0033

Canyon Fuel Company, LLC
Skyline Mines
HC 35 Box 380
Helper, Utah 84526
(435) 448-6463 Fax: (435) 448-2632

COPY

June 18, 2004

Pam Grubaugh-Littig
Permit Supervisor
Utah Division of Oil, Gas and Mining
1594 West North Temple, Suite 1210
Salt Lake City, Utah 84114-5801

Incoming
C/007/0005 OK
Copy Daron & Gregg
& Mary Ann

RE: Response to the Division's TA Regarding the Submittal of the HCI Ground Water Model, Canyon Fuel Company, LLC, Skyline Mine, C/007/005, Task ID #1752

Dear Ms. Grubaugh-Littig:

Please find enclosed with this letter Skyline Mine's response to the Division's May 2004 TA regarding the submittal of the additional data for the HCI Ground Water Model. This submittal includes completed C1 and C2 forms, four redline/strikethrough copies of modified text, and seven clean copies of text. I believe the deficiencies presented in the two informal TA's have been addressed. I have included with this letter an explanation by HCI regarding how items # 3 and #5 on Paul Clark's (OSM) were or were not addressed.

I appreciate your patience in allowing extra time for the preparation of this submittal. If you have any questions, please call me at (435) 448-2669.

Sincerely,

Chris D. Hansen
Environmental Coordinator
Canyon Fuel Company, LLC

enclosures

File in:
- ☐ Confidential
- ☐ Shelf
- ☒ Expandable

Refer to Record No 0033 Date 06182004
In C/0070005, 2004, Incoming
For additional information

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APPLICATI' FOR COAL PERMIT PROCESSI'

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rmit Change ☒ New Permit ☐ Renewal ☐ Exploration ☐ Bond Release ☐ Transfer ☐

'ermittee: Canyon Fuel Company, LLC

Mine: Skyline Mine **Permit Number:** C/007/005

Title: HCI Model TA Response

Description, Include reason for application and timing required to implement:

Modifications to the M&RP as requested by DOGM regarding the HCI Ground Water Model.

Instructions: If you answer yes to any of the first eight (gray) questions, this application may require Public Notice publication.

☐ Yes ☒ No 1. Change in the size of the Permit Area? Acres: _____ Disturbed Area: _____ ☐ increase ☐ decrease.
☐ Yes ☒ No 2. Is the application submitted as a result of a Division Order? DO# _____
☐ Yes ☒ No 3. Does the application include operations outside a previously identified Cumulative Hydrologic Impact Area?
☐ Yes ☒ No 4. Does the application include operations in hydrologic basins other than as currently approved?
☐ Yes ☒ No 5. Does the application result from cancellation, reduction or increase of insurance or reclamation bond?
☐ Yes ☒ No 6. Does the application require or include public notice publication?
☐ Yes ☒ No 7. Does the application require or include ownership, control, right-of-entry, or compliance information?
☐ Yes ☒ No 8. Is proposed activity within 100 feet of a public road or cemetery or 300 feet of an occupied dwelling?
☐ Yes ☒ No 9. Is the application submitted as a result of a Violation? NOV # _____
☐ Yes ☒ No 10. Is the application submitted as a result of other laws or regulations or policies?
Explain: _____
☐ Yes ☒ No 11. Does the application affect the surface landowner or change the post mining land use?
☐ Yes ☒ No 12. Does the application require or include underground design or mine sequence and timing? (Modification of R2P2)
☐ Yes ☒ No 13. Does the application require or include collection and reporting of any baseline information?
☐ Yes ☒ No 14. Could the application have any effect on wildlife or vegetation outside the current disturbed area?
☐ Yes ☒ No 15. Does the application require or include soil removal, storage or placement?
☐ Yes ☒ No 16. Does the application require or include vegetation monitoring, removal or revegetation activities?
☐ Yes ☒ No 17. Does the application require or include construction, modification, or removal of surface facilities?
☒ Yes ☐ No 18. Does the application require or include water monitoring, sediment or drainage control measures?
☐ Yes ☒ No 19. Does the application require or include certified designs, maps or calculation?
☐ Yes ☒ No 20. Does the application require or include subsidence control or monitoring?
☐ Yes ☒ No 21. Have reclamation costs for bonding been provided?
☐ Yes ☒ No 22. Does the application involve a perennial stream, a stream buffer zone or discharges to a stream?
☐ Yes ☒ No 23. Does the application affect permits issued by other agencies or permits issued to other entities?

Please attach four (4) review copies of the application. If the mine is on or adjacent to Forest Service land please submit five (5) copies, thank you. (These numbers include a copy for the Price Field Office)

I hereby certify that I am a responsible official of the applicant and that the information contained in this application is true and correct to the best of my information and belief in all respects with the laws of Utah in reference to commitments, undertakings, and obligations, herein.

DANIEL R MEADORS
Print Name

Mine Manager 6-15-04
Sign Name, Position, Date

Subscribed and sworn to before me this 15 day of June, 2004

Vicky Sue Miller
Notary Public

My commission Expires: 1-5, 2008

Attest: State of UTAH } ss:
County of CARBON

VICKY SUE MILLER
NOTARY PUBLIC • STATE of UTAH
1776 KENILWORTH RD.
HELPER, UTAH 84526
COMM. EXPIRES 1-5-2008

For Office Use Only:	Assigned Tracking Number:	Received by Oil, Gas & Mining
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Form DOGM- C1 (Revised March 12, 2002)

APPLICATIO FOR COAL PERMIT PROCE ING
Detailed Schedule Of Changes to the Mining And Reclamation Plan

COPY

Permittee: Canyon Fuel Company, LLC
Mine: Skyline Mine **Permit Number:** C/007/005
Title: HCI Model TA Response

Provide a detailed listing of all changes to the Mining and Reclamation Plan, which is required as a result of this proposed permit application. Individually list all maps and drawings that are added, replaced, or removed from the plan. Include changes to the table of contents, section of the plan, or other information as needed to specifically locate, identify and revise the existing Mining and Reclamation Plan. Include page, section and drawing number as part of the description.

			DESCRIPTION OF MAP, TEXT, OR MATERIAL TO BE CHANGED
☐ Add	☒ Replace	☐ Remove	Replace pages 2-34, 2-35, 2-35a, 2-5b, 2-35c, 2-36, 2-36a, 2-37, 2-37a, 2-38
☐ Add	☒ Replace	☐ Remove	Replace the Addendum to PHC, July 2002 Table of Contents
☐ Add	☒ Replace	☐ Remove	Replace Addendum to PHC, July 2002 pages A-1 thru A-5, A-7 thru A-11, A-13 thru A-36
☒ Add	☐ Replace	☐ Remove	Add Appendix K to Addendum to PHC, July 2002
☐ Add	☒ Replace	☐ Remove	Replace Drawing 2.3.6-1 in the M&RP
☐ Add	☐ Replace	☐ Remove	
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Any other specific or special instruction required for insertion of this proposal into the Mining and Reclamation Plan.

11/13/02

Received by Oil, Gas & Mining

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June 1, 2004 HCI-1787

Mr. Chris Hansen
Canyon Fuel Company, LLC
HC 35 Box 380
Helper, UT 84526

SUBJECT: Transmittal of Supplemental Modeling Report

Dear Mr. Hansen:

This letter accompanies a pdf-format copy of a report on supplemental modeling of ground-water flow in and around the Skyline Mine. The modeling was performed and the report prepared by Hydrologic Consultants, Inc. of Colorado (HCI) at the request of Canyon Fuel Company.

The report specifically addresses eight comments and recommendations (deficiencies) submitted by Utah Division of Oil Gas and Mining (DOGM, 2004) pertaining to earlier Skyline ground-water flow modeling (HCI, 2003). Most of the deficiencies and recommendations are addressed in the accompanying report. Those items that were not fully addressed as requested include:

1. Item #3 requested a figure representing each layer in the model. HCI prepared 5 such figures, however, several other layers were not represented in separate figures because those layers are redundant (several identical layers, for numerical reasons, representing identical geology).

2. Item #5 requests extension of cross sections to show the geology east and west of major faults. However, the cross sections in question are of the model grid, and the faults coincide with the model boundaries. Therefore, no extension is possible – there is no model beyond the model boundary. A geological cross section from Cris Kravits' report would better satisfy DOGM's request.

All other items were addressed in full. Please give me a call if you have questions regarding the accompanying report.

Sincerely,

HYDROLOGIC CONSULTANTS, INC. OF COLORADO

Roger L. Howell
Project Manager

References:

COPY

Hydrologic Consultants Inc., 2003, Findings of ground-water flow modeling of Skyline Mine and surrounding area, Carbon, Sanpete, and Emery Counties, Utah: report prepared for Manning, Curtis, Bradshaw & Bednar LLC, September.

Utah Division of Oil, Gas, and Mining, 2004, Findings for HCI ground-water model report in PHC, Canyon Fuel Company, LLC, Skyline Mine, C/007/0005 #1871: Letter to Dan Meadors, April 23.

Late fall samples are obtained in October through November. These time periods were selected because the sites are usually inaccessible until late June and after November due to snow depth and frozen water courses. Several sites on Eccles Creek are monitored in December through February since they are adjacent to a maintained road and the water discharged from the mine normally keeps the stream from freezing over.

Water quality samples are collected from the 25 selected springs in the project area. The samples are comprehensively analyzed each year for the parameters listed in Table 2.3.7-1 and Table 2.3.7-2. All water samples collected for use in this permit have been collected and analyzed according to methods in either the "Standard Methods for the Examination of Water and Wastewater" or the 40 CFR parts 136 and 434. A listing identifying the station types is shown on Table 2.3.7-3.

In addition to the collection of the outlined water quality data, water level data has been collected from each of the wells (if functional) as scheduled on Tables 2.3.7-1, 2.3.7-2, 2.3.7-2A and 2.3.7-3, and noted on Plate 2.3.6-1. Water quality samples will be collected from the Waste Rock Disposal Site Well 92-91-03 in accordance with the schedule and parameter list shown on Table 2.3.7-5. Summary information on these observation wells is found on Table 2.3.7-4. Three wells, 79-14-2B and 79-22-2-1 and 79-22-2-2 have experienced casing failures, and are currently nonfunctional. There are no plans to replace these wells.

The amount of water discharged from each mine on each monitoring occasion will also be monitored at the mine mouth through the use of a totalizing flow meter or similar device. Significant changes in the source of water in the mine will be noted during the period of operation. Underground water pumped from each mine will be monitored for water quality. Mine #1 discharge is sampled at Station CS-14. Mine #3 discharge is sampled at Station CS-12.Mine #2 water is discharged at JC-3.

Should the concentrations result in a discharge which exceeds the UPDES discharge permit limitations or indicates potential disturbance to the hydrologic balance, an attempt will be made to isolate the contributing source and an evaluation made of possible appropriate remedial action. The best alternative remedial action will be implemented as soon as practicable to ensure protection of Eccles Creek water quality. Copies of the current UPDES permit (expires September 30, 2004) is appended to this section as Exhibit 2.3-1.

As required, ground water quality data collected from the property area will be submitted to the Utah Division of Oil, Gas, and Mining. Such reports will be submitted within 90 days after completion of the quarterly monitoring program. An annual report which will include a summary of water quality data and water well level data for the previous year will be submitted within 90 days of the end of each year.

In 2002, several new sites were added to the monitoring program. Sites MC-1, MC-2, MC-3, MC-4, MC-5, and MC-6 are surface water sites on Mud Creek (Site MC-6 was added in November 2002 as agreed upon by the operator and the Division). These sites were identified as part of a study to determine the impacts of increase mine discharge on Mud and Eccles Creeks. EarthFax Engineering, Inc. was contracted to write and implement a work plan to evacuate the impacts in July 2002. A copy of the work plan is included in Volume 4 of this M&RP. The study calls for establishing and characterizing reference sites on Eccles and Mud Creeks to: 1)determine depth to ground water at the sites, 2) obtain historic flow data for the stream for comparative purposes, 3) gather and evacuate historic aerial photos of the streams, 4) collect additional water quality data, 5) evaluate bank stability indexes along with vegetation information, and conduct long-term monitoring at the selected sites. The initial field work for this project was

completed in August 2002 but the interim report is not yet available. Skyline will submit this first and subsequent first progress reports for this project with its annual reports.

Samples obtained at the MC-sites will be monitored for total flow, TDS, TSS, and total phosphorous. In addition a stream stability cross-section and reach survey will be conducted approximately 75 yards downstream of the MC-6 monitoring location. The results of these analyses will be reported with the other mine water quality monitoring reports.

Sites MD-1, JC-1, JC-3, and ELD-1 were also added to the monitoring site list. MD-1 is a composite sample of the all water discharged from Skyline Mine to Eccles Creek. JC-1 and JC-3 are samples of the water discharged from the two James Canyon ground and mine dewatering wells. ELD-1 is the total flow from both JC-1 and JC-3. MD-1 and ELD-1 are monitored for total flow and the results are reported to the Division on a monthly basis. Quarterly, MD-1, JC-1, and JC-3 are also monitored for TSS, TDS, and total phosphorous. Since JC-3 is a PacifiCorp UPDES site, it is monitored each month for flow, TSS, TDS, oil and grease, and total iron. The UPDES sampling results are forwarded to the Division monthly.

Spring monitoring sites WQ1-39, WQ3-6, WQ3-26, WQ3-41 WQ3-43, and WQ4-12 were added to the permit. Surface water sites CS-19, CS-20, and CS-21 were added as were wells 91-26-1 and 91-35-1. All of these sites are in the North Lease area. Location of these samples sites are illustrated on Drawing 2.3.6-1.

Skyline Mine has also obtained numerous water samples from within the mine for age-dating purposes. Samples have been analyzed for both stable and unstable isotopes; the majority being analyzed for tritium and carbon 14 content. The analyses results of these samples is discussed in detail in the July 2002 Addendum to the PHC. The results of repeated tritium sampling and analysis in a few location in the mine, specifically those in the 9 and 10 Left panel areas that began in August 2001, suggest that the majority of the water is not younger than 50 years. Only a few carbon 14 samples have been obtained from these

sites but the results indicate the waters are several thousand years old. The sampling sites in the 9 and 10 Left panel areas became inaccessible as that portion of the mine was sealed in September 2002. Remaining significant inflow sites, particularly the east submains site (previously identified as the west submains) and a few of the sites in the 11 and 12 left panel areas, will be accessible through June of 2004. The mine will obtain carbon 14 and tritium samples from these sites on a quarterly basis. The results of these analyses will be compared to previous analyses to determine if the age of the water is getting perceptively younger. A report detailing the location of where samples were obtained and the results of the age-dating analyses will be submitted to the Division each quarter in conjunction with the quarterly water monitoring results.

Mine #2 will be sealed by the end of 2004, with the exception of the west mains. The west mains will be maintained to allow access to the 14, 15, and 16 Left sumps. Skyline will complete mining the 11 and 12 Left A and B panels before the end of 2004. No additional significant inflows are anticipated in these areas. If sustained significant flows of ground water (flows greater than 800 gpm) are encountered in the headgates or tailgates of these panels, tritium and carbon 14 samples will be obtained and sampled on a quarterly basis as long as the sites are accessible. If similar flows are encountered as Mine #3 extends into the North Lease area, the same age-monitoring program will be applied.

Samples will also be obtained from the JC-1 well and analyzed for carbon 14, tritium, and stable isotopes deuterium and oxygen 18 for age dating purposes. JC-1 is, at this time, a ground water discharge site that is assumed to discharge water similar to or the same as the mine inflow waters in the southern portions of Mine #2. Discharge from JC-1

should be accessible for the next several years. The results of the analyses will be monitored for changes in ages that may indicate changes in the source of the mine water inflows. These samples will be obtained as outlined in Table 2.3.7-1.

Samples of water discharging from springs 8-253 (Flat Canyon area), 2-413 (James Canyon), S24-1 (Sulfur Spring in Huntington Canyon), and S15-3 (Upper Huntington Creek) will be collected during the high spring (April - June) and late fall (October - November) monitoring period and analyzed for tritium content. Additional tritium samples will be obtained from EL-1 (inflow to Electric Lake above JC-1 and JC-3 discharge) and EL-2 (outflow from Electric Lake) during the high spring, low summer (August - September), and late fall monitoring periods. These samples will be collected for a period of three years beginning in the spring of 2004. The purpose of collecting these tritium samples, along with the tritium samples from JC-1, is to monitor the change in tritium content, if any, in the local aquifers and Electric Lake during spring, summer, and fall and over the three year period.

Table 2.3.7-1
Comprehensive Water Quality Analytical Schedule
(Surface and Ground Water Stations)

Streams	Protocol	Comments
CS-1	A 1, 2, 6, 8	
CS-3	A 1, 2, 6, 8	
CS-4	A 1, 2, 6, 8	
CS-6	A 1, 2, 3, 6, 7, 8, 10	
CS-7 (F-5)	A 1, 2	
CS-8	A 1, 2	
CS-9	A 1, 2, 6, 8	
CS-10	A 1, 2	
CS-11	A 1, 2, 6, 8	
CS-12	A 1, 2, 3, 6, 8	
CS-13	A 1, 2, 3, 6, 8	
CS-14	A 1, 2, 3, 6, 8	
CS-15	A 13	
CS-16	A 1, 2	
CS-17	A 1, 2	
CS-18	A 1, 2	
CS-19	A 1, 2	
CS-20	A 1, 2	
CS-21	A 1, 2	
CS-22	D 11	
CS-23	D 11	
MD-1	A 7 and B	
SRD-1	B	
F-9	C 16	
F-10	A 1, 2 and C	
UP&L-10	A 1, 2	
VC-6	A 1, 2, 3, 6, 7, 8, 10	
VC-9	A 1, 2, 3, 6, 7, 8, 9, 10	Flow is sum of CS-6 and CS13
VC10	A 1, 2, 3, 6, 7, 8	
VC11	D 11	
VC12	D 11	
MC-1	A 7	
MC-2	A 7	
MC-3	A 7	
MC-4	A 7	
MC-5	A 7	
MC-6	A 7	
NL-1	F 10, 13	North Lease Subsidence Points
NL-2	F 10, 13	North Lease Subsidence Points
NL-3	F 10, 13	North Lease Subsidence Points
NL-4	F 10, 13	North Lease Subsidence Points
NL-5	F 10, 13	North Lease Subsidence Points
NL-6	F 10, 13	North Lease Subsidence Points
NL-7	F 10, 13	North Lease Subsidence Points
NL-8	F 10, 13	North Lease Subsidence Points
NL-9	F 10, 13	North Lease Subsidence Points
WRDS #1	A 1, 2, 6, 8	
WRDS #2	A 1, 2, 6, 8	
WRDS #3	A 1, 2, 6, 8	
WRDS #4	A 1, 2, 6, 8	
EL-1	A 14	Sample spring, summer, and fall for
EL-2	A 14	3 years beginning in 2004

Table 2.3.7-1 (cont.)
Comprehensive Water Quality Analytical Schedule
(Surface and Ground Water Stations)

Springs	Protocol	Comments
S10-1	A 1, 2	
S12-1	A 1, 2	
S13-2	A 1, 2	
S13-7	A 1, 2	
S14-4	A 1, 2	
S15-3	A 1, 2	
S17-2	A 1, 2	
S22-5	A 1, 2	
S22-11	A 1, 2	
S23-4	A 1, 2	
S24-1 Sulfur Spring	A 1, 2	
S24-12	A 1, 2	
S26-13	A 1, 2	
S34-12	A 1, 2	
S35-8	A 1, 2	
S36-12	A 1, 2	
2-413	A 1, 2	
3-290	A 1, 2	
8-253	G 14	Sampled spring and fall for 3 years starting in 2004
WQ1-39	A 1, 2	
WQ3-6	A 1, 2	
WQ3-26	A 1, 2	
WQ3-41	A 1, 2	
WQ3-43	A 1, 2	
WQ4-12	A 1, 2	
Wells		
JC-1	A 5 and B	
JC-3	A 4 and B	
ELD-1	B	
W79-10-1B	E 12	
W79-14-2A	E 12	
W79-26-1	E 12	
W79-35-1A	E 12	
W79-35-1B	E 12	
W2-1 (98-2-1)	E 12	
W20-4-1	E 12	
W20-4-2	E 12	
W99-4-1	E 12	
W99-21-1	E 12	
W99-28-1	E 12	
W20-28-1	E 12	
91-26-1	E 12	
91-35-1	E 12	

Table 2.3.7-2
Water Quality Analytical Schedule
Streams and Springs
High Spring (April - June),
Late Fall (October - November), and
Winter (December - February) Flows

Field Measurements
Flow
pH
Specific Conductance
Temperature, Air
Temperature, Water
Turbidity

Laboratory Measurements
Ammonia
Bicarbonate
Calcium, dissolved
Chloride
Iron, Total and dissolved
Magnesium, dissolved
Manganese, total and dissolved
Nitrate
Phosphate (Orthophosphate)
Potassium, dissolved
Sodium, dissolved
Sulfate
Suspended Solids
Total Dissolved Solids

Table 2.3.7-2A
Water Quality Analytical Schedule
Streams and Springs
-Low Summer Flow-
(August - September)

Field Measurements
Flow
Dissolved Oxygen
pH
Specific Conductance
Temperature, Air
Temperature, Water
Turbidity

Laboratory Measurements
Acidity
Alkalinity
Bicarbonate
Ammonia
Barium, Total and dissolved
Boron Total and dissolved
Calcium, dissolved
Chloride
Copper, total and dissolved
Fluoride
Iron, total and dissolved
Lead, total and dissolved
Magnesium, dissolved
Manganese, total and dissolved
Nitrate
Phosphate (Orthophosphate)
Potassium, dissolved
Sodium, dissolved
Sulfate
Suspended Solids
Total Dissolved Solids

TABLE 2.3.7-3
MONITORING STATION IDENTIFICATION

ECCLES CANYON/MUD CREEK DRAINAGES

STREAM STATIONS - 22 Stations

CS-1	CS-2	CS-3	CS-4	CS-6	CS-9	CS-11	CS-15
VC-6	VC-9	VC-10	MC-1	MC-2	MC-3	MC-4	MC-5
MC-6	CS-19	CS-20	CS-21	VC-11	VC-12		

MINE DISCHARGE STATIONS - 4 Stations

CS-12 (Mine #3) CS-14 (Mine #1) MD-1 (Composite CS-12 & CS-14)
SRD-1 (Total Mine Site Discharge to Eccles Creek/Scofield Reservoir)*

FRENCH DRAIN STATIONS - 1 Station

CS-13

HUNTINGTON CANYON

STREAM STATIONS - 12 Stations

CS-7 (F-5)	CS-8	CS-1	CS-16	CS-17	CS-18	CS-22
CS-23	UPL-3*	UPL-10	F-9	F-10	EL-1	EL-2

*Discontinued Spring, 1989

WASTEROCK DISPOSAL SITE

STREAM STATIONS - 4 Stations

WRDS #1 WRDS #2 WRDS #3 WRDS #4

GROUNDWATER STATIONS

SPRINGS - 25 Stations

S10-1	S12-1	S13-2	S13-7	S14-4	S15-3	S17-2
S22-5	S22-11	S23-4	S24-1 Sulfur	S24-12	S26-13	S34-12
S35-8	S36-12	2-413	3-290	WQ1-39	WQ3-6	WQ3-26
WQ3-41	WQ3-43	WQ4-12	8-253			

WELLS (MONITORING) - 19 Well Stations

W79-10-1A	W79-10-1B	W79-14-2A	W79-26-1	W79-35-1A
W79-35-1B	92-91-03	W2-1(98-2-1)	W20-4-1	W20-4-2
W99-4-1	W99-21-1	W99-28-1	W20- 28-1	JC-1
JC-3	ELD-1 (Total of JC-1 and JC-3)*	91-26-1	91-35-1	

WELLS, CULINARY -Referenced but not monitored

W13-1 W13-2 W17-1 W17-3 W24-1

NATIONAL POLLUTION DISCHARGE ELIMINATION SYSTEM (NPDES)

001 Portal Area 002 Loadout Area 003 Waste Rock Area JC-3 James Canyon

* Sites are monitored for total flow only and the results are reported to the Division on a monthly basis.

Addendum to the Probable Hydrologic Consequences

Table of Contents

Statement of Qualifications

Section	Page
Introduction	PHC A-1
History of Recent Inflows	PHC A-1
Effects of Intercepted Water Within the Mine on Ground Water	PHC A-10
Effects on Surface Waters	PHC A-25
Conclusions	PHC A-35

List of Figures

Figure		
PHC A-1	Skyline Mine Discharge	PHC A-2

List of Tables

Table		
PHC A-1	Mine Inflows	PHC A-6
PHC A-2	Well Data Summary	PHC A-12

List of Drawings

Drawing	
PHC A-1	James Canyon Wells and Monitoring Well Locations
PHC A-2	Mine Inflow Map
PHC A-3	Location of Hydrologic Monitoring Stations and Mine 2 and Mine 3 Workings
PHC A-4	Skyline Leasehold - Cross Section A - A'

List of Appendices

Appendix A Petersen Hydrologic Report

Information in this appendix have been listed in order of their position within the appendix.

Table of Contents

Figure 1	Palmer Hydrologic Drought Index, Utah Region 5 (Skyline Mine area)
Figure 2	S15-3 (Blackhawk Formation), Spring Discharge and PHDI Utah Region 5
	S15-3 (Blackhawk Formation) Discussion
Figure 3	S22-11 (Blackhawk Formation), Spring Discharge and PHDI Utah Region 5
	S22-11 (Blackhawk Formation) Discussion
Figure 4	S24-12 (Blackhawk Formation), Spring Discharge and PHDI Utah Region 5
Figure 5	S26-13 (Blackhawk Formation), Spring Discharge and PHDI Utah Region 5
	S26-13 (Blackhawk Formation) Discussion
Figure 6	S34-12 (Blackhawk Formation), Spring Discharge and PHDI Utah Region 5
	S34-12 (Blackhawk Formation) Discussion
Figure 7	S35-8 (Blackhawk Formation), Spring Discharge and PHDI Utah Region 5
	S35-8 (Blackhawk Formation) Discussion
Figure 8	S36-12 (Blackhawk Formation), Spring Discharge and PHDI Utah Region 5
	S36-12 (Blackhawk Formation) Discussion
Figure 9	2-413 (Blackhawk Formation), Spring Discharge and PHDI Utah Region 5
	2-413 (Blackhawk Formation) Discussion
Figure 10	Burnout Creek (F-5 lower flume), Stream Discharge and PHDI Utah Region 5
	Burnout Creek (F-5 lower flume) Discussion
Figure 11	Well W79-26-1, Well Water Level and PHDI Utah Region 5
	Well W79-26-1 Discussion
Figure 12	Well W79-10-1, Well Water Level and PHDI Utah Region 5
	Well W79-10-1 Discussion
Figure 13	Well W79-14-2A, Well Water Level and PHDI Utah Region 5
	Well W79-14-2A Discussion
Figure 14	Well W99-21-1, Well Water Level and PHDI Utah Region 5
	Well W99-21-1 Discussion
Figure 15	Well W99-28-1, Well Water Level and PHDI Utah Region 5
	Well W99-28-1 Discussion
Figure 16	Well W20-4-1, Well Water Level and PHDI Utah Region 5
	Well W20-4-1 Discussion
Figure 17	Well W20-4-, Boulger Canyon Transducer Data
Figure 18	Well W20-4-2, Well Water Level and PHDI Utah Region 5
	Well W20-4-2 Discussion
Figure 19	Well W79-35-1A, Well Water Level and PHDI Utah Region 5
	Well W79-35-1A Discussion
Figure 20	Well W79-35-1A, Burnout Canyon Transducer Data
Figure 21	Well W79-35-1B, Well Water Level and PHDI Utah Region 5
	Well W79-35-1B Discussion
Figure 22	Well W2-1, Well Water Level and PHDI Utah Region 5
Figure 23	Well W2-1, James Canyon South Ridge Transducer Data
Figure 24	Wells W79-35-1A, B & W2-1, Well Water Level and PHDI Utah Region 5

Wells W79-35-1A, B & W2-1 Discussion

Historic Water Levels in Monitoring Wells in the Skyline Mine Area Discussion

Field and Laboratory Data:
Swens Canyon Creek (CS-16)
Little Swens Canyon Creek (CS-17)
James Canyon Creek (F-10)
Huntington Creek Above Electric Lake (UPL-10)
James Canyon Well (JC-1)
James Canyon Well (JC-2)

Stiff Diagram:
Stiff Diagram for springs and in-mine groundwaters from the Skyline Mine and discussion

Groundwater mean residence times in the Skyline Mine area

Mud Creek:
Mud Creek Discharge figure
Mud Creek Flow Duration figure
Discussion of Mud Creek

Laboratory Data Sheets:
James Canyon Well (JC-1)

Water Discharged to Eccles Creek/Scofield Reservoir

Water Discharged to Electric Lake

Appendix B Norwest Mine Services, Inc

Technical Report Surface Water and Groundwater Resources in Flat Canyon Area
Table of Contents provided at front of the report within the appendix.

Appendix C Hydrologic Consultants, Inc

Progress Report No. 2, Updated Conceptual Hydrogeology, evaluation of Current and Future Dewatering and Proposed Testing Program for Skyline Mine
Table of Contents provided at front of the report within the appendix.

Appendix D EarthFax Engineering, Inc

Hydrologic and Channel-Stability Evaluation of Eccles and Mud Creeks

Table of Contents

Section	Page
Mine Water Discharge Estimates	1
Channel Stability Impacts	2
Peak -Flow Impacts	5
Impacts on Man-Made Structures	7
Alternative Discharge Locations	8
Summary	8
References	9

List of Tables

Table	
1	Flow Measurements and Calculated Roughness Coefficients for Eccles and Mud Creek
2	Soil Property Parameters and Results of Slope Stability Analyses of the Banks of Eccles and Mud Creeks
3	Results of Erosional Stability Analyses of Eccles Creek and Mud Creek
4	Eccles and Mud Creeks Stream Classification
5	Comparison of Pre- and Post-Mine Discharge Bankfull Return Period
6	Evaluation of Man-Made Structures

List of Figures

Figure	
1	Location of Channel Cross Sections
2	Estimated Peak flow Frequencies for Eccles Creek
3	Impact of Increased Flow on Mud Creek Flow Frequency
4	Return Periods of Mine-Water Discharges
5	Flood Frequency of Eccles Creek Above South Fork
6	Flood Frequency of Eccles Creek Above Mud Creek
7	Flood Frequency of Mud Creek Below Winter Quarters
8	Locations of Man-Made Structures

List of Appendices

Appendix

A Mt. Nebo Scientific Report on Riparian communities at Eccles Creek and Mud Creek

B Results of Soil Laboratory Analyses

C Results of Channel Structural Stability Evaluations

D Results of Channel Erosional Stability Evaluations

Addendum to Skyline Mine Discharge Evaluation

Table of Contents

Page

Discharge Evaluation 1

List of Tables

Table

1 Summary of Total and Orthophosphate Data

2 Eccles Creek - Historic Conditions

3 Electric Lake - Expansion Conditions

Appendix E Scofield Reservoir Studies

Table of Contents

1. Nonpoint Source Pollution and Fisheries in Scofield Reservoir, Carbon County, Utah, January 1991, Kevin D. Christopherson, Utah Division of Wildlife Resources and Harry Judd, Utah Bureau of Water Pollution Control

2. Scofield Reservoir Restoration through Phosphorous Control, Prepared by Utah Department of Environmental Quality in cooperation with Southeastern Association of Local Governments and the United States Environmental Protection Agency, Region VIII

3. Synopsis of Water Quality Issues at Scofield Reservoir, February 24, 1989, Walter K. Donaldson, Utah Division of Wildlife Resources

4. UDWR Memorandum- Update on the Water Pollution Issues at Scofield Reservoir, February 21, 1989, Walt Donaldson, SER, Fisheries Program Manager to Timothy H. Provan Director of Utah Natural Resources - Wildlife Resources

5. Why Scofield Reservoir is Eutrophic: Effects of Nonpoint-Source Pollutants on a Water-Supply Reservoir in Utah, Doyle Stephens, U.S. Geological Survey, Salt Lake City, Utah

6. Scofield Reservoir Phase I, 314 Clean Lakes Study, 1980 - 1982, Richard L. Denton, Project Officer; Myron I Cox, Water Quality Specialist; Lavere B Merritt, Ph. D., Brigham Young University in cooperation with the Utah Department of Health, Division of Environmental Health, Bureau of Water Pollution Control, and Brigham Young University

Appendix F October 1, 2002 Internal Correspondence, Expected Water Inflow Rates

Appendix G Petersen Hydrologic Report

Investigation of Fault-related Groundwater Inflows at the Skyline Mine
27 October 2002
Table of Contents provided at the front of the report in the appendix

Appendix H HCI Status of Ground Water Flow Modeling for Skyline Mine
Prepared by HCI in May 2003 as interim report for ground water model of the Skyline Mine permit and Electric Lake area.

Appendix I Petersen Hydrologic Electric Lake Dye Letter Report
Letter report prepared by Petersen Hydrologic in June 2003 discussing the results of the collection and analysis of dye tracing packets placed in ground and surface waters in and around the Skyline Mine permit area in response to PacifiCorp's Electric Lake dye placement activities.

Appendix J HCI Ground Water Flow Modeling of Skyline Mine and Surrounding Area
A ground water model of the Star Point Sandstone aquifer that discharges to Skyline Mine was completed in October 2003 by HCI of Lakewood, CO. The model incorporates all of the available well, surface flow, and ground water discharge data available and germane to the model area. The model also was used to predict the future volume of ground water inflows to the mine using the most current mine plan.

Appendix K Supplemental Report to the Ground-Water Flow Modeling of Skyline Mine and Surrounding Area, Carbon, Sanpete, and Emery Counties, Utah
This is a supplemental report to the initial HCI groundwater model report included in this document as Appendix J. It includes clarifications of some aspects of the initial report, calibration of the initial model (2003), and some predictive simulations.

Introduction

This addendum to the Probable Hydrologic Consequences (PHC) has been included in this permit to address the effects of recent ground water inflows into the active mine workings of Skyline Mine 2, the completion of three ground water wells in James Canyon near the southwest extent of current mining constructed to alleviate mine in-flows, and the effects of discharging significant volumes of water to both Eccles Creek and Electric Lake. This addendum describes the effects to the surface waters and ground waters within the permit and adjacent areas of the recent inflows to the mine and the pumping of the James Canyon wells. This addendum contains this introduction, a discussion of the recent mine inflows, the effects of the flows on both surface and ground water, and conclusions. Appendices to this addendum contain graphs, discussions, and tables concerning monitoring data of numerous spring, well, and stream monitoring sites, reports by consultants related to water issues at Skyline, and reports prepared by or for State agencies regarding the water quality of Scofield Reservoir. This addendum is included as supplemental information to the existing PHC and, in some cases, updates or supercedes information provided in the existing PHC. It is important to bear in mind while reviewing the consultants reports included in this addendum that data collected after publication of the reports may have resulted in updates and refinements to previous theories and conclusions.

History of Recent Inflows

Prior to January 1999, Skyline Mine discharged exclusively to Eccles Creek, a Price River tributary, at an average rate of approximately 350 gpm or less of water intercepted during mining (Figure PHC A-1). This volume was somewhat representative of the average inflows of ground water into the mine. Significant new inflows were encountered in March of 1999 during the development of the south end of the 14 Left panel in Mine 2 (Drawings PHC A-1 and PHC A-2). Ground water flowed into the mine from a small displacement fault at a rate of approximately 1,600 gpm. Initially the water flowed from both the roof and floor but soon only discharged from the floor. The water was captured and pumped to the abandoned workings of Mine 1 and Mine 3 (Drawing PHC A-2). Mine personnel anticipated that this inflow,

Figure PHC A-1

as with previous significant inflows, would soon diminish and possibly cease altogether. However, in December 1999, another water producing fault was encountered in the headgate of the 16 Left panel. The inflow from this fault was initially estimated to be greater than 1200 gpm and resulted in significant mine flooding. This new water was also pumped to the abandoned Mine 1 and Mine 3 workings. By January 2000, the abandoned Mine 3 workings were flooded and water was pumped from behind the Mine 3 seals to the mine site sediment pond. Eventually, the water was pumped to the overflow structure of the sediment pond and directly to Eccles Creek. In March 2000, approximately 1,000 gpm of ground water was encountered in the West Submains near the head of 8 Left (Drawing PHC A-2). Water discharge rates from the mine to Eccles Creek were generally between 700 gpm and 1,200 gpm until September 2000. Pumping and piping changes made underground allowed the mine to discharge more of the stored water from Mines 1 and 3 and mine discharge flows reached about 2,400 gpm in March of 2001.

Additional mine inflows were encountered during development mining in the 9 Left panel area in March of 2001. At nearly the same time, additional pumping capacity was added to the mine water system allowing more of the water stored in Mine 1 and Mine 3 to be discharged. This increased the total discharge from the mine from 2,400 gpm to between 3,500 to 4,500 gpm. Significant water inflows were encountered in the development of the 10 Left panel of Mine 2 in August 2001. The new inflows from this area of the mine alone were initially estimated to be approximately 6,000 to 6,500 gpm but shortly thereafter stabilized at about 4,500 gpm. The new water flooded significant portions of the mine, caused a halt in production, and required emergency action by the mine to deal with the water. Several tens of miles of 8- to 28-inch diameter steel and HDPE pipe were laid within the mine to pump water to other active and inactive workings as well as to the surface and Eccles Creek.

In February and March of 2002, three additional inflows of approximately 1,000 gpm to 1,500 gpm were encountered in the headgate and set-up room of the 11 Left panel (Drawing PHC A-2). Decreases in the flow rates of the 14 Left, 16 Left, and 10 Left ground water inflows have occurred over time. As of June 2002, the flow rates in the 14 Left and 16 Left had dropped to approximately 800 gpm each (these areas are not accessible as of June 2002). The flow rates

in the 10 Left area in the first week of July 2002 appeared to have dropped to approximately 4,700 gpm or less. In the last week of September 2002, the inflows in the 10 Left area were estimated to be approximately 3,200 to 3,800 gpm. In October 2002, the 10 Left area was sealed and flooded. The 10 Left and 9 Left areas were allowed to partially fill with water up to the entrance of the 8 Left panel. Seals and a containment dam were built in this area and the water is pumped from behind the seals to Eccles Creek.

The total discharge rate from the mine in June 2002 averaged approximately 8,200 gpm but measurements in the first week in July indicated that discharges increased to approximately 9,200 gpm due primarily to the draining of Mines #1 and #3. From July to September 2002, the discharge volume fluctuated between approximately 8,400 gpm and 9,400 gpm due to an increase in new ground water inflows encountered in the 11 Left panel. While this water was originally encountered in February and March 2002, a great deal of time was involved in getting pumps, piping, and the collection systems set up. Frequently, water from new inflow locations encountered during mining is sent to gob areas such as the 14, 15, and 16 Left panels or the abandoned portions of Mines 1 and 3 to allow for the suspended load to drop out of the water column. Water removed from the active mine faces in the 11 Left panel has been pumped both to the south end of the 14, 15, and 16 Left gob areas and to Mine 1. Until October 2002, water in the 14, 15 and 16 Left gob area was picked up on the north end of the panels and pumped to the surface to temporary sand filters. After the water passed through the sand filters, it was discharged directly to Eccles Creek. The portion of the water pumped to Mine 1 dropped into the southeast end of panels 1 Right, 2 Right, and 3 Right. This water moved through the gob and passed through 2-inch diameter drill holes connecting Mine 1 with Mine 3 at the west-northwest end of each panel (Drawing PHC A-2). Eventually, this water was pumped from Mine 3 and directly to Eccles Creek. Water pumped from the 10 Left area and the West Submains contained very little suspended load and was pumped directly to temporary sand filters and then to Eccles Creek. Table PHC A-1 summarizes this information.

Skyline Mine sealed the 8, 9, and 10 Left area of the mine in September 2002 and flows from this portion of the mine were reduced by approximately 20 % as the area flooded and hydrostatic head built on the inflow point. Additionally, while the 10 Left area flooded, a decrease of about 3,200 to 3,800 gpm of mine discharge occurred for about 24 days. Seals and a retention dam were built at the entrance to 8 Left Diagonal Mains and pumps were installed to take water from behind the seals and discharge it to Eccles Creek. Also, the majority of the clean water encountered in the 11 and 12 Left areas of the mine was pumped behind the 8 Left seals. This allowed for a simplified pumping system to be installed where most of the water encountered in the southwest area of the mine could be picked-up at one location and pumped to Eccles Creek. The water laden with coal fines generated during mining activities in the 11 and 12 Left panel areas is pumped through a horizontal borehole into the 14, 15, and 16 Left sump.

In October 2002, the sand filters were removed from the mine water discharge system since the 14, 15, and 16 Left sump was fully functional and the 8, 9, and 10 Left areas were sealed. All water carrying suspended solids is directed through underground sump systems and allowed settling time before discharge. This allowed the mine to remove the expensive sand filtering systems and still discharge water without suspended loads and compliant with the Mine's UPDES Permit.

Skyline Mine has removed a portion of the water previously stored in the abandoned Mine 3 workings in advance of mining new areas to the north. The dewatering started about the same time as the 10 Left flooding occurred. Dewatering is accomplished by withdrawing 1,100 to 2,000 gpm of water from Mine # 3 through a series of in-mine horizontal boreholes. In July of 2003, the discharge rate of water from the Mine #3 area dropped to between 100 and 400 gpm, the rate being dependant upon the mines ability to discharge water from the horizontal boreholes from Mine #3 to the 14, 15, 16 Left sumps. New ground water inflow points were not encountered in panels 12 Left A and 12 Left B and the mine discharge has diminished gradually over time.

Table PHC A-1

The proposed timetable for abandoning the mined out areas of Mine #2 has been included with this document as Appendix F. This timetable was prepared on October 1, 2002 and distributed at Skyline Mine in the form of an Internal Correspondence addressed to the Mine Manager. Four figures accompanied the document and illustrated the locations within the mine to be abandoned and flooded. The document itself discusses the timing of abandonment, the location of present significant inflows into the mine with initial and current estimated inflow rates, and anticipated inflow rates after flooding has occurred. Following is a brief discussion regarding the timing of mining and flooding of the mined areas of Mine #2.

The 10 Left area of Mine #2 was abandoned in late September 2002. The pumps that were used to remove water from the 10 Left area and the southern portions of the 8 Left and 9 Left panels were removed. Seals were constructed at the entrance to the 8 Left panel and Diagonal Mains where the water was expected to rise and pump stations were established to handle the water once it flooded the 10 Left and western portions of the 9 Left panels. The initial estimate of the volume of water to be pumped from these seals was approximately 2500 gpm. However, actual volume was estimated to be slightly more than 3000 gpm after the area was flooded. The 10 Left area of the mine was abandoned to reduce the cost of maintaining a mined out portion of the mine and improve mine ventilation.

Skyline Mine completed mining the 11 Left, 12 Left A, and 12 Left B panels in December 2003. Seals were built at the head of the 7 Left panel. In January 2004, the 11 Left, 12 Left A, and 12 Left B panel areas were allowed to flood. JC-3 was operated at rates between 2,980 and 5,100 gpm, thus maintaining the water level behind the 8 Left seals at an elevation less than the base of the seals. It was anticipated that after the 11 Left, 12 Left A and 12 Left B panel areas flood and JC-3 operated at approximately 3,000 gpm, the water level in the mine would rise to the of the 6 Left panel by August 2004 and spill over into the 14 Left area. .
A follow-up modeling report prepared by HCI (Appendix K) in June 2004 suggests that water may not flow over into the 6 Left panel once water reaches an elevation of 8290 feet. This

scenario is based on assumption that as the head builds on the groundwater inflow points in the flooded portions of the mine, inflow rates will significantly decrease.

In May, 2004, the 6 Left B panel was completely mined and seals were built to completely seal the mined areas south of the West Mains (panels 1 Left through 6 Left). By the end of 2004, the only areas of Mine #2 that will be ventilated will be the West Mains to allow access to the 14, 15, 16 Left sump. Leaving these mains open will allow access to the area west of sump if additional mining is deemed economically feasible.

Once mining is completed at Skyline and the mine abandoned, the water level in the flooded portions of the mine may reach as high as approximately 8550 feet above sea level. Since the lowest most portal is approximately 8580 feet above sea level, it is not anticipated water will discharge from the mine.

In addition to pumping water from within the mine to Eccles Creek, two ground water wells were drilled and completed in James Canyon in September and October 2001 (Drawings PHC A-1 and PHC A-3). JC-1 was completed with 14-inch casing and screen while JC-2 was completed with 20-inch casing and screen. Both wells were screened in the Star Point Sandstone approximately 70 feet below the current mine workings in the Lower O'Conner B seam. JC-1 encountered a significant fracture and initially produced about 2,200 gallons per minute using a 600 hp down hole electric pump. JC-2 did not encounter significant fractures and produced approximately 320 gpm using a 300 hp down hole electric pump. JC-2 was operated for only a short period of time and has not operated since December 2001.

In October 2002, PacifiCorp installed a new pump into the JC-1 well and it is currently producing approximately 4,200 gpm. This new pump was placed in the well to increase the discharge of ground water to Electric Lake to further decrease the volume of water flowing into the mine workings at 10 Left and to increase water available to downstream water users

including the Huntington Power Plant. Operation of the pump beyond that time will depend on how fast the lake refills during spring runoff and the length of time Skyline Mine plans to be mining in the area.

In March and April of 2003, PacifiCorp began drilling a third well, JC-3, at the James Canyon well site to intercept the mine workings in the 10 Left area. The well was completed in July 2003 and began pumping water on July 27, 2003. The purpose of this well is to remove water from the mine as close as possible to its inflow point in 10 Left and discharge it to Electric Lake. The JC-3 well has a down hole casing diameter of 24-inch and is screened through the mine works. PacifiCorp, with Skyline Mines aid, obtained a UPDES discharge permit to allow discharge of mine water to the lake. The pump is controlled by a variable frequency drive allowing PacfiCorp to produce between 1,500 and 6,200 gpm of mine water. The volume of discharge will be dependant upon meeting water quality standards set by the Utah Division of Water Quality UPDES permit.

Water discharged from JC-1 and JC-3 is piped from the James Canyon well site to Electric Lake through a buried 16-inch HDPE pipe. When initially constructed in September 2001, the end of the 16-inch pipe was submerged approximately 8 feet below the water level of Electric Lake. A 90-degree elbow was attached to the pipe at approximately 45 degrees above horizontal to avoid disturbing sediments on the bottom of the lake. However, continuing drought conditions in 2001 and 2002 resulted in the lake water level dropping below the end of the discharge pipe. A small area of lake sediments were washed away and the water discharged onto large rocks and cobbles on the surface of the pre-lake ground surface, in effect creating its own rip-rapped energy dissipation area. In July 2003, PacifiCorp constructed a riprapped energy dissipater at the outlet of the pipe to prevent further erosion of the lake sediments.

The James Canyon wells are considered to be mine dewatering wells. A UPDES permit, however, is only required for the discharge of JC-3 since this is the only water coming directly from the mine works. JC-1 and JC-2 are completed in the Star Point Formation and do not intercept the mine works.

A geologic cross section through wells/drill holes W2-1, JC-1, JC-2, W79-35-1, 75-26-3, 74-26-2, and 79-22-1 has been provided as Drawing PHC A-4. The location of the mined coal seams, faults, apparent dip of the beds along the cross section, and a site index map are provided. Also, the location of the mine in-flows of ground water have been projected horizontally to the cross sections. The location of selected springs have been illustrated on the cross section. The elevation of Electric Lake and the dates these measurements were taken are illustrated on the wells with ground water levels.

Effects of Intercepted Water within the Mine on the Local Ground Water Systems

Skyline Mine has continued to monitor ground and surface water flows at all of the Mining and Reclamation Plan (M&RP) required water monitoring sites. No discernable impacts to surface springs or surface waters from the increased ground water inflows to the mine has been observed to date. Specifically, quarterly flow monitoring of seeps and springs in the Huntington Creek drainage area indicates the significant inflows of ground water to the mine and pumping of the wells in James Canyon has not had an observable effect on ground water discharges in these areas. Furthermore, historical spring and seep data do not indicate a reduction in spring, seep and stream flows related to mining.

Included in this document in Appendix A are several graphs generated from measurements of springs and stream flows and well water levels located throughout the Skyline Mine permit area. Each graph illustrates the discharge or water levels compared to the Palmer Hydrologic

Drought Index (PHDI) for Region 5, which includes the mine area, from 1982 to May 2002. Data from the following springs, stream, and well monitoring locations have been graphed: springs S15-3, S22-11, S24-12, S26-13, S34-12, S35-8, S36-12, 2-413; stream monitoring point Burnout Creek F-5; and wells W2-1, W20-4-1, W20-4-2, W99-28-1, W99-21-1,W79-14-2A, W79-10-1, W79-35-1A, W79-35-1B, and W79-26-1. Also, a single graph illustrating the water levels in W79-35-1A, W79-35-1B, W2-1 and the PHDI is presented to compare the effects of mine dewatering on the three wells. Graphs of transducer data for wells W79-35-1A, W20-4-1, and W2-1, which are completed in the Starpoint Sandstone beneath the mine, are presented to illustrate in greater detail the recent draw down of the wells. These last three graphs can be found following the graphs containing the PHDI. Accompanying each spring, stream and well graph is a brief comparison of the discharge or water level and the PHDI. Table PHC A-2 contains a summary of the well completion and water level measurement data for the Skyline Mine water monitoring wells.

Spring discharges, as shown in the graphs, aptly illustrate that almost all discharges from the shallow ground water aquifers are controlled by the fluctuations in yearly precipitation or drought cycles as illustrated by the PHDI. A notable exception is spring S24-12. The graph appears to illustrate a significant drop in spring discharge beginning in 1989. However, as presented in the text attached to the graph, the apparent change in discharge is related to a minor shift in the location of the discharge and not in the total volume of water released from the aquifer in the spring area.

Several springs, for which graphs of flow data have been provided, have been undermined since mining began at the Skyline Mine in 1982 (Drawing PHC A-3). As stated above, the fluctuations in spring discharge are easily related to fluctuations in climatic conditions and not mining activity. The relationship between spring discharge and mining activity was studied in great detail as part of an EIS performed by the Manti-La Sal National Forest for the Flat

Table PHC A-2

Canyon Tract located west of the existing mine leases. The study was performed by Norwest in the summer of 2000. The water monitoring data compiled by the mine since mining activities began in 1982 were studied for any effects on surface and shallow ground water discharge. The conclusion of the study was there is very little evidence that undermining or mining within the vicinity of the springs in the Skyline Mine area has resulted in the diminishment of discharges from the springs. A copy of the Norwest study has been provided in Appendix B of this document.

A comparison of the water chemistry of five springs, the JC-1 well, and three in-mine sample locations has been provided in Appendix A. Stiff Diagrams are provided for springs S22-11, S26-13, S34-12, S35-8, 2-413 and the James Canyon well JC-1. Stiff Diagrams are also provided for water samples obtained from the 10 Left Entry 3 Borehole, Fault Crossing at the West Submains (now referred to as the East Submains), and the 9 Left Horizontal Borehole. A notable difference between the spring water and the James Canyon and in-mine waters is the amount of magnesium in the water. Significantly greater amounts of magnesium are found in the mine and well water than in the spring waters.

Notable differences in the chemistry of intercepted ground water in the mine and the waters found in Electric Lake were found by Hydrologic Consultants, Inc. (HCI) of Lakewood, Colorado. HCI was contracted by Skyline Mine in August 2001 to aid in determining the source of the ground water entering the mine and to help the mine determine how long the inflows could be anticipated to continue, HCI initially submitted a brief report to Skyline in November 2001 regarding where they thought the water coming into the mine may be originating. Subsequent to their initial report, more data were gathered concerning water chemistries, monitoring well data, and water age dating information (tritium and carbon 14). A copy of their second report is included as Appendix C. Briefly, the conclusion of their report (page 12) was that chemical and isotopic differences between water entering the mine and Electric Lake suggested strongly that no direct conduit exists between the mine and the lake.

Petersen prepared a report titled "Investigation of Fault-related Groundwaters Inflows at the Skyline Mine, 27 October 2002". This report is included as Appendix G to this document. This report expands upon the data presented and conclusions of the Petersen Report in Appendix A and the HCI report in Appendix C. Petersen evaluated the chemical composition of the in-mine and surface waters. He concluded that water in the 10 Left area is significantly dissimilar to surface waters and surface waters cannot evolve chemically into the 10 Left waters in the hydrogeologic environment of the mine (Petersen, October 2002, Appendix G, Section 6.5, p. 17). Following is excerpt from his report that details the differences between surface and in-mine waters:

> "Likewise, solute and isotopic data indicate the Electric Lake cannot be a major source of the fault-related groundwater that is flowing into the Skyline Mine. Based on the solute compositions of Electric Lake water and water from the fracture system associated with
> the 10 Left inflow, it is readily apparent that the water flowing into the mine is chemically distinct from that in Electric Lake. The recent solute chemical composition of the 10 Left inflow water and Electric Lake water are summarized in Table 5. Most notably, the average chloride content of the water in Electric Lake (6.5 mg/l) is nearly four times greater than the average chloride content in the fault-related systems (1.7 mg/l). Chloride is considered a conservative species, meaning that the constituent is not attenuated from a groundwater system, other than by dilution (Fetter, 1988). In other words, there is no mechanism whereby the chloride in the lake water could be removed were it to flow through a fault system, regardless of the residence time in the fracture. Although the calcium contents of the in-mine and lake water are similar (Table 5), the magnesium and bicarbonate content of the waters are dissimilar. The average bicarbonate content of the fault-related groundwater (216 mg/l) is approximately 50% greater than the average lake content (148 mg/l). The average magnesium content of the fault-related groundwater (23.0 mg/l) is more than three times that of the average lake water (7.5 mg/l). Mineral saturation indices for calcite, dolomite, and gypsum are

listed in Table 5. Saturation indices at 0 ± 0.1 indicate that a water is saturated with respect to that mineral. Waters at saturation with respect to a mineral will not dissolve additional quantities of that mineral or precipitate the mineral should the water come into contact with it. Waters with a saturation index less than 0 are undersaturated with respect to that mineral. Undersaturated waters have a thermodynamic tendency to dissolve that mineral if it comes into contact with the water. Waters with a saturation index above about 0.1 are supersaturated and have a tendency to precipitate that mineral. Electric Lake waters are supersaturated with respect to both calcite and dolomite, indicating that they have the thermodynamic tendency to precipitate rather than dissolve those minerals. Thus, in the absence of an external source of CO_2, such as deep, metamorphic CO_2 or bacterially mediated organic decay (both of which are considered unlikely in the sandstones of the Star Point Sandstone), the lake water cannot dissolve carbonate minerals (likely the only plausible mechanism whereby the groundwater could acquire additional bicarbonate and magnesium) along a groundwater flowpath regardless of the residence time in the fracture system. That external sources of CO_2 have not influenced the carbon history of the fault-related groundwater is apparent in the $d^{13}C$ composition of these groundwaters (Table 2). As discussed previously, groundwaters with $d^{13}C$ compositions near -10‰ are consistent with the dissolution of carbonate minerals in the presence of soil-zone CO_2 gas. Groundwaters that have been influenced by metamorphic CO_2 or by biogenic CO_2 will likely have $d^{13}C$ contents that deviate significantly from -10‰."

Numerous age-dating samples of surface and in-mine waters have been obtained over the past nine years. Samples from springs, surface streams, and mine in-flows have been analyzed for tritium and carbon 14 content. This sampling has been done to monitor the ages of the water intercepted underground so that if surface waters, or "young" waters, were encountered, steps could be taken to determine its source and replace the waters at the surface, if necessary. Carbon 14 dates indicate that water intercepted underground ranges in age from 5,500 years to 25,800 years old. A single roof drip sample obtained in Mine 3 in

1996 was dated at 2,500 years old. Generally, tritium analyses of water intercepted in the mine indicates that none of the water is younger than 50 years old. Surface waters and most of the spring waters have been determined to be modern water based on their tritium content. Samples of water from shallow wells, W24-1 and W17-3, and from spring S17-2 analyzed for carbon 14 and tritium content indicate waters about 2,000 to 3,500 years old are mixed with modern water. The well samples suggest water from more than one aquifer is being produced from the JC-1. A table listing the location and ages of samples collected within the mine and permit area is provided in Appendix A.

Petersen (October 2002) discussed in detail the relationship between the stable isotopic composition and tritium and carbon 14 contents of the surface waters and mine waters. His results show significant evidence that the recharge water to the aquifer draining to the mine is fundamentally different from the overlying surface and shallow ground waters systems based upon their stable isotopic composition. Petersen (October 2002) states:

> "Stable and unstable isotopic data from Electric Lake, active-zone springs, and streams, indicate that these systems are not a primary source of the water in the fault-related Star Point Sandstone groundwater systems encountered in the Skyline Mine. As discussed previously, Active-zone groundwaters and surface waters in the region contain abundant tritium, have modern radiocarbon ages, and contain anthropogenic carbon. In contrast, the fault-related groundwaters have very old radiocarbon ages and contain little or no tritium (Table 2). In order to validate the conclusions that the isotopic compositions of groundwaters encountered in the fault-related Star Point Sandstone groundwater system are statistically different from those in Electric Lake, two tailed T-Tests were performed. The T-tests confirm that the fault-related groundwaters are statistically different from the Electric Lake waters based on each of their stable isotopic d^2H, $d^{18}O$ content and unstable tritium and radiocarbon contents at the 95% confidence level."

Water level data obtained from wells W79-35-1A, W79-35-1B and W2-1 present a fairly distinct picture of the effects the mine inflows and pumping of the James Canyon wells is having on the aquifer beneath the mine and the lack of impact of an aquifer within the Blackhawk Formation above the mine. The graph labeled "Wells W79-35-1 A, B and W2-1" contains water level data for the two W79-35-1 wells beginning in 1982 and water level data for W2-1 beginning in 1999. The PHDI for region 5 is also plotted. Minor fluctuations in the water levels of the two W79-35-1 wells can be seen from 1982 through 1999. The fluctuations do not appear to be related to climatic conditions. Also, both wells appear to have a slight downward trend of the water level elevations. This downward trend is unlikely related to mining since mining did not occur in this area until the mid 1990's. W79-35-1A is completed at a depth of approximately 1000 feet below ground surface into the Starpoint Sandstone, while W79-35-1B is competed to a depth of approximately 220 feet below ground surface. W2-1 is completed to a depth of approximately 1,520 feet below ground surface. In 1999, a sharp decline in the water level in W79-35-1A began, probably related to the mine inflows encountered in 14 and 16 Left panels in Mine 2. In late 2000, a significant drop in the water level in W2-1 began. (This delay in the drop may be related to measuring error. The well is constricted at about 720 feet below ground surface and, until recently, often resulted in false positive readings at that elevation. The cause of the false positive reading is unknown.) The wells appear to be completed in the same fracture zone as the JC-1 well (Drawing PHC A-3). The drop in water level in these wells is undoubtably related to the mine inflow in both the East Submains and 10 Left. The steady decline in both W79-35-1A and W2-1 has continued to this date. However, W79-35-1B did not decline over the same time period as the other wells. The mine related drawdown effects that were observed in W79-35-1A and W2-1 and not in W79-35-1B strongly suggest a disconnect between the deep aquifer and shallow aquifer. In about October 2002, the water level in W79-35-1A appeared to slowly rise by approximately one foot until mid-December 2002. Since that time the water level has dropped about six feet. The slight rise in the water level and subsequent drop appears to be related to the approach and subsequent passing by of the well location of longwall mining activities. Since this well is

located only a few hundred feet east of the 11 Left panel, this type of response to mining and subsidence is not unexpected. The change in water level in the well will continue to be monitored.

As discussed previously, the water encountered in the western- and southern-most portions of Mine 2 generally enters the mine through fractures in the floor. The potentiometric head on the water has been measured at up to 200 psi in horizontal boreholes that have been drilled into fractures and faults from within the mine. As illustrated on Drawing PHC A-4, water levels in wells W2-1 and W79-35-1A were several hundred feet above the mined coal seam prior to 1999. Also illustrated on the cross-section are Electric Lake water level measurements that were obtained within a few weeks of the well data. The level of the water initially in W2-1 was higher than the Electric Lake level but dropped below the lake level after the significant flows were encountered in the 14 and 16 Left panels in the mine. At the same time, the lake water level was higher than the ground water measured in W79-35-1A. Once the fractures in 14, 16, and 10 Left panels were encountered, the water levels in these wells began to drop noticeably and were consistently lower than the lake level.

Figure "W2-1 James Canyon South Ridge Transducer Data" (Appendix A), formerly provided as Figure PHC A-5 in an earlier version of the PHC James Canyon Addendum (November 2001), illustrates 1) there is hydraulic communication between the well and the 10 Left fractures; and 2) the fractures system in the Star Point Sandstone is being dewatered and depressurized as the result of 10 Left discharge and pumping JC-1. As evidenced by the stabilization and flattening of the recovery curve observed while the pump was off mid-November to mid-December 2002, the system is indeed being dewatered and not recharging at a significant rate. Activities related to mining, pump operation, discharge of water from the fracture to the mine have introduced numerous unknown variables to the aquifer system thus precluding more detailed analysis of the drawdown data.

The water levels in these wells represent a potentiometric surface and not a saturated ground water table surface. As discussed in the PHC and extensively in Petersen (October 2002), the Blackhawk Formation forms an effective seal overlying the Starpoint Sandstone, thus creating a confined aquifer. No evidence has been found that water rose to the surface through any of the recently encountered fractures and faults. Indeed, monitoring of the surface seeps, springs, and streams overlying fractures and faults that discharge ground water to the mine indicate reductions in flow are most certainly related to climatic conditions and not mining activities as evidenced by the PHDI.

Drawdown and/or depressurization of the deep aquifer related to mine dewatering can also be observed in wells W20-4-1, W20-4-2, and W 99-21-1. These wells are located west of Electric Lake (Drawing PHC A-3). The graphs of the monitored water levels in these wells show some responses to changes in the operation of the JC-1 well. This suggests that the aquifer underlying the mine is continuous to the west. As discussed in the main body of the PHC, the calculated velocity of water passing through the Starpoint Sandstone is 0.01 foot per day. The rapid response of these wells and wells W2-1 and W79-35-1 to the mine dewatering suggest that the sandstone is fractured and water is moving toward the mine through these fractures.

No significant sustained inflows of water were encountered in Mine 1. However, as illustrated on Drawing PHC A-2, Mine 1 did not develop far enough west to mine through the fracture locations in the14, 16, 10, and 11 Left panels of Mine 2 that produce water.

The results of the age dating work at Skyline Mine suggest waters currently being intercepted in Mine 2 are "old" waters and not recharging directly from the surface. Age-date samples are periodically obtained both underground and from JC-1. Specifically, samples of the water from the 14, 16, 10, and some of the 11 Left panel inflow points have been obtained and analyzed for tritium and carbon 14 content. The results of the sampling and corresponding sampling

times are listed in Table 2 of the Petersen (October 2002) report. The tritium analyses in the 10 Left area and East Submains E1 XC 5 Fault site has not significantly changed since sampling began in these areas. Additional tritium and carbon 14 results for these sites is pending.

Since the initial start-up of the JC-1 well, periodic samples have been obtained of the discharge water and analyzed for tritium content. The results of the analyses are included as Table 2 of Appendix G. The average tritium value measured in the water discharged from the well since September 2001 is 2.00 TU. Initially, the first sample had a tritium concentration of 0.24 TU. Samples obtained between May and September 2002 had tritium concentrations ranging from 0.98 to 1.50 TU. In October 2002, PacifiCorp installed a pump in JC-1 capable of pumping approximately 4,200 gpm of water, approximately 2,100 gpm greater than the last production rate of the pump previously in the well. Initially, the tritium concentrations increased to 2.22 TU. but then declined to 1.71 TU. It appears that since January 7, 2003 the tritium concentration in the JC-1 well water has increased slightly to approximately 2.5 TUs. This suggests that between 6 and 29 percent of the water being pumped from the JC-1 well has a component of water that could be considered younger than 50 years old (The percentages are based on tritium concentrations measured in water samples from area springs and Electric Lake and range between 8.6 and 30 TU. Table 2 of Appendix G). During the same time period in which the tritium values have fluctuated in the JC-1 well water, no significant changes have occurred in the in-mine water ages.

HCI and mine personnel have attempted to determine the geometry of the aquifer that lies beneath the mine. Most of the coal exploration drill holes in the mine area do not penetrate more than a couple hundred feet into the Star Point Sandstone. However, logs from oil and gas exploration drill holes in the general permit area have been obtained and studied. From these drill hole logs, the thickness of the Star Point Sandstone is estimated to be approximately 900 to 1,000 feet thick in the permit area. The sandstone appears to thicken to

the west. The Star Point is not one continuous unit of sandstone but is comprised of interbedded sandstone, siltstone, and shale. While the sandstone fraction dominates the overall formation in the area, many of the sandstone tongues of the formation are separated by thin units of less permeable siltstone and shale. This relationship is illustrated on Plate III of HCI report (Appendix C).

HCI has prepared a ground water model of the aquifer within the Star Point Sandstone related to the discharges affecting Skyline Mine. One purpose of the model is to help the mine define the recharge and discharge locations of the Star Point Sandstone aquifer and determine potential impacts, if any, to surface waters and their beneficial uses. Several assumptions have been made on the volume, porosity, and transmissivity of the aquifer. However, to construct an accurate ground water model, several ground water monitoring points are needed. No additional monitoring wells in the permit area are planned at this time. Thus the model that HCI has produced contains a number of assumed aquifer parameters including the aquifer geometry. The summary report of the HCI model is included with this Addendum as Appendix J.

Currently, Skyline Mine believes the available data suggests the water entering the mine is sourced by the Star Point Sandstone. The water in the Star Point is under potentiometric head and is forced up through faults and fractures encountered during development mining. Water moves slowly out of the sandstone formation into the fractures and faults and then along the fractures and faults toward the mine (Petersen October 2002, pages 11 through 13). Vertical movement above the Star Point Sandstone is limited by the tight, impermeable beds of the Blackhawk Formation. The current mine inflows are depressing the potentiometric surface of the aquifer in the mine area (HCI Figure 6, Appendix C and Petersen Figure 4 Appendix G, HCI Figure 19 Appendix J). The boundaries of the aquifer discharging ground water to the mine from the Star point is illustrated on Plate II of the HCI Ground Water Model (Appendix J).

The boundaries of the Star Point Sandstone aquifer contributing ground water inflows to the mine as depicted by the HCI ground water model are the Gooseberry Fault on the west, Fish Creek Graben on the north, Pleasant Valley and portions of the O'Connor, Connelville, and Valentine Faults on the east, and the structural and topographic divide to the south in the Northern Joe's Valley Graben. The portions of the Gooseberry, Fish Creek, and Pleasant Valley Faults that define the boundary of the aquifer have significant displacement and juxtapose the Star Point Sandstone against the much less permeable Blackhawk Formation, thus forming a no-flow boundary. The segments of the O'Connor, Connelville, and Valentine Faults that form the eastern and southeastern aquifer boundary also have significant displacement and have juxtaposed of the Star Point Sandstone against the Blackhawk. Additionally, the segments of these three faults forming the eastern boundary in the mine area are down to the west in an areas where the regional dip of the stratigraphy is toward the west - southwest. A more detailed discussion of the both the aquifer and model boundaries is presented in Sections 3.2 and 3.3 of the HCI ground water model report included with this document as Appendix J.

The southern boundary of the aquifer is not a fault-related boundary as are those on the west, north, and east. The south and southwestern boundary of the model and aquifer is defined by a surface water divide between Joe's Valley and Paradise Creek Valley. The topography slopes away both to the north and south of the topographic high that forms this divide.

HCI has illustrated in their ground water model report the potentiometric surface of the aquifer has a gradient from south to north. This gradient is based on water level data from wells in place before and while mining occurred in the area. Figure 16 of the HCI report illustrates a projected potentiometric surface rising from south to north. If this is an accurate depiction of the pre-mining potentiometric surface within the Star point Sandstone in the mine area, it is therefore reasonable to assume that the source of the aquifer water is south of the mine and the Electric Lake basin.

Recharge to the Star Point Sandstone appears to be slow as evidenced by the continued draw down of the aquifer and the age of the in-mine water. The drawdown rate of 0.08 feet per day in W79-35-1A was calculated for the time period between April 17, 2002 and July 1, 2002 (6 feet of drawdown over 74 days). However, the drawdown rate has significantly slowed as the 8, 9 , 10, 11, 12A and 12B Left area of the mine has been flooded. In fact, the drawdown in this well has nearly flattened and may begin to rise as the southern and southwestern portion of the mine is allowed to flood.

According to HCI's first model report, the flows to the mine should diminish to approximately 3,700 gpm by 2013, assuming the mine remains in operation and no additional areas of the mine were flooded. Because mining conditions, mine plans, and flooding plans changed at Skyline after HCI first report, a follow-up model report was prepared by HCI in June 2004 (Appendix K). This new report included additional model runs to predict the impact of pumping water from the mine on surface flows in the surrounding drainages and the anticipated inflow rates of groundwater to the mine. The model predictive runs suggest that inflow rates to the mine from the 10, 11, 12A and 12B Left panel areas should diminish significantly as the flooding of the portion of the mine south of the main entries continues. In fact, the HCI model indicated that as the southern portion of the mine flooded and head built on the mine groundwater discharge points, inflow rates could drop to insignificant levels.

Skyline Mine began flooding the southwest portion of the mine when mining of the 6 Left B panel was completed. Water should fill the abandoned portions of the mine below the 8290 feet above sea level elevation. At that point, water will flow north from the head of the 6 Left B panel and into the 14 - 16 Left sump. Skyline intends to maintain the mine water at this elevation for the foreseeable future.

The discharge of water to the mine from the Star Point aquifer will cause the cone of depression already forming in the potentiometric surface to continue to grow. As discussed in

the HCI report, the effect of water removal from the Star Point should have minimal impacts on the down gradient discharge points. However, concerns have been expressed as to what effect the drawdown will have on discharge locations up gradient of the mine at an elevation at or above 8300 feet (the projected approximate elevation of the life-of-mine pool). The Star Point Sandstone is exposed in a small area up gradient of the mine within the boundaries of the aquifer discharging to the mine above the 8300 foot elevation. These exposures are located east of the Connelville Fault near the Electric Lake dam and southeast of the lake and the O'Connor Fault in Huntington Canyon. Small springs with minor flows have been noted discharging from fractured sandstones near the top of the Star point Sandstone and base of the Blackhawk Formation on the northeastern shore of Electric Lake (the fractures in the sandstone extend from top to bottom of the outcrop but the flow discharges from near the top suggesting the water is not related to the deep sandstone aquifer). More substantial flows have been noted from a spring with in the Star Point Sandstone downstream of the Electric Lake dam and adjacent to Highway 31 between Valentine Gulch and Hughes Creek (SE1/4 NE1/4 Sec. 24 T14S R6E). It is labeled as a sulfur spring on local USGS maps. Additionally, flows discharging from Valentine and Hughes canyons may be sourced from the Star Point. The surface flows and the sulfur spring are located above 8300 feet. The flows at these three locations will be monitored to determine if any impacts are occurring as the Star Point aquifer continues to discharge to the mine. Though these locations are east of the apparent aquifer boundary (Valentine Fault), they are the only reliable Star Point discharge locations with sustained flows within a close proximity to the mine and above the 8300 foot elevation. Skyline Mine continues to provide periodic updates to the holders of the water rights in the mine area of the results of the studies the mine is performing to determine the sources and impacts of the mine dewatering on the area ground water resources.

Effects on Surface Waters

Discharge from the Skyline Mine to Eccles Creek has steadily increased since January 1999 as discussed previously. The mine discharged water to Eccles Creek at a rate of approximately 9,500 to 10,500 gpm, with a portion of the water discharged coming from stored water in Mine #3 until August of 2003. After this date, the discharge from the mine to Eccles Creek dropped to about 3,000 gpm when discharge from Mine #3 was suspended and JC-3 went online and began pumping about 5,000 gpm to Electric Lake. Eccles Creek runs at near bank full conditions when the mine discharges at a rate of 9,000 gpm to 15,000 gpm. The channel has a fairly steep gradient, is well armored, often flows directly over bedrock, has few meanders, and has extensive vegetative growth on its banks (EarthFax, Appendix D). Several abandoned beaver dams have been or are in the process of being eroded. However, the rate of erosion is very slow and addition of sediments from the dams and ponds is slight.

Mud Creek has a much lower gradient than Eccles Creek and has increasing numbers of meanders as it approaches the town of Scofield. The channel banks and floors consist of fine grained sediment with minimal vegetative cover. At current discharge rates, the channel is not yet at bank full conditions and not subjected to significant erosion (EarthFax, Appendix D). Increased flow rates from the mine could impact this stream channel more significantly than the Eccles Creek channel if flows from the mine increase. However, Mud Creek has a significantly higher full carrying capacity than does Eccles Creek. EarthFax was contracted by Skyline to prepare and implement a work plan that involved locating several sites on both Mud and Eccles Creek where the stream channel morphology, vegetation, flow volume, and water chemistry would be monitored on a regular basis. The purpose of the monitoring is to determine what, if any, impacts may be occurring as Skyline Mine discharges large volumes of ground water to these creeks. The monitoring of these aspects of the Mud and Eccles Creeks will continue until at least one year after the mine discharge volume drops to or below pre-March 1999 discharge levels of approximately 350 gpm.

Scofield Reservoir was constructed to serve as flood control, storage for irrigation water, and a drinking water source for Price and the surrounding communities. It has a storage capacity of 73,600 acre feet of water. Assuming the mine continues to discharge at an average rate of approximately 10,000 gpm, this would add approximately 44 acre feet per day of water to the reservoir. This represent approximately 0.06% of the maximum daily storage capacity of the lake. Normally, Eccles Creek drainage contributes less than 1 acre foot per day of water during minimum baseline flow conditions.

The concentration of salts in the mine water discharged to Eccles Creek as measured by the Total Dissolved Solids (TDS) concentration was between 400 and 650 mg/l from July 2000 to June 2001. Between June of 2001 and February 2003, the average TDS concentration of the water discharged from the mine was less than 500 mg/l. Between March 2002 and September 2002, the TDS concentration in the mine discharge water was consistently less than 400 mg/l. Since September 2002, the TDS concentration has ranged between 425 mg/l and 625 mg/l. The increase in TDS since September 2002 is related to the discharge of additional stored Mine #3 water. The average concentration of TDS in Eccles Creek above the mine is slightly less than 300 mg/l with seasonal variations of concentrations between 165 and 435 mg/l.Skyline Mine's current UPDES permit allows the mine to discharge water with a concentration less than 500 mg/l without a volume limit. If the concentration of TDS in the discharge water is 500 mg/l or greater, the mine is limited to a maximum concentration of 1,310 mg/l and 7.1 tons per day of TDS.

Total Suspended Solids (TSS) concentrations in the mine water discharged to Eccles Creek have typically been within the limits set by the mine's UPDES permit. Over the past 10 years, infrequent exceedances of the limit have occurred. These occurrences have become rare since 1999 with one exception. In August 2001, a release of coal fines to Eccles Creek was reported by the mine to DWQ and DOGM. No significant environmental damage occurred as a

result of the release because of its short duration and minimal volume. Changes to the mine's water handling system were instigated to prevent future occurrences of this type of release. No increase in nitrogen or phosphorous compounds above background level has been detected in the mine water discharged to Eccles Creek for several years. A brief study on the effects of mine discharge with regard to total phosphorous was performed by EarthFax in December 2001 as part of the Flat Canyon EIS. A copy of the study is included in Appendix D. The results of this preliminary study indicate that it is unlikely that mine water itself will contribute significant concentrations of total phosphorous to Scofield Reservoir. However, since the Scofield Reservoir is a drinking water source for Price, a top cold water fishery in the State, and has been listed as an impaired water body by the EPA, increases in total phosphorous released to the reservoir is of special concern. Several studies have been conducted since the mid 1970's by the Utah Division of Wildlife Resources, Utah Department of Environmental Quality, and the USGS to determine the sources of phosphorous pollution in the lake. Copies of several of these studies are included in Appendix E. Generally, the studies have identified two significant sources of phosphorous pollution - sediments entering the reservoir and runoff from lands carrying animal waste into the lake. A report written 1992 by Harry Lewis Judd of the Utah Division of Water Quality, Utah Department of Environmental Quality titled "Scofield Reservoir Restoration through Phosphorous Control" suggest that as much as 29% of the total phosphorous load in Scofield Reservoir is delivered by Mud Creek. He sites the poor conditions of stream banks in the lower sections of the creek south of the town of Scofield and the recreational and industrial activities that occur in the drainage as the source of much of the sediment that contains the phosphorous that is detrimental to the lake's water quality. The idea that sediments transported to the lake by its tributaries is a significant source of phosphorous is supported by previous studies.

Beginning in 2002, the total phosphorous concentration in the water discharged into Eccles Creek from the mine has been monitored. Orthophosphate concentrations have historically

been monitored in the discharge water along with periodic monitoring for total phosphorous concentrations. A new monitoring plan to evaluate the effects of increased mine discharges on the stream channels of Mud and Eccles Creek was instigated in the summer of 2002. This study includes monitoring several locations on both creeks for changes in stream morphology and water chemistry. Two sites on Eccles and six sites on Mud Creek will be monitored for total flow, TDS, TSS, and total phosphorous. If significant increases in TDS, TSS, and total phosphorous or changes in stream morphology and/or plant communities are noted, the sources will be investigated. If they are related to Skyline Mine activities, remedial actions will be taken. These actions may consist of, but not limited to, armoring stream channel banks, planting of stream bank stabilizing vegetation, or redirection of some flows to the Huntington Creek drainage. Monitoring information is provided in the "Addendum to the Probable Hydrologic Consequences, July 2002, Appendix D and the work plan for monitoring is provided in Attachment 3 of Section 2.12. Future monitoring information will be provided in the Annual Report.

Total and dissolved iron concentrations in the water are typically below 1 mg/l, similar to background water concentrations. Nickel concentrations have reached as high as 40 μg/l. This concentration is well below the UPDES permit levels. However, it has been determined that levels greater than 15 μg/l in the mine discharge inhibits the reproductive capabilities of Ceriodaphnia dubia, an invertebrate used to biologically monitor the quality of water of industrial and municipal discharges. The mine is working with the DWQ to mitigate the effects of discharging nickel at concentrations below established discharge limits. No other elements or compounds of concern have been detected in the increased mine water discharge.

The increased mine discharges have been a benefit to Scofield reservoir. Scofield Reservoir has a capacity of 73,600 acre feet of water storage. Since August 2001, the mine has discharged approximately 36,352 acre feet (11,845,353,160 gallons) of water to the lake (May 1, 2004). The mine water discharge not only helps to alleviate some of the problems related to

the effects of drought within the Price River drainage area but is also helping to maintain the first class cold water fishery in Scofield Reservoir. Low lake levels in past years have resulted in increased water temperatures and deadly algal blooms. The added water discharged from the mine reduces the potential for algal blooms related to low lake levels.

As of October 2002, PacifiCorp has been discharging ground water from the James Canyon JC-1 well directly to Electric Lake (JC-2 has not operated as of October 2001). The rate of discharge from the well is typically between 3,700 and 4,200 gpm. The quality of the water is similar to the water of James, Huntington, Swen's and Little Swen's Creeks, the major tributaries to Electric Lake. TDS concentrations of the well water range between 175 mg/l to 205 mg/l (Appendix A). TDS concentrations in the waters of the tributaries range from 143 mg/l to 274 mg/l (Division EDI, Skyline Mine). Iron, both dissolved and total, concentration in the well water is less than 0.2 mg/l, similar to or less than stream and ground water concentrations in the Electric Lake basin. Nitrogen and phosphorous compounds have not been detected in the well water above background levels. Since the JC-1 well discharges ground water only, it is reasonable to assume that the chemical composition of the water is similar to the waters discharged by the seeps and springs in the area that feed the tributaries of Electric Lake.

The JC-3 well was permitted to discharge water from the mine workings to Electric Lake in July 2003 when PacifiCorp obtained a UPDES permit for the discharge. The pump in JC-3 is capable of producing at least 6,200 gpm. The water chemistry of the groundwater flowing into the 10 Left area of the mine has similar chemistry as the water described above. It is anticipated the chemistry will not significantly change during its short residence time within the mine works prior to being pumped to the surface. However, as the residency time of the water stored within the mine increases, the TDS and total iron concentrations will likely increase as soluble minerals within the coal and surrounding roof and floor rock go into solution. Samples of water were obtained from the 8 Left area, the upper end of the pool that feeds JC-3, before

that portion of the mine was flooded. The TDS concentrations in those water samples was measured determined to be between 300 and 350 mg/l.

PacifiCorp has noted an increase in the TDS concentration of the water discharged from JC-3 over the past several months. The concentration in the water discharged from JC-3 appears to be directly related to the rate at which JC-3 is pumped, that is, the higher the rate, the higher the TDS concentration. In late June 2004, PacifiCorp began operating JC-3 at approximately 1,700 gpm to determine if this lower flow rate would reduce the TDS concentration in the water to less than 255 mg/l. If the lower rate reduces the TDS concentration in the discharge water, this would suggest that the rate at which water is flowing into the mine in the area of the intake to the well in the 10 Left area is somewhere in the neighborhood of 1,700 gpm.

PacifiCorp monitors the discharge from JC-3 for the parameters listed in the UPDES permit. The permit for the JC-3 discharge water has a limit of 255 mg/l TDS and less than 0.5 mg/l iron concentrations in the discharge water. Total phosphorous concentrations in the discharge water are monitored by Canyon Fuel on a quarterly basis. If the water quality of the discharged mine water does not exceed the UPDES quality limits, Electric Lake and Huntington Creek waters will not be degraded. The JC-3 well is anticipated to be operated while drought conditions persist in the area and the mine needs to maintain access to the West Mains. If either conditions changes, modification to the operation schedule of JC-1 and JC-3 may be appropriate. Appropriate regulatory organizations and water users will be notified of the operational changes. The mine anticipates there will be short-lived periods of time where the pumps may be taken off-line for maintenance purposes. Plans have been made underground to handle the increased inflows and discharges should this occur.

When JC-3 became operational and direct discharge from Mine #3 was suspended, the total discharge of mine water to Eccles Creek was reduced by approximately 5,000 to 6,000 gpm. As discussed previously and detailed in Appendix F, over time the overall discharge of mine

water to Eccles Creek will be reduced as portions of the mine are abandoned and allowed to flood. The actual mine inflow and discharge rates will probably vary slightly from the numbers given in Appendix F and Appendix J, but the overall downward trend of the rates is expected to continue.

As discussed previously, water from the James Canyon wells is piped directly to Electric Lake. Initially, when the pipeline was laid, the end of the pipe was beneath the surface of the lake. This allowed water to be discharged without disturbing lake sediments. However, as the lake level dropped throughout the late summer and fall of 2001, the end of the pipe was exposed. This resulted in the slow erosion of the accumulated lake sediments in the immediate area of the pipeline discharge. The erosion of the sediments resulted in the moving of the material a short distance away from the pipeline to the standing lake level where they were redeposited. The pre-lake ground surface has been exposed and it consists of sands, gravels and cobbles. In July 2003, PacifiCorp constructed a riprapped energy dissipater at the outlet of the pipe to prevent further erosion of the lake sediments.

The capacity of Electric Lake is 31,500 acre feet of water. The reservoir was constructed and is operated by PacifiCorp to maintain a reliable source of cooling water to the Huntington Power Plant. Assuming the James Canyon JC-1 and JC-3 wells pump at a combined rate of 9,000 gpm (a current rate of 3,900 gpm from JC-1 and 5,100 gpm from JC-3), a daily average of approximately 40 acre feet of water would enter the lake. During low flow periods, the volume of water entering Electric Lake from all its tributaries is about 4,000 gpm or less. During high flow periods, inflows may be many times this rate, but accurate inflow records have never been kept. The discharge of the wells to Electric Lake represents 0.12% of the total maximum daily storage capacity of the lake. Since low flow periods generally occur when the lake is at or near its lowest annual level, the well water discharge volume should not significantly affect the daily operation of the reservoir. Indeed, in times of drought, the well water is a significant benefit to both the power company and downstream water users.

The recent drought conditions in the Huntington Creek drainage have resulted in historic low water levels in Electric Lake. This has raised concerns of many of the downstream water users, including PacifiCorp and Huntington Cleveland Irrigation Company. These two entities hold the rights to the water stored in the Huntington Creek drainage. Because of the close proximity of the reservoir to the mine, many naturally have assumed water is entering the mine from the lake. However, age dating of the mine waters, a comparison of the water chemistry of the lake and mine waters, and the low permeability of the formations overlying the coal seam suggest that no direct conduit is present between the lake and the mine (Petersen October 2002). The maximum surface acreage of Electric Lake is 485 acres and a maximum depth of water at the dam is approximately 180 feet. Star Point Sandstone crops out downstream of dam and through Huntington Canyon. The Connelville and O'Connor Faults appear to extend to the south west and into Electric Lake. However, the age-dating and water chemistry data obtained from in-mine water samples does not suggest the faults transmit large volumes of water to the subsurface aquifers intercepted in the mine. Petersen (October 2002) states:

> ".... groundwater flow through the Star Point Sandstone occurs primarily through fracture openings and groundwater flow through the matrix of the sandstone occurs only at a very slow rate. Based on these findings, it is apparent that large volumes of leaking Electric Lake water cannot be the source of the large fault-related inflows in the Skyline Mine. If Electric Lake water was flowing through fractures directly to the 10 Left area, it would be anticipated that the "pulse" of lake water would arrive at the mine in a short period of time. This conclusion is reached because the fracture system in the local area between the lake and the mine has only limited storage potential. Thus, it would be necessary for the potential large volumes of lake water to migrate very rapidly through the fracture network to accommodate continued water movement from the lake into the fracture system. This condition can be likened to the movement of cars on the interstate freeway during rush hour. Because the total surface area available for cars is

limited, the only way to move a large number of vehicles over large distances it to move them rapidly. Calculations of the potential storage capacity of the fracture network in the vicinity of the 10 Left inflow and Electric Lake indicate that were a large inflow of lake water to be migrating through the fracture system, that water should have arrived in the mine in a period of several hours to several days (based on the amount of time required to fill the fracture volume). Based on stable isotopic evidence, solute chemical evidence, tritium concentrations, and radiocarbon contents, it is clear that this is not occurring (i.e., there is not a large slug of modern recharge water anywhere in the Skyline Mine). Similarly, if Electric Lake water were migrating through the pore spaces of the Star Point Sandstone, based on the low hydraulic conductivity of the rock (1.3×10^{-6} to 2.3×10^{-6} cm/sec), it is calculated that the time required for this water to reach the mine workings would likely be measured in the hundreds or thousands of years. Clearly, the lake water could not have migrated through the sandstone pore spaces in the short time that has elapsed since the fracture system was first encountered in the mine."

Skyline Mine continues to study the mine water in-flow problem in an effort to more effectively and efficiently mine coal. The results of these studies are shared with the water right holders and will continue to be shared with the Division.

If operation of the JC-1 and JC-3 wells continues to aid in reducing the overall volume of ground water entering the mine, the well may be operated for the life of mine or until the potentiometric surface of the aquifer has dropped below the mined coal seams. The operation of JC-3 is, and will continue to be, predicated upon the well producing water that is in compliance with the limits of the UPDES discharge permit PacifiCorp maintains for the well. It is reasonable to assume that as the potentiometric surface of the ground water is lowered, the efficiency of the pumps will decrease. This will result in lower rates of water pumped from the wells. Since it appears there is not a direct connection between the water being pumped from

the James Canyon wells and surface waters or surface discharges of ground water, continued operation of the wells should not affect the normal discharge rates of these waters. A table illustrating the daily and computed discharge volumes from the James Canyon wells through February 2004 is attached in Appendix A. More recent discharge data is available online at DOGM's web site.

Several reaches of Burnout Creek have been undermined beginning in 1993. Prior to mining, a study of the effects of undermining the creek was jointly funded by Skyline Mine and the Manti - La Sal National Forest. The study included monitoring the flows of the stream at several locations, monitoring changes to the stream morphology, and maintaining numerous photo monitoring points over the length of the creek. The study was essentially completed in 1998 and the results reported in 2002 by R.C. Sidle in Environmental Geology, volume 39. The conclusion of the study was that no significant impacts to the stream could be related to mining. Flows were not diminished in the stream and the morphology was not significantly modified by subsidence. Norwest used this report along with additional monitoring data to reach essentially the same conclusion (Appendix B). They found that climatic conditions greatly influenced flows in the creek and found no evidence of water loss due to mining induced subsidence. The graph illustrating the stream flows, as measured at flume 5 near the mouth of Burnout Canyon, from 1991 to the present and the PHDI for the same time period is included in Appendix A. The graphed flows demonstrate the changes in stream flow are heavily influenced by climatic conditions.

It is important to note that the June 2004 HCI report (Appendix K) does contain the results of predictive model runs performed to determine the impacts, if any, on the Fish, Mud, and Huntington Creek Drainages based on different mine operation scenerios. The predictions are based upon several different assumptions regarding the water elevations in the flooded portions of the mine, the rate of pumping the JC wells, and the contribution of water to the mine from various sources. These are predictive model runs based on several assumptions

concerning how the mine and wells will be operated in the future. As the basis for these model assumptions change (mining conditions and the operation of the JC wells), the actual impacts to surface and groundwater described in the predictive runs will undoubtably be different.

Conclusions

Significant new ground water inflows into the mine have been encountered since March 1999. The inflows have resulted in increases in the discharge volume of mine water to Eccles Creek. Additionally, two ground water wells have been drilled in James Canyon and one is being pumped in an effort to reduce the volume of ground water entering the mine. A third well will be pumping water from the 10 Left area of the mine to Electric Lake beginning in May, 2003. The water from these wells is discharged directly to Electric Lake. Continued monitoring of the surface seeps and springs and surface water flows in the permit area demonstrates that the increases in ground water inflows to the mine has not adversely impacted the volume of discharges of ground water to the surface in and adjacent to the mine area. Specifically, monitoring of selected wells, springs, and surface waters in Burnout and James Canyons has demonstrated there is no discernable affect to the flow of these water sources by the increase in ground water inflows to the mine. Indeed, most of the fluctuations in spring flows can be attributed to changes in climatic conditions. Analysis of the monitoring of the aforementioned waters further demonstrates the isolation of the ground water encountered in the mine from surface waters in the mine area as described in the existing PHC.

Increased discharges of mine water to Eccles Creek has resulted in near bank full channel conditions. Significant erosion has not been noted in the stream channel. However, if the high discharge volumes continue, erosion of the stream channel will occur at a rate faster than would occur without the mine water discharge. Since the stream channel is well armored and vegetated, increased bank erosion should still occur only at a very slow rate. The Mud Creek channel will need to be monitored closely for increased rates of erosion. Mitigation efforts may

be required for both stream channels if significant erosion is observed. Increased discharges to Scofield Reservoir has helped to alleviate the current drought conditions.

The chemistry of the mine water discharged to Eccles Creek is closely monitored. While TDS concentrations have been reduced in the mine water, the total volume of dissolved solids has increased. The mine is currently working with DWQ in an effort to mitigate TDS and nickel concentrations in the mine water discharge. No other significant chemical impacts due to increased mine water flows have been noted.

Discharges of water from the James Canyon wells should not have a significant impact on the quality of Electric Lake. The well water is piped directly to the lake, thereby eliminating concerns of over loading James Creek. The volume of water discharged to the lake from the wells is a small percentage of the total daily volume of the reservoir. The additional inflows should not adversely impact the operation of the reservoir. In fact, the discharge of ground water and the mine water to Electric Lake should be considered a benefit to the water users in the Huntington Creek drainage.

The operation of JC-3 will benefit the mine since it reduces the overall power, maintenance, and personnel costs associated with discharging mine water to Eccles Creek. If JC-3 were not operated, some or all of that volume of mine water would have to be pumped through the mine works and discharged to Eccles Creek, depending upon what portions of the mine are flooded. Operation of the well will reduce the discharge of water to Eccles Creek and increase the flow of water to Electric Lake. In times of drought, operation of JC-1 and JC-3 could significantly reduce the chance of the Huntington Power Plant needing to scale back their operations and could result in additional agricultural water to users downstream in Emery County.

APPENDIX K

HCI
SUPPLEMENTAL REPORT
GROUND-WATER FLOW MODELING
OF
SKYLINE MINE AND SURROUNDING AREA,
CARBON, SANPETE, AND EMERY COUNTIES

June 18, 2004

SUPPLEMENTAL REPORT

GROUND-WATER FLOW MODELING OF SKYLINE MINE AND SURROUNDING AREA, CARBON, SANPETE, AND EMERY COUNTIES, UTAH

Prepared by

Hydrologic Consultants, Inc. of Colorado
an HCItasca Company

for

Manning, Curtis, Bradshaw and Bednar LLC
Salt Lake City, Utah

HCI-1787

June 2004

TABLE OF CONTENTS

Page

LIST OF FIGURES iii

LIST OF TABLES iv

1.0 INTRODUCTION 1

1.1 PURPOSE OF SUPPLEMENTAL REPORT 1
1.2 HYDROLOGY OF SKYLINE MINE AND VICINITY 2

1.2.1 Mine Inflows 2
1.2.2 Hydrogeology 3
1.2.3 Ground Water and Surface Water 3

2.0 2003 SKYLINE GROUND-WATER FLOW MODEL 4

2.1 CONCEPTUAL MODEL 4
2.2 NUMERICAL GROUND-WATER FLOW MODEL 5

2.2.1 Simulation of Pumping Well 6
2.2.2 Summary of Findings of the 2003 Model 6

3.0 2004 SIMULATIONS USING EXISTING GROUND-WATER FLOW MODEL 8

3.1 VERIFICATION TO CURRENT DATA 9
3.2 PREDICTIVE SCENARIOS 10

3.2.1 Scenario I: Maintenance of Pool at 8,290 ft 10
3.2.2 Scenario II: Maintain Pumping Rate of JC-3 through 2013 11

3.3 SIMULATED IMPACT TO STREAMS DUE TO MINING 11

Scenario I 11
Scenario II 12

4.0 REFERENCES 13

FIGURES

TABLES

LIST OF FIGURES

1. Base Map of Hydrogeologic Investigation
2. Simulated Locations of Faults, Major Inflows, and flooding sequence in Model
3. Pumping from James Canyon Wells
4. Water Levels in Deep and Shallow Wells as of January 2004
5. Geology Simulated in Uppermost Layer (Blackhawk Fm.) of Numerical Model
6. Geology Simulated in Layer 6 (LOB) of Numerical Model
7. Geology Simulated in Layer 8 (Storrs Sandstone) of Numerical Model
8. Geology Simulated in Layer 10 (Panther Sandstone)of Numerical Model
9. Geology Simulated in Layer 12 (Starpoint Fm.) of Numerical Model
10. East-West Cross-Section of Ground-Water Model
11. Northwest-Southeast Cross-Section of Ground-Water Model
12. Northeast-Southwest Cross-Section of Ground-Water Model
13. Comparison of Modeled to Measured Pre-Mining Water Levels in Monitoring Wells
14. Comparison of Modeled to Measured Inflow Rates to Skyline Mine
15. Comparison of Modeled to Measured Water Level Changes in Monitoring Wells: Verification through January 2004
16. Simulated Total Ground-Water Inflow to Mine Through 2013, Scenario I: JC-3 shut down
17. Simulated Total Ground-Water Inflow to Mine Through 2013, Scenario II: Continued Pumping from JC-3
18. Predicted Impact to Major Streams in Model Domain

LIST OF TABLES

1. Simulated Ground-Water Budgets for Pre-Mining, Current Mining, and End of Mining Conditions without Flooding of Mine

2. Simulated Ground-Water Budgets for Pre-Mining, Current Mining, and End of Mining Conditions with Flooding of Mine to 8,290 ft and shut-down of JC-3

3. Simulated Ground-Water Budgets for Pre-Mining, Current Mining, and End of Mining Conditions with Flooding of Mine to 8,130 ft

1.0 INTRODUCTION

This report supplements an earlier report submitted by Hydrologic Consultants, Inc of Colorado (HCI) entitled *Findings of ground-water flow modeling of Skyline Mine and surrounding area, Carbon, Sanpete, and Emery Counties, Utah* (HCI, 2003). The earlier report describes the findings of a three-dimensional ground-water flow model (the 2003 Model) that was developed to evaluate the relationship between ground water and surface water in the vicinity of the Skyline Mine. The current report was written with the assumption that the reader has ready access to HCI (2003).

Skyline Mine, operated by Canyon Fuel Company (CFC), is a longwall coal mine located in the northern Wasatch Plateau of central Utah. The mine began operations in the early 1980s. Large, persistent ground-water inflows have been encountered in the Skyline Mine beginning in March 1999. The total inflow rate to the mine from 8 major inflows reached a maximum of more than 10,000 gpm in April 2002, but had declined to less than 8,000 gpm at the time of the April 2003 modeling, and to less than 6,600 gpm as of April 2004. The operators of Electric Lake, which is located on surface west of the mine workings, have questioned whether water flowing into the Skyline Mine is coming from the reservoir. Together with water chemistry, temperature, and inflow-decay data, results of the 2003 Model suggest that the vast majority of water flowing into Skyline Mine workings comes from a deep ground-water source.

1.1 PURPOSE OF SUPPLEMENTAL REPORT

Although the primary purpose of the 2003 Model was to investigate the origins of ground-water inflows into the Skyline Mine, the model was also used to make preliminary predictions of impacts to surface waters. Those predictions were incorporated into Skyline Mine's PHC submittal for the Winter Quarters development. The Utah Division of Oil, Gas, and Mining (DOGM) reviewed the 2003 Model report, and in late April 2004 requested a number of clarifications, verifications, and additional predictive simulations. The current report is intended to clarify some aspects of conceptualization and construction of the model, and verify the

calibration of the 2003 Model using more recent data. However, as will be shown below, significantly changed mining conditions (since calibration of the 2003 Model) require that the model be modified somewhat in order to make requested predictive simulations.

1.2 HYDROLOGY OF SKYLINE MINE AND VICINITY

1.2.1 Mine Inflows

Throughout the development of Levels 1 and 3 of the Skyline Mine (see Figure 1), mining encountered small, short-lived ground-water inflows, typical of underground coal mines in the western U.S. Beginning in 1999, mining on Level 2 encountered a number of large, persistent ground-water inflows related to a set of north- to northeast-trending normal faults of relatively small displacement. Initial discharges at individual locations might have been as large as 6,500 gpm, although discharges of about 1,000 gpm were more typical. The total mine inflow, which reached a peak of about 10,500 gpm in March 2002, decreased to about 7,500 gpm by March 2003, and to about 6,600 gpm by April 2004 (See Figure 6 in HCI, 2003). Figure 2 shows the locations of the major inflows within the Level 2 mine workings.

Mitigation efforts have had only a minor effect on decreasing the inflow rates in the mine. As described in HCI (2002), pumping well JC-1 was completed into the Storrs sandstone beneath the 10-Left inflow in October 2001. Pumping well JC-3 was completed into the flooded mine workings in July 2003. Figure 3 shows the pumping rates of both wells.

Mining has since been completed in most of Level 2, and beginning in October 2002, ground water was allowed to flood portions of the 8-Left and 9-Left longwall panels up to seals placed at an elevation of 8,110 ft NGVD. The mine again is allowing the pool level to rise, and the higher water levels are effecting the mine hydrology.

1.2.2 Hydrogeology

The hydrostratigraphy of the study area is described in detail in HCI (2003). Rock units are dominated by approximately 1,500 ft of Starpoint Formation sandstones and siltstones overlain by an equivalent thickness of shales and siltstones of the Blackhawk Formation. The Skyline Mine extracts coals at the boundary between these two major units.

Faults with large vertical displacement (the Pleasant Valley, Gooseberry, Fish Creek Graben, and Valentine Faults, and portions of the O'Connor Fault) impede horizontal ground-water flow, whereas numerous north/south-trending structures of small displacement, including portions of the Connelville Fault, locally transmit water.

1.2.3 Ground Water and Surface Water

Ground-water levels in monitoring wells indicate that there are two continuous, but poorly connected ground-water systems in the vicinity of the Skyline Mine: a relatively shallow ground-water system in the Blackhawk Formation, and a deep aquifer system comprised of the Starpoint Sandstones and coals at the boundary between the Starpoint and Blackhawk Formations. Inflows to the mine and ground-water pumping since 1999 have resulted in drawdown of as much as 400 ft over a broad area in the deep aquifer, but they have not affected ground-water levels in the shallow ground-water system (Figure 4).

Pre-mining water-level data indicate that the potentiometric surface of the deep aquifer in the area of the mine had a regional gradient from south-southwest to north-northeast in the range of 0.03 to 0.009 ft/ft (Figure 5 in HCI, 2003). Most of the recharge to the deep aquifer probably occurs in the high country to the south of Huntington and Cleveland Reservoirs. Ground-water discharge is believed to occur in the vicinity of Scofield Reservoir, although direct evidence of the discharge has not been observed.

2.0 2003 SKYLINE GROUND-WATER FLOW MODEL

The stated goals of the 2003 Model investigation were to develop a hydrogeologically-based numerical ground-water flow model that could:

1) describe the ground-water system in the vicinity of the Skyline Mine,

2) evaluate significantly different explanations of the source of ground water flowing into the mine.

3) be used as a management tool for both the ground-water and surface-water resources of the region, and

2.1 CONCEPTUAL MODEL

HCI (2003) describes in detail the essential components of the conceptual model on which the 2003 numerical ground-water flow model was based. The conceptual model includes eleven geologic units, shown in the hydrostratigraphic column in Figure 8 of HCI (2003). The Mancos shale is implied as the basement to the ground-water flow system with a very low hydraulic conductivity.

The conceptual model incorporates recharge to the ground-water system, including shallow-circulating ground water, which re-emerges in the surface-water system, and a much smaller component of deeply circulating ground water; perennial streams and reservoirs and their interaction with the regional ground-water system; ground-water pumping (including mine inflows); and mining and its hydrologically-significant consequences. Hydraulic conductivities of the hydrostratigraphic units and interior faults are shown in Tables 4 and 5 in HCI (2003).

The boundaries of the Skyline model (2003 Model) were selected to coincide with natural hydrologic boundaries, in order to limit the amount of ground-water and surface-water flow that naturally enter and exit the hydrologic study area (HSA). The eastern, western, and northern boundaries are defined by faults of major offset (Figure 5). The southwestern model boundary is defined by a surface-water divide, and the southeastern model boundary follows the channel of

Left Fork where Mancos shale (with very low hydraulic conductivity) is exposed in the creek bed. All of these boundaries are assumed to be no-flow boundaries (i.e., there is no lateral inflow or outflow across them).

2.2 NUMERICAL GROUND-WATER FLOW MODEL

The 2003 Model utilizes the numerical code *MINEDW*, which solves three-dimensional ground-water flow problems with an unconfined, or phreatic, surface using the finite element method (HCI, 1993). The model domain encompasses approximately 140 mi^2, and the finite-element grid contains 32,172 nodes and 58,188 elements within 13 layers.

The finite-element grid was discretized to incorporate the key hydrogeologic features of the HSA including the sandstone outcrops near the eastern boundary of the model, the location and orientation of the faults, and various surface-water bodies. Representation of the geology and active faults in key layers of the model such as Overburden, LOB coal seem, Storrs, Panther, and Starpoint Formations are shown in Figures 5 through 9, as requested by DOGM (2004). The 13 model layers are shown in cross section in Figures 10 through 12. No changes to the grid were required for the supplemental modeling described in this report.

HCI (2003) describes in detail the methods used to simulate model boundaries, hydrologic features (surface water, hydrostratigraphy, transmissive faults, recharge), and mine excavation, and stresses (major mine inflows, pumping).

DOGM (2004) requested two other specific clarifications of the 2003 model. Figure 13 shows the comparison between modeled and measured pre-mining water levels in monitoring wells, color-coded according to the formation in which the monitoring well is screened. The second requested clarification is of the method used to simulate pumping well JC-1. That method is described below.

2.2.1 Simulation of Pumping Well

Pumping from well JC-1 is simulated explicitly in the model by a pumping node located on the Diagonal Fault in the Panther Sandstone layer. It should be noted that JC-1 was actually completed into the Storrs Sandstone within or immediately adjacent to the Diagonal Fault. In the model, the very large hydraulic conductivity in the fault zone puts the Storrs and Panther sandstones in direct hydraulic connection. Therefore, the pumping node has been assigned to the lower Panther Sandstone interval.

During predictive runs, when the calculated water level reaches an elevation of 15 ft above the top of the Panther within the simulated well, the pumping node is converted to a drain node with specified head elevation. The drain node, using a large leakance factor, fixes the water level in the well at the specified elevation, thus simulating a variable pumping rate dependent on changes in the water level within the formation. This is done in order to prevent simulation of over-pumping by the well at low water levels. (Some versions of *MODFLOW* will automatically guard against this by reducing the pumping rate proportionally to residual transmissivity of the saturated zone.)

2.2.2 Summary of Findings of the 2003 Model

Results of simulations using the 2003 Model indicate that all of the water that has flowed into the Skyline Mine can be accounted for by depletion of storage in the deep Starpoint aquifer system. No shallow ground-water or surface-water source is necessary to account for the inflows. Efforts to "force" surface water from Electric Lake into the mine with the model, described in HCI (2003), require unreasonably high values of hydraulic conductivity for the Diagonal Fault beneath the lake.

The 2003 Model estimates that mine inflows and pumping as of April 2003 resulted in decreased flow in Upper Huntington/Electric Lake, Fish, and Mud Creeks by about 0.2, 0.1, and

0.3 cfs, respectively (Table 1). The total reduction in the rate of ground-water discharge to Scofield Reservoir was estimated to be about 0.4 cfs, or 200 gpm.

The 2003 Model was also used to make very limited predictive simulations. The predictive simulations suggest that by 2014, the impact on Scofield Reservoir would increase to about 2.2 cfs (1,000 gpm). The 2003 Model also predicts that the inflow rate to the Skyline mine from all sources will decrease by 2014 to approximately 3,700 gpm as a result of diminished hydraulic heads in the deep aquifer system. However, the 2003 Model did not incorporate current and future mine flooding conditions in the predictive simulations. Scenarios described in HCI (2003) yield significantly different results when the mine flooding is included, as will be seen below.

3.0 2004 SIMULATIONS USING EXISTING GROUND-WATER FLOW MODEL

The 2004 simulations required no changes to the 2003 Model grid or to the hydrogeology, streams, faults, recharge, or wells. However, major changes were required in the simulation of the major mine inflows and the mine excavations, in order to simulate the effects of mine flooding.

Beginning in October 2002, ground water was allowed to flood portions of the 8-Left and 9-Left longwall panels up to seals placed at an elevation of 8,110 ft NGVD. The pool level was maintained at 8,110 ft until 7 January 2004, when pumps were shut off and the water level was allowed to rise. The pool level reached an elevation of 8,130 ft in the 8-Left, 9-Left, 11-Left and 12-Left panels (Figure 2) in about mid April, 2004. According to mine plans, the pool level will rise to an elevation of 8,290 ft before pumps are again used to maintain the level.

Preliminary simulations in 2004 showed that impacts to surface waters in predictive simulations are sensitive to current and future mine inflow rates, and these rates are highly dependent on the pressures at the individual inflow points induced by the pool of standing water. Consequently, all drain nodes representing mine workings and major inflows were modified to account for the flooding. The inflow rate of a drain node is calculated as:

$$Q = C_L \left(H_C - H_S\right) \tag{1}$$

where

Q = ground-water discharge to node (cfs),
H_S = specified elevation of node equal to pool level for the flooded portion of the mine and floor elevation for the nodes above pool level (ft),
H_C = model-calculated formation water level (ft), and
C_L = leakance factor for node (ft^2/s).

Changes in the pool level were simulated using the following schedule:

Date	Pool Level, ft
November 2002	8,100
April 2004	8,130
August 2004	8,230
September 2004	8,250
January 2005	8,290

Figure 2 shows the locations of the pool levels in time, and is based on the elevation of the LOB coal seem. It should be noted that simulated flooding in the 11-Left and 12-Left mining area begins in April 2004 when the pool level reaches an elevation of 8,130 ft, though in reality flooding began sometime before that date. The specified head (H_s) for each drain node within the flooded portion of the mine was changed from the original underground elevation to the elevations of the different pool levels, at the respective times described above. Leakance factors, which had been derived from calibration to measured inflows in the 2003 Model, were left unchanged. Comparisons between simulated and measured inflows and water levels are shown in Figures 14 and 15.

3.1 VERIFICATION TO CURRENT DATA

DOGM (2004) requested verification of the 2003 Model results using data collected after the model calibration in April 2003. Available data includes additional water levels in 5 monitoring wells, through mid January 2004, and two additional estimates of total ground-water inflow to the mines. The recent monitoring-well hydrographs (see, for instance, 79-35-1a and 99-4-1, in Figure 4) show perturbations in 2003 and 2004 that HCI attributes to rising pool levels, including independently-rising pools in 9 Left and 11 Left.

Verification of the model to current data was completed by extending the simulations of mine inflows and water levels from May 2003 to April 2004 while incorporating the flooding condition since November 2002 in 10-Left area, and comparing to measured data. Figure 14 shows a comparison of the modeled and measured individual inflows; Figure 15 shows a

comparison of water levels in monitoring wells; and Figures 16-17 show the modeled and measured (estimated) total mine inflow.

3.2 PREDICTIVE SCENARIOS

DOGM (2004) also requested predictions of the impacts to surface water bodies other than the two reservoirs, and a prediction of the recovery time of the reservoir after mining activity ends. Because of uncertain mining and mine-dewatering plans, however, it was necessary to model two different scenarios in order to make these predictions. Scenario I assumes that the mine flooding schedule will proceed as described above, with the final pool elevation maintained at 8,290 ft until the year 2014. As described below, however, results of Scenario I suggest that the high pool elevation would decrease ground-water inflow rates so that the current pumping rate of JC-3 (3,100 gpm) could not be sustained. Consequently, Scenario II assumes that instead of maintaining the high pool elevation, the pumping rate of JC-3 would be maintained at about 3,100 gpm, and the pool allowed to reach its own level (8,130 ft according to the model results). In Scenario II, as in Scenario I, JC-1 continues to pump at a rate of 4,000 gpm through 2013. All pumps are shut down at the end of 2013, and the pool is allowed to rise to its static level.

3.2.1 Scenario I: Maintenance of Pool at 8,290 ft

Figure 16 shows the total mine inflow and inflows from major water hits predicted if the underground pool elevation is maintained at 8,290 ft; the simulated ground-water budget at end of mining is shown in Table 2. The model predicts that the increased pressure on the mine inflows (the decreased differential between formation head and pressure at inflow point) would reduce the flow rates to the extent that pumping-well JC-3 would have to be shut down in order for the pool to reach 8,290 ft.

3.2.2 Scenario II: Maintainence of JC-3 Pumping Rate through 2013

Figure 17 shows the predicted total mine inflow and inflow from major water hits if the pool level is not maintained, but JC-3 continues to pump at about 3,100 gpm. The simulated ground-water budget at end of mining is shown in Table 3. The model predicts that by maintaining the pool level at an elevation of approximately 8,130 ft through the end of year 2013, the resultant inflow volume will be sufficient to allow JC-3 to be pumped at a rate of about 4,000 gpm in 2005, reducing to about 2,000 gpm by 2013.

3.3 SIMULATED IMPACT TO STREAMS DUE TO MINING

The impact to streams was simulated as the difference between ground-water discharge to the streams under pre-mining conditions and ground-water discharge during mining (or post-mining) conditions. As shown below, the maximum value of the impact will depend on the elevation at which the underground pool will be maintained. Figure 18 shows predicted impacts to Fish Creek, Mud Creek, and Huntington Creek (total, including the Electric Lake and Left Fork). Separate impacts to Huntington Creek (above and below Electric Lake), Electric Lake, and Left Fork can be seen in Tables 1-3.

Scenario I

In the first scenario, with the pool elevation maintained at 8,290 ft, and inflow rates greatly reduced after 2005, the impacts to Fish Creek, Mud Creek, and Huntington Creek will reach maximum values of 0.3 cfs, 1.5 cfs, and 1.4 cfs, respectively. The maxima will occur at 3 to 10 years after mine dewatering is completed (Figure 18). Recovery of the hydrologic system will take a very long period of time because of the very low vertical hydraulic conductivity of overburden and interburden layers (K_v=0.0001 ft/day). The model predicts that the impacts to the Creeks after about 50 years of recovery will be 0.15 cfs, 0.4 cfs, and 0.7 cfs, respectively.

Scenario II

The second scenario, with the pool elevation "maintained" at 8,130 ft, results in predicted maximum values of 0.4 cfs, 1.8 cfs, and 1.7 cfs for Fish Creek, Mud Creek, and Huntington Creek, respectively. The maximum values will occur at from 4 to 11 years after the end of mine dewatering (Figure 18). Again recovery will take a very long period of time because of the very low vertical hydraulic conductivity of the overburden and interburden layers. The model predicts that impacts to Fish Creek, Mud Creek, and Huntington Creek after about 50 years of recovery will be 0.15 cfs, 0.4 cfs, and 0.7 cfs, respectively.

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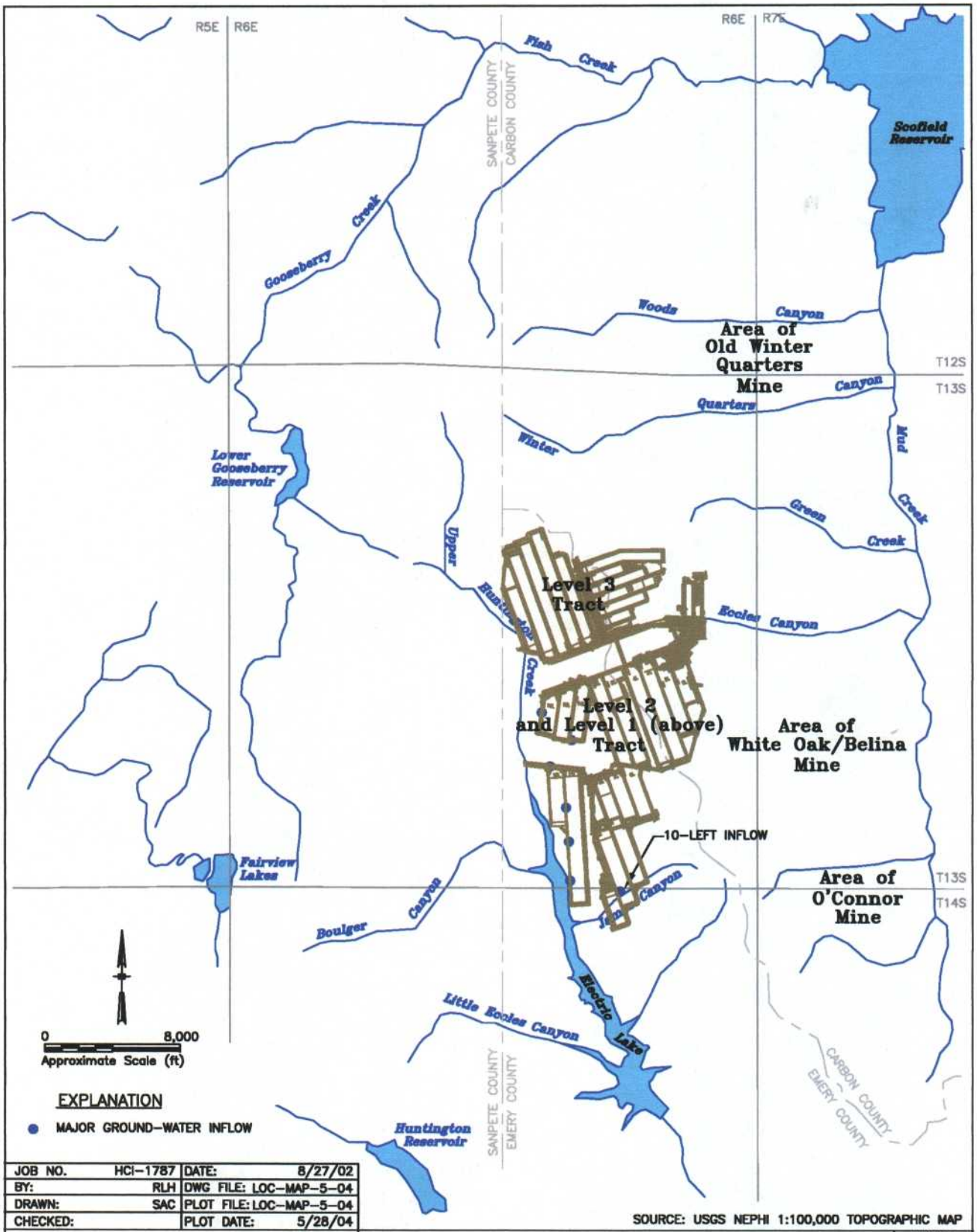

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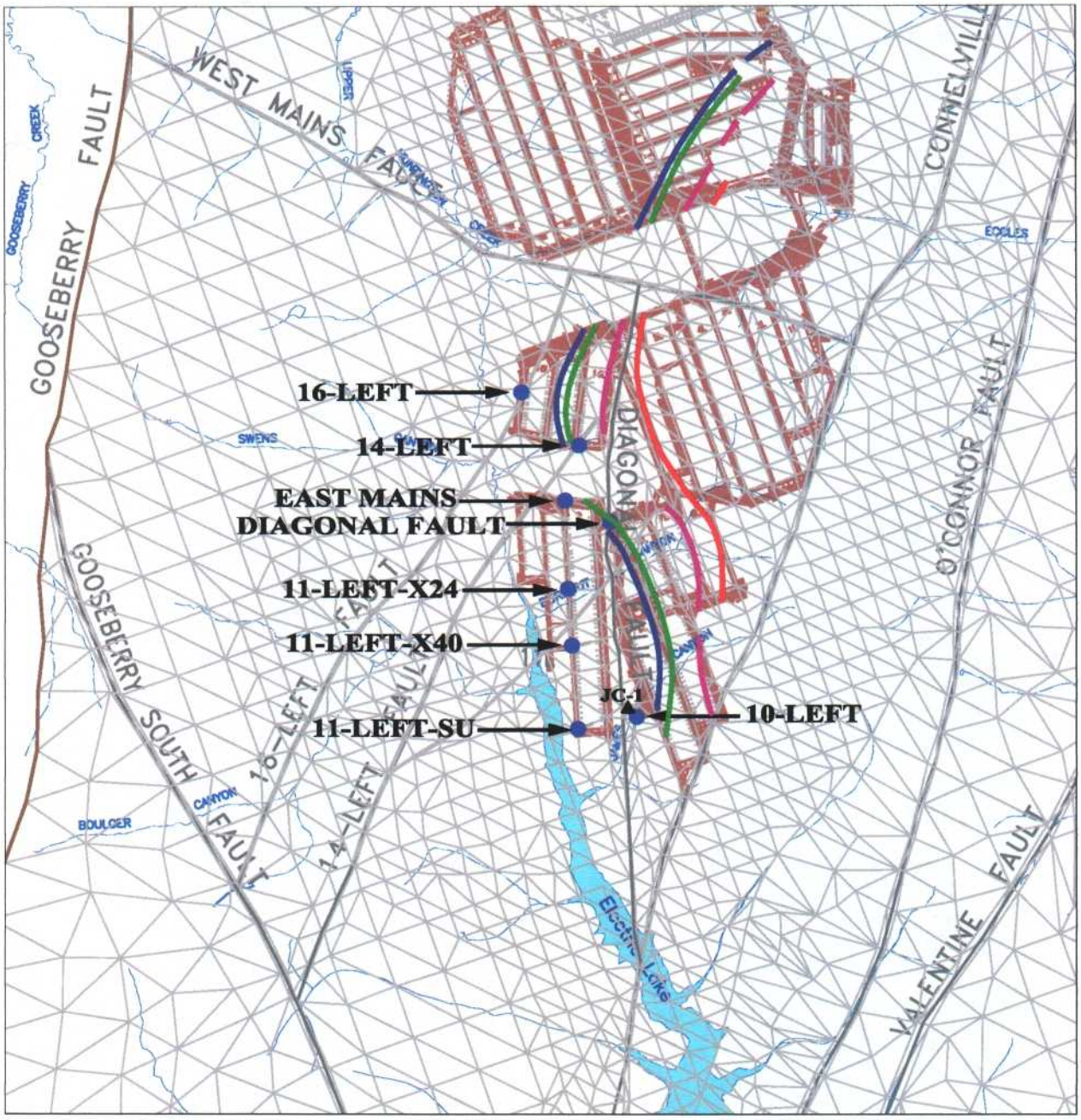
DRAWN:	SAC	PLOT FILE:	LOC-MAP-5-04
CHECKED:		PLOT DATE:	5/28/04

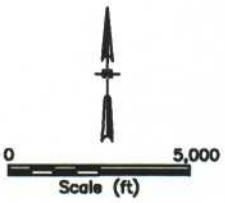
SOURCE: USGS NEPHI 1:100,000 TOPOGRAPHIC MAP

HCI HYDROLOGIC CONSULTANTS, INC. HC TASCA company

Base Map of Hydrogeologic Investigation

FIGURE 1





EXPLANATION

POOL LEVEL (ft)

- 8110 (NOV. 2002)
- 8130 (APR. 2004)
- 8230 (AUG. 2004)
- 8290 (JAN. 2005)

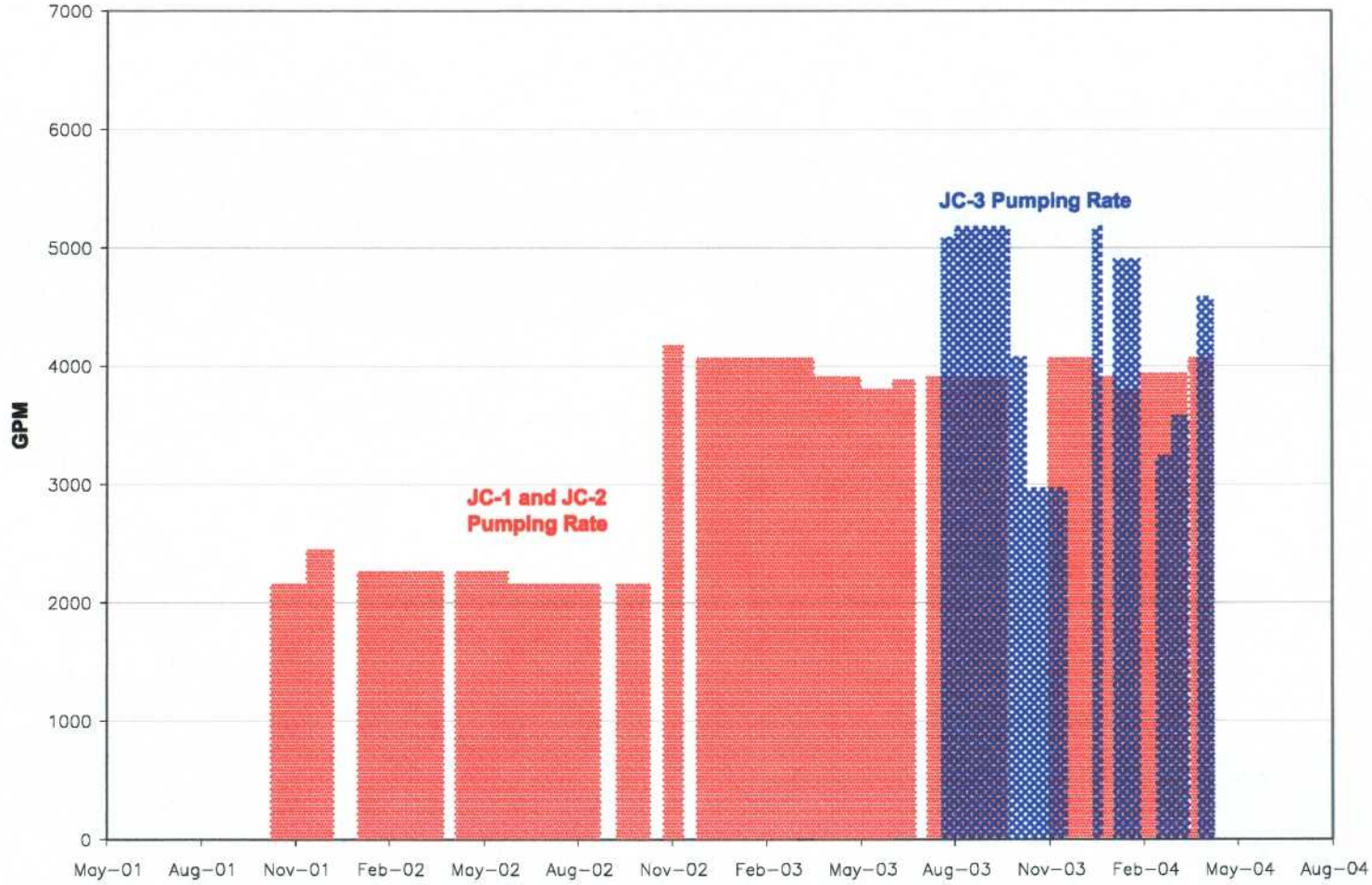
- MAJOR GROUND-WATER INFLOW
- FAULT SIMULATED IN MODEL
- MODEL BOUNDARY
- JC-1 PUMPING WELL

JOB NO.	HCI-1787	DATE:	9/26/03
BY:	VIU	DWG FILE:	POOL-LEVELS
DRAWN:	SAC	PLOT FILE:	POOL-LEVELS
CHECKED:		PLOT DATE:	5/28/04

HCI HYDROLOGIC CONSULTANTS, INC. HC TASCA company

Simulated Locations of Faults, Major Inflows, and Flooding Sequence in Model

FIGURE 2



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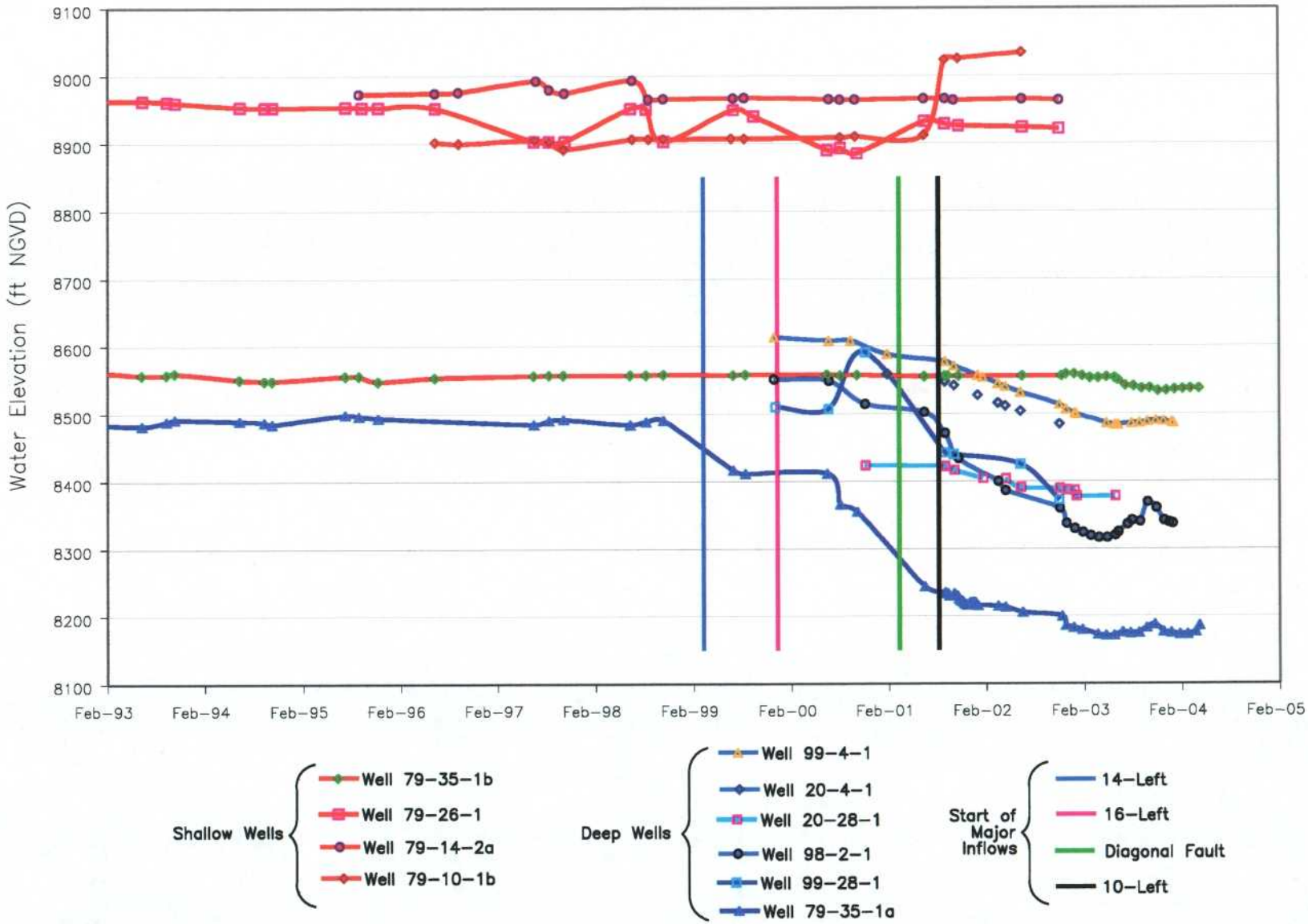
JOB NO.	HCI-1787	DATE:	5/28/04
BY:	RLH	DWG FILE:	GWI-JAN2004
DRAWN:	SAC	PLOT FILE:	GWI-JAN2004
CHECKED:		PLOT DATE:	5/28/04

Pumping from James Canyon Wells

FIGURE 3



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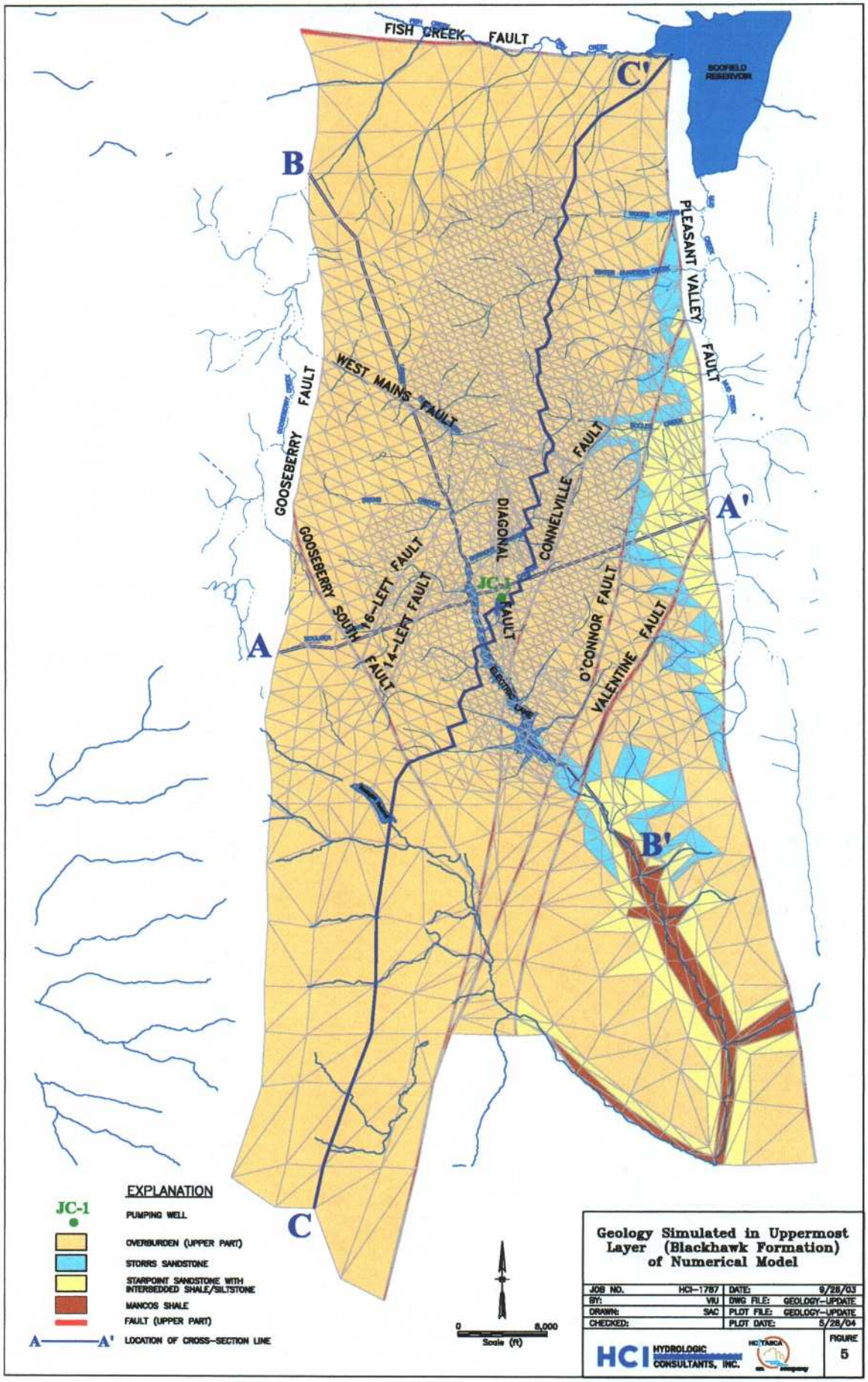
JOB NO.	HCI-1787	DATE:	5/28/04
BY:	VIU	DWG FILE:	WATER-LEVELS
DRAWN:	SAC	PLOT FILE:	WATER-LEVELS
CHECKED:		PLOT DATE:	5/28/04

Water Levels in Deep and Shallow Wells as of January 2004

FIGURE 4



Geology Simulated in Uppermost Layer (Blackhawk Formation) of Numerical Model

JOB NO.	HCI-1787	DATE:	9/26/03
BY:	VIU	DWG FILE:	GEOLOGY-UPDATE
DRAWN:	SAC	PLOT FILE:	GEOLOGY-UPDATE
CHECKED:		PLOT DATE:	5/26/04

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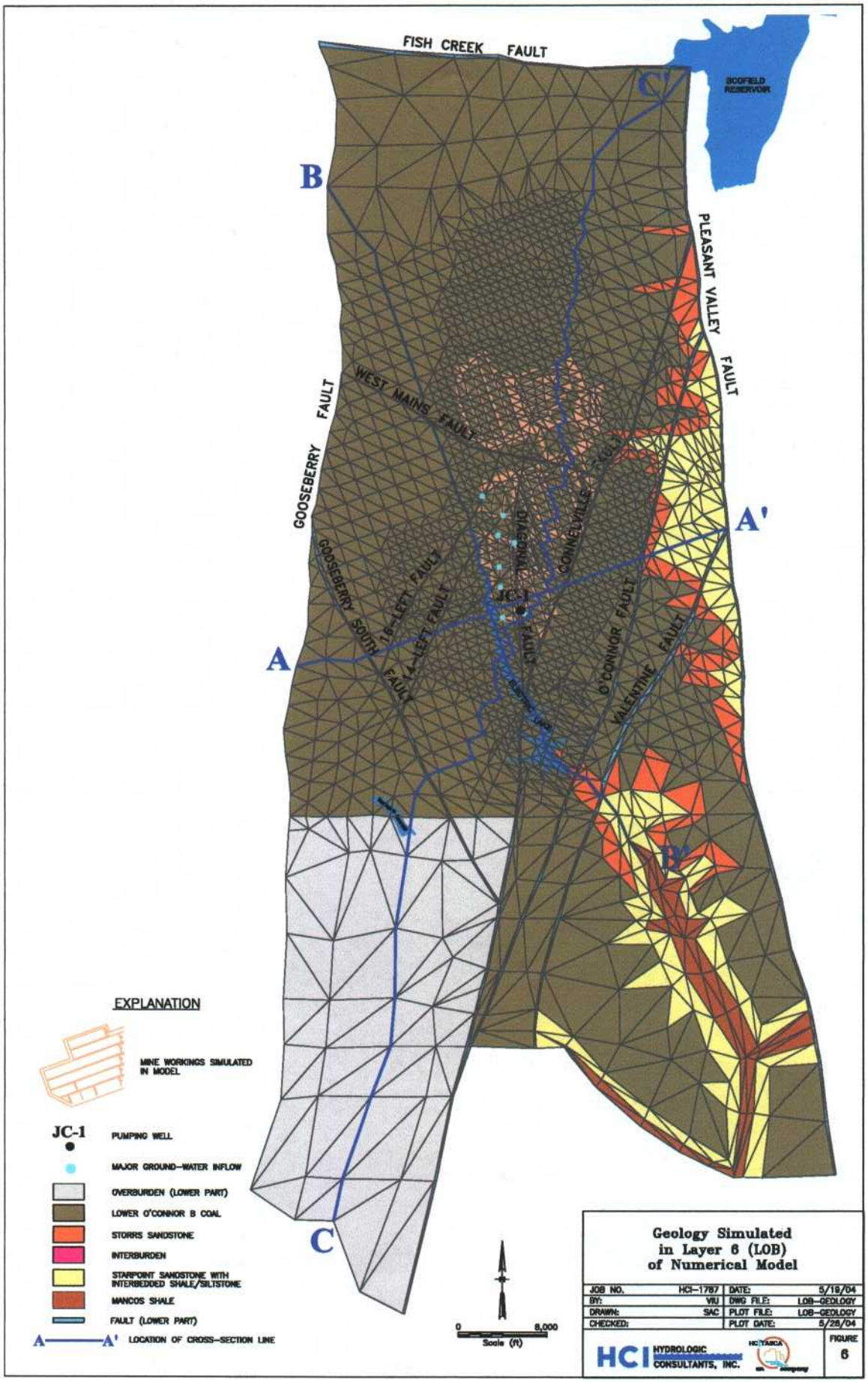
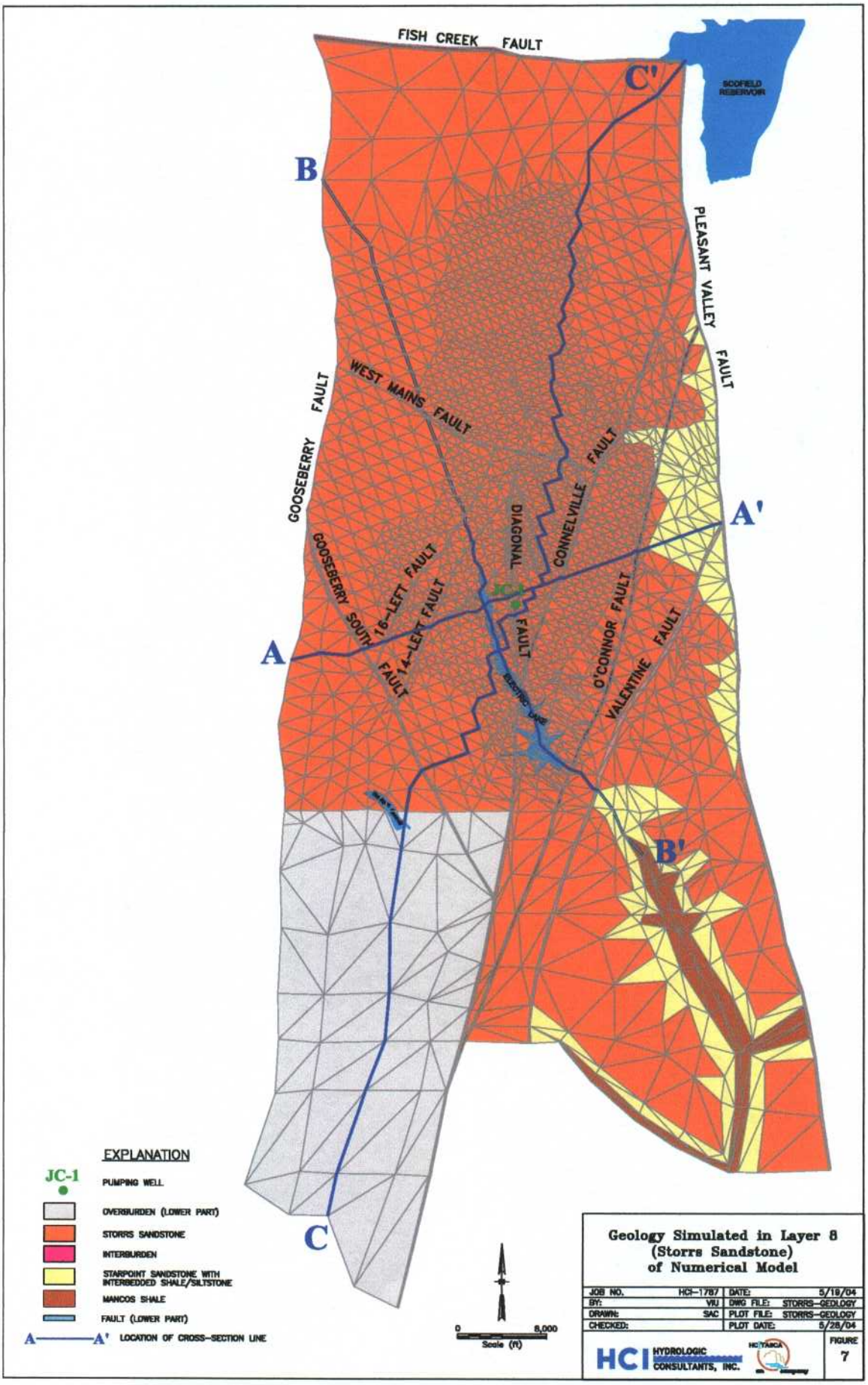
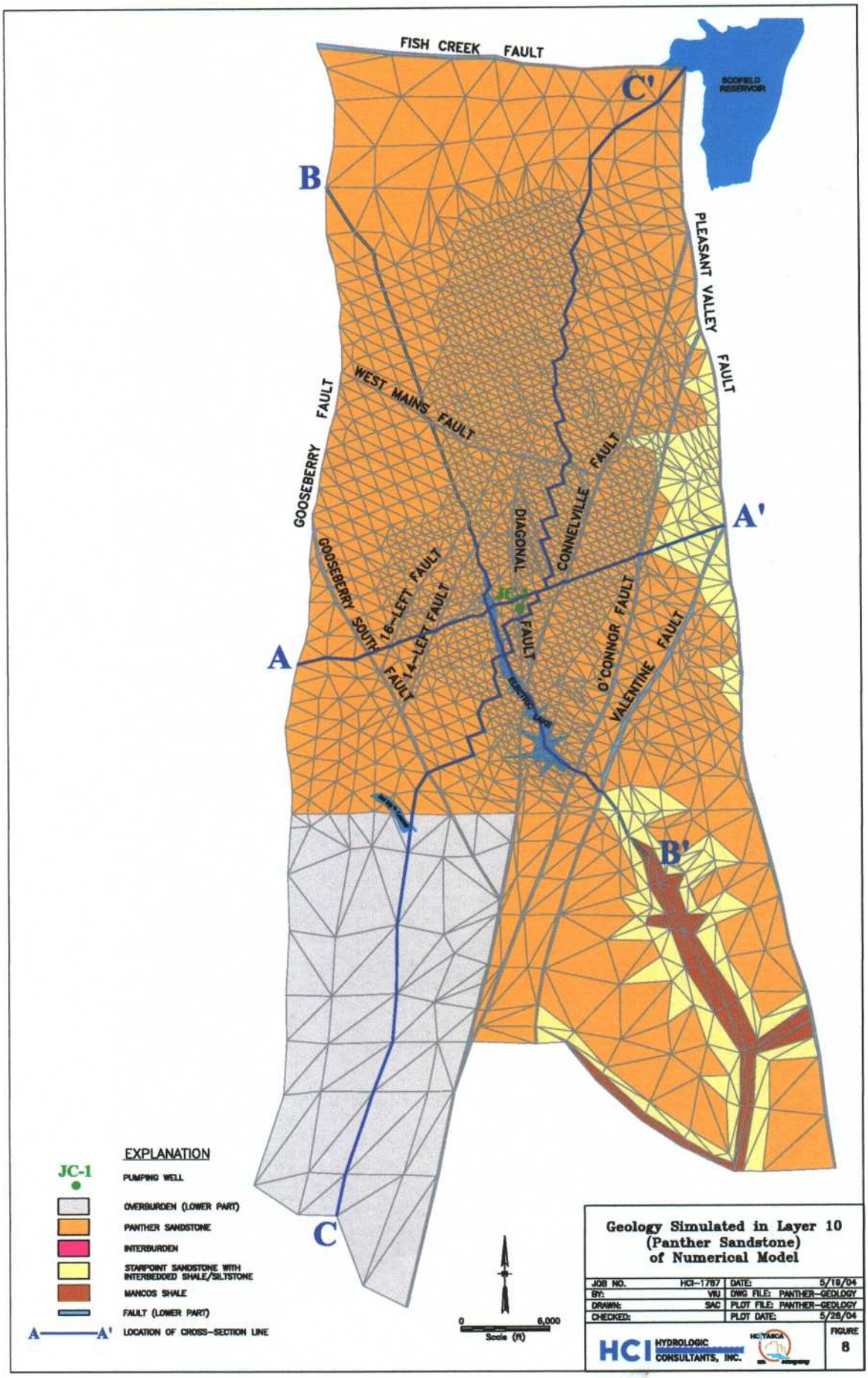
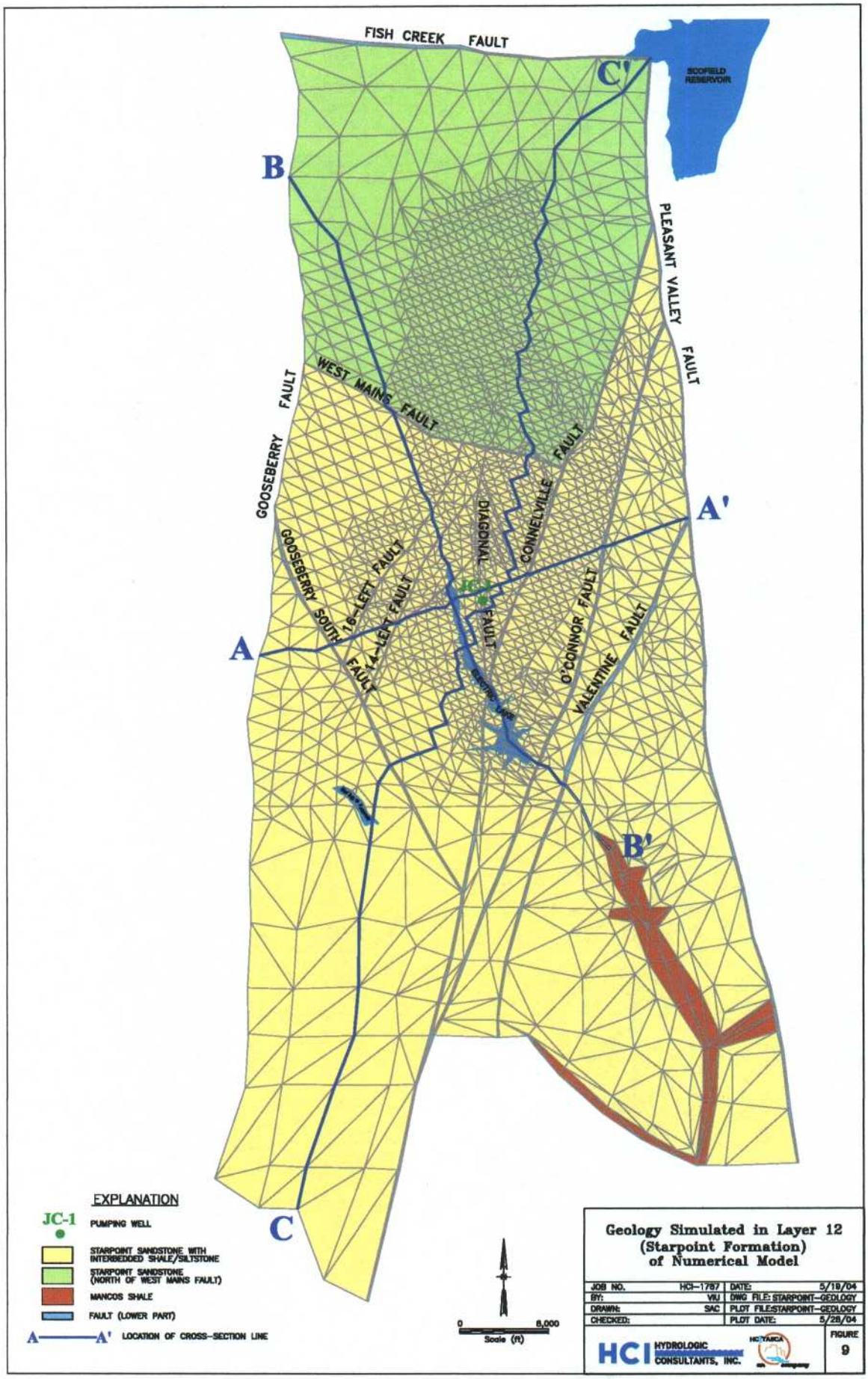
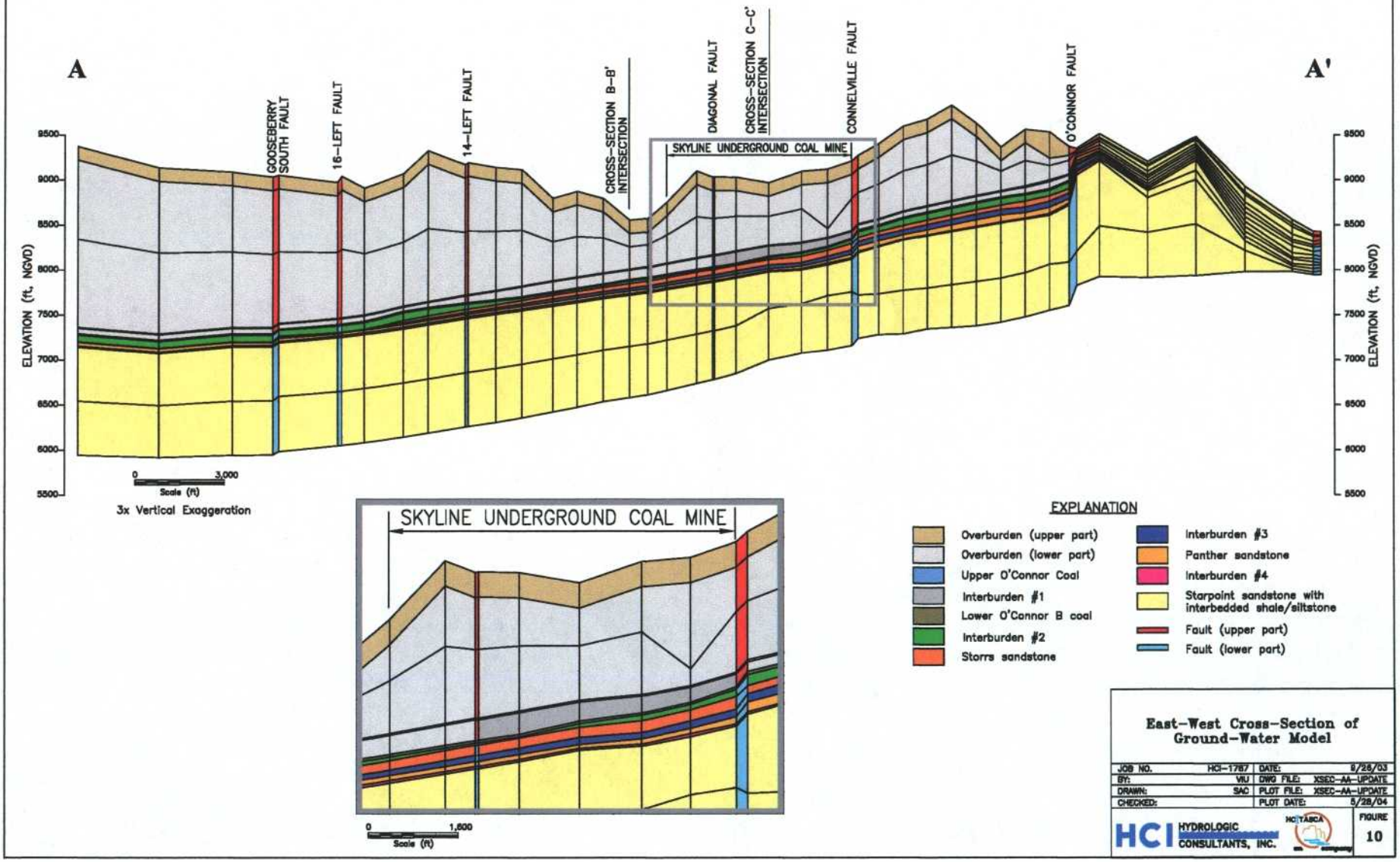
FIGURE 5


FISH CREEK FAULT
SCOFIELD RESERVOIR
B
C'
PLEASANT VALLEY FAULT
WEST MAINS FAULT
GOOSEBERRY FAULT
CONNELVILLE FAULT
DIAGONAL FAULT
A'
JC-1
GOOSEBERRY SOUTH FAULT
15-LEFT FAULT
14-LEFT FAULT
FAULT
O'CONNOR FAULT
VALENTINE FAULT
A
B'
C
EXPLANATION
MINE WORKINGS SIMULATED IN MODEL
JC-1
PUMPING WELL
MAJOR GROUND-WATER INFLOW
OVERBURDEN (LOWER PART)
LOWER O'CONNOR B COAL
STORRS SANDSTONE
INTERBURDEN
STARPOINT SANDSTONE WITH INTERBEDDED SHALE/SILTSTONE
MANCOS SHALE
FAULT (LOWER PART)
A——A' LOCATION OF CROSS-SECTION LINE
0
8,000
Scale (ft)
Geology Simulated in Layer 6 (LOB) of Numerical Model
JOB NO. HCI-1787
DATE: 5/19/04
BY: VIU
DWG FILE: LOB-GEOLOGY
DRAWN: SAC
PLOT FILE: LOB-GEOLOGY
CHECKED:
PLOT DATE: 5/26/04
HCI HYDROLOGIC CONSULTANTS, INC.
FIGURE 6


FISH CREEK FAULT
SCOFIELD RESERVOIR
C'
B
PLEASANT VALLEY FAULT
WEST MAINS FAULT
GOOSEBERRY FAULT
CONNELVILLE FAULT
DIAGONAL FAULT
A'
GOOSEBERRY SOUTH FAULT
16-LEFT FAULT
14-LEFT FAULT
JC-1
A
O'CONNOR FAULT
VALENTINE FAULT
B'
C
EXPLANATION
JC-1 PUMPING WELL
OVERBURDEN (LOWER PART)
STORRS SANDSTONE
INTERBURDEN
STARPOINT SANDSTONE WITH INTERBEDDED SHALE/SILTSTONE
MANCOS SHALE
FAULT (LOWER PART)
A——A' LOCATION OF CROSS-SECTION LINE
0 8,000
Scale (ft)
Geology Simulated in Layer 8 (Storrs Sandstone) of Numerical Model
JOB NO. HCI-1787 DATE: 5/19/04
BY: VIJ DWG FILE: STORRS-GEOLOGY
DRAWN: SAC PLOT FILE: STORRS-GEOLOGY
CHECKED: PLOT DATE: 5/28/04
HCI HYDROLOGIC CONSULTANTS, INC.
FIGURE 7


FISH CREEK FAULT
SCOFIELD RESERVOIR
C'
B
PLEASANT VALLEY FAULT
WEST MAINS FAULT
GOOSEBERRY FAULT
CONNELVILLE FAULT
DIAGONAL FAULT
A'
GOOSEBERRY SOUTH FAULT
1.6-LEFT FAULT
1.4-LEFT FAULT
JC-1
O'CONNOR FAULT
VALENTINE FAULT
A
B'
C
EXPLANATION
JC-1 PUMPING WELL
OVERBURDEN (LOWER PART)
PANTHER SANDSTONE
INTERBURDEN
STAIRPOINT SANDSTONE WITH INTERBEDDED SHALE/SILTSTONE
MANCOS SHALE
FAULT (LOWER PART)
A—A' LOCATION OF CROSS-SECTION LINE
0 6,000
Scale (ft)
Geology Simulated in Layer 10 (Panther Sandstone) of Numerical Model
JOB NO. HCI-1787 DATE: 5/19/04
BY: VMJ DWG FILE: PANTHER-GEOLOGY
DRAWN: SAC PLOT FILE: PANTHER-GEOLOGY
CHECKED: PLOT DATE: 5/28/04
HCI HYDROLOGIC CONSULTANTS, INC.
FIGURE 8


FISH CREEK FAULT
SCOFIELD RESERVOIR
C'
B
PLEASANT VALLEY FAULT
WEST MAINS FAULT
GOOSEBERRY FAULT
CONNELVILLE FAULT
DIAGONAL FAULT
A'
GOOSEBERRY SOUTH FAULT
16-LEFT FAULT
14-LEFT FAULT
JC-1
A
O'CONNOR FAULT
VALENTINE FAULT
B'
C
EXPLANATION
JC-1 PUMPING WELL
STARPOINT SANDSTONE WITH INTERBEDDED SHALE/SILTSTONE
STARPOINT SANDSTONE (NORTH OF WEST MAINS FAULT)
MANCOS SHALE
FAULT (LOWER PART)
A——A' LOCATION OF CROSS-SECTION LINE
0 8,000
Scale (ft)
Geology Simulated in Layer 12 (Starpoint Formation) of Numerical Model
JOB NO. HCI-1787
DATE: 5/19/04
BY: VIJ
DWG FILE: STARPOINT-GEOLOGY
DRAWN: SAC
PLOT FILE: STARPOINT-GEOLOGY
CHECKED:
PLOT DATE: 5/28/04
HCI HYDROLOGIC CONSULTANTS, INC.
FIGURE 9



East-West Cross-Section of Ground-Water Model

JOB NO.	HCI-1767	DATE:	9/26/03
BY:	VRJ	DWG FILE:	XSEC-AA-UPDATE
DRAWN:	SAC	PLOT FILE:	XSEC-AA-UPDATE
CHECKED:		PLOT DATE:	5/28/04

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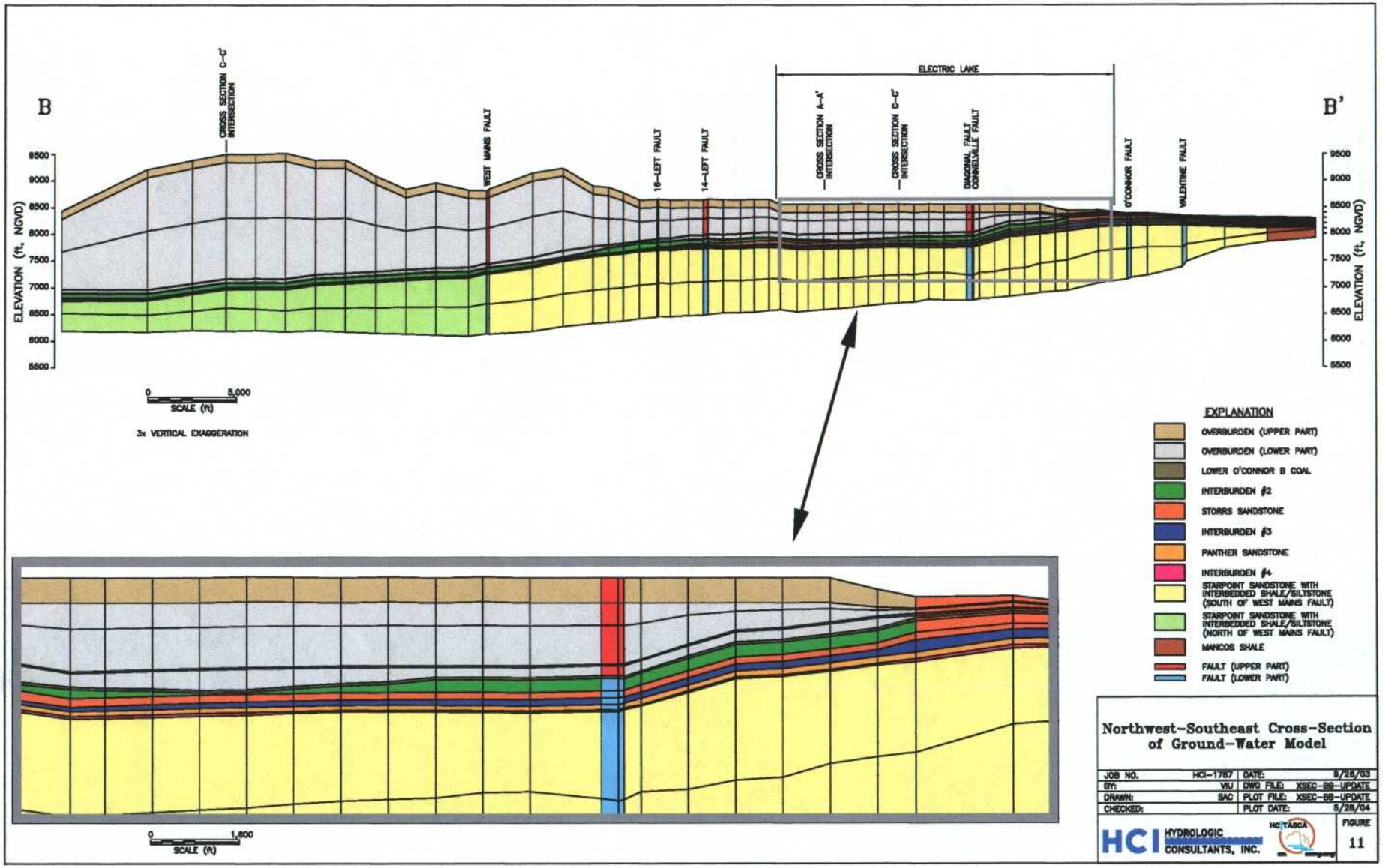
FIGURE 10



Northwest–Southeast Cross–Section of Ground–Water Model

JOB NO.	HCI–1787	DATE:	9/26/03
BY:	VIU	DWG FILE:	XSEC–99–UPDATE
DRAWN:	SAC	PLOT FILE:	XSEC–99–UPDATE
CHECKED:		PLOT DATE:	5/28/04

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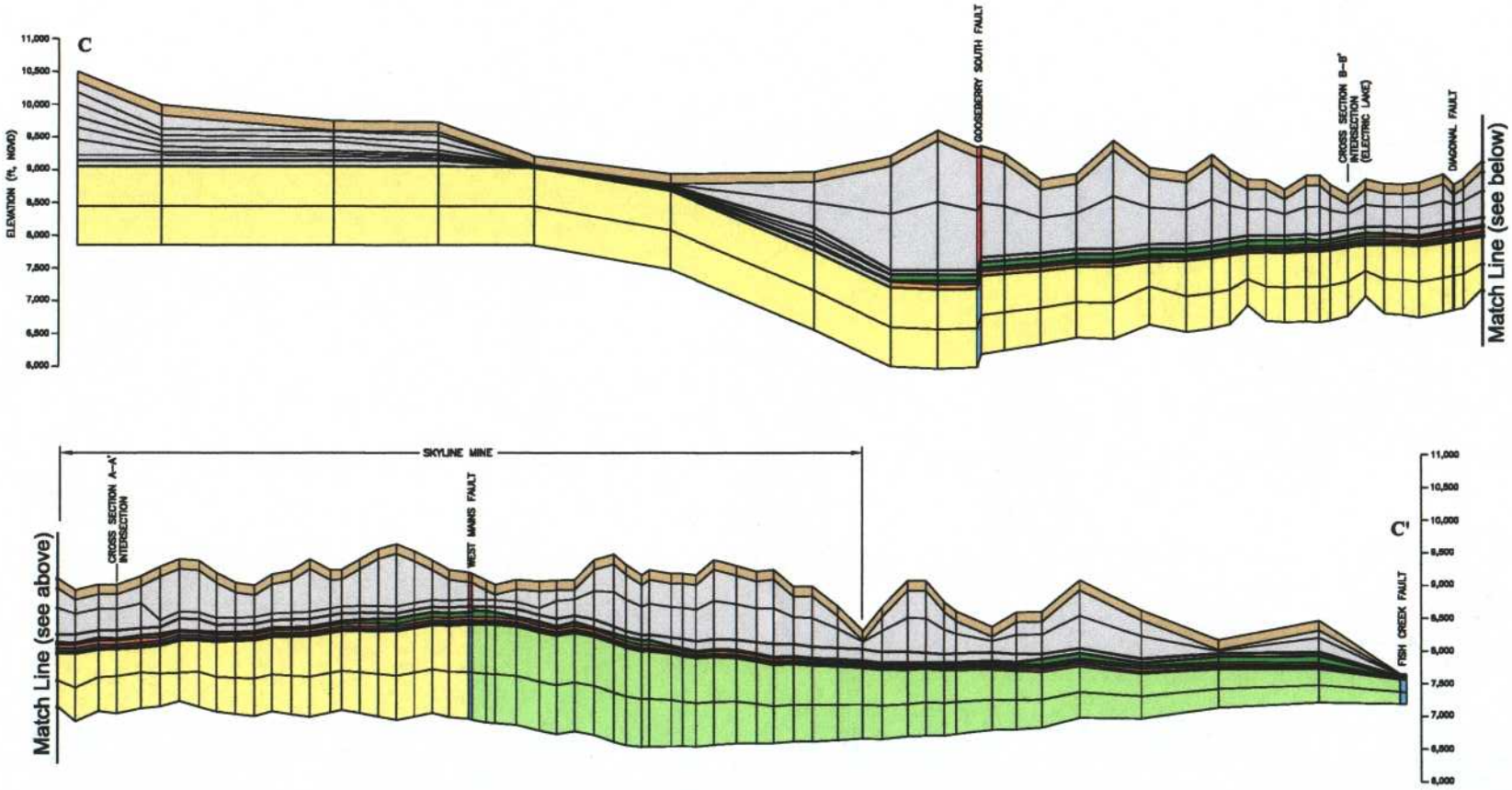
FIGURE 11



0 5,000
SCALE (ft)
3x VERTICAL EXAGGERATION

EXPLANATION

- OVERBURDEN (UPPER PART)
- OVERBURDEN (LOWER PART)
- INTERBURDEN #1
- LOWER O'CONNOR B COAL
- INTERBURDEN #2
- STORRS SANDSTONE
- INTERBURDEN #3
- PANTHER SANDSTONE
- INTERBURDEN #4
- STARPOINT SANDSTONE WITH INTERBEDDED SHALE/SILTSTONE
- STARPOINT SANDSTONE WITH INTERBEDDED SHALE/SILTSTONE (NORTH OF WEST MAINS FAULT)
- FAULT (UPPER PART)
- FAULT (LOWER PART)

Southwest-Northeast Cross Section of Ground-Water Model

JOB NO.	HCI-1767	DATE:	5/18/04
BY:	VIU	DWG FILE:	XSEC-CC
DRAWN:	SAC	PLOT FILE:	XSEC-CC
CHECKED:		PLOT DATE:	5/28/04

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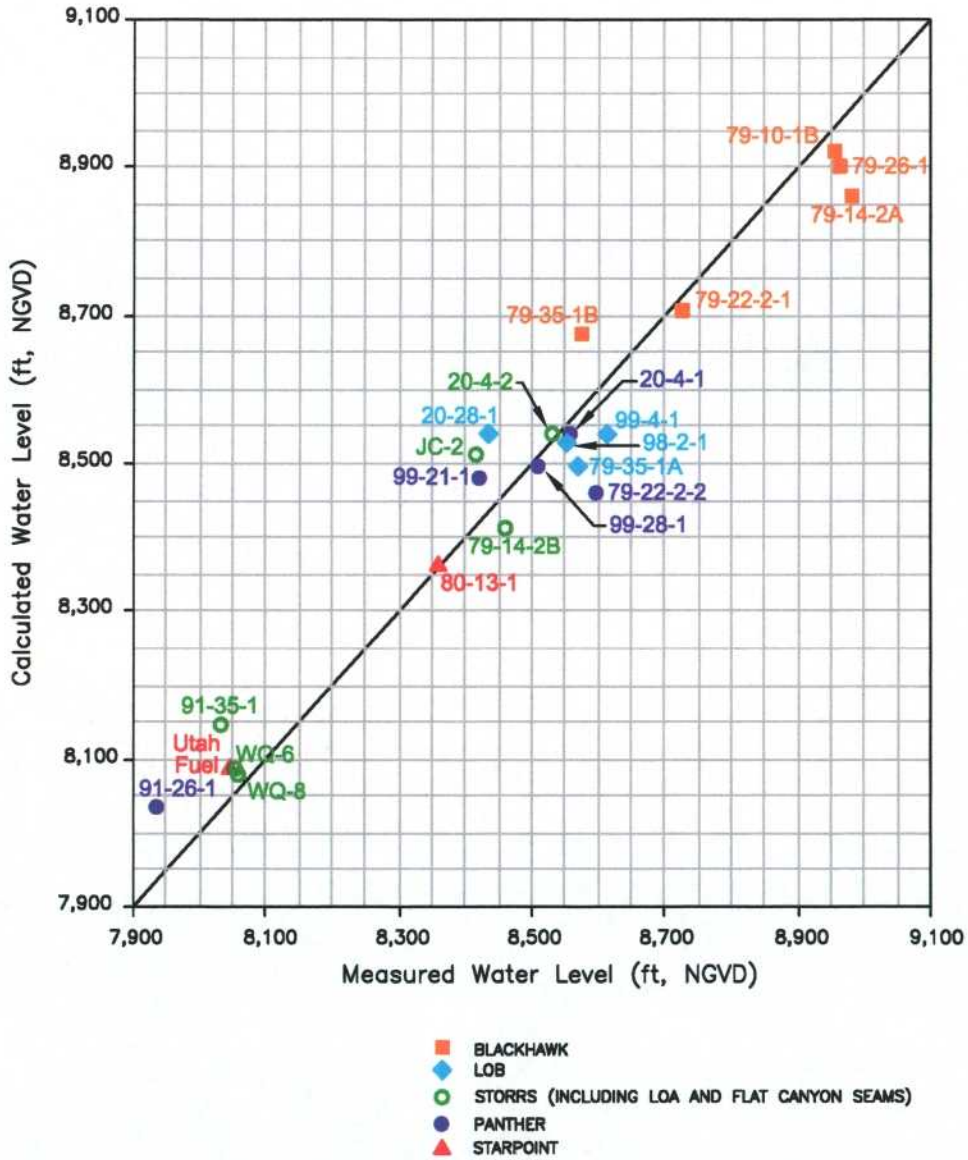
FIGURE 12



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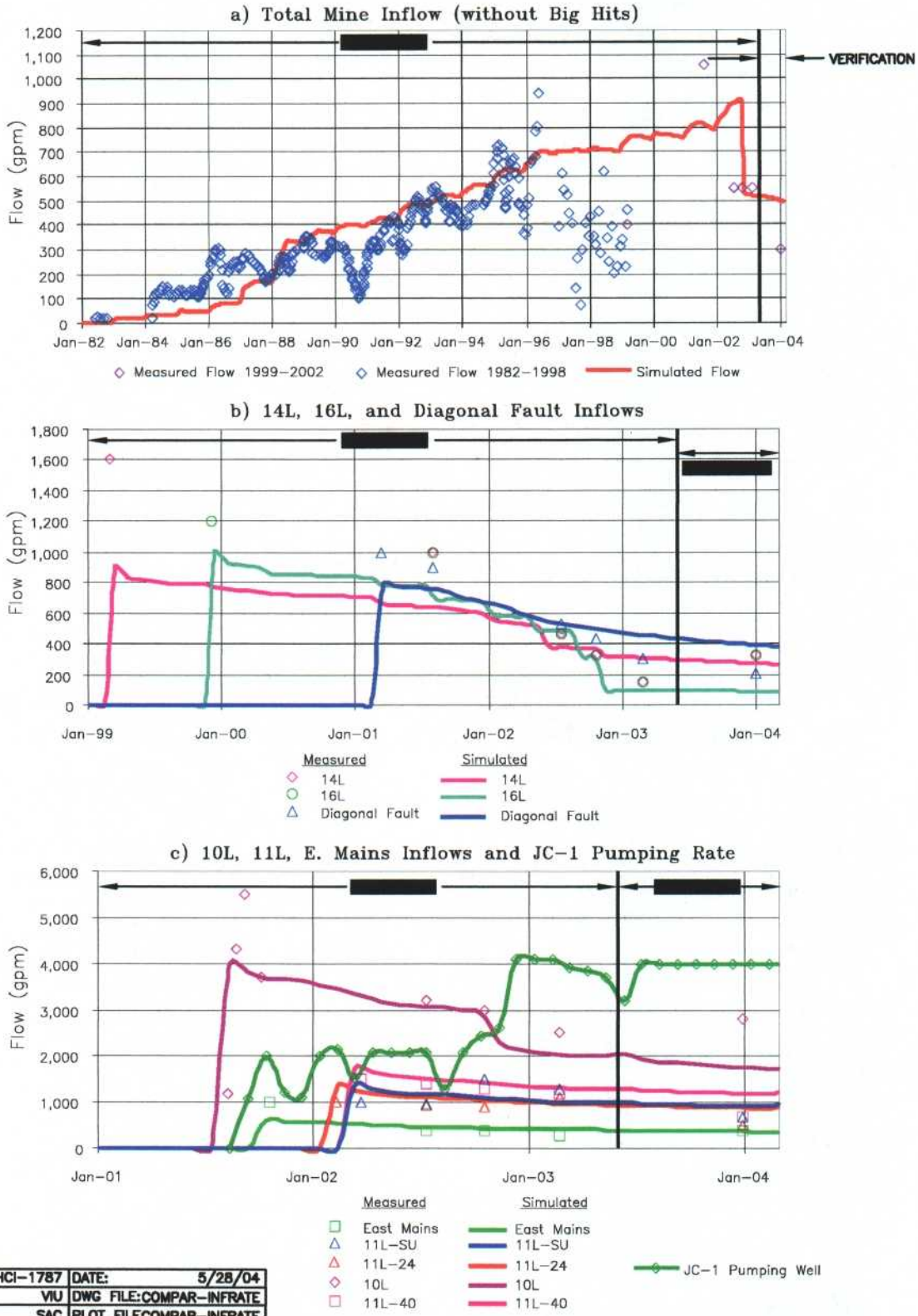
JOB NO.	HCI-1787	DATE:	9/26/03
BY:	VIU	DWG FILE:	CALIB-UPDATE
DRAWN:	SAC	PLOT FILE:	CALIB-UPDATE
CHECKED:		PLOT DATE:	5/28/04

Comparison of Modeled to Measured Pre-Mining Water Levels in Monitoring Wells

FIGURE 13

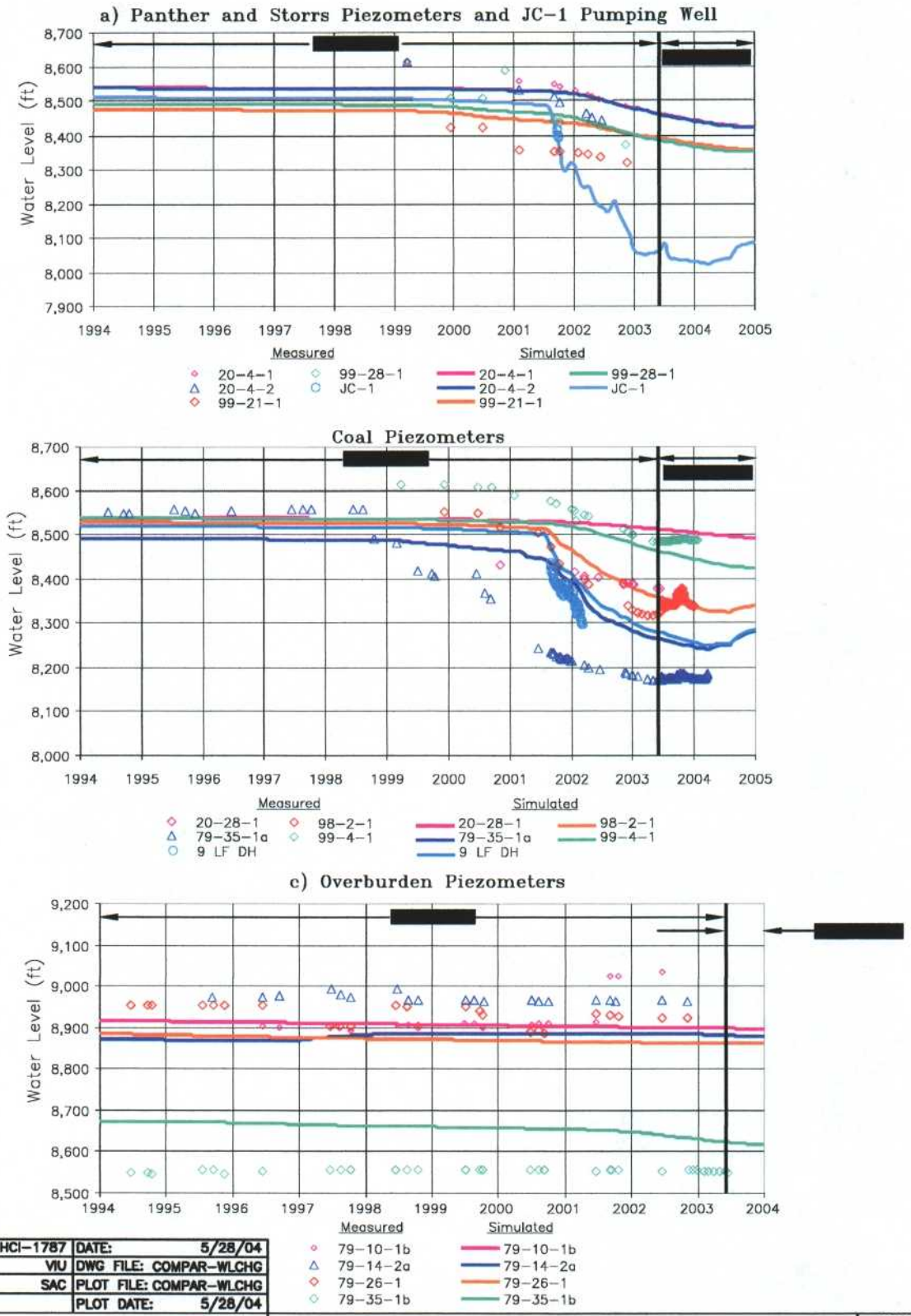


JOB NO.	HCI-1787	DATE:	5/28/04
BY:	VIU	DWG FILE:	COMPAR-INFRATE
DRAWN:	SAC	PLOT FILE:	COMPAR-INFRATE
CHECKED:		PLOT DATE:	5/28/04

HCI HYDROLOGIC CONSULTANTS, INC. HC TASCA company

Comparison of Modeled to Measured Inflow Rates to Skyline Mine

FIGURE 14



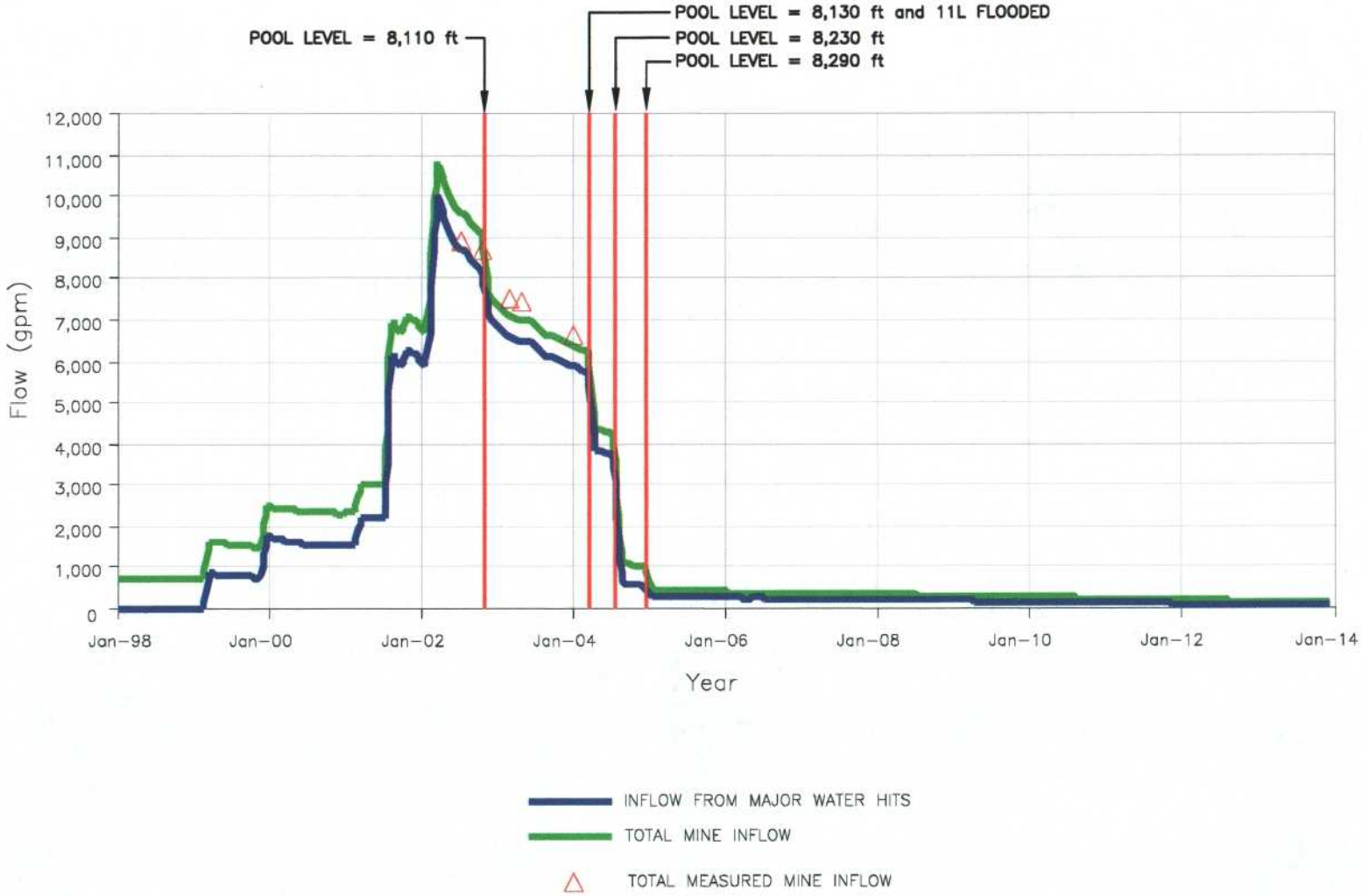
JOB NO.	HCI-1787	DATE:	5/28/04
BY:	VIU	DWG FILE:	COMPAR-WLCHG
DRAWN:	SAC	PLOT FILE:	COMPAR-WLCHG
CHECKED:		PLOT DATE:	5/28/04

HCI HYDROLOGIC CONSULTANTS, INC.

HC TASCA company

Comparison of Modeled to Measured Water Level Changes in Monitoring Wells: Verification through January 2004

FIGURE 15



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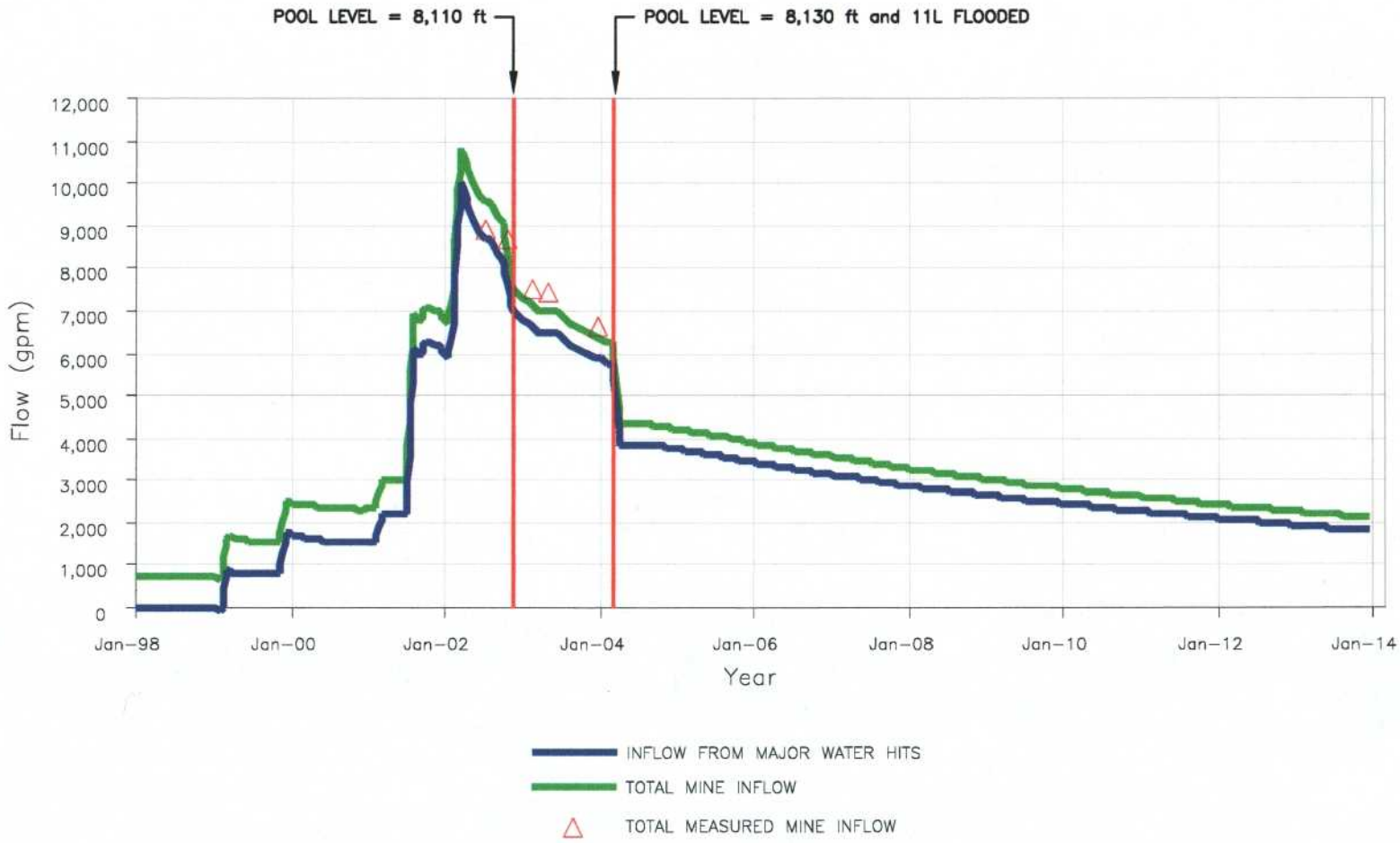
JOB NO.	HCI-1787	DATE:	5/28/04
BY:	VIU	DWG FILE:	SIM-TOTINFLOW
DRAWN:	SAC	PLOT FILE:	SIM-TOTINFLOW
CHECKED:		PLOT DATE:	5/28/04

Simulated Total Ground-Water Inflow to Mine Through 2013, Scenario I: JC-3 Shut Down

FIGURE 16



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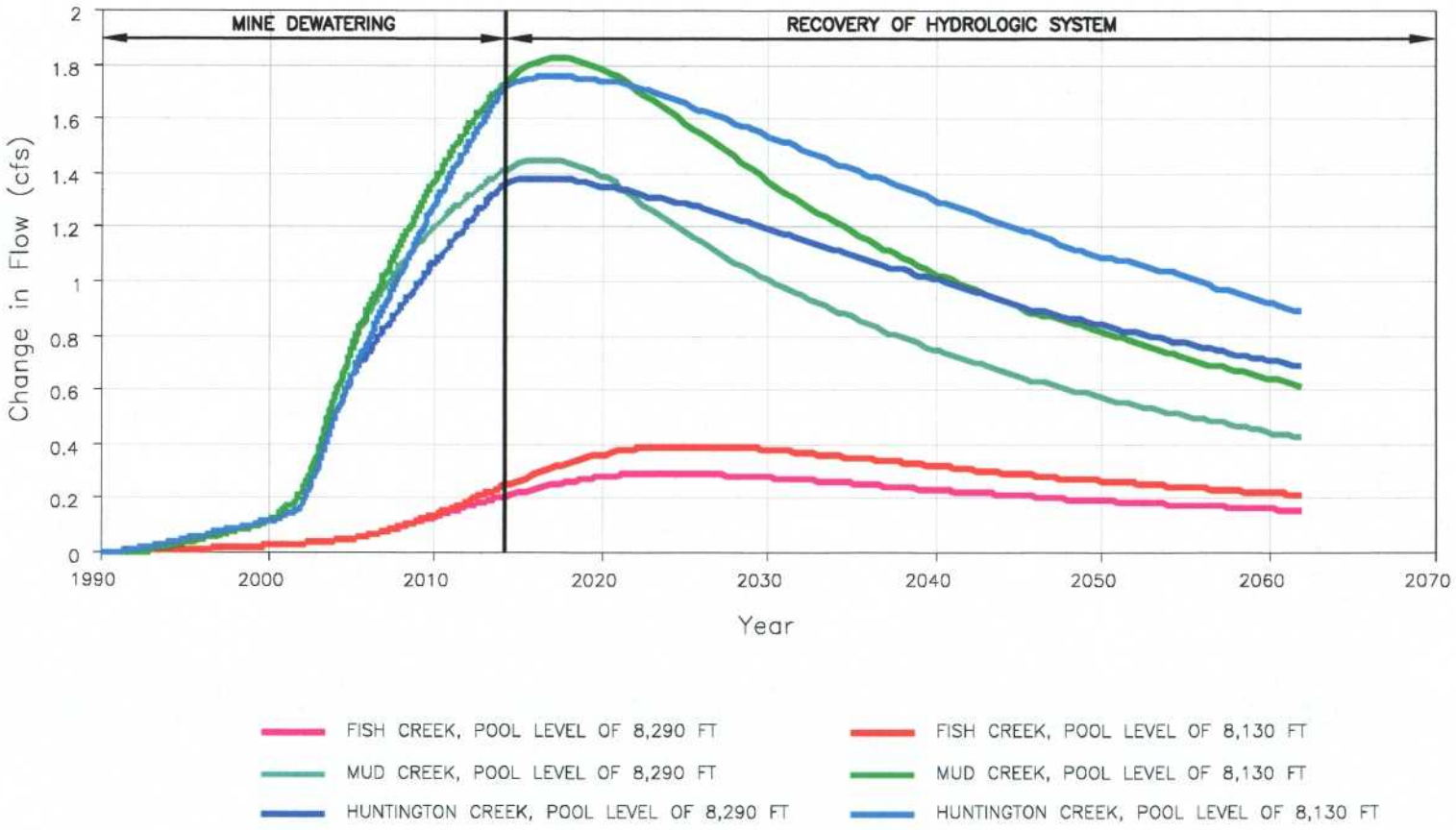
JOB NO.	HCI-1787	DATE:	5/28/04
BY:	VIU	DWG FILE:	SIM-TOTINFLOW2
DRAWN:	SAC	PLOT FILE:	SIM-TOTINFLOW2
CHECKED:		PLOT DATE:	5/28/04

Simulated Total Ground-Water Inflow to Mine Through 2013, Scenario II: Continued Pumping from JC-3

FIGURE 17



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HC TASCA an company

JOB NO.	HCI-1787	DATE:	5/28/04
BY:	VIU	DWG FILE:	PRED-IMPACT
DRAWN:	SAC	PLOT FILE:	PRED-IMPACT
CHECKED:		PLOT DATE:	5/28/04

Predicted Impact to Major Streams in Model Domain (VIU new results)

FIGURE 18

TABLE 1

Simulated Ground-Water Budgets for Pre-Mining, Current Mining, and End of Mining Conditions without Flooding of Mine

Pre-Mining Conditions					
Inflow Component	**Flow (cfs)**		**Outflow component**	**(cfs)**	
Recharge from Precipitation	54.6		GW Boundary Outflow	0	
GW Boundary Inflow	0		GW Discharge to SW		
Recharge to GW from Electric Lake	0.1		a) Mud Creek	12.4	
GW Storage	0		b) Fish Creek	6.9	
			c) Upper Huntington Creek and Other Creeks to Electric Lake	9.4	
			d) Electric Lake	1.2	
			e) Huntington Creek Below Electric Lake	9.5	
			f) Left Fork of Huntington Creek	15.3	
Total	54.7		Total	54.7	
Current Mining Conditions (April 30, 2003)					
Inflow Component	**Flow (cfs)**	**Change (cfs)**	**Outflow component**	**Flow (cfs)**	**Change (cfs)**
Recharge from Precipitation	54.6	0	GW Boundary Outflow	0	0
GW Boundary Inflow	0	0	GW Discharge to SW		
Recharge to GW from Electric Lake	0.2	0.1	a) Mud Creek	12.1	-0.3
GW Storage	25.1	25.1	b) Fish Creek	6.8	-0.1
			c) Upper Huntington Creek and Other Creeks to Electric Lake	9.4	0
			d) Electric Lake	1.1	-0.1
			e) Huntington Creek Below Electric Lake	9.4	-0.1
			f) Left Fork of Huntington Creek	15.3	0
			Subtotal	54.1	-0.6
			Pumping from JC-1	8.6	8.6
			Mine Inflow	17.2	17.2
Total	79.9	25.2	Total	79.9	25.2
Calculated impact to Electric Lake = difference in recharge to GW from Electric Lake + difference in GW discharge to Upper Huntington Creek and Electric Lake				0.2	
End of Mining Conditions (December 31, 2013)					
Inflow Component	**Flow (cfs)**	**Change (cfs)**	**Outflow component**	**Flow (cfs)**	**Change (cfs)**
Recharge from Precipitation	54.6	0	GW Boundary Outflow	0	0
GW Boundary Inflow	0	0	GW Discharge to SW		
Recharge to GW from Electric Lake	0.6	0.5	a) Mud Creek	10.6	-1.8
GW Storage	12.5	12.5	b) Fish Creek	6.6	-0.3
			c) Upper Huntington Creek and Other Creeks to Electric Lake	9.2	-0.2
			d) Electric Lake	0.9	-0.3
			e) Huntington Creek Below Electric Lake	9.0	-0.5
			f) Left Fork of Huntington Creek	14.8	-0.5
			Subtotal	51.1	-3.6
			Pumping from JC-1	8.4	8.4
			Mine Inflow	8.2	8.2
Total	67.7	13.0	Total	67.7	13.0
Calculated impact to Electric Lake = difference in recharge to GW from Electric Lake + difference in GW discharge to Upper Huntington Creek and Electric Lake				1.0	

TABLE 2

Simulated Ground-Water Budgets for Pre-Mining, Current Mining, and End of Mining Conditions with Flooding of Mine to 8,290 ft and Shut-down of JC-3

Pre-Mining Conditions			
Inflow Component	**Flow (cfs)**	**Outflow component**	**(cfs)**
Recharge from Precipitation	54.6	GW Boundary Outflow	0
GW Boundary Inflow	0	GW Discharge to SW	
Recharge to GW from Electric Lake	0.1	a) Mud Creek	12.4
GW Storage	0	b) Fish Creek	6.9
		c) Upper Huntington Creek and Other Creeks to Electric Lake	9.4
		d) Electric Lake	1.2
		e) Huntington Creek Below Electric Lake	9.5
		f) Left Fork of Huntington Creek	15.3
Total	54.7	Total	54.7

Current Mining Conditions (April 30, 2003)					
Inflow Component	**Flow (cfs)**	**Change (cfs)**	**Outflow component**	**Flow (cfs)**	**Change (cfs)**
Recharge from Precipitation	54.6	0	GW Boundary Outflow	0	0
GW Boundary Inflow	0	0	GW Discharge to SW		
Recharge to GW from Electric Lake	0.2	0.1	a) Mud Creek	12.1	-0.3
GW Storage	23.6	23.6	b) Fish Creek	6.8	-0.1
			c) Upper Huntington Creek and Other Creeks to Electric Lake	9.4	0
			d) Electric Lake	1.1	-0.1
			e) Huntington Creek Below Electric Lake	9.4	-0.1
			f) Left Fork of Huntington Creek	15.3	0
			Subtotal	54.1	-0.6
			Pumping from JC-1	8.6	8.6
			Mine Inflow	15.7	15.7
Total	78.4	23.7	Total	78.4	23.7
Calculated impact to Electric Lake = difference in recharge to GW from Electric Lake + difference in GW discharge to Upper Huntington Creek and Electric Lake				0.2	

End of Mining Conditions (December 31, 2013)					
Inflow Component	**Flow (cfs)**	**Change (cfs)**	**Outflow component**	**Flow (cfs)**	**Change (cfs)**
Recharge from Precipitation	54.6	0	GW Boundary Outflow	0	0
GW Boundary Inflow	0	0	GW Discharge to SW		
Recharge to GW from Electric Lake	0.4	0.3	a) Mud Creek	11.0	-1.4
GW Storage	6.3	6.3	b) Fish Creek	6.7	-0.2
			c) Upper Huntington Creek and Other Creeks to Electric Lake	9.2	-0.2
			d) Electric Lake	1.1	-0.1
			e) Huntington Creek Below Electric Lake	9.2	-0.3
			f) Left Fork of Huntington Creek	14.9	-0.4
			Subtotal	52.1	-2.6
			Pumping from JC-1	8.9	8.9
			Mine Inflow	0.3	0.3
Total	61.3	6.6	Total	61.3	6.6
Calculated impact to Electric Lake = difference in recharge to GW from Electric Lake + difference in GW discharge to Upper Huntington Creek and Electric Lake				0.6	

TABLE 3

Simulated Ground-Water Budgets for Pre-Mining, Current Mining, and End of Mining Conditions with Flooding Mine to 8,130 ft

Pre-Mining Conditions			
Inflow Component	**Flow (cfs)**	**Outflow component**	**(cfs)**
Recharge from Precipitation	54.6	GW Boundary Outflow	0
GW Boundary Inflow	0	GW Discharge to SW	
Recharge to GW from Electric Lake	0.1	a) Mud Creek	12.4
GW Storage	0	b) Fish Creek	6.9
		c) Upper Huntington Creek and Other Creeks to Electric Lake	9.4
		d) Electric Lake	1.2
		e) Huntington Creek Below Electric Lake	9.5
		f) Left Fork of Huntington Creek	15.3
Total	54.7	Total	54.7

Current Mining Conditions (April 30, 2003)					
Inflow Component	**Flow (cfs)**	**Change (cfs)**	**Outflow component**	**Flow (cfs)**	**Change (cfs)**
Recharge from Precipitation	54.6	0	GW Boundary Outflow	0	0
GW Boundary Inflow	0	0	GW Discharge to SW		
Recharge to GW from Electric Lake	0.2	0.1	a) Mud Creek	12.1	-0.3
GW Storage	23.6	23.6	b) Fish Creek	6.8	-0.1
			c) Upper Huntington Creek and Other Creeks to Electric Lake	9.4	0
			d) Electric Lake	1.1	-0.1
			e) Huntington Creek Below Electric Lake	9.4	-0.1
			f) Left Fork of Huntington Creek	15.3	0
			Subtotal	54.1	-0.6
			Pumping from JC-1	8.6	8.6
			Mine Inflow	15.7	15.7
Total	78.4	23.7	Total	78.4	23.7
Calculated impact to Electric Lake = difference in recharge to GW from Electric Lake + difference in GW discharge to Upper Huntington Creek and Electric Lake				0.2	

End of Mining Conditions (December 31, 2013)					
Inflow Component	**Flow (cfs)**	**Change (cfs)**	**Outflow component**	**Flow (cfs)**	**Change (cfs)**
Recharge from Precipitation	54.6	0	GW Boundary Outflow	0	0
GW Boundary Inflow	0	0	GW Discharge to SW		
Recharge to GW from Electric Lake	0.5	0.4	a) Mud Creek	10.7	-1.7
GW Storage	10.0	10.0	b) Fish Creek	6.7	-0.2
			c) Upper Huntington Creek and Other Creeks to Electric Lake	9.2	-0.2
			d) Electric Lake	0.9	-0.3
			e) Huntington Creek Below Electric Lake	9.1	-0.4
			f) Left Fork of Huntington Creek	14.9	-0.4
			Subtotal	51.5	-3.2
			Pumping from JC-1	8.9	8.9
			Mine Inflow	4.7	4.7
Total	65.1	10.4	Total	65.1	10.4
Calculated impact to Electric Lake = difference in recharge to GW from Electric Lake + difference in GW discharge to Upper Huntington Creek and Electric Lake				0.9	