13 HYDROLOGY AND WATER QUALITY

This chapter describes the physical characteristics of the Village at Squaw Valley Specific Plan (VSVSP) area, focused on surface hydrology, drainage, flooding, groundwater, and water quality; identifies laws and regulations related to these resources; and presents an analysis of the environmental effects of associated with implementation of the proposed project.

13.1 ENVIRONMENTAL SETTING

Information for the environmental setting is drawn primarily from the Placer County General Plan and EIR, the Squaw Valley General Plan and Land Use Ordinance (SVGPLUO), and several project-specific reports including:

- *Village at Squaw Valley Specific Plan Water Supply Assessment* (Farr West Engineering et al. 2014; included as Appendix C).
- *Potential Impacts of Increased Groundwater Pumping on Fisheries, Village at Squaw Valley Specific Plan Project* (GANDA 2014).
- *Squaw Valley Water Quality Investigation Report, Drainage Area of Squaw Creek at the Confluence of the Main Stem and the Olympic Channel* (Balance Hydrologics 2013).
- *Design Basis Report: Squaw Creek Restoration, Squaw Valley Specific Plan, Placer County, California* (Balance Hydrologics 2014).
- *Task 4.2 Technical Memorandum on Pumping Impacts on Squaw Creek* (HydroMetrics WRI 2013a).
- *Task 4.1 Technical Memorandum on Seasonal Creek/Aquifer Interactions. Consulting report prepared for Squaw Valley Public Service District* (HydroMetrics WRI 2013b).
- *Technical Memorandum: Squaw Valley Groundwater Model 2014 Recalibration* (HydroMetrics WRI 2014).

As well as other sources where cited below.

13.1.1 Watersheds/Climate/Hydrology

The plan area is located within the low elevation portion of the approximately eight square mile Squaw Creek watershed, a tributary to the middle reach of the Truckee River (downstream of Lake Tahoe). The middle Truckee River flows northeast, terminating at Pyramid Lake, Nevada (a remnant of ancient Lake Lahontan). The main Village area is at the west end of the valley floor, at the transition from the steep headwater tributaries. The East Parcel is at the east end of the valley floor approximately 0.5 miles southwest from Squaw Creek's confluence with the Truckee River (Exhibit 13-1).

The west end of the plan area is just upstream of the confluence of the north and south forks of Squaw Creek. The North Fork has an undeveloped (0.16 percent impervious) 3.5 square mile watershed consisting of forest land and the South fork has an undeveloped (0.63 percent impervious) 1.8 square mile watershed consisting of forest land with a very small area of low density residential land (Table 13-1). The main channel of Squaw Creek flows approximately 3,200 feet along the north side of the main Village area in a trapezoidal channel constructed before the 1960 winter Olympics by the U.S. Army Corps of Engineers (USACE) (Exhibit 13-2, photographs of the trapezoidal channel are also provided in Exhibit 3-16). At the east end of the main Village area, the Olympic channel enters Squaw Creek along its south bank (see Subwatershed S9 in Exhibit 13-2). The Olympic channel drains the KT-22 and Olympic Lady portions of the ski resort, along with receiving overflow from Searchlight Pond (which stores water for snowmaking). This 0.41 square mile area of the watershed has impervious surface coverage of 1.85 percent. Total percent of impervious area for the entire watershed, shown in Exhibit 13-2, is approximately 2 percent (see Table 13-1). The majority of the impervious area within the watershed area lies between 6,200 feet and 6,300 feet (42.8 percent). Only 13.9 percent of the watershed area with an elevation less than 6,200 feet is impervious. Less than 5 percent of the area higher than 6,300 feet is impervious (MacKay & Somps 2012). Existing land use is a combination of open space, recreational, residential, and commercial in the contributing areas.

Downstream of the Olympic channel, the total contributing Squaw Creek watershed area is approximately 6.03 square miles. The creek flows approximately 2.6 river miles farther to the Truckee River, including 1.7 river miles through the broad, low gradient meadow and 0.9 river miles in a steeper gradient reach across the glacial moraine into the Truckee River canyon. The 8.8-acre East Parcel is south of and adjacent to Squaw Creek east of the main meadow (Exhibit 13-1), in the steeper gradient reach.

Table 13-1 Existing Watershed Areas and Impervious Cover Conditions in Western Olympic Valley

Squaw Valley Creek Sub-Drainage	MacKay & Somps ID[1]	Contributing Area (square miles)	Percent Impervious Cover
Headwater Tributaries			
North Fork	N1-N6, N7A-N7G	3.5	0.16
South Fork	S1-S5, S5A, S5B	1.76	0.63
Main stem Tributaries			
Unnamed Tributary to Squaw Creek #2	N8A, N8C	0.11	12.26
Unnamed Tributary to Squaw Creek #3	N8B, N8D, N8E	0.05	5.42
North Slope to Culvert	N9	0.05	26.75
Squaw Creek Direct Runoff	S5C, S6A, N91-96, S11B	0.05	39.25
Unnamed Tributary to Squaw Creek #4	S6	0.01	68.71
Cushing Pond	S7A, S7C	0.06	21.51
Unnamed Tributary to Squaw Creek #5	S7B	0.01	1.31
Searchlight Pond Overflow Area	S8A, S8, S10	0.32	7.67
Unnamed Tributary to Squaw Creek #6	S9, S11C	.02	51.39
Olympic Channel	S11A,D	0.09	1.85
Total Area/Average % Cover Entire Watershed		6.03	2.00

Notes:

[1] Subwatershed IDs from drainage studies, although some subwatersheds extend beyond the frame of Exhibit 13-2.

Source: MacKay & Somps 2012

The Olympic Valley is located just east of the crest of the Sierra Nevada and has an overall climatic pattern similar to the surrounding montane area: cool, wet winters (average daytime highs of 42F) and mild, dry summers (average daytime highs of 82F). Exhibit 13-3 expresses this trend, showing overall average monthly temperatures that are mild in the summer and cold in the winter and average monthly precipitation highest in the winter and spring and little to no precipitation in July, August, and September. The valley floor is represented by data collected at the Squaw Valley Fire Station gage, at an elevation of approximately 6,000 feet. The mountains are represented by data collected at the Squaw Valley Ski Resort SNOTEL gage, at an elevation of 8,029 feet (Farr West Engineering et al. 2014). Most of the precipitation occurs as snow between December and March, while a small percentage is received as rain in the spring and summer months.

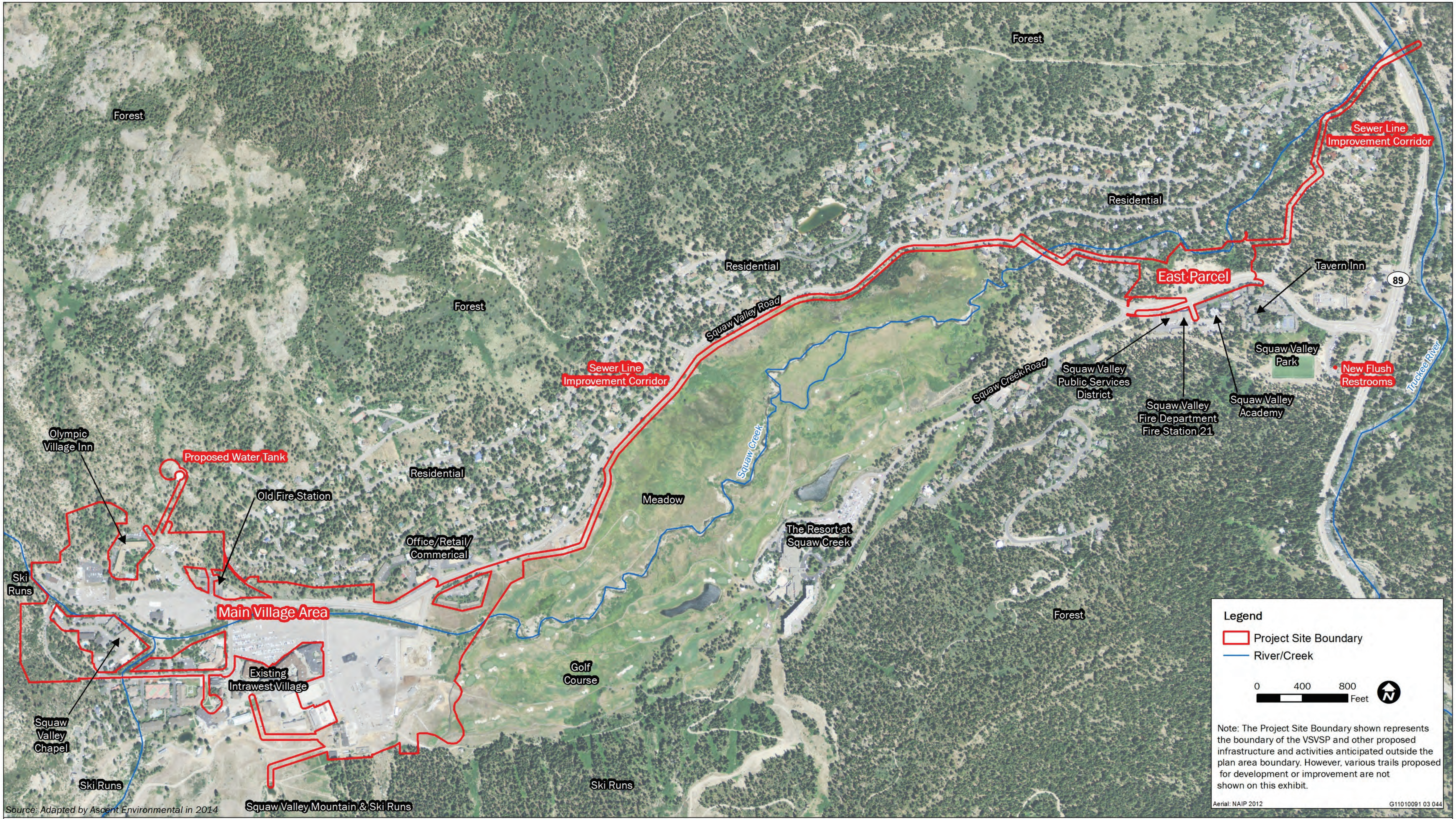

Exhibit 13-1 **Squaw Creek Watershed and Vicinity**

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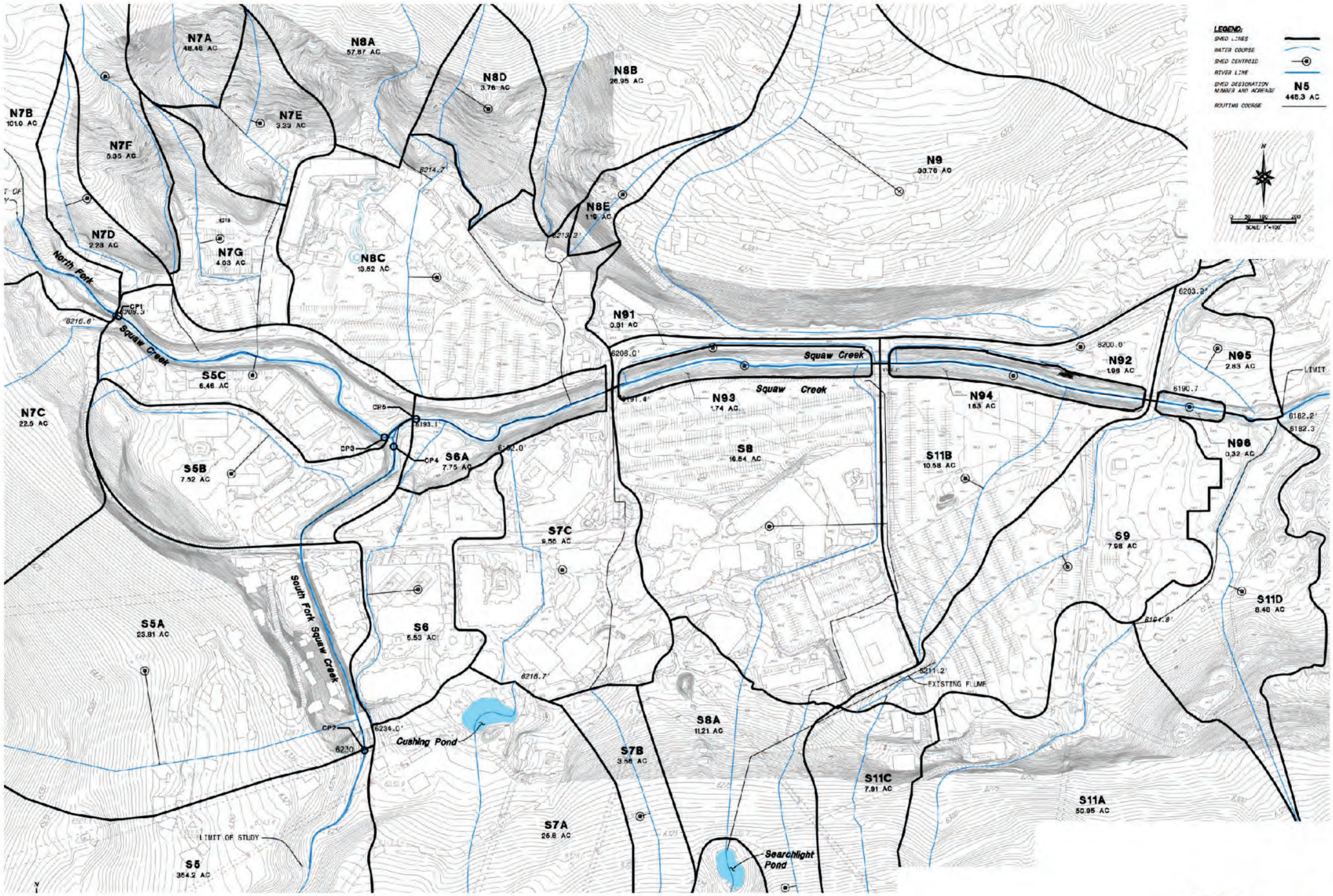

Data Source: MacKay & Somps, December 2012

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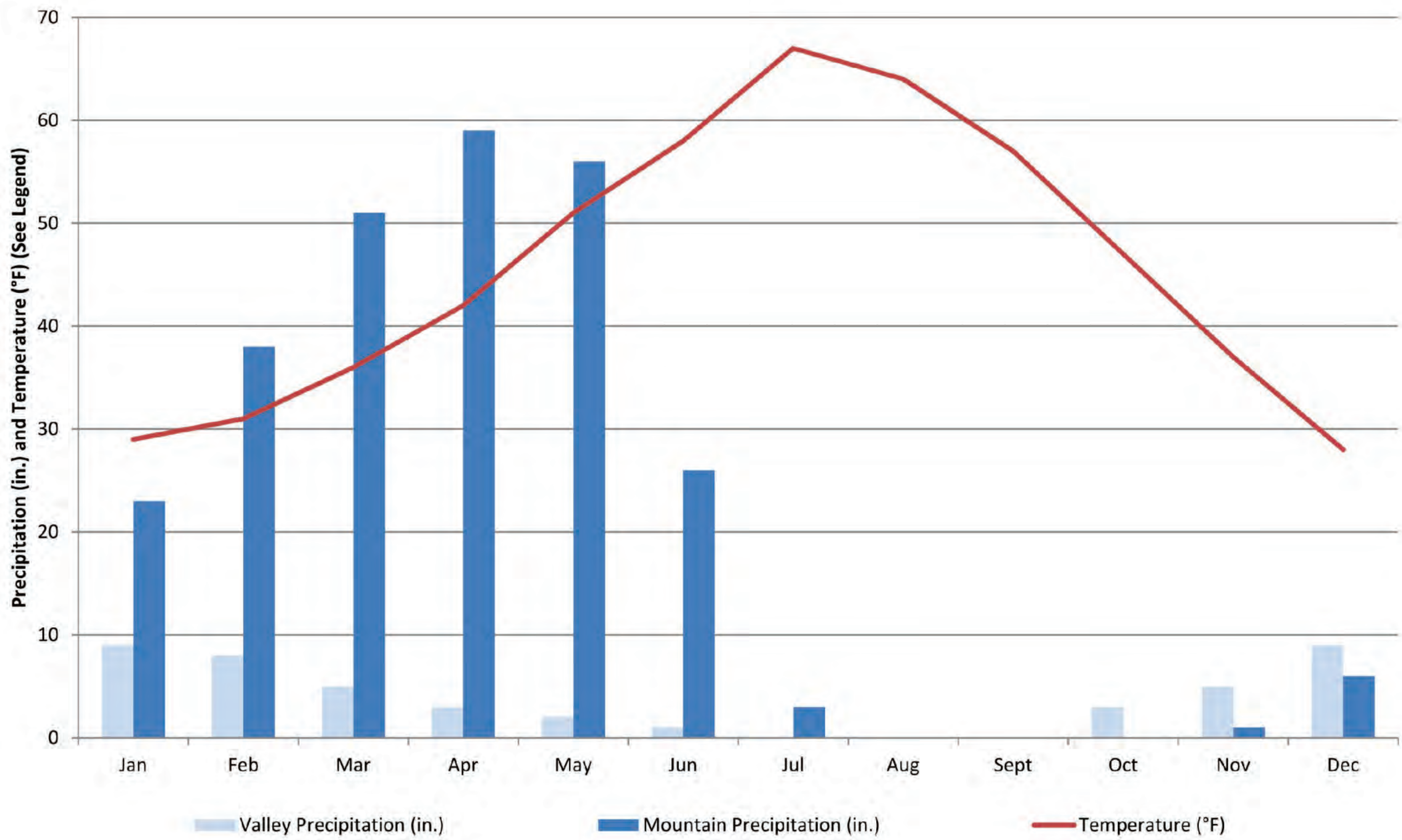
Exhibit 13-2 **Subwatersheds, Streams, and Drainage Features in Western Olympic Valley**



Data Source: Cardno Entrix, October 2014

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Data Sources include: Squaw Valley Fire Station Gage from 1992-2011 for Valley Precipitation, SNOTEL NOAA gage for the Mountain Precipitation from 1993-2011, and Truckee Station NOAA gage for the Air Temperature (ongoing).

Exhibit 13-3 **Squaw Valley Monthly Precipitation and Monthly Temperature Averages: 1992–2011**

In addition to the distinct seasonal patterns of temperatures and precipitation, conditions also vary year to year as a result of regional weather conditions. Furthermore, the nearly 3,000 foot elevation difference between the valley floor (~6,200 feet) and ridge crests (~9,000 feet) produces local climate diversity. The average total annual precipitation on the valley floor is 47 inches, while the average for surrounding mountains is 263 inches (expressed as “snow in water equivalent” meaning the inches of water both as rain and if all snow were melted) (Exhibit 13-4). The year-to-year variability in total precipitation for the valley is large relative to its average, while the variability of total precipitation (including snow in water equivalent) on the mountain is extreme (a minimum around 120 inches and a maximum over 500 inches). The pattern of years with high versus low precipitation is not consistent for the mountain and valley locations (Exhibit 13-4), which has mixed effects on surface runoff production and groundwater recharge potential.

Surface runoff generated within the various contributing sub-basins and peak flows conveyed through the stream channel have been estimated by MacKay & Somps (2012, 2014e) for storm drainage and flood assessments. Peak flows in Squaw Creek have also been calculated for the flood study (2010) and by Balance Hydrologics (2014) for stream corridor restoration design (Table 13-2).

Table 13-2 Estimated Squaw Creek Peak Streamflow, Downstream of the Main Village Area

Recurrence Interval (years)	Estimated Peak Discharge (cfs)		
	MacKay & Somps (2012)[1]	FEMA (2010)	Balance Hydrologics (2014)
2	2,200	–	200-250
5	3,000	–	470-500
10	3,500	2,226	–
100	5,200	3,206	–

Notes: -- = No value calculated, or not useful for primary purpose of study; cfs = cubic feet per second

[1] Estimates include 200 cfs resulting from snow melt.

Sources: MacKay & Somps 2012, FEMA 2010, Balance Hydrologics 2014

MacKay & Somps (2012) utilized HEC modeling software to develop hydrographs based on estimates of surface cover (land use, vegetation, and imperviousness), contributing areas and watercourse lengths, and soil types. Input precipitation values were generated from Placer County’s Precipitation Design Program (PDP). Snowmelt rates were included in the total design flows and were distinguished for 1,000 foot elevation zones in the contributing area. These provide conservative values for drainage design (higher than the FEMA estimates).

The most recent Federal Emergency Management Agency (FEMA) Flood Insurance Study (FIS) for Placer County (FEMA 2010) incorporates a hydrologic and hydraulic analysis of Squaw Creek completed by Nolte Associates, Inc. in 2004.

Balance Hydrologics (2014) compiled data from this FEMA study and a variety of other sources to produce estimates of peak streamflow at different recurrence intervals, but focused on the empirical estimates for the smaller, more frequent events as the basis for restoration design. The range of estimates for the 2- and 5-year flows will be considered and applied during final design to support creation of diverse overbank inundation areas.

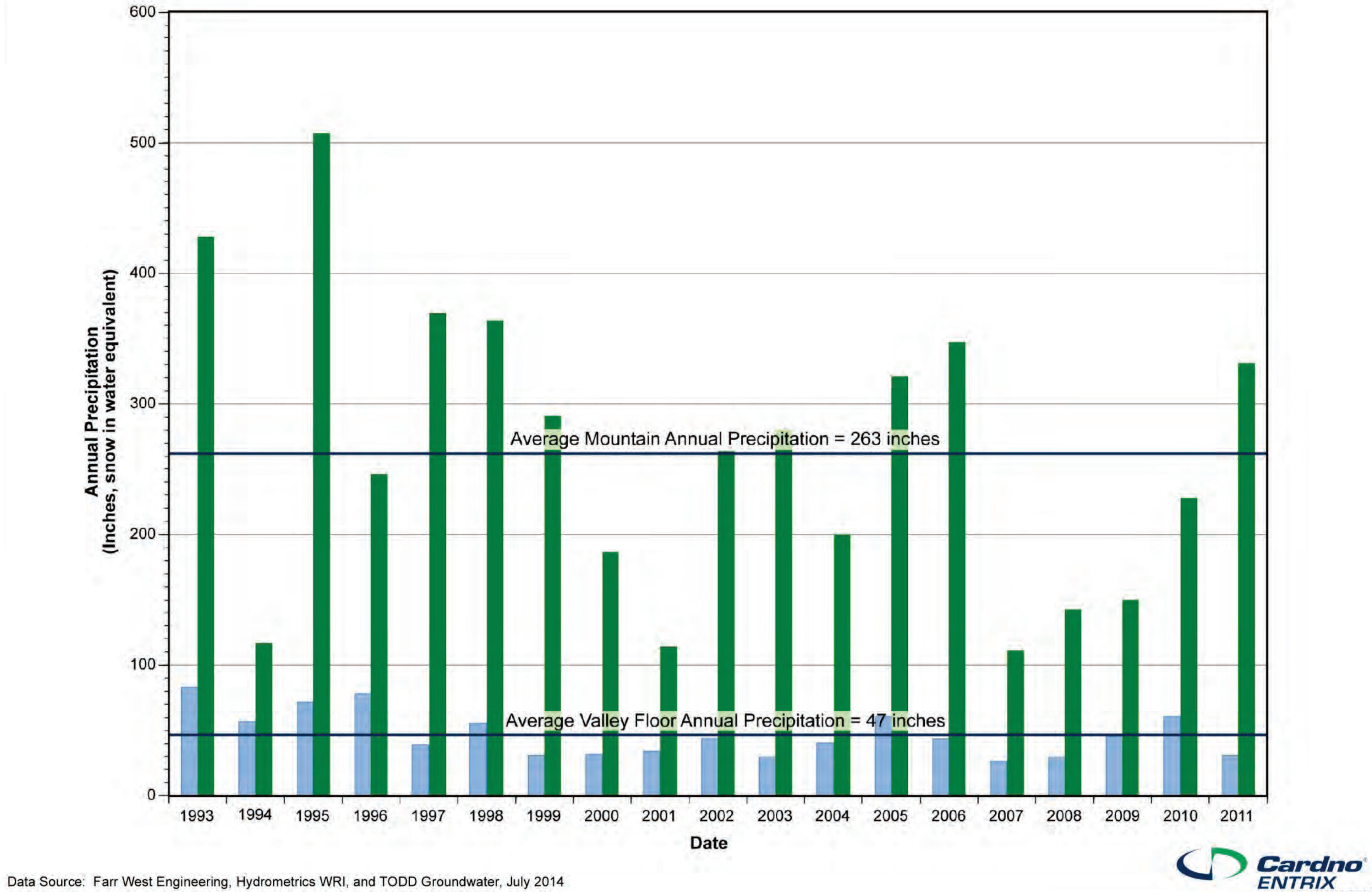

Exhibit 13-4 **Annual Precipitation in the Squaw Valley Watershed: 1993–2011**

13.1.2 Surface Water Features

The surface water features draining to and through the main Village area include a combination of natural features and artificially modified or constructed elements (Table 13-3, Exhibit 13-2, and Appendix E2). The North Fork and South Fork channels of Squaw Creek are largely unmodified, except in the reaches immediately upstream of the confluence, which have concrete-protected infrastructure crossings, storm drainage outfalls, and sections of hardened bank protection.

Table 13-3 Surface Water Features of the Plan Area

Location	Natural Features	Modified Elements
Upstream/Upslope of Plan Area	Upper North Fork Squaw Creek Upper South Fork Squaw Creek Upper Olympic Channel Unnamed tributaries	South Fork Squaw Creek just above confluence North Fork Squaw Creek just above confluence Cushing Pond Searchlight Pond
Main Village Area	Unnamed tributaries Wetland adjacent to confluence of Squaw Creek and Olympic Channel	Squaw Creek main channel Searchlight Pond/Olympic Channel flume Olympic Channel (Lower)
East Parcel Area	Squaw Creek Wetlands	None

Source: Data provided by Cardno ENTRIX in 2014

Several unnamed intermittent and ephemeral drainages contribute to Squaw Creek at and downstream of the headwaters' confluence (Exhibit 13-2). The tributaries on the north side of the valley tend to flow in natural channels up to the margin of the existing developed land uses; then are conveyed through open ditches and pipes with discharge outfalls along the stream. The tributaries on the south side of the valley are within the managed ski area, and have modified channels, swales, and small earthen dams and water storage ponds (Exhibit 13-2).

Substantial changes to the stream channels of the main Village area were made in the 1950s in anticipation of the 1960 Olympics (Balance Hydrologics 2014), eliminating the meandering, dynamic main channel and altering the pathways, flows and sediment delivered from various tributaries. From the confluence downstream through the main Village area, Squaw Creek is an artificially constructed trapezoidal channel with relatively uniform dimension (90 feet wide and 25 feet bottom width) and low bed slope (0.4 percent). Bed material generally consists mostly of small cobbles intermixed with decomposed granite and fine sediment. The stream banks are vegetated, although some areas are sparsely vegetated or barren. The channel modifications altered historical channel processes, increasing sediment transport locally and depositing materials further east (at the confluence with the Olympic Channel). Modified sediment transport characteristics in the trapezoidal reach have contributed to channel instability downstream (Balance Hydrologics 2014).

Olympic Channel has a natural upslope watershed and also receives water from Searchlight Pond, which drains off the KT-22 and Olympic Lady portions of the mountain. The pond outfalls to a flume that bypasses a series of wetlands, culvert crossings, and wetland meadows, and discharges to a culvert that crosses under the parking lot and outfalls at the head of wetland IS-6, which ultimately joins Squaw Creek just upstream of the site boundary and the golf course bridge (Exhibit 13-5).

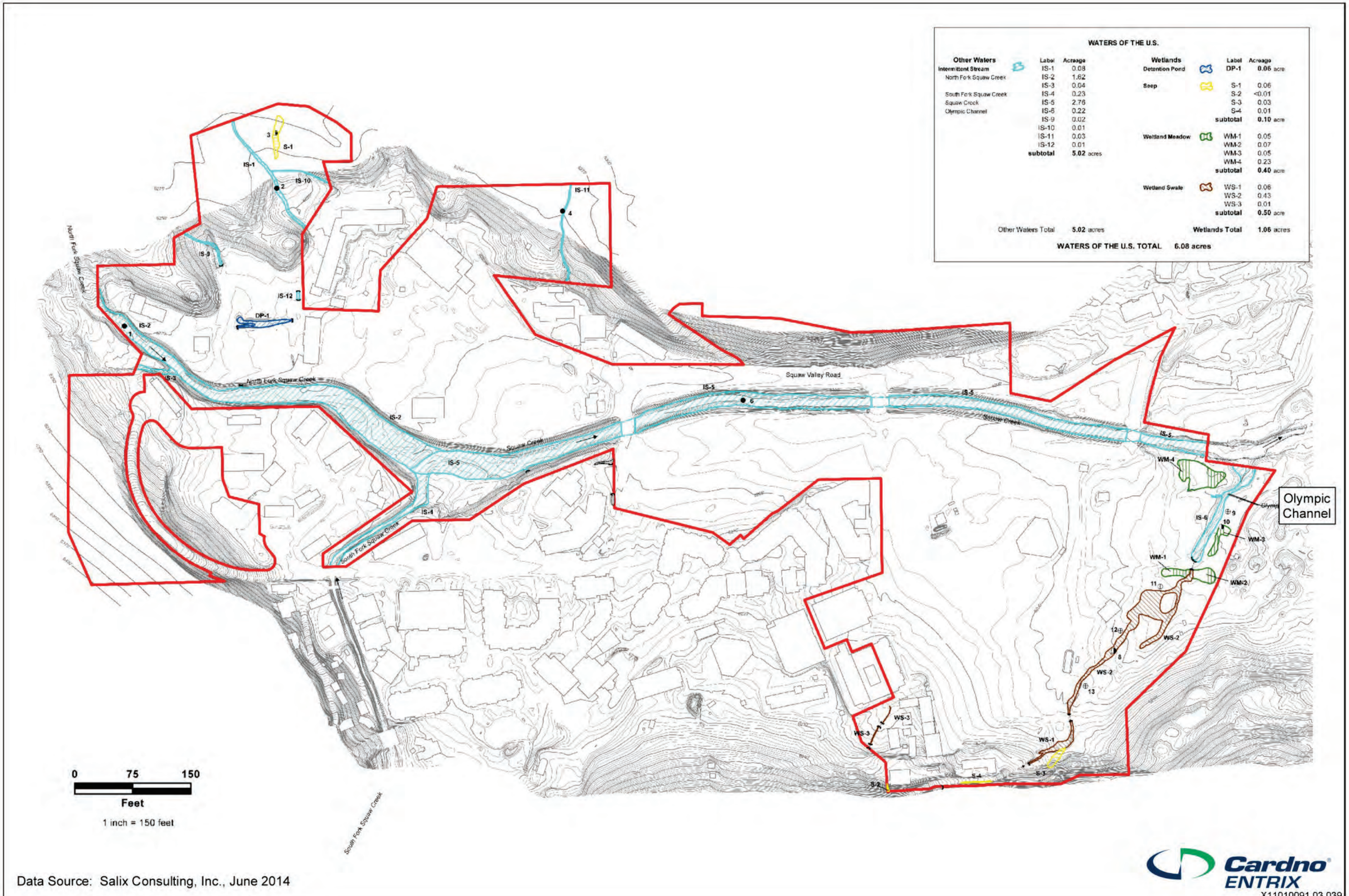

Exhibit 13-5 **Wetland Delineation Map Showing Waters of the U.S. in the Main Village Area**

The headwater tributaries and main stem of Squaw Creek, as well as the Olympic Channel, are intermittent streams through the main Village area (Salix Consulting 2014). These channels may have surface water year-round during above-normal or wet years, but are typically dry during the late summer and may be dry throughout severe drought years.

In the East Parcel area, Squaw Creek is located just north of the parcel, which drains to the creek. Small seeps, swales, and wetland areas on the east and west sides of the parcel carry surface drainage to the creek (see Appendix E2 for wetland delineation maps).

13.1.3 Groundwater

The alluvial aquifer underlying Olympic Valley is the Olympic Valley Groundwater Basin (OVGB) as designated by the California Department of Water Resources (DWR) (DWR basin No. 6-108). It has a surface area of slightly over one square mile (700 acres) (Exhibit 13-6). The geohydrology of the basin has been characterized multiple times by several investigators over the decades and these data have been integrated in the Squaw Valley Public Service District (SVPSD) Olympic Valley Groundwater Management Plan (OVGMP) (HydroMetrics WRI 2007). The OVGMP area is slightly smaller than the OVGB (Exhibit 13-6), varying at the west end of the basin based on HydroMetrics' geologic studies and excluding a portion of the eastern end of the OVGB, because the glacial moraine sediments (the forested area by the intersection of Squaw Valley Road and Squaw Creek Roads) represent an effective barrier to groundwater movement.

SVPSD uses a numerical model to simulate groundwater conditions in the OVGB. This model uses the U.S. Geological Survey (USGS) MODFLOW computer code and was initially developed in 2001. The model has been updated many times as additional data has been obtained to refine the conceptual framework and improve calibration. The update used in the WSA scenarios (HydroMetrics WRI 2014) incorporated additional data regarding the thickness and extent of the geologic units, made adjustments to the recharge zones and precipitation infiltration timing, corrected unrealistic pipe loss assumptions, and extended the calibrated model period to include additional available data. As of this update, the model incorporates precipitation, withdrawal, and groundwater conditions recorded for the period from May 1992 to December 2011. The calibration statistics show a slight bias towards underestimating average groundwater elevations, but an improved calibration relative to previous model iterations (HydroMetrics WRI 2014). Review of the observed groundwater level data and simulated hydrographs for individual wells (HydroMetrics WRI 2014) indicates that the model does not capture the lowest observations in several of the calibration well records, even as it matches typical and high elevation observations (e.g., Olympic Valley well ID numbers: SVPSD-5S, SVPSD-5R, SVMWC-1, SVMWC-2, RSC-328, RSC-304, RSC-305, RSC-323, RSC-325, RSC-326, RSC-308, RSC-312, RSC-321, RSC-322, RSC-320). Therefore, interpretation of model simulation results for either existing or future conditions should consider that the model may have a small bias that does not reflect extreme drawdowns at local wells(i.e., the simulated 'lowest' elevations could be a few feet too high), but does reflect the regional aquifer conditions.

The bedrock beneath Olympic Valley forms a trough that trends generally east of northeast, carved in igneous bedrock that is not porous, but may hold some groundwater in vertical fractures. The unconsolidated sediments filling the bedrock trough were deposited by a combination of glacial, fluvial (stream), and lacustrine (lake) processes and have varied composition and extent. The lateral and vertical variation in materials has complicated mapping and correlation of the lithologic units (i.e., particular rock formations) (Farr West Engineering et al. 2014). Recent analyses characterize three hydrogeologic units:

- Unit 1 is the surface unit (~ the five to 25 feet of soil/sediment closest to the ground surface), comprised of fine sands and silts in the west with increasing fines (clay, silts, peaty organics) to the east;
- Unit 2 is the underlying layer, which has a wide range of depth and thickness but is the primary water-bearing unit of sands and gravels, with increasing silt and clay to the east; and,
- Unit 3 is the base layer, comprised of fine materials and occasional sand and gravel, occurring primarily in the east and having low production capacity.

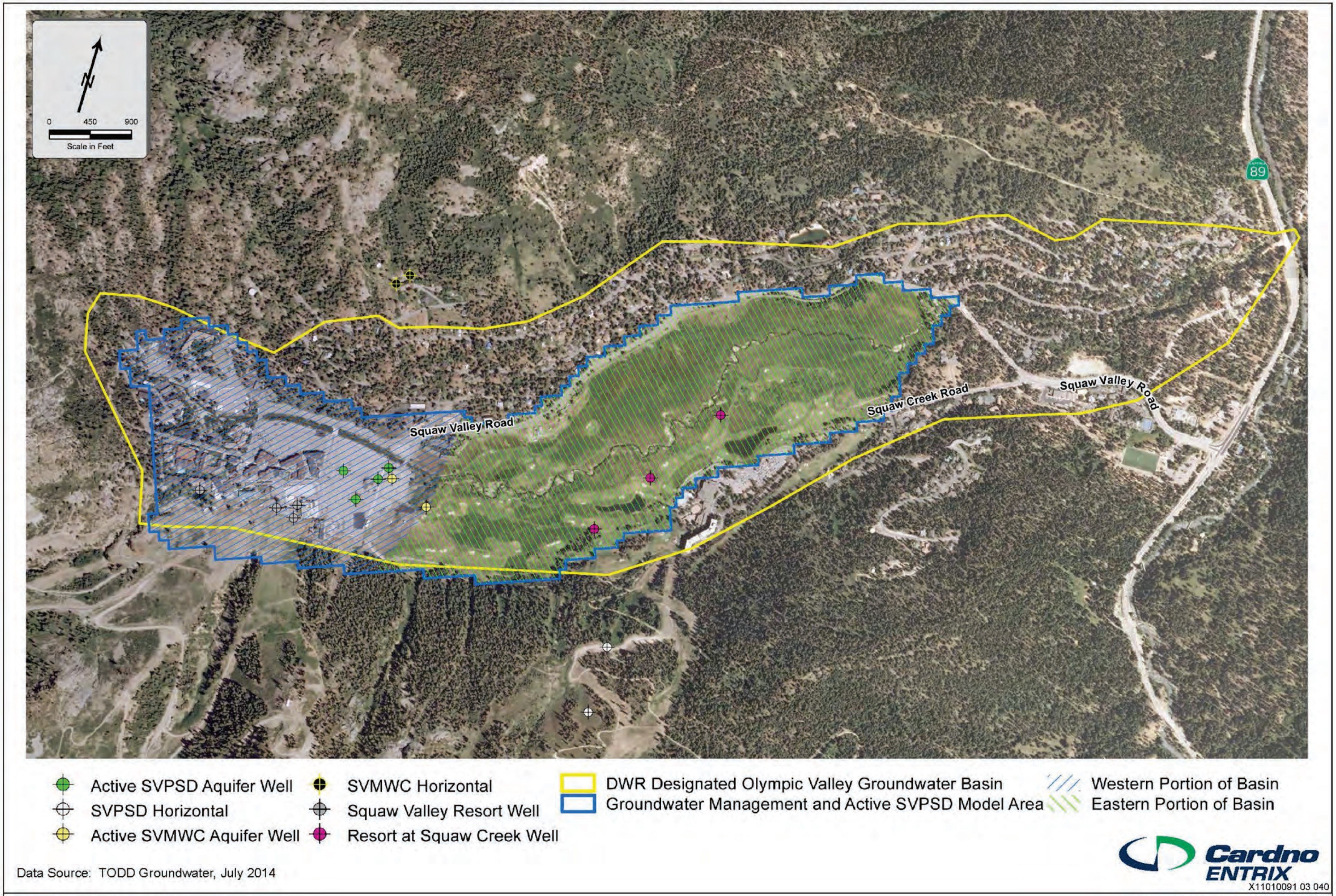

Exhibit 13-6 **Olympic Valley Groundwater Basin and Existing Wells**

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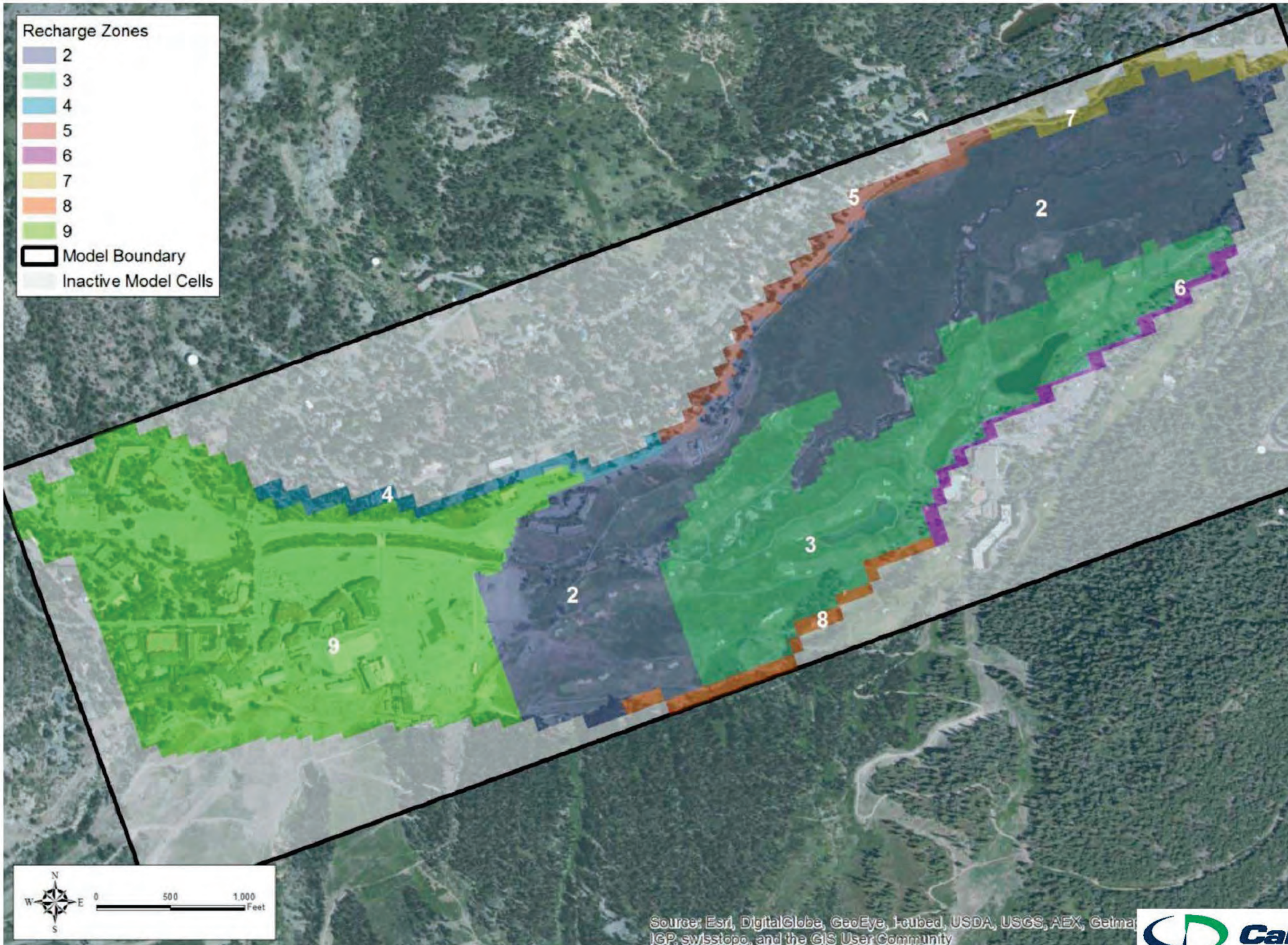
Generally, materials in the western portions of the basin are coarser and have higher groundwater storage and transmission capability.

Groundwater in the OVGB generally flows from west to east, with some flow towards the center of the basin off the north and south side slopes. Flow patterns are also affected by local depressions around production wells during pumping.

The groundwater model identifies eight recharge zones (numbered 2 through 9) to the OVGB (Exhibit 13-7), and recent studies have been conducted to refine the understanding of recharge mechanisms, locations, and temporal patterns (Moran 2013, HydroMetrics WRI 2013a). The exact locations, extent and magnitude of recharge from different sources have not been precisely quantified. Recharge occurs primarily through deep percolation of direct precipitation through the valley floor soils to the underlying unconfined aquifer, infiltration of surface runoff off surrounding hill slopes, and subsurface flow along the mountain front. It remains uncertain whether recharge from the mountain front is relatively uniform around the basin margins, or if there are particular locations with more concentrated infiltration. Deep percolation of direct precipitation and infiltration of surface runoff can be restricted by rainfall or snow melt rates exceeding the soils' ability to accept water (including blocking effects of snow cover), or when the ground is already fully saturated. Fractured bedrock has been determined to have little net contribution to the valley aquifer (Farr West Engineering et al. 2014; included as Appendix C). Streambed infiltration is also limited on an annual basis. However, infiltration from the stream to the aquifer does occur at critical times, such as when groundwater levels begin to decrease, creating additional storage. Groundwater losses to surface water in Squaw Creek do occur and generally peak during the winter and spring when groundwater elevations are higher than surface water elevations in the channel (and the channel bed).

While complex and not fully mapped or quantified, the existing groundwater recharge conditions are not pristine. Historical development on the valley floor may have reduced direct infiltration opportunities where soils have been covered by impervious surfaces. Conversely, vegetation and soil cover management on ski slopes may have increased potential hill slope or mountain front infiltration. Groundwater is the major source of domestic and irrigation water supply in Olympic Valley, with an existing network of nine vertical wells in the alluvial aquifer and five horizontal wells into fractured bedrock (Exhibit 13-6). Groundwater extraction by the SVPSD, Squaw Valley Mutual Water Company (SVMWC), Resort at Squaw Creek (RSC), and existing Squaw Valley Resort (SVR) for irrigation, snowmaking, commercial, and residential uses occurs year-round but is greater in summer months. Historical groundwater data for the SVPSD and SVMWC production wells in the western wellfield demonstrate that the wells experience large annual fluctuations (10 to 15 feet) between the winter/spring maxima and the summer/fall minima (Exhibit 13-8). The year-to year fluctuations are smaller than the seasonal changes, typically less than five feet (Exhibit 13-8) and closely reflect year-to-year precipitation patterns (Exhibit 13-4). Historical groundwater elevations do not display a distinct trend of increase or decrease over time. Groundwater elevations recover to within ten feet of the ground surface (~6,200 feet) in slightly more than half (11) of the 19 years of record (i.e., the 1992 to 2011, 19-year period of precipitation and groundwater data used for the groundwater model), and recover to within 15 feet in remaining years. HydroMetrics WRI (2007) found that even in years with below average precipitation, water levels rose to "near the maximum elevations," suggesting the basin was near total capacity even in dry conditions. The existing groundwater elevation record (Exhibit 13-8) can also be interpreted as indicating that groundwater levels may rise quickly (e.g. 1994-1995) or slowly (e.g. 2001-2004), and levels can drop a few feet soon after wet year maxima (e.g., 1993-1994, 2006-2009). However, the pattern of precipitation, recharge, and pumping all affect the groundwater elevation patterns observed in these active production wells. The percent saturation[1] data for existing wells over the same historical period shows that most of the wells recharge to over 95 percent saturation in most years, but the SVPSD-2R well experiences seasonal low percent saturation under 80 percent in many years, and its maxima are around 90 percent (Exhibit 13-9).

[1] Percent Saturation, in this case, is defined by Farr West Engineering et al. to be the percent of the maximum depth/height of the aquifer that is saturated at any given time. For example, if the distance between the maximum recorded groundwater elevation and underlying bedrock that stopped further downward migration of groundwater was 100 feet, the maximum holding capacity or saturation is 100 feet (i.e., when groundwater elevations are at the highest). If groundwater was 10 feet below the maximum elevation, 90 feet of the aquifer would be saturated with groundwater, and the percent saturation would be 90 percent.



Data Source: Farr West Engineering et al., July 2014

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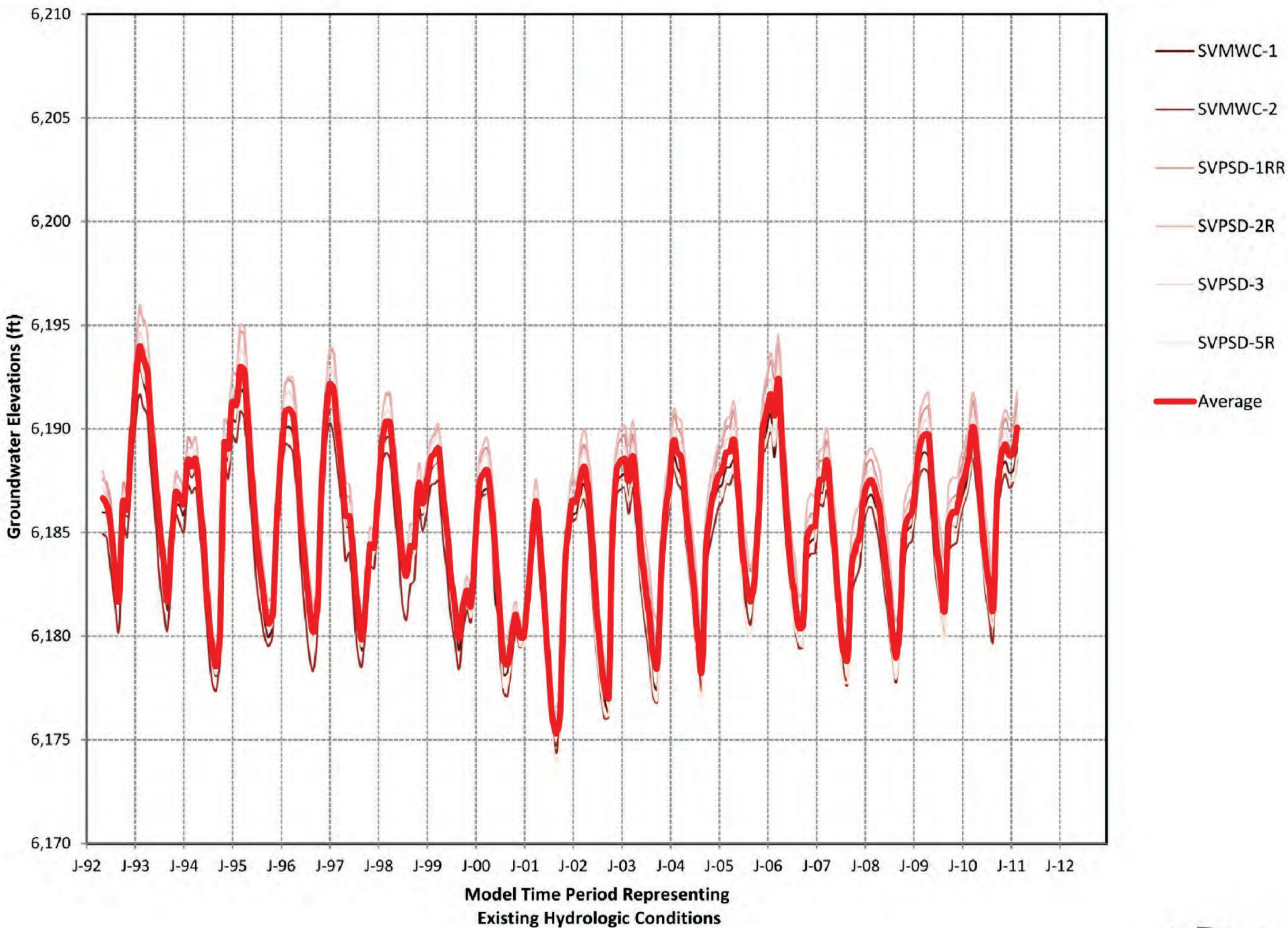
Exhibit 13-7 **Squaw Valley Groundwater Basin Recharge Zones**



Data Source: Cardno Entrix Email Correspondence with TODD Groundwater, October 2014

Cardno ENTRIX

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Exhibit 13-8 **Groundwater Elevation in Existing Wells: 1992–2011**

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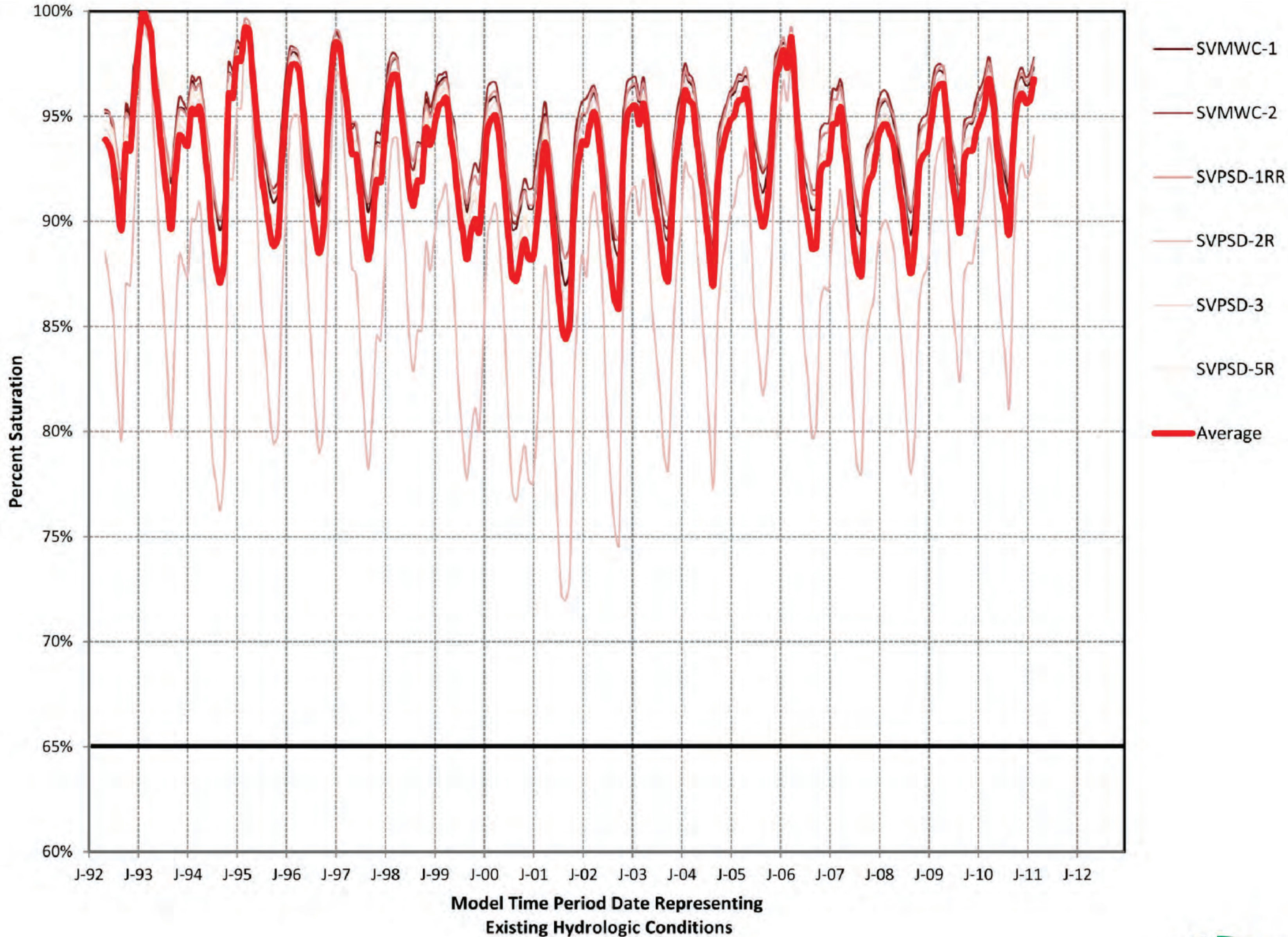

Data Source: Cardno Entrix Email Correspondence with TODD Groundwater, October 2014

Cardno ENTRIX

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Exhibit 13-9 **Percent Saturation in Existing Wells: 1992–2011**

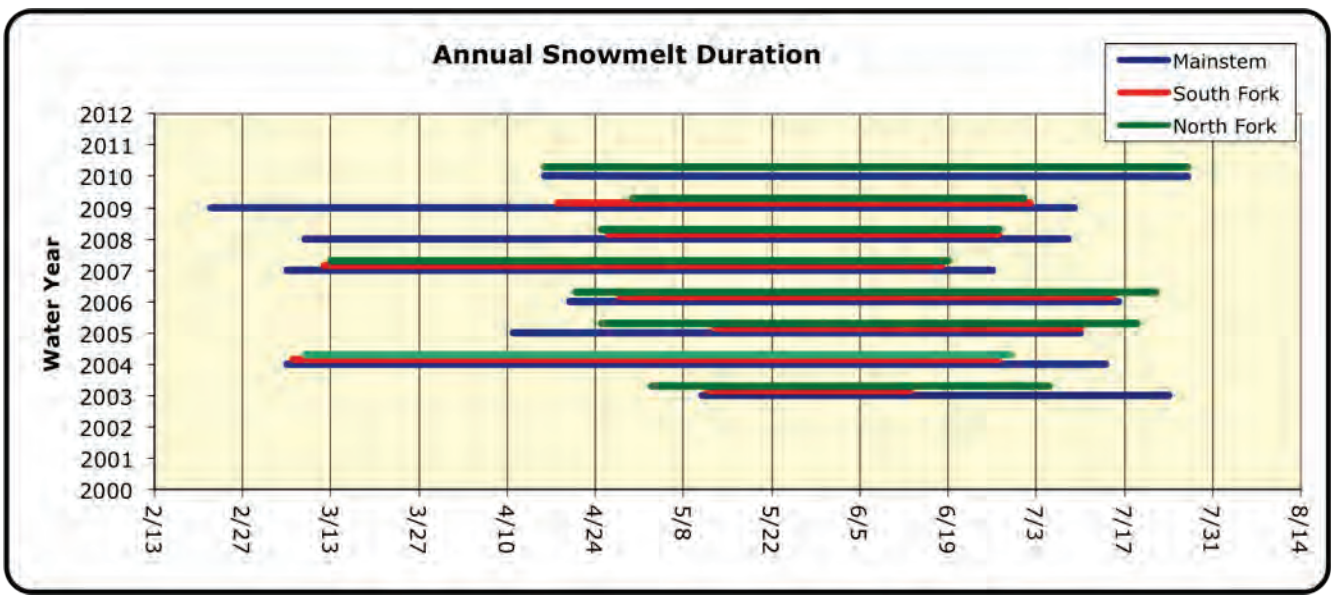
ASCENT ENVIRONMENTAL

The WSA for the proposed project (Farr West Engineering et al. 2014) concludes that in all years there is ample runoff produced in the watershed, but much of it is generated during times when the groundwater basin is already 'full' and therefore it is rejected as recharge and leaves the watershed as surface runoff in Squaw Creek. Regardless of some uncertainty about how readily and completely recharge occurs under various water year types, no studies of the OVGB indicate that the aquifer has been or is now experiencing overdraft.

GROUNDWATER-SURFACE WATER INTERACTION

Groundwater and surface water interactions are controlled by several factors, including the overall surface hydrology and groundwater hydrology conditions described above, and their spatial and temporal interactions with the existing channel geomorphology, topography, and groundwater extraction patterns. Groundwater and surface water interactions throughout Olympic Valley (and in Squaw Creek) have been modified for many decades, through direct reconstruction and straightening of the stream channel(s), developed land use effects on slope and valley floor infiltration and runoff patterns, groundwater extraction, and the stream channel responses to the various disturbances.

Streamflow in Squaw Creek has been measured (initially by the SVPSD and subsequently by the Friends of Squaw Creek) since late 2002 at three locations: North Fork Squaw Creek near the Shirley Canyon trailhead; South Fork Squaw Creek downstream of the Sunnyside ski run bridge; and, Squaw Creek near the eastern Placer County bridge on Squaw Valley Road (Sound Watershed Consulting 2013). The primary source of flows in Squaw Creek is snowmelt runoff, while periodic major flood events are usually rain-on-snow events. Snowmelt lasts for several months, typically beginning between late February and mid-April and lasting until mid-June or later (Exhibit 13-10). The low-flow months are typically August, September, and October, although some sections of the stream may have more persistent low flows and/or remain dry year-round during droughts.

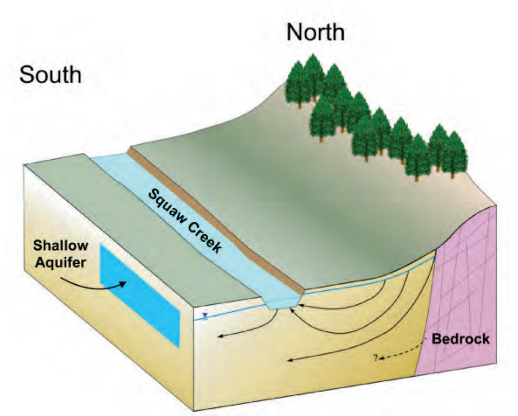


Source: Sound Watershed Consulting 2013

Exhibit 13-10 **Squaw Creek Snowmelt Duration: 2003–2010**

Existing aquifer-creek interactions have been studied using shallow and deep aquifer piezometers near the creek; monitoring wells throughout the valley; aquifer tests; temperature probes; and supplemental studies using radon, distributed temperature testing, and stable isotopes (HydroMetrics WRI 2013a). The interactions between the stream and groundwater are complex and have distinct seasonality in the channelized reach of Squaw Creek (Table 13-4). The interactions between the stream and groundwater in the meadow reach are relatively consistent seasonally (Table 13-5).

Table 13-4 Existing Groundwater/Surface Water Interactions: West Olympic Valley

Season	Groundwater Condition	Surface Water Condition	Relationship	Groundwater Age and/or Recharge Source
Winter through Early Spring	Groundwater elevations are generally above the streambed	Relatively high streamflow derived from rainfall and snowmelt	Groundwater discharges to the stream; stream gains 80 gallons per minute per 1,000 feet of channel.	Relatively young groundwater; recharge is estimated to occur between 6,200 feet and 8,000 feet of elevation with most recharge occurring just above the Olympic Valley floor.
Late Spring to Early Summer	Groundwater elevations are near the streambed	Relatively high, but declining streamflow	 Groundwater from the north side discharges to the stream, and the stream discharges to groundwater south of the channel.	While snowmelt and streamflow persist, groundwater produced from wells is expected to remain relatively young; recharge continues to occur from the mountain front areas; fracture flow may make a limited contribution to groundwater recharge.
Mid-Summer	Groundwater elevation is below streambed	Relatively low streamflow as snowmelt runoff ends	Creek starts losing water to the aquifer, losing more at the eastern end of the trapezoidal channel than near the middle of the creek.	Groundwater produced from wells may still be relatively young; recharge from stream losses occurs in addition to remnant mountain front recharge.
Late Summer to Fall	Groundwater elevation is below streambed	Streamflows go to zero due to lack of surface or groundwater inputs, with some pools remaining	No exchange occurs until first large fall precipitation events; then creek loses water to the aquifer until groundwater levels rise. Groundwater elevations rise quickly after storms and are well-connected to the stream.	Groundwater pumped during this time has been shown to be 3 to 5 years old.

Source: HydroMetrics WRI 2013b

Aquifer tests have indicated that pumping from existing wells during periods when Squaw Creek is flowing (typically winter/spring/early summer) captures only a small amount of extracted water from the creek (<2 percent, <0.2 cfs) (HydroMetrics WRI 2013a); that is, during periods of the year when the creek is flowing, pumping of groundwater from existing wells results in only a small amount of creek surface flows being "pulled" into the groundwater aquifer. Under these conditions, current groundwater pumping does not substantially alter stream flow. However, during periods when there are lower flows in the creek (typically summer and fall), pumping from existing wells would capture a higher overall percentage of the reduced flow and existing pumping operations can have a greater influence on observed stream surface flows.

Table 13-5 Existing Groundwater/Surface Water Interactions: East Olympic Valley

Season	Groundwater Condition	Surface Water Condition	Relationship	Groundwater Age and/or Recharge Source
Winter through Early Spring	Groundwater elevations are generally above the streambed	Relatively high streamflow derived from rainfall and snowmelt	Groundwater discharges to the stream at a fairly steady rate	Groundwater that seeps into the creek is at least two years old.
Late Spring to Early Summer	Groundwater elevations are generally above the streambed	Relatively high, but declining streamflow (groundwater comprises ~5 percent of surface flow)	Groundwater discharges to the stream at a fairly steady rate; Groundwater discharge becomes an increasing percentage of surface flow by mid-summer	Groundwater that seeps into the creek is at least two years old.
Late Summer	Groundwater elevations are generally above the streambed	Relatively low streamflow, nearly entirely comprised of groundwater	Groundwater discharges to the stream at a fairly steady rate	Groundwater that seeps into the creek is at least two years old.
Fall	Groundwater elevation falls below streambed	Streamflows go to zero due to falling groundwater inputs	Groundwater discharges to the stream at a decreased rate	Groundwater that seeps into the creek is at least two years old.

Sources: HydroMetrics WRI 2013b, Moran 2013

13.1.4 Drainage and Flooding

STORM DRAINAGE

About 5.3 square miles (~88 percent) of the 6.03 square mile watershed draining to Squaw Creek at the downstream end of the main Village area lacks any engineered stormwater drainage systems. The remaining 0.73 square mile area has been modified for recreation, commercial, residential, and related developed land uses and is served by a drainage system comprised of various open channels, pipes, and culverts that discharge to the stream channels (Exhibit 13-11), and were installed by several parties over many decades.

There is one storm drain outfall along the South Fork channel, serving the developed areas west of the confluence and outside the plan area (sub-basins S5B, S5C in Exhibit 13-11).

Runoff generated on the slopes above and northwest of the Olympic Village Inn and the Olympic Valley Lodge (sub-basins N7, N8A, N8D in Exhibit 13-11) is conveyed through stormwater pipes mingled with runoff from the developed areas and west parking lots (sub-basins N7G, N8C in Exhibit 13-11) to several outfalls along the north bank of Squaw Creek upstream of the Squaw Valley Road bridge. These storm drainage features probably date back to the 1960s and lack any water quality control features (MacKay & Somps 2012). The only other stormwater discharge points along the north bank of Squaw Creek drain off the mixed and commercial land uses along the Squaw Valley Road corridor east of the Village East bridge (sub-basins N91, N92, N96 in Exhibit 13-11).

The Cushing Pond drain conveys mountain runoff (sub-basin S7A) along with runoff from existing commercial areas (sub-basin S7C) through a 36 inch pipe to an outfall downstream of the confluence (Exhibit 13-11).

The Searchlight Pond drain conveys mountain runoff (sub-basin S10, upslope and south of the plan area) through a culvert to a flume and double culvert system to discharge in the Olympic Channel. Mountain runoff flows that exceed the flume capacity are released overland towards the existing commercial areas (sub-basin S8A). Under these existing conditions, a portion of the runoff is redirected downstream of its natural location to the Olympic Channel, but reduces mountain runoff comingling with urban runoff. However, a portion of the furthest east parking lot (sub-basin S9) drains to this pipe system before discharging into the Olympic Channel (Exhibit 13-11).

The Intrawest Drain System serves the existing developed uses in the Village complex (sub-basin S8) and conveys runoff via pipes under a portion of the east parking lot to underground filtration systems (but these are of uncertain sizing, type, efficiency or maintenance status) before discharging to Squaw Creek upstream of the East Village Bridge.

Runoff generated on the farthest east parking lot and ski facilities support areas (sub-basin S11B) is piped to underground filtration systems (but these are of uncertain sizing, type, efficiency or maintenance status) before discharging to Squaw Creek upstream of the East Village Bridge.

Existing snow storage practices and locations may have an influence on the volume and peak runoff during snow melt. Field observations suggest that the south margin of the west parking lot along Squaw Creek and the east margin of the east parking lot along the Olympic Channel are active snow storage areas. However, little information documents the existing locations and/or methods of snow storage, or its relationship to the existing plow areas (MacKay & Somps 2014f).

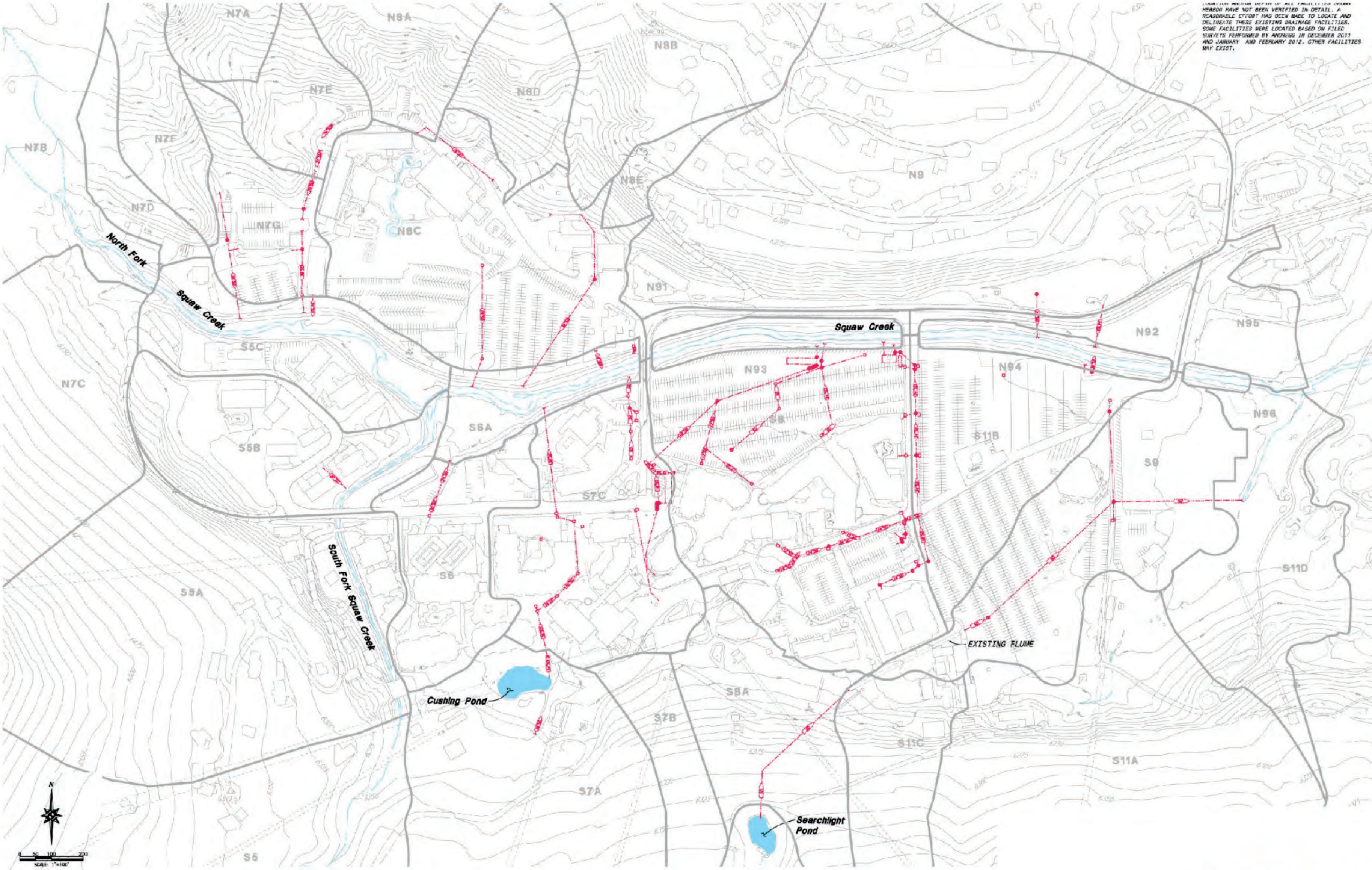
FLOODING AND FLOOD HAZARDS

Recent flooding and flood hazards analysis of Squaw Creek have been performed for FEMA map updates (FEMA 2010) and to specifically evaluate the proposed project (MacKay & Somps 2014e). The project specific study applied a worst-case hydrology for the 100-year flood event that assumed snow cover as a starting condition (an assumption not used in the FEMA map update), creating larger estimates of the peak flows (see Table 13-2).

Both studies indicate that along the North Fork of Squaw Creek, the 100-year flood event is contained within existing banks upstream of the headwaters' confluence (Exhibits 13-12 and 13-13). However, MacKay & Somps (2014e) indicates that the 100-year floodplain extends out-of-bank along the South Fork of Squaw Creek upstream of and on either side of Squaw Valley Lodge, and crosses Squaw Peak Road. These areas are outside of and upstream of the plan area (Exhibit 13-12).

Within the main Village area, both studies indicate the 100-year event is contained within existing banks upstream of HEC cross section station ~3860 and for a short distance downstream of the Squaw Valley Road Bridge (Exhibits 13-12 and 13-13). Although there are minor differences in results, both models suggest that under existing conditions the 100-year event is not entirely contained in the trapezoidal channel upstream of the Village East Bridge and the Far East Bridge. Both studies show existing 100-year floodplain along the Olympic Channel, but its width and upstream extent is slightly larger in the MacKay & Somps' model (Exhibit 13-12) than in the preliminary FEMA study (Exhibit 13-13). The existing 100-year floodplain at the main Village area does not affect any existing structures, as the mapped inundation areas are parking lots and/or open space.

Downstream of the main Village area, outside of the plan area, the 100-year floodplain spans much of the meadow, including portions of the golf course. The floodplain does extend to the Squaw Valley Road in a couple of locations upstream of the Squaw Creek crossing that include short sections of the project's sewer line improvement corridor (Exhibit 13-14). At the East Parcel, the 100-year floodplain is limited to the narrow, deeply entrenched stream corridor along the northern margin of the site (Exhibit 13-14).



Data Source: MacKay & Somps, December 2012

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Exhibit 13-11

Existing Storm Drainage Infrastructure

ASCENT ENVIRONMENTAL

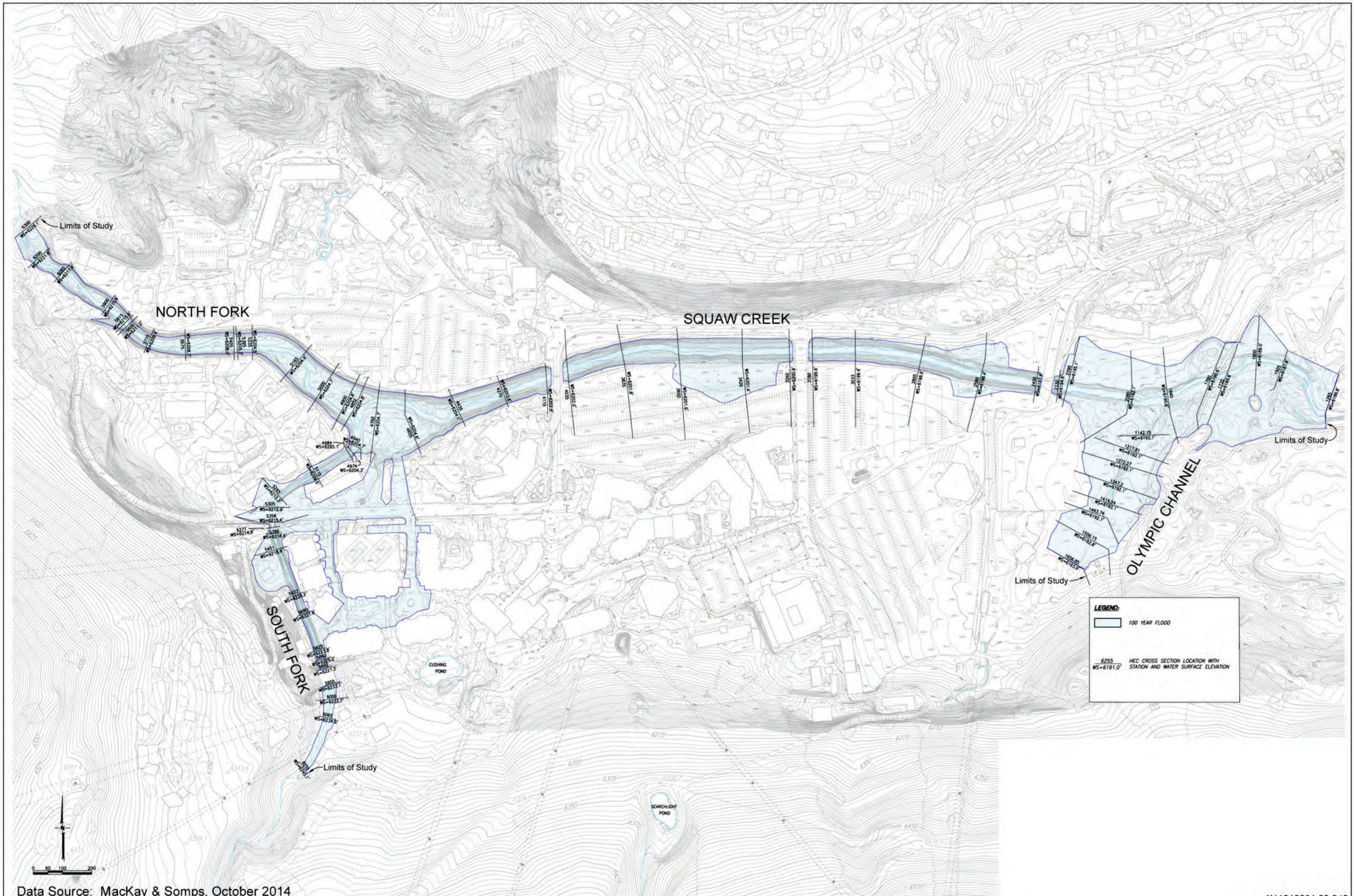

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Exhibit 13-12 **Existing 100-year Floodplain and Floodway in the Main Village Area**

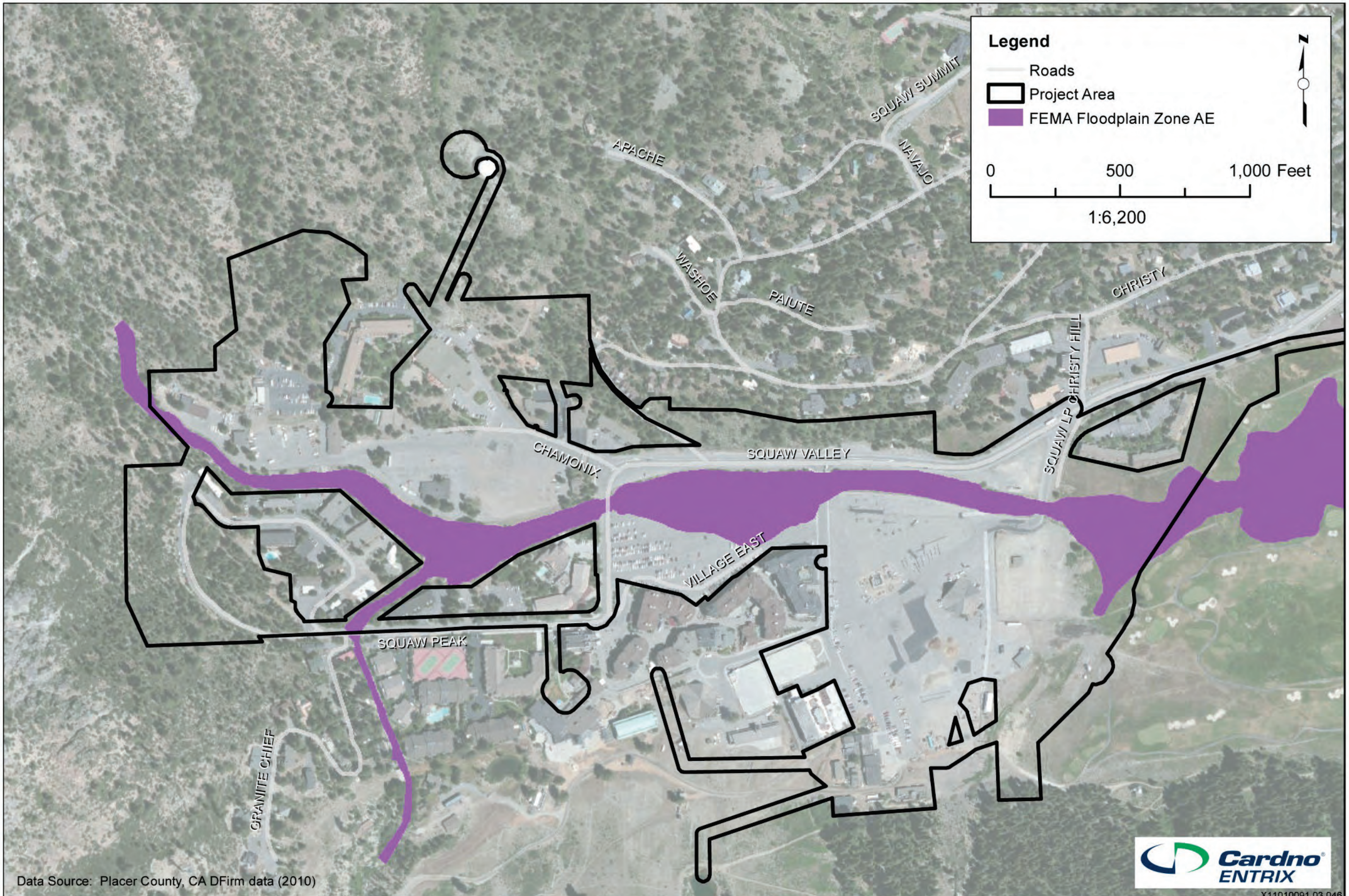


Exhibit 13-13 **Preliminary FEMA Regulatory Floodplain in the Main Village Area**

ASCENT ENVIRONMENTAL

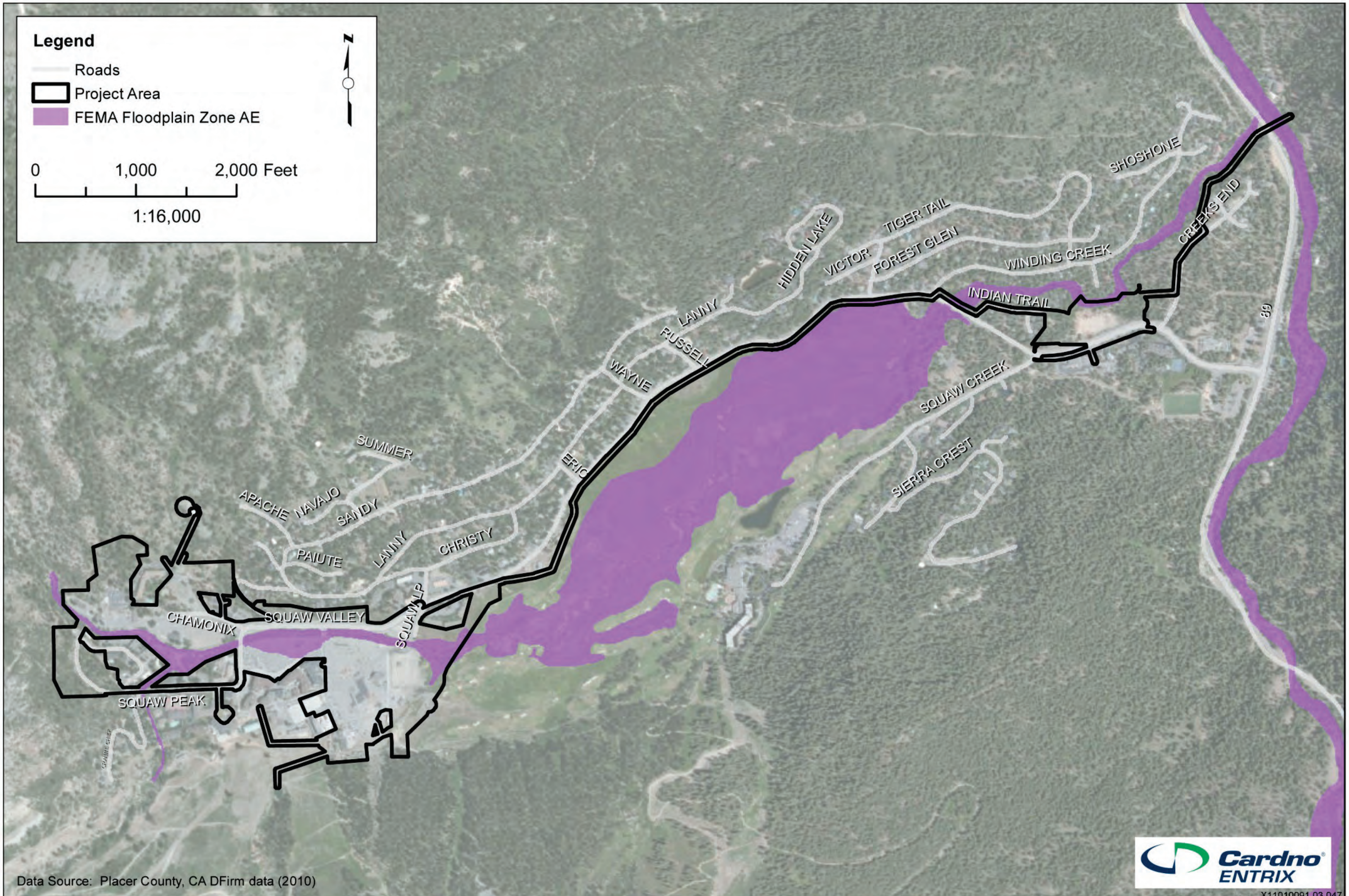


Exhibit 13-14 **Preliminary FEMA Regulatory Floodplain through Olympic Valley**

ASCENT ENVIRONMENTAL

13.1.5 Water Quality

GROUNDWATER WATER QUALITY

In the western portion of the basin, untreated groundwater extracted for municipal use is generally of good quality; regular testing by the SVPSD and SVMWC finds it in accordance with federal, state, and local primary and secondary drinking water standards. Groundwater that is extracted for residential, commercial, municipal, and fire suppression purposes does not regularly exceed primary drinking water standards.

In the eastern end of the valley, where groundwater is currently only used for snowmaking and irrigation, groundwater quality is poorer and has been shown to contain levels of arsenic that exceed primary drinking water standards, as well as iron, manganese, and TDS that exceed secondary standards.

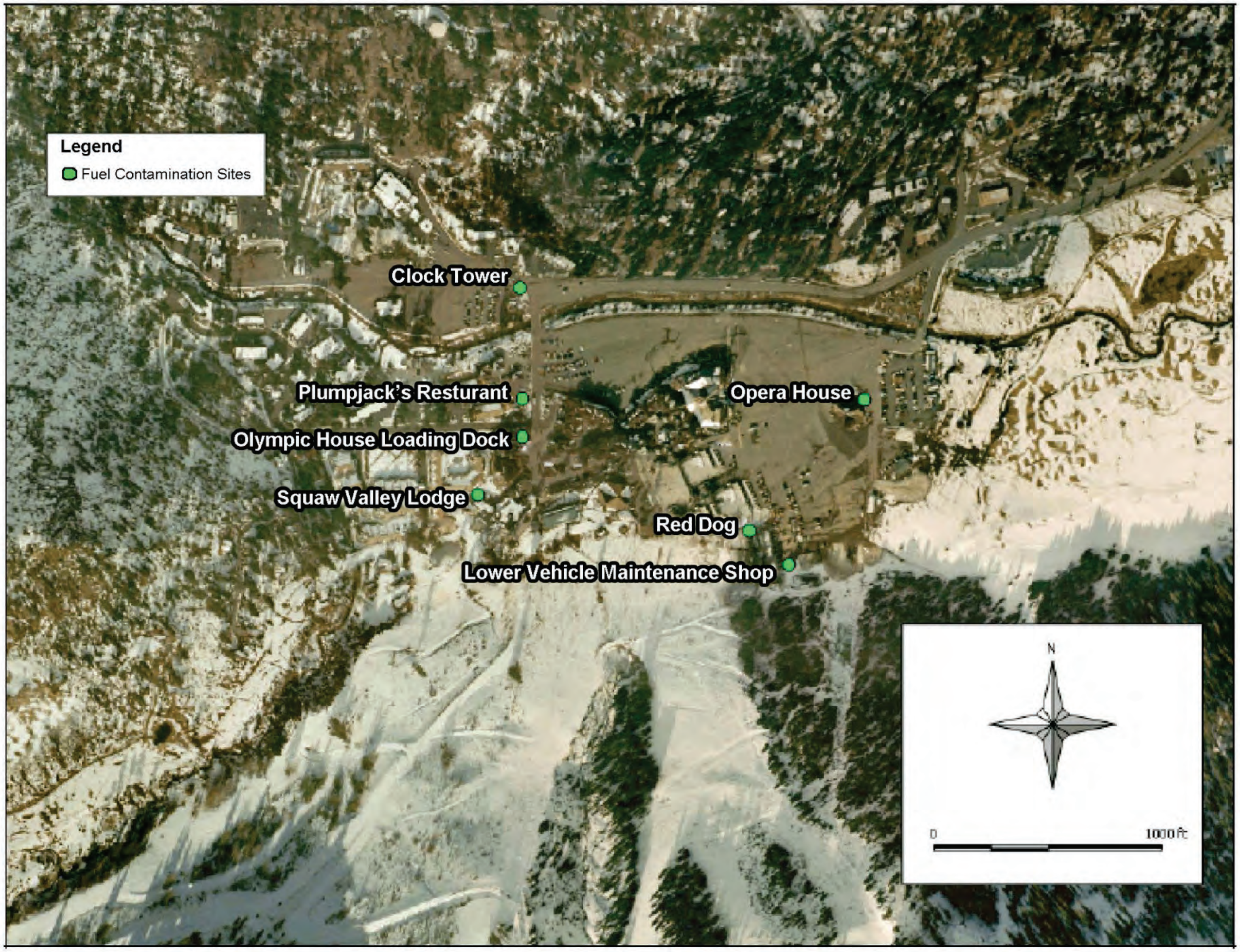
A watershed sanitary survey (West Yost & Associates 2003) identified potentially contaminating activities and locations of known groundwater contamination present in or prior to 2003 (Exhibit 13-15). Contamination resulted from petroleum fuel leaks and spills from underground storage tanks (USTs). Although the soils on the sites have been remediated (also see Section 15.1.2 in Chapter 15, “Hazardous Materials and Hazards”), the contaminants have highly-mobile characteristics that could become transported in the aquifer because of its high permeability. Two of the contamination sites, the Plump Jack site and the Opera House site, had been of particular concern because of their location upstream of drinking water wells. However, groundwater at some of the sites was monitored after soil remediation, and the results have not shown any impact to existing groundwater production wells (HydroMetrics WRI 2007). Notification of site closure has been completed for all sites and no restrictions were posed under the closure conditions (Kennedy/Jenks 2013). While there is no evidence that there is residual groundwater contamination from the sites shown in Exhibit 13-15, as is the case with any area in which construction and occupation has occurred over multiple decades, there could be unknown sources of contaminated soil and/or groundwater located within the plan area.

SURFACE WATER QUALITY

Sediment

Because of excessive sediment load, Squaw Creek is listed by the Lahontan Regional Water Quality Control Board (Lahontan RWQCB) as an impaired water body in accordance with Clean Water Act Section 303(d). The Truckee River is also an impaired water body and is included on the same listing. Squaw Creek is listed as impaired because of sediment (Lahontan RWQCB 2006). The total maximum daily load (TMDL) for sediment recognizes ski-runs and dirt roads as primary sediment sources, with urban runoff and road sand as secondary sources. Implementation of the TMDL focuses on tracking compliance with existing regulatory actions, and monitoring channel bed conditions in lower Squaw Creek.

Historically, Squaw Creek was a migrating, meandering channel, with an alluvial fan configuration near the west end of the current Village area beginning at the natural profile break where the headwater streams enter the valley. The west end of the Olympic Valley naturally stored coarse sediment generated during larger events that was slowly delivered to the meadow reaches over intervening years (between large storms). The construction of the trapezoidal channel increased sediment transport capacity through the plan area, such that sediment is more readily and consistently transported downstream to the meadow. However, during large magnitude events (e.g., January 1997), the confluence area continues to accumulate sediment, but sediments from these large magnitude events have been actively removed (e.g., by U.S. Natural Resources Conservation Service) to minimize episodic delivery to the meadow.



Data Source: Hydrometrics, May 2007

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Exhibit 13-15 **Remediated Underground Storage Tank and Groundwater Sites**

ASCENT ENVIRONMENTAL

The Olympic Channel also contributes relatively high sediment loads to squaw creek downstream of the trapezoidal channel because of steep slope erosion and parking lot runoff. The steep slopes draining to the Olympic Channel and the erosion of volcanic material produces fine material transported as suspended sediment (i.e., sediment suspended within the water column, versus larger or heavier sediment that is more often transported or deposited along the bottom of the water body). As a result of this process as well as being a source for untreated parking lot runoff, the Olympic Channel accounts for up to 30 percent of total suspended sediment load even though its watershed is only 7 percent of the size of the entire Squaw Creek watershed.

Suspended sediment yield is approximately the same in the North Fork and South Fork of Squaw Creek (although the North Fork contributes a higher percentage of heavier coarser grained sands and gravels). In addition, the off-site meadow reach of Squaw Creek to the east of the main Village area has and continues to experience bank instability and bank erosion. Bank instability and erosion in the meadow reach is a significant contributor to total sediment loading (i.e., combination of smaller/lighter suspended sediment and larger/heavier substrate sediment components).

When compared to similar low-gradient reference stream sites, Squaw Creek substrate material had a smaller median particle size (also known as D-50 size), and larger percentages of fines and sand. Excessive fines as substrate material is evidence of hill slope erosion, bank erosion, and nearby road sanding operations.

Urban Contaminants

Existing snow storage operations at the existing Village area immediately adjacent to the Olympic Channel have no documented best management practices (BMPs) and may contribute to the sediment loads in addition to urban contaminants. The snow scraped off the parking lots is likely to contain heavy metals, grease, petroleum products, asbestos and other chemicals associated with motor vehicle use.

Urban runoff from the developed uses within and surrounding the existing Village area has only partial pre-treatment before discharging to the streams. Because many of the existing storm drainage features were built in the 1950s and 1960s, there are minimal water quality control elements, although some areas of the existing Village area and portions of the east parking lot have been retrofitted with underground filtration systems (but these are of uncertain sizing, type, efficiency or maintenance status) (Balance Hydrologics 2014).

Balance Hydrologics (2013) conducted a water quality study using data from the 2007 to 2011 period as this timeframe produced the most complete records and largest amount of data. The availability and apparent quality of specific measurements in the data set indicated that total suspended solids (TSS), nitrate nitrogen, and total phosphorous would provide the highest quality predictions of water quality loadings to Squaw Creek. These three constituents also provide reasonably good indicators of water quality conditions in the creek. Nitrate correlates fairly well with other forms of nitrogen, while total phosphorous represents the variability of all forms of phosphorous. TSS is a good surrogate for fine sediment concentrations. Fine sediment transport is of particular interest as it is the subject of the one TMDL requirement for Squaw Creek and the Truckee River.

Nearly half of the suspended sediment load, a majority of nitrate load and nearly all of phosphate load reaching the meadow appear to be contributed by the drainage areas upstream of the confluence of the south and north forks of Squaw Creek (Table 13-6). The main Village area is calculated to account for approximately 21 percent of total suspended sediment loading in the system. Nitrate and phosphate loadings from the main Village area and adjacent areas are negligible. The Olympic Channel, however, appears to contribute 35 percent of the total suspended sediment load to the meadow, and a 14 percent contribution to nitrates. These contributions are large when compared with the total area drained by the Olympic Channel and the flow rates associated with the storm events. Approximately 15 percent of the drainage area contributing to the Olympic Channel is in the project area, while most of the watershed is located at upper elevations, upstream of Searchlight Pond and the Olympic Drain.

During the past 50 years, elevated levels of biologically available nitrogen and phosphorus have caused increased algae biomass in the Sierra Nevada Mountains of California. Before the discovery of gold in 1848 and the resulting urban development, the waters of the High Sierras (areas above 6,000 feet in elevation) were nearly algae-free (Derlet et al. 2009). Since then, increased levels of algae have caused problems for wildlife, humans, and pets. High levels of algae lowers available dissolved oxygen for fish populations, and certain types of algae can produce toxins that are harmful to exposed humans and animals (Derlet et al. 2009). Nitrogen and phosphorus levels are important water quality indicators for Squaw Creek because of its location in the Sierra Nevada, where streams typically have low nutrient loads and are particularly sensitive to these materials.

Table 13-6 Summary of Predicted Water Quality Constituent Loadings under Existing Conditions

Location/Measurement[1]	2-Year Event	5-Year Event	10-Year Event	100-Year Event
Confluence				
Total Suspended Solids	71	127	168	385
Nitrate-N	202	259	290	420
Total Phosphorous	127	174	202	320
Main Village Area				
Total Suspended Solids	29	55	76	200
Nitrate-N	5	3	3	0
Total Phosphorous	0	0	0	0
Olympic Channel				
Total Suspended Solids	17	61	104	340
Nitrate-N	30	39	45	67
Total Phosphorous	6	8	8	12
Total to Meadow				
Total Suspended Solids	117	243	348	925
Nitrate-N	237	301	338	487
Total Phosphorous	133	182	210	332

Notes:

[1] Loading measurements are total releases for a single storm event for each event category. Reported Phosphorous and Nitrate loading numbers are in pounds; Total Suspended Solids loading numbers are in tons.

Source: Balance Hydrologics 2013

The existing 15-inch sewer pipe crossing under Squaw Creek just downstream of the Far East Road bridge is very shallow and its concrete encasement has been exposed as a result of historical streambed erosion (MacKay & Somps 2014b, 2014d). This existing condition elevates the risk of water quality contamination to Squaw Creek and downstream receiving waters if a leak in the pipe were to occur.

An existing 10-inch sewer line crosses Squaw Creek attached to the Squaw Valley Road (westerly) bridge (MacKay & Somps 2014b, 2014d). This existing condition also creates vulnerability for water quality contamination to Squaw Creek and downstream receiving waters if a leak were to occur.

There are existing water line crossings of Squaw Creek within the plan area (MacKay & Somps 2014a) that may not have adequate existing cover or resistance to flood damage given the existing stream channel conditions. However, vulnerability of the water lines to damage produces a risk of erosion and sedimentation in the event of a rupture, rather than direct discharge of contaminants.

Downstream of the plan area, the segment of the existing sewer transmission system that conveys sewer flows from the Olympic Valley under the Truckee River (the siphon segment) to meet the Tahoe-Truckee Sewer Agency Interceptor is in a highly deteriorated state because of internal corrosion (MacKay & Somps 2014b, 2014d). The existing condition of this section of the sewage transmission system creates an elevated risk of water quality contamination to the Truckee River. However, upsizing and replacement of this section of the sewage transmission system is included in SVPSD facility planning and is anticipated to be reflected in the Capital Replacement and Improvement Plan currently in preparation.

13.2 REGULATORY SETTING

13.2.1 Federal

CLEAN WATER ACT

The U.S. Environmental Protection Agency (EPA) is the lead federal agency responsible for water quality management. The Clean Water Act (CWA) is the primary federal law that governs and authorizes water quality control activities by EPA as well as the states. Various elements of the CWA address water quality. These are discussed below.

CWA Water Quality Criteria/Standards

Pursuant to federal law, EPA has published water quality regulations under Title 40 of the Code of Federal Regulations (CFR). Section 303 of the CWA requires states to adopt water quality standards for all surface waters of the United States. As defined by the act, water quality standards consist of designated beneficial uses of the water body in question and criteria that protect the designated uses. Section 304(a) requires EPA to publish advisory water quality criteria that accurately reflect the latest scientific knowledge on the kind and extent of all effects on health and welfare that may be expected from the presence of pollutants in water. Where multiple uses exist, water quality standards must protect the most sensitive use. As described in the discussion of state regulations below, the State Water Resources Control Board (SWRCB) and its nine RWQCBs have designated authority in California to identify beneficial uses and adopt applicable water quality objectives.

CWA Section 303(d) Impaired Waters List

Under Section 303(d) of the CWA, states are required to develop lists of water bodies that do not attain water quality objectives after implementation of required levels of treatment by point source dischargers (municipalities and industries). Section 303(d) requires that the state develop a TMDL for each of the listed pollutants. The TMDL is the amount of the pollutant that the water body can receive and still be in compliance with water quality objectives. The TMDL is also a plan to reduce loading of a specific pollutant from various sources to achieve compliance with water quality objectives. EPA must either approve a TMDL prepared by the state or disapprove the state's TMDL and issue its own. NPDES permit limits for listed pollutants must be consistent with the waste load allocation prescribed in the TMDL. After implementation of the TMDL, it is anticipated that the problems that led to placement of a given pollutant on the Section 303(d) list would be remediated.

CWA Section 404

In accordance with Section 404 of the CWA, USACE regulates discharge of dredged or fill material into waters of the United States (US). Waters of the US and their lateral limits are defined in Title 33, Part 328.3(a) of the CFR to include navigable waters of the US, interstate waters, all other waters where the use or degradation or destruction of the waters could affect interstate or foreign commerce, tributaries to any of these waters, and wetlands that meet any of these criteria or that are adjacent to any of these waters or their tributaries. Any activity resulting in the placement of dredged or fill material within waters of the US requires a permit from USACE. In accordance with Section 401 of the Clean Water Act, projects that apply for a USACE permit for discharge of dredged or fill material must obtain water quality certification from the appropriate RWQCB indicating that the project will uphold water quality standards. Wetland protection elements of the CWA administered by USACE are further discussed in Chapter 6, "Biological Resources."

CWA Section 401 and 402 National Pollutant Discharge Elimination System

The National Pollutant Discharge Elimination System (NPDES) permit program was established in the CWA to regulate municipal and industrial discharges to surface waters of the US. NPDES permit regulations have been established for broad categories of discharges including point source waste discharges and nonpoint source stormwater runoff. Each NPDES permit identifies limits on allowable concentrations and mass emissions of pollutants contained in the discharge. Sections 401 and 402 of the CWA contain general requirements regarding NPDES permits. "Nonpoint source" pollution originates over a wide area rather than from a definable point. Nonpoint source pollution often enters receiving water in the form of surface runoff and is not conveyed by way of pipelines or discrete conveyances. Two types of nonpoint source discharges are controlled by the NPDES program: discharges caused by general construction activities and the general quality of stormwater in municipal stormwater systems. The goal of the NPDES nonpoint source regulations is to improve the quality of stormwater discharged to receiving waters to the maximum extent practicable. The RWQCBs in California are responsible for implementing the NPDES permit system (see the discussion of state regulations below).

NATIONAL TOXICS RULE

In 1992, EPA issued the National Toxics Rule (NTR) (40 CFR 131.36) under the CWA to establish numeric criteria for priority toxic pollutants in 14 states and jurisdictions, including California, to protect human health and aquatic life. The NTR established water quality standards for 42 pollutants for which water quality criteria exist under CWA Section 304(a) but for which the respective states had not adopted adequate numeric criteria. EPA issued the California Toxics Rule (CTR) in May 2000. The CTR establishes numeric water quality criteria for 130 priority pollutants for which EPA has issued Section 304(a) numeric criteria that were not included in the NTR.

FEDERAL ANTIDEGRADATION POLICY

The federal antidegradation policy, established in 1968, is designed to protect existing uses of waters and water quality and national water resources. The federal policy directs states to adopt a statewide policy that includes the following primary provisions:

- existing in-stream uses and the water quality necessary to protect those uses shall be maintained and protected;
- where existing water quality is better than necessary to support fishing and swimming conditions, that quality shall be maintained and protected unless the state finds that allowing lower water quality is necessary for important local economic or social development; and,
- where high-quality waters constitute an outstanding national resource, such as waters of national and state parks, wildlife refuges, and waters of exceptional recreational or ecological significance, that water quality shall be maintained and protected.

NATIONAL FLOOD INSURANCE ACT

FEMA is tasked with responding to, planning for, recovering from and mitigating against disasters. Formed in 1979 to merge many of the separate disaster related responsibilities of the federal government into one agency, FEMA is responsible for coordinating the federal response to floods, earthquakes, hurricanes, and other natural or man-made disasters and providing disaster assistance to states, communities and individuals. The Federal Insurance and Mitigation Administration within FEMA is responsible for administering the National Flood Insurance Program (NFIP) and administering programs that provide assistance for mitigating future damages from natural hazards. Established in 1968 with the passage of the