RESISTIVITY RANGES

- Low (6 - 25 ohm-m)
- Moderate (35 - 70 ohm-m)
- High (105 - 115 ohm-m)

LEGEND

- 3-1b TEM Sounding Location
- Ground Surface
- Resistivity Interface
- Interpreted Bedrock Surface
- R1 Resistivity Layer

Horizontal Scale: 1 inch = 100 feet
Vertical Scale: 1 inch = 50 feet
Figure 3-30
Daily Pumping Rate for El Sur Ranch
El Sur Ranch

Flow Rate (cfs)

Date

04/01/04 05/01/04 05/31/04 06/30/04 07/30/04 08/29/04 09/28/04 10/28/04

Old Well    New Well
Figure 3-33

River Level and Groundwater Level Response to Rain Events
El Sur Ranch

Pumping Stops
October 16, 2004

Rain Events

The instantaneous response to rain events demonstrates connectivity between river and groundwater.

Groundwater Elevation (feet above msl)

Stilling Well WL Elevation (feet above msl)

Date

10/15/04 10/17/04 10/19/04 10/21/04 10/23/04 10/25/04 10/27/04 10/29/04 10/31/04

ESR-10B ▲ JSA-04 ▼ ESR-10A ▲ ESR-10C ▼ Old Well • River (Stilling Well)
Figure 3-40
Tidal Influence in Aquifer Wells (ESR-10A and ESR-10B)
El Sur Ranch

Groundwater elevations exhibit a delayed response to tidal changes.
Figure 3-41
Tidal Influence in Terrace Well (ESR-12)
El Sur Ranch

Groundwater elevations exhibit a delayed response to tidal changes.
Figure 3-44
Effect of Lagoon Closure on Groundwater Elevations
El Sur Ranch

Pumping New Well

Lagoon Closure
(Evening 8/26/04)

Groundwater elevations rise in response to lagoon closure.

Tidal Response

Date

08/25/04 08/26/04 08/27/04 08/28/04 08/29/04 08/30/04 08/31/04 09/01/04

WL Elevation (feet above MSL)

4.0 4.5 5.0 5.5 6.0 6.5 7.0

ESR-02  ESR-03  JSA-03  JSA-04  Old Well
Figure 3-46
Spring Tide Effects on Electrical Conductivity in Old Well - 1991
El Sur Ranch

Electrical Conductivity (uS/cm)

Tide Elevation (feet above MSL)

Date

05/01/91  05/21/91  06/10/91  06/30/91  07/20/91  08/09/91  08/29/91  09/13/91  10/06/91  10/28/91

Old Well EC  Tide - NOAA Tidal Station #9413450  Old Well Pumping
APPENDIX M

WATER QUALITY DATA
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Temperature Measurements
Big Sur River - July 12, 2004
El Sur Ranch
Temperature Measurements
Big Sur River - July 23, 2004
El Sur Ranch

Temperature (°F)

Transect ID
Temperature Measurements
Big Sur River - August 6, 2004
El Sur Ranch
Temperature Measurements
Big Sur River - August 19, 2004
El Sur Ranch

![Graph showing temperature measurements along transects ID 1 to 21.](image-url)
Temperature Measurements
Big Sur River - September 15, 2004
El Sur Ranch
Temperature Measurements
Big Sur River - April 18, 2004
El Sur Ranch
Temperature Measurements
Big Sur River - September 30, 2004
El Sur Ranch
Temperature Measurements
Big Sur River - October 15, 2004
El Sur Ranch
Temperature Measurements
Big Sur River - October 28, 2004
El Sur Ranch

Temperature (F)

Transect ID
Dissolved Oxygen Measurements
Big Sur River - July 12, 2004
El Sur Ranch

Graph showing dissolved oxygen (mg/l) measurements along Transect ID.
Dissolved Oxygen Measurements
Big Sur River - July 23, 2004
El Sur Ranch
Dissolved Oxygen Measurements
Big Sur River - August 5, 2004
El Sur Ranch

Graph showing dissolved oxygen measurements across Transect ID from 1 to 21.
Dissolved Oxygen Measurements
Big Sur River - August 19, 2004
El Sur Ranch
Dissolved Oxygen Measurements
Big Sur River - September 2, 2004
El Sur Ranch
Dissolved Oxygen Measurements
Big Sur River - September 15, 2004
El Sur Ranch

Transect ID

Dissolved Oxygen (mg/l)
Dissolved Oxygen Measurements
Big Sur River - October 14, 2004
El Sur Ranch

Graph showing dissolved oxygen measurements across transect ID.
Dissolved Oxygen Measurements
Big Sur River - October 28, 2004
El Sur Ranch
Electrical Conductivity Measurements
Big Sur River - April 18, 2004
El Sur Ranch
Electrical Conductivity Measurements
Big Sur River - July 12, 2004
El Sur Ranch
Electrical Conductivity Measurements
Big Sur River - July 23, 2004
El Sur Ranch
Electrical Conductivity Measurements
Big Sur River - August 5, 2004
El Sur Ranch

Electrical Conductivity (μS/cm)

Transect ID

200 210 220 230 240 250 260 270 280 290 300

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
Electrical Conductivity Measurements
Big Sur River - August 19, 2004
El Sur Ranch
Electrical Conductivity Measurements
Big Sur River - September 2, 2004
El Sur Ranch

Electrical Conductivity (μS/cm)

Transect ID
Electrical Conductivity Measurements
Big Sur River - September 15, 2004
El Sur Ranch
Electrical Conductivity Measurements
Big Sur River - September 30, 2004
El Sur Ranch
Electrical Conductivity Measurements
Big Sur River - October 15, 2004
El Sur Ranch
Figure 3-2a
JSA-04 Hydrograph
El Sur Ranch
Big Sur, California

JSA-04 Groundwater Elevation

- **Drawdown**: Noise associated with changes in tide elevation
- **Recovery**: Both Pumps On
- **Drawdown**: Old Well On
- **Recovery**: Rain event
- **Drawdown**: New Well On
- **Recovery**: Groundwater recovery takes less than 4 days after pump is shut down
- **Groundwater recovery takes 4 days after pumps shut down**
- **Level of stable groundwater - no pumping (~6.3-ft)**
- **Aquifer responds the same regardless of drawdown or recovery.**
- **Point of initial drawdown stabilization (~4 days). It is difficult to determine exactly due to fluctuations in pumping.**
- **Note drawdown change from 5.83 cfs to 5.61 cfs pump rate change**
- **Note drawdown change from 2.88 cfs to 3.49 cfs pump rate change**
Figure 3-2b
JSA-04 Recovery Curve Post Two Well Pumping Test
El Sur Ranch
Big Sur, California

Groundwater elevation recovering to pre-pumping levels following shut down of the two pumping wells.

Line denoting full groundwater recovery

Approximately 4 Days

Both pumps shut off here

Approximate Point of full GW recovery.

Time to drawdown stabilization or full recovery of a groundwater system in response to pumping is equally valid from both the drawdown curve and the recovery curve. Recovery curves are easier to interpret as they are unaffected by fluctuations in pumping rate.
Figure 3-7
Old Well Distance Drawdown Graph
El Sur Ranch
Big Sur, California

Max Influence Distance = 1,120ft (equivalent to 720ft from New Well Location)
Figure 3-8
New Well Distance Drawdown Graph
El Sur Ranch
Big Sur, California

Max Influence Distance = 1,000ft from New Well Location
Figure 3-11
P2RD Groundwater Elevation
El Sur Ranch
Big Sur, California

Maximum groundwater drawdown of 0.20-feet
Figure 3-12
P3RD Groundwater Elevation
El Sur Ranch
Big Sur, California

Both Pumps On

Old Well On

New Well On

Groundwater Elevation (ft)

Maximum Groundwater drawdown of 0.17-feet

2006

Figure 3-16
Vertical Gradients of Piezometer P4
El Sur Ranch
Big Sur, California

P4L Vertical Gradient

P4R Vertical Gradient

River Gains Water
River Loses Water
Figure 3-17
Vertical Gradients at Piezometer P3
El Sur Ranch
Big Sur, California

P3L Vertical Gradient

Vertical Gradient (ft/ft)

River Gains Water

River Loses Water

2006

P3R Vertical Gradient

Vertical Gradient (ft/ft)

River Gains Water

River Loses Water

2006

SGI 2007
Figure 3-20
Piezometer P1L Vertical Gradient
El Sur Ranch
Big Sur, California

Gradient fluctuation does not correlate with changes in ESR irrigation well pumping.

Throughout this period, the ESR irrigation wells are pumping at a combined rate of between 5.61 cfs and 5.93 cfs.
Figure 3-21
Groundwater Elevations at Piezometer Pair P4L
El Sur Ranch
Big Sur, California

P4LS Groundwater Elevation

Both Pumps On

Old Well On

New Well On

Note no discernable response to ESR irrigation well pumping

P4LD Groundwater Elevation

Both Pumps On

Old Well On

New Well On

Note the significant response to ESR irrigation well pumping as seen in well defined drawdown curves.
Zone 3 Left (P3L) Groundwater Flux to River

Zone 3 Right (P3R) Groundwater Flux to River

Zone 3 - Total Groundwater Flux to River
Figure 3-34
Navy Well Electroconductivity
El Sur Ranch
Big Sur, California

Electroconductivity decreases when irrigation wells are pumping.
Figure 3-36
Lagoon Stilling Well River Elevation vs. Min and Max Daily Tide Elevation
El Sur Ranch
Big Sur, California

Max Spring Tide Height of 3.4-feet
Both Pumps On
Old Well On
New Well On

Max Spring Tide Height of 3.9-feet

Temporary clogging of Lagoon outlet by kelp observed. Responsible for increase in water elevation in Lagoon during this Spring Tide event.

Lagoon Water Elevation (ft)
Tide Elevation (ft)

2006

SGI 2007

THE SOURCE GROUP, INC.
Table 3-4
Correlation Between Pumping Rate and Decrease in Groundwater Inflow to River, Zone 1 Through Zone 4
El Sur Ranch
Big Sur, California

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Figure 3-3
Drawdown at P2RD
El Sur Ranch
Big Sur, California

Groundwater levels decreasing after rain event. Red line indicates groundwater elevation without pumping.

These sporatically high groundwater elevations are the result of tidal influence.

This is the maximum groundwater drawdown resulting from pumping.

~0.17-ft drawdown
Figure 3-5
P6L and P5L Vertical Gradient Across Riverbed
El Sur Ranch
Big Sur, California

There are no discernable responses to pumping events in either the P5L vertical gradient or the P6L vertical gradient. Note that the vertical gradients for P5 and P6 are both negative, illustrating the natural losing condition of the River at both locations.
Figure 3-6
P4uL Vertical Gradient Across Riverbed
El Sur Ranch
Big Sur, California

Note the flat line nature of the vertical gradient suggesting that the deep piezometer casing might have leaked.
Figure 3-7
P4L (Left Bank) and P4R (Right Bank) Vertical Gradient Across Riverbed
El Sur Ranch
Big Sur, California

The vertical gradients along both banks of the River remain mostly positive throughout the study. Note that the magnitude of the gradient is higher near the right bank of the River due to the higher hydraulic pressures generated by the inflowing groundwater from Creamery Meadow. The effects of groundwater pumping can be seen during the New Well pumping test and the test with both wells pumping.
Figure 3-8
P3L (Left Bank) and P3R (Right Bank) Vertical Gradient Across Riverbed
El Sur Ranch
Big Sur, California

Right bank vertical gradient still higher than left bank due to hydraulic pressure from Creamery Meadow groundwater. Clearly illustrated, pumping has the effect of reducing positive hydraulic gradients or inducing negative hydraulic gradients.

- New Well Pumping
- Old Well Pumping
- Both Wells Pumping
- Labor Day Weekend
- Lagoon Closed
- Bad data due to transducer fault
- Bad data due to transducer fault
- Pumping reduces magnitude of vertical hydraulic gradient
- Bad data due to transducer fault
Figure 3-9
P2L (Left Bank) and P2R (Right Bank) Vertical Gradient Across Riverbed
El Sur Ranch
Big Sur, California

The effect of both wells pumping is to increase the negative vertical gradients (i.e. the River is more 'losing') near both banks of the River.

Change in gradient due to closure of the mouth of the River.

New Well Pumping
Labor Day Weekend
Lagoon Closed
Old Well Pumping
Both Wells Pumping

Date
8/30 9/3 9/7 9/11 9/15 9/19 9/23 9/27 10/1 10/5 10/9 10/13 10/17

Vertical Gradient (ft/ft)
-0.4 -0.3 -0.2 -0.1 0 0.1 0.2 0.3 0.4

P2L Vertical Gradient
P2R Vertical Gradient

event timing
Figure 3-10
P1L Vertical Gradient Across Riverbed
El Sur Ranch
Big Sur, California

Vertical hydraulic gradients are neutral or positive throughout the 2007 Study. The effects of pumping were not significant enough to cause a discernable change in gradient conditions.

Transducers were submerged when Lagoon backed up due to closure of River mouth, resulting in bad data.
Figure 3-11
Average Daily Flow Volume at VT2 and VT3
El Sur Ranch
Big Sur, California

Overall loss in River flow occurs when downstream flow at VT2 (blue dots) is less than the upstream flow at VT3 (red dots). In general, the River gains flow between VT3 to VT2.

- VT2 (Downstream)
- VT3 (Upstream)
- Event Timing
Figure 3-12
Change in Flow Between VT3 and VT2
El Sur Ranch
Big Sur, California

- Maximum daily average flow gain of 1.6 cfs
- Maximum daily average flow loss of 0.4 cfs
- Gain in River flow
- Loss of River flow

Legend:
- Hourly Difference
- Event Timing
- Daily Average Difference
Figure 3-13
River Flow Gain Loss - Zone 4
El Sur Ranch
Big Sur, California

Zone 4 Left Bank River Gain/Loss

Zone 4 Right Bank River Gain/Loss

Zone 4 Total River Gain/Loss

0.2 cfs gain when both wells pumping
Figure 3-14
River Flow Gain Loss - Zone 3
El Sur Ranch
Big Sur, California

Zone 3 Left Bank River Gain/Loss

Zone 3 Right Bank River Gain/Loss

Bad data due to transducer fault.

Zone 3 Total River Gain/Loss

Bad data due to transducer fault.

Maximum loss of 0.3 cfs when both wells pumping
Figure 3-15
River Flow Gain Loss - Zone 2
El Sur Ranch
Big Sur, California

Zone 2 Left Bank River Gain/Loss

Zone 2 Right Bank River Gain/Loss

Zone 2 Total River Gain/Loss

Maximum loss of 0.5 cfs when both wells pumping.
Figure 3.18
Longitudinal Profile
El Sur Ranch
Big Sur, California

No data was obtained between the P6 location and VT1. The purple line is the average surface water level while the dotted blue line is the projected groundwater elevation between the two points.

STUDY AREA

AREA OF PUMPING INFLUENCE

Interpreted groundwater and surface water elevation point

This figure shows the cross-sectional profile along the thalweg of the Big Sur River (green line). Superimposed on the bottom profile are groundwater levels under both pumping and non-pumping conditions (blue lines) and surface water levels under both pumping and non-pumping conditions (purple lines). The broken blue line is the projection of groundwater levels from the P6 location to the VT1 location. Riffle zones are indicated by red circles. The black arrows show relative water flow across the riverbed. A down arrow indicates losing conditions while an up arrow indicates gaining conditions. Note that, based on the groundwater projection, the River is generally losing water to the underlying aquifer from the P6 location to the VT1 location.

Data from this section not available due to vegetative cover.

- Riverbottom Profile
- Data Collection Points
- Prepumping GW
- Both Pumping GW
- Prepumping River
- Both Pumping River
Figure 3-20
Groundwater Temperature Measured at Monitoring Well ESR-1
El Sur Ranch
Big Sur, California

Date
8/30  9/3  9/7  9/11  9/15  9/19  9/23  9/27  10/1  10/5  10/9  10/13  10/17

Groundwater Temperature (deg F)

58
57
56
55
54
53
52

Labor Day Weekend
Lagoon Closed
New Well Pumping
Old Well Pumping
Both Wells Pumping
Figure 3-21
Average Daily River Water Temperature Comparison Between Locations P5, P6 and VT1
El Sur Ranch
Big Sur, California

Note that there is very little difference in temperature between stations P6 (blue), P5 (red) and VT1 (green).
Figure 3-22
Average Daily River Water Temperature Measured at P4u
El Sur Ranch
Big Sur, California

Temperature at P4u 2 degrees colder for first five days, coincident with period of lowest flow.

Note minimum flow condition occurring over Labor Day weekend.

- Lagoon Closed
- Labor Day Weekend
- New Well Pumping
- Old Well Pumping
- Both Wells Pumping

Date
8/30 9/3 9/7 9/11 9/15 9/19 9/23 9/27 10/1 10/5 10/9 10/13 10/17

Average Daily River Water Temperature (deg F)
50 54 58 62 66 70

River Flow Volume (cfs)
0 1 2 3 4 5
Figure 3-23
Average Daily River Water Temperature Measured at P4
El Sur Ranch
Big Sur, California

Temperatures at P4 (right and left bank) are higher than upstream station P4u due to the effects of solar heating. Note the lack of significant difference between the left and right bank indicative of minimal groundwater influence.
Figure 3-24
Average Daily River Water Temperature Measured at P3
El Sur Ranch
Big Sur, California

- Lagoon Closed
- Labor Day Weekend
- New Well Pumping
- Old Well Pumping
- Both Wells Pumping

Less groundwater mixing results in higher temperatures along the left bank.

Spike in River flow reduces difference in temperature between left and right bank.

Reduced temperature on right bank result of directly sampling groundwater. Note that the temperature is ~55 degrees, identical to groundwater temperature found in well ESR-1 (Figure 3-22).

- P3L Temp
- Event Timing
- P3R Temp
- Flow at VT3
Figure 3-25
Average Daily River Water Temperature Measured at P2
El Sur Ranch
Big Sur, California

Water temperature on left and right banks are very similar indicating that the River is well mixed and that there is little groundwater influence at this location.
Figure 3-26
Average Daily River Water Temperature Measured at P1 (Lagoon)
El Sur Ranch
Big Sur, California

Average Daily River Water Temperature (deg F)

New Well Pumping
Lagoon Closed
Labor Day Weekend
Old Well Pumping
Both Wells Pumping

Date

8/30  9/3  9/7  9/11  9/15  9/19  9/23  9/27  10/1  10/5  10/9  10/13  10/17

P1 Temp  Event Timing
Figure 3-27
Daily Average Dissolved Oxygen Content in River Water at P5
El Sur Ranch
Big Sur, California

- Lagoon Closed
- Labor Day Weekend
- See DO concentrations at P5 mirroring daily average flow at VT1
- Note minimum flow condition over Labor Day weekend
- New Well Pumping
- Old Well Pumping
- Both Wells Pumping

Date

8/30  9/3  9/7  9/11  9/15  9/19  9/23  9/27  10/1  10/5  10/9  10/13  10/17

Daily Average Dissolved Oxygen Content (mg/L)

Daily Average River Flow (cfs)
Figure 3-28
Daily Average Dissolved Oxygen Content in River Water at P4u
El Sur Ranch
Big Sur, California

Data from P4u is nearly identical to P5 except during and immediately after Labor Day weekend due to low River flow and the resulting greater influence of low DO groundwater.

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[Graph showing daily average dissolved oxygen content with key events labeled: New Well Pumping, Old Well Pumping, Both Wells Pumping, Lagoon Closed, Labor Day Weekend.]
Figure 3-29
Daily Average Dissolved Oxygen Content in River Water at P4
El Sur Ranch
Big Sur, California

[Graph showing daily average dissolved oxygen content with event markers and date range 8/30 to 10/17]
Figure 3-30
Daily Dissolved Oxygen Content in River Water at P3
El Sur Ranch
Big Sur, California

DO content is generally greater near the left bank than the right bank, except during the extremely low River flows that occurred over the Labor Day weekend when DO near both banks was similar.
Figure 3-31
Daily Average Dissolved Oxygen Content in River Water at P2
El Sur Ranch
Big Sur, California

Note that there is very little difference in DO concentration between the left bank and the right bank, except around the time both wells are pumping.
Figure 3-35
Big Sur Flows vs. Zone 2-4 Flows Regression Analysis
El Sur Ranch
Big Sur, California

Big Sur Flows vs. Zone 2-4 Flows with Average September Pumping

\[ y = 1.3218x - 8.4234 \]
\[ R^2 = 0.9991 \]

Big Sur Flows vs. Zone 2-4 Flows with No Pumping

\[ y = 1.3353x - 7.771 \]
\[ R^2 = 0.9986 \]
Table 3-1
Correlation Between Pumping Rate and Decrease in Groundwater Inflow to River, Zone 2 Through Zone 4
El Sur Ranch
Big Sur, California

<table>
<thead>
<tr>
<th>Wells Active</th>
<th>Total Pumping Rate (cfs)</th>
<th>Calculated Decrease in Groundwater Inflow (cfs)</th>
<th>Is There a Net Gain in River Flow?</th>
<th>Pumping to Groundwater Inflow Reduction Ratio (cfs per cfs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Both</td>
<td>5.02</td>
<td>~1 to 1.2</td>
<td>NO</td>
<td>0.24</td>
</tr>
<tr>
<td>New</td>
<td>2.37</td>
<td>NA*</td>
<td>NO</td>
<td>NA*</td>
</tr>
<tr>
<td>Old</td>
<td>2.26</td>
<td>~0.2</td>
<td>YES</td>
<td>0.09</td>
</tr>
</tbody>
</table>

*due to overlapping hydraulic events (specifically, the closing of the Lagoon), it is not possible to calculate the decrease in overall groundwater flow with any amount of accuracy.
APPENDIX G

RIVER PIEZOMETER HYDROGRAPHS
Appendix G - P2RD Hydrograph - 2007

Water Elevation (ft amsl)

Date

8/30 9/3 9/7 9/11 9/15 9/19 9/23 9/27 10/1 10/5 10/9 10/13 10/17

Lagoon Closed
Labor Day Weekend

New Well Pumping
Old Well Pumping
Both Wells Pumping
Appendix G - P3LD Hydrograph - 2007

Water Elevation (ft amsl)

Date

8/30 9/3 9/7 9/11 9/15 9/19 9/23 9/27 10/1 10/5 10/9 10/13 10/17

Lagoon Closed
Labor Day Weekend
New Well Pumping
Old Well Pumping
Both Wells Pumping
Appendix G - P4RS Hydrograph - 2007

![Graph showing water elevation over time with key events labeled: Lagoon Closed, Labor Day Weekend, New Well Pumping, Old Well Pumping, Both Wells Pumping.](AttachedGraph.png)
Appendix G - P4RD Hydrograph - 2007

[Graph showing water elevation over time with key events such as Lagoon Closed, Labor Day Weekend, New Well Pumping, Old Well Pumping, and Both Wells Pumping marked]
Appendix G - P4uLS Hydrograph - 2007

Date

8/30 9/3 9/7 9/11 9/15 9/19 9/23 9/27 10/1 10/5 10/9 10/13 10/17

Water Elevation (ft. amsl)

6 6.5 7 7.5 8 8.5 9 9.5 10

Lagoon Closed
Labor Day Weekend
New Well Pumping
Old Well Pumping
Both Wells Pumping
Appendix G - P5LD Hydrograph - 2007

Water Elevation (ft. amsl) vs Date

- Lagoon Closed
- Labor Day Weekend
- New Well Pumping
- Old Well Pumping
- Both Wells Pumping