Exhibit DFG-C-A

TESTIMONY OF KIT CUSTIS
REGARDING
El SUR RANCH
WATER RIGHT APPLICATION 30166

I. INTRODUCTION

I am currently employed by the California Department of Fish & Game (Department or DFG) as a Senior Engineering Geologist. I have worked for the Department for approximately four years. I am certified in California and Oregon as an Engineering Geologist. I am also a California certified Hydrogeologist. I received my Bachelor of Science degree in Geology and my Masters of Science degree in Geology from California State University, Northridge. I attended the University of California, Davis in the Ph.D. program for Hydrologic Sciences. I have over thirty-three years of experience with engineering geology and hydrology issues. I have testified on behalf of the Department at State Water Resources Control Board (SWRCB or Board) hearings on matters such as Victor Valley Water Reclamation Authority's Mojave River diversion permit and North Gualala Water Company's subterranean stream channel determination. A true and correct copy of my statement of qualifications is attached as Exhibit DFG C-B. The statements made in my testimony are based upon information or facts of which I have personal knowledge, or are based upon information that I believe to be true.

II. PURPOSE OF TESTIMONY

The Department is providing testimony to respond to some of the key questions posed by the SWRCB in the Notice of Public Hearing for Water Right Application 30166 of El Sur Ranch (El Sur) and to support the terms and conditions it has proposed for inclusion in El Sur's water right permit. The Department believes that the terms and conditions are necessary to protect public trust resources and other lawful water right holders on the Big Sur River.

III. OVERVIEW OF TESTIMONY

The unique circumstances of El Sur's proposed diversion create several challenges and hurdles to properly ascertaining the terms and conditions necessary to maintain, let alone protect, the existing condition of the watershed and the biological resources it contains.

The fact that the applied for diversion is from a subterranean stream presents several challenges to accurately determining the amount of water available for diversion and the impacts to water quality, the environment, and public trust resources that would be caused by such diversion. Although my testimony will detail these challenges in the applicable section of testimony, this preface is intended to introduce these concepts to underscore the fact that the very nature of the diversion creates a common challenge throughout the analysis. As a result of these challenges, it is necessary to make certain assumptions that wouldn't generally be necessary if the diversion were directly from the surface flow of the Big Sur River. Also, these factors underscore the weaknesses in El Sur's analysis for failing to determine and utilize proper assumptions.

First, it is necessary to recognize that the dynamic nature of the Big Sur River makes certain forecasts regarding flow unreliable. The Big Sur River, naturally changes orientation, flow depth, water table elevation, and makes other adjustments on a frequent basis. These changes are caused, in part, by tidal fluctuation, closing of the outlet at the sand bar, evapotranspiration fluctuations, and storm events. However, the severity of surface impacts caused by diverting from the underflow depends on several factors that are more easily assessed in a static system. These factors include the distance between the well and river, the hydraulic characteristics of the aquifer, storage coefficient and hydraulic conductivity, the permeability and thickness of any low hydraulic conductivity streambed layer, and the duration of pumping. In this case, El Sur's analysis regarding the impacts of their diversions on the surface flow of the river, assume relatively static conditions. This is a fundamental flaw in their analysis. When the channel changes, as it has in the past, the impacts will also change. As a simple example, should the river channel shift back to its historic location closer to the Old and New wells, then the losses from pumping are likely to increase because the distance between the wells and river will have decreased. Yet, El Sur's diversion request fails to account for this potential change and for the dynamic system in general making their proposed diversion limitations inadequate to protect the biological resources of the watershed.

Next, it is important to recognize that diverting water from the Big Sur's underflow is unlike diverting directly from the river's surface flow and as a result, the diversion presents challenges to not only quantifying available water and impacts, but also assigning a proper bypass flow. For example, diverting 3 cfs from the underflow of the Big Sur river by pumping at a well may not equate with a 3 cfs reduction in the surface flow at a point on the river nearest to the well (for purposes of this overview, this point shall be referred to as the POD). In other words, calculating the Zone of Influence of the pumping is extremely complex. River flow can be affected <u>both downstream and upstream of the POD</u>. Another factor that differentiates diversions from underflow as compared to surface flow is that underflow diversions continue to affect surface and subterranean flows long after pumping has ceased. These two factors, among others that are discussed in my testimony, affect the analysis of a diversion including calculating a Cumulative Flow Impairment Index (CFII) and assigning a bypass flow.

Regarding CFII, the manner in which it is calculated does not differentiate between diversions taken directly from surface flow as compared to diversions from underflow. This failure to differentiate raises a number of questions including where to locate the actual impact of pumping e.g. at the POD, above, or below. As a result, my WAA (and El Sur's) assumes the diversion from underflow would also be from the surface flow at the closest point to the river.

Regarding assigning a bypass flow, one will need to account for the residual depletion that occurs after a pump is turned off. This concept will be explained more fully in my testimony. But at its simplest, because the effects of pumping on surface flow continue despite having turned off a pump, there are several issues that must be addressed that wouldn't normally be addressed when diverting from the surface flow. For example, if one takes into account residual depletion, the bypass should actually be higher than what is required to account for this additional effect; yet, how much higher? As a result, my testimony (and it appears El Sur's as well) assumes there would be no residual depletion and that the effects of pumping would stop the instant a pump is turned off.

To compound the challenges presented by the dynamic system and shortcomings in existing models, the location of El Sur's proposed point of diversion makes it impossible to monitor flows downstream of the diversion. Therefore, one must forecast flows downstream of the diversion point based on measurements upstream of the diversion. As a result, it is necessary to assume that El Sur would be diverting at the maximum instantaneous rate. Otherwise, analysis will underestimate the potential impacts of the allowed diversion.

An additional layer of complexity is presented by El Sur's proposed diversion scheme. Not only does it make enforcement untenable, it also requires one to assume greater total diversions than what is possible. Otherwise, to average out potential diversions, as is done by El Sur in the Draft Environmental Impact Report, severely underestimates the potential significant impacts because it doesn't accurately reflect the actual amount of water that El Sur would be allowed to divert.

In summary, it is important to keep in mind that the Big Sur River's dynamic system, the location of pumping, and the fact that the diversion would be from the underflow rather than surface flow require certain assumptions that would not normally be required for diversions directly from surface flow. However, El Sur's analysis fails to take these factors into account and as result it is deficient. Nevertheless, the Department's recommended bypass flows are designed to account for the unique characteristics of the environment and diversion and should be included as conditions of El Sur's water right permit.

IV. WATER AVAILABILTY ANALYSIS

a) Is water available for appropriation under the application?

Subject to maintenance of bypass flows that are protective of fisheries and other public trust resources, and recognition of existing prior rights, subterranean stream flow is available for appropriation at the El Sur Ranch points of diversion (POD) within the flood plain of the lower Big Sur River. The determination of the existence of a subterranean stream at the points of diversion is reflected in the hearing announcement. Further, the Draft Environmental Impact Report (DEIR) states that the water being appropriated comes from a subterranean stream. A discussion of the key elements for determination of a subterranean stream as defined by the Garrapata Water Rights Decision No. 1639 are present in general comment no. 1 of my December 10, 2009 memorandum commenting on the October 2009 DEIR. (Exhibit DFG-C-59)

To determine whether there is water available for appropriation in the Big Sur River, I have developed a Water Availability Analysis (WAA) and Cumulative Flow Impairment Index (CFII) for the El Sur Ranch points of diversion that differ from the one supplied by the applicant and presented in the October 2009 Draft Environmental Impact Report. The different approach was utilized to obtain a more accurate water availability assessment. Generally, my analysis differs from the one supplied by the applicant in five main ways. First, I identified and included in my analysis, additional upstream diversions. Second, I included all of the applicant's riparian diversions. Third, the calculations were made on a monthly basis because it is more representative of the impairment to the river. Fourth, my analysis accounted for the fact that the proposed diversion is year round. Finally, my analysis utilized median flows as opposed to average flows. Particularly in regards to hydrologic data, the use of the median, as opposed to an average, produces more precise results.

My WAA included additional upstream diverters not identified in the applicant's WAA. I obtained riparian and appropriative water right information from the Board's eWRIMS web site GIS and database. My WAA assumed that the El Sur Ranch's point of diversion is the only point of interest, POI#1. My WAA analysis identified thirty (30) additional upstream diverters in addition to the seven (7) listed in the applicant's WAA (Exhibit DFG-C-1). All but one of these upstream diverter are either claimed riparian or have a prior appropriative water right, and therefore have priority over any appropriative water right issued to El Sur Ranch. The one diverter whose water right is potentially a lower priority is Clear Ridge Mutual Water Company (A030956). The priority of this water right is one of the subjects of this hearing. Seven of the thirty additional upstream diversions I identified are claimed riparian rights belonging to Mr. James Hill III with the points of diversion being the same wells as Application A030166, the "Old" and "New" wells. These diversions were included in my WAA because they are claimed riparian rights with their own unique water right identification number and therefore are considered a prior water rights in my WAA and CFII calculation. One of the seven prior water rights listed in the applicant's WAA has been canceled, California Parks and Recreation Application A031432, and therefore was not included in my WAA.

My WAA and CFII calculations were done on a monthly basis to better determine the seasonal availability of water and thus allow for a more accurate depiction of the impairment to the river from the diversion.

The following exhibits were created to help illustrate my WAA and CFII calculations:

Exhibit DFG-C-2 presents specific information on the season of diversion and calculations of the maximum monthly water volume of diversions in acre-feet (AF) for months with 28.25, 30 and 31 days. The monthly diversions were calculated assuming either the permit or statement of diversion maximum instantaneous diversion rate in cubic feet per second (cfs), when specified (Exhibit DFG-C-1), or an instantaneous rate in cfs calculated from the daily, seasonal or annual volume of diversion.

Exhibit DFG-C-3 lists the monthly diversion volume in acre-feet for each diversion listed in Exhibits DFG-C-1 and DFG-C-2. The calculation of monthly volumes assumes continuous diversion unless the monthly value exceeded the seasonal or annual permitted volume. In that case, the maximum seasonal or annual permitted volume was listed. Exhibit DFG-C-3 also presents the monthly maximum diversion volume in acre-feet for POI#1 and the annual maximum diversion for all water rights in the Big Sur watershed as given in the either the permit or statement of diversion.

Exhibit DFG-C-4 presents a summary of the daily discharge in cubic feet per second (cfs) for each month and annually as measured upstream of POI#1 at the US Geological Survey's Big Sur river gauge, #11143000. This table ranks the discharges by exceedence probability, and also lists the average, median, highest and lowest recorded flows.

Exhibit DFG-C-5 presents a summary of the monthly and annual discharge at USGS gauge #1114300 in acre-feet. Values in this table were calculated by multiplying the corresponding flow in cfs from Exhibit DFG-C-4 by the number of seconds in each month and then converting to acre-feet. Exhibit DFG-C-5 shows a darkened band over the median values and bold horizontal lines where the monthly average flow values occur.

The USGS Big Sur gauge, #11143000, is located approximately 6 miles upstream from the El Sur Ranch POD. Thus, an adjustment to the river flows is need for the WAA to account for the additional drainage area and differences in precipitation at POI#1. I made this adjustment using the USGS area proration procedure as described in the Board's example WAA/CFII document (dated 4/2006). The coefficient to adjust streamflow in Exhibits DFG-C-4 and DFG-C-5 was estimated based on a proration of areas method uses the following formula:

$$Q_2 = Q_1 \times (A_2/A_1) \times (I_2/I_1)$$

Where: Q_2 = Average monthly flow (cfs) at point of interest;
Q_1 = Average monthly flow (cfs) at nearby gauge;
A_2 = Watershed area above point of interest;
A_1 = Watershed area above nearby gauge;
I_2 = Precipitation at point of interest; and
I_1 = Precipitation at nearby gauge

Exhibit DFG-C-6 is a map of the Big Sur watershed taken from Figure 3-19 of The Source Group, Inc.'s (SGI) May 2005 report, also known as El Sur Ranch Volume 1.. I've added to the SGI map the approximate location of the El Sur Ranch wells as POI #1, the drainage area above the USGS Big Sur gauge #11143000, the National Weather Services Big Sur Station #040790, and USGS gauge #11143010 that was recently installed near the parking lot at Andrew Molera State Park as part of DFG's instream flow studies. I've also listed the drainage areas above each of these points of measurement.

In order to determine the effect of the change in precipitation on the flows at the POI#1, I needed to obtain an estimate of the historic precipitation at the El Sur Ranch point of use. To do this I utilized the simulated historic precipitation record available for California at the PRIZM Climate Group at Oregon State University (http://www.prism.oregonstate.edu/). PRIZM is the United States Department of Agriculture's official climatological data. I utilized the internet map server's PRIZM Data Explorer (http://prismmap.nacse.org/nn/) to download simulated monthly precipitation records using the approximate latitude and longitude of the El Sur Ranch pastures (36.2458, -121.772). I also obtained simulated monthly precipitation records for the area of the Big Sur State Park weather station, NWS #040790, using its latitude and longitude (36.247, -121.780).

Exhibit DFG-C-7 is a historic summary of the precipitation at the Big Sur State

Park weather station, NWS # 040790, from the Western Regional Climate Center (http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?ca0790). I compared the PRIZM simulated historic monthly weather record to the actual historic weather record to determine what adjustments would be needed to make the PRIZM simulated data match the actual data.

Exhibit DFG-C-8 is a table showing the monthly and annual precipitation at the Big Sur State Park weather station and the El Sur Ranch pastures, the adjustments needed to shift the PRIZM data to match the actual recorded data, and the proration values for precipitation. In order to make the proration adjustment for precipitation, I had to assume that the Big Sur USGS river gauge #11143000 and the Big Sur State Park weather station, NWS #010790, are sufficiently close together to be used jointly as the reference stations. My WAA proration method utilized the ratio of an adjusted PRIZM annual precipitation record for El Sur Ranch pasture area to the Big Sur State Park recorded annual record. I adjusted the PRIZM record for El Sur Ranch upward by the amount that the PRIZM record needed to be raised to match the historic Big Sur State Park weather state data. This produces a ratio that is consistent. Monthly precipitation records were not utilized for the proration method because the summer month precipitation records are so close together, that there is almost no precipitation. If monthly proration values were used then the results would show an increase in unit runoff during the summer versus the winter, which is illogical. In other words, the results would show that reduced precipitation in the lower portion of the watershed would produce more summer baseflow, which is not likely. Historic record of river flow collected during the studies for the El Sur Ranch water right application indicate that generally flows during summer months are less downstream from the Big Sur USGS gauge #11143000, not more.

Exhibit DFG-C-9 shows the calculations for proration method of the WAA. The combined adjustment for flows at El Sur Ranch point of diversion, POI#1, is 0.991 indicating that the unimpaired river flows at POI#1 are approximately the same as at the Big Sur USGS gauge #11143000. Exhibit DFG-C-8 also has a calculation showing that the adjusted median February discharge at gauge #11143000 shown in Exhibit DFG-C-4 is 184.7 cfs. The adjusted median February flow is the bypass flow recommended by the *2002 National Marine Fisheries Services (NMFS) and DFG Guidelines for Maintaining Instream Flow to Protect Fisheries Resources Downstream of Water Diversions in Mid-California Coastal Streams*. The February median flow value is much greater than the 132 cfs flow recommended as an interim December to May bypass based on the regional equations of the Board's *Policy for Maintaining Instream Flows in Northern California Coastal Streams*.

Based on the WAA and the proration method of adjustment, the unimpaired median annual flow as shown in Exhibit DFG-C-5 in the Big Sur River at the

El Sur Ranch point of diversion is 55,353 acre-feet (55,856AF * 0.991 = 55,353 AF).

Exhibit DFG-C-10 shows a map taken from the Board's eWRIMs GIS web site that shows most of the water rights in the Big Sur watershed and close vicinity as colored blocks of text. The only water rights not shown are those of the US Forest Service, which are in the upper reaches of the watershed, to the right and off the map.

Exhibit DFG-C-11 is a Google Earth image (2009) of El Sur Ranch's application A030166 points of diversion and the claimed riparian points of diversion in the flood plain of the Big Sur River at Andrew Molera State Park. The location for each point of diversion was taken from the eWRIMS database and plotted using the listed latitude and longitude.

Exhibit DFG-C-12 is a table showing the El Sur Ranch points of diversion for both the appropriative application A030166 and the claimed riparian statements of diversion and use. The table lists the instantaneous diversion rates, the acreage of the area of use, and identifies the well that is associated with each diversion, and the cumulative annual diversion for each of the two wells. Exhibit DFG-C-11 clearly shows that the locations of the El Sur Ranch points of diversion are not properly aligned.

Exhibit DFG-C-13 contains four tables that present the results of the monthly and annual WAA and CFII for different proposed water diversions. The diversion rates and volumes of the other diverters in the Big Sur watershed are set at the monthly maximum allowed under each permit or claim, but the permitted annual diversion volume is not exceeded. The following four proposed El Sur Ranch diversions rates were evaluated:

- Proposal 1a – the appropriative diversion is set at the rate and volume sought by El Sur Ranch along with the sum of all riparian diversions at the rate and volume claimed. The El Sur Ranch diversion with this proposal is limited by the combined maximum pumping rate of 8 cfs for both wells.
- Proposal 1b – the appropriative diversion is at the rate and volume sought by El Sur Ranch, but the riparian diversions are set at zero. This proposal assumes that the El Sur Ranch's riparian lands are irrigated under the proposed water right.
- Proposal 2 – the calculations assume that El Sur Ranch's appropriative diversions are at the instantaneous diversion rate and annual diversion rate recommended by DFG and that El Sur Ranch still diverts the full amount claimed under the riparian right.
- Proposal 3 – the calculations assume that El Sur Ranch's appropriative

diversions are at the instantaneous diversion rate and annual diversion rate recommended by DFG and that El Sur Ranch only diverts under a riparian right for the claimed 25 acres at the same rate recommended for the appropriative diversions. I assumed that the cumulative acres irrigated by El Sur Ranch are the 248 acres that I measured rather than the 267 acres listed in the application.

It should be noted when reading the Exhibit DFG-C-13 tables that the annual CFII is often less than the monthly CFIIs. This occurs because the sum of maximum monthly diversion rates for El Sur Ranch exceed the requested annual diversion. This is but one example of the complexity of the diversion conditions being requested in application A030166.

Conclusions from the WAA and CFII Analysis

The impairment calculations for Proposal 1b show that during June through November the CFII varies from approximately 27% to 63%, and from December through May from approximately 5% to 16%. The CFII also shows that the cumulative instantaneous rate of diversion of all other watershed diverters is less than 1 cfs with a CFII of less than 5% for all months, which is the case for all of the four CFII analyses. In Proposal 1b, El Sur Ranch's diversions account for most of the impairment index.

The impairment calculations for Proposal 1b show that during June through November the CFII is slightly less than Proposal 1a varying from approximately 19% to 33%, and from December through May from approximately 3% to 11%. In Proposal 1b, El Sur Ranch's diversions account for most of the impairment index.

The impairment calculations for Proposal 2 show that during June through November the CFII varies from approximately 27% to 63%, and from December through May from approximately 5% to 16%. This is the same as Proposal 1a because El Sur Ranch's riparian diversions dominate the impairment index.

The impairment calculations for Proposal 3 show that during June through November the CFII varies from approximately 10% to 23%, and from December through May from approximately 2% to 6%. Proposal 3 assumes that the pumping irrigates a total of 248 acres and that water for irrigating the 25 acres of riparian is provided at the same rate and volume as the rest of the pasture. As with the other proposals, El Sur Ranch's diversions dominate the impairment index.

The conclusion reached from the CFII analysis is that El Sur Ranch's proposed diversions have the potential to have a significant impact on the flows in the rivers and thus impact the fisheries particularly if the diversion rates that El Sur

Ranch is requesting are approved. If the diversion rates that DFG recommends are used for the appropriative permit, then the monthly CFII values during December to May are significantly reduced to a value at or below 6%. Adoption of the DFG recommended diversion rates for June to November still results in monthly CFII values greater than 10%, suggesting potential impairment to the fisheries resources. Therefore, protection of the fisheries and other public trust resources requires that permit conditions include a requirement for maintaining bypass flows throughout the year as a condition of the requested diversion.

As shown in Exhibit DFG-C-4, the interim bypass flows recommended by DFG, 29 cfs from June to November and 132 cfs from December to May occur as a dark, bold line in the exceedence probability listings. For a complete discussion of the reasoning for these bypass flows see Mr. Titus's testimony (Exhibit DFG-T-A) and part V.b. of my testimony below. Exhibit 4 shows that the amount of time that El Sur Ranch can divert during June to November is restricted. For example, during the months of August, September and October, El Sur Ranch can possibly only divert during wet water year conditions. This restriction in the ability to pump is consistent with the current SWRCB instream flow policy to not approve any new diversions during summer months. (*Policy for Maintaining Instream Flows in Northern California Coastal Streams*)

b) If so, when is water available and under what circumstances, taking into consideration prior rights?

Based on the results of my WAA and CFII calculations and the assumption that a CFII of less than 10% is water is desired, water is generally available for diversion from January to April under pumping rates sought by El Sur Ranch (Proposals 1a, 1b and 2) and December to May under Proposal 3 pumping rates. A CFII above 10% from June to November argues for following the current SWRCB policy for no new diversions during summer months. However, if a CFII greater than 10% is determined to be in the public interest, then diversions might occur provided that they are subject to permit condition(s) requiring maintenance of bypass flows that are protective of the fisheries and other public trust resources. If El Sur Ranch is permitted to divert during the summer months, the duration that flows will exceed DFG's recommended bypass flow values varies from month to month. Exhibit DFG-C-4 shows the exceedance probability for historic flows at the USGS Big Sur gauge, #11143000, which can be used as an estimate of the frequency that El Sur Ranch may be able to divert if DFG recommended bypass flows are adopted as a permit condition.

c) What terms and conditions, if any, should the State Water Board adopt to protect prior rights?

Exhibit DFG-C-A

Protection of prior water rights as well as fisheries and other public trust resources requires that a bypass flow condition be included as a part of El Sur Ranch's appropriative water right permit. When developing proper bypass terms and conditions, I took into consideration the ability of the SWRCB to monitor and enforce the conditions given that there are several unique factors about El Sur Ranch's diversion. For instance, the proximity of the El Sur Ranch POD at the mouth of the Big Sur River presents an uncommon problem with setting "bypass" flows because placement of a river gauge downstream of the POD is not possible. The presence of a beach bar and the variation in river stage caused by tidal fluctuations makes calibration of a long-term rating curve impossible. In addition, the periodic, seasonal closure of the river outlet across the beach bar creates a condition where the entire flow of the river becomes a subterranean stream discharging through the beach bar into the ocean. Therefore, the point of monitoring for application A030166 diversions must occur upstream of the POD. El Sur Ranch and the 2009 DEIR have proposed to use the existing USGS Big Sur gauge #11143000 as the monitoring gauge.

The use of an upstream monitoring point introduces a number of additional requirements. Specifically, the need to account for natural and anthropogenic losses between the monitoring gauge and the downstream POD, and the need to add in the maximum amount of diversion into the bypass flow calculation. Normal monitoring of bypass flows downstream of the POD doesn't require accounting for flow losses upstream of the POD or the amount being diverted at the POD at any particular time. In the normal case, once the river flows drop to the permit bypass flow, then all diversion ceases no matter what rate is being diverted at the POD or by upstream users or by natural evapotranspiration or discharge to the subsurface. However, the use of an upstream monitoring point requires the prediction of what flow will occur at the downstream POD and the need to account for the POD's rate of diversion. Because these values vary, sometimes minute-to-minute, and because there is no monitoring of actual downstream losses, it is not workable to set the bypass flow rate that accounts for variations in the actual short-term (daily or hourly) changes in diversion rate and downstream losses. The only practical, and enforceable method of calculating bypass flows is to require that flow losses from the POD upstream to the monitoring gauge be set at the maximum historically measured and that the calculation assume the maximum permitted diversion rate can occur at any time. I will provide a more detailed discussion on the upstream flow losses and the need to consider maximum diversion in calculating the bypass flow requirement in part V.b. of my testimony below.

For this issue, protection of prior rights, I recommend for the following reasons that in the calculation of bypass flows the SWRCB should use the maximum measured losses downstream of the monitoring gauge and the maximum El Sur Ranch diversion rate to protect prior water rights:

- o If downstream of the gauge the natural and diversion loss components of the bypass flow are either ignored or set at less than the maximum, then the bypass flow would be designed assuming that it would be achieved only a percentage of the time. For example, if the median flow loss is used, then at best only 50% of the time flows would be adequate to protect resources.

  If the downstream of the bypass flow monitoring gauge, actual flow losses are greater than the maximum prescribed by the Board in the permit's bypass flow calculation, then any negative effects from this reduced flow would not be attributable to El Sur Ranch's diversion. That is, El Sur Ranch has the right to expect that the cumulative upstream losses would be no greater than the value used in the bypass flow calculation for their permit. The use of less than maximum measured downstream flow loss in calculating the bypass flow effectively shifts, at least for part of the time, the responsibility for negative effects at El Sur Ranch's POD to the upstream diverter, most of which have a priority water right. (see illustration below the next point)

- o A similar problem with shifting responsibility would occur if less than the maximum permitted pumping is used in the bypass flow calculation because the actual rate of flow at El Sur Ranch's POD isn't being measured. If there is a negative effect to public trust resources during pumping, the percentage of responsibility for the effect that is attributable to El Sur Ranch's diversion versus the upstream diversions, and upstream natural flow losses, can't be discerned because there are no actual measurements. If the bypass flow calculation doesn't assume the maximum permitted diversion can occur at any time, then the upstream diverters may, at least for part of the time, become responsible for the negative effects to public trust resources at El Sur Ranch's POD. To illustrate these two points:

  - Assume for purposes of this illustration that the habitat and public trust resources require 100 cfs;
  - Downstream of the monitoring gauge but before El Sur Ranch's POD maximum losses could be 20 cfs, but the Board prescribes an average of 10 cfs to its bypass flow calculation;
  - El Sur Ranch could pump a maximum of 40 cfs, but the Board prescribes an average of 30 cfs to its bypass flow calculation,

Based on these numbers, the Board calculates a bypass flow at the monitoring gauge of 140 cfs.

If flows are 145 cfs at the monitoring gauge, then El Sur ranch would operate its pumps. But actual losses between the monitoring gauge and El Sur Ranch's POD could be 20 cfs (i.e the potential maximum), and as a result only 125 cfs would flow at the POD. If El Sur Ranch pumps at 40 cfs (i.e. the permitted maximum), only 85 cfs would flow downstream of El Sur Ranch's POD and therefore there would be adverse impacts to habitat and public trust resources caused by the 15 cfs deficit. Because El Sur Ranch would be complying with its bypass requirement, one could logically conclude that the impact to habitat and public trust resources is caused by diversions upstream of El Sur Ranch and as a result those water rights could be affected.

V. IMPACTS TO PUBLIC TRUST RESOURCES

a) Will approval of the application result in any significant adverse impacts to water quality, the environment, or public trust resources?

Yes. The El Sur Ranch diversions as specified in water right application #A030166 will likely result in significant impacts to steelhead habitat and other public trust resources. Approval of the diversions at the requested rates creates the physical setting where periods of low flow will likely result in significant impacts to fisheries both in the zone of pumping influence (ZOI) and lagoon because the reduction in flow can restrict fish passage and mobility, degrade habitat, possibly dry up the river, and may result in an increase in water temperature and a reduction in dissolved oxygen depending on the channel location and geomorphology.

Diversion by El Sur Ranch from the Big Sur River, especially during the low flow period of June through November, increases the vulnerability of the river to adverse impacts because the maximum instantaneous rate of diversion of 5.84 cfs requested in application #A030166 ranges from approximately 18.5% (June) to 42.3% (September) of the median flow (Exhibit DFG-C-4). In addition, the monthly average diversions from upstream diverters during the low-flow period appear to constitute less than 5% of the median flow (Exhibit DFG-C-13). The claimed riparian rights of El Sur Ranch range from approximately 26% to 59% of the median flow. Combining the diversions of the El Sur Ranch, including its claimed riparian diversions, with those of the upstream diverters during the low flow period, it is highly likely that significant impacts will occur to the public trust resources of the Big Sur River.

The risk for adverse impacts to public trust resources from El Sur Ranch's diversions is less during the winter months of December through May. During this period, the applicant's requested maximum instantaneous diversion rate of 5.84 cfs ranges from approximately 3% to 11% of the median flow (Exhibit DFG-C-4), but during dry and critically dry years the risk of impact during this period rises significantly.

Without the requirement to maintain minimum protective bypass flows, significant impacts to steelhead and other public trust resources will likely occur. These impacts may occur even if the diversion rates recommended by DFG are adopted for the El Sur Ranch's appropriative permit. As a result, DFG's recommended minimum bypass flow conditions should be adopted for all periods of diversion (i.e. an annual bypass requirement).

b) What terms and conditions, if any, should the State Water Board adopt to avoid or mitigate any such potential adverse impacts?

The terms and conditions that are needed to avoid and mitigate potential adverse impacts from El Sur Ranch's diversions should follow the fundamental principle that subterranean streams and underflow are governed by the same rules that apply to surface steams. The issue of whether the diversion of subterranean stream flow by El Sur Ranch's wells should be subject to the standard bypass flow permit condition that requires the passage of the "total flow," that is all permitted diversions stop when the bypass limit is reached, is fundamental to the terms and conditions presented below. DFG proposes that the requirement that all pumping and diversion must stop whenever flows fall below the minimum bypass flow values be included in El Sur Ranch's permit terms and conditions.

The following paragraphs describe how I developed the recommended bypass flow requirement of 132 cfs from December to May and 29 cfs from June to November.

I briefly discussed in part IV.c. of my testimony above that the calculation to establish bypass flows at the El Sur Ranch POD requires three separate parts: (1) minimum flows to mitigate biological impacts; (2) flows to account for the maximum flow loss downstream from the monitoring gauge; and (3) flows to account for maximum instantaneous rate of El Sur Ranch's diversion. All of these components are required because of the unique nature of El Sur Ranch's diversion. Mr. Titus's testimony (Exhibit DFG-T-A) presents a detailed discussion of the types of impacts that occur to fisheries resources and thus the rationale for the first component of the bypass flow calculation. My testimony on this issue will focus on the reasoning and methods for calculating the last two components of the minimum bypass flow because they are hydrologic rather than biologic components. I will also provide a discussion and recommendations for permit terms and conditions needed to protect water quality, the environment and public trust resources.

The second component of the bypass recommendation requires the addition of flows to account for the maximum flow loss downstream from the monitoring gauge. This is necessary due to El Sur Ranch's unique position at the mouth of the river. A functional, long-term river gauge can't be established downstream of the El Sur Ranch's POD because of the proximity to the ocean. Tidal influences, changes in the condition of the beach bar and periodic shifts in the river course make measurement of bypass flows downstream of the POD unsuitable for long-term monitoring. Therefore, the point of monitoring for bypass flows must be located somewhere upstream of El Sur Ranch's POD.

Exhibit DFG-C-A

At the present time, there are two flow gauges on the Big Sur River, USGS #11143000 and USGS #11143010. Gauge #1143000 has been continuously monitoring river flows near the Pfeiffer-Big Sur State Park since 1950. Gauge #11143010 was installed on October 22, 2010 in the lower reach near Andrew Molera State Park's parking lot at the request of DFG for its use during the ongoing instream flow study. The USGS is in the process of calibrating this new gauge, with river stage being the only data reported and available on the web.

Historic information is available for several short periods of time on the losses in surface flow between the USGS gauge #11143000 and the area of El Sur Ranch's POD. Exhibits DFG-C-14 and DFG-C-15 are taken from my December 10, 2009 memorandum commenting on the October 2009 DEIR and present summaries of changes in flow measured by either Jones and Stokes (1999), SGI (2005), or Hanson Environmental (Hanson) (2007 and 2008). Exhibit DFG-C-16 provides a summary of changes in flow during late August 2007 through mid-October 2007 along with the status of the pumping and the average rate of diversion. Exhibits DFG-C-17, DFG-C-18 and DFG-C-19 are taken from the 2005, 2007 and 2008 SGI reports, respectively, and show the locations of various monitoring points listed in these tables along with other important features. Exhibit DFG-C-20 shows the zone of influence for the El Sur Ranch wells (SGI, 2008). It should be noted that the locations and corresponding numbering of the velocity transects changed between the 2005 Volume 1 SGI report and the 2008 SGI Volume 3 report. Apparently, for the 2006 Volume 2 study river flows in the area of El Sur Ranch's POD were only monitored at VT-1 (Hanson, 2007).

These tables show that changes in river flow between USGS gauge #11143000 and the area of El Sur Ranch's POD can be highly variable. This historic data shows that between gauge #1143000 and VT-1, located near Andrew Molera State Park parking lot (Exhibit DFG-C-17), there is typically a loss in surface flow, although there were two days with a slight increase in flow.

Changes in river flow between VT-1 and VT-2 during late-July to late-October 2004 varied from losing to gaining (Exhibit DFG-C-14). Note that in the 2004 study VT-2 was near the upper reach of the ZOI of El Sur Ranch's well pumping (Exhibit DFG-C-17). Maximum losses and gains were -1.65 cfs and 4.90 cfs, respectively. A portion of the variation in flow in this reach is likely due to changes during the day in evapotranspiration demand by the riparian vegetation.

Exhibits DFG-C-15 and DFG-C-16 show that maximum downstream losses ranging from 8.84 to 8.9 cfs were measured on two days, August 22, 1997 by Jones and Stokes (1999), and on October 10, 2007 by Hanson (2007). During the August 22, 1997 measurement, Jones and Stokes noted that only the New well was turned on close to that time presumably pumping at 1,500 gallons per minute (gpm) or 3.34 cfs (Jones and Stokes, 1999; page 2-5). During the October 10, 2007 measurement, the status of the pumping is better documented, with pumping at the Old well stopping on October 3rd and the New well on October 5th (Exhibit DFG-C-16). Thus, the downstream loss in river flow of at least 8.84 cfs has been recorded during periods of no pumping by El Sur Ranch. Flow losses during these two days don't appear to be related to a holiday or weekend. August 22, 1997 was a non-holiday Friday, and October 10, 2007 was a non-holiday Wednesday, although October 8th was Columbus Day and October 9th is Leif Erickson Day. Given the high variability of flows between the USGS Gauge and El Sur's POD, and the uncertainty associated with the timing of maximum downstream loss events, I believe it is necessary to include the maximum downstream loss numbers into the bypass flow calculation. To do otherwise, would leave the public trust resources vulnerable when large losses downstream of USGS gauge #11143000 occur.

The third component of the bypass flow calculation is the maximum rate of diversion. As I discussed in part IV.c of my testimony above, the fact that monitoring of "bypass" flows can't occur downstream of El Sur Ranch's POD requires that the bypass flow value include all potential losses downstream of the monitoring gauge in order to predict the flows downstream at the POD. To account for the losses from the El Sur Ranch's diversions, the maximum permitted rate should be used in the bypass flow calculation. If a value less than the maximum rate of diversion is used, then resource protection will be compromised (for an illustration see part IV.c of my testimony above). An alternative to using the maximum rate of diversion is a variable bypass flow value that accounts in real-time the actual maximum instantaneous rate of pumping. This alternative would require at least daily recalculation of the value for minimum bypass flow. While daily re-calculation of the minimum bypass flow is numerically possible, this type of permit condition would be nearly impossible to monitor or enforce, unless pumping rates are reported instantaneously to state agencies. A variable bypass flow might also require predicting the daily change in flow at the upstream monitoring gauge because any decrease in upstream flow during the day might trigger a permit violation. Therefore, I recommend that the calculation of the bypass flow include the maximum permitted instantaneous diversion rate of 5.84 cfs being sought by El Sur Ranch.

El Sur Ranch's application #A030166 proposes several diversion limits for instantaneous rate, time-averaged rate, seasonal and annual total volume of diversion. Exhibit DFG-C-21 graphically presents my interpretation of their diversion conditions and time intervals for each along with the Department's recommendations for permit diversion conditions. I have discussed in detail each of the El Sur Ranch diversion conditions in General Comment No. 4 of my December 10, 2009 memorandum that comments on the October 2009 DEIR. (Exhibit DFG-C-59.)

The El Sur Ranch's application doesn't propose any limitations on their diversion that are based on flows in the river or protection of fisheries or other public trust resources. Rather, the application focuses on El Sur Ranch's water needs and the historic pumping as justification for a complex set of six overlapping diversion limitations or conditions. The technical studies undertaken by El Sur Ranch's consultants to try to resolve the protests against their application studied two general issues, (1) the conditions of the fisheries in the river adjacent to the POD, and (2) the impacts of the well pumping on the flows and water quality of the river. While these studies span three seasons and different water years, the results of the studies didn't provide any specific recommendations or conditions for protection of fisheries or public trust resources. El Sur Ranch's consultants focused much of their effort on measurement of the impacts of their pumping on river flows and concluded that: the pumping doesn't have an impact on the flow such that the downstream outflow volume is less than the upstream inflow volume (SGI, 2008, page 4-3);the pumping doesn't affect either the temperature or dissolved oxygen content of the river in the ZOI that would impact habitat conditions (Hanson, 2008, section 4.0); fish passage is not compromised by low flow conditions that occur upstream from the ZOI (SGI, 2008, page 4-5); and there is no evidence that El Sur Ranch's well operations are the limiting factor in successful rearing of juvenile steelhead in the lower reaches of the Big Sur River (Hanson, 2008, page section 4.0). My response to some of these assertions is addressed in parts VII.b, and c. of my testimony below.

Apparently, El Sur Ranch wants any minimum bypass flow imposed to be based on the level of impact(s) that their well pumping causes to the river with the basic argument that because they cause no impact, bypass flow conditions are unnecessary. El Sur Ranch appears to be proposing an alternative to the standard method for development of bypass flow conditions for subterranean stream flow that isn't based on the requirements for protecting fisheries and other public trust resources. The standard method for establishing minimum bypass flow is to determine the level necessary to protect the resource and habitat based on biological and hydrologic conditions in the river. The standard presumption is that any diversion when the flow is below the bypass criteria is detrimental.

As I discussed above, my testimony assumes that the Board won't change the rules on how bypass flows and other public trust permit conditions are determined for diversions from a subterranean stream or underflow. Therefore, El Sur Ranch's conclusions regarding the impacts of their pumping on the fisheries and other public trust resources won't be used to eliminate or significantly reduce the protections that standard bypass flow and other public trust permit terms and conditions give to a river. Nevertheless, I have included in part VII.d. below, a separate discussion on the issues and problems associated with the use of an "impact test" for subterranean stream flow diversions.

<u>Testimony on the inadequacies of the flow limitations proposed by the 2009 Draft EIR</u>

Exhibit DFG-C-A

The October 2009 Draft EIR proposes a number of flow limitation mitigation measures. Exhibit DFG-C-22 is modified from Table 5 of my December 10, 2009 memorandum and summarizes my interpretation of the flow limitation mitigation measures proposed in the DEIR. When taken together these flow limitation mitigation measures are effectively the "bypass flow" permit conditions. These flow limitation mitigations as proposed are a series of stepped, overlapping and interlinked measures based primarily on the concept that the coupling of the CEQA baseline diversions to historic flow percentiles will adequately protect public trust resources, and that permit conditions during periods of low flow that are more protective than those currently in place are unnecessary. In fact, the DEIR states on page 4.2-66 that "no minimum flow has been established" and then suggests that only when the "flow drops below a minimum flow rate necessary to maintain aquatic habitat and riparian vegetation more often than baseline conditions" would there be "a substantial effect on river hydrology." This standard for significant impact presumably also applies to the river's ecology because hydrology drives in part the physical conditions that maintain aquatic habitat and riparian vegetation. The DEIR flow limitation mitigation or potential permit conditions effectively allow "baseline" diversions to occur under all flow conditions regardless of the significance of the effect. The DEIR proposes that diversions greater than "baseline" can only occur when flows exceed the values specified in Exhibit DFG-C-22 and when other water quality conditions given in the linked mitigations measures are acceptable. The DEIR's use of the CEQA baseline to set flow limitation or bypass flows effectively grandfathers El Sur Ranch's diversions, even though for most of its historic diversion, it has not held a valid water right to divert. El Sur Ranch's only existing valid water right is for the irrigation of 25 acres of riparian land. This fact was stated in Mr. Moeller's April 12, 1992 report of investigation (included in Exhibit SWRCB-3), but apparently wasn't considered a valid basis for setting the project's CEQA baseline.

Exhibit DFG-C-23 shows three tables from the 2009 DEIR that present information on the El Sur Ranch's diversions during the CEQA baseline period of 1985 to 2004. Exhibit DFG-C-24 shows DEIR Table A that list the allowable baseline diversion associated with the flow limitations listed in Exhibit DFG-C-22. Note that the flow values for the percentile values within listed in Exhibit DFG-C-22 are taken from my statistical analysis given in Exhibit DFG-C-4. This is due to the fact that there are many inconsistencies in percentile values within the DEIR tables and because my statistics are nearly the same as those in the applicant's Table 2 of application #A030166.

Exhibit DFG-C-23 contains three tables from the DEIR Table 4.1-1 in Exhibit DFG-C-23 compares the baseline diversions to the application #A030166 requested diversions. Table 4.2-2 gives a statistical analysis of El Sur Ranch's diversion during the baseline period. Finally, Table 4.2-6 presents a comparison between baseline diversions and the proposed 20-year average for diversions and the maximum project diversions.

Exhibit DFG-C-A

The information presented in the three tables reproduced in Exhibit DFG-C-23 creates some confusion as to whether the mean or maximum of the seasonal baseline diversions or any annual baseline diversion will be used in the flow limitation mitigation measures. The maximum monthly diversion baseline during the DEIR low-flow period of July 1 to October 31 is given in Table 4.1-1 as 269 acre-feet, which is greater than the application's requested maximum monthly diversion of 230 acre-feet for this period. The maximum seasonal July 1 to October 31 diversion baseline is given as 701 acre-feet, which is only slightly less than the 735 acre-feet requested in the application. Table 4.2-6 lists the baseline seasonal value as 540 acre-feet, which is the sum of the mean monthly values for the July to October seasonal baseline from Table 4.2-2. Then Table 4.2-6 switches to the maximum of the seasonal monthly baseline of 269 acre-feet as the seasonal monthly baseline. While the maximum baseline annual diversion of 1,136 acre-feet is less than 1,615 acre-feet requested in the application, there doesn't appear to be any requirement to limit diversions to the lower annual baseline of 1,136 acre-feet. Even if the annual baseline diversion of 1,136 acre-feet was the maximum and used as baseline, this equates to an irrigation rate of approximately 4.6 feet-per-acre-per-year for 248 acres, or 4.25 feet for 267 acres, an amount that exceeds reasonable beneficial use, as I'll discuss in detail in part VI.a. of my testimony below.

Table 4.1-1 shows the baseline maximum monthly instantaneous diversion rate is 5.84 cfs, which equals the maximum amount requested in application A#030166. In Table 4.2-2, the highest instantaneous pumping rate listed is 5.70 cfs for June. Table 4.2-6 uses the mean values given in Table 4.2-2 for the monthly baselines. Table A in Exhibit DFG-C-24 attempts to link the baseline monthly instantaneous rates of diversions of Table 4.2-6 to flow non-exceedence probabilities as measured at the USGS gauge #11143000. That is, the DEIR appears to be saying that the historic diversions by El Sur Ranch are directly linked to these percentile river flows and therefore the CEQA baseline effects of those diversions can be indexed to the non-exceedence probabilities or flow percentiles listed in Table A. The DEIR also seems to say that because of this linkage, the project's impacts are less than significant when diversions don't exceed baseline pumping.

The DEIR's use of only the historic percentile flow values as measured at the USGS gauge #1143000 in the flow limitation mitigation measures doesn't appear to account for flow losses downstream of the gauge, and clearly doesn't include El Sur Ranch's rate of diversion. If these additional losses are not accounted for in the flow limitation mitigations or bypass flow requirements, then the flow limitations listed in Exhibit DFG-C-23 may actually result in pumping during a condition with little or no flow in the river at the POD. For example, during September there is no restriction in diversion until flows are less than 7.3 cfs at USGS gauge #1143000, at which time continued diversion at the baseline rate of 2.60 cfs is still allowed. As discussed above, losses below the USGS gauge have been measured as high as 8.9 cfs and when combined with a maximum allowable instantaneous diversion rate of 5.84 cfs, losses below USGS gauge #11143000 as high as 14.74 cfs may occur. Thus, during September the combined upstream and POD flow losses can reach above 7.3 cfs, which will result in no or little surface flow below the POD, yet El Sur Ranch will not be restricted from pumping.

Continued pumping with very little flow in the river appears to have occurred during September 2007 as shown in Exhibit DFG-C-16 and as discussed in investigation summary on pages 4-1 and 4-2 of SGI's 2008 report. During the early part of September 2007, the USGS gauge #1143000 recorded flows ranging from 6.3 to 7.2 cfs resulting in flows in the ZOI of 0.30 to 0.46 cfs, while El Sur Ranch was diverting at a rate of 2.37 cfs. Under the flow limitations proposed in the 2009 DEIR, El Sur Ranch can divert up to 2.60 cfs in September (Exhibit DFG-C-22). Any additional diversion would likely decrease the flow in the ZOI. This instance of near baseline pumping during a low-flow event clearly shows that the flow limitations given in DEIR's Table A are insufficient to protect fisheries and clearly much less than the minimum 17 cfs recommended by Mr. Titus as the interim biological component of bypass flow for the ZOI.

Therefore, implementation of the flow limitations proposed in the 2009 DEIR that allow CEQA baseline diversions to occur at all times, will clearly result in significant impact to fisheries and can't be considered mitigation measures that reduce the potential impacts of the diversion below the level of significance or that protect public trust resources.

Testimony on terms and conditions necessary to mitigate potential adverse impacts from the El Sur Ranch's diversion and protect pubic trust resources.

Minimum Bypass Flow Conditions

Protection of fisheries and other public trust resources require permit terms and conditions for minimum bypass flow during both the low-flow months of June to November and winter-flow months of December to May. These bypass flow terms and conditions must be based on protection of fisheries and other public trust resources, not historic level of unauthorized diversion. Because of the unique setting of El Sur Ranch's POD, these minimum bypass flows need to be the summation of three parts, (1) the minimum flows needed to protect fisheries and other public trust resources, (2) the maximum historic flow losses downstream from the gauge used to monitor compliance, and (3) the maximum permitted instantaneous diversion rate.

These minimum bypass flow terms and conditions must also require El Sur Ranch to stop all diversions once the flow at the monitoring gauge is at or below the bypass value specified in the permit. Continued pumping at unpermitted historic pumping rates isn't protective of public trust resources even if those levels are considered the CEQA baseline for El Sur Ranch's appropriative water right project. El Sur Ranch can pump under a valid riparian right, but the rate and volume of pumping is limited to the reasonable and beneficial use of water applied to the 25 acres of riparian land. The per-acre irrigated rate and volume diverted under a riparian right should be the same as under the appropriative right for the same land use. As I will discuss in detail in my testimony on Hearing Issue No. 3, the rate of diversion for the 25 acres of riparian should be no greater than 0.31 cfs and the annual diversion no greater than 62.5 acre-feet. These diversion limitations are necessary to provide protection to the fisheries and other public trust resources and are consistent with the rules that govern other surface streams, subterranean streams and underflow.

<u>The following language is recommended for the bypass flow terms and conditions:</u>

<u>Term:</u> *For the protection of fish and wildlife, permittee shall during the period:*

1. from June 1 through November 31 bypass a minimum of 29.0 cubic feet per second, and

2. from December 1 through May 31 bypass minimum of 132.0 cubic feet per second.

3. The total streamflow shall be bypassed whenever it is less than the designated amount.

4. Streamflows shall be as measured at the USGS Big Sur River gauge #11143000 or by a device acceptable to the Chief of the Division of Water Rights and the State Department of Fish and Game.

5. These bypass flows values shall be considered interim and will be revised upon completion Big Sur River Instream Flow Physical Habitat Simulation (PHABSIM) Study being conducted the State Department of Fish and Game.

6. All minimum flows that must bypass the permittee's point of diversion shall be calculated based on summation of the seasonal requirements for the protection of fisheries and other public trust resources, plus the maximum recorded losses in flow between the permittee's point of diversion and the gauge used to monitor river flows, plus the maximum permitted instantaneous diversion rate.

7. Periodic monitoring of river flow in the zone of influence shall be conducted during dry and critically dry years to ensure that the permittee

bypasses sufficient flow to ensure adequate adult passage and juvenile rearing for steelhead, and water quality is maintained in the zone of influence of the permitee's wells and downstream.

8. Monitoring of all diversions shall record the instantaneous diversion rate and the total diversion rate for all wells, or other methods of diversion, and provide separate measurements for each point of diversion that irrigate riparian lands. The instantaneous rate of diversion shall be collected on no greater than a 15-minute time interval along with the date and time to document compliance with permit terms and conditions. The sum of the diversion shall be totaled and recorded at least daily.

9. The monitoring data shall be maintained by the permittee for at least ten years from the date of collection. Diversion records will be made available to the Chief of the Division of Water Rights, the State Department of Parks and Recreation and the State Department of Fish and Game, as required in the terms and conditions for the Compliance Monitoring Plan and upon request.

10. The permittee shall be responsible for all costs associated with developing the Compliance Plan, and installing and maintaining all bypass flow and other monitoring facilities described in the Compliance Plan.

11. Any non-compliance with the terms of the permit shall be reported by the permittee promptly, but no later than 24 hours after discover of a violation, to the Chief of the Division of Water Rights, the State Department of Parks and Recreation and the State Department of Fish and Game.

12. Diversion and use of water prior to approval of the Compliance Plan and the installation of facilities specified in the Compliance Plan is not authorized.

Term: *Within 30 days of the issuance of this permit, the permittee shall submit a Compliance Plan for approval by the Chief of the Division of Water Rights, the State Department of Parks and Recreation, and the State Department of Fish and Game that will demonstrate compliance with the flow bypass terms specified in this permit. The Compliance Plan shall include the following:*

1. A description of the physical facilities (i.e., outlet pipes, siphons, pipelines, bypass ditches, splitter boxes etc.) that will be constructed or have been constructed at the project site and will be used to direct flow at the place of use or bypass flow.

2. A description of the gages and monitoring devices that will be installed to separately make direct measurement of the diversion at each well pump of

the instantaneous rate of diversion in cubic feet per second and volume of diversion.

3. A description of the gauges and monitoring devices that will be installed to make separate, direct measurement of the instantaneous rate and volume of all water use under the appropriative right, and separate instantaneous rate and volume of water use under any riparian right.

4. A time schedule for the installation of these facilities with date of final installation, but no later than 60 days for the date of Compliance Plan approval.

5. A description of the frequency of data collection and the methods for recording diversion rates and volumes, bypass flows, and any other monitoring to demonstrate compliance with the permit terms and conditions.

6. An operation and maintenance plan that will be used to maintain all facilities in good condition.

7. Water usage and well pumping data shall be reported for each well separately shall be accumulated and reported monthly during the period between December and May, and weekly between June and November to the Chief of the Division of Water Rights, the State Department of Parks and Recreation and the State Department of Fish and Game.

8. Collected information on river flows, and rates and volumes of diversion by any other method not in the approved Compliance Plan shall also be submitted to Chief of the Division of Water Rights, the State Department of Parks and Recreation and the State Department of Fish and Game, at least twice per year, in January and June or upon request.

9. Should the meters, recording and/or monitoring devices fail, become uncalibrated or otherwise fail to report an accurate record of each diversion and point of use, then no pumping shall be allowed until the meters, recording and all other devices and fixtures necessary for monitoring are properly repaired and made operable. A report of monitoring devise failure and repair shall be submitted to Chief of the Division of Water Rights, the State Department of Parks and Recreation and the State Department of Fish and Game, at least 5 working days prior to resumption of diversions.

10. Any non-compliance with the terms of the permit shall be reported by the permittee promptly, but no later than 24 hours after discovery of any non-compliance event, to the Chief of the Division of Water Rights, the State Department of Parks and Recreation and the State Department of Fish and Game.

11. Diversion and use of water prior to approval of the Compliance Plan and the installation of facilities specified in the Compliance Plan is not authorized.

The following language is recommended to allow for an alternative to the terms and conditions required use of USGS gauge #11143000 for monitoring bypass flow:

Term: *The permittee may propose the use of another river gauge to monitor compliance with the bypass flows terms and conditions under the following:*

1. The permittee shall submit a plan along with engineering design drawings, figures and any operation requirements for any stream gauge proposed as an alternative for monitoring bypass flows to the Chief of the Division of Water Rights and the State Department of Fish and Game for review and approval. If the location of an alternative monitoring gauge is on state parks land, then the alternative gauge plans and design documents shall also be submitted to the State Department of Parks and Recreation for review and approval.

2. The permittee shall provide funding for the installation and the long-term maintenance of any alternative stream gauge. The permittee shall deposit the necessary funds into a non-wasting endowment account sufficient to provide the funding for gauge construction, including all permit and environmental document preparation and review, and for long-term maintenance and repair of the alternative monitoring gauge in perpetuity.

3. The location of any alternative monitoring stream gauge shall be upstream of the permittee's PODs and below the other diverters in the watershed.

4. The use of an alternate monitoring gauge for permit bypass flow compliance shall require collection, maintenance and reporting of recorded river stage and instantaneous flows at time increments equal to or less than at USGS gauge #11143000. The calibration of the alternative monitoring gauge shall be kept current and updated at a frequency consistent with USGS river gauge requirements.

5. The instantaneous rate of flow measured at the alternative monitoring gauge as well as daily, monthly and annual statistics shall be calculated and made continuously available on the internet so that governmental agencies and the public can review compliance with permit bypass flow conditions.

6. The alternative monitoring gage shall not be accepted for demonstrating compliance with the permit bypass flow terms and conditions until it has

been calibrated and operated for a period of at least two years. During which time a comparison shall be made between the alternative monitoring gauge and USGS gauge #11143000 to determine the range of instream flow losses between the alternative monitoring gauge and USGS gauge #11143000. The instream flow losses downstream from the USGS gauge #11143000 may be adjusted to account for the change in location of the bypass flow monitoring gauge.

7. The minimum values for bypass flow may be adjusted for the change in the location of the bypass flow monitoring gauge provided that the adjusted values are the summation of the seasonal requirements for the protection of fisheries and other public trust resources, plus the adjusted maximum recorded instream flow losses between the permittee's point of diversion and the alternative monitoring gauge, plus the maximum permitted instantaneous diversion rate.

8. Periodic adjustment shall be made whenever the calculated instream flow losses between the alternative monitoring gauges and USGS gauge #11143000 is found to be insufficient to provide adequate bypass flows at the permitee's point of diversion.

9. If the permittee fails to provide funding to support operation of the alternative monitoring stream gage, then monitoring compliance with the permit bypass flow terms and conditions shall be at the existing USGS Big Sur gauge, #11143000. Should this occur, the minimum bypass flow values shall revert to those established for bypass flow monitoring at the USGS gauge #11143000. Flows at gauge #1143000 shall then be used to measure flows in the river and determine when the permittee's wells or other points of diversion must stop pumping and bypass the total flow of the river.

<u>The following language is recommended for permit terms and conditions requiring a Stream or Lake Alteration Agreement:</u>

<u>Term:</u> *For the protection of fish and wildlife, the permittee shall submit a Stream or Lake Alteration Agreement to the State Department of Fish and Game that covers all diversions authorized under this permit.*

1. No work shall commence and no water shall be diverted, stored or used under this permit until a copy of a Stream or Lake Alteration Agreement between the State Department of Fish and Game and the permittee is filed with the Division of Water Rights.

2. Compliance with the terms and conditions of the Stream or Lake Alteration Agreement is the responsibility of the permittee. If a stream of lake agreement is not necessary for this permitted project, the permittee shall

provide the Division of Water Rights a copy of a waiver signed by the State Department of Fish and Game.

VI. REASONABLE AND BENEFICIAL USE

a) Will the water be put to reasonable and beneficial use?

El Sur Ranch is requesting an appropriative water right to divert from January 1 to December 31 of each year an annual maximum of 1,615 acre feet of the subterranean stream flow of the Big Sur River for use on 267 acres of pasture, although I've measured the irrigated pasture area at approximately 248 acres. A discussion on how I arrived at 248 acres is expanded upon below. All but 25 acres of pasture are outside of the Big Sur River watershed. El Sur Ranch is also requesting an appropriative water right to divert at a maximum instantaneous diversion rate of 5.84 cfs. In addition to these maximum diversions, El Sur Ranch has requested that the appropriative water right have a number of other flow limitations, two June to October seasonal monthly and cumulative averages, year-round 30 day-running average, and a 20-year running annual average, see Exhibit DFG-C-21. The maximum annual diversion amount requested will allow irrigation of the 267 acres, or 248 acres by my measurement, to a total annual depth of applied water of approximately 6.05 acre-feet per acre, or 6.5 feet using my area.

The total volume and instantaneous rate of diversion sought by El Sur Ranch exceeds the amount of water that is normally considered reasonable beneficial use by Water Code section 1004 (2.5 acre-feet-per-acre-per-year) and California Code of Regulations Title 23 697(a)(1) (1 cfs per 80 irrigated acres), in comparison to application rates for pastures in the general area, and calculation of crop water requirements using standard methods.

Also, the irrigation requirement as calculated by the National Resources Consulting Engineers, Inc. (NRCE) 2007 exceeds the irrigation requirement that I calculated using using two standard methods of estimating evapotranspiration and crop water requirement, the Department of Water Resources' California Irrigation Management Information System (CIMIS) (http://wwwcimis.water.ca.gov/cimis/welcome.jsp) and Pruitt & Snyder, 1985.

In addition to the issue of pasture water requirement, the total irrigated pasture acreage appears to be in error in part because the Swiss Canyon channel and riparian area is included in the total. I've calculated a total irrigated pasture area of approximately 248 acres, which includes the 25 acres of riparian land, using ArcMap software and the georeferenced USGS digital orthoquadrangle image, DOQQ o36121c7sw.tiff, as a base map, Exhibit DFG-C-25.

I have previously commented extensively in my General Comments Nos. 2, 3, 4, 10, 11 and 13 of my December 10, 2009 memorandum on the October 2009

Draft EIR (Exhibit DFG-C-59). These comment present my professional opinions on the requested rates of diversion and on the whether they are a reasonable and beneficial use, as well as possible negative impacts that may be occurring from pasture irrigation. The information submitted in this testimony will summarize and augment my previous comments. Those previous comments are included in this testimony by reference.

Testimony on comparison of requested diversions to Water Code and Title 23 regulatory standards for reasonable and beneficial use.

El Sur Ranch is requesting an appropriative water right to divert from January 1 to December 31 of each year an annual maximum of 1,615 acre feet of the subterranean stream flow of the Big Sur River for use on 267 acres of pasture, or 248 acres based on the pasture area that I've measured. Water Code in Section 1004 states that "*useful or beneficial purposes' shall not be construed to mean the use in any one year of more than 2-1/2 acre-feet of water per acre in the irrigation of uncultivated areas of land not devoted to cultivated crops.*"

The Water Code doesn't indicate whether an irrigated pasture is considered a cultivated or uncultivated crop. The U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS) does, however, define the difference between a cultivated and noncultivated cropland for its National Resource Inventory Program (NRI). It is my opinion that given the lack of a Water Code definition, that the NRCS definition should be utilized. National Resource Inventory provides updated information on the status, condition, and trends of land, soil, water, and related resources on the Nation's non-Federal lands. The 2007 glossary for the NRI resource descriptions can be found at: http://www.nrcs.usda.gov/technical/nri/2007/glossary.html. The 2007 glossary has the following definition for two types of cropland:

> **Cropland.** A *Land cover/use* category that includes areas used for the production of adapted crops for harvest. Two subcategories of cropland are recognized: cultivated and noncultivated. Cultivated cropland comprises land in *row crops* or *close-grown crops* and also other cultivated cropland, for example, hayland or pastureland that is in a rotation with row or close-grown crops. Noncultivated cropland includes permanent *hayland* and *horticultural cropland.*

According to the USDA definition, the permanent pasture land at the El Sur Ranch would likely be considered noncultivated lands, or uncultivated in Water Code terms, because it is functionally equivalent to permanent *hayland* and therefore subject to the beneficial use limitation of 2-1/2 acre-feet-per-acre-per year as required by Water Code section 1004.

The water right application also requests a maximum instantaneous diversion rate of 5.84 cfs based on an irrigation rate of 1 cfs for each 50 acres assuming a total irrigated acreage of 292 acres (see Table 1 on page 3 of the memorandum accompanying the 3rd Amendment to the application (October 17, 2006). The hearing announcement and DEIR assume that the total irrigated area is 267 acres, but at this acreage the maximum instantaneous diversion rate would be 5.34 cfs. The application requests that this 5.34 cfs diversion rate be measured as a 30-day average, not a maximum. The October 2009 DEIR doesn't give any discussion or reasoning as to why the maximum diversion is set at 5.84 cfs beyond stating that it is below the historic high pumping rate that periodically exceeded 6 cfs (page 4.2-59). I have provided additional discussion on these diversion rates in my December 10, 2009 memorandum in my General Comment No. 3. (Exhibit DFG-C-59.)

The standard of one cubic foot per second per 50 acres apparently comes from California Code of Regulations (CCR) Title 23, section 697(a)(1), which discusses reasonable use of water appropriated by direct diversion. According to this regulation, the 1 cfs per 50 acres rate of use, or duty, applies when "*there is an abundance of water and a heavy transportation loss, or for irrigating porous, sandy or gravelly soils in the Central Valley of California or elsewhere in the State where similar conditions prevail.*" For other than porous, sandy or gravelly soils in the Central Valley or area with similar conditions Section 697(a)(1) considers a duty of 1 cfs per 80 acres to be reasonable use. In areas where water supply is less abundant and conditions are favorable to a more economical use, a duty of 1 cfs for 150 acres is considered reasonable use. The physical setting of the El Sur Ranch doesn't fit the requirements for a duty of 1 cfs for 50 acres, but may fit the duty of 1 cfs for 80 acres.

The majority of the soils, 86%, being irrigated in the pastures at El Sur Ranch are a Santa Ynez series fine sandy loam and don't meet the porous, sandy or gravelly criteria of the CCR Title 23, section 697(a)(1). The distribution of soil types in the pastures is shown in Figure 4-1 of the 2007 NRCE report and the general physical characters of the soils are given in Table 4-1 of that report. Even though the climatic conditions at the El Sur Ranch along the Central Coast of California adjacent to Big Sur are wetter than the Central Valley of California, water available for appropriation is not abundant throughout the year, especially during summer months. Conveyance or transport losses at El Sur Ranch are minimal because water is delivered to the pastures by pipes.

Therefore, the conditions in CCR Title 23, section 697(a)(1) that apply to a diversion rate of 1 cfs for 50 acres are not met at El Sur Ranch and thus the 5.84 cfs maximum instantaneous diversion is not a reasonable use of water under CCR Title 23, section 697(a)(1). A reasonable diversion rate of 3.1 cfs is calculated from CCR Title 23 section 697(a)(1) using a duty of 1 cfs per 80 acres, along with an actual irrigated area of 248 acres (248 acres * (1 cfs / 80 acres) = 3.1 cfs). This value assumes that the El Sur Ranch lands being irrigated have a climate similar or better than the Central Valley of California.

Exhibit DFG-C-A

Testimony on the results of the comparison of methods for estimating pasture water use

The results of the reasonable beneficial use study done for application A030166 by National Resources Consulting Engineers, Inc. (NRCE) in 2007 calculated an irrigation requirement of 1,180 acre-feet per year, and a seasonal July-October requirement of 583 acre-feet, see page 11-2. The application, however, requests that the maximum annual diversion be set at 1,615 acre-feet and a maximum cumulative July-October seasonal diversion of 735 acre feet. The NRCE irrigation requirement calculation assumed that irrigation efficiency would decrease from a high of 82% down to 65%, that an additional 10% per year was necessary to leach salts, and an additional 12% for a "margin of uncertainty and safety." The total requirement for irrigating acreage of 267 acres also included water for Swiss Canyon, the natural drainage running between the pastures, which is said to provide grazing land and is provided water through irrigation seepage, page 2-9. In addition to the maximum volume limits, the application requests other monthly and seasonal diversion limitations, see Exhibit DFG-C-21.

The 2007 NRCE report calculated irrigation requirements for the El Sur Ranch pastures using a methodology that is more complex than the methods that I used. NRCE used a combination of the FAO Penman-Monteith method, the single crop coefficient approach, the SCS Modified Blaney-Criddle method, with the USDA-SCS effective precipitation equation, along with development of estimated pasture precipitation by using 2.5 years of data from a temporary on-site weather station that was then correlated to a National Weather station in Monterey (NWS#040790), followed by validation with a weather station in San Luis Obispo (DWR Bulletin 3, 1975).

Although the NRCE methodology is more complex than the ones that I use, there are several areas where our methods use the same procedures or coefficients. My testimony will focus on these areas of similarity so that a comparison can be made of the pasture water and net irrigation requirements, and precipitation.

In order to evaluate the NRCE calculation of the net irrigation water requirement, I utilized two simpler methods for estimating crop water and net irrigation requirements. The first method I used was a simple single crop coefficient method as presented in the CIMIS web site. The CIMIS method divides California into 18 reference evapotranspiration (ETo) zones with monthly ETo in inches per month. The maps and zone values are available at http://wwwcimis.water.ca.gov/cimis/pdf/CimisRefEvapZones.pdf.

El Sur Ranch is located in CIMIS zone 1, the *Coastal Plain Heavy Fog Belt*, which has the lowest ETo in California and is characterized by dense fog. Exhibit DFG-C-26 is taken from Figure 7-4 of the 2007 NRCE report and shows the ETo zones in the vicinity of El Sur Ranch. Exhibit DFG-C-27 is the table of ETo values for each zone taken from the CIMIS web document listed above. The water requirement for a single crop, ETc, is found by multiplying the reference ETo by the crop coefficient, Kc. This is the same method as NRCE describes in section 7.4.1 and equation 2 of their 2007 report.

$$ETc = Kc * ETo$$

For my CIMIS analysis, I assumed a single growth stage crop coefficient for pasture of 1.00 rather than the 0.95 recommended by CIMIS for improved pasture in the Bise.xls spreadsheet, http://biomet.ucdavis.edu/irrigation_scheduling/bis/BIS.htm, in order to allow for a simple comparison of the monthly crop water requirements using CIMIS zone 1 Eto as a baseline. In the 2007 report, NRCE also appears to have used a single growth stage crop coefficient throughout the year for a pasture with rotating grazing of 1.06, see NRCE 2007, Table 7-2.

The second method that I used to estimate the pasture net irrigation requirement is based on a series of reference maps developed by Pruitt and Snyder, 1985, that give daily values of ETo across California for each month. I interpolated that daily ETo value from these maps for El Sur Ranch area and then calculated a monthly ETo value. The monthly water requirement was calculated using the same single crop coefficient as the CIMIS method. The crop coefficient I used for the Pruitt-Snyder method was also 1.00 because these ETo maps were developed for a well-maintained pasture.

Exhibit DFG-C-28 shows the monthly average reference ETo and calculated ETc values for the El Sur Ranch area as calculated by NRCE, CIMIS and Pruitt-Snyder methods along with the CIMIS ETo of the two National Weather Service stations and ETc of two stations in San Luis Obispo.

In order to calculate the net irrigation requirement, a water balance is done by subtracting the crop water requirement from precipitation. That is, irrigation is needed to meet the ETc that is not provided by precipitation. Additionally, some inefficiency is assumed in the delivery of the water to the field. For my analysis of pasture net irrigation requirement, I assumed an efficiency of 70%, which is the long-term average for El Sur Ranch, NRCE 2007 page 11-1.

El Sur Ranch lacks a nearby long-term weather station to provide a site-specific record of average monthly precipitation. Two nearby National Weather Service stations in Big Sur (NWS#040790) and Monterey (NWS#045796) are both in ETo zones different from El Sur Ranch, ETo zones, 6 and 3, respectively. Rather than adjust the data from these weather stations, as NRCE did, I obtained a site-specific record using the precipitation data explorer web site of the PRIZM Climate Group, http://prismmap.nacse.org/nn/, and downloaded synthesized monthly precipitation records for the El Sur Ranch area for the years of 1915 to

2010. Exhibit DFG-C-29 lists the results of this effort as well as average precipitation values for other weather stations in the area taken from the Western Regional Climate Center web site, http://www.wrcc.dri.edu/, and the values used by NRCE in their 2007 report on Table 7-6.

I used the monthly PRIZM data without adjustment, contrary to what I did for the WAA because I wasn't interested in the ratio to another gauge, and because the average annual 30.63 inches of precipitation measured from 1992 to 2006 at the El Sur Ranch (NRCE Appendix B, Table 1) is nearly the same as the unadjusted annual PRIZM value of 30.58 (Exhibit DFG-C-29). Exhibit DFG-C-30 presents a graph of the monthly average precipitation for the two nearby National Weather stations sites, NRCE Table 7-6, and the 1915 to 2010 PRIZM data.

The monthly precipitation data in Exhibit DFG-C-30 show that the Big Sur #040790 and Monterey #025796 weather stations are the high and low conditions, respectively. The NRCE Table 7-6 and PRIZM data are in between and are very close to each other except for the months of December, January and February, where the NRCE precipitation is lower during winter months. Exhibit DFG-C-31 compares the PRIZM precipitation to the two National Weather Stations and shows good correlations to both, with the regression coefficient for the Big Sur stations being slightly better.

Once the monthly crop water requirement and the precipitation data are developed, a mass balance can be done to determine how much irrigation water is needed above the amount provided by precipitation, which give the net irrigation requirement.

NRCE provides four tables that list each the value of each component of the net irrigation calculation for each month from 1975 to 2006. Exhibit DFG-C-32 is a summary table of the NRCE data giving the average values and sums of the April to October and November to March irrigation requirements along with sums of the precipitation that is not available to the plants or lost, and the annual percentage of this lost precipitation. Exhibit DFG-C-33 provides a graph of the components of the NRCE net irrigation requirement. NRCE used a crop coefficient of 1.06 for each month, Table 7-2. As part of the analysis, NRCE calculated monthly effective precipitation, the portion of total precipitation that satisfies or reduces the crop water requirement (NRCE, 2007, page 7-16). The NRCE calculation of net irrigation requirement shows that irrigation water is needed each month, and that average precipitation can't meet the pasture water requirement.

I also calculated monthly water balances using the CIMIS and PRIZM data and a crop coefficient of 1.00, which resulted in the net irrigation requirements shown in Exhibit DFG-C-34. To compare my monthly net irrigation calculations to those of NRCE, I summed the irrigation requirement into two intervals, April to October, and November to March. Whenever the precipitation exceeded the crop water requirement, I assumed that the need for irrigation was minimal. I also assumed that the irrigation system operates at an efficiency of 70 percent. Exhibit DFG-C-35 shows a graph of the CIMIS net irrigation calculations. The graph shows that the need for irrigation begins between March and April and ends between October and November. During November to March, irrigation is on average not required.

I made a second calculation of a monthly water balance for the Pruitt-Snyder and PRIZM data using a crop coefficient of 1.00, which resulted in the net irrigation requirements shown in Exhibit DFG-C-36. To compare my net irrigation calculations to those of NRCE, I summed the irrigation requirement into two intervals, April to October, and November to March. Whenever the precipitation exceeded the crop water requirement, I assumed that the need for irrigation was minimal. I also assumed that the irrigation system operates at an efficiency of 70 percent. Exhibit DFG-C-37 shows a graph of the Pruitt-Snyder net irrigation calculations. Similar to the CIMIS calculations, the graph shows that the need for irrigation begins between March and April and ends between October and November. During November to March, irrigation is on average not required.

Exhibit DFG-C-38 is a summary table of the monthly net irrigation requirements for the three methods. The NRCE calculations find that irrigation is required during the rainy season, November to March where as the CIMIS and Pruitt-Snyder calculations show that there is sufficient precipitation to meet the pasture water requirement. The difference is in part due to NRCE use of effective precipitation, although my calculations found a similar annual percentage of precipitation loss. NRCE also used lower rates of precipitation during the winter months.

To evaluate the relative difference in the three methods in the calculation of net irrigation requirement, I divided the crop water requirement coefficient, ETc, of the NRCE and Pruitt-Snyder methods by the CIMIS zone 1 ETc to create a normalized the data set. Exhibit DFG-C-39 shows a graph with the normalized monthly ETc values with the CIMIS zone 1 ETc equal to 1.0. This graph shows that the NRCE Table 7-5 values generally exceed those of the Pruitt-Snyder. Both NRCE and Pruitt-Snyder approach the CIMIS from April to September, with the Pruitt-Snyder often less than CIMIS, but the NRCE was always greater. The greatest difference between the three methods occurs from October through April. The greatest difference occurs in December when the Pruitt-Snyder method is approximately 2.5 times large than CIMIS and NRCE approximately 3.5 times larger.

NRCE assumed in the calculation of the final irrigation requirement that an additional 10 percent of applied water was needed each year to leach salts. To determine whether leaching water is necessary and using my method of calculating the net irrigation requirement, I made a series of direct runoff calculations using the rainfall-runoff equation method described in SCS T-149 publication for a number of different rainfall events, http://www.wsi.nrcs.usda.gov/products/w2q/H&H/docs/TRs_TPs/TP_149.pdf.

I took the percentage of soils and soil type from NRCE 2007 Table 4-1 and the curve numbers, CN, from Table 2 of SCS T-149 with the assumption that the land use was a pasture in good condition with no mechanical treatment. For my calculations, I used an area weighted average CN value. I used the 1973 NOAA Atlas 2 precipitation contour maps, http://www.wrcc.dri.edu/pcpnfreq.html, to determine a series of 2-year to 100-year, 6-hour and 24-hour precipitations rates for the El Sur Ranch area. I then calculated the runoff for each type of storm event and the percentage of runoff. I selected the 2-year, 24-hour storm event as a representative "average" event and then subtracted the SCS direct runoff percentage from the annual percentage of "lost" precipitation found in my net irrigation requirement calculations. The results of these calculations show that during a 2-year, 24-hour storm event approximately 14 to 26 percent of the precipitation in excess of that needed by the pasture remains on-site. Exhibit DFG-C-40 is a SCS figure for graphically calculating the direct runoff. I plotted the 2-year, 24-hour example. Exhibit DFG-C-41 is a table showing the results of my direct runoff calculations.

Although these calculations were made on short duration storm events and not monthly or annually as would usually be done to estimate groundwater recharge, the results show that the percentage of runoff decrease with shorter duration storms. Thus, the amount of precipitation typically remaining on the pastures will likely fall within the values calculated for a 2-year storm event. In addition, most precipitation occurs during the winter months, Exhibits DG-C-29 and -30, when my calculations indicate low pasture water requirements. The precipitation that remains on-site in excess of the pasture needs is then available for deep infiltration. Because the volume of the precipitation water remaining on site is equal to or greater than the additional 10% desired by El Sur Ranch for leaching of salts, natural precipitation appears to be sufficient to meet this requirement. In other word, there appears to be sufficient water from rainfall to meet the leaching needs provided that the total annual volume of diverted water applied to the pasture is consistent with Water Code section1004, at 2.5 acre-feet-per-acre.

I took the pasture water requirements calculated by the three methods and compared them to the 2009 Draft EIR monthly irrigation baseline to determine whether the historic irrigation practices were consistent with the water needs of the pasture. Exhibit DFG-C-42 is a graph of the pasture water requirements calculated by the three methods and the CEQA baseline mean monthly irrigation rate. Baseline mean monthly irrigation rate was calculated by dividing the mean monthly irrigation shown in DEIR Table 4.2-2 by the acreage, 248 acres, and then converting to inches. The shape of the NRCE mean monthly pasture water requirement curve of ETc that was taken from NRCE Table 7-5 is similar, but consistently higher than, the ETc curves from the CIMIS and Pruitt-Snyder methods. A comparison of these ETc curves to historic mean CEQA baseline irrigation graphs shows that the need for irrigation typically begins between March and April and ends around November, see Exhibits DFG-C-35 and -37. This contrasts with the pasture irrigation requirement calculated by NRCE, which shows a need for a year-round irrigation, Exhibit DFG-C-33.

I also made comparisons of the pasture net irrigation requirements calculated by the three methods to the 2009 Draft EIR monthly irrigation baseline to determine whether the net irrigation requirement is consistent with historic irrigation practices. Exhibits DFG-C-43 and -44 are graphs of the mean and maximum pasture net irrigation requirements calculated by NRCE and the mean of ETc values from the CIMIS and Pruitt-Snyder methods along with the mean and maximum CEQA baseline monthly irrigation rate. The CEQA baseline monthly irrigation rates were calculated by dividing the monthly irrigation shown in DEIR Table 4.2-2 by the acreage, 248 acres, and then converting to inches.

In Exhibit DFG-C-43, the shape of the three mean monthly pasture net irrigation curves are similar to the NRCE curve, and are consistently greater than ETc curves from the CIMIS and Pruitt-Snyder methods. I assumed that the net irrigation requirement for CIMIS and Pruitt-Snyder is the same as ETc, the values were not adjusted for irrigation inefficiency to be consistent with NRCE Table 7-8 values. For this graph, I set the net irrigation requirement to zero whenever the values were negative, i.e., precipitation exceeds ETc. The graph shows that the shape of the CIMIS and Pruitt-Snyder curves are similar to the CEQA mean baseline irrigation, except that the CEQA mean baseline is approximately 1.5 to 2 times greater during June to September. This graph also shows that the historic average need for irrigation typically began between March and April and ended around November. This contrasts with the mean pasture irrigation requirement calculated by NRCE, which shows a need for a year-round irrigation, Exhibit DFG-C-33.

Exhibit DFG-C-44, plots the maximum NRCE monthly pasture net irrigation and maximum CEQA baseline irrigation against the mean ETc curves from the CIMIS and Pruitt-Snyder methods. I used the mean values from my calculations because I didn't calculate maximums. I assumed that the net irrigation requirement for CIMIS and Pruitt-Snyder is the same as ETc, the values were not adjusted for irrigation inefficiency to be consistent with NRCE Table 7-8 values. For this graph, I set the net irrigation requirement to zero whenever the values were negative, i.e., precipitation exceeds ETc. The graph shows that the shape of the CIMIS and Pruitt-Snyder curves are similar to the CEQA maximum baseline irrigation, except the CEQA maximum baseline is approximately 2 to 4 times greater during April to October. This graph also shows that the historic maximum need for irrigation typically began between March and April and continued until January. This contrasts with the maximum pasture irrigation requirement calculated by NRCE which shows a need for a year-round irrigation.

Conclusions on reasonable and beneficial use for El Sur Ranch pasture irrigation.

The diversion rate requested in application A030166 exceeds the Title 23 section 697(a)(1) standard of 1 cfs per 80 irrigated acres. If this regulatory standard is utilized, it would calculate to a maximum instantaneous diversion rate of 3.10 cfs for 248 acres.

The annual total diversion volume requested in application A030166 exceeds the standard given in Water Code section 1004 for 2.5 feet-per-acre-per-year for uncultivated land not devoted to cultivated crops. The El Sur Ranch pastures meet the USDA-NRI definition of non-cultivated land, and therefore the limitations in Water Code section 1004 apply.

The use of a 30-day average for maximum instantaneous diversion as allowed by Title 23 section 697(a)(1) shouldn't apply in the calculation of minimum bypass flows because protection of fisheries and other public trust resources needs to be based on the maximum instantaneous diversion, otherwise the resource will likely be harmed because they can be subjected to short periods of extremely high diversion rates.

The conclusions from my comparison of the CIMIS and Pruitt-Snyder 1985 methods for calculating pasture water requirements and the water balance calculations of net irrigation requirements against the values presented in the NRCE 2007 report are as follows:

> The NRCE analysis used a precipitation rate that is less than the PRIZM values during the winter months, Exhibit DFG-C-30.
>
> The NRCE analysis used a crop coefficient, Kc, of 1.06 for each month of the year, which is higher than the 1.00 value used in the CIMIS and Pruitt-Snyder methods that represents the typical well managed pasture.
>
> The NRCE analysis resulted in monthly pasture water requirements, ETc, that were consistently higher than those calculated using the CIMIS or Pruitt-Snyder methods, particularly from November to February, Exhibit DFG-C-39.
>
> The SCS direct runoff calculation indicates that precipitation that doesn't runoff and isn't needed to meet the pasture water requirement may be sufficient to provide the 10 percent water needed to leach salts, Exhibit DFG-C-41.
>
> The CIMIS and Pruitt-Snyder methods of calculating the pasture water requirement with an assumed irrigation efficiency of 70% found that the

irrigation requirement with an efficiency of 70% is approximately the annual 2.5 acre-feet per-acre required by Water Code section 1004.

The NRCE calculations of net irrigation requirement are higher than either the CIMIS or Pruitt-Snyder methods, particularly during winter months.

The total irrigation water requirement has an additional 10% for leaching salts, a reduction in efficiency to 65% and 12% for a margin of safety. The resulting total irrigation requirement of 6 plus feet-per-acre-per year exceeds what is reasonable and beneficial use by the Water Code and is much greater than at other pastures in the area.

<u>Testimony on potential environmental impacts that may be occurring from pasture irrigation.</u>

This testimony is included under the answer to the question of reasonable and beneficial use because the environmental effects are related to the place of use not the points of diversion. Much of this testimony was presented in detail in my General Comments 10 through 13 of my December 10, 2009 memorandum commenting on the October 2009 Draft EIR and is incorporated by reference.

El Sur Ranch irrigates two pastures on an ocean terrace between Highway 1 and the Pacific Ocean, see DEIR Figures 2-2 and 2-3. The pastures drainage generally slopes at a grade from 2 to 3% towards the ocean, but an approximate 25-acre area drains towards the Big Sur River and is considered riparian to the diversion. Runoff on the eastern pasture area generally runs to a tailwater pond where it is stored and may discharge through a culvert to the beach (Section 2.2, NRCE, 2007). Runoff on the western pastures discharges "*to a water control structure that discharges the water to the ocean with minimal erosion.*" Some drainage can apparently discharge either by direct runoff or by seepage to Swiss Canyon, an incised drainage that runs between the pastures and is considered suitable habitat for California red-legged frog.

Excessive irrigation of pastures can cause a build up of ground water greater than the natural condition and force ground water to discharge along the edges of the pastures at the coastal bluffs or the slopes of Swiss Canyon. While some ground water discharge will occur as the result of heavy precipitation, the continued irrigation during summer months can increase the moisture content of the soils and aid in the increased build up of groundwater. As discussed below, a low permeability subsoil underlies much of the pastures creating a condition for perched ground water.

Most of the pasture soils, 86%, are a sandy loam of the Santa Ynez series, NRCE, 2007 Figure 4-1, which has a low permeability zone caused by a 25-inch thick clay subsoil at a depth from 16 to 36 inches (Table 4-1, NRCE, 2007). When the water applied to the pastures exceeds the evapotranspiration demand of the vegetation, it either runs off as surface flow or infiltrates to eventually become perched above this clay subsoil. Because the slope of the land is towards the ocean, perched ground water likely flows towards the ocean bluffs, although some may seep towards Swiss Canyon (NRCE, 2007 page 2-9). Where the ground water seeps out of the cliff face it can cause blocks of the bluff to slump at a greater rate or entrap and transport grains of soil, which eventually undermine the slope through the process known as sapping. The sapping process is evidenced by the development of scalloped heads on the resulting gullies. These gullies erode from the top down, not the bottom up. They aren't created by sea waves eroding the toe of the cliff which migrate upwards. I've included as part of my December 10, 2009 DEIR comments a time-series of oblique images of the bluffs showing both the sapping, Figures 6 to 10, and the seepage and block slumping, Figures 11 to 15. (Exhibit DFG-C-59.) Application of irrigation water in excess of what is needed by vegetation can increase the amount of perched water and thereby accelerate bluff erosion.

Based on the slope of the terrain, there is potential for irrigation water to run into Swiss Canyon by overland flow or subsurface seepage. However, various studies come to conflicting conclusions regarding this point. On page 1 of Attachment A in the October 17, 2006 Amendment to application A030166, it is stated that irrigation return flow contributes "*to the maintenance of endangered species and ecosystems in Swiss Canyon*." However, according to the technical reports submitted by El Sur Ranch, Swiss Canyon may or may not receive seepage from the adjacent El Sur Ranch irrigated pastures. In their 2007 report, NRCE stated that the irrigated portion of the 267 acres "*includes a portion of Swiss Canyon that is irrigated by seepage*," while Hanson in section 3.8 of the 2008 report states that "*the 2007 study provides no evidence to suggest that El Sur Ranch irrigation practices were an important factor affecting habitat or surface waters within Swiss Canyon in 2007*." The DEIR states that the Swiss Canyon area is not within the point of use (POU) and is not part of the irrigated area (page 2-6).

If either surface runoff or groundwater seepage from the pastures is discharging to Swiss Canyon there may be impacts to quality and beneficial uses of the canyon waters and habitat due to the fact that the runoff is from a pasture where cattle graze and seepage apparently carries away excess salts from the soils. The DEIR also states in several places that there is "upwelling" or a spring of ground water in Swiss Canyon that occurs near the boundary of pastures 2 and 7 (page 4.2-17). Hanson commented on page 6 of a report on status of the Swiss Canyon habitat, which is attached to the main 2007 biological report, that there was standing water "*within the creek bed in the vicinity of irrigation pipe repair and testing downstream of Station 2 between fields 2 and 3.*" The DEIR in Figure 2-3 shows that there is an irrigation pipe running across Swiss Canyon that aligns with the boundaries between pastures 2 and 7, and pastures 3 and 6. Although a leaky irrigation pipe running under Swiss Canyon might supply water to the habitat, this type of water discharge might require a permit and monitoring to document the quality and quantity of the discharge and any environmental impacts.

The DEIR discusses on page 4.2-42 that the irrigated pastures are subject to the requirements of the Central Coast Regional Water Quality Control Board's (CCRWQCB) *Conditional Waiver of Waste Discharge Requirements for Discharges From Irrigated Lands*, Order R3-2004-0117. The CCRWQCB has recently replaced that order with Order R3-2009-0050 (Order), which requires that the Monitoring and Reporting Plan (MRP) No. R3-2004-0117 continue under this new order. Order R3-2009-0050 has a number of General Conditions that require compliance with water quality standards. The Order also has a list of documents that need to be submitted along with the Notice of Intent during the Enrollment Process. Among the needed documents are a completed management practice checklist/self assessment form, and a statement of completion of a Farm Water Quality Management Plan, and monitoring in accordance with the MRP. The MRP requires monitoring of any discharges to surface or ground water, including discharges to streams, tailwater ponds, and stormwater runoff. Apparently, El Sur Ranch is not participating in this conditional waiver monitoring program because no results from water quality sampling are discussed in the DEIR or otherwise made available. The fact that the eastern pastures collect runoff in a tailwater pond should allow for periodic water quality sampling. Due to the cattle grazing and the salt leaching, the runoff from pastures may be a significant impact to the environment, water quality and beneficial uses depending upon the quality of the water in tailwater pond

b) Is the proposed appropriation in the public interest?

The proposed diversion is not in the public interest if the underlying assumption is that the historic diversions and existing rate of diversion have been protective of the environment, fisheries and other public trust resources and therefore establishes a protective environmental baseline. Except for reasonable use on 25 acres of riparian land, the historic diversion has been done without a water rights permit, which is needed for a place of use that is outside of the area of origin whether the diversion was from surface water, underflow, subterranean stream flow or percolating groundwater. The DEIR assumption that baseline impacts from an un-permitted diversion that apparently exceeds what is considered reasonable beneficial use would be automatically protective of the environment creates a precedence that is not in the public interest. A precedence that allows for a permit to be obtained after an unreasonable diversion starts and doesn't consider the environmental conditions before the start of the illegal diversion or the reasonableness of the diversion isn't protective of public trust resources and therefore is not in the public interest.

Appropriation would be in the public interest if the permit has sufficient terms and conditions to maintain adequate bypass flows to protect fisheries and other public trust resources, requires accurate and timely monitoring and reporting of the diversion from each well and the separate discharge to riparian and non-riparian lands, requires a site-specific plan to prevent and monitor erosion, sedimentation and other impacts to water quality and beneficial uses, and limits the total diversion to the rate and volume that are consistent with the reasonable and beneficial use standards of Water Code section 1004 and CCR Title 23 section 697(a)(1).

c) If the State Water Board approves the application, what terms and conditions, if any, should the board adopt to ensure that the diversions are in accordance with applicable law and best serve the public interest?

The laws and regulations that are applicable to the El Sur Ranch requested appropriation include sections of the Water Code and Title 23 regulations that specifically establish reasonable and beneficial uses, Water Code section 1004 and CCR Title 23 section 697(a)(1), other sections of the Water Code that address water quality and protection of beneficial uses, which include but are not limited to Sections 13263, 13264 13267, 13269, 13050, Fish and Game Code sections 1602, 1725, the California Endangered Species Act - 2050 to 2097, 6900 to 6903.5, 10,000 and the Federal Endangered Species Act -16 U.S.C.A. sections 1531 to 1544.

In addition, diversion from subterranean streams flowing through known and definite channels should be governed by the same rules that apply to surface streams in accordance with the Garrapata Decision No. 1639 and long-standing subterranean stream case law.

d) What terms and conditions, if any, should the State Water Board adopt to prevent the waste, unreasonable use, unreasonable method of use, or unreasonable method of diversion of water?

The following is a list describing in general the terms and conditions that need to be included in any permit for application #A030166 to prevent waste, unreasonable use and method of use, and unreasonable method of diversion.

From policy

1. Require a registered professional surveyor, verified by the Division of Water Rights, to determine the acreage of irrigated lands, including riparian acreage, in order to resolve the issue of reasonable quantity of water available and permitted for diversion.
2. Restrict the annual diversion based on a formula that would multiply the acres of irrigated pasture subject to the appropriated water right by the af/acre appropriate to local conditions, not to exceed 2 ½ af/acre, as specified for uncultivated lands in Water Code section 1004.

3. Restrict to 2.79 cfs (or 3.1 cfs if 25 acres of riparian land is included in the appropriation) the maximum allowable instantaneous rate of diversion for 223 acres of irrigated pasture (248 if riparian land is included), based on a water duty of 1 cfs/80 acres [CCR T23 section 697(a)(1)].
4. Restrict to 558 af, (or 620 af if riparian land is included in the appropriation) the maximum allowable annual diversion for 223 (248) acres of irrigated pasture based on a 2.5 af/acre water duty as established for "useful and beneficial purposes" in California Water Code section 1004.
5. If the 25 acres of riparian land is included in the appropriative water right, then the diversion of water for use on this land under the applicant's riparian right should be suspended, or the appropriative right revoked. The combined diversion should not exceed the values specified in the permit.
6. Excluding pasture lands subject to planting, areas susceptible to potential erosion shall be stabilized by planting and seeding with native species, with mulching being conditionally acceptable. Where suitable vegetation cannot reasonably be expected to become established, non-erodible material shall be used for such stabilization. Natural-fiber, biodegradable meshes and coir rolls are acceptable for use; "photodegradable" and other plastic mesh products are not acceptable, as they have been found to persist in the environment, ensnaring and killing terrestrial wildlife.
7. The applicant shall prepare and implement a plan to control erosion and stabilize areas subject to disturbance during water diversion, application and tailwater discharge activities. An Erosion Control and Sedimentation Prevention Plan shall be submitted for Department approval and implemented on a year-round basis for all areas subject to water application and tailwater discharge.
8. If the Regional Water Quality Control Board determines that a Report of Waste Discharge or other permit is required for the applicant's discharge waters, then the necessary permit should be obtained and a copy of the permit and Report of Waste Discharge provided to the Department.
9. El Sur Ranch shall develop and implement a plan for compliance monitoring within 90 days of State Board approval of the permit, and the plan shall be reviewed and approved by the State Board and the Department.
10. The applicant shall install and maintain water flow meters and automated data logger(s) of a type, number and location subject to the approval of the State Board and Department, which records the volume and rate of diverted water, including instantaneous and cumulative diversion rates, and the date and time of day of diversion.
11. Water usage and well pumping data for each well separately shall be accumulated and reported monthly during the period between December

and May, and weekly between June and November to the State Board and the Department.

12. Collected information on flows and rates of diversions shall also be submitted to the Department upon request.

13. The quantity of water diverted for riparian use and the quantity diverted for use under the appropriative right shall each be metered and monitored separately and reported to the State Board and Department as described above.

14. Should the meters, recording and/or monitoring devices fail, or otherwise fail to report a record of diversions, no pumping shall be allowed until the meters, recording and all other devices and fixtures necessary for monitoring are properly repaired and made operable.

15. The El Sur Ranch shall fund the long-term maintenance of the stream gauge, to be located above the diversion, but below the other numerous diverters in the watershed. Within 30 days of approval of the permit by the State Board, the applicant is required to deposit funds into a non-wasting endowment account sufficient to provide funding for maintenance of the new gauge in perpetuity.

16. If El Sur Ranch fails to provide funding to support operation of the stream gage, then the permit shall specify that the existing USGS Big Sur gauge, #11143000, shall be used to measure flows in the river and determine when ESR wells stop pumping to provide for adequate bypass flows. The use of the Big Sur gauge for bypass flow compliance monitoring requires that the instantaneous flow bypass flow rate shall be calculated based on summation of the seasonal requirements for protection of fisheries and other public trust resources, plus the maximum recorded losses in flow between the ESR point of diversion and the Big Sur gauge #11143000, plus the maximum permitted instantaneous diversion rate.

17. El Sur Ranch shall include in its reports, printouts of stream gauge flow data identifying periods where diversion restrictions were required and verification that pumping was restricted, by including reports of all diversion meters readings and data collected by electronic data loggers along with all corresponding stream gauge data for the same time periods.

18. El Sur Ranch shall perform at least monthly inspections for erosion and potential discharge of sediments and other pollutants in runoff from irrigated pastures. More frequent monitoring and reporting shall be conducted as required by any approved Erosion Control and Sedimentation Prevention Plan and/or requirements of any permit required by the Regional Water Quality Control Board. The monitoring report, taking an adaptive management approach, shall include identification and description of potential causes of erosion, corrective measures implemented to prevent additional erosion, assessments of corrective

measures and further mitigation as necessary.

19. The El Sur Ranch shall prepare, implement, and submit to the Department for prior approval, a Water Quality Monitoring Plan. The Plan shall include monitoring methodology outlined in Attachment A to the Department's policy statement. Measurements may be collected using either a handheld meter or automated water quality monitoring device of acceptable quality and capable of measuring temperature, dissolved oxygen, electrical conductivity, and pH. Sampling locations and frequency shall be pursuant to the attached methodology. Monitoring results, as well as response actions taken (i.e., pumping restrictions) shall be reported to the State Board and Department monthly from May through December, and annually to include all monitoring data.

20. The Water Quality Monitoring Plan shall be in conformance with the accuracy and precision, and quality assurance requirements of the Surface Water Ambient Monitoring Program.

21. The water rights permit shall require the El Sur Ranch to mitigate present and future potential impacts to public trust resources to the satisfaction of the State Board and Department.

22. The total quantity and rate of water diverted and used under the permit and under permittee's claimed existing right for the place of use specified in the permit, shall not exceed the quantity and rate of diversion and use specified in the permit. To the extent that the permittee claims riparian, overlying, pre-1914 appropriative, or other rights to use the water on lands covered by the permit, the permittee shall not be entitled to water in excess of the amount authorized in the permit.

VII. COMPLICATIONS WITH USING IMPACTS TEST

a) Testimony on the use of an impact test in determining minimum bypass flows and other mitigations to protect public trust resources for diversions from a subterranean stream flowing through a known and definite channel.

The application of the standard bypass flow term and condition where the total river flow must be allowed to seasonally pass the point of diversion is commonly applied to surface water diversions where protection of fisheries and other public trust resources is required.

Studies to measure the flow in the Big Sur River adjacent to the El Sur Ranch wells found that their pumping causes a decrease in flow (SGI. 2005, 2007, 2008). If the concept that the same rules that govern water rights for surface streams also apply to subterranean streams and its subset underflow, then the issue of what percentage of that surface flow is diverted by a pumping well is irrelevant to setting permit conditions for minimum bypass flows or protection of other public trust and environmental resources. The critical factor is whether the subterranean stream is connected to the river because a subterranean stream doesn't have to be connected to surface water to be jurisdictional (Garrapata Decision, 1999). If the subterranean stream is connected to surface water, then both are part of one watercourse, underflow as a subunit of subterranean stream is also part of the watercourse, and a diversion from any part of that watercourse should be considered a diversion from the whole watercourse.

If the Board, however, chooses to require that the impact from well pumping will be factored into the calculation of minimum bypass flows, or other environmental mitigation measures, then there are a number of site-specific and general technical issues that should be considered before applying an "impact" test to the El Sur Ranch appropriative water right permit. The testimony that follows will discuss briefly some of the issues that should be considered and evaluated in applying an "impact" test to the diversion of a subterranean stream flowing through a known and definite channel.

b) Testimony on site-specific issues related to use of an impact test for calculation of minimum bypass flows for appropriative diversions from the El Sur Ranch wells.

The hydrogeologic and fisheries studies conducted by SGI and Hanson for water rights application A030166 concentrated on determining how much of the water pumped by the El Sur Ranch wells comes from the Big Sur River. These studies were done in part to support El Sur Ranch's recommendation that the Board consider in setting minimum bypass flow permit conditions only the direct impact of their well pumping on the flow of Big Sur River and not the entire amount of the diversion. El Sur Ranch is essentially advocating for the use of an "impact" test as part of the calculation of minimum bypass flows, and perhaps in the development of other environmental mitigations. El Sur Ranch appears to be advocating two positions to support their recommendation.

1. First, El Sur Ranch has been pumping at the rate requested in application A030166 for a number of years and they therefore argue that the "impact" of their historic, unpermitted diversion has set the environmental baseline that their permitted diversion should be measured against. Because of this logic, their permitted diversion can't cause a significant impact above this baseline and therefore permit conditions for minimum bypass flows are unnecessary and unwarranted.
2. The second position is that the pumping does not affect either the temperature, dissolved oxygen content or flow in the river (SGI, 2008 page 4-5). Fish passage is compromised by low flow conditions that occur upstream of the pumping area of influence (ZOI) and are unchanged by the pumping of the El Sur Ranch wells. Although the data from SGI 2007 and 2008 reports, Exhibit DFG-C-45, indicate that there is a reduction in

flow in river during pumping, the reduction is stated as being a decrease in the "upwelling" groundwater inflow, rather than change in river flow. They further state that the interception of this "upwelling" water doesn't reduce the flow to the point such that the downstream outflow volume is less than the upstream inflow volume (SGI, 2008 page 3-6). El Sur Ranch appears to consider the subterranean stream or underflow that discharges to the river in the ZOI as a separate and unconnected watercourse and that diverting this water causes no impact because it would otherwise "upwell," as if this upwelling provides no benefit to the river. In other words, El Sur Ranch's pumping doesn't cause an "impact" to flows in the Big Sur River, therefore minimum bypass flow permit conditions are unnecessary and unwarranted.

There are several technical issues regarding the assertion that the El Sur Ranch well pumping has no impact on the flows in the Big Sur River including, the methods of measurement of flow river gains and losses, the fluvial geomorphic conditions of the river, and the implication of mass balancing the diversions with inflows and outflows.

The methods used by SGI to measure the gains and losses in the ZOI involved placing piezometers in the bed of the river to measure changes in subterranean stream water elevation, conducting falling-head permeameter tests in the bed of the river to measure vertical hydraulic conductivity, and measuring the actual river flow at different locations. The gain or loss to the river flow was then estimated using Darcy's law. SGI calculated an average hydraulic conductivity of the riverbed at 104 ft/day by using a geometric mean of the permeameter tests (SGI, 2007, section 3.3). While the 2006 study took measurements in shallow and deep piezometers and permeameter to measure hydraulic conductivity placed in the riverbed, the 2007 study apparently only took piezometer measurements to calculate vertical gradients and didn't retest the hydraulic conductivity. In the 2007 study, two velocity transects were established in the ZOI to measure change in river flow, VT3 upstream in streambed zone 4 and VT2 downstream in streambed zone 2, Exhibit DFG-C-46. It should be noted that the 2007 SGI study apparently shifted the streambed zones from those of the 2006 study, complicating comparisons between reports. Technical issues with the 2006 and 2007 studies and the resulting calculation of river gains and losses include:

1. The average hydraulic conductivity for the ZOI was improperly calculated as a geometric mean of all the validated falling-head permeameter tests. Geometric mean is often used to calculate an average of hydraulic conductivity because the data are often skewed and this average transforms the data thereby reducing the skew. The problem with using the geometric mean is that the data all need to come from the same geologic unit. This does not appear to be the case for the Big Sur River. The description of the streambed materials given in Table 3-2 of the SGI

2007 report, i.e. Volume II, indicates that the riverbed was made of various material. Descriptions range from cobbles, gravel with [occasional] cobbles, shallow sandbar, silt and leaves, and silt. Interestingly, because it seems counterintuitive, some of the highest vertical hydraulic conductivity values were measured within the finer-grained silt and leaves. In areas where the material types differ, a geometrically averaged hydraulic conductivity won't produce an accurate result. Instead the streambed needs to be subdivided into areas of similar bed material and then the hydraulic conductivity within each subarea is averaged. Gains and losses would then be calculated for each subarea and the total gain or loss would be the sum of the subareas. Measurement of the actual flow in the river is needed to validate this point data calculation. This is not what was done in the 2006 and 2007 technical studies.

Exhibit DFG-C-47 shows an example calculation with two cases of "streambed" that vary from mostly coarse-grained with a small area of fines, and the opposite. The area-weighted flow for each case is derived along with the flow for each case of using the geometric mean hydraulic conductivity. The two area-weighted flow values are clearly different, which they should be, but the geometric mean average is the same for both cases. This demonstrates why the use of geometric mean has to be restricted to similar geologic units.

2. In addition to the issue of how the vertical hydraulic conductivity of the riverbed should be calculated, there is an issue regarding the consistency of the riverbed hydraulic conductivity. A series of permeameter tests done near P5, Exhibit DFG-C-46, showed that the thickness of the lower hydraulic conductivity layer at the surface of the riverbed is approximately 1 foot. Exhibit DFG-C-48a to 48c are printouts from a SGI spreadsheet that show the calculations for three 2006 study permeameter tests. One test was done on the unaltered bed, a second test removed the upper 1 foot of bed material, and the third test replaced the 1 foot of material. The unaltered bed test found the vertical hydraulic conductivity to range from approximately 121 to 126 feet/day. The 1-foot replacement test, measured values from approximately 668 to 960 feet/day, and the 1-foot total removal test values ranged from approximately 3,470 to 3,950 feet/day. These higher values are within the range of the underlying subterranean stream as measured by pump tests on the El Sur Ranch wells, 3,389 to 3,918 feet/day (SGI, 2005, page 3-9).

3. Validation of the gains and losses in a stream needs to be done using direct measurement of river flows because sampling at a small number of points typically has a high variance. In the 2007 study, velocity transects were established at VT2 and VT3, Exhibit DFG-C-46. These velocity transects where placed within the ZOI and not at the edges. No measurements of river flow were made at the edges of the ZOI. As such,

the direct measurements of the changes in river flow measured between VT2 and VT3 only captured a portion of the actual change in flow.

4. The studies do not appear to measure all potential losses within the ZOI. Exhibit DFG-C-49 shows the 2008 SGI Figure 2-1 with the ZOI for the Old and New wells taken from 2008 SGI Figure 3-1. I've drawn solid radius lines that extend out from the Old and New wells to intersect at the approximate outside edge of the river and the ZOI for each well. I've also drawn dashed lines from each well that intersect the monitoring points VT2 and VT3. I measured the angle of arc for the ZOI radii and the angle for the velocity transect radii. A table of the arc angles is given on the exhibit along with the percentage of the velocity-transect arcs within their entire ZOI arc. My calculation shows that the section of river between VT2 and VT3 is approximately 31% to 38% of the ZOI for each well. SGI 2008, Table 3-1, Exhibit DFG-C-45 shows that when both wells pumped, a calculated loss of 1 to 1.2 cfs of groundwater inflow occurred during a diversion of 5.02 cfs, but this loss was measured in only a third of the ZOI. Additional losses are likely elsewhere in the ZOI, unless the remainder of the ZOI has no hydraulic connection to the subterranean stream, which has never been shown.

   In fact, reduction in river flow during pumping varies from a low of 18% of the pumping to a high of 56%, Exhibit DFG-C-45. Most of the measured or calculated changes in river flow were done in river zones 2 to 4, but even then only a portion of these zone were samples, see Exhibit DFG-C-46 for placement of VT2 and VT3. Losses in the lagoon were only measured during the 2006 study and the impact of pumping appears to nearly double the reduction in groundwater inflow, compare Tables 3-4 and 3-5 in Exhibit DFG-C-45. An interesting result occurred when river zone 1, the lagoon, was included in the measurements. The loss from only pumping the New well was about 1/3 higher as compared to pumping both the Old and New wells, Table 3-4. This is surprising because the distance between the Old well and the lagoon is about the same as the New well, and theoretically pumping of two adjacent wells should induce a deeper cone of depression and thereby induce more river loss. In addition, the distance between the Old well and bedrock that forms the subterranean stream bed is much shorter than at the New well, which theoretically should cause more drawdown towards the river because the lack of flow in the bedrock.

5. The studies do not appear to have utilized proper sampling points and as a result appears to have failed to accurately record gains in flows. The direction of natural flow through a streambed is highly dependant on the stream fluvial geomorphology. For example, rivers typically lose flow on the upstream side of a riffle and gain flow on the downstream. This is the natural condition of hyproheic flow, which in water rights is called

"underflow." When a well next to a river is pumped, the drawdown changes the natural flow paths of hyproheic flow and the natural gains and losses to the river flow.

SGI's placement of the piezometer sampling locations are shown in Exhibit DFG-C-46 and in a longitudinal profile taken from Figure 3-16 of their 2008 report, Exhibit DFG-C-50. I've annotated the longitudinal profile with arrows showing the expected natural direction of hyporheic flow or underflow. The red circles show the riffle zones. I've also added to this exhibit a generalized longitudinal profile taken from Buffington and Tonina, 2009, http://www.treesearch.fs.fed.us/pubs/33568, that shows the flow of the hyproheic zone in a pool-riffle type channel. The direction of vertical flow measured by SGI is consistent with the location of the piezometers within the natural hyproheic flow of the pool-riffle channel.

Piezometers P5, and P6 were found to be in losing reaches (SGI, 2008 page 3-4), which is consistent with being upstream of a riffle section. Piezometer 4u was discarded because of seeming erroneous reading. Piezometer 4 was found to be in a gaining reach under non-pumping conditions, also consistent for its location downstream of a riffle. Piezometer 3 was found to be gaining, but began to lose during pumping of the New well (SGI, 2008, page 3-5). This is also consistent with its location in the river and the flatter hydraulic grade of the underflow. Piezometer 2, while it is in the same fluctuating bottom profile area as P3, is also near the head of a riffle and at the beginning of a steeping in the hydraulic grade, which makes the losing condition consistent with natural hyproheic flow. This profile shows that the placement of sampling points is critical to understanding gains and losses in the river. Proper sampling of the natural hyproheic flows, underflows, is necessary to accurately calculate whether gains and losses in river are really occurring and not just the result of incomplete sampling.

6. The studies fail to recognize the dynamic nature of the Big Sur River. The lower reach of the Big Sur River in the area of the El Sur Ranch wells is very dynamic with documented changes in channel location and geometry from1929 to today. Exhibits DFG-C-52 to -56 show historic aerial photos of the mouth of the Big Sur River. The 1929, 1942,1956, and 2003 images are taken from documents submitted by El Sur Ranch (NRCE, 2007 and Rogers. E. Johnson and Associates, 2007). The 1994 and 2009 images are from Google Earth. The 1929 to 1994 images show the low flow of the river having less meander and being located closer to the El Sur Ranch wells. The 2003 and 2009 image are taken from Google Earth and show the locations of the wells as cited in the application and the 2004 survey location of the New well. The 1929, 1942 and 1956 images show scoured channel along the present low-flow channel. The location of the river was documented in the Moeller April 12, 1992 Water Rights

Inspection memo (included in Exhibit SWRCB 3) as being approximately 160 feet from the New well which is consistent with the channel location before 1994. (Exhibit DFG-C-60) From these images, I conclude that for approximately 74% of the time since the El Sur Ranch wells have been in place, from 1950 to 1994, the low flows in the river were closer to the wells and the river meandered less. In fact, during the first 10 years of the CEQA baseline period, the river was closer to the wells, a fact that wasn't considered in the environmental impact analysis.

A fundamental requirement to justify the use of the information presented by El Sur Ranch as representative of ongoing conditions at their point of diversion is stability of channel and that the data collected will be representative of future impacts from their subterranean stream diversion. If the channel changes, as it has in the past, then the impacts will change. If the channel shifts back to its historic location closer to the Old and New wells, then as explained more fully next, the losses from pumping should increase because the distance between the wells and the river will have decreased.

The impact of a well pumping on the flow in a hydraulically connected river is dependant on certain static assumptions including: the distance between the well and river, the hydraulic characteristics of the aquifer, storage coefficient and hydraulic conductivity, the permeability and thickness of any low hydraulic conductivity streambed layer, and the duration of pumping. In the calculation of losses and gains in a river within the ZOI of a well, the vertical hydraulic conductivity of the riverbed can be an important factor if it is much lower than the underlying aquifers. The permeability test described above for the El Sur Ranch well ZOI showed that the upper 1-foot of the riverbed has a vertical hydraulic conductivity lower than the subterranean stream. The replacement permeameter test described above also shows that the vertical hydraulic conductivity of the upper riverbed in the ZOI is sensitive to how the material is layered. When the removed upper riverbed material was replaced, the resulting vertical hydraulic conductivity was approximately 6 to 7 times that of the unaltered riverbed.

During high runoff events, the upper portion of the riverbed mobilizes and becomes bedload, which transports and redistributes the bed material. Redistribution of bed material will change the hydraulic conductivity and the amount of change will depend on the size and depth of the material mobilized. The recent storm event of October 2009 appears to have deposited a large volume of sediment into the lagoon. This sediment had to come from upstream of the lagoon with a large portion likely being transported as bedload through the ZOI. This transport occurred after the 2006 and 2007 studies and has likely changed the composition and distribution of riverbed materials in the ZOI and with that the vertical hydraulic conductivity. This natural periodic movement of bed material invalidates any assumption that a fixed or maximum amount of river flow loss from the El Sur Ranch well diversions can be established at the mouth of the Big Sur River because it is a dynamic river system.

The discussion on longitudinal profiles and hyproheic flow is only a two dimensional cross-section of the hyproheic flow. Additional insight can be obtained by looking at surface-water ground-water interaction in plan view. Exhibit DFG-C-51 is taken from a paper by Woessner, 2000, that discusses the conditions of natural exchange between an aquifer and stream. Woessner discusses how the orientation of the river to the flow field of the aquifer will determine if the exchange results in gaining, losing, flow-through or parallel flow reaches.

The lower portion of the Big Sur River adjacent to the El Sur Ranch wells resembles the idealized river shown in Figure 1 of Woessner. The meandering of the river across the groundwater flow creates a condition where the up stream sections are losing (P5 and P6), then an area of parallel flow (P4u?), then a section of flow-through (P3 and P2), and then a gaining reach (lagoon). When the planar flow field of the subterranean stream is combined with the localized flows of the hyproheic zone, a very complex system of surface water – ground water exchange develops. If the orientation of the river changes, the flow depth on the river, the water table elevation, and the system adjusts. These type of adjustments occur frequently at the mouth of the Big Sur River because of changes in river flow from both the river and subterranean stream, tidal fluctuation, closing of outlet at the sand bar, evapotranspiration fluctuations, storm events that change the shape, orientation of the river, and moved bedload sediment through the ZOI and lagoon. The concept advanced by El Sur Ranch, that the Big Sur River in the area of their diversion is in a constant condition where the losses from pumping their wells are well-determined and will never exceed the values already calculated, is flawed because the river is dynamic and those values will change.

c) Testimony on alternative site-specific analysis related to impact from diversions of the El Sur Ranch wells on surface flow of the Big Sur River.

I made a comparison of measured losses in river flow when both the Old well and New well were pumping during late-September to early October 2007 with two standard analytical models of stream depletion, Jenkins, 1977 and Hunt, 1999. The Jenkins model was developed by the USGS and is commonly used to calculate well impacts on stream flow, http://pubs.usgs.gov/twri/twri4d1/. Walton, 1984, provides equations in section 5.11.6 for calculating pumping depletion and residual stream losses using the Jenkins model. I used Walton's equations in a Jenkins model spreadsheet. The second stream depletion model by Hunt, 1999, addresses some of the major issues where the Jenkins model is criticized, specifically the lack of a low permeability streambed layer and that the streambed penetrates the entire underlying aquifer. Hunt's paper can be found at this web site, http://info.ngwa.org/gwol/pdf/990364673.PDF. A more reader friendly paper on assessing groundwater abstraction effects on stream flow using Hunt's equation can be found at a New Zealand web site, http://ecan.govt.nz/publications/Reports/guidelines.pdf.

SGI, 2008, Table 3-1 shows that pumping of both wells at 5.02 cfs resulted in a river loss in Zones 2 to 4 ranging from 1.0 to 1.2 cfs, Exhibit DFG-C-45. This loss is in close agreement with the results of the Jenkins and Hunt models when you account for the fact that the area of loss is only a portion of the streambed within the ZOI, approximately 40%.

I calculated that when both wells pumped at 5.02 cfs, the Old well was pumping at a rate of 2.65 cfs. This was based on the assumption that the New well continued pumping at a constant rate of 2.37 cfs after the Old well shut down on the fifth day. Using these pumping rates, the distances between each well and the river, and the hydraulic parameters for the aquifer and streambed from the SGI reports, I calculated the theoretical depletion rate from these two wells that show pumping impacts at various times, including 5 days. Exhibits DFG-C-58a to -58d are spreadsheet printouts from the Jenkins and Hunt models for both wells for 5 days of pumping. The total depletion to the river can be calculated as the sum of the individual well depletion rates for the same time interval. Because the reach distance for the depletion is approximately 40%, the total reach distance within the ZOI, the depletions calculated by the models has to be divided by 2.5 to approximate the losses of zones 2 to 4. The model results are discussed below.

The results of both the Jenkins and Hunt models show that at the end of the 5 days of pumping the stream depletion from the Old well pumping is 1.544 cfs, and from the New well is 1.881 cfs, with a sum of 3.425 cfs. This sum is approximately 2.85 times the 1.2 cfs loss in zones 2 to 4 stated in Table 3-1, suggesting that for this short-term 5 day pump test the model results are approximately 14% greater. The duration of this pump test didn't allow the cone of depression to fully develop. Extended pumping time would increase the impact. The models suggest that at 5 days of pumping the stream depletion is approximately 50% to 75% of the total pumping, and after 30 days the depletion rate would be approximately 80% of the total pumping. The zone 2 to 4 loss of 1.0 to 1.2 cfs multiplied by 2.5 to adjust for the partial river length, suggest losses during the 5-day pump test actually ranged from 50% to 60%.

This comparison shows that the theoretical models of Jenkins and Hunt can be used to estimate stream depletion. In fact, the results of these spreadsheets can be used to calculate stream depletion for any pumping rate of the Old and New wells using the percentage depletion values, which are the same for all pumping rates as long as the other physical parameters are unchanged. An additional factor to be considered in stream depletion by wells is the fact that once a well is turned off, river losses continue as the cone of depression is filled in. Exhibits DFG-C-58e and -58f show the residual stream depletion after 5 days of pumping the New and Old well, respectively. For example, one day after shutting off the Old well after 5 days of pumping, the river is still losing approximately 40% of the total pumping rate, and after 5 days approximately 12%.

A comparison of the results between the Jenkins and Hunt models finds that for the El Sur Ranch, setting the low permeability streambed layer doesn't cause a reduction in stream depletion after the first few hours of pumping. For the Hunt model to calculate a sustained reduction in depletion due to a "clogging" layer, the streambed has to have a much lower hydraulic conductivity than the underlying aquifer or the thickness of the clogging layer has to be relatively large. For example, if the thickness of the 104 feet/day streambed increased to 15 feet, the Hunt model would calculate a 10% reduction in steam depletion rate after 5 days of pumping, Exhibit DFG-C-58g. A streambed hydraulic conductivity of 1 feet/day, 1/100 of the SGI value, produces a depletion rate at 5 days that's approximately 32% lower, Exhibit DFG-C-58h.

The results of this comparison between the theoretical stream depletion calculated by two models and the calculated losses from stream measurements found reasonable agreement. This suggests that the Jenkins and Hunt models can be used to estimate stream depletion from pumping at a nearby well. The model results also show that the losses from pumping the El Sur Ranch well are much higher than the losses measured in zones 2 to 4 for only a portion of the river in the ZOI and that sustained pumping for 30 days will result in increasing losses to the stream as the cone of depression develops. After pumping for 30 days, stream depletion in the range of 80 to 90 percent is expected. Impacts from cyclic pumping can be approximated by time-weighted averaging. For example, the steam depletion from pumping at 1,000 gpm for 15 days can be approximated by modeling at a rate of 500 gpm for 30 days.

The Jenkins and Hunt models assume that the river being depleted is generally linear with the distance between the well and river increases outwards from the shortest distance and that the aquifer is infinite in extent. This isn't the case for the El Sur Ranch wells. The river bends sharply after zone 2 to form the lagoon, and then stays approximately the same distance from the New well through zones 2 to 4, and becomes much closer to the Old well than zones 2 to 4. In addition, the Old well is much closer to the bedrock or "bank" of the subterranean stream and therefore water supplied to the well has to come from the side closer to the river. SGI, 2008, Figure 3-1, Exhibit DFG-C-20, gives some indication of this shift away from the "bank." The drawdown at P1L in the lagoon is shown as 0.25 feet, which is greater than the 0.12 to 0.17 feet of drawdown measured in zones 2 to 4. Because steam depletion is directly related to drawdown, the increase in drawdown in the lagoon area suggests that the rate of depletion is higher than in zones 2 to 4. The results of these models also show that residual losses to the river after a pump is shut off can be significant.

c) Testimony on the general technical issues with implementing an impact test in the calculation of minimum bypass flows for diversions from subterranean stream flowing through known and definite channels and underflow.

Implementation of an impact test for calculation of minimum bypass flows for diversions from subterranean streams and underflow will require the development of alternative methods for measuring and analyzing the potential impact of these diversions on public trust and other environmental resources, along with rules and standard permit conditions for implementing the impact test. The following testimony is a summary of some technical issues and questions that need to be considered in making new rules for the subterranean stream diversion impact test.

a. A water availability analysis (WAA) and calculation of the cumulative flow impairment index (CFII) for each point of interest is a standard procedure for a water right application to appropriate water. The CFII is particularly important to the issue of protection of fisheries and other public trust resources because it accounts for the existing senior diverter with the index being a percentage of the available unimpaired flow. If the impact test is going to be a part of the minimum bypass flow calculation, then the method of accounting for senior diverters in the CFII needs to be revised.
b. The CFII, as it is presently calculated, does not differentiate between diversion taken directly from surface flow from those taken from either underflow or subterranean stream flow. A policy allowing the use of an impact test would require this differentiation because one of the main uses for the CFII is to assess availability of surface flow as an assessment of the need for bypass flows permit conditions. If subterranean stream flow diversions, and likely its subunit of underflow, are no longer considered fully part of the surface flow, then an alternative method is needed to account for this separation. Issues to consider in development of a new method of accounting include:
    1. What methods should be used to partition the diversions of senior water rights that take water by well or some other subsurface method, e.g., an infiltration galley or Ranney collectors?
    2. How will parameters needed to make engineering calculation at senior water right diversions be estimated if the actual values are unknown? For example, what method would be used to estimate hydraulic conductivity, storage coefficient, streambed vertical permeability?
    3. Will the CFII developed by an applicant for a junior water right create any encumbrance on the senior water rights?

For example, would the CFII analysis prevent the holder of a senior water rights from changing their method or place of diversion, for example from a well to direct surface diversion, because it would increase the impact to surface flows, thereby injuring the junior right.

4. Where will the impacts from subterranean stream diversions be placed in the stream relative to the Point of Diversion and Point(s) of Interest? Only at the point in the stream that is directly adjacent to the points of diversion, or elsewhere based on where the impact from pumping actually occurs?
5. Will the fact that the impacts from diversion by a well extend downstream and sometimes upstream some distance from the Point of Diversion be a factor in the CFII accounting or placement of the Points of Interest?
6. How should the adjustment for drainage area and precipitation be made to subterranean stream flow?
7. The volume and rate of flow in the subsurface is restricted by the cross-sectional area of the subterranean stream. If the hydraulic carrying capacity is exceeded, then the excess flow becomes surface flow. Will it then have to be counted as surface flow?
8. There is a theoretical limit to how much ground water can flow through a section of a subterranean stream. Does this have to be calculated and counted at points of diversion for senior water rights and/or riparian rights?.
9. Will the rights of riparian users that divert through wells differ from riparian users that divert directly from the stream?
10. Will they both have to cut back at the same time if there is insufficient flow in the river, or can those pumping from well continue longer or without restriction?
11. If this difference in riparian rights occurs because of the impact test, how should it be accounted for in the WAA/CFII analysis?
12. Where is diversion from underflow counted, as surface flow or subterranean stream flow? If hyproheic flow is considered underflow, then underflow is clearly part of the surface flow.
13. Is there a point where underflow becomes an upper subunit of the subterranean stream?
14. What is the cutoff criterion for the impact test that determines the watercourse of underflow?
15. Will parameters other than just flow be considered in the impact test? For example, impact from the diversion on temperature or dissolved oxygen.

16. If other parameters are considered, how will the bypass flow be calculated and monitored?
17. Will the parameter with the greatest sensitivity be the limiting factor, and where and how often should the monitoring take place?
18. How will the residual depletion that occurs after the pump is turned be considered in the impact test?
19. How will the residual depletion be calculated and counted?
20. Will the inclusion of residual depletion in the impact test require pumping to stop earlier so that these additional losses can be properly counted?

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