	Directed Recharge	84	146	84	21	335	63	125	63	0	250
	Springs	--	--	--	--	--	--	--	--	--	--
	River Losses	149	127	162	187	626	0	0	0	0	-1
	Evapotranspiration	--	--	--	--	--	--	--	--	--	--
	Head-Dep Bdy Inflow	178	171	175	183	707	0	0	0	0	-1
	Recharge	3,763	6,457	4,049	1,826	16,095	0	0	0	0	0
	Stream Losses	907	1,088	732	416	3,144	-1	-1	-1	0	-3
Outflows	To Storage	878	2,551	344	103	3,877	14	67	12	4	96
	Groundwater Outflow	0	0	0	0	0	0	0	0	0	0
	Well Discharge	889	563	915	1,138	3,506	1	5	2	2	9
	Springs	1,119	1,338	1,213	1,058	4,729	12	13	13	13	52
	River Gains	1,059	1,254	1,111	943	4,367	1	1	1	1	3
	Evapotranspiration	331	390	682	412	1,815	4	5	9	7	24
	Head-Dep Bdy Outflow	335	342	330	304	1,311	1	1	1	1	2
	Recharge	--	--	--	--	--	--	--	--	--	--
	Stream Gains	1,902	2,234	2,002	1,730	7,868	15	17	16	15	62
Summary	Enhanced Aquifer Recharge						63	125	63	0	250
	Change in Groundwater Storage						29	83	20	-37	96
	Change in Surface Water Baseflow						17	19	18	15	69
	Change in Springs and ET discharge						16	18	22	19	76

Table 1C-A18: Summary of results from Sensitivity Analysis - 500 afy scenario. All seasonal quantities are in acre-feet per quarter, and total quantities are in acre-feet. "Less Base Case" quantities represent the difference between the results for this scenario and the Base Case.

		Simulation Results (acre-feet)					Relative to Base Case (acre-feet)				
		Fall	Winter	Spring	Summer	Total	Fall	Winter	Spring	Summer	Total
Inflows	From Storage	984	252	968	2,702	4,905	-39	-35	-15	119	30
	Groundwater Inflow	423	412	420	429	1,684	0	0	0	0	0
	Directed Recharge	209	396	209	21	835	188	375	188	0	750
	Springs	--	--	--	--	--	--	--	--	--	--
	River Losses	149	127	162	187	625	0	0	-1	-1	-2
	Evapotranspiration	--	--	--	--	--	--	--	--	--	--
	Head-Dep Bdy Inflow	178	170	174	182	705	-1	-1	-1	-1	-3
	Recharge	3,763	6,457	4,049	1,826	16,095	0	0	0	0	0
	Stream Losses	906	1,087	732	416	3,141	-3	-2	-1	0	-7
Outflows	To Storage	919	2,724	391	116	4,151	54	241	58	16	370
	Groundwater Outflow	0	0	0	0	0	0	0	0	0	0
	Well Discharge	889	564	915	1,138	3,506	1	5	2	2	10
	Springs	1,140	1,361	1,236	1,080	4,818	33	37	36	35	141
	River Gains	1,061	1,255	1,113	944	4,373	2	2	2	2	9
	Evapotranspiration	339	400	699	425	1,862	12	15	25	19	71
	Head-Dep Bdy Outflow	336	344	331	306	1,316	2	2	2	2	7
	Recharge	--	--	--	--	--	--	--	--	--	--
	Stream Gains	1,928	2,383	2,030	1,756	8,097	40	166	44	40	291
Summary	Enhanced Aquifer Recharge						188	375	188	0	750
	Change in Groundwater Storage						96	279	76	-100	351
	Change in Surface Water Baseflow						46	171	48	44	308
	Change in Springs and ET discharge						45	51	62	54	213

Table 1C-A19: Summary of results from Sensitivity Analysis - 1,250 afy scenario. All seasonal quantities are in acre-feet per quarter, and total quantities are in acre-feet. "Less Base Case" quantities represent the difference between the results for this scenario and the Base Case.

		Simulation Results (acre-feet)					Relative to Base Case (acre-feet)				
		Fall	Winter	Spring	Summer	Total	Fall	Winter	Spring	Summer	Total
Inflows	From Storage	963	241	965	2,780	4,949	-60	-46	-17	197	74
	Groundwater Inflow	423	412	420	429	1,684	0	0	0	0	0
	Directed Recharge	334	646	334	21	1,335	313	625	313	0	1,250
	Springs	--	--	--	--	--	--	--	--	--	--
	River Losses	148	127	161	187	623	-1	-1	-1	-1	-3
	Evapotranspiration	--	--	--	--	--	--	--	--	--	--
	Head-Dep Bdy Inflow	177	170	174	182	702	-1	-1	-1	-1	-5
	Recharge	3,763	6,457	4,049	1,826	16,095	0	0	0	0	0
	Stream Losses	904	1,084	731	417	3,136	-5	-6	-2	1	-12
Outflows	To Storage	966	2,892	444	129	4,432	102	408	111	30	651
	Groundwater Outflow	0	0	0	0	0	0	0	0	0	0
	Well Discharge	891	565	917	1,140	3,512	3	7	3	3	16
	Springs	1,159	1,382	1,256	1,099	4,896	52	57	56	53	219
	River Gains	1,062	1,257	1,114	946	4,379	3	4	4	4	14
	Evapotranspiration	350	414	722	443	1,930	23	30	49	38	139
	Head-Dep Bdy Outflow	337	344	332	307	1,321	3	3	3	3	12
	Recharge	--	--	--	--	--	--	--	--	--	--
	Stream Gains	1,948	2,285	2,053	1,780	8,065	61	67	67	64	259
Summary	Enhanced Aquifer Recharge						313	625	313	0	1,250
	Change in Groundwater Storage						165	458	133	-162	595
	Change in Surface Water Baseflow						70	78	73	68	289
	Change in Springs and ET discharge						75	87	105	91	358

Table 1C-A20: Summary of results from Horizontal Well Test scenario. All seasonal quantities are in acre-feet per quarter, and total quantities are in acre-feet. "Less Base Case" quantities represent the difference between the results for this scenario and the Base Case.

		Simulation Results (acre-feet)					Relative to Base Case (acre-feet)				
		Fall	Winter	Spring	Summer	Total	Fall	Winter	Spring	Summer	Total
Inflows	From Storage	1,021	368	975	2,563	4,926	-2	80	-8	-20	50
	Groundwater Inflow	423	412	420	429	1,684	0	0	0	0	0
	Directed Recharge	21	21	21	21	85	0	0	0	0	0
	Springs	--	--	--	--	--	--	--	--	--	--
	River Losses	149	128	162	188	627	0	0	0	0	0
	Evapotranspiration	--	--	--	--	--	--	--	--	--	--
	Head-Dep Bdy Inflow	178	171	175	183	708	0	0	0	0	0
	Recharge	3,763	6,457	4,049	1,826	16,095	0	0	0	0	0
	Stream Losses	919	1,147	757	420	3,243	10	58	24	4	96
Outflows	To Storage	869	2,447	408	103	3,828	4	-36	75	4	47
	Groundwater Outflow	0	0	0	0	0	0	0	0	0	0
	Well Discharge	1,038	1,265	1,063	1,136	4,503	150	706	150	0	1,006
	Springs	1,106	1,324	1,200	1,045	4,674	-1	0	-1	-1	-3
	River Gains	1,059	1,253	1,110	942	4,365	0	0	0	0	0
	Evapotranspiration	327	385	673	406	1,791	0	0	0	0	0
	Head-Dep Bdy Outflow	334	342	329	304	1,309	0	0	0	0	0
	Recharge	--	--	--	--	--	--	--	--	--	--
	Stream Gains	1,741	1,690	1,777	1,696	6,904	-146	-527	-209	-19	-902
Summary	Enhanced Aquifer Recharge						-150	-706	-150	0	-1,006
	Change in Groundwater Storage						6	-117	83	24	-3
	Change in Surface Water Baseflow						-156	-585	-233	-24	-997
	Change in Springs and ET discharge						-1	-1	-1	-1	-3

Table 1C-A21: Summary of results from Bean Creek Wellfield Test scenario. All seasonal quantities are in acre-feet per

		Simulation Results (acre-feet)					Relative to Base Case (acre-feet)				
		Fall	Winter	Spring	Summer	Total	Fall	Winter	Spring	Summer	Total
Inflows	From Storage	536	32	623	2,171	3,362	1	0	1	8	9
	Groundwater Inflow	423	413	420	429	1,685	0	0	0	0	0
	Directed Recharge	21	21	21	21	85	0	0	0	0	0
	Springs	--	--	--	--	--	--	--	--	--	--
	River Losses	151	129	163	188	632	0	0	0	0	0
	Evapotranspiration	--	--	--	--	--	--	--	--	--	--
	Head-Dep Bdy Inflow	188	180	183	190	740	-1	-1	-1	-1	-3
	Recharge	3,763	6,457	4,048	1,826	16,094	0	0	0	0	0
	Stream Losses	907	1,106	735	422	3,170	2	11	6	0	19
Outflows	To Storage	794	2,462	347	75	3,678	3	42	17	3	64
	Groundwater Outflow	0	0	0	0	0	0	0	0	0	0
	Well Discharge	554	433	588	763	2,338	0	0	0	0	0
	Springs	1,109	1,328	1,201	1,044	4,682	1	1	1	1	5
	River Gains	1,058	1,255	1,114	947	4,373	0	0	0	0	1
	Evapotranspiration	325	386	678	412	1,801	1	1	2	2	6
	Head-Dep Bdy Outflow	334	345	343	331	1,353	1	1	1	2	6
	Recharge	--	--	--	--	--	--	--	--	--	--
	Stream Gains	1,816	2,126	1,923	1,677	7,542	-6	-37	-15	-2	-59
Summary	Enhanced Aquifer Recharge						0	0	0	0	0
	Change in Groundwater Storage						4	44	18	-3	64
	Change in Surface Water Baseflow						-8	-47	-20	-1	-77
	Change in Springs and ET discharge						2	2	3	3	11

Attachment B: Seasonal Variations in the Hydrologic Budget Relative to the Base Case Scenario

2 Summary of Results from All Scenarios

Table 1C-B1: Summary of results from all scenarios. All quantities are fluxes in acre-feet per year.

	Scenario	Base Case	Surface Recharge				Lompico Injection				Disp. Surface		In-Lieu Recharge			Sensitivity Analysis					Bean Creek		
			SHQ	NHQ	MHR	SV	SHQ	NHQ	MHR	SV	SL	SV	SL	SVB	SVL	250	500	750	1,250	1,500	Horiz	Wellfield	base21
Inflows	From Storage	4,875	5,076	5,059	5,016	4,895	4,921	4,928	4,902	4,886	5,025	4,937	4,766	4,522	4,610	4,884	4,977	4,879	4,905	4,949	4,926	3,362	3,353
	Groundwater Inflow	1,684	1,684	1,684	1,684	1,684	1,684	1,684	1,684	1,684	1,639	1,684	1,684	1,684	1,684	1,684	1,684	1,684	1,684	1,684	1,684	1,685	1,685
	Directed Recharge	85	1,085	1,085	1,085	168	1,085	1,085	1,085	1,085	1,075	915	85	85	85	585	1,585	335	835	1,335	85	85	85
	Springs	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	River Losses	627	626	626	626	627	624	621	623	623	626	626	625	623	624	625	623	626	625	623	627	632	632
	Evapotranspiration	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Head-Dep Bdy Inflow	708	707	707	705	708	703	697	692	678	707	705	705	644	694	706	701	707	705	702	708	740	743
	Recharge	16,095	16,095	16,095	16,095	16,095	16,095	16,095	16,095	16,095	16,095	16,095	16,095	16,095	16,095	16,095	16,095	16,095	16,095	16,095	16,095	16,094	16,094
	Stream Losses	3,147	3,139	3,142	3,127	3,125	3,135	3,133	3,122	3,112	3,133	3,097	3,143	3,095	3,129	3,142	3,132	3,144	3,141	3,136	3,243	3,170	3,151
Outflows	To Storage	3,781	4,106	4,017	4,220	3,808	4,288	4,377	4,356	4,338	4,053	4,044	3,862	3,691	3,819	4,004	4,583	3,877	4,151	4,432	3,828	3,678	3,614
	Groundwater Outflow	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	Well Discharge	3,496	3,508	3,506	3,518	3,498	3,506	3,513	3,516	3,516	3,508	3,522	3,078	2,607	2,957	3,506	3,512	3,506	3,506	3,512	4,503	2,338	2,338
	Springs	4,677	5,159	5,069	4,766	4,680	4,857	4,782	4,749	4,725	4,924	4,769	4,750	4,683	4,711	4,777	4,931	4,729	4,818	4,896	4,674	4,682	4,677
	River Gains	4,365	4,367	4,365	4,366	4,365	4,376	4,376	4,372	4,370	4,376	4,365	4,370	4,366	4,368	4,370	4,381	4,367	4,373	4,379	4,365	4,373	4,373
	Evapotranspiration	1,791	1,800	1,797	1,966	1,791	1,895	1,873	1,840	1,839	1,884	1,812	1,855	1,841	1,819	1,833	1,967	1,815	1,862	1,930	1,791	1,801	1,795
	Head-Dep Bdy Outflow	1,309	1,310	1,310	1,316	1,309	1,319	1,332	1,343	1,372	1,310	1,315	1,314	1,610	1,338	1,314	1,323	1,311	1,316	1,321	1,309	1,353	1,347
	Recharge	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Stream Gains	7,806	8,173	8,350	8,200	7,855	8,042	8,004	8,037	8,010	8,253	8,253	7,896	7,955	7,918	7,920	8,108	7,868	8,097	8,065	6,904	7,542	7,601
	Change in Storage	-1,095	-970	-1,042	-796	-1,087	-633	-551	-546	-548	-971	-893	-904	-831	-792	-879	-394	-1,002	-755	-517	-1,098	316	261

3 Difference between each scenario and base case

Table 1C-B2: Summary of difference from base case for all recharge scenarios. All quantities are fluxes in acre-feet per year, less the flux in the base case (see Table 2).

	Scenario	Surface Recharge				Lompico Injection				Disp. Surface		In-Lieu Recharge			Sensitivity Analysis					Bean Creek	
		SHQ	NHQ	MHR	SV	SHQ	NHQ	MHR	SV	SL	SV	SL	SVB	SVL	250	500	750	1,250	1,500	Horiz	Wellfield
Inflows	From Storage	201	184	140	1,542	46	52	26	11	149	62	-109	-353	-265	4	8	30	74	102	50	9
	Groundwater Inflow	-1	0	0	-1	0	0	0	0	-45	0	0	0	0	0	0	0	0	0	0	0
	Directed Recharge	1,000	1,000	1,000	83	1,000	1,000	1,000	1,000	990	830	0	0	0	250	500	750	1,250	1,500	0	0
	Springs	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	River Losses	0	0	-1	-6	-3	-5	-4	-4	0	0	-2	-4	-2	-1	-1	-2	-3	-4	0	0
	Evapotranspiration	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Head-Dep Bdy Inflow	-1	0	-3	-35	-4	-11	-16	-29	-1	-3	-2	-64	-14	-1	-2	-3	-5	-6	0	-3
	Recharge	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Stream Losses	-8	-6	-20	-26	-13	-14	-25	-36	-14	-50	-4	-52	-19	-3	-6	-7	-12	-15	96	19
Outflows	To Storage	325	236	439	194	507	596	575	557	272	263	81	-90	38	96	224	370	651	802	47	64
	Groundwater Outflow	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
	Well Discharge	11	10	22	1,160	10	17	19	20	11	26	-418	-890	-539	9	10	10	16	16	1,006	0
	Springs	482	392	89	3	180	105	71	48	247	92	72	6	33	52	99	141	219	254	-3	5
	River Gains	3	0	1	-8	11	12	7	5	11	1	6	1	4	3	6	9	14	17	0	1
	Evapotranspiration	9	6	175	-4	104	82	49	48	93	21	64	50	28	24	42	71	139	176	0	6
	Head-Dep Bdy Outflow	1	1	7	-38	10	23	34	63	1	6	5	301	29	2	5	7	12	14	0	6
	Recharge	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Stream Gains	367	544	394	255	236	198	231	204	447	447	90	148	112	62	113	291	259	302	-902	-59
	Change in Storage	124	53	298	-1,348	462	544	549	546	123	201	190	263	303	92	215	340	577	701	-3	55

Summary of Fall Results from All Scenarios

Table 1C-B3: Summary of fall results from all scenarios. All quantities are fluxes in acre-feet per quarter.

	Scenario	Base	Surface Recharge				Lompico Injection				Disp. Surface		In-Lieu Recharge			Sensitivity Analysis					Bean Creek		
		Case	SHQ	NHQ	MHR	SV	SHQ	NHQ	MHR	SV	SL	SV	SL	SVB	SVL	250	500	750	1,250	1,500	Horiz	Wellfield	base21
Inflows	From Storage	1,023	1,016	1,013	996	1,025	972	975	973	961	997	993	1,001	956	924	994	954	1,008	984	963	1,021	536	536
	Groundwater Inflow	423	423	423	423	423	423	423	423	423	414	423	423	423	423	423	423	423	423	423	423	423	423
	Directed Recharge	21	271	271	271	42	271	271	271	271	269	229	21	21	21	146	396	84	209	334	21	21	21
	Springs	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	River Losses	149	149	149	149	149	149	148	148	148	149	149	149	148	149	149	148	149	149	148	149	151	152
	Evapotranspiration	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Head-Dep Bdy Inflow	178	178	178	178	178	177	176	175	171	178	178	178	162	175	178	177	178	178	177	178	188	188
	Recharge	3,763	3,763	3,763	3,763	3,763	3,763	3,763	3,763	3,763	3,763	3,763	3,763	3,763	3,763	3,763	3,763	3,763	3,763	3,763	3,763	3,763	3,763
	Stream Losses	909	907	907	903	903	905	903	900	892	905	894	907	887	902	907	903	907	906	904	919	907	905
Outflows	To Storage	865	910	916	937	869	942	962	958	944	899	903	888	863	875	898	993	878	919	966	869	794	791
	Groundwater Outflow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Well Discharge	888	890	889	892	888	889	891	892	892	890	893	792	662	722	889	891	889	889	891	1,038	554	554
	Springs	1,107	1,215	1,185	1,128	1,107	1,150	1,132	1,124	1,117	1,163	1,127	1,124	1,108	1,115	1,130	1,167	1,119	1,140	1,159	1,106	1,109	1,108
	River Gains	1,059	1,059	1,059	1,059	1,059	1,062	1,062	1,060	1,060	1,062	1,059	1,060	1,059	1,060	1,060	1,063	1,059	1,061	1,062	1,059	1,058	1,057
	Evapotranspiration	327	329	328	352	327	345	342	336	336	340	330	339	336	332	334	356	331	339	350	327	325	324
	Head-Dep Bdy Outflow	334	334	334	336	334	336	339	342	349	334	336	335	410	341	335	337	335	336	337	334	334	333
	Recharge	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Stream Gains	1,887	1,972	1,995	1,980	1,899	1,938	1,934	1,942	1,934	1,987	1,982	1,905	1,924	1,914	1,915	1,959	1,902	1,928	1,948	1,741	1,816	1,821
	Change in Storage	-158	-106	-97	-59	-155	-30	-14	-15	-17	-97	-90	-113	-93	-49	-96	39	-130	-64	4	-152	258	255

Fall Difference between each scenario and base case

Table 1C-B4: Summary of fall difference from base case for all recharge scenarios. All quantities are fluxes in acre-feet per quarter, less the flux in the base case (see Table 1C-B).

	Scenario	Surface Recharge				Lompico Injection				Disp. Surface		In-Lieu Recharge			Sensitivity Analysis					Bean Creek	
		SHQ	NHQ	MHR	SV	SHQ	NHQ	MHR	SV	SL	SV	SL	SVB	SVL	250	500	750	1,250	1,500	Horiz	Wellfield
Inflows	From Storage	-7	-10	-27	489	-50	-47	-50	-62	-26	-30	-22	-67	-98	-15	-28	-39	-60	-69	-2	1
	Groundwater Inflow	0	0	0	0	0	0	0	0	-10	0	0	0	0	0	0	0	0	0	0	0
	Directed Recharge	250	250	250	21	250	250	250	250	248	208	0	0	0	63	125	188	313	375	0	0
	Springs	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	River Losses	0	0	0	-2	-1	-1	-1	-1	0	0	0	-1	-1	0	0	0	-1	-1	0	0
	Evapotranspiration	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Head-Dep Bdy Inflow	0	0	-1	-10	-1	-3	-4	-7	0	-1	-1	-16	-3	0	-1	-1	-1	-2	0	-1
	Recharge	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Stream Losses	-2	-1	-6	-2	-4	-6	-9	-16	-4	-15	-2	-21	-7	-1	-2	-3	-5	-5	10	2
Outflows	To Storage	46	51	72	78	77	97	93	79	34	38	23	-2	10	14	33	54	102	128	4	3
	Groundwater Outflow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Well Discharge	2	1	4	334	1	3	4	4	2	5	-96	-226	-166	1	1	1	3	3	150	0
	Springs	108	78	21	-1	43	25	17	10	56	20	17	1	8	12	23	33	52	60	-1	1
	River Gains	1	0	0	1	3	3	2	1	3	0	1	0	1	1	1	2	3	4	0	0
	Evapotranspiration	2	1	25	3	17	15	9	8	13	3	12	9	5	4	7	12	23	29	0	1
	Head-Dep Bdy Outflow	0	0	2	1	2	5	8	15	0	1	1	76	7	1	1	2	3	3	0	1
	Recharge	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Stream Gains	85	108	93	78	51	46	55	46	100	94	18	37	27	15	28	40	61	71	-146	-6
	Change in Storage	52	61	99	-411	128	144	143	141	61	68	45	65	108	28	61	94	161	197	6	2

Summary of winter Results from All Scenarios

Table 1C-B5: Summary of winter results from all scenarios. All quantities are fluxes in acre-feet per quarter.

	Scenario	Base Case	Surface Recharge				Lompico Injection				Disp. Surface		In-Lieu Recharge			Sensitivity Analysis					Bean Creek		
			SHQ	NHQ	MHR	SV	SHQ	NHQ	MHR	SV	SL	SV	SL	SVB	SVL	250	500	750	1,250	1,500	Horiz	Wellfield	base21
Inflows	From Storage	287	276	282	266	287	246	244	241	247	274	267	279	272	254	260	237	272	252	241	368	32	32
	Groundwater Inflow	412	412	412	412	412	412	412	412	412	398	412	412	412	412	412	412	412	412	412	412	413	413
	Directed Recharge	21	521	521	521	63	521	521	521	521	516	436	21	21	21	271	771	146	396	646	21	21	21
	Springs	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	River Losses	128	127	128	127	128	127	126	127	127	127	127	127	127	127	127	127	127	127	127	128	129	129
	Evapotranspiration	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Head-Dep Bdy Inflow	171	171	171	170	171	170	168	167	164	171	170	170	155	168	171	169	171	170	170	171	180	181
	Recharge	6,457	6,457	6,457	6,457	6,457	6,457	6,457	6,457	6,457	6,457	6,457	6,457	6,457	6,457	6,457	6,457	6,457	6,457	6,457	6,457	6,457	6,457
	Stream Losses	1,090	1,083	1,088	1,083	1,086	1,084	1,086	1,080	1,082	1,073	1,078	1,088	1,073	1,083	1,087	1,082	1,088	1,087	1,084	1,147	1,106	1,095
Outflows	To Storage	2,484	2,744	2,665	2,786	2,504	2,805	2,829	2,818	2,820	2,714	2,682	2,488	2,379	2,482	2,632	2,979	2,551	2,724	2,892	2,447	2,462	2,421
	Groundwater Outflow	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	Well Discharge	559	564	564	567	559	564	565	566	566	564	568	492	494	466	563	565	563	564	565	1,265	433	433
	Springs	1,325	1,450	1,448	1,348	1,326	1,371	1,352	1,343	1,339	1,392	1,351	1,344	1,326	1,334	1,351	1,391	1,338	1,361	1,382	1,324	1,328	1,327
	River Gains	1,253	1,254	1,253	1,253	1,253	1,256	1,256	1,255	1,255	1,256	1,253	1,255	1,254	1,254	1,255	1,257	1,254	1,255	1,257	1,253	1,255	1,255
	Evapotranspiration	385	383	386	417	385	407	402	396	395	402	389	397	394	391	393	423	390	400	414	385	386	384
	Head-Dep Bdy Outflow	342	342	342	343	342	344	347	350	356	342	343	343	411	349	343	345	342	344	344	342	345	343
	Recharge	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Stream Gains	2,217	2,311	2,410	2,324	2,232	2,290	2,271	2,277	2,278	2,345	2,363	2,251	2,258	2,248	2,247	2,295	2,234	2,383	2,285	1,690	2,126	2,163
	Change in Storage	2,196	2,468	2,383	2,520	2,217	2,559	2,585	2,577	2,573	2,440	2,416	2,209	2,108	2,227	2,372	2,741	2,279	2,473	2,651	2,080	2,430	2,388

Winter Difference between each scenario and base case

Table 1C-B6: Summary of winter difference from base case for all recharge scenarios. All quantities are fluxes in acre-feet per quarter, less the flux in the base case (see Table 1C-B).

	Scenario	Surface Recharge				Lompico Injection				Disp. Surface		In-Lieu Recharge			Sensitivity Analysis					Bean Creek	
		SHQ	NHQ	MHR	SV	SHQ	NHQ	MHR	SV	SL	SV	SL	SVB	SVL	250	500	750	1,250	1,500	Horiz	Wellfield
Inflows	From Storage	-11	-5	-21	255	-41	-43	-46	-40	-13	-20	-9	-16	-33	-15	-27	-35	-46	-50	80	0
	Groundwater Inflow	0	0	0	0	0	0	0	0	-14	0	0	0	0	0	0	0	0	0	0	0
	Directed Recharge	500	500	500	42	500	500	500	500	495	415	0	0	0	125	250	375	625	750	0	0
	Springs	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	River Losses	0	0	0	-2	-1	-1	-1	-1	0	0	0	-1	-1	0	0	0	-1	-1	0	0
	Evapotranspiration	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Head-Dep Bdy Inflow	0	0	-1	-10	-1	-3	-4	-7	0	-1	-1	-16	-3	0	-1	-1	-1	-2	0	-1
	Recharge	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Stream Losses	-7	-2	-7	-9	-6	-4	-10	-8	-16	-12	-2	-17	-7	-1	-2	-2	-6	-8	58	11
Outflows	To Storage	260	181	303	83	321	345	334	337	231	199	4	-104	-2	67	148	241	408	495	-36	42
	Groundwater Outflow	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
	Well Discharge	5	5	8	127	5	7	7	8	5	9	-66	-65	-92	5	5	5	7	7	706	0
	Springs	125	123	23	-1	47	28	19	14	67	26	19	2	9	13	26	37	57	66	0	1
	River Gains	1	0	0	-2	3	3	2	1	3	0	1	0	1	1	1	2	4	4	0	0
	Evapotranspiration	-2	1	32	0	22	17	11	11	18	4	13	9	6	5	8	15	30	38	0	1
	Head-Dep Bdy Outflow	0	0	1	-1	2	5	8	14	0	1	1	69	7	1	1	2	3	3	0	1
	Recharge	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Stream Gains	94	193	107	69	73	54	60	61	128	145	34	41	31	17	30	166	67	78	-527	-37
	Change in Storage	271	187	324	-171	363	388	380	377	244	219	13	-89	31	83	176	276	454	545	-117	42

Summary of Spring Results from All Scenarios

Table 1C-B7: Summary of spring results from all scenarios. All quantities are fluxes in acre-feet per quarter.

	Scenario	Base Case	Surface Recharge				Lompico Injection				Disp. Surface		In-Lieu Recharge			Sensitivity Analysis					Bean Creek		
			SHQ	NHQ	MHR	SV	SHQ	NHQ	MHR	SV	SL	SV	SL	SVB	SVL	250	500	750	1,250	1,500	Horiz	Wellfield	base21
Inflows	From Storage	982	984	1,013	984	984	963	972	962	962	981	968	959	852	950	967	966	975	968	965	975	623	622
	Groundwater Inflow	420	419	420	420	420	420	420	420	420	407	420	420	420	420	420	420	420	420	420	420	420	420
	Directed Recharge	21	271	271	271	42	271	271	271	271	269	229	21	21	21	146	396	84	209	334	21	21	21
	Springs	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	River Losses	162	162	162	162	162	162	161	161	161	162	162	162	161	162	162	161	162	162	161	162	163	163
	Evapotranspiration	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Head-Dep Bdy Inflow	175	175	175	174	175	174	172	171	168	175	174	175	159	172	175	174	175	174	174	175	183	184
	Recharge	4,049	4,049	4,049	4,049	4,049	4,049	4,049	4,049	4,049	4,049	4,049	4,049	4,049	4,049	4,049	4,049	4,049	4,049	4,049	4,049	4,048	4,048
	Stream Losses	733	733	731	729	728	731	729	726	722	737	721	732	718	728	732	731	732	732	731	757	735	729
Outflows	To Storage	333	351	337	390	336	419	447	446	443	339	354	368	349	346	365	473	344	391	444	408	347	330
	Groundwater Outflow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Well Discharge	913	916	915	918	914	915	917	918	918	916	919	789	607	805	915	917	915	915	917	1,063	588	588
	Springs	1,200	1,331	1,316	1,223	1,201	1,246	1,227	1,219	1,213	1,266	1,225	1,219	1,202	1,209	1,226	1,265	1,213	1,236	1,256	1,200	1,201	1,200
	River Gains	1,110	1,111	1,110	1,111	1,110	1,113	1,113	1,112	1,112	1,113	1,111	1,112	1,111	1,111	1,112	1,115	1,111	1,113	1,114	1,110	1,114	1,114
	Evapotranspiration	673	677	676	739	673	710	701	690	690	712	681	695	690	683	689	735	682	699	722	673	678	677
	Head-Dep Bdy Outflow	329	330	330	331	330	332	335	338	345	330	331	331	403	337	331	333	330	331	332	329	343	342
	Recharge	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Stream Gains	1,986	2,084	2,142	2,087	2,000	2,046	2,036	2,045	2,036	2,108	2,117	2,005	2,022	2,014	2,015	2,064	2,002	2,030	2,053	1,777	1,923	1,938
	Change in Storage	-650	-633	-677	-594	-648	-544	-525	-516	-519	-642	-613	-590	-503	-604	-602	-493	-630	-576	-521	-566	-277	-292

Spring Difference between each scenario and base case

Table 1C-B8: Summary of spring difference from base case for all recharge scenarios. All quantities are fluxes in acre-feet per quarter, less the flux in the base case (see Table 1C-B).

	Scenario	Surface Recharge				Lompico Injection				Disp. Surface		In-Lieu Recharge			Sensitivity Analysis					Bean Creek	
		SHQ	NHQ	MHR	SV	SHQ	NHQ	MHR	SV	SL	SV	SL	SVB	SVL	250	500	750	1,250	1,500	Horiz	Wellfield
Inflows	From Storage	2	31	1	362	-20	-10	-20	-20	-1	-15	-24	-130	-32	-8	-15	-15	-17	-17	-8	1
	Groundwater Inflow	0	0	0	0	0	0	0	0	-13	0	0	0	0	0	0	0	0	0	0	0
	Directed Recharge	250	250	250	21	250	250	250	250	248	208	0	0	0	63	125	188	313	375	0	0
	Springs	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	River Losses	0	0	0	-1	-1	-1	-1	-1	0	0	0	-1	-1	0	0	-1	-1	-1	0	0
	Evapotranspiration	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Head-Dep Bdy Inflow	0	0	-1	-9	-1	-3	-4	-7	0	-1	-1	-16	-3	0	-1	-1	-1	-2	0	-1
	Recharge	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Stream Losses	0	-2	-4	-1	-2	-4	-7	-11	4	-12	-1	-15	-5	-1	-1	-1	-2	-2	24	6
Outflows	To Storage	18	4	57	6	86	114	113	110	6	21	36	16	13	12	32	58	111	141	75	17
	Groundwater Outflow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Well Discharge	2	2	5	326	2	4	4	4	2	6	-124	-307	-108	2	2	2	3	3	150	0
	Springs	131	116	23	1	46	27	19	13	66	25	19	2	9	13	26	36	56	65	-1	1
	River Gains	1	0	0	-3	3	3	2	1	3	0	1	0	1	1	1	2	4	4	0	0
	Evapotranspiration	4	3	66	-3	37	28	16	16	38	8	21	17	9	9	15	25	49	62	0	2
	Head-Dep Bdy Outflow	0	0	2	-12	2	6	8	15	0	2	1	73	7	1	1	2	3	3	0	1
	Recharge	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Stream Gains	98	156	101	62	60	50	59	50	122	131	19	37	28	16	30	44	67	78	-209	-15
	Change in Storage	17	-27	56	-356	106	125	133	130	7	36	59	146	45	19	48	73	129	157	83	15

Summary of summer Results from All Scenarios

Table 1C-B9: Summary of summer results from all scenarios. All quantities are fluxes in acre-feet per quarter.

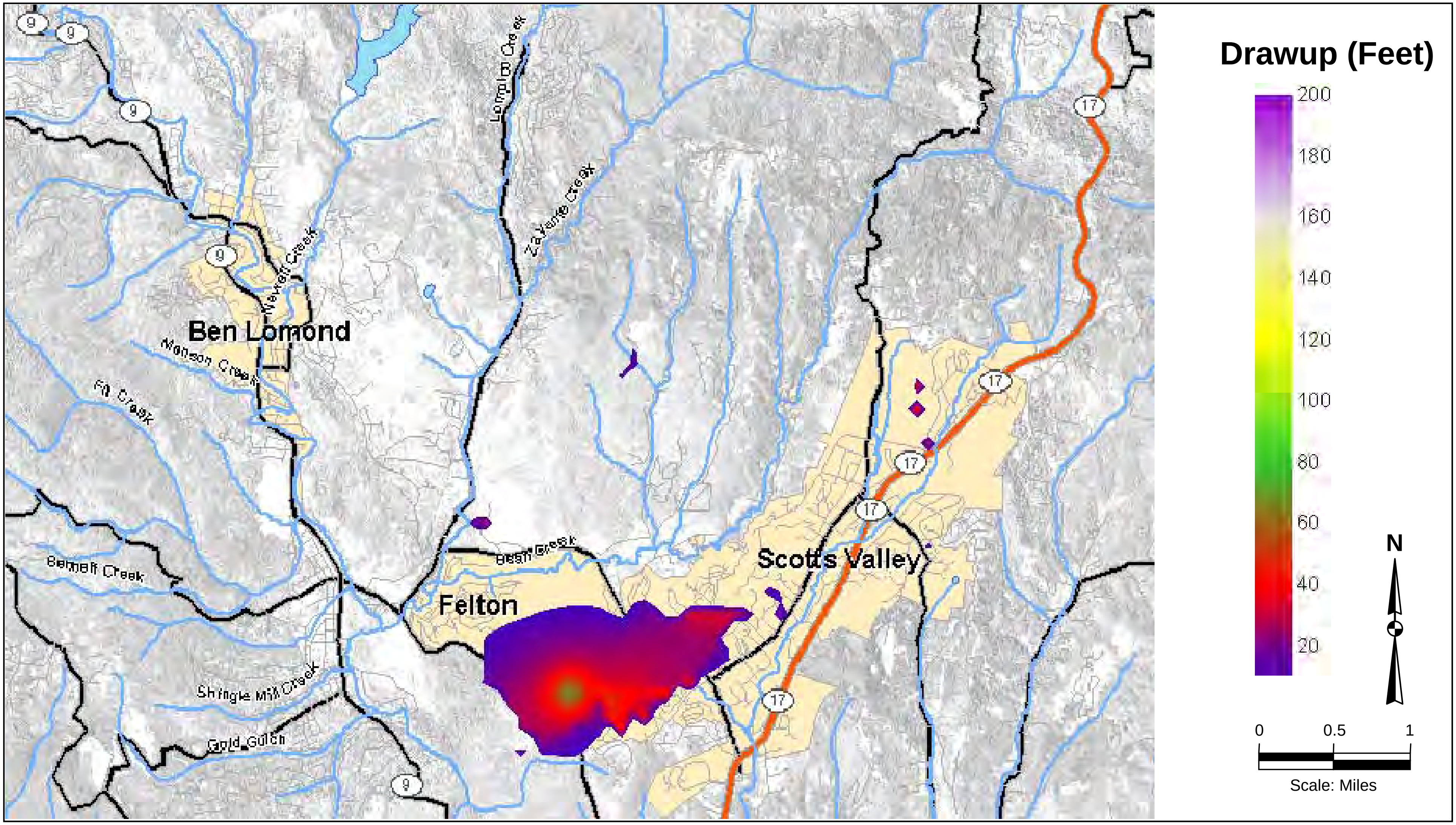
	Scenario	Base Case	Surface Recharge				Lompico Injection				Disp. Surface		In-Lieu Recharge			Sensitivity Analysis					Bean Creek		
			SHQ	NHQ	MHR	SV	SHQ	NHQ	MHR	SV	SL	SV	SL	SVB	SVL	250	500	750	1,250	1,500	Horiz	Wellfield	base21
Inflows	From Storage	2,583	2,800	2,751	2,770	2,600	2,740	2,736	2,725	2,715	2,773	2,709	2,528	2,442	2,482	2,662	2,820	2,625	2,702	2,780	2,563	2,171	2,163
	Groundwater Inflow	429	429	429	429	429	429	429	429	429	421	429	429	429	429	429	429	429	429	429	429	429	429
	Directed Recharge	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21
	Springs	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	River Losses	188	188	188	187	188	187	186	187	187	188	187	187	187	187	187	187	187	187	187	188	188	188
	Evapotranspiration	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Head-Dep Bdy Inflow	183	183	183	182	183	182	180	179	176	183	183	183	167	180	183	182	183	182	182	183	190	190
	Recharge	1,826	1,826	1,826	1,826	1,826	1,826	1,826	1,826	1,826	1,826	1,826	1,826	1,826	1,826	1,826	1,826	1,826	1,826	1,826	1,826	1,826	1,826
	Stream Losses	416	416	415	412	409	415	415	417	416	418	404	416	418	416	415	416	416	416	417	420	422	422
Outflows	To Storage	99	100	100	106	100	122	139	134	130	101	104	118	100	116	109	138	103	116	129	103	75	73
	Groundwater Outflow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Well Discharge	1,136	1,139	1,138	1,141	1,137	1,138	1,140	1,141	1,141	1,139	1,142	1,005	844	964	1,138	1,140	1,138	1,138	1,140	1,136	763	763
	Springs	1,046	1,163	1,120	1,067	1,046	1,090	1,071	1,063	1,057	1,103	1,065	1,063	1,047	1,054	1,070	1,108	1,058	1,080	1,099	1,045	1,044	1,042
	River Gains	942	943	942	943	942	945	945	944	944	945	942	944	943	943	944	946	943	944	946	942	947	946
	Evapotranspiration	406	411	407	459	406	434	428	418	418	429	411	424	422	413	417	453	412	425	443	406	412	410
	Head-Dep Bdy Outflow	304	304	304	306	304	306	310	314	322	304	305	305	386	312	305	308	304	306	307	304	331	329
	Recharge	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Stream Gains	1,716	1,806	1,803	1,809	1,724	1,768	1,762	1,773	1,762	1,812	1,792	1,734	1,750	1,742	1,742	1,790	1,730	1,756	1,780	1,696	1,677	1,679
	Change in Storage	-2,484	-2,699	-2,651	-2,664	-2,500	-2,618	-2,597	-2,591	-2,585	-2,672	-2,606	-2,410	-2,342	-2,365	-2,553	-2,682	-2,521	-2,587	-2,651	-2,459	-2,095	-2,090

Summer Difference between each scenario and base case

Table 1C-B10: Summary of summer difference from base case for all recharge scenarios. All quantities are fluxes in acre-feet per quarter, less the flux in the base case (see Table 1C-B).

	Scenario	Surface Recharge				Lompico Injection				Disp. Surface		In-Lieu Recharge			Sensitivity Analysis					Bean Creek	
		SHQ	NHQ	MHR	SV	SHQ	NHQ	MHR	SV	SL	SV	SL	SVB	SVL	250	500	750	1,250	1,500	Horiz	Wellfield
Inflows	From Storage	217	168	187	437	157	153	142	132	190	127	-55	-141	-101	42	79	119	197	237	-20	8
	Groundwater Inflow	0	0	0	0	0	0	0	0	-9	0	0	0	0	0	0	0	0	0	0	0
	Directed Recharge	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Springs	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	River Losses	0	0	0	-1	-1	-1	-1	-1	0	0	-1	-1	-1	0	0	-1	-1	-1	0	0
	Evapotranspiration	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Head-Dep Bdy Inflow	0	0	-1	-7	-1	-3	-4	-8	0	-1	-1	-17	-4	0	-1	-1	-1	-2	0	-1
	Recharge	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Stream Losses	0	-1	-4	-13	-1	-1	0	0	2	-12	0	2	0	0	-1	0	1	0	4	0
Outflows	To Storage	1	1	7	27	23	40	35	31	1	4	18	1	17	4	10	16	30	39	4	3
	Groundwater Outflow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Well Discharge	2	2	5	373	2	4	4	4	2	6	-132	-293	-173	2	2	2	3	3	0	0
	Springs	118	75	22	4	44	25	17	11	57	20	17	2	8	13	24	35	53	62	-1	1
	River Gains	1	0	0	-4	3	3	2	1	3	0	1	0	1	1	1	2	4	4	0	0
	Evapotranspiration	5	1	53	-4	28	23	12	13	23	6	18	16	7	7	11	19	38	47	0	2
	Head-Dep Bdy Outflow	0	0	2	-26	3	7	10	18	0	2	1	83	9	1	1	2	3	4	0	2
	Recharge	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Stream Gains	90	87	93	45	52	47	57	46	96	76	18	34	26	15	27	40	64	74	-19	-2
	Change in Storage	-216	-167	-180	-410	-134	-114	-107	-102	-189	-122	74	141	118	-38	-69	-103	-167	-198	24	-5

Attachment C: Maps Showing the Distribution of Groundwater Buildup for the Winter and Summer



Color scale runs from drawup values of 10 (blue-purple) to 200 (purple) feet.

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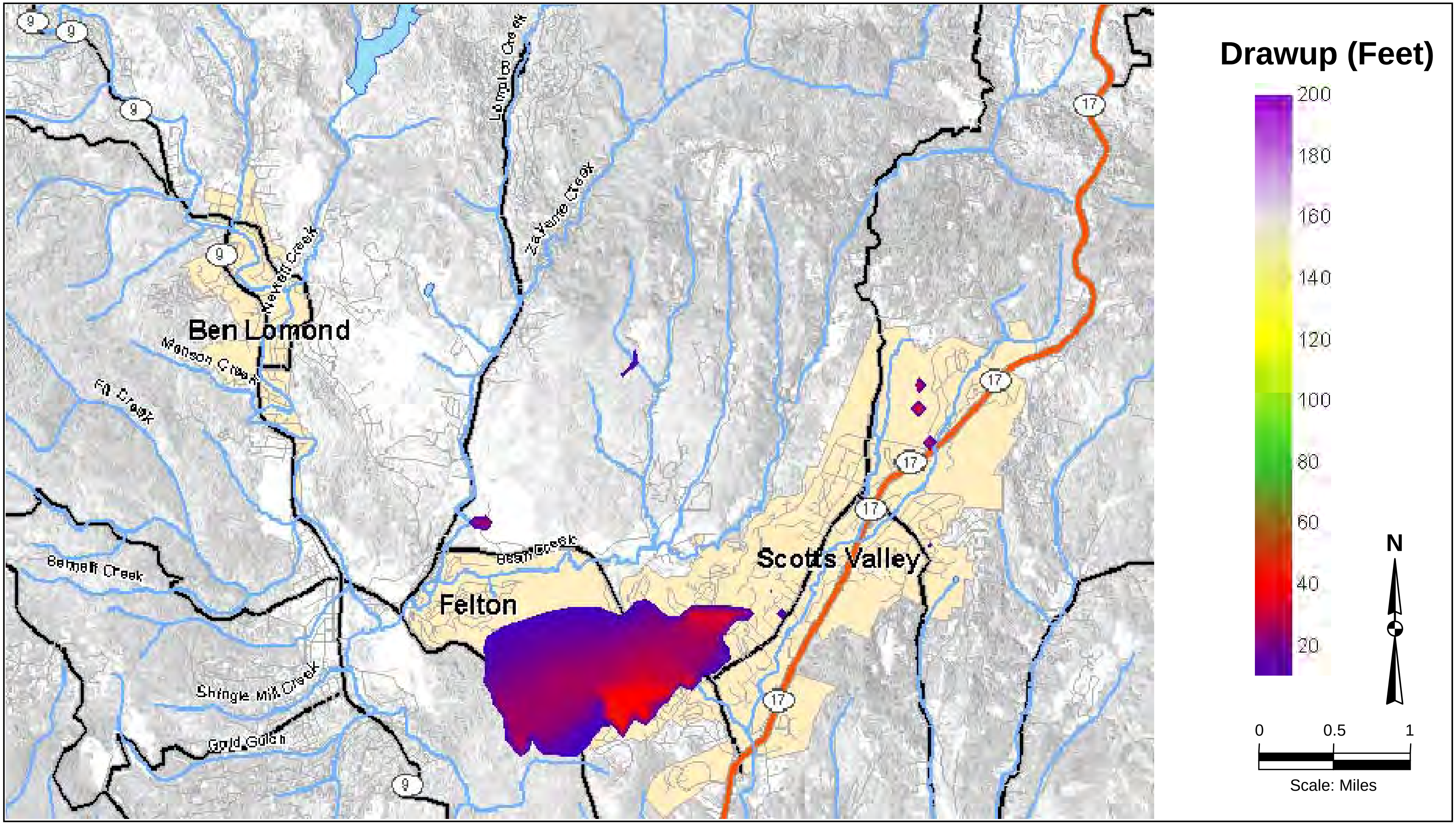
TM1C – Groundwater Model Evaluation
Conjunctive Use and Enhanced Aquifer Recharge Project
Santa Cruz County, California

Winter Drawup: Surface Recharge at South Hanson Quarry

K/J Project 0864005
November 2010
Figure 1C-C1



Color scale runs from drawup values of 10 (blue-purple) to 200 (purple) feet.

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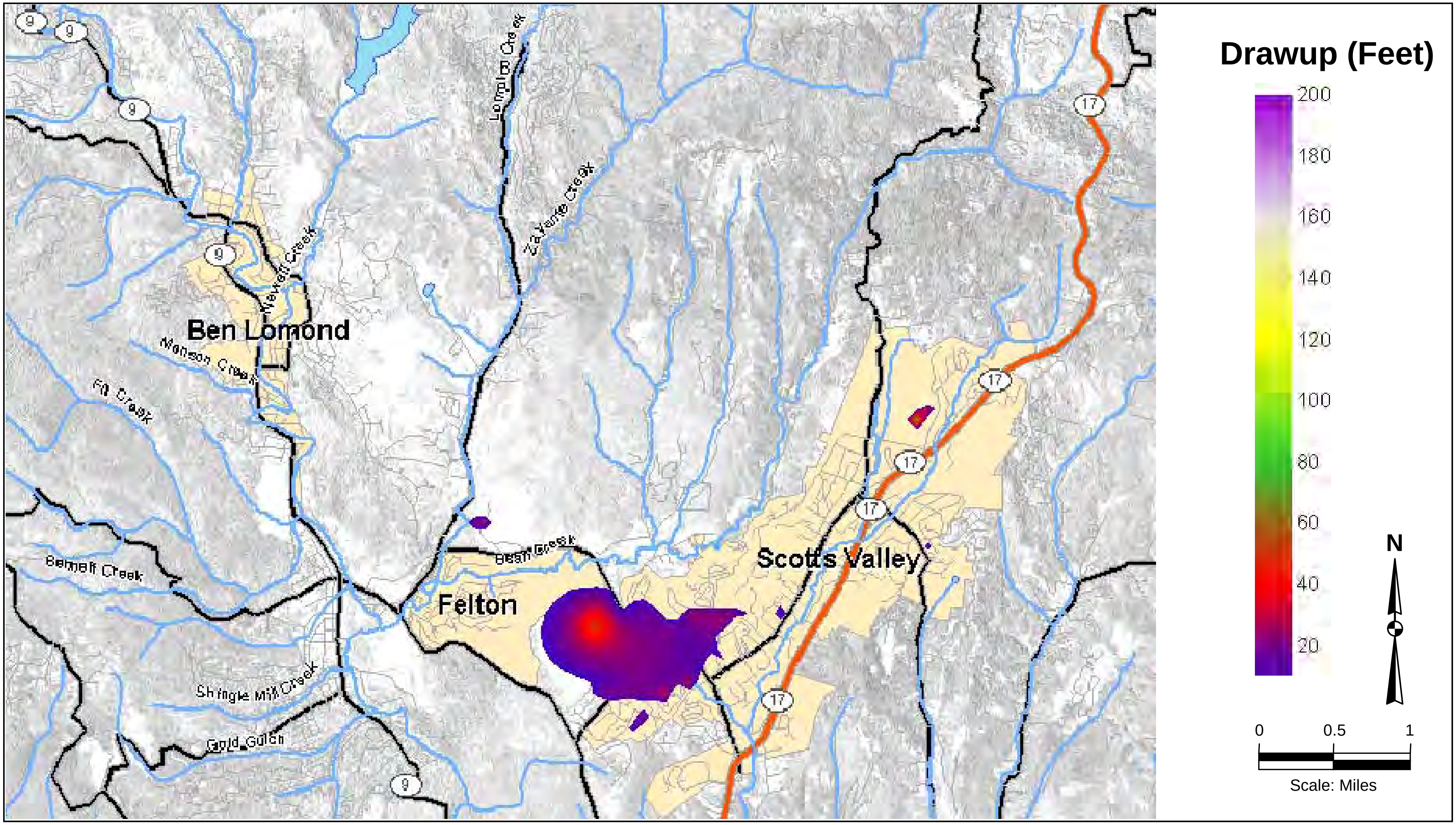
Summer Drawup: Surface Recharge at South Hanson Quarry

K/J Project 0864005
November 2010
Figure 1C-C2



Color scale runs from drawup values of 10 (blue-purple) to 200 (purple) feet.

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Winter Drawup: Surface Recharge at North Hanson Quarry

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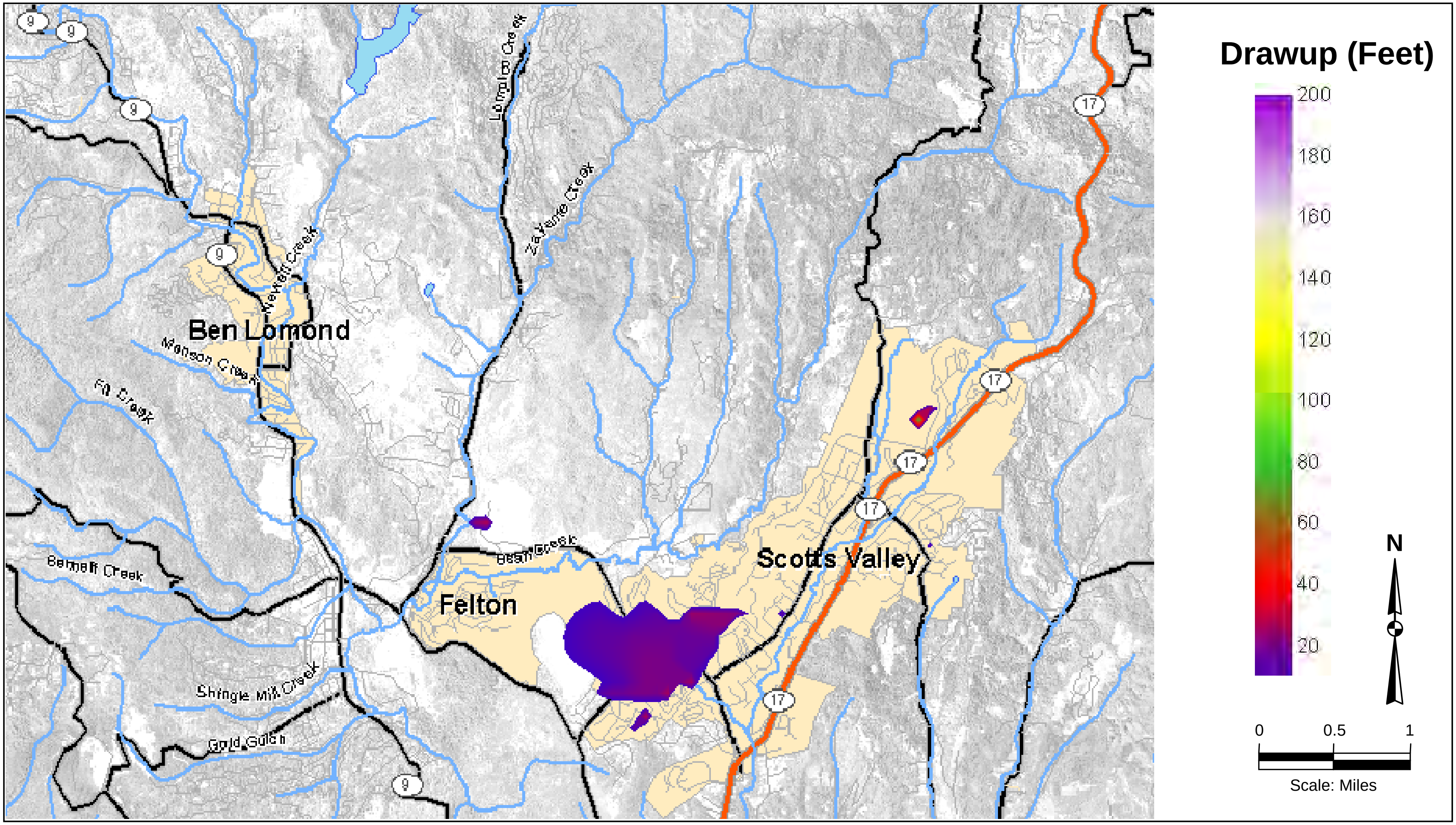
November 2010

Figure 1C-C3



Color scale runs from drawup values of 10 (blue-purple) to 200 (purple) feet.

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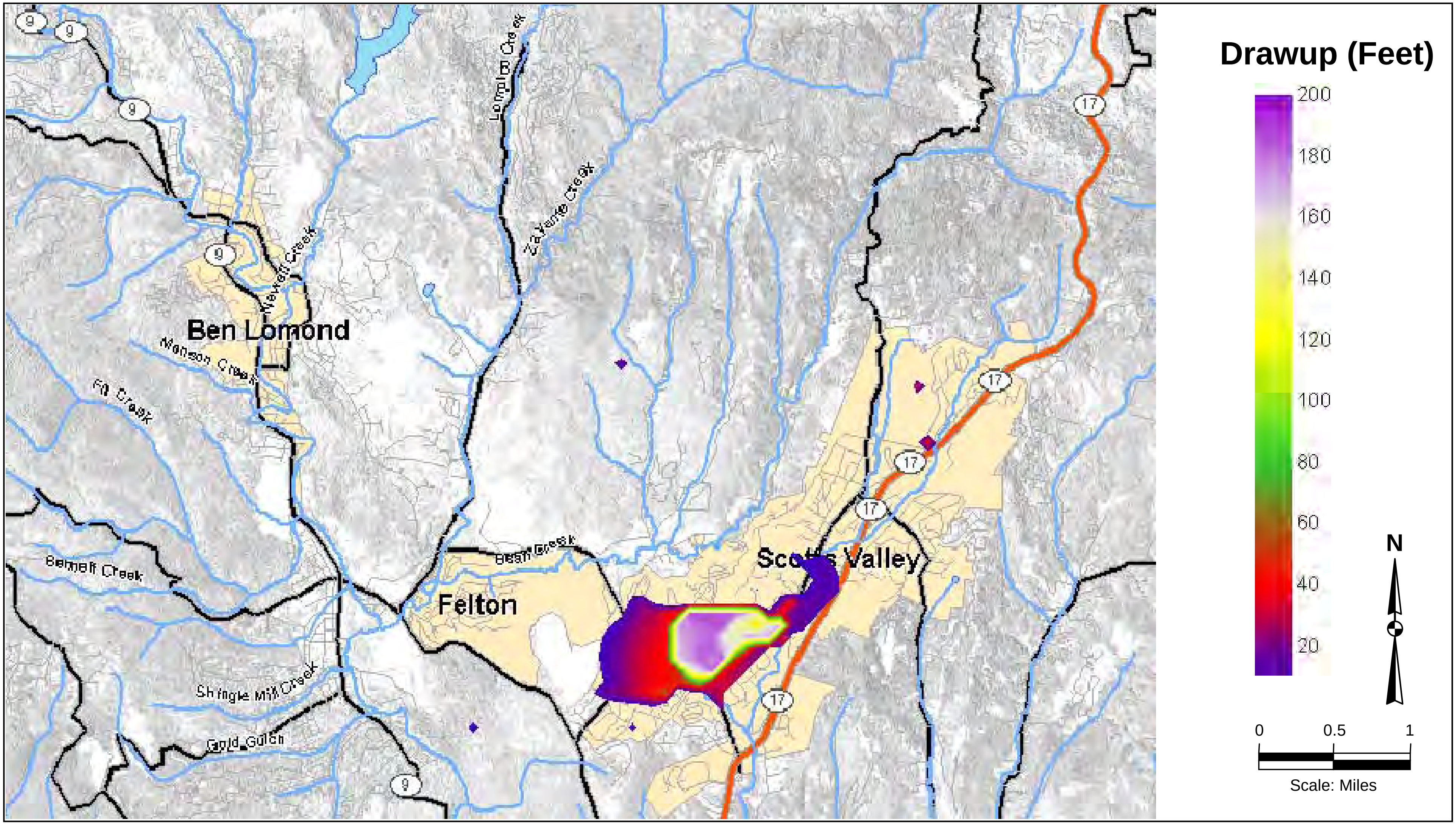
Santa Cruz County, California

Summer Drawup: Surface Recharge at North Hanson Quarry

K/J Project 0864005
November 2010

Figure 1C-C4



Color scale runs from drawup values of 10 (blue-purple) to 200 (purple) feet.

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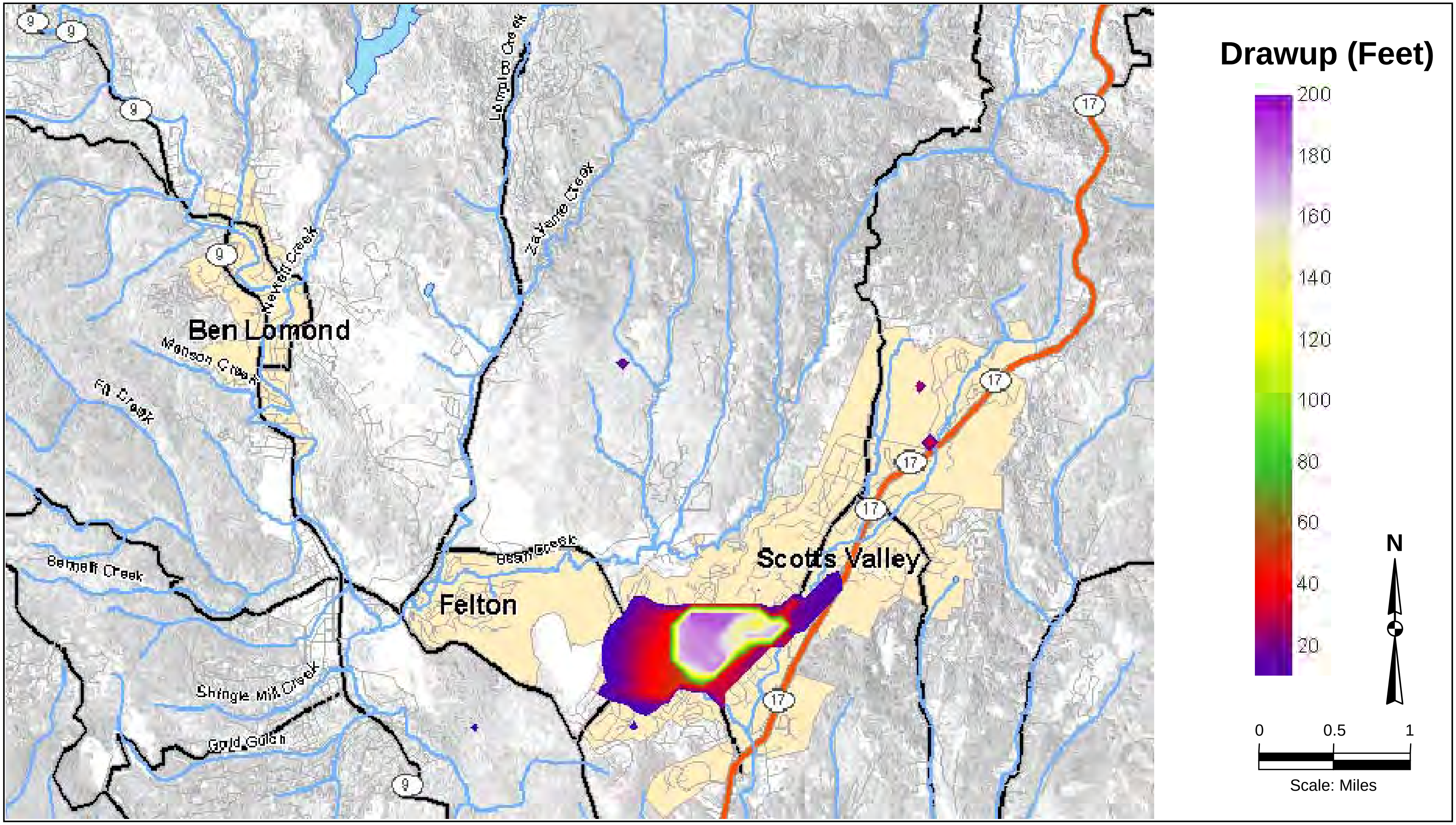
Santa Cruz County, California

Winter Drawup: Surface Recharge at Mount Hermon Road

K/J Project 0864005
November 2010
Figure 1C-C5



Color scale runs from drawup values of 10 (blue-purple) to 200 (purple) feet.

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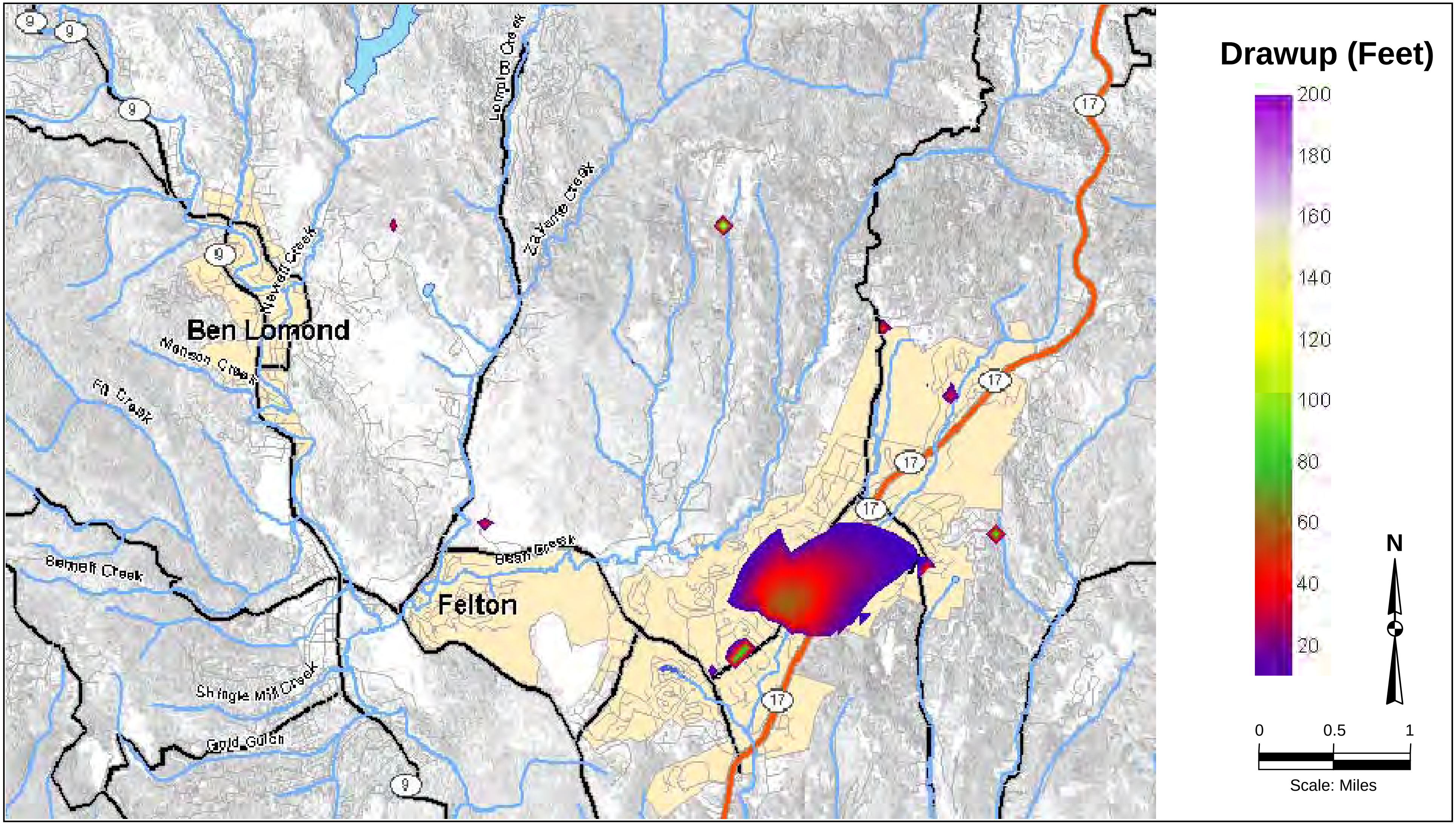
Santa Cruz County, California

Summer Drawup: Surface Recharge at Mount Hermon Road

K/J Project 0864005
November 2010
Figure 1C-C6



Color scale runs from drawup values of 10 (blue-purple) to 200 (purple) feet.

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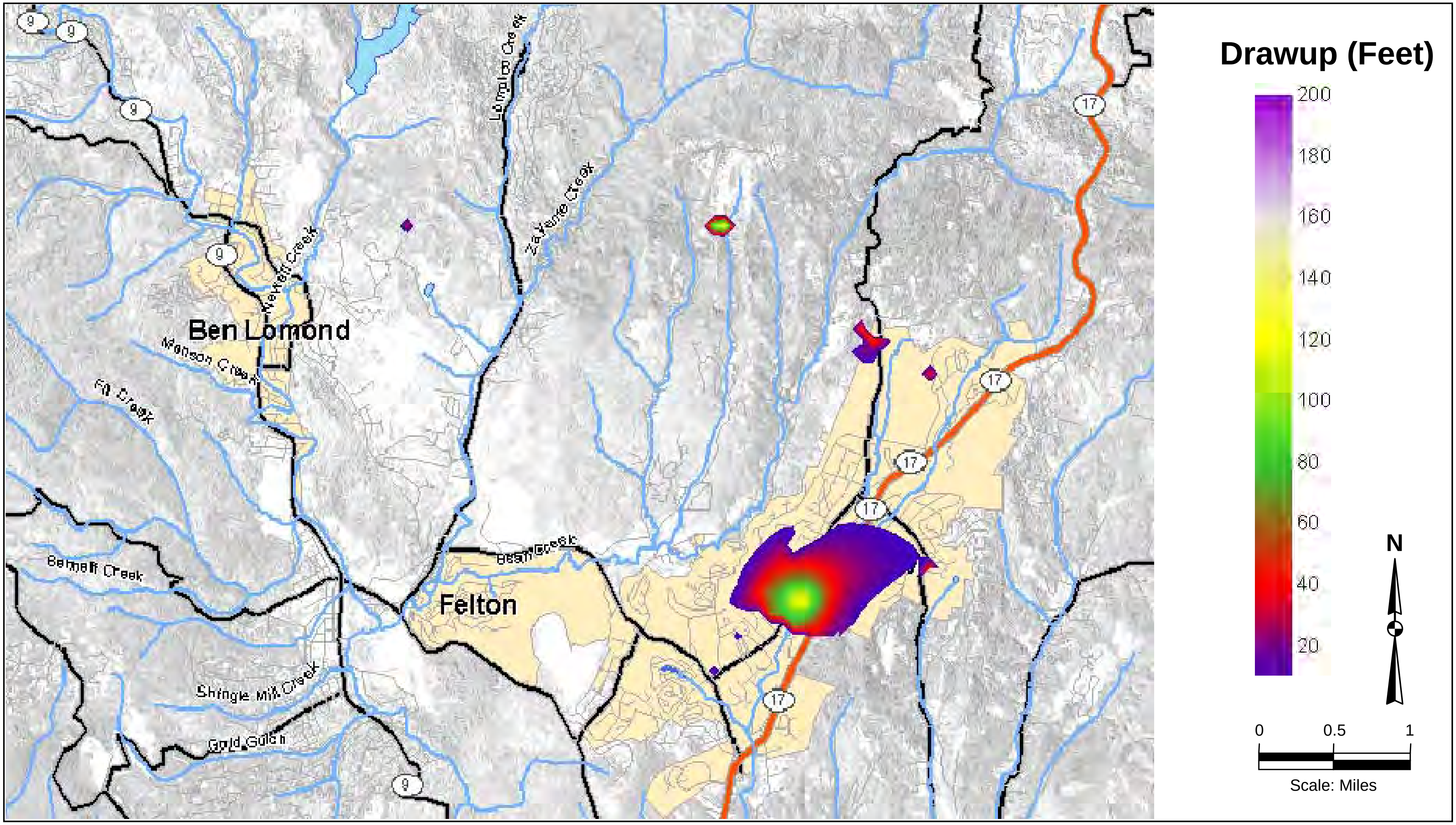
Santa Cruz County, California

Winter Drawup: Surface Recharge at Scotts Valley

K/J Project 0864005
November 2010

Figure 1C-C7



Color scale runs from drawup values of 10 (blue-purple) to 200 (purple) feet.

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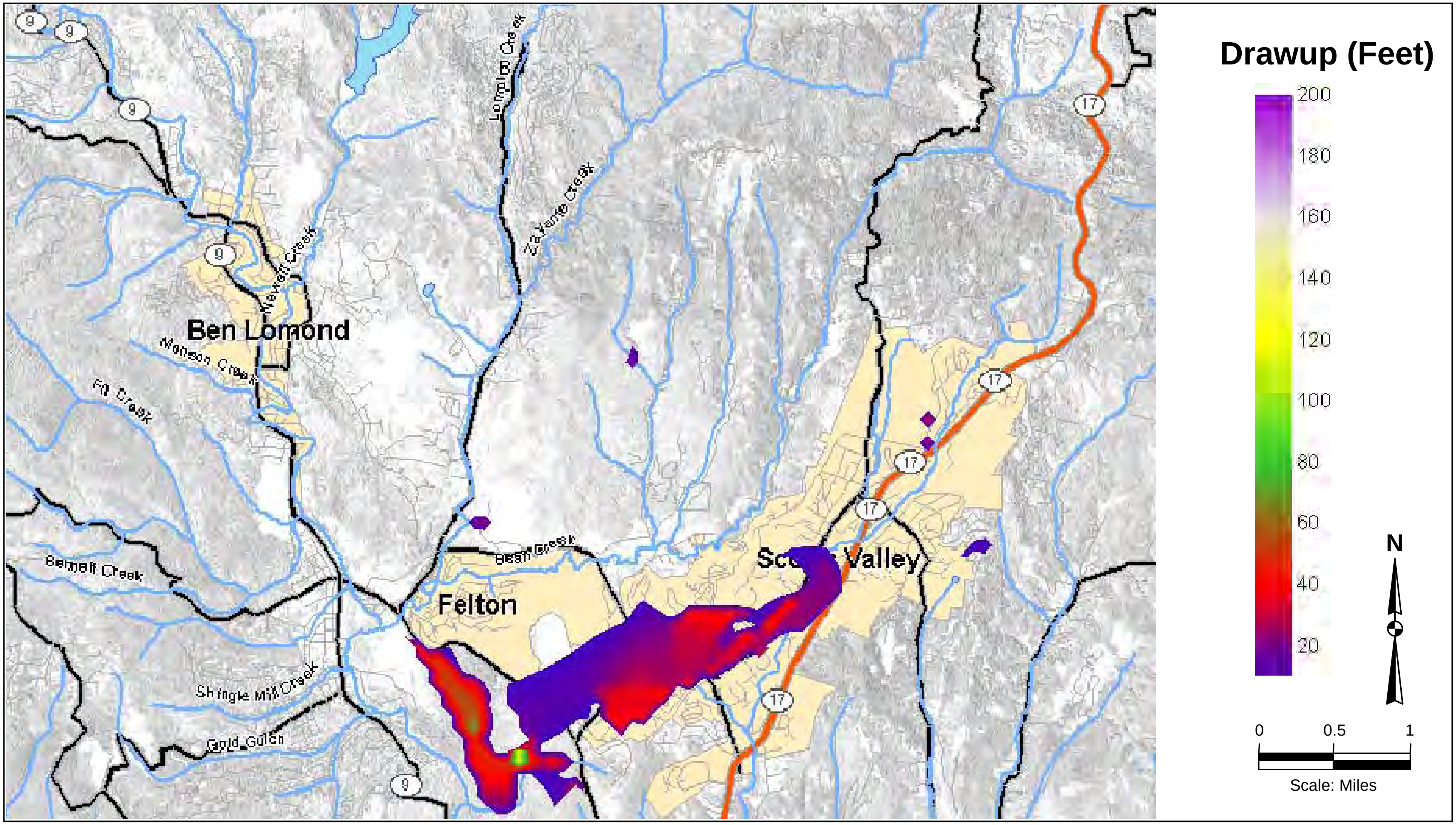
Conjunctive Use and Enhanced Aquifer Recharge Project
Santa Cruz County, California

Summer Drawup: Surface Recharge at Scotts Valley

K/J Project 0864005
November 2010

Figure 1C-C8



Color scale runs from drawup values of 10 (blue-purple) to 200 (purple) feet.

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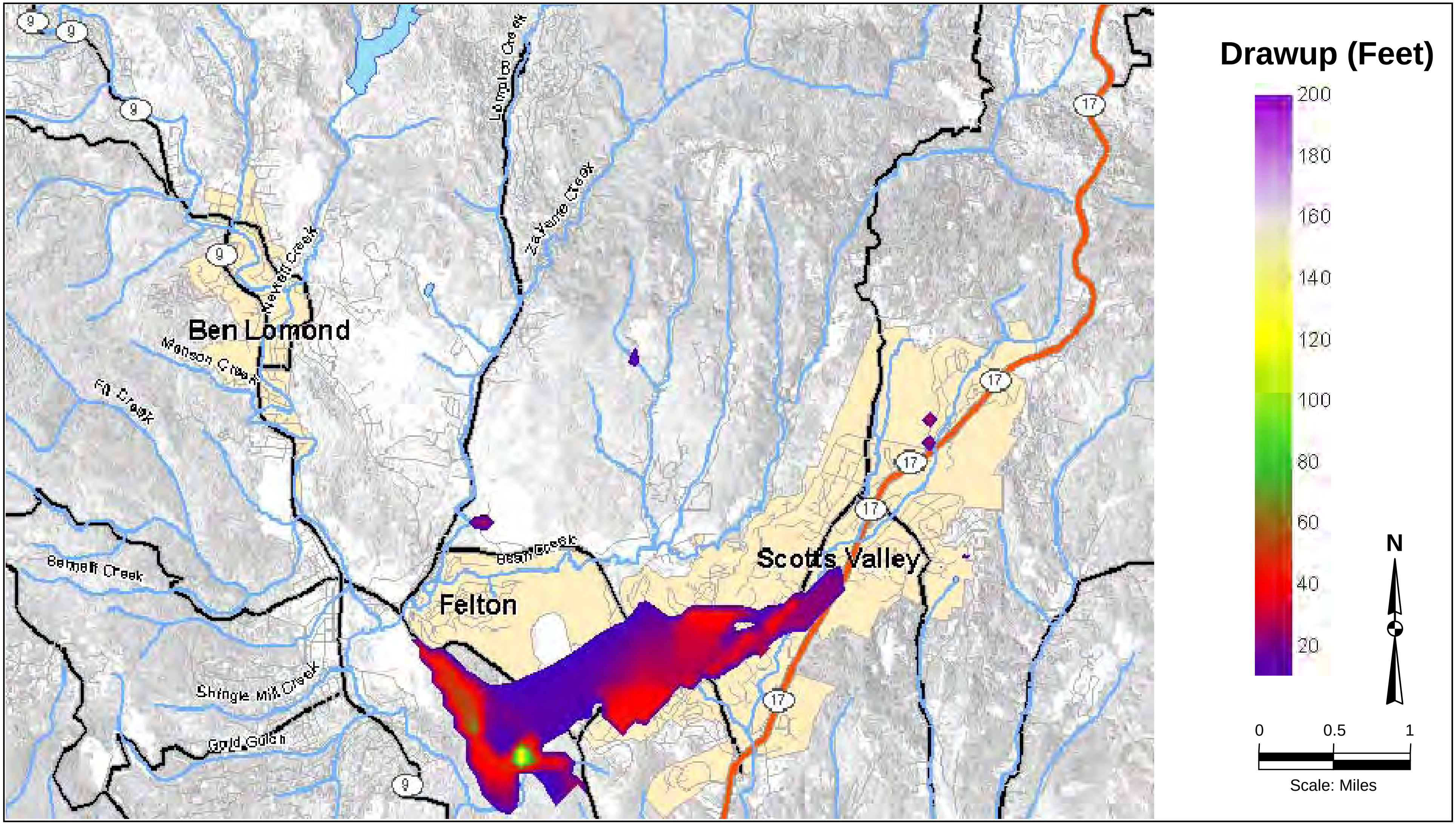
Santa Cruz County, California

Winter Drawup: Lompico Injection at South Hanson Quarry

K/J Project 0864005
November 2010
Figure 1C-C9



Color scale runs from drawup values of 10 (blue-purple) to 200 (purple) feet.

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Santa Cruz County, California

Summer Drawup: Lompico Injection at South Hanson Quarry

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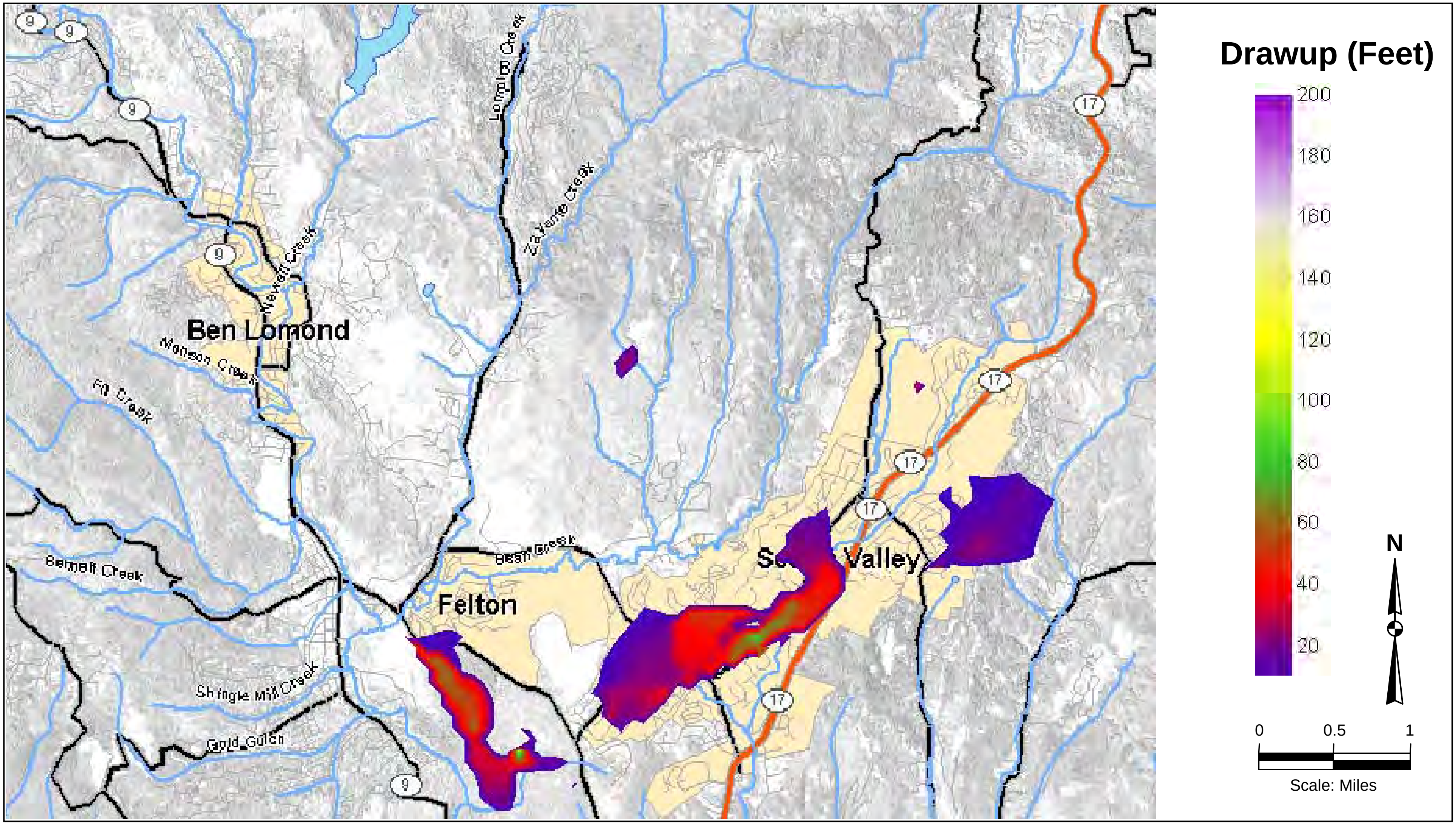
November 2010

Figure 1C-C10



Color scale runs from drawup values of 10 (blue-purple) to 200 (purple) feet.

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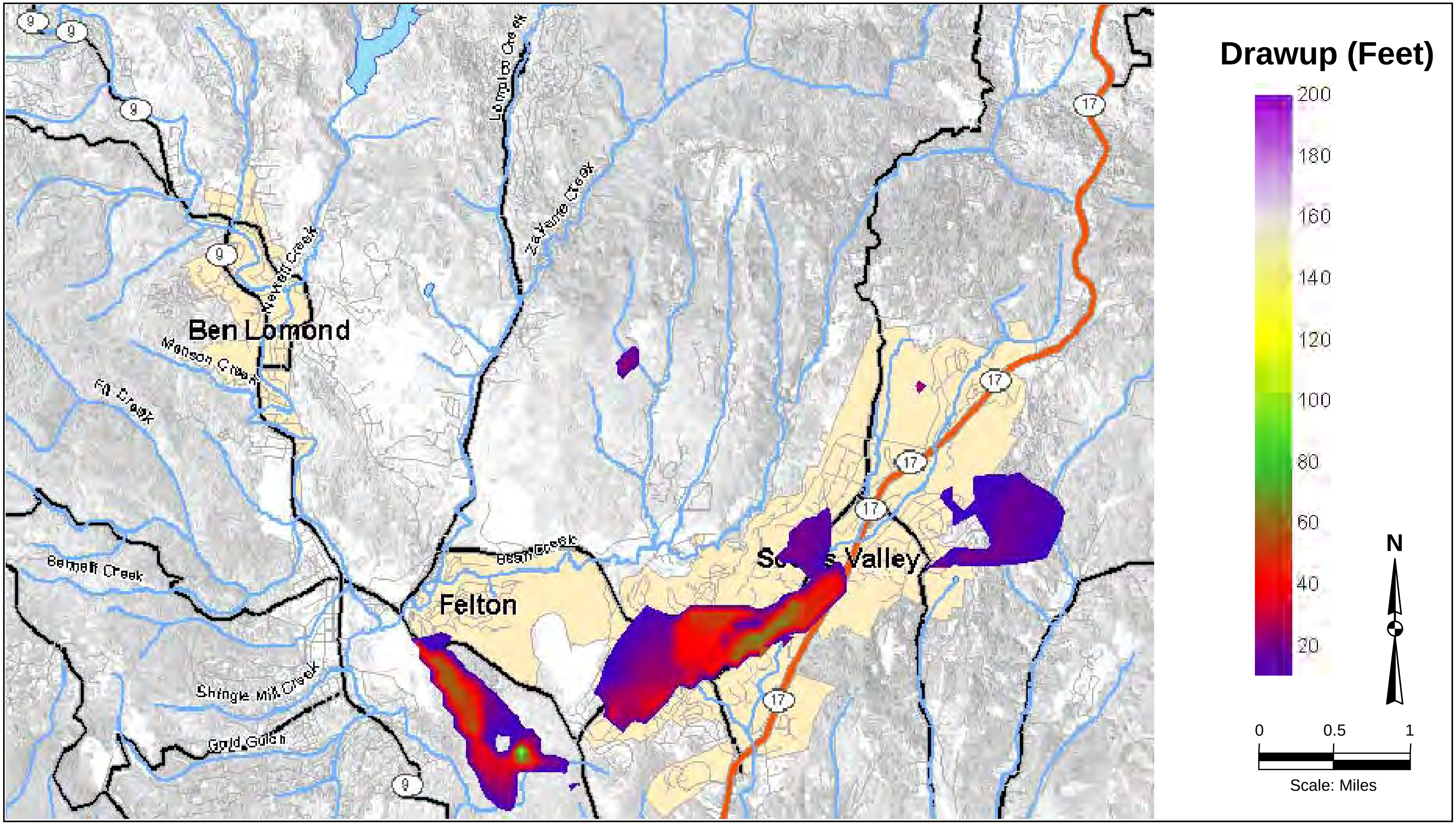
Santa Cruz County, California

Winter Drawup: Lompico Injection at North Hanson Quarry

K/J Project 0864005
November 2010

Figure 1C-C11



Color scale runs from drawup values of 10 (blue-purple) to 200 (purple) feet.

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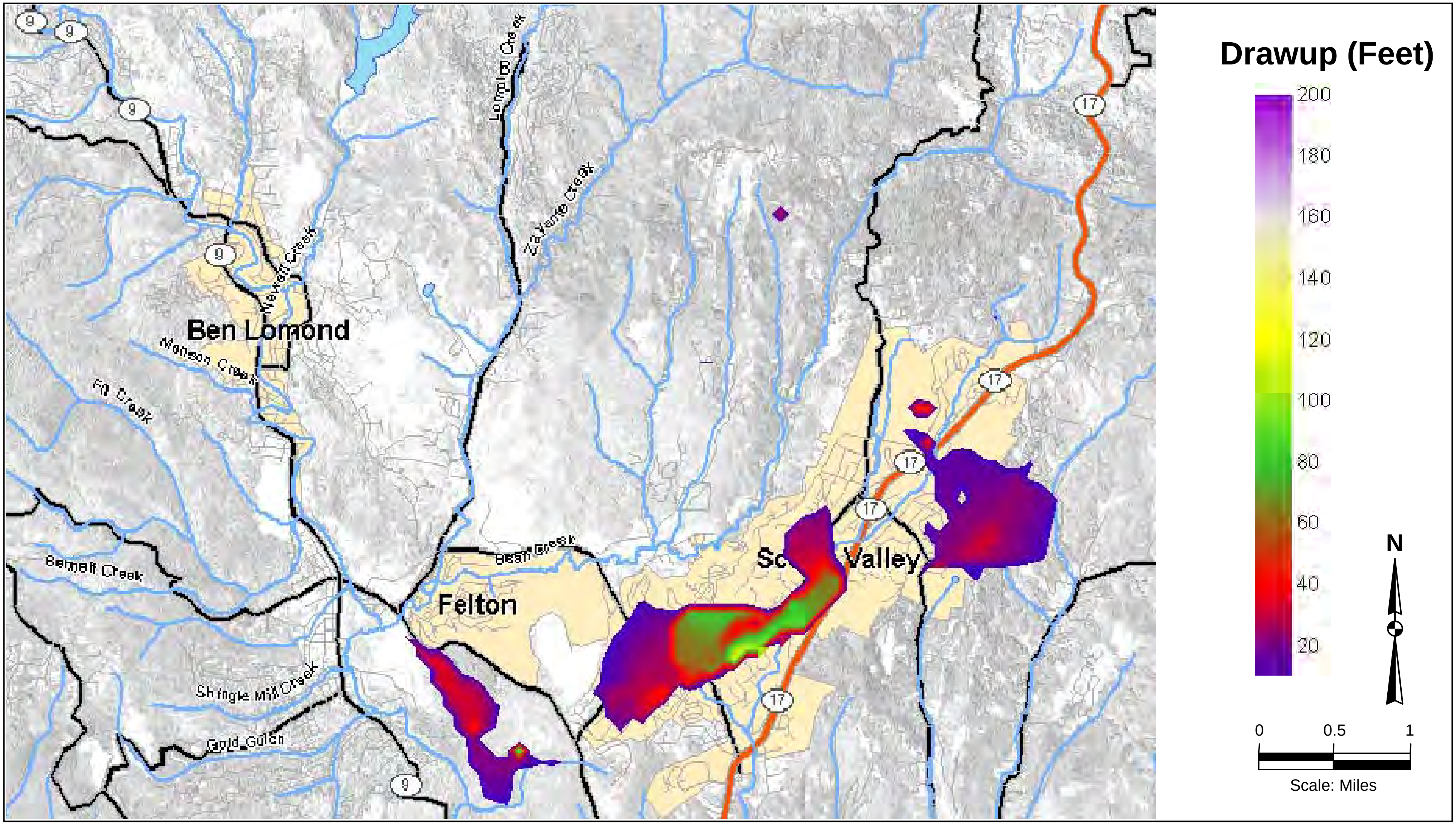
Santa Cruz County, California

Summer Drawup: Lompico Injection at North Hanson Quarry

K/J Project 0864005
November 2010
Figure 1C-C12



Color scale runs from drawup values of 10 (blue-purple) to 200 (purple) feet.

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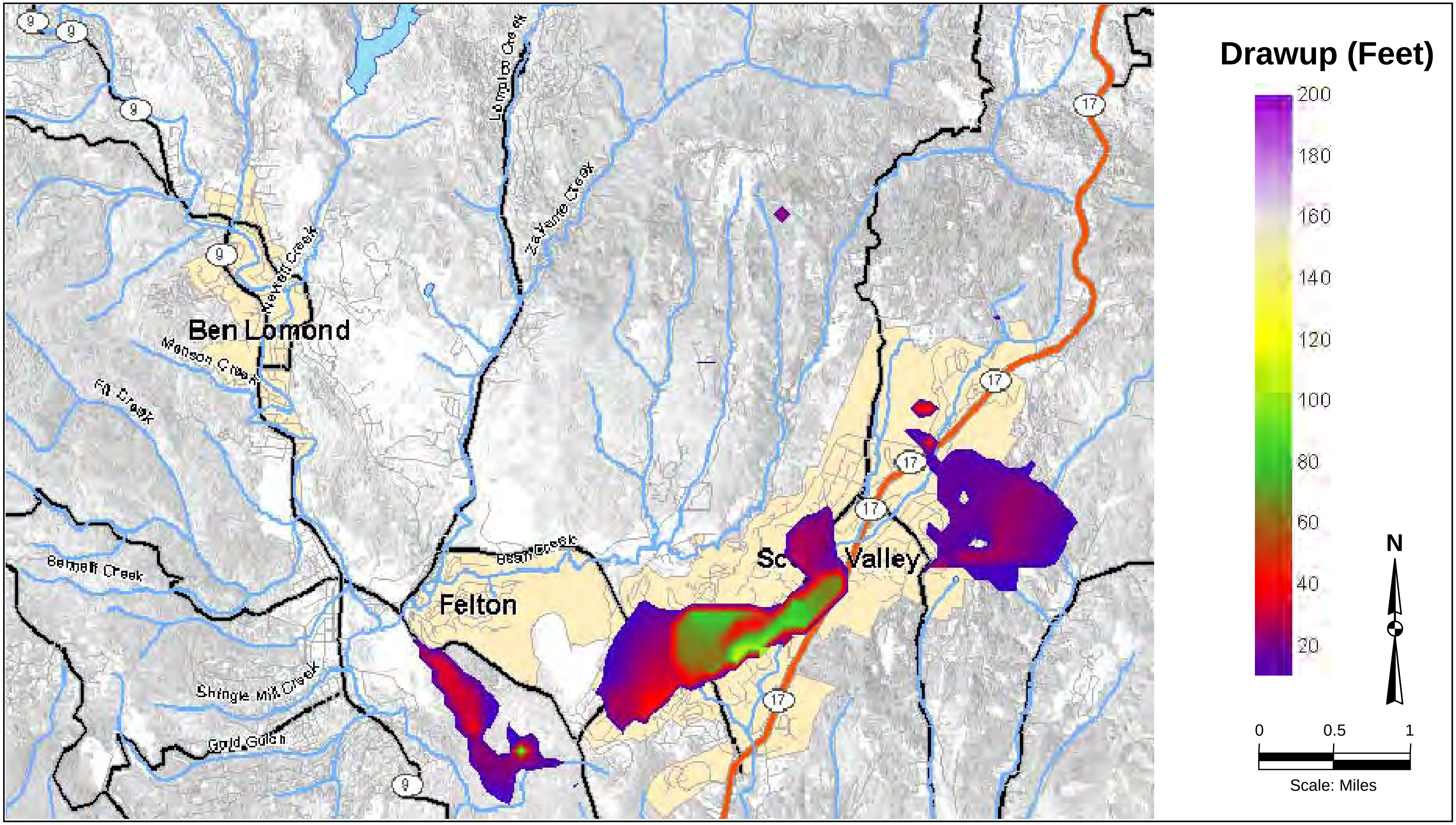
TM1C – Groundwater Model Evaluation
Conjunctive Use and Enhanced Aquifer Recharge Project
Santa Cruz County, California

Winter Drawup: Lompico Injection at Mount Hermon Road

K/J Project 0864005
November 2010

Figure 1C-C13



Color scale runs from drawup values of 10 (blue-purple) to 200 (purple) feet.

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Santa Cruz County, California

Summer Drawup: Lompico Injection at Mount Hermon Road

K/J Project 0864005
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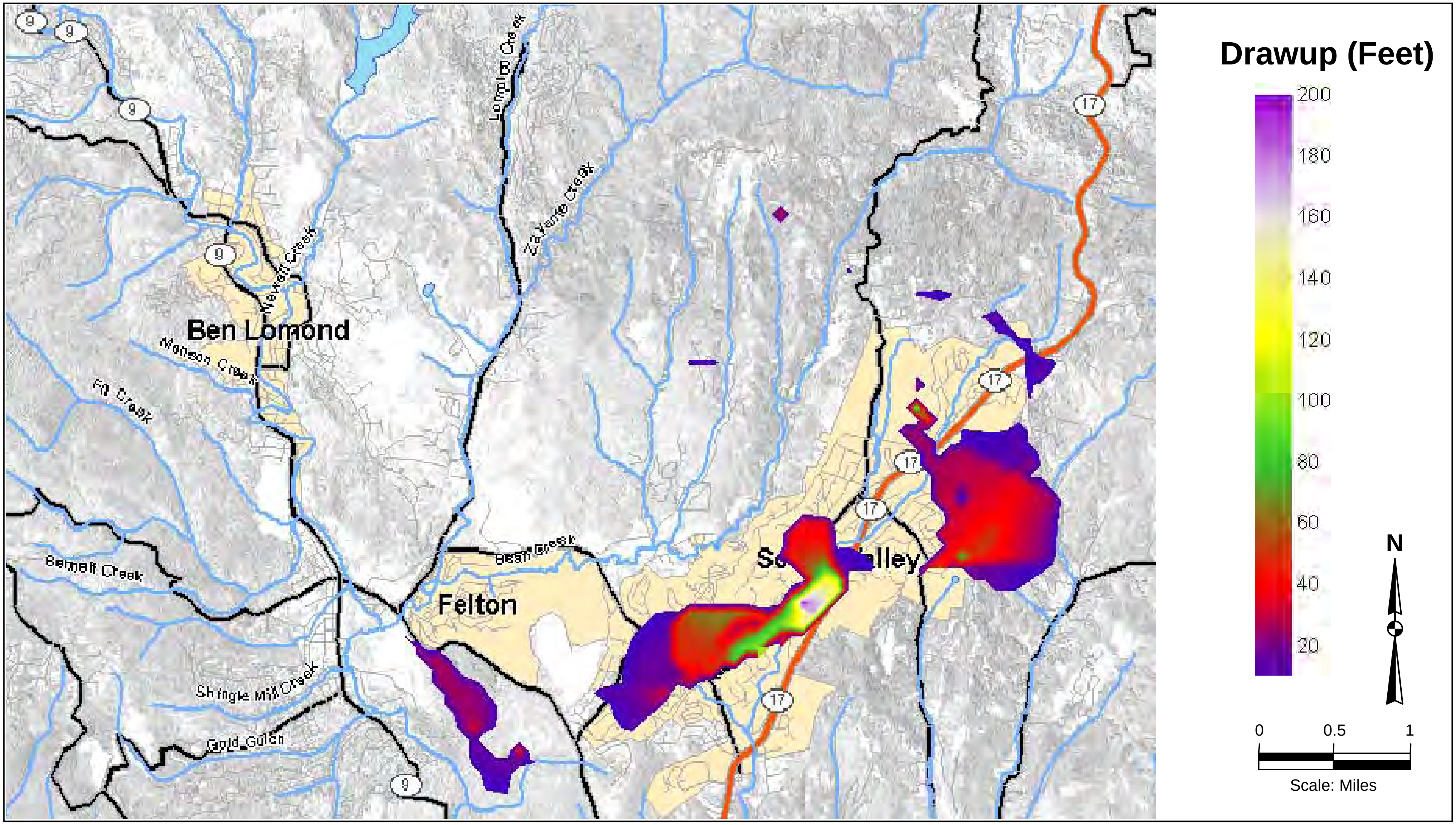
Figure 1C-C14



Color scale runs from drawup values of 10 (blue-purple) to 200 (purple) feet.

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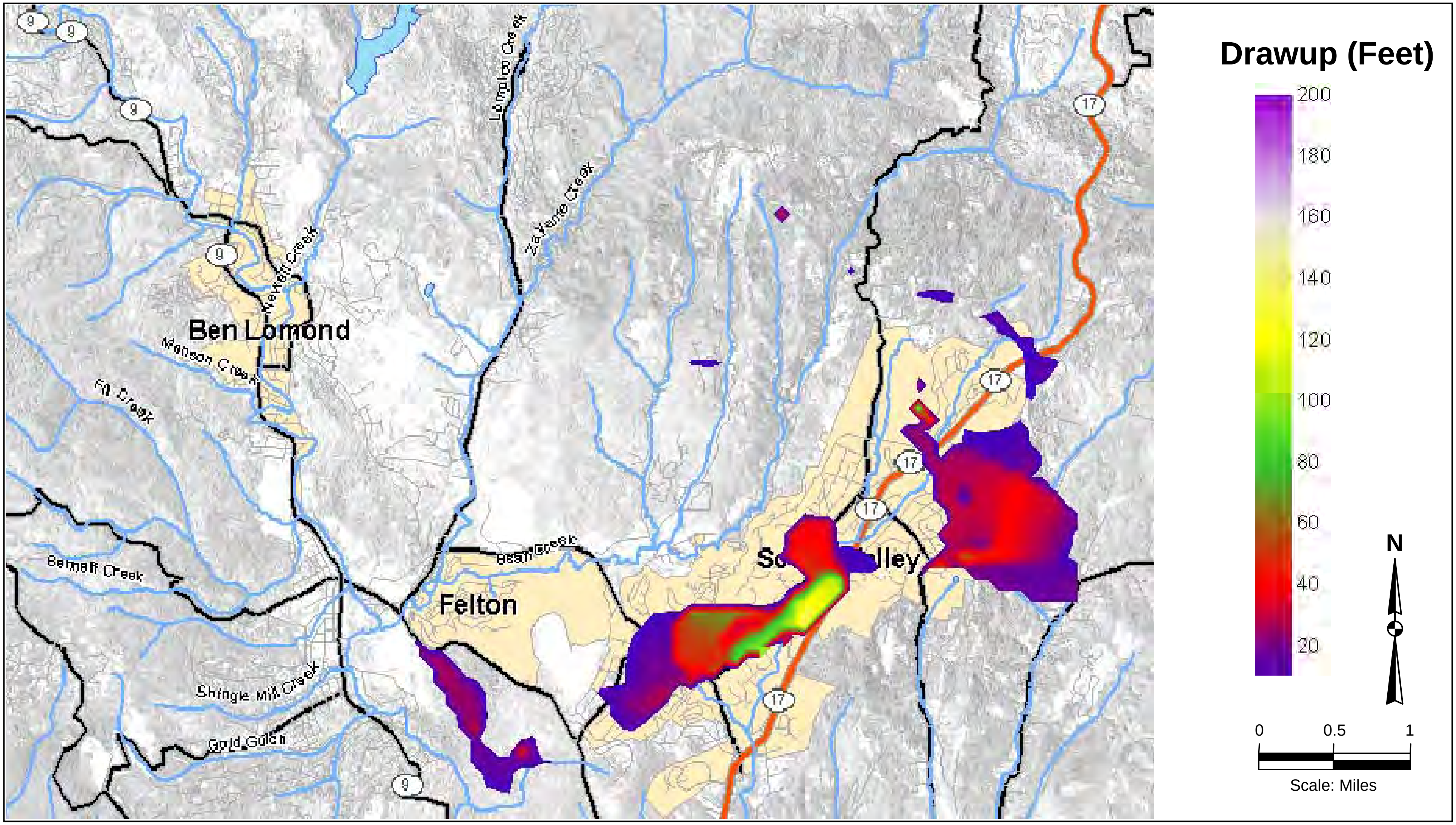
Santa Cruz County, California

Winter Drawup: Lompico Injection at Scotts Valley

K/J Project 0864005
November 2010

Figure 1C-C15



Color scale runs from drawup values of 10 (blue-purple) to 200 (purple) feet.

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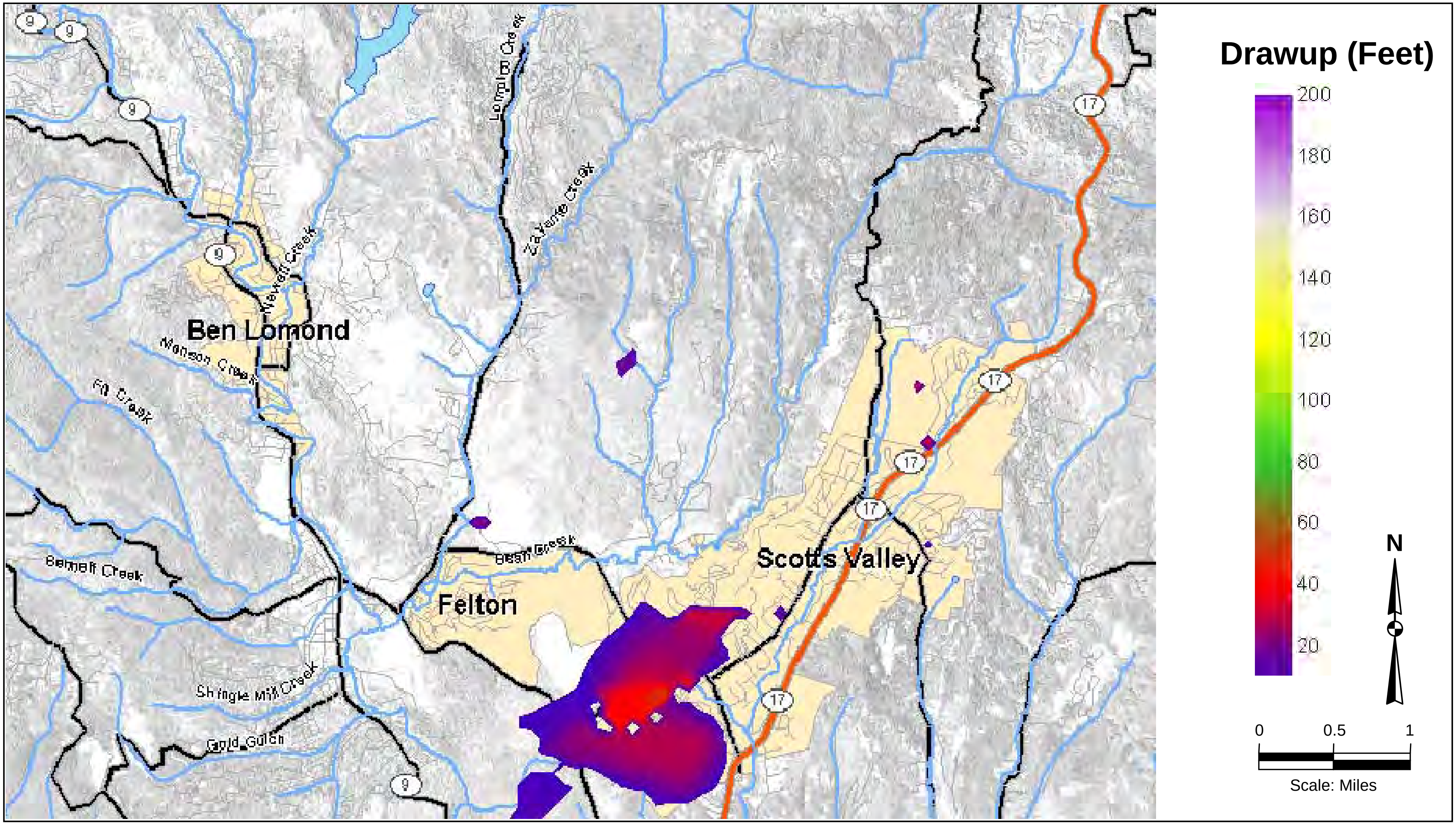
TM1C – Groundwater Model Evaluation
Conjunctive Use and Enhanced Aquifer Recharge Project
Santa Cruz County, California

Summer Drawup: Lompico Injection at Scotts Valley

K/J Project 0864005
November 2010
Figure 1C-C16



Color scale runs from drawup values of 10 (blue-purple) to 200 (purple) feet.

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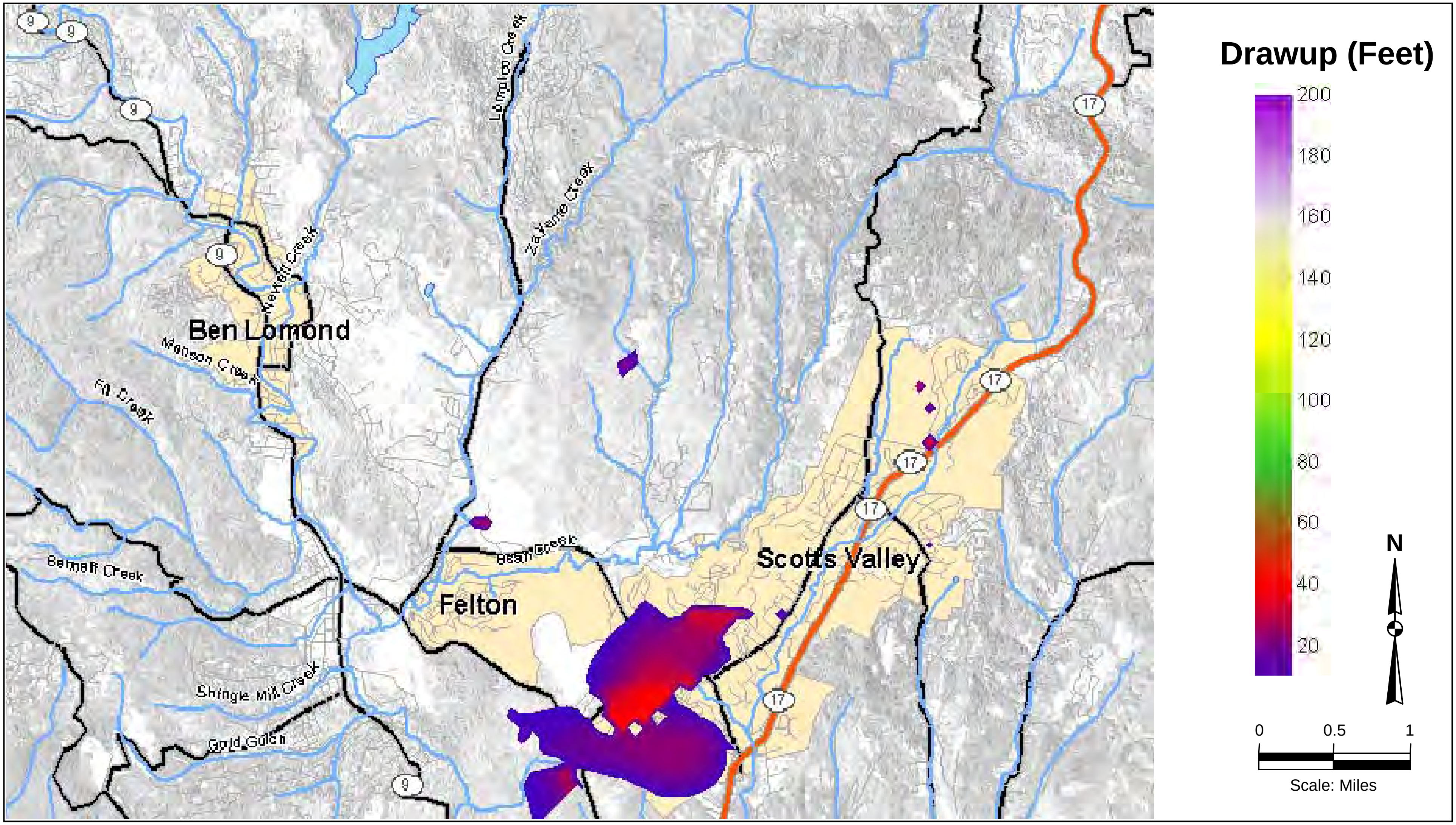
TM1C – Groundwater Model Evaluation
Conjunctive Use and Enhanced Aquifer Recharge Project
Santa Cruz County, California

Winter Drawup: Disperse Surface Recharge at San Lorenzo

K/J Project 0864005
November 2010

Figure 1C-C17



Color scale runs from drawup values of 10 (blue-purple) to 200 (purple) feet.

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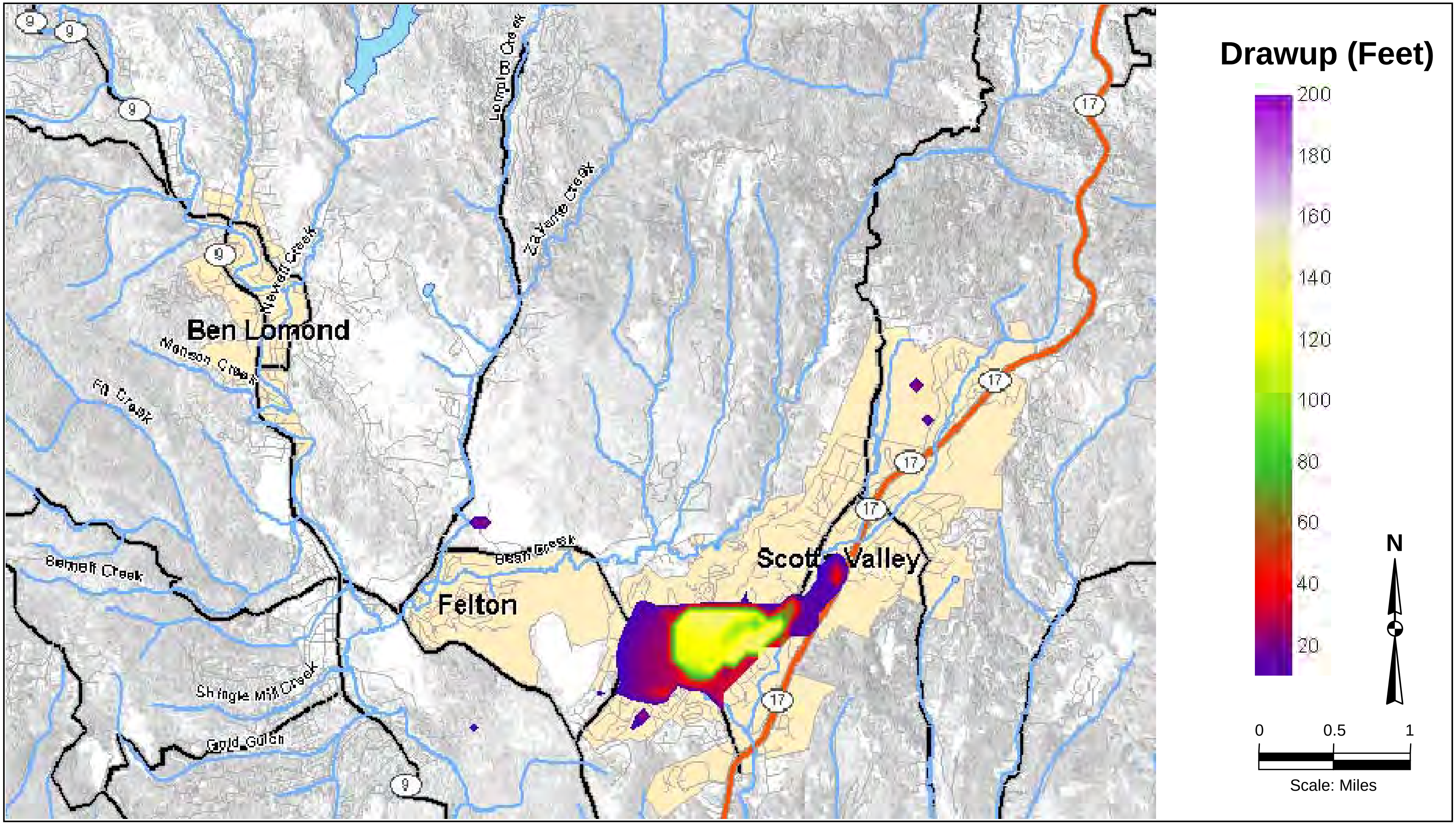
Santa Cruz County, California

Summer Drawup: Disperse Surface Recharge at San Lorenzo

K/J Project 0864005
November 2010
Figure 1C-C18



Color scale runs from drawup values of 10 (blue-purple) to 200 (purple) feet.

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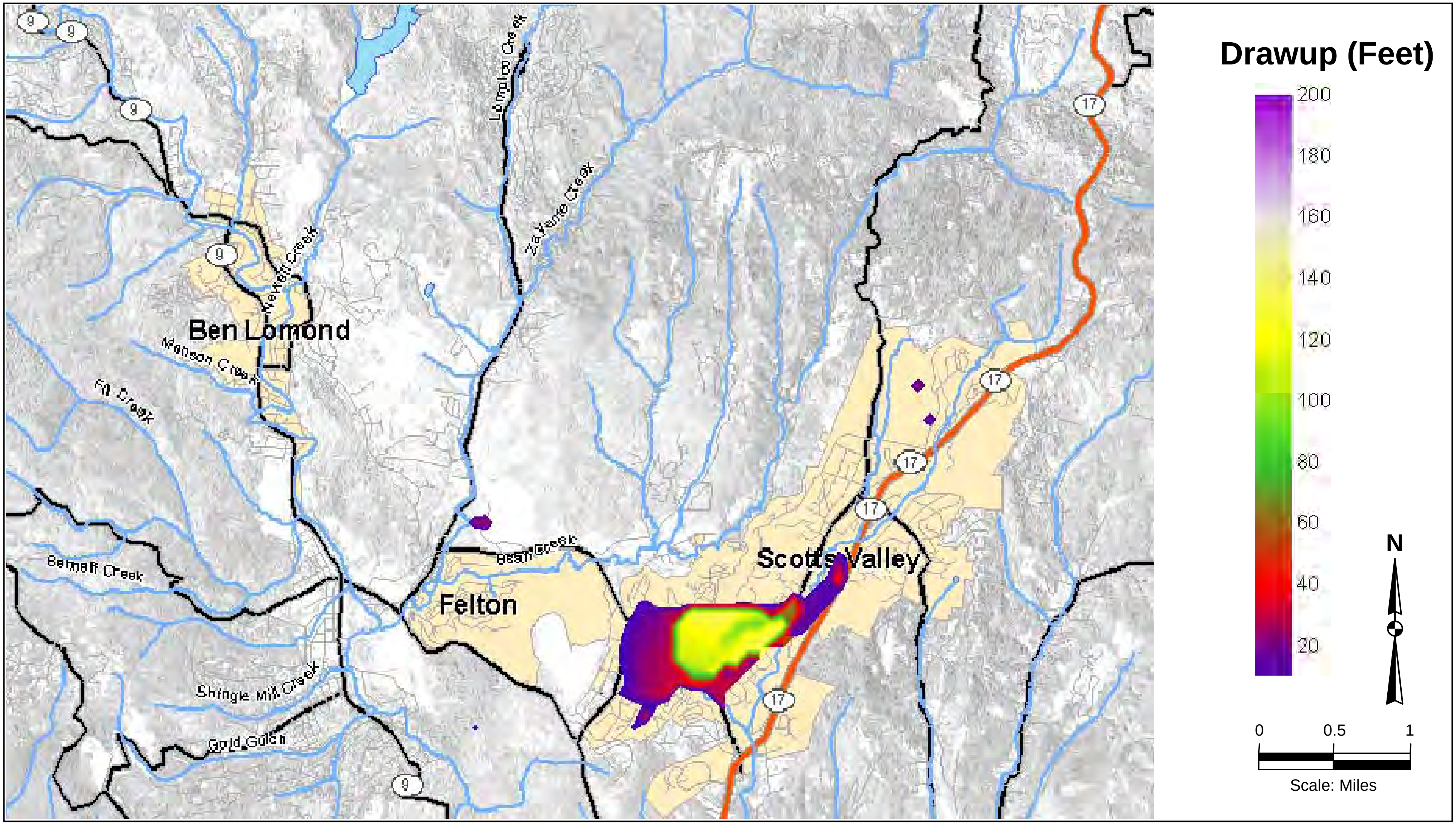
Conjunctive Use and Enhanced Aquifer Recharge Project
Santa Cruz County, California

Winter Drawup: Disperse Surface Recharge at Scotts Valley

K/J Project 0864005
November 2010
Figure 1C-C19



Color scale runs from drawup values of 10 (blue-purple) to 200 (purple) feet.

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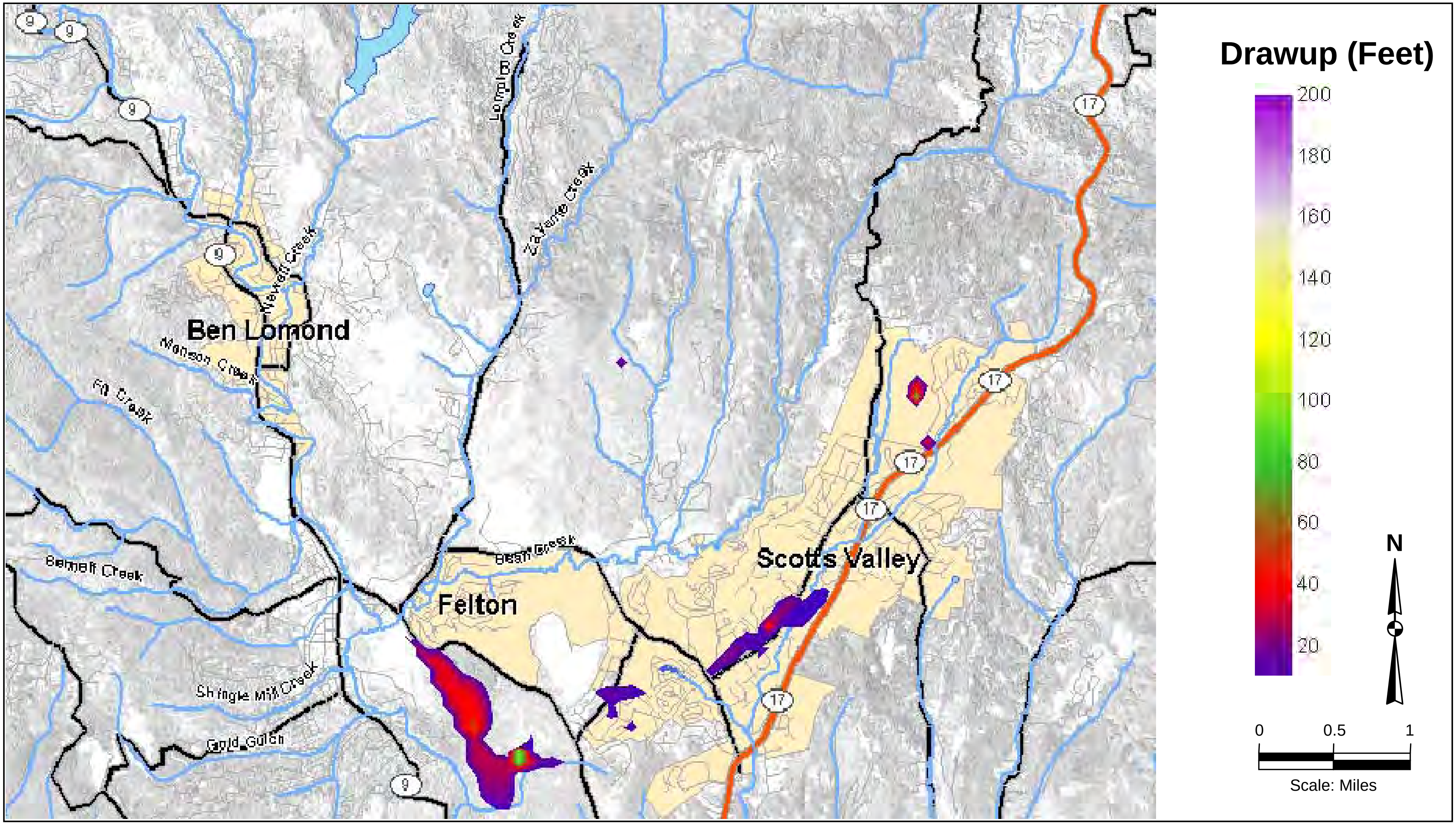
TM1C – Groundwater Model Evaluation
Conjunctive Use and Enhanced Aquifer Recharge Project
Santa Cruz County, California

Summer Drawup: Disperse Surface Recharge at Scotts Valley

K/J Project 0864005
November 2010

Figure 1C-C20



Color scale runs from drawup values of 10 (blue-purple) to 200 (purple) feet.

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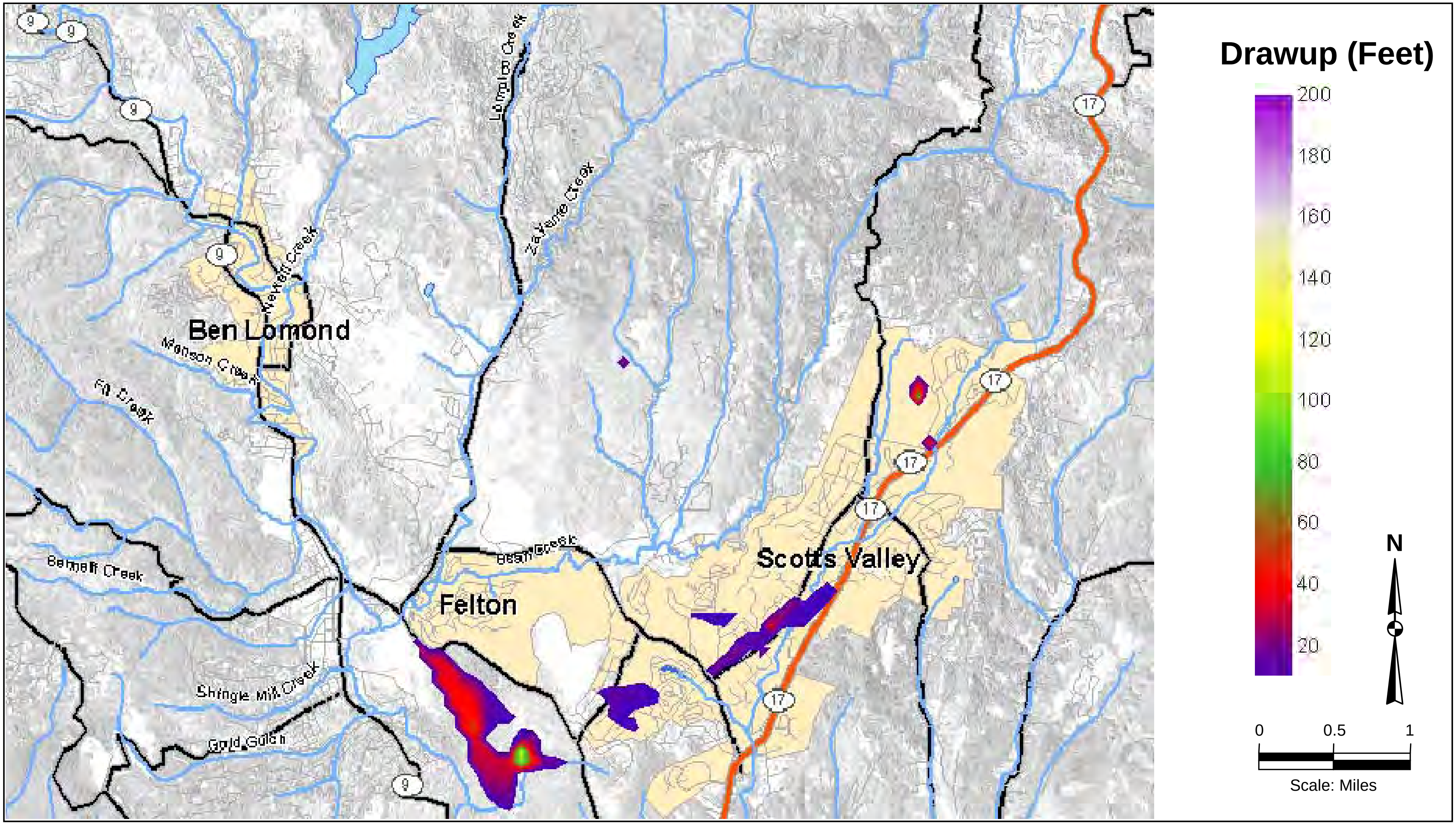
TM1C – Groundwater Model Evaluation
Conjunctive Use and Enhanced Aquifer Recharge Project
Santa Cruz County, California

Winter Drawup: In-Lieu Recharge at San Lorenzo

K/J Project 0864005
November 2010

Figure 1C-C21



Color scale runs from drawup values of 10 (blue-purple) to 200 (purple) feet.

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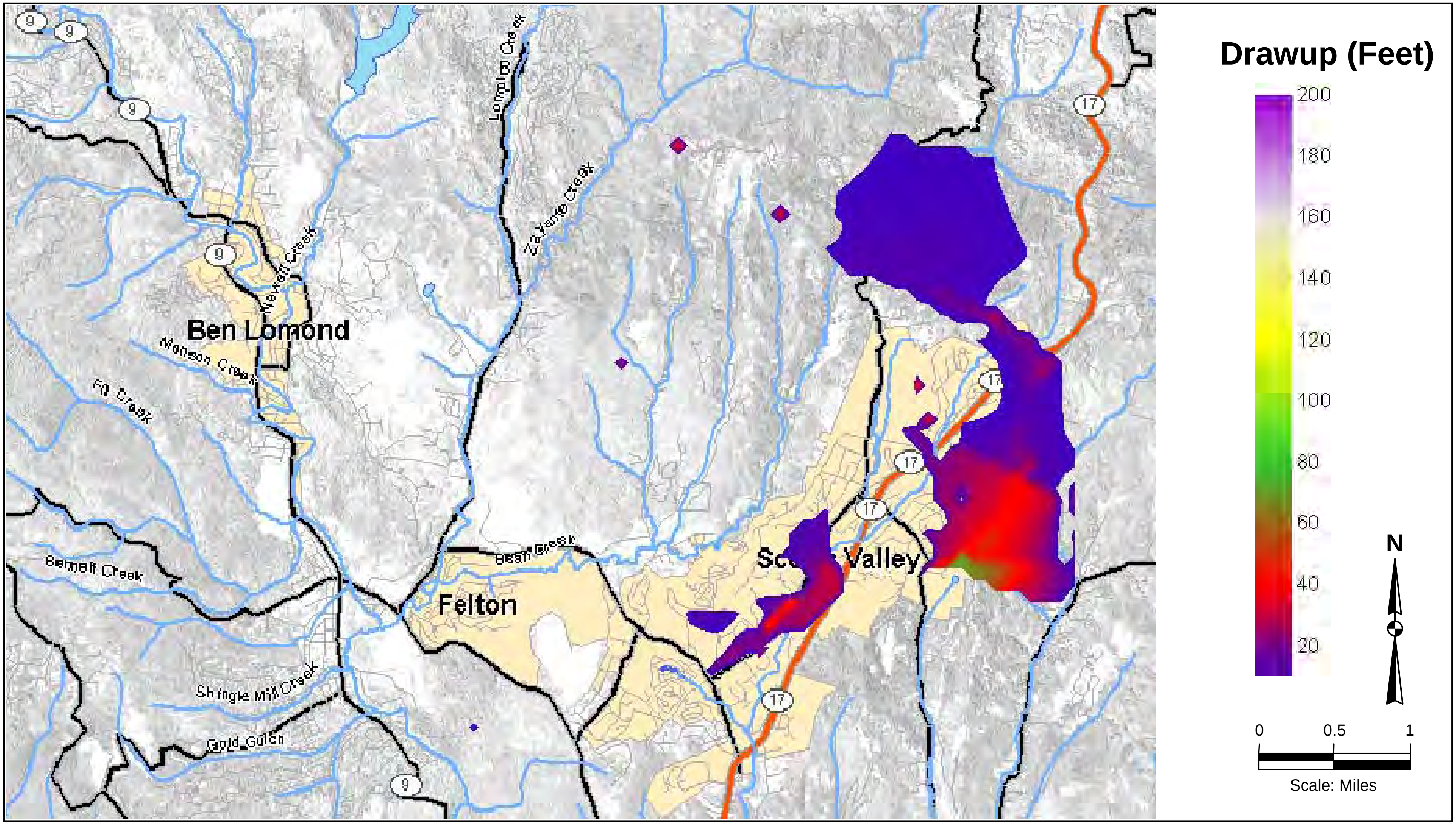
TM1C – Groundwater Model Evaluation
Conjunctive Use and Enhanced Aquifer Recharge Project
Santa Cruz County, California

Summer Drawup: In-Lieu Recharge at San Lorenzo

K/J Project 0864005
November 2010

Figure 1C-C22



Color scale runs from drawup values of 10 (blue-purple) to 200 (purple) feet.

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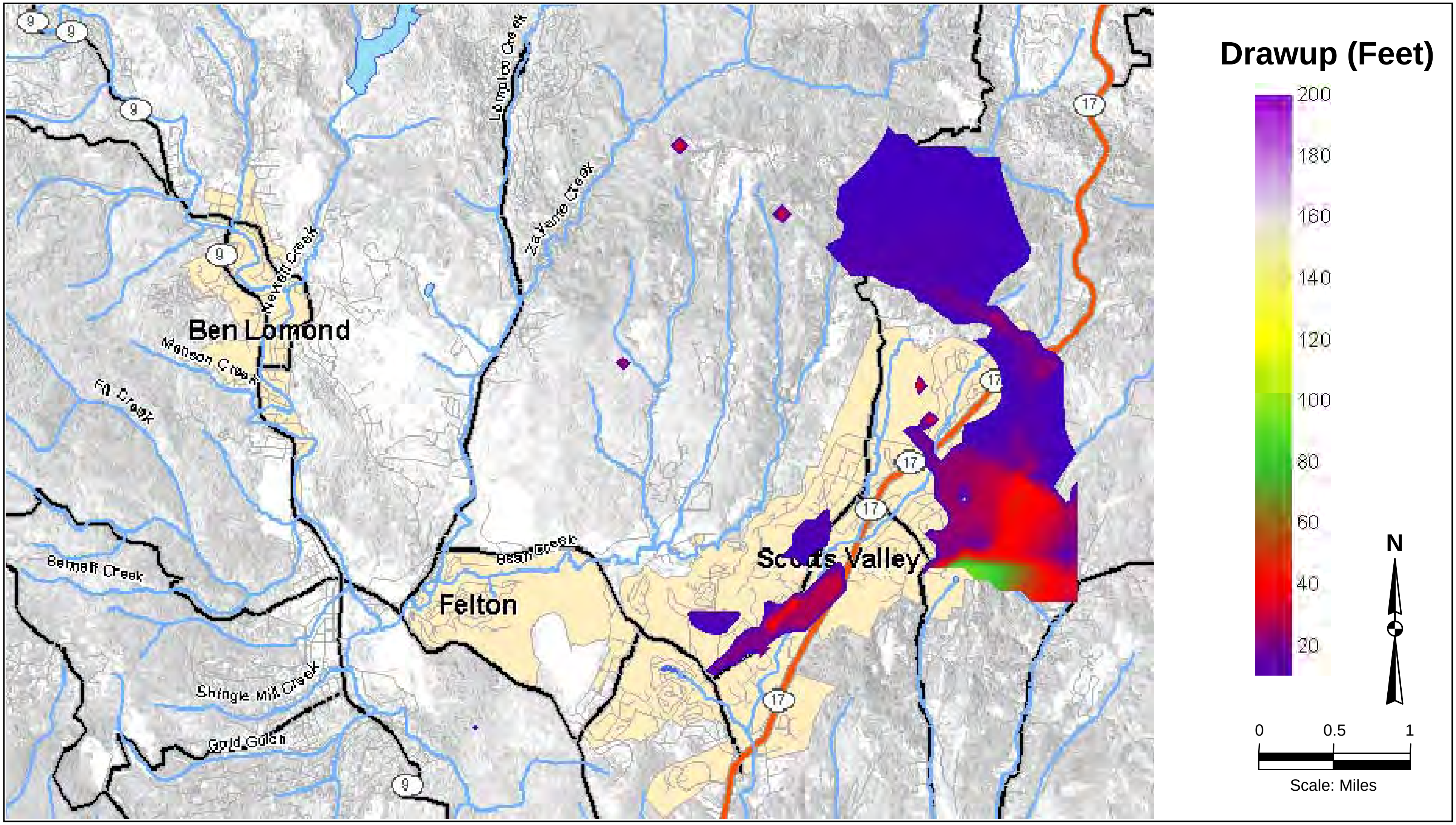
TM1C – Groundwater Model Evaluation
Conjunctive Use and Enhanced Aquifer Recharge Project
Santa Cruz County, California

Winter Drawup: In-Lieu Recharge at Scotts Valley: Butano

K/J Project 0864005
November 2010

Figure 1C-C23



Color scale runs from drawup values of 10 (blue-purple) to 200 (purple) feet.

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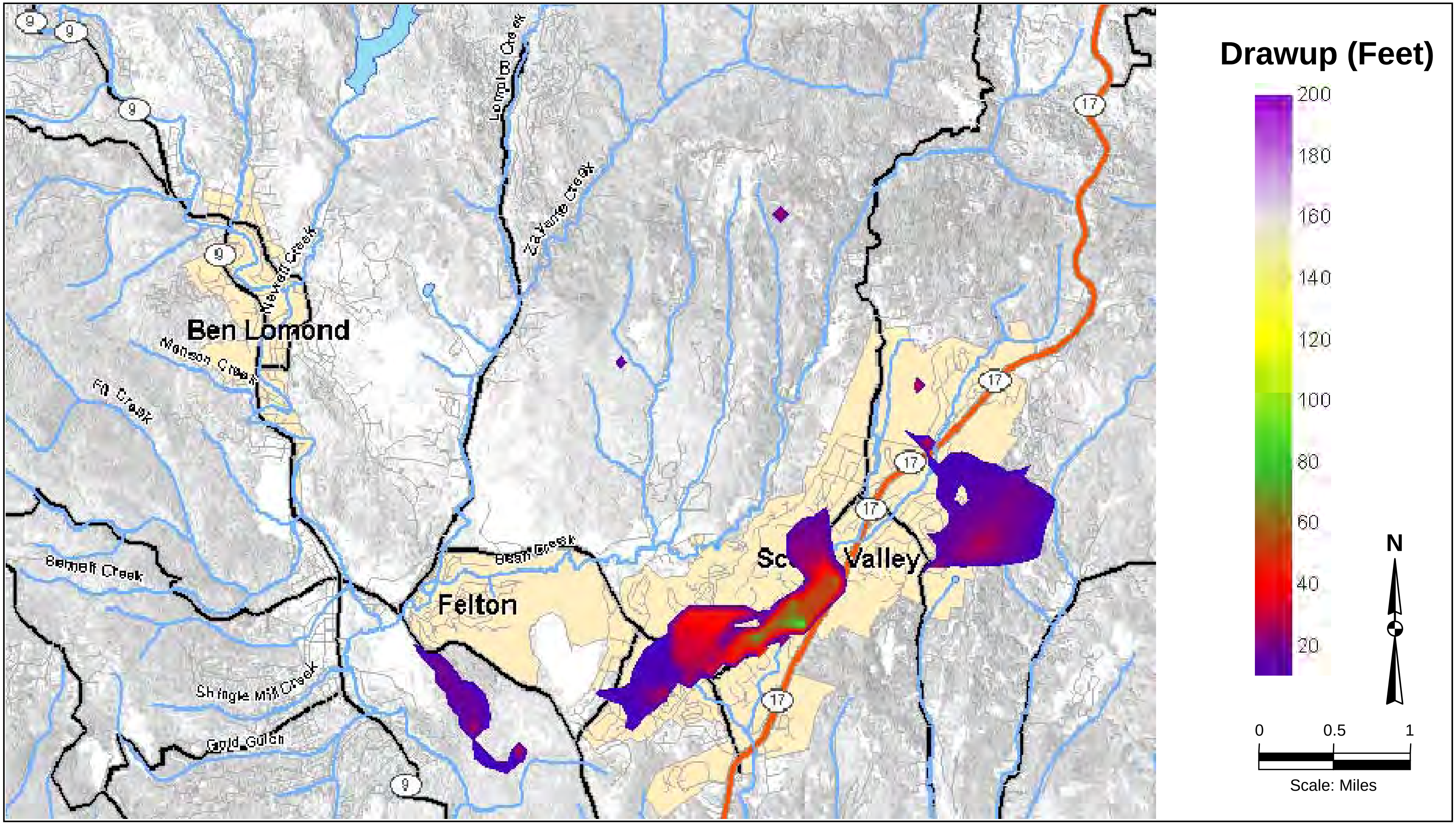
TM1C – Groundwater Model Evaluation
Conjunctive Use and Enhanced Aquifer Recharge Project
Santa Cruz County, California

Summer Drawup: In-Lieu Recharge at Scotts Valley: Butano

K/J Project 0864005
November 2010

Figure 1C-C24



Color scale runs from drawup values of 10 (blue-purple) to 200 (purple) feet.

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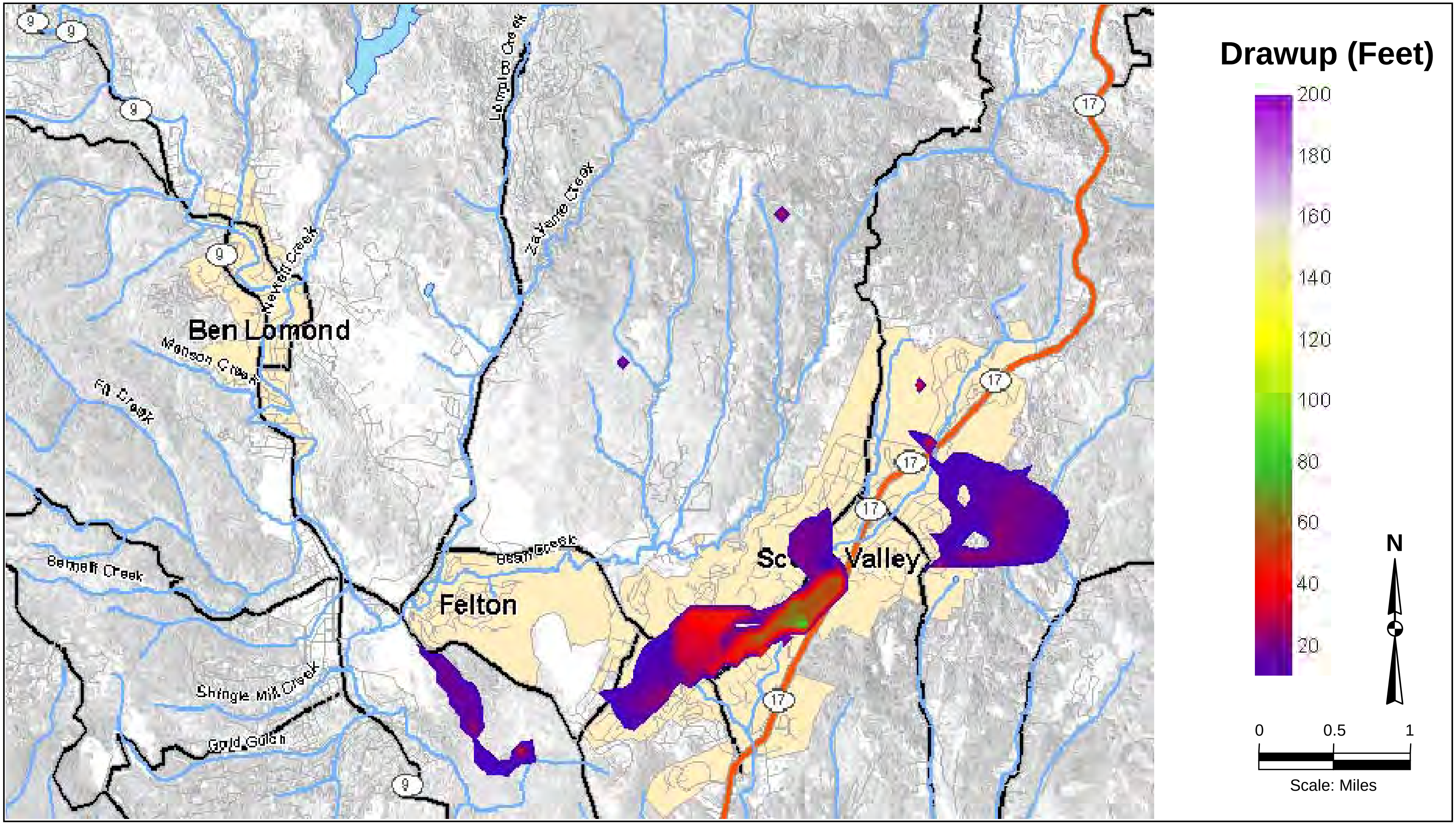
TM1C – Groundwater Model Evaluation
Conjunctive Use and Enhanced Aquifer Recharge Project
Santa Cruz County, California

Winter Drawup: In-Lieu Recharge at Scotts Valley: Lompico

K/J Project 0864005
November 2010

Figure 1C-C25



Color scale runs from drawup values of 10 (blue-purple) to 200 (purple) feet.

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Conjunctive Use and Enhanced Aquifer Recharge Project
Santa Cruz County, California

Summer Drawup: In-Lieu Recharge at Scotts Valley: Lompico

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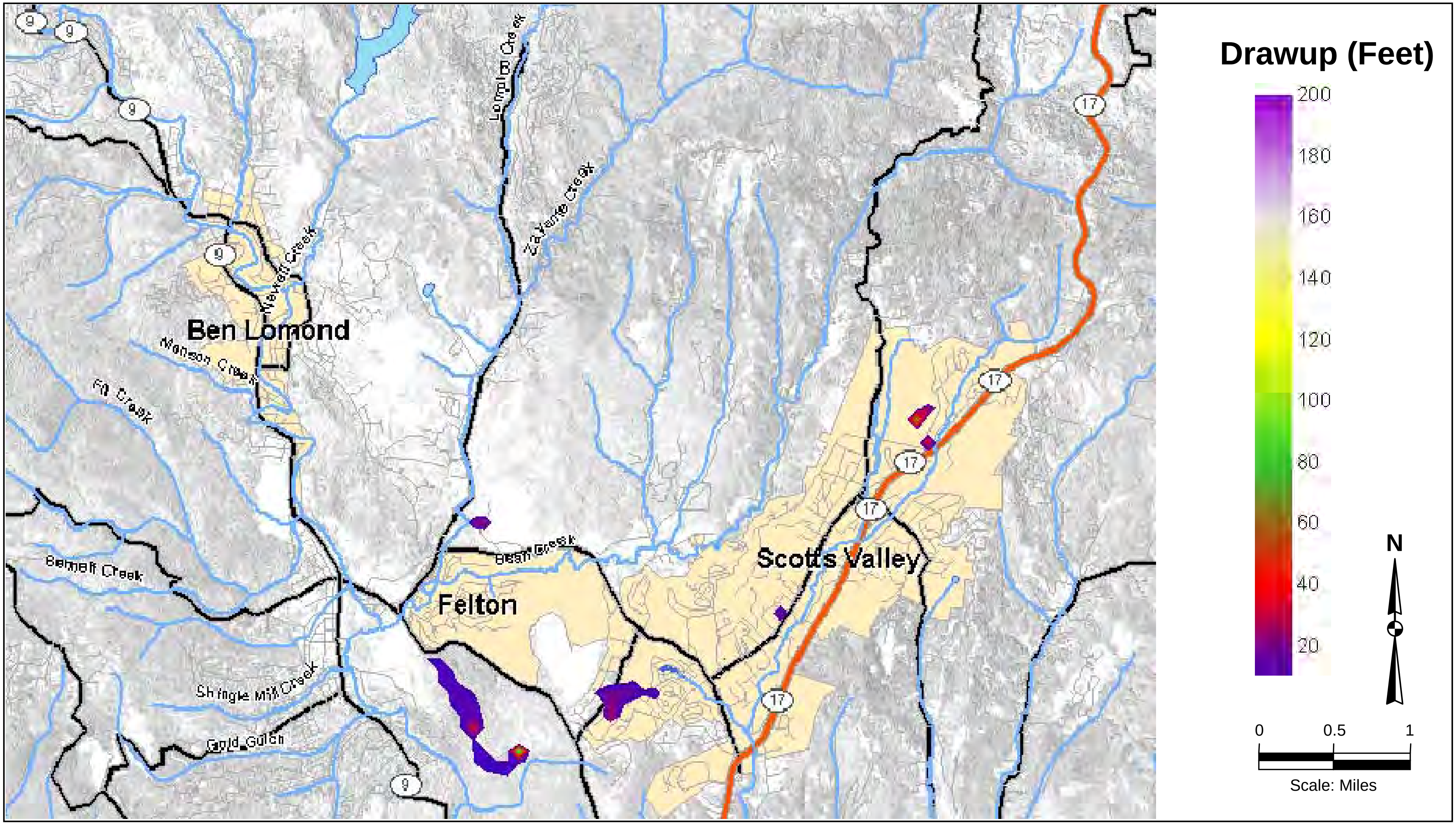
November 2010

Figure 1C-C26



Color scale runs from drawup values of 10 (blue-purple) to 200 (purple) feet.

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TM1C – Groundwater Model Evaluation
Conjunctive Use and Enhanced Aquifer Recharge Project
Santa Cruz County, California

Winter Drawup: Lompico Injection at South Hanson Quarry: 250 afy

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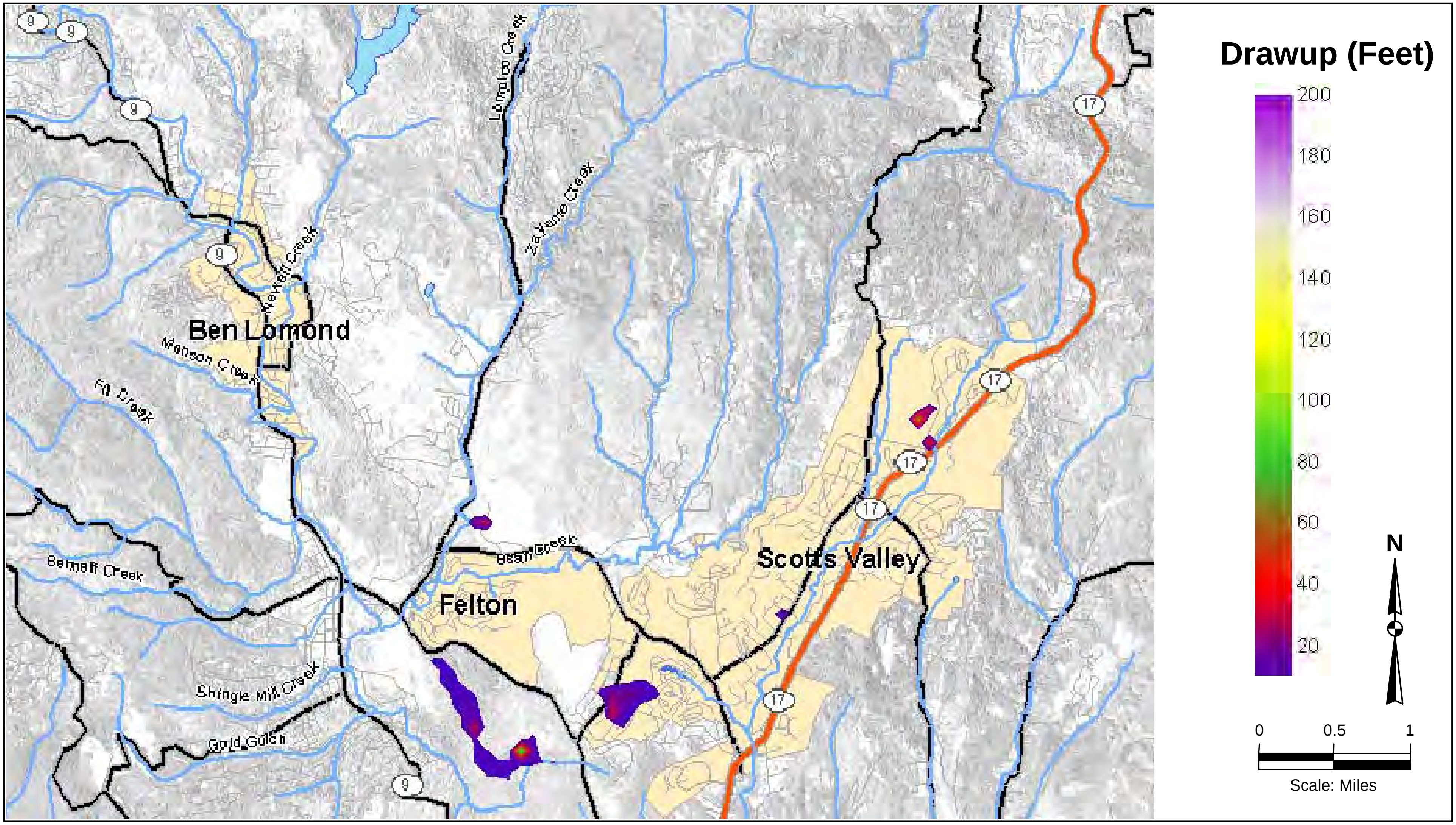
November 2010

Figure 1C-C27



Color scale runs from drawup values of 10 (blue-purple) to 200 (purple) feet.

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TM1C – Groundwater Model Evaluation
Conjunctive Use and Enhanced Aquifer Recharge Project
Santa Cruz County, California

Summer Drawup: Lompico Injection at South Hanson Quarry: 250 afy

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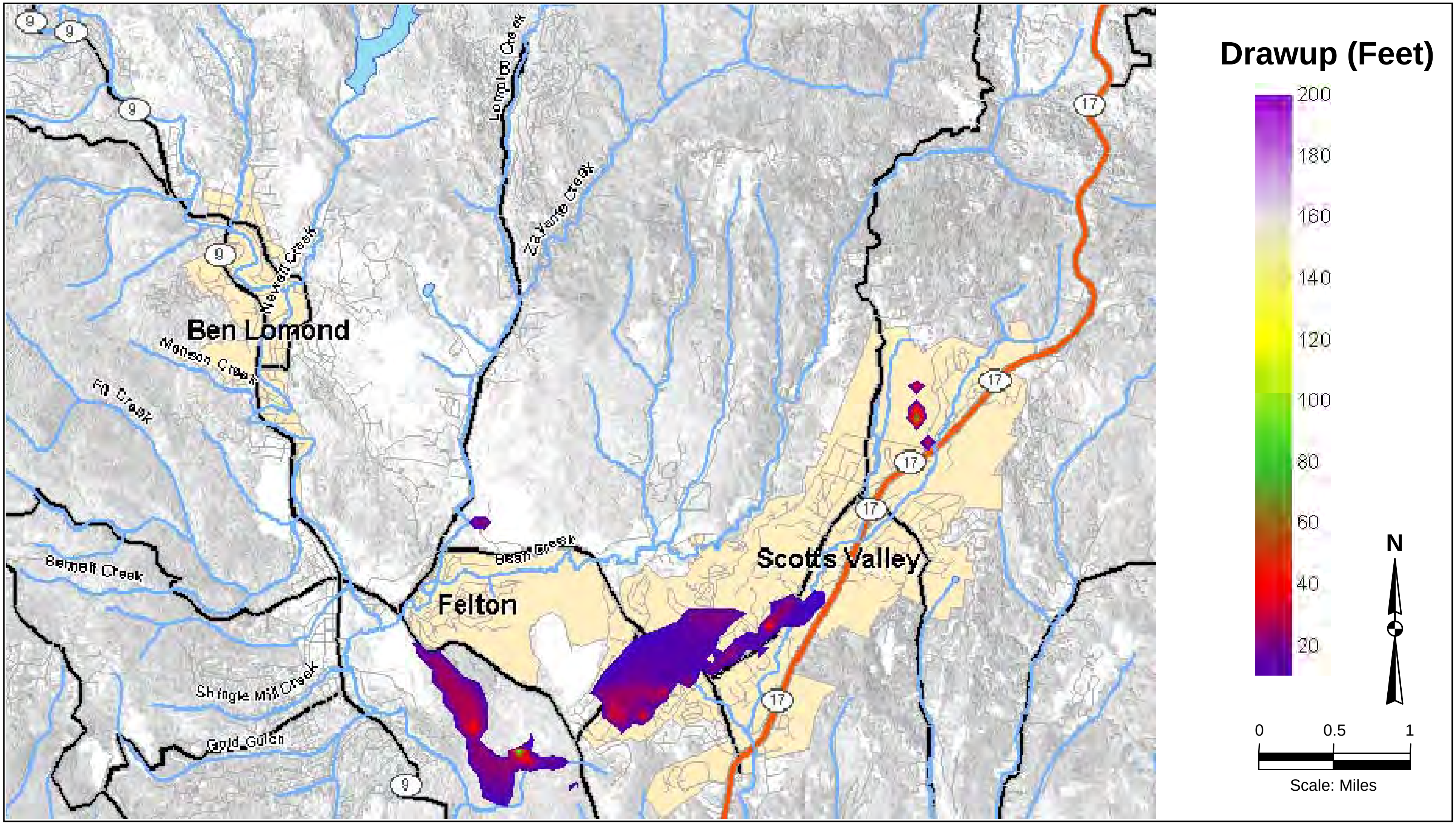
Figure 1C-C28



Color scale runs from drawup values of 10 (blue-purple) to 200 (purple) feet.

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TM1C – Groundwater Model Evaluation
Conjunctive Use and Enhanced Aquifer Recharge Project
Santa Cruz County, California

Winter Drawup: Lompico Injection at South Hanson Quarry: 500 afy

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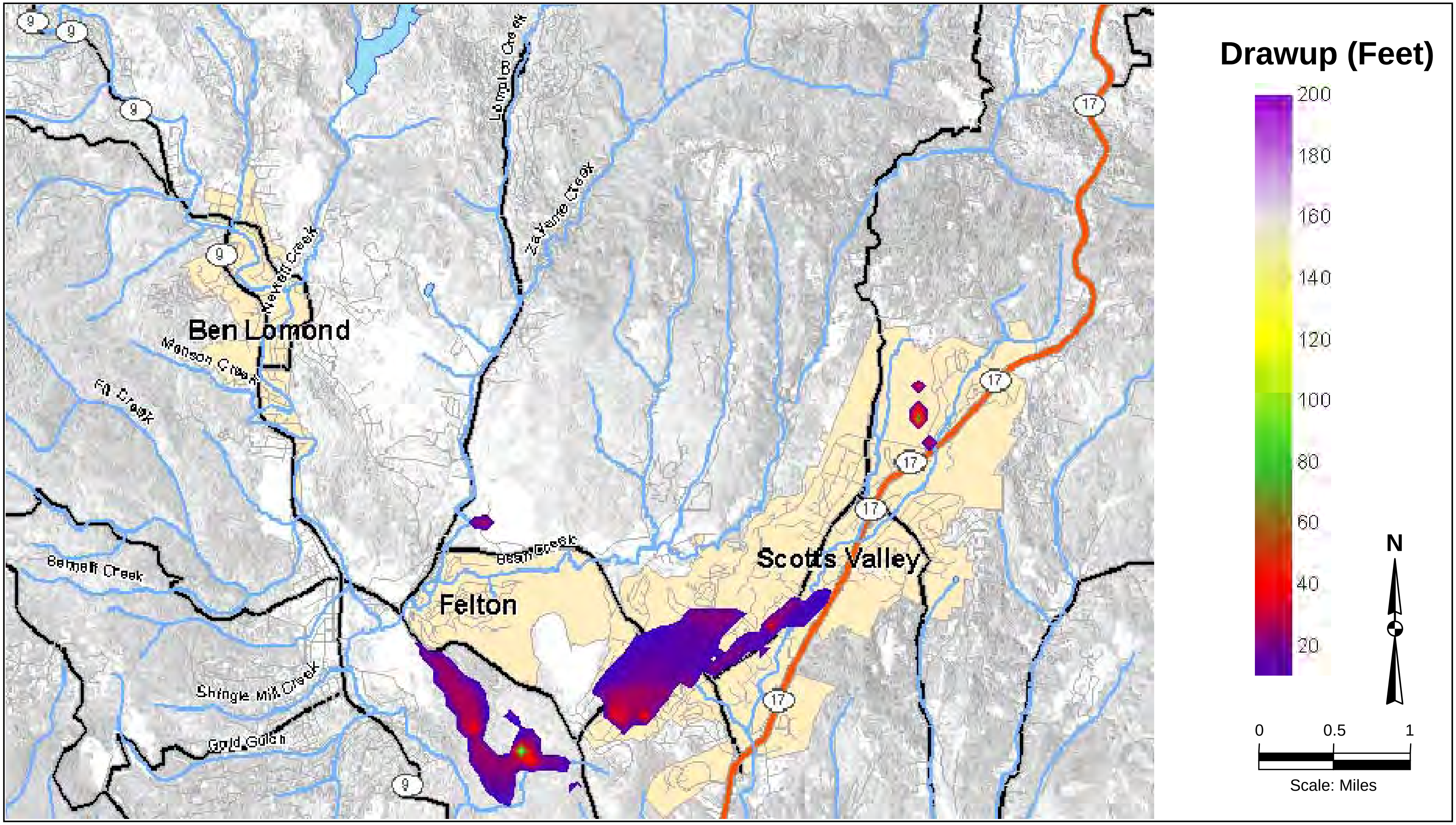
Figure 1C-C29



Color scale runs from drawup values of 10 (blue-purple) to 200 (purple) feet.

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Conjunctive Use and Enhanced Aquifer Recharge Project
Santa Cruz County, California

Summer Drawup: Lompico Injection at South Hanson Quarry: 500 afy

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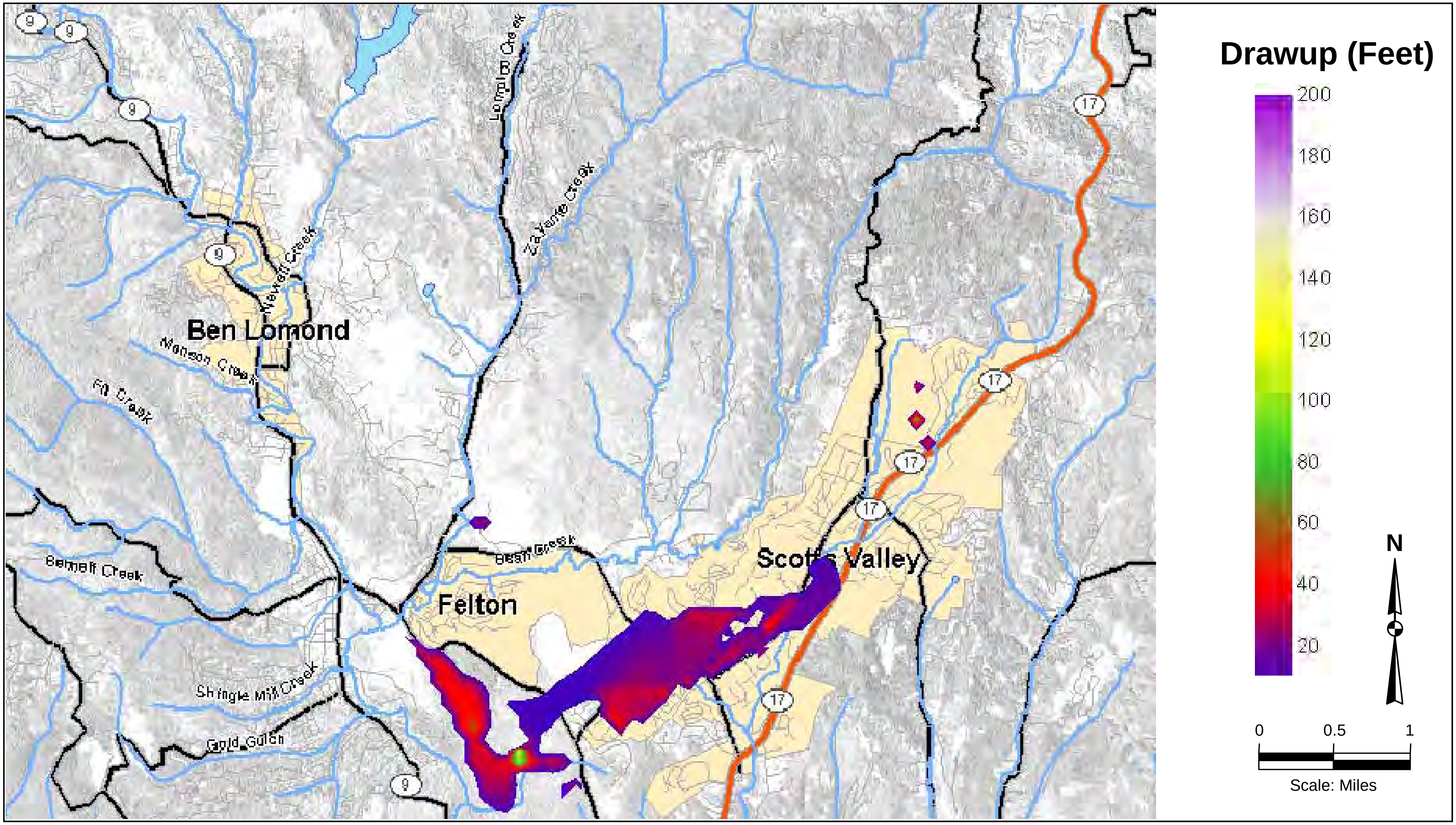
Figure 1C-C30



Color scale runs from drawup values of 10 (blue-purple) to 200 (purple) feet.

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TM1C – Groundwater Model Evaluation
Conjunctive Use and Enhanced Aquifer Recharge Project
Santa Cruz County, California

Winter Drawup: Lompico Injection at South Hanson Quarry: 750 afy

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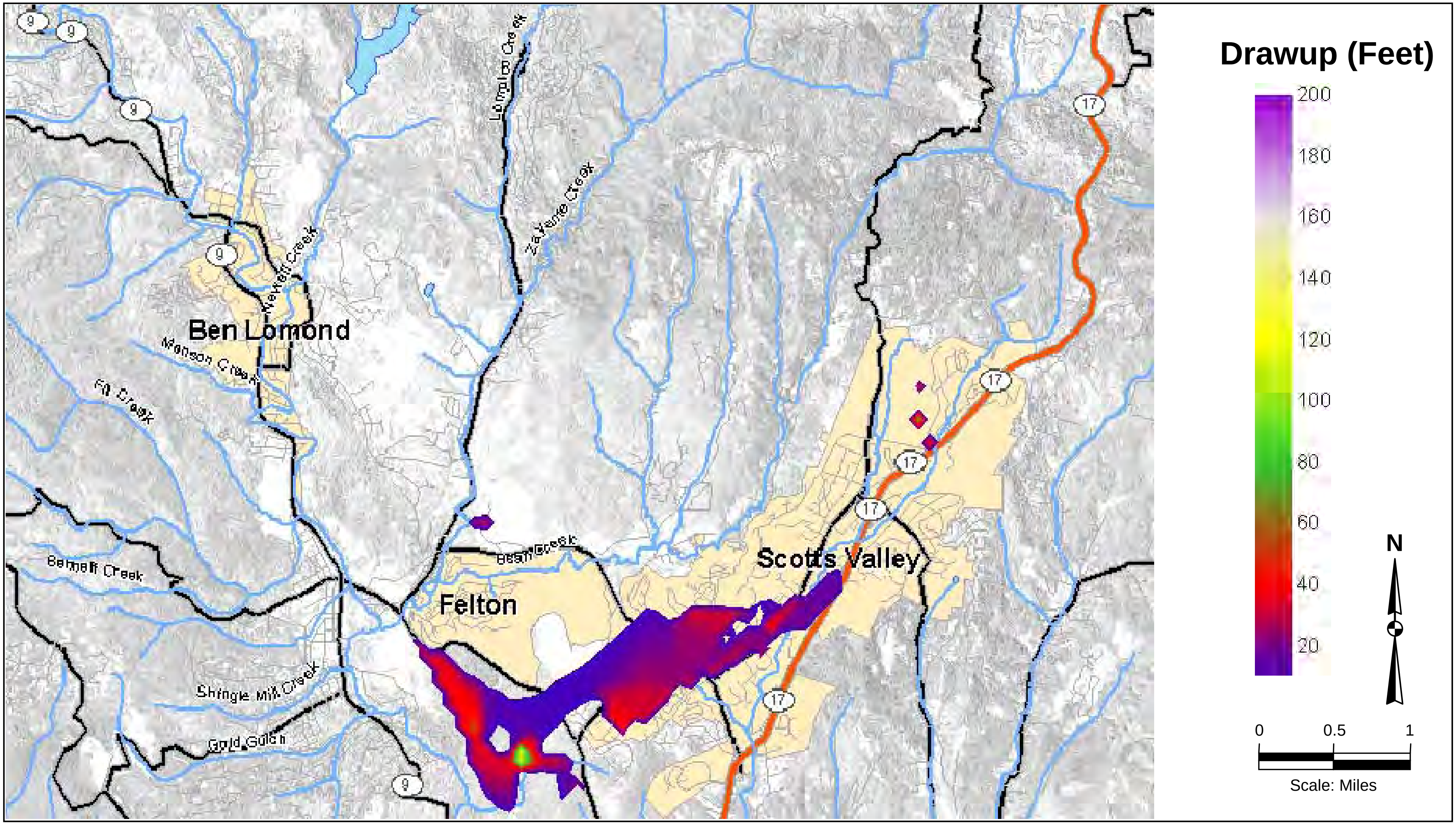
Figure 1C-C31



Color scale runs from drawup values of 10 (blue-purple) to 200 (purple) feet.

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TM1C – Groundwater Model Evaluation
Conjunctive Use and Enhanced Aquifer Recharge Project
Santa Cruz County, California

Summer Drawup: Lompico Injection at South Hanson Quarry: 750 afy

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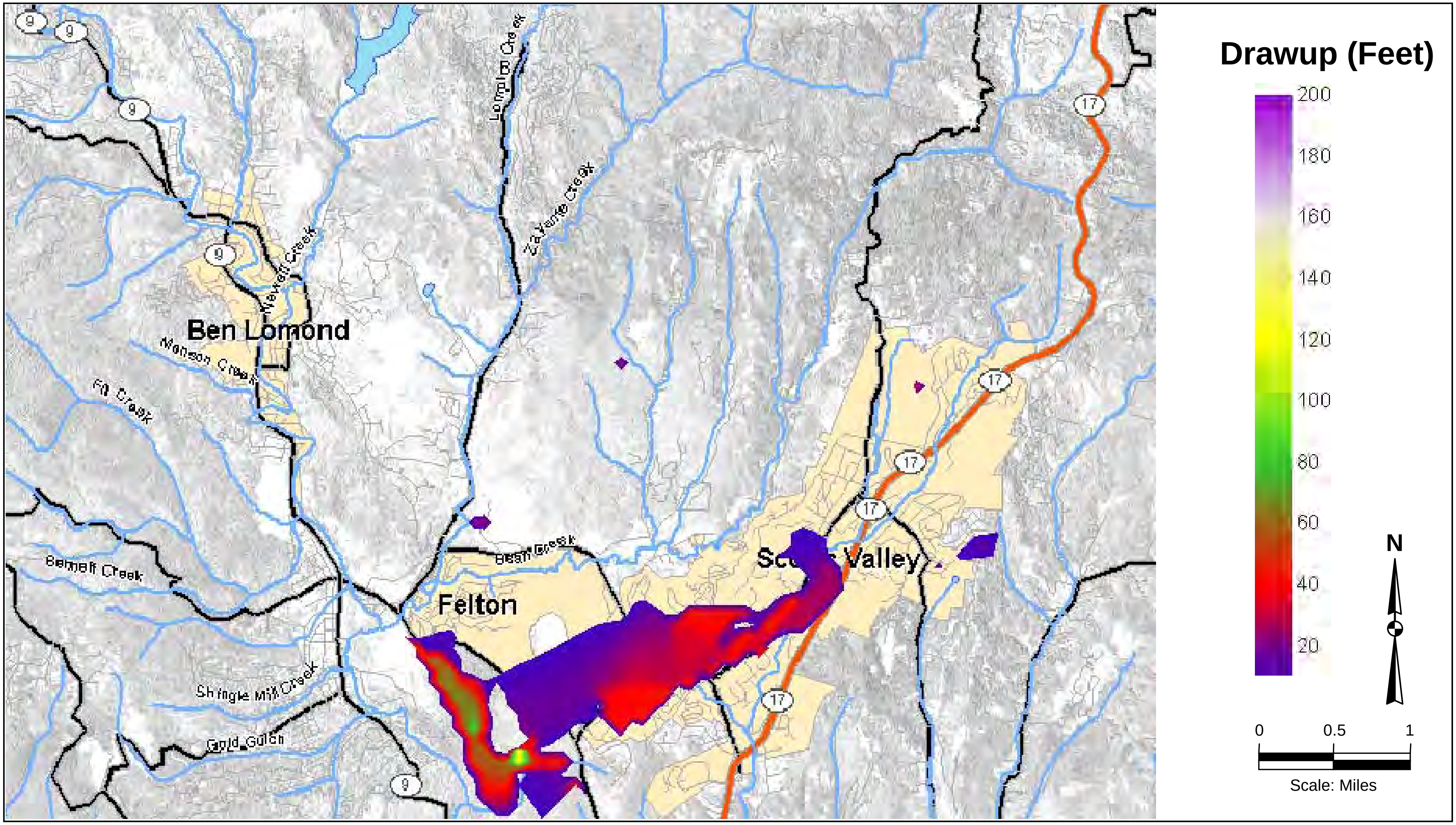
Figure 1C-C32



Color scale runs from drawup values of 10 (blue-purple) to 200 (purple) feet.

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TM1C – Groundwater Model Evaluation
Conjunctive Use and Enhanced Aquifer Recharge Project
Santa Cruz County, California

Winter Drawup: Lompico Injection at South Hanson Quarry: 1,250 afy

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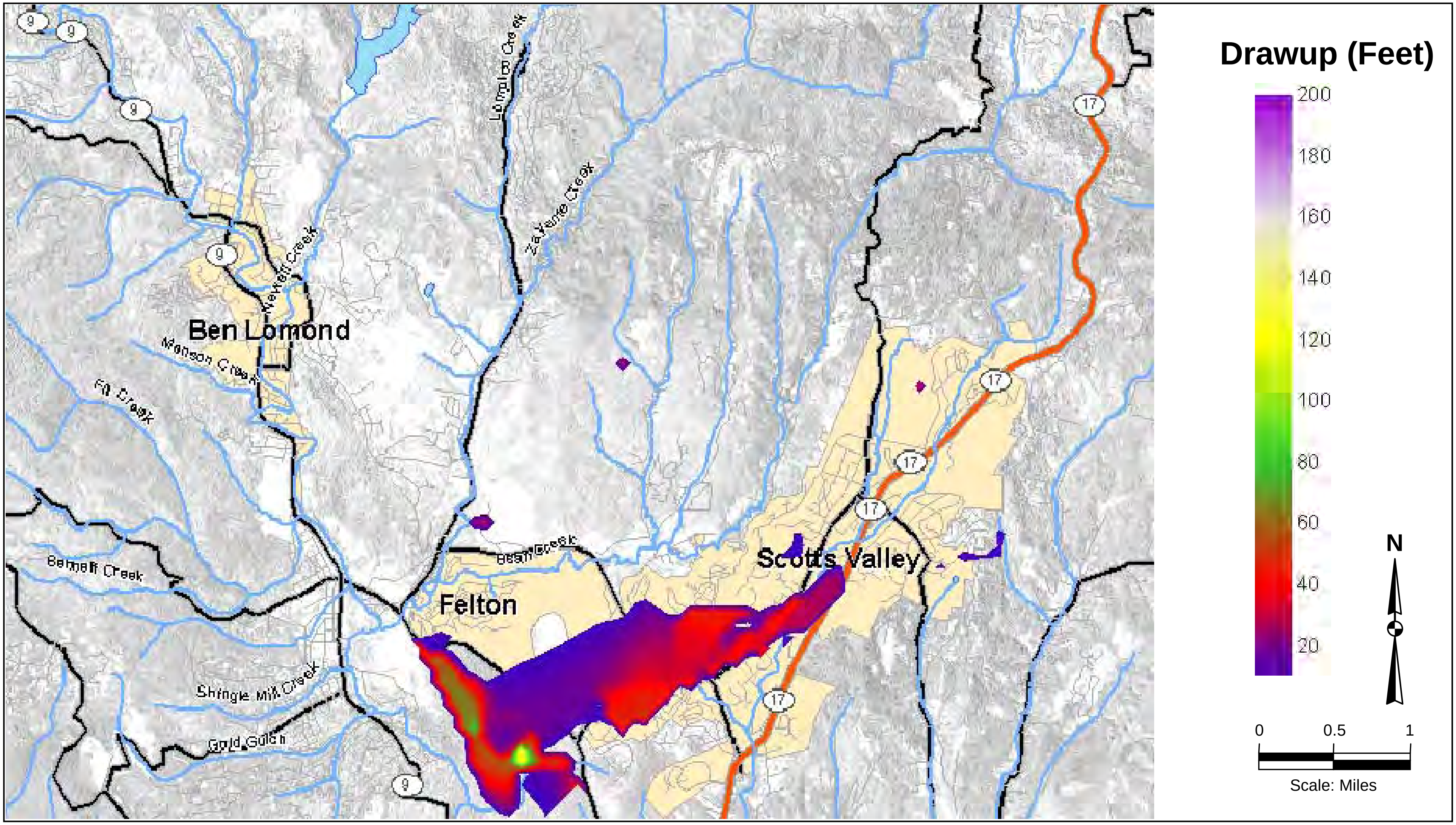
November 2010
Figure 1C-C33



Color scale runs from drawup values of 10 (blue-purple) to 200 (purple) feet.

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TM1C – Groundwater Model Evaluation
Conjunctive Use and Enhanced Aquifer Recharge Project
Santa Cruz County, California

Summer Drawup: Lompico Injection at South Hanson Quarry: 1,250 afy

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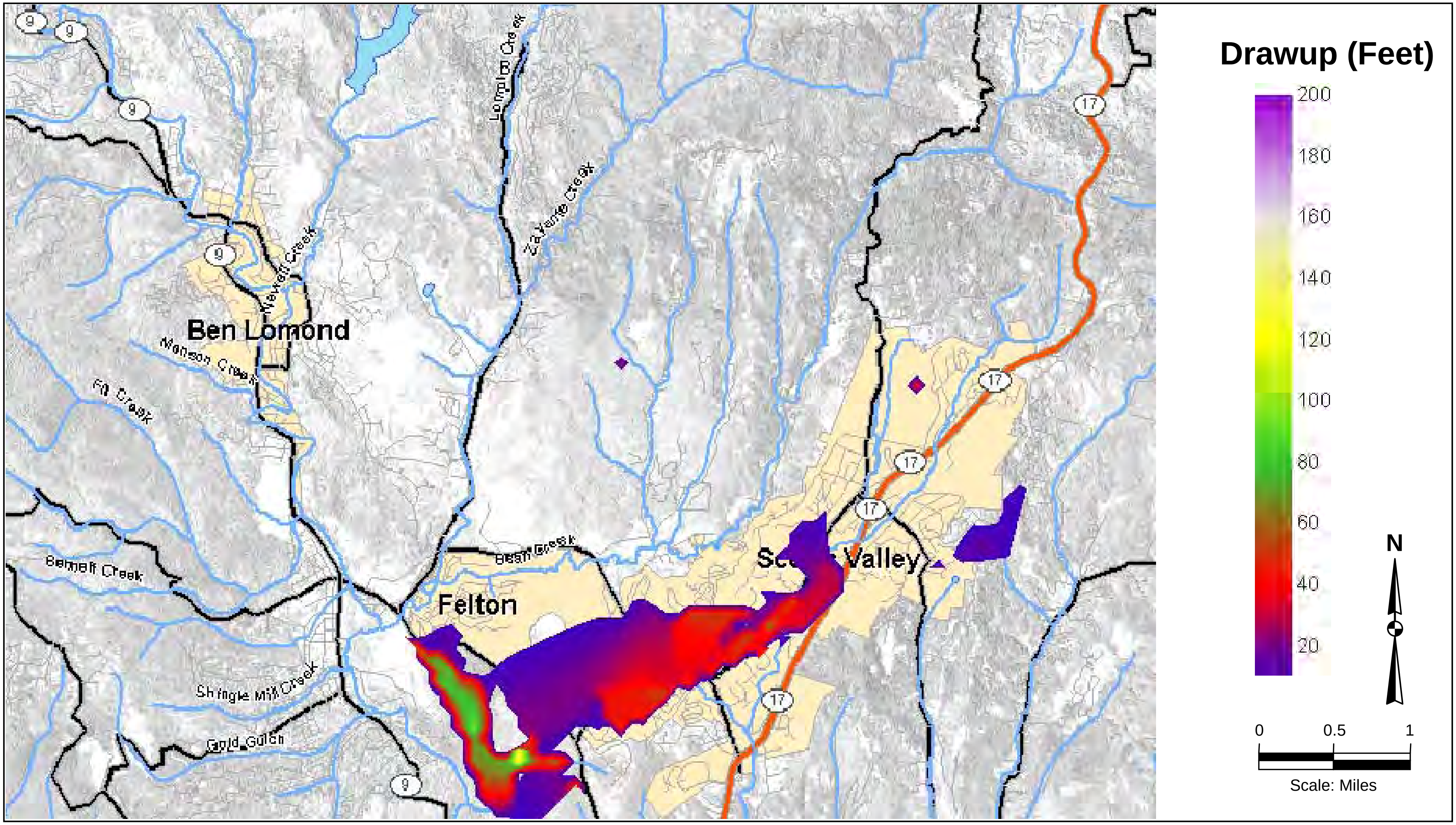
Figure 1C-C34



Color scale runs from drawup values of 10 (blue-purple) to 200 (purple) feet.

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TM1C – Groundwater Model Evaluation
Conjunctive Use and Enhanced Aquifer Recharge Project
Santa Cruz County, California

Winter Drawup: Lompico Injection at South Hanson Quarry: 1,500 afy

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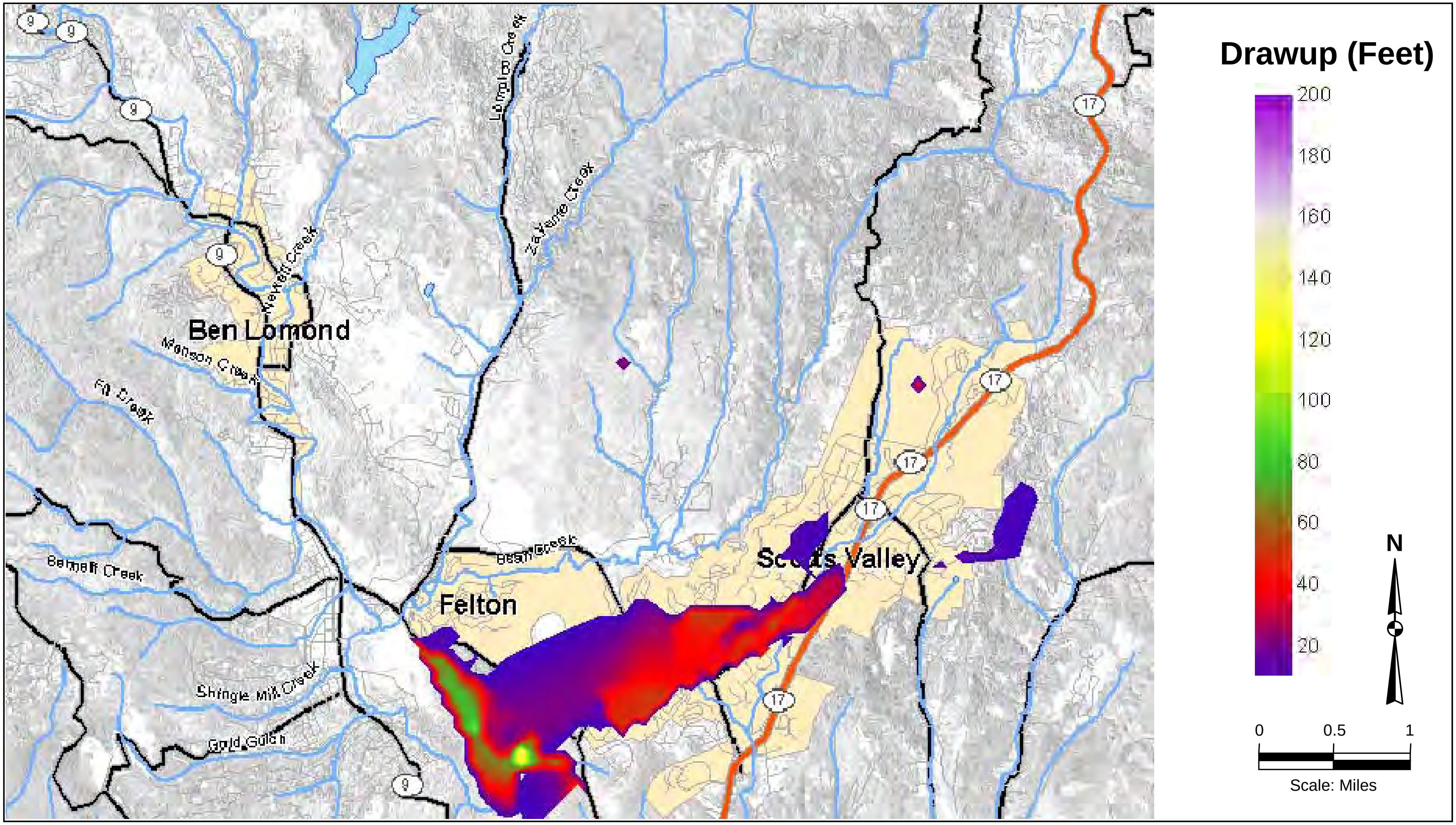
Figure 1C-C35



Color scale runs from drawup values of 10 (blue-purple) to 200 (purple) feet.

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TM1C – Groundwater Model Evaluation
Conjunctive Use and Enhanced Aquifer Recharge Project
Santa Cruz County, California

Summer Drawup: Lompico Injection at South Hanson Quarry: 1,500 afy

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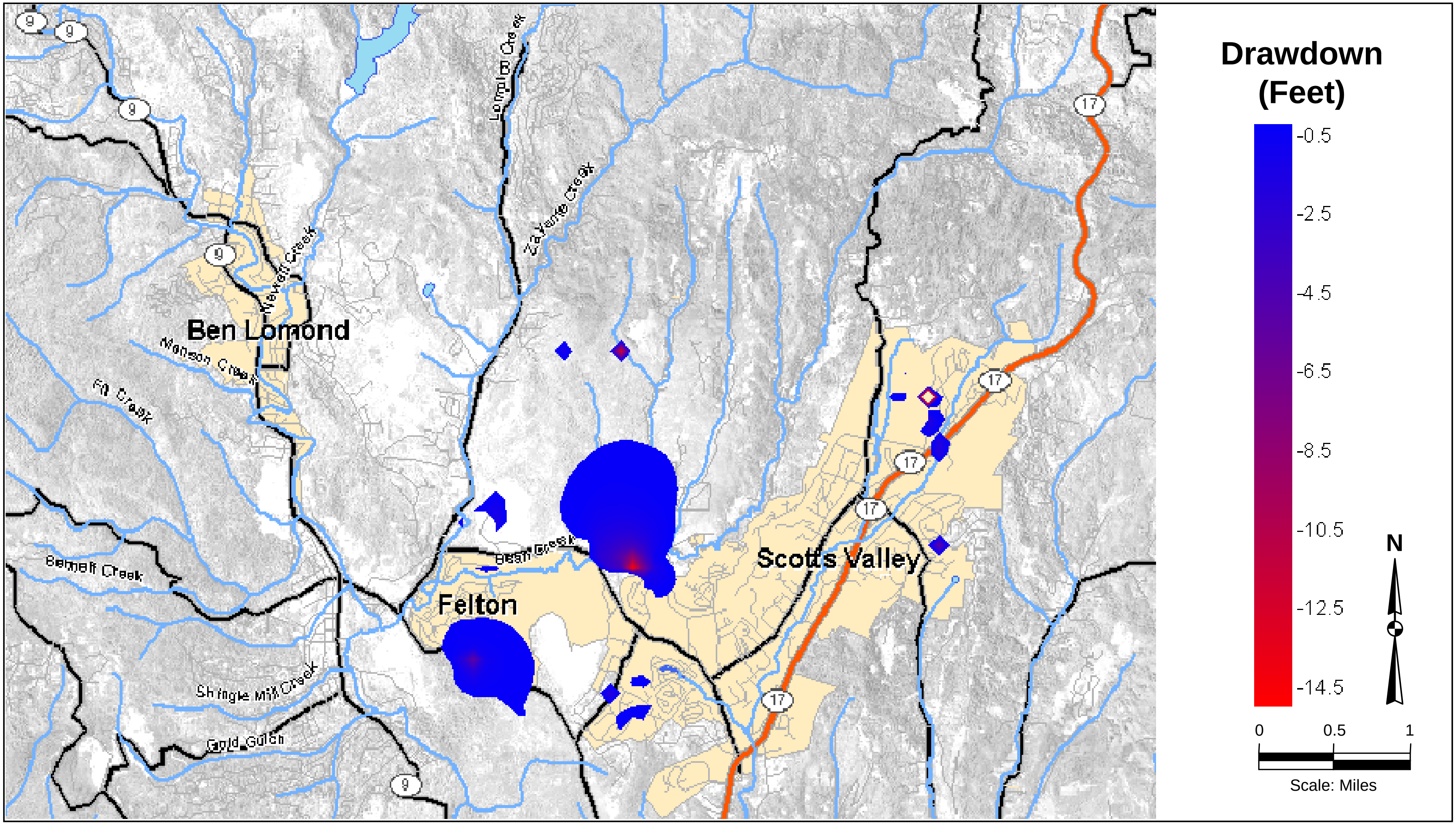
Figure 1C-C36



Color scale ranges from drawdown values of 0.3 (blue) to 15.0 (red) feet.

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TM1C – Groundwater Model Evaluation
Conjunctive Use and Enhanced Aquifer Recharge Project
Santa Cruz County, California

Winter Drawdown: Horizontal Well

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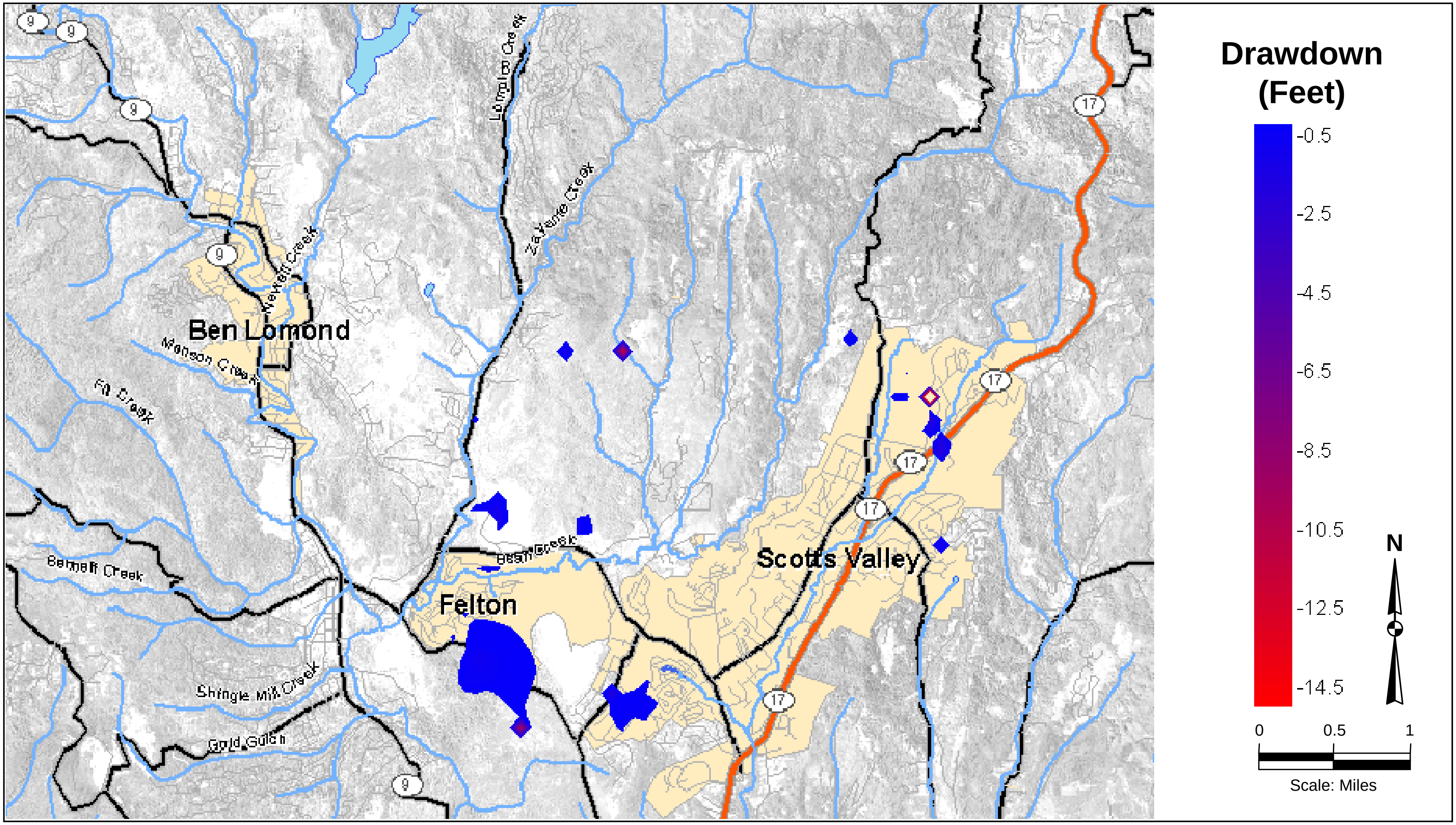
Figure 1C-C37



Color scale ranges from drawdown values of 0.3 (blue) to 15.0 (red) feet.

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TM1C – Groundwater Model Evaluation
Conjunctive Use and Enhanced Aquifer Recharge Project
Santa Cruz County, California

Summer Drawdown: Horizontal Well

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Figure 1C-C38