Janet Napolitano
Governor

ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY

1110 West Washington Street • Phoenix, Arizona 85007
(602) 771-2300 • www.azdeq.gov

Stephen A. Owens
Director

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Return Receipt Requested

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MAY 01 2008

April 24, 2008

Attention: E. L. (Ned) Hall
Freeport-MacMoRan Sierrita Inc.
6200 W. Duval Mine Road
P.O. Box 527
Green Valley, AZ 85622-0527

Re: Mitigation Order, Docket No: P-50-06 – Review of Aquifer Characterization Report

Dear Mr. Hall:

The Arizona Department of Environmental Quality (ADEQ) has completed its review of the December 28, 2007 Aquifer Characterization report (ACR) submitted by Freeport MacMoRan Sierrita Inc. (Freeport). ADEQ has concerns about the ACR that are described in more detail in the attached comments, but the main concerns are as follows:

1. The vertical characterization of the sulfate plume is not complete. Freeport did not attempt to characterize sulfate in the bedrock in determining the full vertical extent of contamination. ADEQ is concerned that fractured bedrock may provide a conduit for continuing sulfate migration from the Phelps Dodge Sierrita Tailing Impoundment (PDSTI) and/or the known basin fill sulfate plume.

2. Freeport has not adequately delineated the sulfate concentrations throughout the strata of the basin fill aquifer. ADEQ noticed that the concentrations of sulfate vary significantly based on the information provided in the various cross sections described in the ACR. Instead of providing detailed contours for each screen interval, Freeport chose to use maximum concentrations in its model. The result is that the model may be a poor predictor of sulfate plume fate and transport, especially with regard to estimating the timing of the plume migration. Moreover, the model may be flawed as a tool for planning interim or final mitigation actions for drinking water sources.

3. As an illustration of the previous point, ADEQ is concerned about an apparent "bulge" in the southeast portion of the sulfate plume. ADEQ has estimated the extent of the "bulge" based on the data provided by Freeport. The "bulge" appears to be in a higher permeability zone of the aquifer in which sulfate migration is more aggressive than other nearby zones, and appears to extend in the direction of production well CW-10. Based on the comments noted above, it is unlikely that Freeport's model will accurately predict

the fate and transport of the sulfate plume in this area. In addition, ADEQ is concerned that Freeport does not have a monitoring well which defines the full lateral extent of contamination in this area. Such a monitoring well may also act as a "sentinel well" to provide Freeport and Community Water with valuable information regarding plume migration which would be helpful in determining appropriate interim and final mitigation actions.

ADEQ requests that Freeport respond to the attached comments in writing within 15 days of receipt of this letter.

ADEQ is also in receipt of a letter dated April 17, 2008 from E.L. (Ned) Hall, Chief Environmental Engineer for Freeport requesting an extension of time for Freeport to submit the Feasibility Study and Mitigation Plan required in the Mitigation Order Work Plan. Although ADEQ has some significant concerns about the scope of the ACR submitted by Freeport, it believes that any deficiencies can be addressed contemporaneously and incorporated into the Feasibility Study and Mitigation Plan, thus minimizing any delays in completing the activities required by the Work Plan.

ADEQ agrees that a meeting to discuss subsequent measures and continuation of activities under the approved Work Plan would be useful. ADEQ suggests the following dates and times for a meeting between ADEQ and Freeport at ADEQ's Phoenix Office: Friday, May 9 all day; Wednesday, May 14 at 1:00 p.m.; Tuesday, May 20 at 10:00 a.m.; or Thursday, May 22 at 10:00 a.m.

Please call me at 602-771-2209 if you have any questions.

Sincerely,

Cynthia S. Campbell

Cynthia S. Campbell, Manager
Water Quality Compliance Section

cc: Stuart M. Brown, President
Bridgewater Group, Inc.
4500 SW Kruse Way Suite 110
Lake Oswego, or 97035

Ray Lazuk, Freeport McMoran Gold & Copper Inc.

Joan Card , Director, WQD, ADEQ

Robert Casey, Manager, WQEU, ADEQ
Henry Darwin, Administrative Counsel, ADEQ
David Haag, Senior Hydrologist, Groundwater Section, ADEQ
Michele Robertson, Manager, Groundwater Section, ADEQ
Moses Olade, Hydro IV, WQCAU, ADEQ

EU08: 829

GENERAL COMMENTS

1. The Aquifer Characterization Report (ACR) is the final report of field activities involving several months of site investigations, groundwater monitoring and computer modeling of the hydrology and water quality of the sulfate plume located downgradient of the Phelps Dodge Sierrita Tailing Impoundment (PDSTI). The objectives of the report are to characterize the sulfate plume and collect data for a feasibility study. The scope of the report includes the findings of the following tasks:

- Completion of a well inventory to identify drinking water wells that could be impacted by the sulfate plume.
- Determination of the lateral and vertical extent of the sulfate plume.
- Evaluation of the fate and transport of the sulfate plume.
- Evaluation of the effectiveness of the current interceptor wellfield.

Several interim reports were submitted during the period of investigations, and the final ACR briefly summarizes and references the results of the previously reported work.

2. ADEQ believes that the ACR does not adequately summarize or integrate all the relevant information obtained from background data, five quarters of groundwater monitoring and field work results from newly installed wells in characterizing the sulfate plume. The first sentence on Page 4, Section 1.2 "*Scope of the Aquifer Characterization Report*," states, "*For completeness, this report summarizes the results of previously reported work conducted under the Aquifer Characterization Plan, but will not reproduce previously submitted reports.*" The ACR should be a "*stand alone*" document that allows reasonable conclusions to be made on the adequacy of the plume characterization. It would be helpful if Freeport would revise the text of the ACR to provide full documentation as to all work that was conducted, and integrate the information/data with previously known information/data. At a minimum, Freeport should include CD copies of all of all previous major reports as part of the ACR.

3. Appendices: The main part of the report is followed by Appendix A which describes "*Data Compilation and Evaluation of Bedrock Elevation*" and then by Appendix B which contains a "*Summary of Water Quality Data.*" For easy reference, Freeport should

reverse the sequence of these two appendices. Other Appendices could be rearranged to facilitate easy flow of information.

4. Background Sulfate Concentration: During the development of the Work Plan, it was discussed that, at the end of the aquifer characterization, adequate water quality data would be generated to establish a background sulfate concentration in groundwater for the basin fill sediments and bedrock respectively, using new and existing data sources from locations upgradient and outside the areas affected by the plume. This issue has not been addressed in the ACR, although there were references to the value of "50 ppm" to separate sulfate sources near the Santa Cruz River. The sulfate background value should be determined and used in defining areas impacted by the PDSTI sulfate plume.

5. In Section 4, "*Numerical Model of Groundwater Flow and Transport*," Freeport should provide a more detailed summary of the groundwater model including model specifics, (i.e., grid spacing, layers, hydraulic conductivities, calibration, sensitivity analysis, etc.).

6. In Appendix I,"*Numerical Model for Simulation of Groundwater Flow and Sulfate Transport,*" Freeport should include a section that summarizes the Conceptual Site Model.

7. In general, all sections of Appendix I should include additional documentation to provide the rationale as to the starting input conditions for the numerical model.

8. It would be helpful if Freeport would provide additional information, and rationale regarding these areas:

- Appropriateness of hydraulic data;
- Appropriateness of contouring the highest sulfate concentration data regardless of the depth from which the sample was collected;
- Description of the ranges of groundwater elevation;
- Description of how depth specific sampling was conducted;
- Discussion of any potential data gaps that may exist;
- Rationale regarding the choice of screen intervals for the newly installed monitoring wells;
- Description of the usefulness of step-drawdown aquifer tests and whether constant-discharge aquifer tests should be conducted;
- Re-evaluating sulfate loading of the lower basin fill aquifer as the data presented in the Attachments seems to indicate;
- Additional well installation into bedrock to fully characterize the horizontal and vertical , sulfate concentrations;
- Groundwater and transport modeling.

SPECIFIC COMMENTS

1. Section 2.1: Task 1 – Well Inventory

The results of the well inventory are well summarized in this section of the report. However, Freeport should provide the sulfate concentrations in the 10 active drinking water wells on the map (Figure 2) showing the locations of these drinking water wells. Also, it is relevant to indicate if the sulfate concentrations at these wells have changed over time during the period of groundwater monitoring. For example, the sulfate concentrations in the Green Valley drinking water well GV-2, showed increasing concentrations of sulfate - 48 ppm, 85ppm, 103 ppm and 106 ppm during four quarters of consecutive groundwater monitoring. Well CW-10 may be showing a similar pattern of increasing sulfate concentrations. These wells are all located near the southeastern edge of the plume where a former drinking water well CW-3 has been "impacted" by the plume. ADEQ notes evidence of an aggressive subsurface plume migration along this edge of the plume boundary where the sulfate distribution shows a prominent protrusion ("bulge" shape) (see Fig 1 of the ACR). It is important for Freeport to include this observation in the ACR and explain or rationalize the plume's behavior.

2. Section 2.2.1: Task 2.1 - Data Compilation and Evaluation

In this section Freeport states that all data evaluation was conducted in Appendix A, and the last sentence reads, "*The hydraulic properties data reported in the Work Plan were determined to be suitable for use in aquifer characterization.*" The body of the ACR should provide, at a minimum, the results of the evaluation to justify the statement that the data provided in the work plan is suitable.

Specifically, the vertical extent of the sulfate plume is not defined. Freeport should include a summary of the hydraulic properties of the bedrock in the vicinity of the PDSTI based on the accumulated data. In Appendix A, Freeport describes how the data was compiled, but provides no significant analysis or discussion. The conclusions reached in the report do not appear to consider the data compiled in the tables. The extent of fracturing of the bedrock is not fully explored. It is possible that the fractured bedrock has an impact on hydraulic conductivity, which in turn, might indicate the sulfate is migrating deeper through the fractured bedrock. These issues should be more fully explained.

Within the sulfate plume, none of the monitor wells are screened solely within bedrock, with the exception of MH 25D which contains 600 ppm of sulfate as compared to 1400

ppm of sulfate in the overlying basin fill. The possible correlation between the elevated sulfate content in the basin fill and the hydraulic characteristics of the underlying bedrock is not explained. The characterization of the hydraulic properties and sulfate distribution in bedrock underlying the plume is currently poorly understood, and requires a more rigorous evaluation of its potential impact on sulfate migration. There is a probability that, if the underlying bedrock is not adequately characterized, it may affect future mitigation actions.

3. Section 2.2.2: Task 2.2 – Groundwater Monitoring

A comparison of the lateral extent of the sulfate plume in October 2007 and April 2006 shows that the plume has expanded in the southeastern margin based on data from Wells MO 2007-5B and 5C. This plume migration may threaten newly-installed drinking water wells CW-10, GV-1 and GV-2. ADEQ has concerns as to whether the plume's southern boundary west of well GV-1 has been well defined. ADEQ suggests sampling existing wells or installation of a new monitoring well to serve as a "sentinel well" for the drinking water wells in this area, especially CW-10. A well in this general location was originally proposed in the Work Plan, but was moved approximately 3000 feet to the southwest.

Another location where ADEQ recommends that Freeport perform additional monitoring is midway between the MO-2007-4 and MO 2007-5 series of monitoring wells, because of the need to better define the boundary and monitor the migration of the plume along this edge of the plume.

4. Section 2.2.2.2 Sulfate Distribution

Freeport states in the last sentence of the first paragraph "*The contours on Figures 1 and 4 were developed using the highest measured sulfate concentrations at co-located wells*," but the report does not provide a rationale as to why the highest concentration of sulfate was used. ADEQ believes it would be more informative to contour the sulfate data per potential hydrostratigraphic units. Freeport also should discuss the vertical distribution of sulfate within the basin fill aquifer, and include cross-sections that post and contour the sulfate data (See Attachments).

5. Section 2.2.2.3 Groundwater Elevation

Freeport should describe the ranges of groundwater elevations for the sampling events, a discussion of changes of groundwater elevation over time, especially from wells that have been monitored prior to the mitigation order, and a discussion of horizontal and vertical hydraulic gradients. The ACR should also include cross-sections that include groundwater elevation contours.

6. Section 2.2.3 Task 2.3 Depth-Specific Sampling

a. ADEQ agrees that a vertical zonation of sulfate probably exists in the middle aquifer in association with a high permeability zone, although there are still some data gaps. The observation in the report about vertical uniformity in sulfate concentrations in wells MH-11 and MH-12 may be best attributed to the limited penetration of these wells as shown in the hydrogeologic cross sections.

b. Freeport should include a description of how depth-specific groundwater samples were collected from long-screened groundwater monitoring wells MW-11 and MW-12, and provide a description of depth-specific sampling and flow velocity profiling that conducted at ESP-2 and ESP-4.

c. The last bullet on page 15 states "*Sulfate concentrations in samples from MH-11 (screened from 300 to 800 feet below ground surface (ft bgs) and sampled from 450 to 750 ft bgs) and MH-12 (screened from 280 to 800 ft bgs and sampled from 470 to 700 ft bgs) are consistent from top to bottom of the intervals samples.*" Freeport should provide depth to water measurements from MH-11 and MH-12 during depth specific sampling, and explain why depth specific samples were not collected at the water table.

d. The last sentence in Section 2.2.3 states "*The uniformity and continuity of the high permeability zones is uncertain given the large distances between wells.*" Freeport should provide a discussion on whether that is a data gap that should be addressed with additional investigation or at least considered in evaluating mitigation options. If these high permeability zones are continuous, the lateral extent of the sulfate plume may be much further down-gradient than currently determined. This scenario would place down-gradient production wells at risk of impact by the sulfate plume, as sulfate concentrations would rapidly increase with little lead time to implement the chosen mitigation action.

e. It appears from the report that most of the evaluation of the depth specific data was focused on the middle and northern half of the impacted area around MH 11, MH 12 and ESP 2 & 4. In the southeastern part of the plume, the data obtained from nested wells MH-13A, B and C were not discussed in the same detail particularly to determine if there is any correlation with data obtained along the eastern edge of the plume in nested wells MO-007-5A, 5B & 5C.

7. Section 2.2.4.1 Well Drilling and Installation:

a. The first sentence of the second Paragraph under Appendix D, Section 2.3 states, "*Deminimus General Permits were obtained for the release of development water into*

nearby washes for each with the exception of MO-2007-4C, where water was stored in a 20,000-gallon tank and later hauled away for disposal." Freeport should provide an explanation as to why development water from this particular well was hauled away for disposal.

b. Freeport should provide the rationale for the location and screen intervals selected for the MO-2007-series monitoring wells that were installed.

c. Well MO-2007-6 was supposed to serve as a sentinel well to drinking water wells GV-1 and GV-2 along the southeastern edge of the plume. Instead, it was installed several thousand feet to the southwest. Freeport should explain why this well was constructed at a different location from that in the Work Plan, potentially creating a gap in the monitoring of the southeast edge of the sulfate plume. A replacement monitoring point or new well may be necessary.

8. Section 2.2.4.3 Initial Sampling of MO-2007 Wells

a. In the second paragraph of this section, Freeport states that the water quality data for the newly-installed nested monitoring wells "*indicate that sulfate concentrations tend to be higher in the lowermost screened intervals than in screened intervals at more shallow depths,*" and further hypothesizes in this same paragraph, "*A possible explanation for the observed distribution of sulfate is that the naturally occurring background sulfate concentration is higher in the lower basin fill, possibly due to the presence of hydrothermal alteration in the underlying bedrock as observed in MO-2007-2 and MO-2007-3.*" While sulfate concentrations do increase closer to the bedrock, Freeport has not provided any data to support that the source of the increase is bedrock. However, in Section 3.1, "*Sulfate Sources*," the second sentence of the second paragraph on Page 28 reads, "*However, the contribution of sulfate by bedrock recharge is likely very minor compared to the tailing seepage because the low permeability of bedrock would limit the sulfate mass flux from the upgradient area.*" This is a clear contradiction of the earlier stated hypothesis. The report should clarify which hypothesis is correct. Furthermore, considering the fact that the underlying bedrock is indurated arkosic sandstone, if hydrothermal alteration occurred, one would expect some connection with igneous/volcanic activity. However, in Well MO-2007-6C where the basin fill overlies bedrock of felsic volcanics where hydrothermal alteration is more likely, the sulfate concentration is relatively low.

At paragraph 3 of this section where Freeport discusses water level measurements at co-located MO-2007 wells, the last sentence reads, "*A possible explanation for the large vertical downward hydraulic gradients at sites MO-2007-5 and MO-2007-6 may be groundwater pumping at nearby wells.*" This explanation raises some questions considering the distance between these wells and the pumping water supply wells.

Nevertheless, a probable implication of the strong vertical hydraulic gradients at these wells is the likelihood that they may promote the vertical migration of sulfate-rich water into fractured underlying bedrock or indurated lower basin fill. This may partly explain the elevated sulfate in sedimentary bedrock.

A possible explanation for the high sulfate concentrations within the lower basin fill aquifer may be that sulfate has been transported through fractures in bedrock due to mass loading from mining operations and/or mass loading into bedrock and deep basin fill from the PDSTI, which is contributing to elevated concentrations at lower depths. (See Attachment, Modified Cross-Section B-B'). In order to fully address this issue, ADEQ recommends further vertical characterization involving the installation of monitor wells screened exclusively in bedrock.

b. In the first sentence of the third paragraph of this section, Freeport states, "*The sulfate concentration data from initial water sampling at the MO-2007 wells better define the eastern and northern limits of the sulfate plume and provide monitoring facilities capable of depth-specific sampling in areas between the sulfate plume and drinking water supply wells.*" The sulfate data does not support this statement. Based upon data presented from MO-2007-2 and M-20, sulfate concentrations at these northern monitoring wells are 591 mg/L and 1400 mg/L, respectively. Therefore, there may be additional sources of sulfate other than just the PDSTI. If Freeport intends to determine the full lateral extent of sulfate contamination in the northern portion of the plume, ADEQ recommends installation of additional groundwater monitoring wells.

11. Section 2.3 Task 3- Evaluation of PDSI Groundwater Control System

In this section Freeport provides a brief discussion on the effectiveness of the interceptor well field focusing on the previously identified challenges of the northern portion of the wellfield. However, based upon sulfate concentration data, it is clear that the wellfield has not contained sulfate contamination in the central and south-central portions. In evaluating locations for a second well field to contain the sulfate plume, this information should be provided in the report. Additionally, when evaluating capture in the future, Freeport should use the following guidance:

a. A Systematic Approach for Evaluation of Capture Zones at Pump and Treat Systems, Final Project Report, 2008 (EPA/600/R-08/003);
b. Methods for Monitoring Pump-and-Treat Performance, 1994 (EPA/600/R-94/123); and,
c. Elements for Effective Management of Operating Pump and Treat Systems, 2002 (EPA/542-R-0-2-009).

12. Section 3 Conceptual Model For The Groundwater Sulfate Plume

a. ADEQ finds the three hydrostratigraphic units identified by Freeport in the geologic logs to be reasonable. They can be used as a three layer working model for the sulfate transport modeling. The major sources of sulfate were sufficiently identified. However, it appears that undue prominence may have been given to upgradient bedrock as a potential source of sulfate for the plume. Freeport should state that the bedrock upgradient of the PDSTI is composed of low permeability indurated or crystalline rocks that are not likely to contribute much sulfate to the plume although the concentrations of sulfate in groundwater from the two piezometers in upgradient bedrock (360 - 450 ppm) are relatively high. This should be attributed to the fact that the igneous bedrock is most probably mineralized with sulfides, and the elevated levels may not be typical of groundwater sulfate in regional bedrock, comprised mostly of arkosic sandstones. Hence, the sulfate mass flux from the bedrock to basin fill would be minimal.

b. In this section Freeport should discuss potential receptors and include a "cartoon" block diagram.

13. Section 4 Numerical Model of Groundwater Flow and Transport

Though ADEQ agrees that some correlation exists between simulated groundwater elevation contours and measured values, ADEQ has serious reservations about the ability of the model to simulate sulfate concentrations. The boundary conditions are not well defined. There appears to be problems with the calibration of the model due to parameters that are not well understood and/or for which there are data gaps. A comparison of the simulated and measured sulfate in specific wells shows mismatches. If Freeport intends to use this sulfate transport model in evaluating the impact of mitigation actions, a more rigorous evaluation of the sources of the mismatches should be undertaken at various scales, including regional, local and specific wells.

14. Appendix I, Section 3.1 Spatial and Temporal Extents

In this section Freeport provides the areal extent of the active portion of the PDSI Regional-Scale Model (PDSIRM) to be approximately 100 square miles (260 square kilometers), and states the "*active model region extends from just above West Arivaca Road on the south (Universal Transverse Mercator [UTM] 3510500) to just below Pima Mine Road on the north (UTM 3540000). From the PDSTI this region extends east about 8.5 miles (13.5 km).*" However, Freeport does not provide similar areal information for the area of primary emphasis for the PDSIRM, only stating, "*the area of primary emphasis for the PDSIRM is the area in the vicinity of PDSTI, including the areas surrounding tangle the current extent of the sulfate plume. This area of primary interest is depicted as the rectangle within the lateral model boundaries shown in Figure b1.2.*" Freeport should provide areal information for the area of primary emphasis and state

whether the lateral boundaries of the rectangle correspond to the 250 mg/l sulfate contour east of the interceptor well field.

15. Appendix I, Section 3.2 Discretization

In this section Freeport explains that the PDSIRM was discretized into three layers to represent the upper, middle, and lower zones of the basin fill aquifer. ADEQ concurs with this delineation. However, having stated that the PDSIRM is divided into 25 rows and 162 columns, Freeport did not provide a rational for this discretization. This information should be included in this section.

16. Appendix I, Section 3.3.1 No Flow Boundaries

a. Freeport should provide a discussion as to why no flow conditions in the PDSIRM are assigned along the model boundary at locations that represent the outer edges of the basin fill aquifer, Figure 1.4, corresponding to the Sierrita Mountains to the west and the Santa Rita Mountains to the southeast. At Table I, "*Initial and Calibrated Model Parameters, Final Value or Range*" Freeport provides flow values of 7,700 acre feet/year for Western Mountain Front Recharge, and 2,600 acre feet /year for Southeastern Mountain Front Recharge, respectively.

b. In the final paragraph of this section Freeport states, "*For the purpose of model stability, the total thickness of each layer of the PDSIRM was kept to a minimum of 30 meters (98 feet).*" Freeport should state whether these thicknesses correspond to the measured thickness of the respective basin fill layers, and if not, discuss their impact on the data generated by the PDSIRM.

17. Appendix I, Section 3.4.2 River and Agricultural Recharge

In the final paragraph of this section Freeport states, "The ADWR model runs only through 1999. The value of river and agricultural recharge in the PDSIRM after 1999 was set at about 15,400 ac-ft/yr, which is near the recharge volumes in the mid 1990's." Based on Figure 1.7, ADEQ believes the amount of Agricultural Recharge should be determined over a wider time period and recommends at least a value of 18,500 ac-ft/yr.

18. Appendix I, Section 3.4.3.1 Phelps Dodge Sierrita Tailing Impoundment

Freeport states that the "total estimated seepage volume through 2006 is 252,406 ac-ft." ADEQ questions this quantity, because it apparently neither takes into account the 38,294 ac-ft of seepage from the Esperanza Tailing Impoundment shown in Table I, nor includes the estimated seepage value from the Twin Buttes Mine.

19. Appendix I, Section 3.4.5 Pumping

The first sentence in this section states, "*Groundwater withdrawal by pumping is the major groundwater sink in the PDSTI region.*" Freeport then acknowledges that few pumping records are available for the period 1940 through at least 1979, and the available pumping estimates are of questionable accuracy. Freeport should provide a discussion on how this may affect data generated by the PDSIRM.

20. Appendix I, Section 4.3.2 Sulfate Concentration calibration

a. In this section Freeport discusses Chemographs based on the average simulated sulfate concentrations over the upper two layers of the model and "*measured sulfate concentrations at several key locations.*" Freeport should define "*key locations,*" and prepare Chemographs based on simulated sulfate concentrations at each individual layer of the model and measured sulfate concentrations at corresponding layers in the basin fill aquifer. This approach should provide a more rigorous test of the model's capabilities.

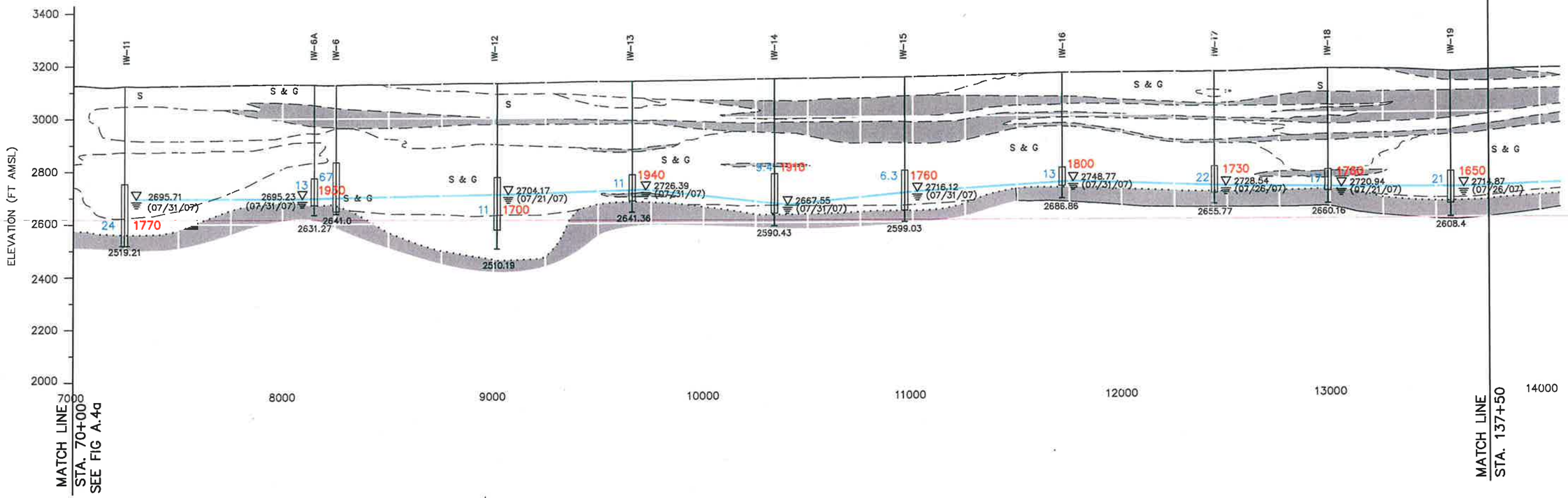
b. In the third paragraph Freeport states, " *The model simulation suggests that the high sulfate concentrations measured in MO-2007-5 may represent residual concentrations from a retreating plume rather than an advancing plume.*" Freeport should describe how this was determined. The measured data does not show this phenomenon. Freeport should discuss this discrepancy.

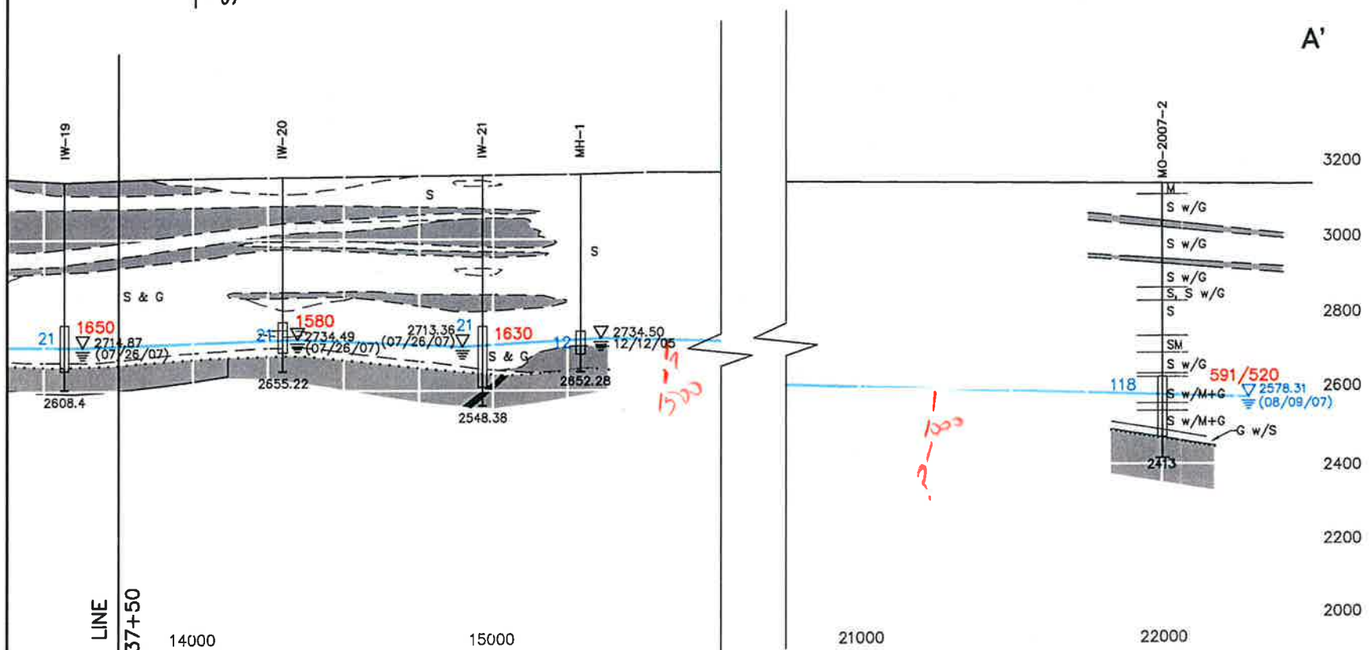
c. In the fourth paragraph Freeport broadly discusses the model's inability to match the sharpness of the plume front and concentrations at certain point locations, concluding that this may be due to "*aquifer heterogenities that cannot be adequately captured in the model.*" Freeport should provide a more detailed discussion on this matter pointing out the specific aquifer heterogenities in question.

21. Appendix I, Section 6 Summary and Conclusions

ADEQ agrees with the summary of strengths and limitations presented in the ACR. However, based on the limitations of the model, and particularly on the uncertainty regarding the assumptions made by Freeport, ADEQ has serious doubts regarding Freeport's conclusion at Section 6.3 that "*The PDSIRM is capable of meeting objectives identified in the Work Plan (HGC, 2006).*"

SEE FIGURE A.4a FOR SOUTHWARD CONTINUATION





LEGEND

BASIN FILL

- CALICHE CEMENTED GRAVEL, SAND, SILT AND CLAY
- S — SAND
- Sw/G — SAND WITH GRAVEL
- Sw/M&G — SAND WITH SILT AND GRAVEL
- S&G — SAND & GRAVEL, INCLUDES INTERVALS LOGGED AS SANDY GRAVEL AND GRAVELLY SAND
- SAND & GRAVEL WITH COBBLES AND INTERVALS LOGGED AS UNIDENTIFIED ROCK
- SILT AND SANDY CLAY, CLAY
- OLIGOCENE PANTANO FORMATION

BEDROCK COMPLEX

- EARLY TERTIARY QUARTZ MONZONITE
- CRETACEOUS ANGELICA ARKOSE
- TOP OF BEDROCK

HYDRAULIC CONDUCTIVITY (FEET/DAY) (APPENDIX E AND HGC, 2006a) 7–30 ft/d

0 250 500 1000
SCALE IN FEET

? 1000 Sulfate Concentration contour, queried where uncertain.

IW-6A — WELL ID

WELL

WATER LEVEL (DATE)

1,700 mg/L — SCREEN

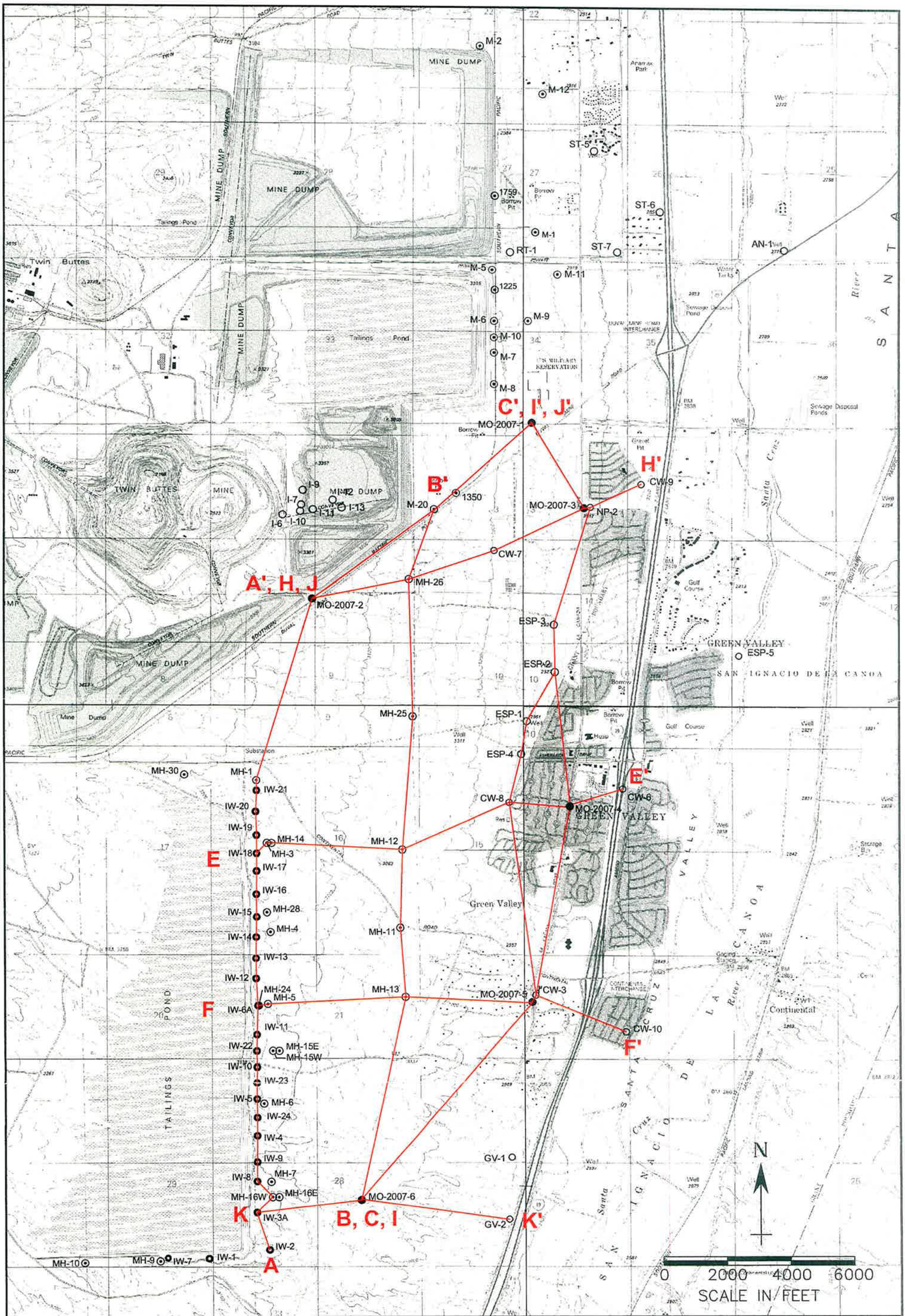
SULFATE CONCENTRATION (MILLIGRAMS PER LITER) IN JULY THROUGH OCTOBER 2007 (APPENDIX B) DUPLICATE SAMPLES ARE SEPARATED BY A FORWARD SLASH (/)

Attachment

HYDRO GEO CHEM, INC.

A - A' CROSS SECTION SHOWING WATER QUALITY AND HYDRAULIC CONDUCTIVITY DATA SIERRITA TAILING IMPOUNDMENT AREA

Approved	Date	Revised	Date	Reference:	FIG.
KW	11/28/07			7830164A	H.2b



EXPLANATION

- IW-2 INTERCEPTOR WELL
- MH-16E MONITOR WELL
- ESP-4 OTHER WATER WELL
- MO-2007-2 NEW MONITORING WELL

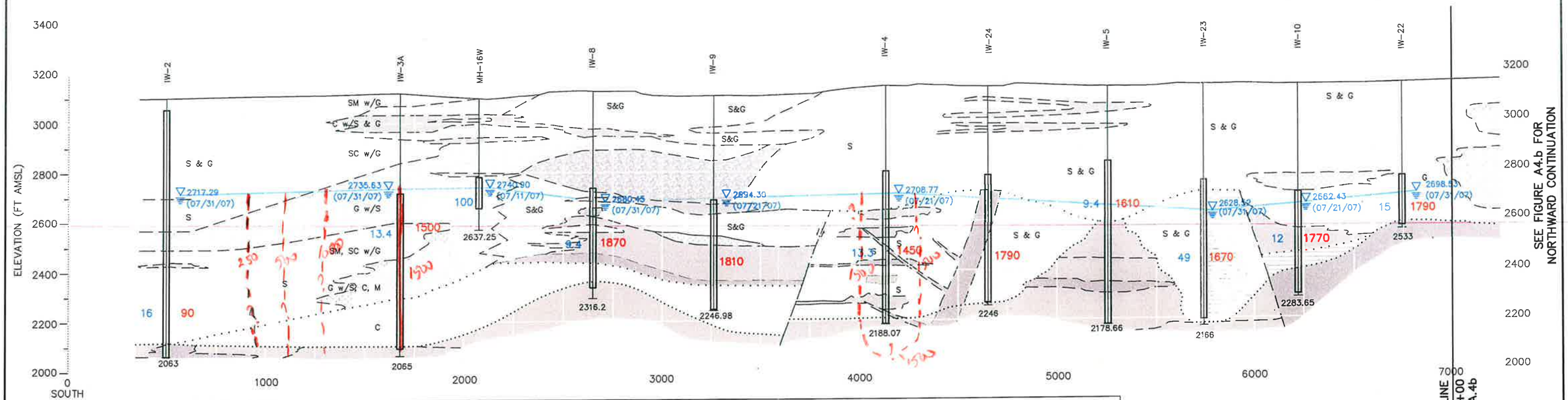
HYDRO GEO CHEM, INC.

Attachment 5

SIERRITA TAILING IMPOUNDMENT AREA
CROSS SECTION LOCATION MAP

Approved	Date	Revised	Date	Reference:	FIG:
KSW	09/04/07			7830023A	H.1

A



LEGEND

BASIN FILL

- C — CLAY
- M — SILT
- SC — CLAYEY SAND
- SM — SILTY SAND
- SM w/G — SILTY SAND WITH GRAVEL
- S — SAND
- S&G — SAND & GRAVEL
- Gw/S — GRAVEL WITH SAND
- G — GRAVEL
- SAND, GRAVEL AND/OR BOULDERS +/− SAND
- LOGGED AS "HARD ROCK" OR "ROCK AND SAND"
- SANDY CLAY, CLAYEY LAYERS
- ····· TOP OF BEDROCK
- · · · · · TOP OF DEMETRIE VOLCANICS AND ANGELICA ARKOSE

0 250 500 1000
SCALE IN FEET

BEDROCK COMPLEX

- EARLY TERTIARY GRANODIORITE/MONZONITE FRACTURED TO SAND & GRAVEL
- Cretaceous Demetrie Volcanics:
  - CLASTIC INTERBED, SANDSTONE, SILTSTONE AND ARKOSE
  - VOLCANICS ALTERED AND FRACTURED TO CLAY RICH MATERIAL
  - VOLCANICS ALTERED AND FRACTURED TO SAND−SIZE MATERIAL
  - VOLCANICS ALTERED AND FRACTURED TO SAND & GRAVEL−SIZE MATERIAL
  - ANDESITE & DACITE
  - RHYOLITE
- CRETACEOUS ANGELICA ARKOSE ALTERED AND FRACTURED TO GRAVEL, SAND & CLAY
- CRETACEOUS ANGELICA ARKOSE

? 1000? Sulfate concentration contour, queried where uncertain

IW-6A — WELL ID

WELL

WATER LEVEL (DATE)

1,700 mg/L — SULFATE CONCENTRATION (MILLIGRAMS PER LITER) IN JULY THROUGH OCTOBER 2007 (APPENDIX B) DUPLICATE SAMPLES ARE SEPARATED BY A FORWARD SLASH (/)

HYDRAULIC CONDUCTIVITY (FEET/DAY) (APPENDIX E AND HGC, 2006a) 7−30 ft/d

SCREEN

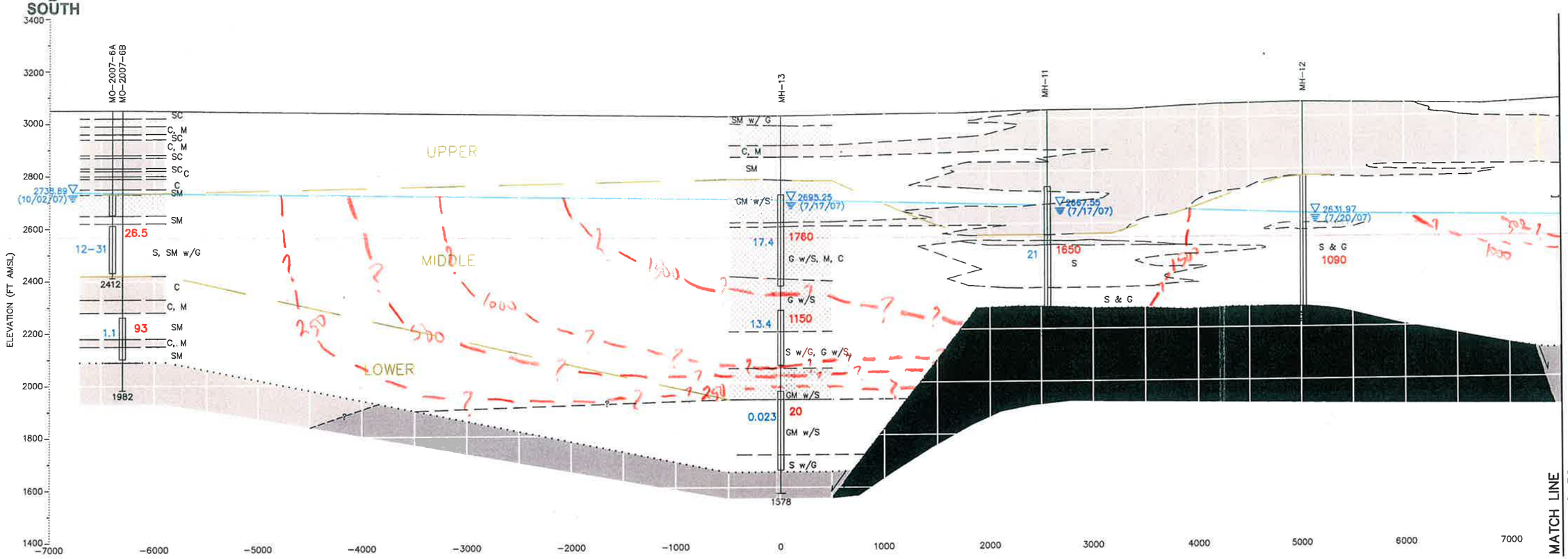
Attachment

HYDRO GEO CHEM, INC.

A - A' CROSS SECTION SHOWING WATER QUALITY AND HYDRAULIC CONDUCTIVITY DATA SIERRITA TAILING IMPOUNDMENT AREA

Approved	Date	Revised	Date	Reference:	FIG.
KW	11/29/07			7830163A	H.2a

B
SOUTH



LEGEND

BASIN FILL
- C — CLAY
- M — SILT
- SC — CLAYEY SAND
- SM — SILTY SAND
- SMw/G — SILTY SAND W/ GRAVEL
- S — SAND
- Sw/G — SAND WITH GRAVEL
- Gw/S — GRAVEL W/ SAND
- GMw/S — SILTY GRAVEL WITH SAND
- GRAVEL
- CLAYEY LAYERS, CLAY WITH INTERBEDDED SAND AND SMALL AMOUNTS OF GRAVEL
- OLIGOCENE PANTANO FORMATION

BEDROCK COMPLEX
- FELSIC VOLCANICS
- CRETACEOUS ANGELICA ARKOSE
- LIMESTONE
- TOP OF BEDROCK

0 500 1000 2000
SCALE IN FEET

HYDRAULIC CONDUCTIVITY (FEET/DAY) 7-30 ft/d
(APPENDIX E AND HGC, 2006a)

MO-2007-6B — WELL ID
— WELL
WATER LEVEL (DATE)
1,700 mg/L — SULFATE CONCENTRATION (MILLIGRAMS PER LITER) IN JULY THROUGH OCTOBER 2007 (APPENDIX B)
DUPLICATE SAMPLES ARE SEPARATED BY A FORWARD SLASH (/)
— SCREEN

Sulfate concentration contour, queried where uncertain

Attachment

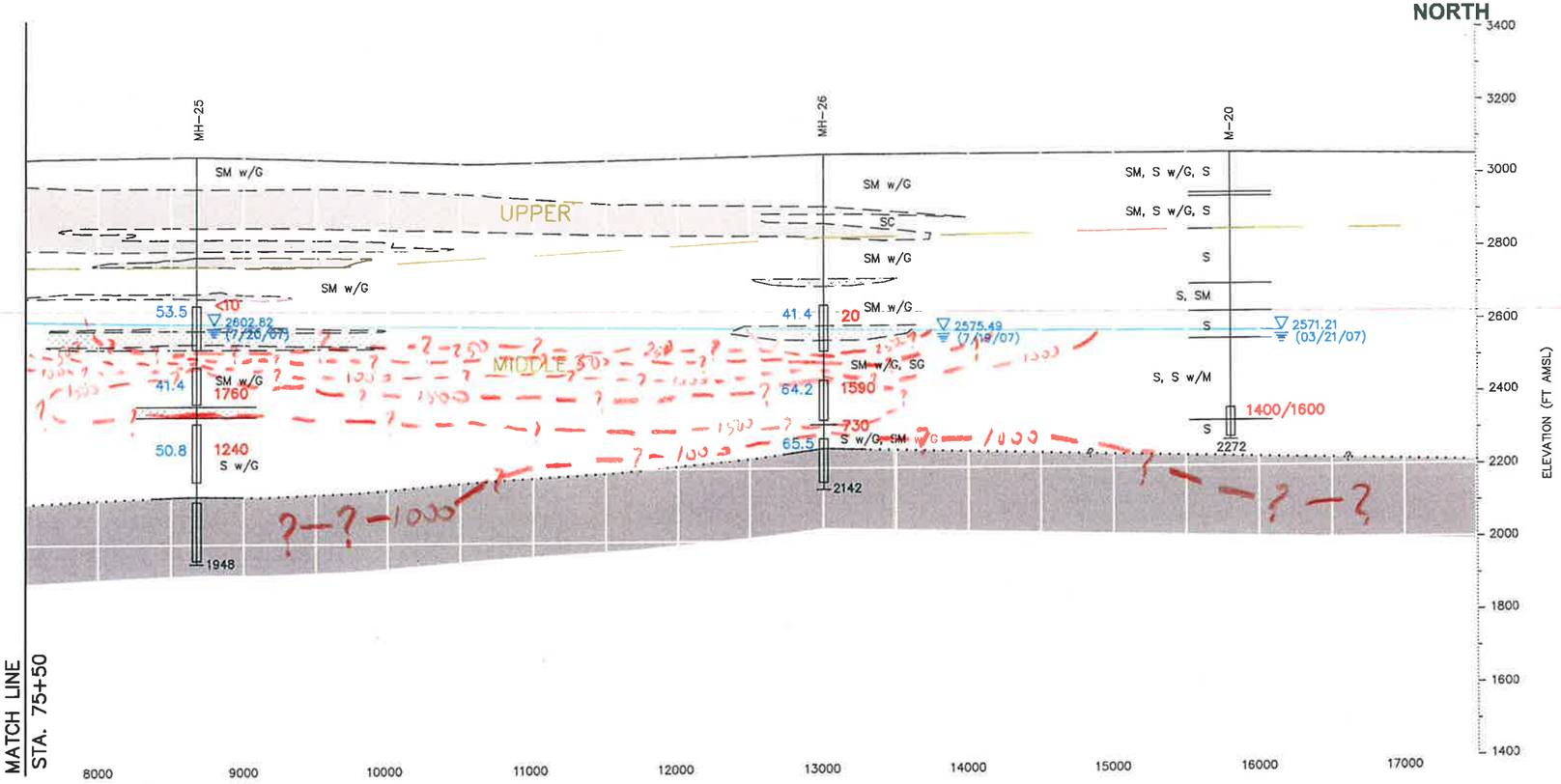
HYDRO GEO CHEM, INC.

B - B' CROSS SECTION SHOWING WATER QUALITY AND HYDRAULIC CONDUCTIVITY DATA STA. -70+00.00 TO 75+50.00

SHEET 1 OF 2

Approved	Date	Revised by	Date	File Name	Figure
KW	11/29/07	KW	11/29/07	7830165A	H.3a

B'
NORTH



LEGEND

BASIN FILL

- S&G — SAND & GRAVEL
- SMw/G — SILTY SAND W/ GRAVEL
- S — SAND
- Sw/G — SAND WITH GRAVEL
- GRAVEL WITH SAND AND/OR COBBLES
- CLAYEY LAYERS, CLAY WITH INTERBEDDED SAND AND SMALL AMOUNTS OF GRAVEL
- OLIGOCENE PANTANO FORMATION

BEDROCK COMPLEX

- FELSIC VOLCANICS
- CRETACEOUS ANGELICA ARKOSE
- TOP OF BEDROCK

0 500 1000 2000
SCALE IN FEET

? - 1000 - sulfate concentration contours, guessed where unknown.

MH-25 — WELL ID
— WELL
▽ WATER LEVEL (DATE)
1,700 mg/L — SULFATE CONCENTRATION (MILLIGRAMS PER LITER) IN JULY THROUGH OCTOBER 2007 (APPENDIX B) DUPLICATE SAMPLES ARE SEPARATED BY A FORWARD SLASH (/)
— SCREEN

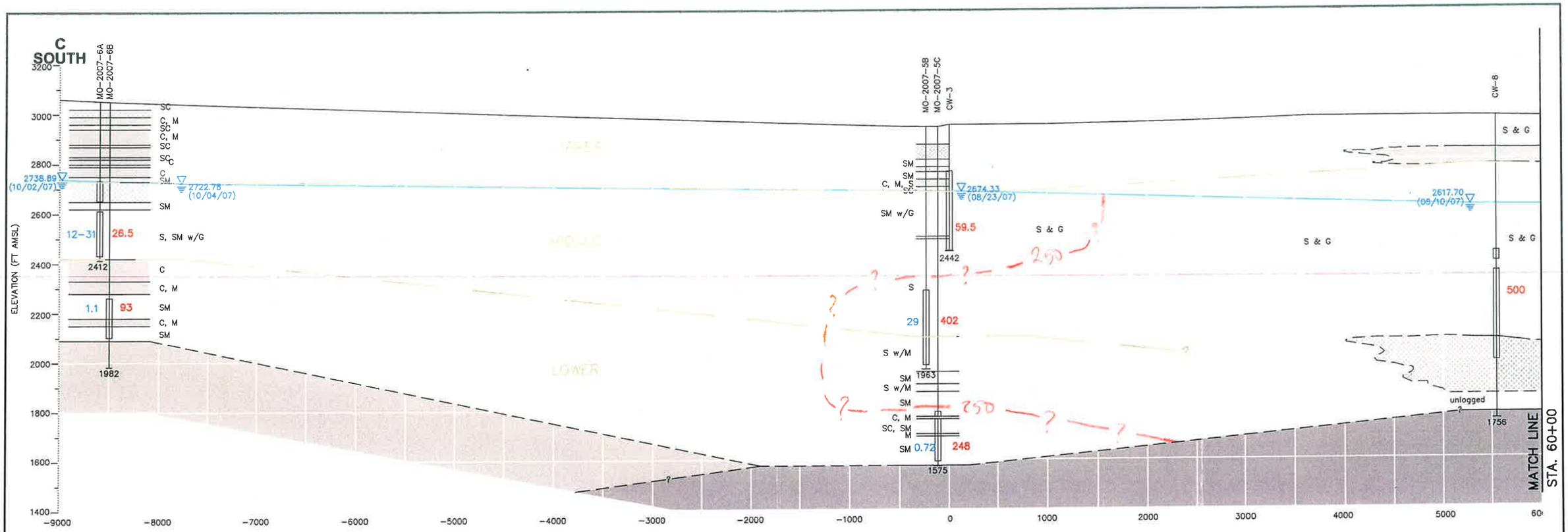
HYDRAULIC CONDUCTIVITY (FEET/DAY) (APPENDIX E AND HGC, 2006a) 7-30 ft/d

Attachment

HYDRO GEO CHEM, INC.

B - B' CROSS SECTION SHOWING WATER QUALITY AND HYDRAULIC CONDUCTIVITY DATA
STA. 75+50.00 TO 170+50.00 SHEET 2 OF 2

Approved	Date	Revised by	Date	File Name	Figure
KW	11/29/07	KW	11/29/07	7830165A	H.3b



LEGEND

BASIN FILL

- C — CLAY
- M — SILT
- S — SAND
- Sw/M — SAND w/ SILT
- SC — CLAYEY SAND
- SM — SILTY SAND
- S&G — SAND AND GRAVEL
- S&Gw/C — SAND & GRAVEL WITH CLAY
- SMw/G — SILTY SAND WITH GRAVEL
- S w/G — SAND WITH GRAVEL
- G — GRAVEL
- GRAVEL, GRAVEL w/ SAND +/- COBBLES AND/OR BOULDERS
- CLAY, SANDY CLAY, CLAY & GRAVEL
- OLIGOCENE PANTANO FORMATION, CONGLOMERATE, SAND AND CLAY
- OLIGOCENE PANTANO FORMATION, QUARTZOSE SANDSTONE MARKER
- BEDROCK COMPLEX
- CRETACEOUS ANGELICA ARKOSE

? — 1000 — Sulfate concentration contours, queried where uncertain

ESP-3 — WELL ID

WELL

WATER LEVEL (DATE)

HYDRAULIC CONDUCTIVITY (FEET/DAY) (APPENDIX E AND HGC, 2006a) 7-30 ft/d

1,700 mg/L — SULFATE CONCENTRATION (MILLIGRAMS PER LITER) IN JULY THROUGH OCTOBER 2007 (APPENDIX B) DUPLICATE SAMPLES ARE SEPARATED BY A FORWARD SLASH (/)

SCREEN

0 500 1000 2000
SCALE IN FEET

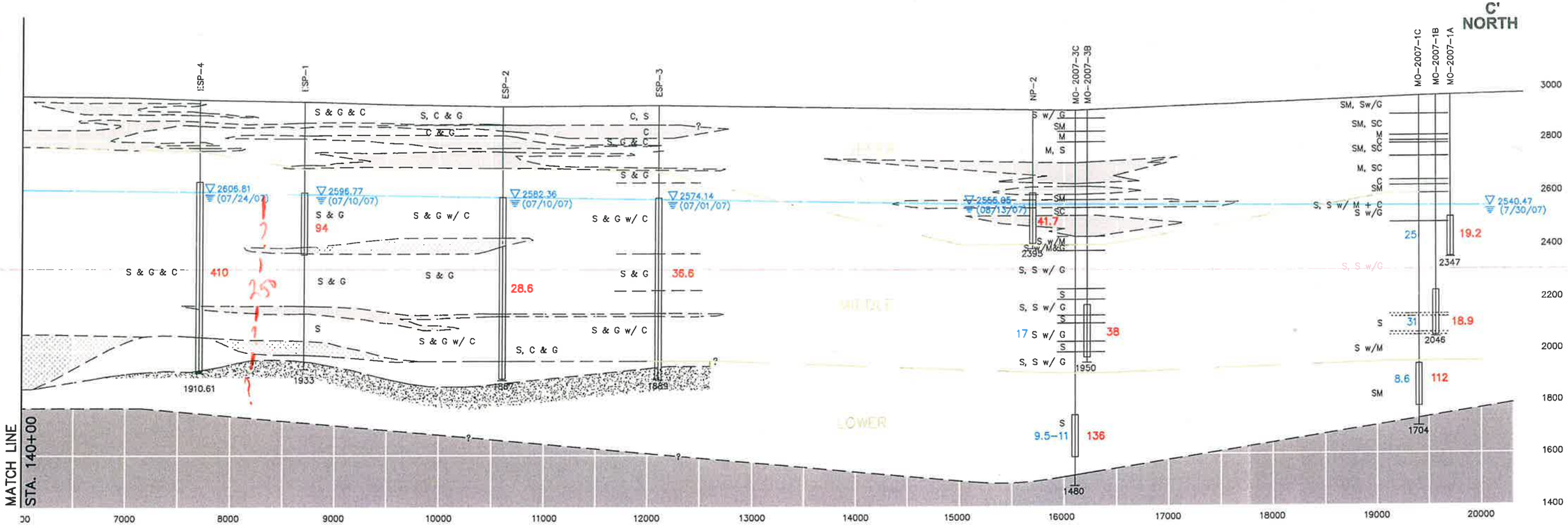
Attachment

HYDRO GEO CHEM, INC.

C - C' CROSS SECTION SHOWING WATER QUALITY AND HYDRAULIC CONDUCTIVITY DATA STA. -90+00.00 TO 60+00.00

SHEET 1 OF 2

Approved	Date	Revised	Date	Reference:	FIG.
KW	11/29/07			7830166A	H.4a



LEGEND

BASIN FILL

- C — CLAY
- M — SILT
- S — SAND
- Sw/M — SAND w/ SILT
- SC — CLAYEY SAND
- SM — SILTY SAND
- S&G — SAND AND GRAVEL
- S&Gw/C — SAND & GRAVEL WITH CLAY
- SMw/G — SILTY SAND WITH GRAVEL
- S w/G — SAND WITH GRAVEL
- G — GRAVEL
- GRAVEL, GRAVEL w/ SAND +/– COBBLES AND/OR BOULDERS
- CLAY, SANDY CLAY, CLAY & GRAVEL
- OLIGOCENE PANTANO FORMATION, CONGLOMERATE, SAND AND CLAY
- OLIGOCENE PANTANO FORMATION, QUARTZOSE SANDSTONE MARKER
- BEDROCK COMPLEX
- CRETACEOUS ANGELICA ARKOSE

SCALE IN FEET: 0, 500, 1000, 2000

HYDRAULIC CONDUCTIVITY (FEET/DAY) (APPENDIX E AND HGC, 2006a) 7–30 ft/d

ESP-3 — WELL ID

WELL

WATER LEVEL (DATE)

1,700 mg/L — SULFATE CONCENTRATION (MILLIGRAMS PER LITER) IN JULY THROUGH OCTOBER 2007 (APPENDIX B) DUPLICATE SAMPLES ARE SEPARATED BY A FORWARD SLASH (/)

SCREEN

? — 1000 — ? - Sulfate concentration contours, queried where uncertain.

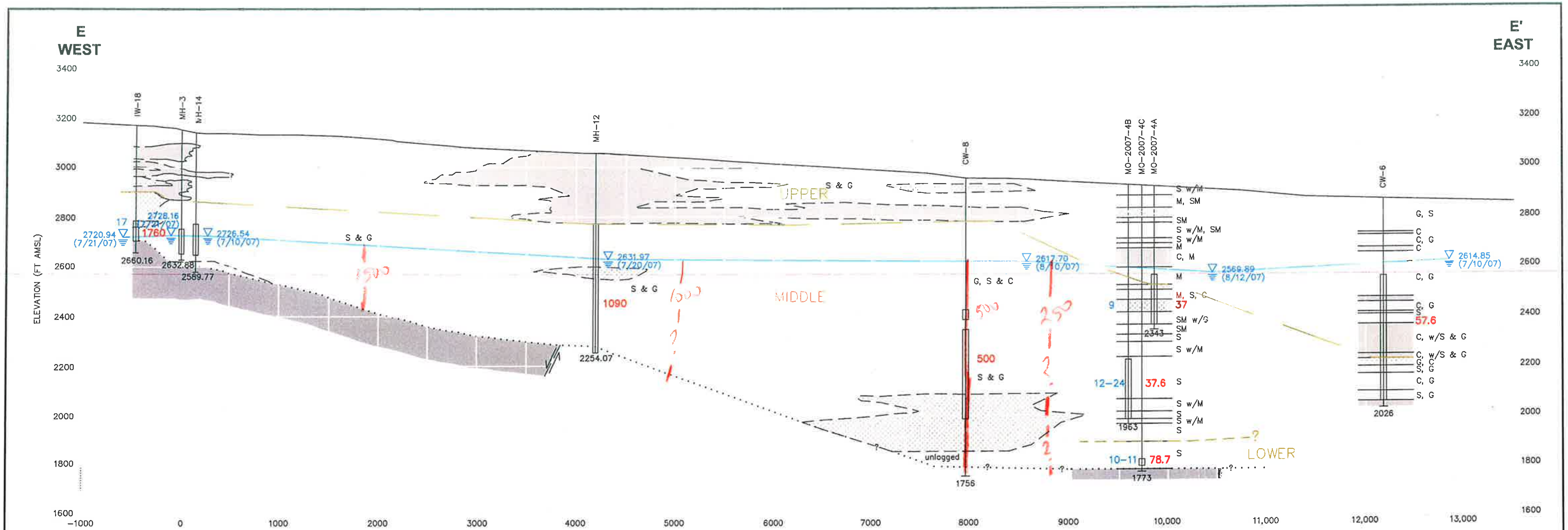
Attachment

HYDRO GEO CHEM, INC.

C - C' CROSS SECTION SHOWING WATER QUALITY AND HYDRAULIC CONDUCTIVITY DATA SIERRITA TAILING IMPOUNDMENT AREA

SHEET 2 OF 2

Approved	Date	Revised	Date	Reference:	FIG.
KW	11/29/07			7830166A	H.4b



LEGEND

BASIN FILL

S&G	SAND AND GRAVEL
GS&C	GRAVEL, SAND AND CLAY
C	CLAY
M	SILT
G	GRAVEL
SM w/G	SILTY SAND WITH GRAVEL
S	SAND
Sw/M	SAND w/ SILT
SM	SILTY SAND
	CLAY AND SANDY CLAY
	GRAVEL, GRAVEL w/ SAND, SAND AND GRAVEL WITH BOULDERS
	CONGLOMERATE
	OLIGOCENE PANTANO FORMATION

BEDROCK COMPLEX

	CRETACEOUS ANGELICA ARKOSE
	LIMESTONE
....	TOP OF BEDROCK

—?—1000 - Sulfate concentration contour, queried where uncertain

CW-8 — WELL ID

— WELL

WATER LEVEL (DATE)

HYDRAULIC CONDUCTIVITY (FEET/DAY) (APPENDIX E AND HGC, 2006a) 7–30 ft/d

1,700 mg/L — SCREEN

SULFATE CONCENTRATION (MILLIGRAMS PER LITER) IN JULY THROUGH OCTOBER 2007 (APPENDIX B). DUPLICATE SAMPLES ARE SEPARATED BY A FORWARD SLASH (/)

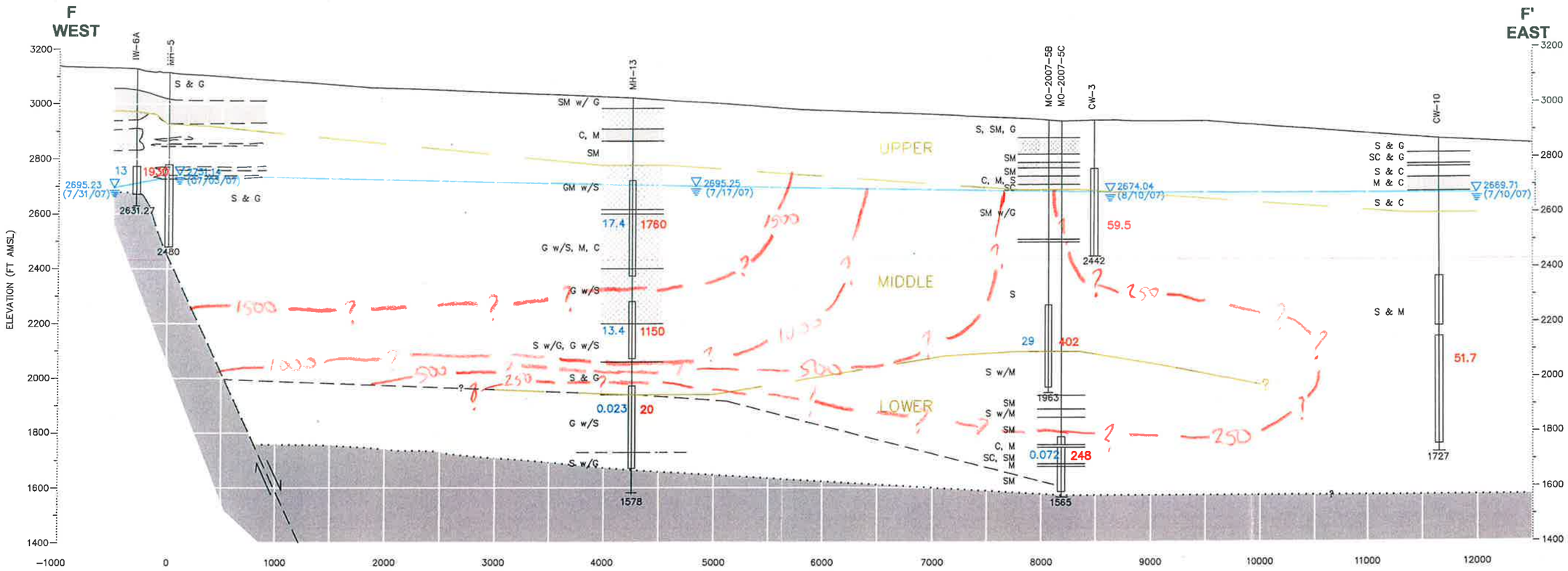
0 500 1000
SCALE IN FEET

Attachment

HYDRO GEO CHEM, INC.

E - E' CROSS SECTION SHOWING WATER QUALITY AND HYDRAULIC CONDUCTIVITY DATA SIERRITA TAILING IMPOUNDMENT AREA

Approved	Date	Revised	Date	Reference:	FIG.
KW	11/29/07			7830167A	H.5



LEGEND

BASIN FILL

- C — CLAY
- M — SILT
- SC — CLAYEY SAND
- SM — SILTY SAND
- Sw/M — SAND WITH SILT
- SMw/G — SILTY SAND w/GRAVEL
- S — SAND
- G — GRAVEL
- S&G — SAND AND GRAVEL
- Sw/G — SAND WITH GRAVEL
- GRAVEL, GRAVEL w/SAND +/- COBBLES
- CLAY & SILTY LAYERS, SANDY CLAY
- OLIGOCENE PANTANO FORMATION

BEDROCK COMPLEX

- CRETACEOUS ANGELICA ARKOSE
- TOP OF BEDROCK

HYDRAULIC CONDUCTIVITY (FEET/DAY) 7-30 ft/d
(APPENDIX E AND HGC, 2006a)

IW-6A — WELL ID

WELL

WATER LEVEL (DATE)

1,700 mg/L — SCREEN

SULFATE CONCENTRATION (MILLIGRAMS PER LITER) IN JULY THROUGH OCTOBER 2007 (APPENDIX B)
DUPLICATE SAMPLES ARE SEPARATED BY A FORWARD SLASH (/)

1000 — Sulfate concentration contour, queried where uncertain

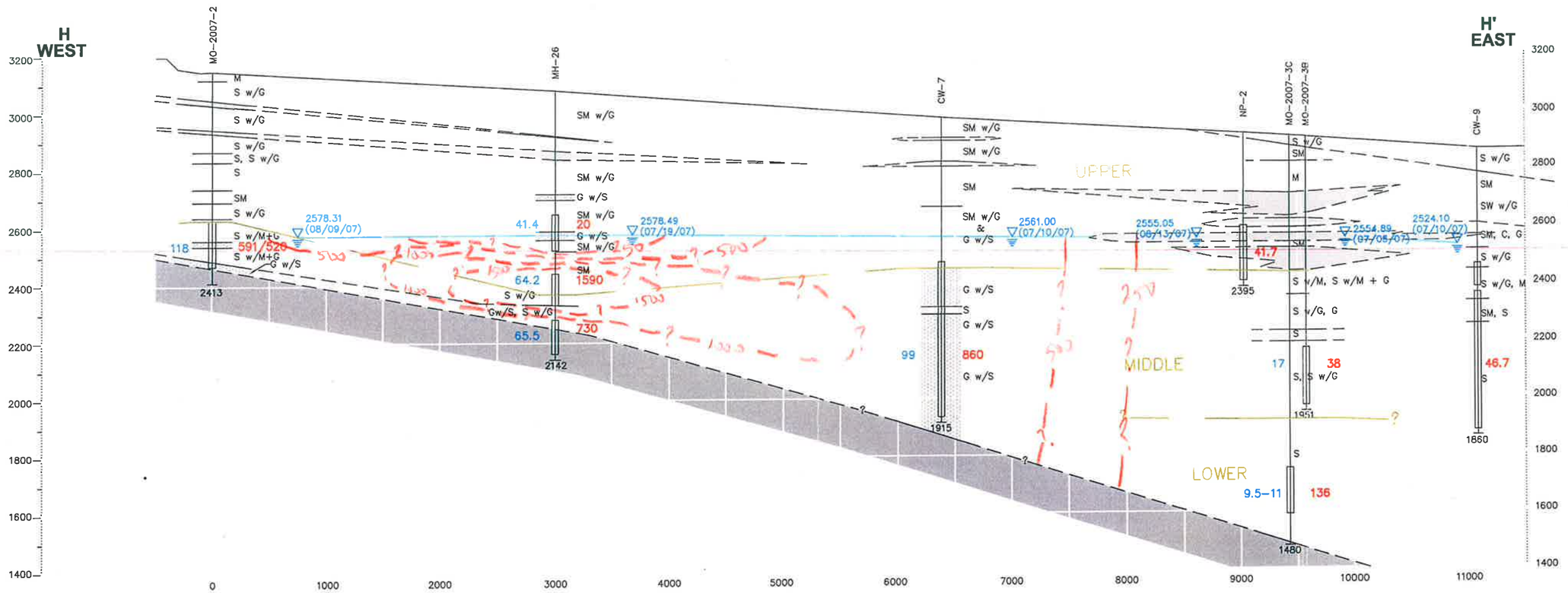
0 500 1000
SCALE IN FEET

Attachment

HYDRO GEO CHEM, INC.

F - F' CROSS SECTION SHOWING WATER QUALITY AND HYDRAULIC CONDUCTIVITY DATA SIERRITA TAILING IMPOUNDMENT AREA

Approved	Date	Revised	Date	Reference:	FIG.
KW	11/29/07			7830168A	H.6



LEGEND

BASIN FILL

- C — CLAY
- M — SILT
- SM — SILTY SAND
- S w/M — SAND WITH SILT
- SM w/G — SILTY SAND WITH GRAVEL
- S w/M+G — SAND WITH SILT AND GRAVEL
- S — SAND
- S w/G — SAND WITH GRAVEL
- G w/S — GRAVEL WITH SAND
- GRAVEL, GRAVEL w/ SAND, +/- COBBLES
- CLAY AND SILT

BEDROCK COMPLEX

- CRETACEOUS ANGELICA ARKOSE

HYDRAULIC CONDUCTIVITY (FEET/DAY) 7–30 ft/d
(APPENDIX E AND HGC, 2006a)

CW-7 — WELL ID

WELL

WATER LEVEL (DATE)

1,700 mg/L — SULFATE CONCENTRATION (MILLIGRAMS PER LITER) IN JULY THROUGH OCTOBER 2007 (APPENDIX B)
DUPLICATE SAMPLES ARE SEPARATED BY A FORWARD SLASH (/)

SCREEN

0 500 1000 2000
SCALE IN FEET

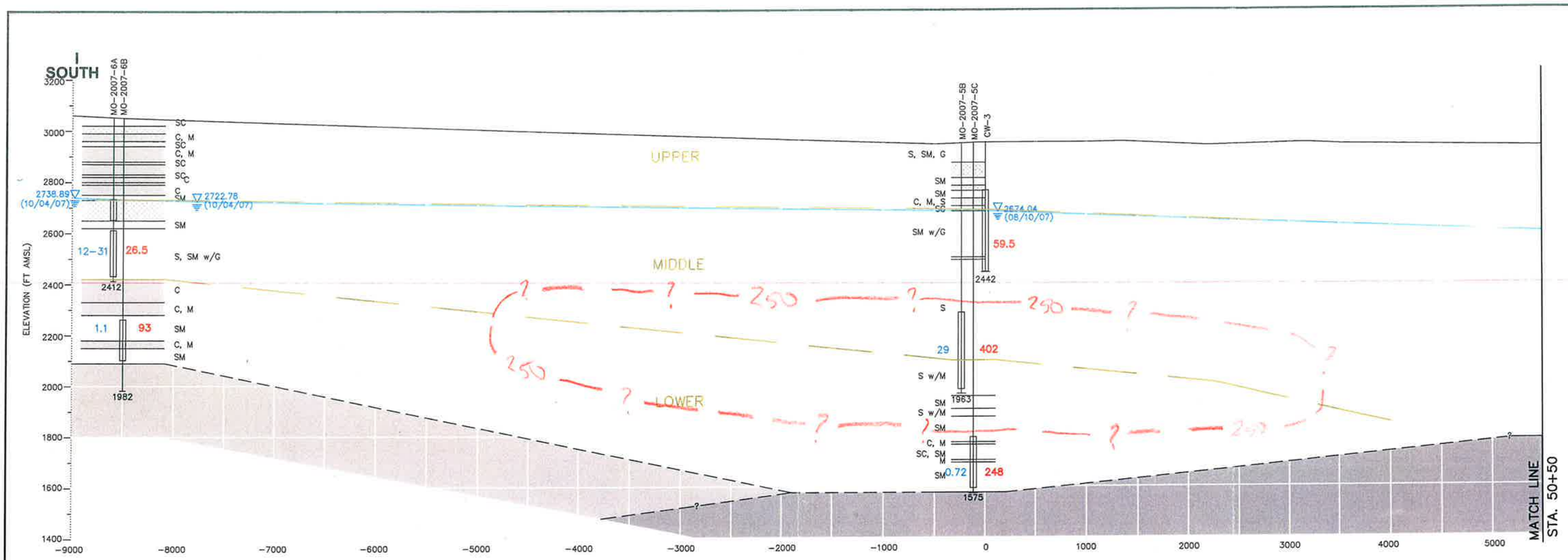
?—1000 Sulfate concentration contour, queried where uncertain

Attachment

HYDRO GEO CHEM, INC.

H - H' CROSS SECTION SHOWING WATER QUALITY AND HYDRAULIC CONDUCTIVITY DATA SIERRITA TAILING IMPOUNDMENT AREA

Approved	Date	Revised	Date	Reference:	FIG
KW	11/29/07			7830169A	H.7



LEGEND

BASIN FILL

- C — CLAY
- M — SILT
- S — SAND
- SC — CLAYEY SAND
- SM — SILTY SAND
- S w/M — SAND WITH SILT
- S&G — SAND AND GRAVEL
- S&Gw/C — SAND & GRAVEL WITH CLAY
- S w/G — SAND WITH GRAVEL
- G — GRAVEL
- GRAVEL, GRAVEL w/ SAND AND/OR SILT
- CLAY, SANDY CLAY, CLAY & SILT
- OLIGOCENE PANTANO FORMATION, CONGLOMERATE, SAND AND CLAY
- OLIGOCENE PANTANO FORMATION, QUARTZOSE SANDSTONE MARKER

BEDROCK COMPLEX

- FELSIC VOLCANICS
- CRETACEOUS ANGELICA ARKOSE

HYDRAULIC CONDUCTIVITY (FEET/DAY) 7-30 ft/d
(APPENDIX E AND HGC, 2006a)

ESP-3 — WELL ID

WELL

WATER LEVEL (DATE)

1,700 mg/L — SCREEN

SULFATE CONCENTRATION (MILLIGRAMS PER LITER) IN JULY THROUGH OCTOBER 2007 (APPENDIX B)
DUPLICATE SAMPLES ARE SEPARATED BY A FORWARD SLASH (/)

0 500 1000 2000
SCALE IN FEET

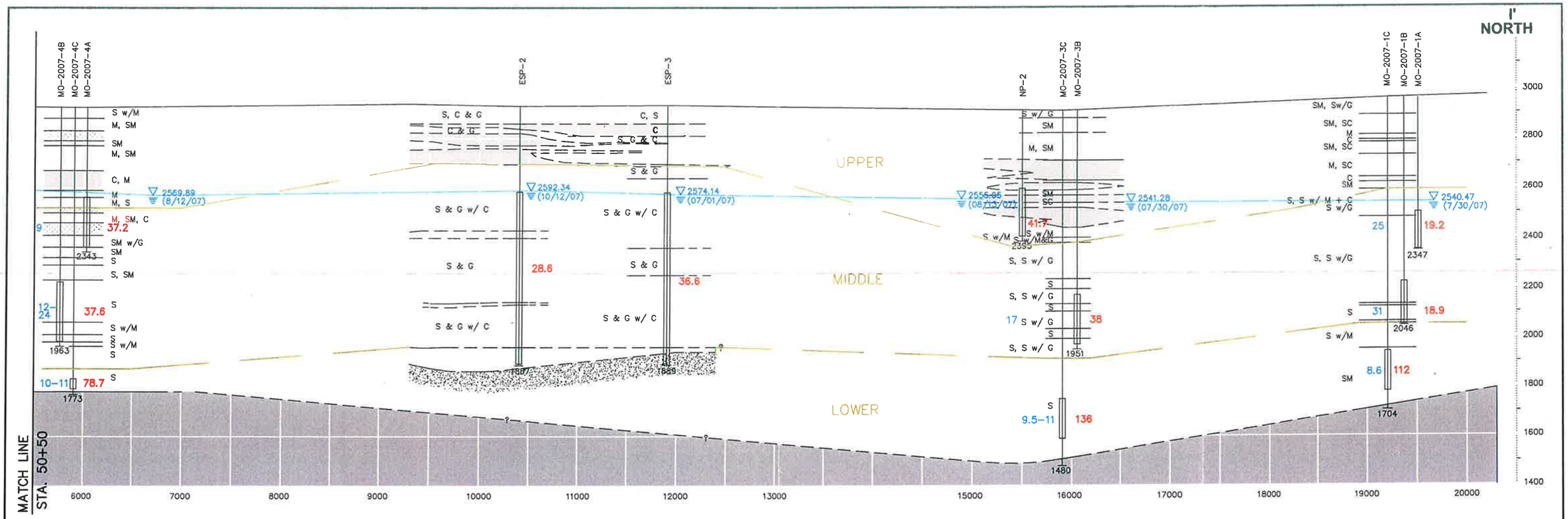
?-1000 — sulfate concentration contours, queried where uncertain

Attachment

HYDRO GEO CHEM, INC.

I - I' CROSS SECTION SHOWING WATER QUALITY AND HYDRAULIC CONDUCTIVITY DATA SIERRITA TAILING IMPOUNDMENT AREA STA. -90+00.00 TO 50+50.00 SHEET 1 OF 2

Approved	Date	Revised	Date	Reference:	FIG.
KW	11/29/07			7830170A	H.8a



LEGEND

BASIN FILL

- C — CLAY
- M — SILT
- S — SAND
- SC — CLAYEY SAND
- SM — SILTY SAND
- S w/M — SAND WITH SILT
- S&G — SAND AND GRAVEL
- S&G w/C — SAND & GRAVEL WITH CLAY
- S w/G — SAND WITH GRAVEL
- G — GRAVEL
- GRAVEL, GRAVEL w/ SAND, +/- COBBLES AND/OR BOULDERS
- CLAY, SANDY CLAY, CLAY & GRAVEL
- OLIGOCENE PANTANO FORMATION, CONGLOMERATE, SAND AND CLAY
- OLIGOCENE PANTANO FORMATION, QUARTZOSE SANDSTONE MARKER

BEDROCK COMPLEX

- FELSIC VOLCANICS
- CRETACEOUS ANGELICA ARKOSE

7 — 1000 — Sulfate Concentration contour, queried where uncertain.

ESP-3 — WELL ID

WELL

WATER LEVEL (DATE)

HYDRAULIC CONDUCTIVITY (FEET/DAY) 7–30 ft/d
(APPENDIX E AND HGC, 2006a)

1,700 mg/L — SCREEN

SULFATE CONCENTRATION (MILLIGRAMS PER LITER) IN JULY THROUGH OCTOBER 2007 (APPENDIX B)
DUPLICATE SAMPLES ARE SEPARATED BY A FORWARD SLASH (/)

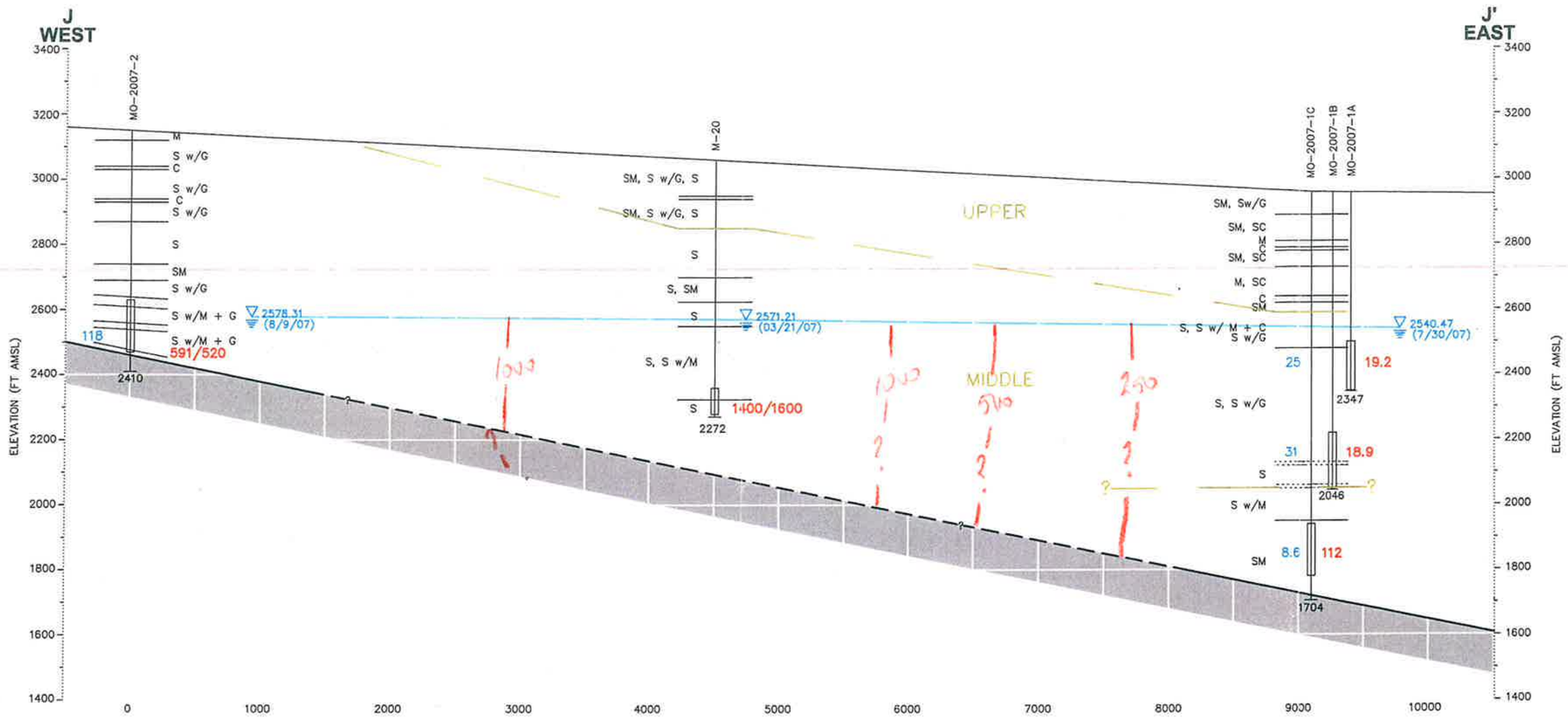
0 500 1000 2000
SCALE IN FEET

Attachment

HYDRO GEO CHEM, INC.

I - I' CROSS SECTION SHOWING WATER QUALITY AND HYDRAULIC CONDUCTIVITY DATA
SIERRITA TAILING IMPOUNDMENT AREA
STA. 50+50.00 TO 205+00.00 SHEET 2 OF 2

Approved	Date	Revised	Date	Reference:	FIG.
KW	11/29/07			7830170A	H.8b



LEGEND

BASIN FILL

- M — SILT
- SC — CLAYEY SAND
- SM — SILTY SAND
- Sw/M+C — SAND w/ SILT AND CLAY
- Sw/M — SAND w/ SILT
- S — SAND
- Sw/M+G — SAND w/ SILT + GRAVEL
- Sw/G — SAND w/ GRAVEL
- CLAY, CLAY & SILT, SANDY CLAY
- GRAVEL, GRAVEL W/ SAND

BEDROCK COMPLEX

- CRETACEOUS ANGELICA ARKOSE

0 500 1000 2000
SCALE IN FEET

HYDRAULIC CONDUCTIVITY (FEET/DAY) 7-30 ft/d
(APPENDIX E AND HGC, 2006a)

MO-2007-1C
WELL ID
WELL
WATER LEVEL (DATE)
1,700 mg/L
SCREEN

SULFATE CONCENTRATION (MILLIGRAMS PER LITER)
IN JULY THROUGH OCTOBER 2007 (APPENDIX B)
DUPLICATE SAMPLES ARE SEPARATED BY A FORWARD SLASH (/)

~~?~~ 1000 — Sulfate concentration contour, queried where uncertain

Attachment

HYDRO GEO CHEM, INC.

J - J' CROSS SECTION SHOWING WATER QUALITY AND HYDRAULIC CONDUCTIVITY DATA SIERRITA TAILING IMPOUNDMENT AREA

Approved	Date		Date	File Name	Figure
KW	11/29/07	DKW	11/29/07	7830171A	H.9