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(520) 648-8500

February 27, 2007

CERTIFIED MAIL #7002 1000 0005 6776
RETURN RECEIPT REQUESTED

Mr. Robert Casey
Arizona Department of Environmental Quality
Water Quality Enforcement Unit
1110 West Washington Street
Phoenix, Arizona 85007-2935

Re: Evaluation of the Current Effectiveness of the Sierrita Interceptor Wellfield, Phelps Dodge Sierrita, Inc. – Mitigation Order on Consent, Docket No. P-50-06

Dear Mr. Casey:

Phelps Dodge Sierrita, Inc. (PDSI) submits three copies of the attached Evaluation of the Current Effectiveness of the Sierrita Interceptor Wellfield Report. This document was prepared by Errol L. Montgomery and Associates, Inc. pursuant to Section III.C.4 of Mitigation Order P-50-06 and in accordance to Section 3.0 of the Work Plan.

The document concludes that due to a decrease in the saturated thickness of the aquifer underlying the Phelps Dodge Sierrita Tailings Impoundment (PDSTI), the northern portion of the middle interceptor wellfield and the north interceptor wellfield do not provide fully effective hydraulic capture. As a result, PDSI proposes to perform a focused feasibility study to evaluate potential options for improving the effectiveness of the interceptor wellfield. PDSI proposes to evaluate several alternatives for increasing the extent of capture. Potential alternatives would be developed and evaluated using the feasibility study approach described in Section 5 of the Mitigation Order Work Plan, with an emphasis placed on balancing the effectiveness of each alternative against the length of time it takes to permit and implement the alternative, its feasibility and its cost. If Arizona Department of Environmental Quality (ADEQ) agrees with this approach, PDSI would produce a report on this focused feasibility study within four months for review by ADEQ and placement in the document repository (and distribution to the Community Advisory Group [CAG]). The focused feasibility study would propose a recommended alternative for consideration by ADEQ and discussion with the CAG. PDSI will consider accelerated implementation of actions based upon the focused feasibility study. PDSI is committed to providing source control of seepage from the PDSTI, which is consistent with the overall objectives of Mitigation Order P-50-06.

Please do not hesitate to contact Mr. Stuart Brown at (503) 675-5252 or myself at (520) 648-8857 if you have any question regarding this submittal.

Very Truly Yours,

Ned Hall

E. L. (Ned) Hall
Chief Environmental Engineer

Attachment
20070228-001

cc: John Brack, Phelps Dodge Sierrita, Inc.
Chad Fretz, Phelps Dodge Sierrita, Inc.
Ray Lazuk, Phelps Dodge Corporation
Stuart Brown, Bridgewater Group, Inc.

February 26, 2007

EVALUATION OF THE CURRENT EFFECTIVENESS OF THE SIERRITA INTERCEPTOR WELLFIELD PHELPS DODGE SIERRITA MINE PIMA COUNTY, ARIZONA

Prepared for
Phelps Dodge Sierrita, Incorporated

ERROL L. MONTGOMERY & ASSOCIATES, INC.
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ERROL L. MONTGOMERY & ASSOCIATES, INC.

February 26, 2007

EVALUATION OF THE CURRENT EFFECTIVENESS OF THE SIERRITA INTERCEPTOR WELLFIELD PHELPS DODGE SIERRITA MINE PIMA COUNTY, ARIZONA

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ERROL L. MONTGOMERY & ASSOCIATES, INC.

February 26, 2007

EVALUATION OF THE CURRENT EFFECTIVENESS OF THE SIERRITA INTERCEPTOR WELLFIELD PHELPS DODGE SIERRITA MINE PIMA COUNTY, ARIZONA

Prepared for
Phelps Dodge Sierrita, Incorporated

EXECUTIVE SUMMARY

This report has been prepared for Phelps Dodge Sierrita, Incorporated (PDSI), to summarize an evaluation of the current effectiveness of the Sierrita interceptor wellfield in controlling movement of and capturing seepage containing sulfate from the Phelps Dodge Sierrita Tailing Impoundment (PDSTI). This report was prepared to satisfy the requirement in Section III.C.4 of Mitigation Order P-50-06 for an analysis of the effectiveness of PDSI's current groundwater sulfate source control system and in accordance with Task 3, Evaluation of PDSI Groundwater Sulfate Control System, in the October 31, 2006 Work Plan to Characterize and Mitigate Sulfate with Respect to Drinking Water Supplies in the Vicinity of the Phelps Dodge Sierrita Tailing Impoundment, Pima County, Arizona (Hydro Geo Chem, 2006).

TAILING IMPOUNDMENT DEVELOPMENT

- Discharge of tailing slurry from the Sierrita concentrator to the PDSTI began in March 1970 and has continued through present day **(Figures 1 and 2)**.

- Tailing slurry is presently discharged to the PDSTI through spigots installed on pipelines positioned along the PDSTI dam. The slope of the PDSTI surface permits decanted water to flow towards the reclaim pond. Decanted water (reclaim water) is then pumped back to the Sierrita concentrator for reuse in mineral beneficiation.

INTERCEPTOR WELLFIELD DEVELOPMENT

- A line of interceptor wells was constructed along the east and south edge of the PDSTI to control and capture seepage from the PDSTI. The first seven interceptor wells began pumping in April 1979 and the wellfield was expanded and upgraded several times between 1979 and 2004; the interceptor wellfield currently consists of 23 active wells **(Figures 1 and 2)**.

- The Sierrita interceptor wellfield has been divided into South, Middle, and North Wellfields based on aquifer thickness and pumping rates:

    - South Wellfield: IW-1, IW-2, IW-3, IW-3A, IW-4, IW-7, IW-8, IW-9, and IW-24;

    - Middle Wellfield: IW-5, IW-6, IW-6A, IW-10, IW-11, IW-22, and IW-23;

    - North Wellfield: IW-12 through IW-21.

- In the south wellfield, a large aquifer thickness accounts for large groundwater pumping rates. Interceptor wells in this area are capable of pumping 300 to 1,000 gallons per minute (gpm). A decrease in aquifer thickness of about 100 feet has occurred in the south wellfield since pre-wellfield conditions in 1977, primarily due to interceptor wellfield pumping **(Figure 3)**.

- In the middle wellfield, a moderate aquifer thickness results in pumping rates on the order of 150 to 400 gpm. A decrease in aquifer thickness of about 80 feet has occurred in the middle wellfield since pre-wellfield conditions in 1977, primarily due to interceptor wellfield pumping **(Figure 3)**.

- In the north wellfield, a small aquifer thickness results in small groundwater pumping rates. At the time of installation, interceptor wells in this area were capable of pumping on the order of 100 to 400 gpm. A decrease in aquifer thickness of about 60 feet has occurred in the north wellfield since pre-wellfield conditions in 1977, primarily due to groundwater pumping at the north wellfield **(Figure 3)**. As a result of the decrease in aquifer thickness, sustainable pumping rates have decreased to as little as 10 percent of the original pumping capacity. During 2006, average operational pumping rates in the north wellfield ranged from 10 to 180 gpm.

INTERCEPTOR WELLFIELD PUMPING

- Groundwater pumping from the interceptor wellfield has generally increased since 1979, when the first wells began pumping **(Figure 5)**; however, decreased saturated aquifer thickness in recent years **(Figure 4)** has resulted in reduced pumping capacity from some of the wells, particularly in the north wellfield **(Figure 8)**.

- In 2006, the operational run time for the wellfield averaged approximately 86 percent **(Figure 9)**. Total groundwater pumped from the interceptor wellfield in 2006 was about 7,900 acre-feet **(Figure 5)**.

- Of the 7,900 acre-feet of groundwater pumped in 2006, about 54 percent was from the south wellfield, 31 percent was from the middle wellfield, and 15 percent was from the north wellfield **(Figures 5 through 8)**.

- Based on the current configuration of interceptor wells and current aquifer thickness, and assuming an average run time of 90 percent, the estimated 2007 operational pumping capacity of the interceptor wellfield is about 5,000 gpm or about 8,100 acre-feet **(Table 2)**.

SULFATE MASS CAPTURE

- In general, the annual amount of sulfate mass captured by the interceptor wellfield has increased over time from about 5,000 tons in the early 1980s to about 15,000 tons in 2006 **(Figure 11)**.

- Of the 15,000 tons of sulfate captured in 2006, about 45 percent of the sulfate mass was captured from the south wellfield, 38 percent was captured by the middle wellfield, and about 17 percent was captured by the north wellfield **(Figure 11)**.

INTERCEPTOR WELLFIELD EFFECTIVENESS FOR CAPTURE OF PDSTI SEEPAGE

- Analysis of groundwater level gradients, sulfate concentrations in groundwater pumped from interceptor and monitor wells, and numerical simulation of groundwater movement indicates that the south wellfield and most of the middle wellfield can provide an effective hydraulic barrier to groundwater flow from the PDSTI when interceptor wells are consistently pumped **(Figures 12,**

13, and 18). However, limited aquifer thickness in the northernmost middle wellfield and north wellfield results in physical limitations that prevent sufficient pumping to develop an effective hydraulic barrier with the current wellfield configuration **(Figures 14 through 18)**.

February 26, 2007

EVALUATION OF THE CURRENT EFFECTIVENESS OF THE SIERRITA INTERCEPTOR WELLFIELD PHELPS DODGE SIERRITA MINE PIMA COUNTY, ARIZONA

Prepared for
Phelps Dodge Sierrita, Incorporated

INTRODUCTION

On behalf of Phelps Dodge Sierrita, Incorporated (PDSI), Errol L. Montgomery & Associates, Inc. (Montgomery & Associates) has prepared this report summarizing results of an evaluation of the current effectiveness of the Sierrita interceptor wellfield in controlling movement of and capturing seepage from the Phelps Dodge Sierrita tailing impoundment (PDSTI). The evaluation included a comprehensive review of interceptor wellfield operations and pumping history, hydrogeologic conditions in the vicinity of the wellfield, and groundwater quality data for the wellfield area.

This report was prepared to satisfy the requirement in Section III.C.4 of Mitigation Order P-50-06 for an analysis of the effectiveness of PDSI's current groundwater sulfate source control system and in accordance with Task 3, Evaluation of PDSI Groundwater Sulfate Control System, in the October 31, 2006 Work Plan to Characterize and Mitigate Sulfate with Respect to Drinking Water Supplies in the Vicinity of the Phelps Dodge Sierrita Tailing Impoundment, Pima County, Arizona (Hydro Geo Chem, 2006).

PDSI operates the PDSTI to receive discharge of tailing from mineral beneficiation at the Sierrita mill. The PDSTI is located about 2 miles southeast from the Sierrita mill, and about 1.5 miles west from the town of Green Valley. PDSI operates the Sierrita interceptor wellfield to control and capture seepage from the PDSTI. Locations for wells that comprise the interceptor wellfield are shown on **Figure 1.**

TAILING IMPOUNDMENT DEVELOPMENT AND OPERATION

Open-pit mining by Duval Corporation began at the Esperanza pit in October 1959 and at the Sierrita pit in March 1970. From 1959 through 1981, ore removed from the Esperanza pit was processed at the Esperanza concentrator, and tailing slurry from the Esperanza concentrator was discharged to the Esperanza tailing impoundment (ETI). From 1970 to present, ore removed from the Sierrita pit has been processed at the Sierrita concentrator, and tailing slurry has been discharged to the PDSTI. **Figure 2** shows six stages of development of the ETI and PDSTI from the early 1970s to present.

Discharge of mine tailing slurry from the Esperanza concentrator to the ETI was continuous from October 1959 through December 1971 and from January 1973 through December 1978; and was intermittent from January 1979 through December 1981, when the ETI was closed. The surface of the ETI was subsequently capped with a layer of alluvial material (Reed & Associates, 1986).

Discharge of mine tailing slurry from the Sierrita concentrator to the PDSTI began in March 1970 and has continued through present day **(Figure 2)**. Tailing slurry is presently discharged to the PDSTI through banks of spigots installed on pipelines positioned along the crest of the PDSTI dam. Slurry discharge is progressively moved around the perimeter of the PDSTI to ensure even distribution of tailings across the surface of the PDSTI. The slope of the PDSTI surface allows decanted water to flow to the west where the water collects at the reclaim pond. Water from the reclaim pond is then pumped back to the Sierrita concentrator for reuse in mineral beneficiation.

INTERCEPTOR WELLFIELD DEVELOPMENT AND OPERATION

In the mid 1970s, results of monitor well installation and groundwater sampling along the east edge of the PDSTI indicated that elevated concentrations of sulfate were present in the aquifer in these areas. In 1978, Duval Corporation initiated development of an interceptor wellfield to control eastward movement of seepage from the PDSTI. Operation and expansion of the interceptor wellfield have continued to date, with 23 interceptor wells currently being operated by PDSI **(Figure 1)**. Groundwater pumped from the interceptor wellfield is conveyed back to the Sierrita concentrator for use in mineral beneficiation operations.

Interceptor wells IW-1 through IW-11 were installed between 1978 and 1984 by Duval Corporation (Reed & Associates, 1986). Interceptor wells IW-6A, and IW-12 through IW-21 were installed in 1994 and 1995 by Cyprus Sierrita Corporation (Montgomery & Associates, 1995). Interceptor wells IW-22, IW-23, IW-24, and IW-3A were installed in 2003 and 2004 by PDSI (Montgomery & Associates, 2004a). The overall progression of monitor well installation and interceptor wellfield development is shown on **Figure 2**.

The numbers assigned to the interceptor wells reflect the chronological order in which they were drilled. Because of small pumping capacity at well IW-7 and poor well conditions at wells IW-6 and IW-3, these wells are presently unequipped and capped. Interceptor wells IW-3 and IW-6 were replaced by wells IW-3A and IW-6A. The interceptor wellfield study area is shown on **Figure 1** and schematic diagrams for each well are given in **Appendix A.** Records for interceptor wells and monitor wells shown on **Figure 1** are summarized in **Table 1.**

Hydrogeologic Conditions

Regional hydrogeologic conditions for the upper Santa Cruz basin are given in Davidson (1973), Pima Association of Governments (1979, 1983a, 1983b, and 1983c), Murphy and Hedley (1984), and Anderson (1987). Hydrogeologic conditions in the vicinity of the Sierrita Mine are summarized in Montgomery & Associates and Dames & Moore (1994), Montgomery & Associates (1987, 1989, 1991, 2001, and 2006) and Hydro Geo Chem (2006). The principal hydrogeologic units in the vicinity of the PDSTI and interceptor wellfield include recent alluvial deposits, basin-fill deposits, and a bedrock complex. The basin-fill deposits comprise the principal aquifer in the area, and is the principal source of water pumped from the interceptor wells. Detailed lithologic descriptions for hydrogeologic units in the interceptor wellfield area are provided in Montgomery & Associates and Dames & Moore (1994) and Montgomery & Associates (1991, 1995, 2004a, 2006).

A generalized hydrogeologic section of the interceptor wellfield area is shown on **Figure 3**. Based on aquifer thickness and interceptor well pumping rates, the interceptor wellfield has been divided into three parts:

- South Wellfield: IW-1, IW-2, IW-3, IW-3A, IW-4, IW-7, IW-8, IW-9, and IW-24;
- Middle Wellfield: IW-5, IW-6, IW-6A, IW-10, IW-11, IW-22, and IW-23;
- North Wellfield: IW-12 through IW-21.

Saturated thickness of the basin-fill deposits aquifer is largest in the south wellfield, and decreases substantially to the north as the depth to bedrock decreases. Since installation of interceptor wells, the saturated thickness of the basin-fill deposits has decreased by about 100 feet in the south wellfield and about 60 feet in north wellfield. However, percent reduction in saturated thickness has been substantially larger in the north wellfield, with reduction in aquifer thickness approaching 80 percent in some areas.

Groundwater level hydrographs for the period 2003 through 2006 for monitor wells located in the south, middle, and north wellfields are shown on **Figure 4**. Inspection of the hydrographs indicates that groundwater levels declined in all three parts of the wellfield during this time period. In the south wellfield, decline was about 35 feet; in the middle wellfield, maximum decline was nearly 60 feet; in the north wellfield, decline was about 30 feet. Observed groundwater level declines at the wellfield area during the period 2003 through 2006 appear to be primarily due to increased pumping of groundwater from some parts of the wellfield during this period.

In the south wellfield, large saturated thickness of basin-fill deposits allows larger groundwater pumping rates. Wells in the south wellfield are capable of pumping 300 to 1,000 gallons per minute (gpm). In the middle wellfield, moderate aquifer thickness results in pumping rates on the order of 150 to 400 gpm. In the north wellfield, the relatively small saturated thickness of basin-fill deposits results in small groundwater yields. Wells in the north wellfield were originally capable of pumping on the order of 100 to 400 gpm. Because of decreasing aquifer thickness, the sustainable pumping rate for the north wellfield has decreased to about 30 percent of original design pumping capacity. During 2006, average operational pumping rates in the north part of the wellfield ranged from 10 to 180 gpm.

ANALYSIS AND RESULTS

This evaluation included a comprehensive review of current interceptor wellfield operations and pumping history, hydrogeologic conditions in the vicinity of the wellfield, and groundwater quality data for the wellfield area. Analysis and results are given in the following progression:

- Analyses of annual volumes of groundwater and sulfate mass removal by the interceptor wellfield,
- Results of groundwater monitoring, and
- Results of groundwater flow modeling capture analysis for the interceptor wellfield.

INTERCEPTOR WELLFIELD PUMPING

The interceptor wellfield has been operating from 1979 through present. Wellfield data for this operational period are summarized on the following illustrations:

- Annual groundwater pumped from the entire interceptor wellfield **(Figure 5)**
- Annual groundwater pumped from the south wellfield **(Figure 6)**
- Annual groundwater pumped from the middle wellfield **(Figure 7)**
- Annual groundwater pumped from the north wellfield **(Figure 8)**

Annual groundwater pumped for each interceptor well is shown on **Figures B-1 through B-24 (Appendix B)**.

Annual groundwater pumping generally increased from about 3,600 acre-feet in 1979 to a maximum of 8,640 acre-feet in 1994 **(Figure 5)**. Wellfield pumping decreased from 1995 through 1996 due to substantial pumping decreases in the south and middle wellfields **(Figures 6 and 7)**. Groundwater pumping generally increased from 1997 through 2000 as existing wells were pumped near operational capacity and as 10 additional wells in the north wellfield (IW-12 through IW-21) began operation in late 1996 **(Figure 8)**. Groundwater pumping decreased in 2001 primarily as a result of decreased pumping from the middle wellfield **(Figure 7)**. Groundwater pumping also decreased in 2003 due to decreased pumping in the south wellfield **(Figure 7)**. Annual groundwater pumped during 2004 through 2006 was relatively constant at about 8,000 acre-feet per year **(Figure 5)**.

Of the 7,900 acre-feet of groundwater pumped in 2006, about 54 percent was from the south wellfield, 31 percent was from the middle wellfield, and 15 percent was from the north wellfield **(Figures 5 through 8)**.

Wellfield percent run time data are available for years 2003 through 2006; average percent run time for the entire wellfield is shown on **Figure 9**. Average operational run time increased from about 36 percent in 2003 to 86 percent in 2006. **Figure 10** shows average percent run time and annual groundwater pumping volumes for the south, middle, and north wellfields for 2003 through 2006. In general, operational run time percentages for all three parts of the wellfield increased from 2003 through 2006 with the largest increase occurring in the north wellfield from about 24 percent in 2003 to about 90 percent in 2006. However, despite the increased operational run time percentage over the 4-year period, annual groundwater pumping volumes for the middle and north wellfields showed little to no increase. This is due to decreasing saturated aquifer thickness and the resulting reduction in pumping capacities for many of the wells in the middle and north wellfields.

Based on the current configuration of interceptor wells and current aquifer thickness, and assuming an average run time of 90 percent, the estimated 2007 operational pumping capacity of the interceptor wellfield is about 5,000 gpm or about 8,100 acre-feet **(Table 2)**.

Sulfate Mass Capture

Annual sulfate mass captured by the interceptor wellfield was computed using annual groundwater pumped and annual average sulfate concentrations for each individual well. Annual average sulfate concentrations for each interceptor well are shown on **Figures B-1 through B-24** (**Appendix B)**. Annual average sulfate concentrations for intercepted groundwater for the entire wellfield, and for the south, middle, and north wellfields were computed and are shown on **Figures 5 through 8.** Annual average sulfate concentrations for the wellfield were calculated using reported sulfate concentrations for individual wells for a given year and were weighted based on the annual average pumping volume for the wells. For example, for the entire wellfield calculation **(Figure 5)**, the average sulfate concentration for a single well for a given year was multiplied by the amount of groundwater pumped by that well for that year divided by the total groundwater pumped for all the wells for that year. The weighted values for all the wells were summed to give an average concentration for the entire wellfield, and similarly for the south, middle, and north wellfields. For years when sulfate concentrations are unavailable for individual wells, and when those wells pumped groundwater, the sulfate concentration for that year was computed using the average of the previous and subsequent years.

For the entire wellfield, the average sulfate concentration of intercepted water generally increased from about 900 milligrams per liter (mg/L) in the early 1980s to about 1,700 mg/L in 2002 and then decreased slightly to about 1,400 mg/L by 2006 **(Figure 5)**. Sulfate concentrations in the south wellfield showed a similar trend to the calculated concentrations for the entire wellfield with a more pronounced decrease in sulfate concentration occurring from about 1,500 mg/L in 2002 to less than 900 mg/L in 2006

(Figure 6). Sulfate concentrations in the middle wellfield increased from about 1,300 mg/L in 1980 to about 2,000 mg/L in 2002 and then decreased to about 1,700 mg/L in 2006 **(Figure 7)**. In the north wellfield, sulfate concentrations have generally increased from about 1,300 mg/L in 1997 to about 1,600 mg/L in 2006 **(Figure 8)**.

Cumulative sulfate mass capture for the south, middle, and north wellfields for the period 1980 through 2006 is shown on **Figure 11**. In general, sulfate mass capture increased from about 4,800 tons in 1982 to about 17,000 tons in 1999. After about 1986, relatively low sulfate mass capture occurred in 1990, 1996, and 2001, corresponding to years of low groundwater pumping from the interceptor wellfield **(Figure 5).** During 2004 through 2006 the cumulative sulfate mass capture averaged about 15,000 tons per year with relatively consistent sulfate capture for each part of the wellfield.

INTERCEPTOR WELLFIELD EFFECTIVENESS FOR CAPTURE OF PDSTI SEEPAGE

Effectiveness of the interceptor wellfield in capturing groundwater seepage from the PDSTI was analyzed by two methods:

1. GROUNDWATER MONITORING: Groundwater levels and sulfate concentrations at interceptor wells and monitor well suites were used to determine the capture effectiveness at specific locations in the south, middle, and north wellfields; and

2. GROUNDWATER MODELING: A particle-tracking analysis using a numerical groundwater flow model was conducted to evaluate the effectiveness of the entire interceptor wellfield in capturing groundwater seepage from the PDSTI.

Groundwater Monitoring

The interceptor wellfield can provide an effective hydraulic barrier to groundwater flow when the water table is lowered sufficiently to create a hydraulic line-sink along the length of the wellfield. The groundwater depression along the line-sink should be sufficiently large that reversal of the hydraulic gradient occurs along the full distance between pumping wells. In 1990, the MH-15 and MH-16 paired monitor well suites were constructed between interceptor wells IW-10 and IW-11, and IW-3 and IW-8, respectively, to determine if the hydraulic line-sink was effective at these locations (Montgomery & Associates, 1991). In addition, monitor well MH-14 was constructed and paired with existing monitor well MH-3 to evaluate groundwater level gradients in what is now considered the north wellfield. The MH-14 monitor well suite is located between interceptor wells IW-18 and IW-19. Locations for the monitor well suites are shown in **Figure 1**.

For this evaluation, groundwater level and groundwater quality data for the MH-16, MH-15 and MH-14 monitor well suites were analyzed to determine if an effective hydraulic line-sink has been established between selected interceptor well pairs in the south, middle, and north wellfields. Although 13 new interceptor wells have been installed since the monitor well suites were established in 1990, the MH-16 and MH-14 monitor well suites are still located at a mid-point between operating pairs of interceptor wells.

SOUTH WELLFIELD: **Figure 12** shows water level altitudes at the MH-16 monitor well suite, for the time period from July 2003 through 2006. Inspection of **Figure 12** shows that from June 2003 through about August 2004 groundwater level altitude at well MH-16W was higher than well MH-16E, indicating the hydraulic gradient at this location was to the east, concordant with the regional gradient. During this time, well IW-3A was not pumping at operational capacity **(Figure B-3)**. Starting in September 2004 and continuing until the end of April 2006, wells IW-3A and IW-8 were pumping at or near operational capacity **(Figures B-3 and B-8)** which resulted in a reversal of the gradient (from east to west) for most of that 20-

month period. At the end of April 2006, well IW-8 was shutdown for well rehabilitation which led to a groundwater level rise at the well MH-16 monitor well suite and a gradient change directed back to the east. These relations illustrate that the south wellfield at this location can be effective in capturing PDSTI seepage when interceptor wells are pumped at operational capacity.

Figure 13 shows annual groundwater pumping and average sulfate concentrations in groundwater for wells IW-3, IW-3A, and IW-8 along with sulfate concentrations in groundwater at well MH-16W for the period 1979 through 2006. From 1990 through 1995, average sulfate concentrations at interceptor wells IW-3 and IW-8 ranged from about 800 mg/L to larger than 1,600 mg/L. Conversely, sulfate concentrations measured at monitor well MH-16W during this time period had stabilized at about 50 mg/L, which is in the range of ambient concentrations for the regional aquifer. These relations indicate that, during this period, the interceptor wellfield at this location was effective in capturing PDSTI seepage. However, between 1996 and about 2000, combined pumping rates for wells IW-8 and IW-3 were smaller **(Figures B-3 and B-8)**. This resulted in an increase in sulfate concentrations at monitor well MH-16W to more than 1,500 mg/L by 1998, indicating less seepage capture at this location. Sulfate concentration in groundwater continued to increase at well MH-16W to more than 2,000 mg/L in 2001. By 2001, pumping from interceptor wells IW-3 and IW-8 began increasing once again to pre-1996 levels, and sulfate concentrations at monitor well MH-16W began to decrease. In 2006, observed sulfate concentration at monitor well MH-16W had decreased to about 1,000 mg/L.

MIDDLE WELLFIELD: **Figure 14** shows groundwater level altitudes at the MH-15 monitor well suite for the period from July 2003 through 2006. From July 2003 through June 2005, prior to commencement of pumping at well IW-22, comparison of measured water level altitudes at well MH-15W and MH-15E indicated that hydraulic gradient was to the east and concordant with the regional gradient, indicating that seepage capture was not complete at this location. During this time, wells IW-10 and IW-11 were not pumped at operational capacity **(Figures B-10 and B-11)**. However, during the period January through April 2005, wells IW-10 and IW-11 were pumped near operational capacity and the hydraulic gradient decreased but was not reversed.

In 2004, interceptor wells IW-22, IW-23, and IW-24 were installed in between existing interceptor wells to improve capture in this part of the wellfield. Well IW-22 was installed between wells IW-10 and IW-11 and began operation in July 2005, diminishing the effectiveness of this monitor well suite for monitoring development of a continuous hydraulic line-sink between interceptor wells IW-10 and IW-11. Inspection of **Figure 14** for the period July 2005 through 2006 shows that reversal of hydraulic gradient had occurred most of the time at the MH-15 monitor well suite, indicating improved effectiveness of the wellfield in this area.

Figure 15 shows annual groundwater pumping and average sulfate concentrations in groundwater for wells IW-10, IW-11, and IW-22 along with sulfate concentrations in groundwater at well MH-15W for the period 1986 through 2006. Average sulfate concentrations at wells IW-10, IW-11, and IW-22 generally ranged from about 1,500 mg/L to more than 2,000 mg/L and averaged about 1,750 mg/L. Sulfate concentrations at well MH-15W generally ranged from about 1,500 mg/L to about 2,300 mg/L and averaged about 1,750 mg/L; indicating incomplete capture at this location.

NORTH WELLFIELD: **Figure 16** shows groundwater level altitudes at the MH-14 monitor well suite for the time period from July 2003 through 2006. The hydraulic gradient at this location for the entire time period was to the east, concordant with the regional gradient, illustrating that this portion of the interceptor wellfield is less effective than the south and middle wellfields in capturing PDSTI seepage. Groundwater pumping did not occur at wells IW-18 and IW-19 during the time period from July 2003 through January 2004 **(Figures B-18 and B-19)**. From January 2004 through about February 2005, wells IW-18 and IW-19 were pumping near operational capacity and this resulted in a decrease in the magnitude of the gradient at the monitor well suite and substantial groundwater level declines **(Figure 16)**. For most of 2005 and 2006, pumping decreased at well IW-18 **(Figure B-18)** and this resulted in an increase in the magnitude of the gradient between the MH-3 and MH-14 monitoring suite. Due to declining groundwater levels at this location, the pumping rate of IW-18 was reduced from about 85 gpm in 2004 to 10 gpm in 2006. The rate of water level decline at the monitoring suite decreased substantially in 2006, which suggests that at this location the system is approaching hydraulic equilibrium based on nearly continuous pumping at well IW-18 (90 percent run time in 2006) and well IW-19 (94 percent run time in 2006).

Figure 17 shows annual groundwater pumping and average sulfate concentrations in groundwater for wells IW-18 and IW-19 along with sulfate concentrations in groundwater at well MH-14. Average sulfate concentrations at wells IW-18 and IW-19 increased from about 1,300 mg/L in 1997 to about 1,600 mg/L in 2004. Sulfate concentrations at well MH-14 ranged from about 1,200 mg/L in 1997 to about 1,500 mg/L in 2004 indicating incomplete capture during this time period at this location. Sulfate concentrations in groundwater from wells IW-18, IW-19, and MH-14 have remained relatively constant from 2004 through 2006.

Groundwater Modeling

Preliminary groundwater flow-path modeling has been conducted to evaluate the effectiveness of the interceptor wellfield based on the current wellfield configuration.

Groundwater flow paths from the PDSTI to the interceptor wellfield were simulated using a modified version of the numerical groundwater flow model constructed in support of the 1994 Aquifer Protection Permit application for the Sierrita Mine property (Montgomery and Associates, 1994). The model was updated in 2004 for evaluation of groundwater flow and sulfate transport in the vicinity of the PDSTI. The flow model was constructed using MODFLOW, a finite-difference groundwater flow model developed by the U.S. Geological Survey (USGS) (McDonald and Harbaugh, 1988). Flow paths are simulated with particles using the particle path model MODPATH, a code developed by USGS for use with the MODFLOW code (Pollock, 1994).

The model is constructed as one layer with grid cell spacing of 50 by 50 feet in the vicinity of the interceptor wellfield. The bottom of the model layer coincides with bedrock surface, as encountered during drilling of exploration boreholes and the interceptor wells. Rates for PDSTI seepage and interceptor well pumping were updated in the model through 2006; the model results reasonably reproduce groundwater level altitudes observed in the vicinity of the wellfield in 2006. The hydrogeologic section shown on **Figure 3** depicts the bedrock altitude and 2006 groundwater level altitude along the interceptor wellfield.

For the particle-tracking analysis, interceptor well pumping rates were updated based on current pumping capacity and assuming a 90 percent run time for each well. Estimated interceptor well pumping rates for 2007 are given in **Table 2**. A preliminary water balance for the PDSTI (Montgomery & Associates, 1989) was updated to estimate seepage volume through 2006. Under equilibrium conditions and using an interceptor wellfield pumping volume for 2007 of 8,107 **(Table 2)** acre-feet, particles were released along the south, east, and northeast edge of the PDSTI. Projected capture zones as defined by simulated flow paths, and contours of simulated groundwater level altitude, are shown on **Figure 18**. Results of the analysis suggest the following:

SOUTH WELLFIELD: Particles along the southern part of the PDSTI are captured by the south wellfield, suggesting that pumping from the south wellfield effectively acts as a barrier to eastward movement of PDSTI seepage.

MIDDLE WELLFIELD: Particles from the middle part of the PDSTI are captured along most of the middle wellfield. Some particles pass by well IW-6A, which is the northernmost interceptor well in the middle wellfield, suggesting effective hydraulic capture exists south from interceptor well IW-11, but not north of it. Consistent with model results, observed aquifer thickness in this area is approximately 75 feet, which limits pumping in well IW-6A and prevents development of an effective hydraulic line-sink between well IW-6A and adjacent wells IW-11 and IW-12.

NORTH WELLFIELD: The model further shows that particles from the north part of the PDSTI are only partially captured, indicating that effective hydraulic capture does not exist in the north wellfield. Consistent with model results, observed aquifer thickness along the north wellfield ranges from about 30 feet at well IW-16 to about 300 feet at well IW-12, which limits pumping in the north wellfield and prevents hydraulic capture.

DISCUSSION AND RECOMMENDATION

INTERCEPTOR WELLFIELD OPERATION AND MAINTENANCE

Maximum effectiveness of the interceptor wellfield can be achieved with consistent operation and maintenance of wells and pipeline infrastructure. Routine monitoring and analysis of wellfield operational parameters, and implementation of a preventative maintenance program linked to the monitoring program, provides a basis for consistent wellfield operation. Since June 2003, PDSI has developed and implemented an Operation and Maintenance program to maintain consistent operation of the interceptor wellfield (Montgomery & Associates, 2004b, 2004c, and 2005). In 2006, the average percent run time for the wellfield was about 86 percent **(Figure 9),** with an annual pumpage volume of about 7,900 acre-feet. It is important to note that 100 percent run time is not possible to achieve given that routine maintenance (e.g. pump replacement and well rehabilitation) must occur on the wellfield infrastructure to keep it operational.

INTERCEPTOR WELLFIELD EFFECTIVENESS FOR CAPTURE OF PDSTI SEEPAGE

The effectiveness of the Sierrita interceptor wellfield in capturing seepage from the PDSTI has been evaluated by review and analysis of wellfield operational data and groundwater monitoring data, and by particle-tracking analysis using a numerical groundwater flow model. Results of this evaluation indicate that the interceptor wellfield can provide effective capture of seepage in the south and most of the middle wellfields. However, as presently constructed, the northernmost portion of the middle wellfield and north wellfield are only partially effective.

South Wellfield

The south wellfield can provide an effective hydraulic barrier when interceptor wells are consistently pumped. Effective hydraulic control and seepage capture have been documented for the south wellfield in the past, and is presently occurring **(Figures 12, 13, and 18)**.

Middle Wellfield

Installation of wells IW-22, IW-23, and IW-24 in 2004 has improved the effectiveness of the middle wellfield. However, large well spacing and small saturated thickness in the vicinity of wells IW-6A and IW-11 prevents sufficient pumping to develop an effective hydraulic barrier in the north part of the middle wellfield **(Figures 14, 15, and 18)**.

North Wellfield

In the north wellfield, small aquifer thickness prevents sufficient pumping to develop an effective hydraulic barrier **(Figure 16, 17, and 18)**.

RECOMMENDATION

PDSI is committed to providing source control of seepage from the PDSTI, which is consistent with the overall objectives of Mitigation Order P-50-06. Given that the northern portion of the middle wellfield and the north wellfield have been determined to not provide effective hydraulic capture, PDSI proposes to perform a focused feasibility study to evaluate potential options for improving the effectiveness of the interceptor wellfield. PDSI proposes to evaluate at least three alternatives for increasing the extent of capture. Alternatives to be evaluated may include installation of: 1) additional small-capacity wells near the PDSTI in the northern portion of the middle wellfield and north wellfield, 2) a horizontal well near the PDSTI, or 3) several large-capacity wells east of the PDSTI. Potential alternatives should be developed and evaluated using the feasibility study approach described in Section 5 of the Mitigation Order Work Plan, although emphasis should be placed on balancing the effectiveness of each alternative against the length of time it takes to permit and implement the alternative, its feasibility and its cost. If Arizona Department of Environmental Quality (ADEQ) agrees with this approach, PDSI would produce a report on this focused feasibility study within four months for review by ADEQ, placement in the document repository [and distribution to the CAG]. The focused feasibility study should propose a recommended alternative for consideration by ADEQ and discussion with the Community Advisory Group. PDSI will consider accelerated implementation of actions based upon the focused feasibility study.

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TABLE 1. RECORDS FOR INTERCEPTOR AND MONITOR WELLS IN VICINITY OF SIERRITA INTERCEPTOR WELLFIELD, SIERRITA MINE, PIMA COUNTY, ARIZONA

WELL NAME	CADASTRAL	OWNER	ADWR REGISTRATION NUMBER	DATE COMPLETED	DEPTH DRILLED (feet below land surface)	CASING DIAMETER (inches)	CASING DEPTH (feet)	CASING PERFORATED INTERVAL (feet below land surface)	REPORTED PUMPING RATE (gpm)[a]	ALTITUDE OF LAND SURFACE (feet, msl)[b]	NON-PUMPING WATER LEVEL DEPTH (feet)[c]	NON-PUMPING WATER LEVEL DATE MEASURED	NON-PUMPING WATER LEVEL ALTITUDE (feet, msl)[b]	LOG[d]	USE[e]
INTERCEPTOR WELLS															
IW-1	(D-18-13)29dcd	PDSI	623129	7/31/1978	855	14	843	234-843	1,200	3,141	349.89	3/15/2005	2,758	D,L	I
IW-2	28ccc	PDSI	623130	5/18/1978	1,035	16	0-700	40-1,035	1,529	3,098	331.88	3/15/2005	2,704	D,L	I
						12.75	560-930								
						10.75	891-1,011								
						8.63	1,005-1,035								
IW-3	28cbc1	PDSI	623131	7/9/1978	1,047	14	1,041	232-1,041	1,001	3,118.44	331.17	12/2/2003	2,787.27	D,L	I,U
IW-3A	28cbc2	PDSI	201732	2/3/2004	1,052	14	1,050	400-1,030	1,000	3,117 ?	353	9/14/2006	2,785	D,L,GL	I
IW-4	28bbc	PDSI	623132	7/23/1978	946	14	946	334-946	1,300	3,134.07	385.75	3/14/2006	2,748.32	D,L	I
IW-5	21ccc	PDSI	623133	6/13/1979	956	14	956	301-956	---	3,134.66	372.55	12/17/2005	2,762.11	D,L	I
IW-6	21bcc2	PDSI	623134	6/21/1979	489	14	489	297-489	---	3,130	317.09	10/12/1993	2,812.91	D,L	I,U
IW-6A	21bcc3	PDSI	545565	11/29/1994	498	12	497	356-458	300	3,129.27	380.18	10/22/2005	2,749.09	D,L	I
IW-7	29cdd2	PDSI	623135	9/ /1979	1,050	14	1,045	321-1,045	---	3,161	342	3/18/1981	2,819	D,L	I,U
IW-8	28cbb2	PDSI	508236	8/ /1984	803	14	783	382-783	---	3,119.20	363.44	9/27/2005	2,755.76	D,L	I
IW-9	28bcc2	PDSI	508238	8/6/1984	853	14	853	412-853	725	3,099.98	340.55	11/18/2005	2,759.43	D,L	I
IW-10	21ccb1	PDSI	508237	8/15/1984	843	14	831	420-831	1,350	3,126.65	363.20	6/24/2005	2,763.45	D,L	I
IW-11	21cbb	PDSI	508235	8/24/1984	605	14	605	371-605	1,150	3,124.21	381.30	8/13/2006	2,742.91	D,L	I
IW-12	21bcb	PDSI	545555	12/6/1994	625	12	600	358-559	400	3,135.19	368.35	4/15/2006	2,766.84	D,L	I
IW-13	21bbc	PDSI	545556	12/12/1994	499	12	497	355-456	175	3,140.36	386.25	3/14/2006	2,754.11	D,L	I
IW-14	21bbb2	PDSI	545557	12/18/1994	553	12	549	357-507	200	3,143.43	379.95	3/14/2006	2,763.48	D,L	I
IW-15	16ccc	PDSI	545558	1/7/1995	550	12	547	355-506	175	3,149.03	387.55	3/14/2006	2,761.48	D,L	I
IW-16	16ccb	PDSI	545559	1/15/1995	473	12	469	357-427	100	3,159.86	399.6	1/14/2006	2,760.26	D,L	I
IW-17	16cbc	PDSI	545560	1/20/1995	502	12	499	357-457	200	3,157.77	426.35	8/13/2006	2,731.42	D,L	I
IW-18	16cbb	PDSI	545561	1/24/1995	508	12	503	381-461	150	3,168.16	441.60	1/14/2006	2,726.56	D,L	I
IW-19	16bcc3	PDSI	545562	1/30/1995	544	12	540	378-499	400	3,152.40	418.60	11/11/2006	2,733.80	D,L	I
IW-20	16bcb	PDSI	545563	2/5/1995	506	12	502	380-460	200	3,161.22	421.25	11/11/2006	2,739.97	D,L	I
IW-21	16bbc	PDSI	545564	2/12/1995	620	12	601	399-560	300	3,168.38	424.8	11/11/2006	2,743.58	D,L	I
IW-22	21cbc3	PDSI	200554	12/19/2003	592	14	590	359-560	600	3,119	390.5	3/14/2006	NA	D,L,GL	I
IW-23	21ccb2	PDSI	200555	1/18/2004	974	14	964	375-935	300	3,117	377.75	3/14/2006	NA	D,L,GL	I
IW-24	28bbb3	PDSI	200556	1/3/2004	884	14	880	348-860	350	3,101	353.9	3/14/2006	NA	D,L,GL	I
MONITOR WELLS															
MH-1	(D-18-13)16bbb	PDSI	803629	11/19/1975	524	3	480	420-480	---	3,176.28	443.9	11/21/2006	2,732.38	D,L	M
MH-2	28ccd2	PDSI	35-34590	11/26/1975	1,040	3	1,038	520-1,038	---	3,097	295	5/15/1979	2,802	D,L	M,Z
MH-3	16bcc1	PDSI	803630	2/ /1976	520	3	1	400-500	15	3,152.88	427.7	12/18/2006	2,725.18	D,L	M
MH-4	21bbb1	PDSI	803631	3/2/1976	550	3	520	420-520	---	3,136.63	368.8	5/24/1988	2,767.83	D,L	M
MH-5	21bcc1	PDSI	803632	3/ /1976	640	3	640	340-640	---	3,120.48	389.22	11/21/2006	2,731.26	D,L	M
MH-6	28bbb2	PDSI	803633	4/ /1976	960	3	960	320-960	---	3,130.98	381.65	11/14/2006	2,749.33	D,L	M
MH-7	28cbb1	PDSI	803634	4/1/1976	1,100	3	1,100	300-1,100	---	3,108.24	357.85	11/21/2006	2,750.39	D,L	M
MH-8	29ddc	PDSI	---	6/17/1976	1,065	3	1,060	300-1,060	100	3,125.00	293	12/14/1981	2,832.00	D,L	M,Z
MH-9	29cdd1	PDSI	803635	7/ /1976	1,400	3	1,365	350-1,365	---	3,159.58	380.58	11/8/2006	2,779.00	D,L	M
MH-10	30ddd	PDSI	803636	2/ /1977	600	3	600	280-600	---	3,184.85	346.7	11/8/2006	2,838.15	D,L	M
MH-11	16ddd	PDSI	803637	2/ /1977	820	3	820	300-820	---	3,040.30	369.9	11/9/2006	2,670.40	D,L	M

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						CASING					NON-PUMPING WATER LEVEL				
WELL NAME	CADASTRAL	OWNER	ADWR REGISTRATION NUMBER	DATE COMPLETED	DEPTH DRILLED (feet below land surface)	DIAMETER (inches)	DEPTH (feet)	PERFORATED INTERVAL (feet below land surface)	REPORTED PUMPING RATE (gpm)[a]	ALTITUDE OF LAND SURFACE (feet, msl)[b]	DEPTH (feet)[c]	DATE MEASURED	ALTITUDE (feet, msl)[b]	LOG[d]	USE[e]
MH-12	16daa	PDSI	803638	2/ /1977	800	3	800	280-800	---	3,054.07	415.94	11/13/2006	2,638.13	D,L	M
MH-13	21add1	PDSI	803639	2/ /1977	1,425	3	1,420	420-1,420	---	3,023.42	302.20	11/7/2003	2,721.22	D,L	M
MH-13A	21add2	PDSI	904071	3/17/2006	665	4	660	300-650	---	3,022.37	327.84	11/10/2006	2,694.53	D,L	M
MH-13B	21add3	PDSI	904072	4/2/2006	980	4	960	750-950	---	3,025.19	330.70	11/10/2006	2,694.49	D,L	M
MH-13C	21add4	PDSI	904073	3/6/2006	1,447	4	1,360	1,050-1,350	---	3,022.96	335.38	11/10/2006	2,687.58	D,L, GL	M
MH-14	16bcc2	PDSI	528098	6/12/1990	561	6	522	376-501	15	3,150.77	427.7	12/18/2006	2,723.07	D,L	M
MH-15E	21cbd2	PDSI	528094	6/22/1990	467	4	462	317-442	---	3,108.38	385.25	11/10/2006	2,723.13	D,L	M
MH-15W	21cbd1	PDSI	528093	6/15/1990	466	6	465	320-445	15	3,114.08	390.6	12/18/2006	2,723.48	D,L	M
MH-16E	28cba	PDSI	528100	7/1/1990	460	4	458	315-440	---	3,094.73	343.75	12/18/2006	2,750.98	D,L	M
MH-16W	28cbb3	PDSI	528099	6/29/1990	460	6	450	315-440	15	3,097.25	345.78	12/18/2006	2,751.47	D,L	M
MH-24	21bcc4	PDSI	563799	9/17/1997	468	6	468	358-468	---	3,128.17	397.50	11/21/2006	2,730.67	D	M
MH-25A	09dda1	PDSI	201528	12/17/2003	545	5	530	410-530	18	3,068.00	454.11	11/13/2006	2,613.89	D,L	M
MH-25B	09dda2	PDSI	208429	11/19/2005	690	4	680	580-680	---	3,068.80	455.36	11/13/2006	2,613.44	D,L	M
MH-25C	09dda3	PDSI	208426	11/10/2005	1,121	4	1101	731-901, 951-1081	---	3,069.28	454.65	11/13/2006	2,614.63	D,L, GL	M
MH-26A	09aaa1	PDSI	201527	12/18/2003	545	5	538	418-538	17	3,063	495.74	11/13/2006	2,567.26	D,L	M
MH-26B	09aaa2	PDSI	208427	12/4/2005	737	4	735	620-730	---	3,060.90	493	11/13/2006	2,567.90	D,L	M
MH-26C	09aaa3	PDSI	208428	11/23/2005	920	4	900	780-900	---	3,062.27	494.45	11/13/2006	2,567.82	D,L, GL	M
MH-28	21bbb3	PDSI	903648	12/15/2005	492	10	0-40	355-485	---	3,137.00	402.25	12/19/2006	2,734.75	D,L	M
						4	0-490								
MH-29	28bba	PDSI	903649	12/19/2005	480	10	0-40	340-470	---	3,100.00	377.01	12/19/2006	2,722.99	D,L	M
						4	0-475								
MH-30	17aba	PDSI	903884	1/21/2006	547	10	0-20	430-530		3,166.00	422.78	11/9/2006	2,743.22	D,L,GL	M
						5	0-535								

NOTE: Data queried where uncertain

[a] gpm = gallons per minute

[b] feet, msl = feet above mean sea level

[c] Depth in feet below land surface; P denotes pumping water level

[d] Logs available:

D = Drillers Log

L = Lithologic log

GL = Geophysical Log

[e] Use:

I = Industrial

U = Unused

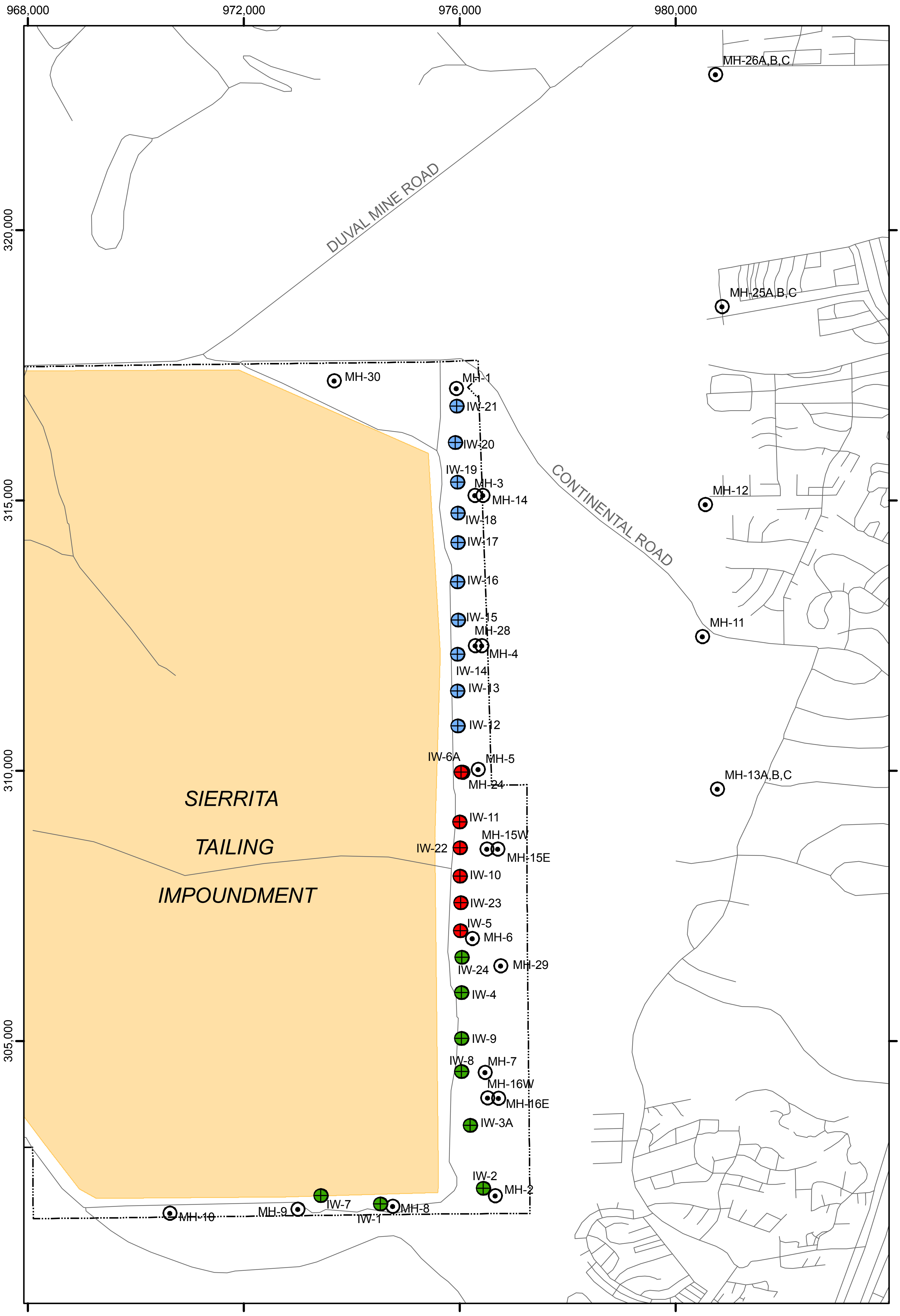
M = Monitor

Z = Destroyed or Abandoned

TABLE 2. ESTIMATED 2007 PUMPING CAPACITY OF INTERCEPTOR WELLFIELD SIERRITA MINE, PIMA COUNTY, ARIZONA

INTERCEPTOR WELL	2007 OPERATIONAL PUMPING RATE	ADJUSTED 2007 PUMPING CAPACITY[a]	
	gpm[b]	gpm[b]	AF/yr[c]
IW-1	375	338	545
IW-2	700	630	1,017
IW-3A	850	765	1,235
IW-4	250	225	364
IW-5	150	135	218
IW-6A	125	113	182
IW-8	500	450	726
IW-9	275	248	399
IW-10	375	338	545
IW-11	400	360	581
IW-12	175	158	254
IW-13	25	23	36
IW-14	75	68	109
IW-15	50	45	73
IW-16	10	9	15
IW-17	10	9	15
IW-18	10	9	15
IW-19	150	135	218
IW-20	75	68	109
IW-21	150	135	218
IW-22	350	315	508
IW-23	200	180	291
IW-24	300	270	436
TOTAL:	5,580	5,022	8,107

[a]adjusted 2007 pumping capacity = based on 2007 operational pumping rate and assuming 90 percent run time
[b]gpm = gallons per minute
[c]AF/yr = acre-feet per year



EXPLANATION

IW-15 INTERCEPTOR WELL AND IDENTIFIER, NORTH WELLFIELD

IW-10 INTERCEPTOR WELL AND IDENTIFIER, MIDDLE WELLFIELD

IW-8 INTERCEPTOR WELL AND IDENTIFIER, SOUTH WELLFIELD

MH-6 MONITOR WELL AND IDENTIFIER

TAILING IMPOUNDMENT

SIERRITA PROPERTY BOUNDARY

0 2,000 4,000
Feet

N

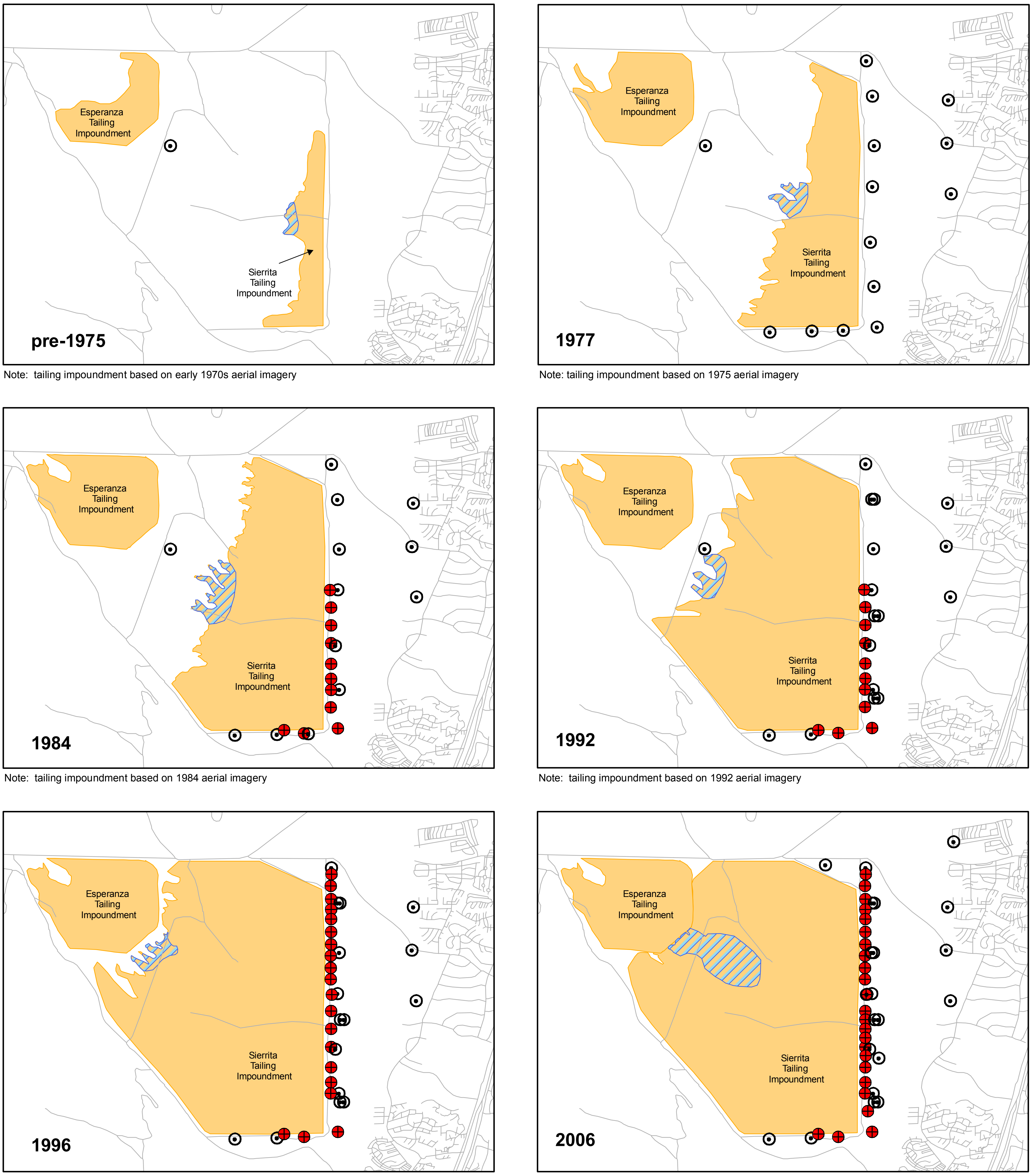
phelps dodge Sierrita Inc.

LOCATION MAP

ERROL L. MONTGOMERY & ASSOCIATES, INC. 2007
CONSULTANTS IN HYDROGEOLOGY
TUCSON, ARIZONA

FIGURE 1

GIS-Tuc\546.39\LocationMap.mxd 23Feb2007 State Plane NAD83 Arizona Central, Feet



Note: tailing impoundment based on early 1970s aerial imagery

Note: tailing impoundment based on 1975 aerial imagery

Note: tailing impoundment based on 1984 aerial imagery

Note: tailing impoundment based on 1992 aerial imagery

Note: tailing impoundment based on 1996 aerial imagery

Note: tailing impoundment based on 2005 aerial imagery

EXPLANATION

TAILING IMPOUNDMENT

RECLAIMED WATER POND

INTERCEPTOR WELL

MONITOR WELL

0 3,000 6,000 9,000
Feet

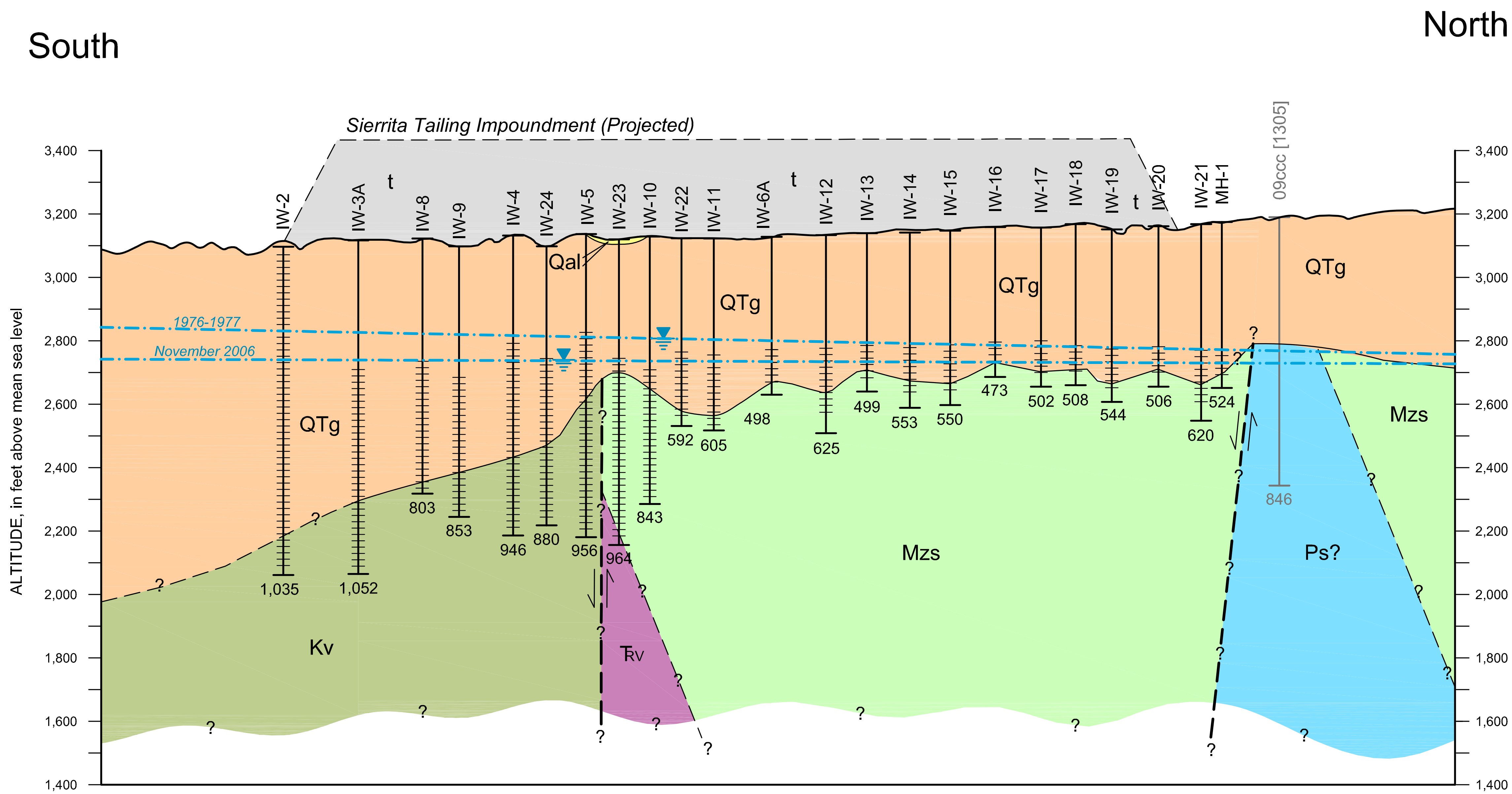
phelps dodge Sierrita Inc.

DEVELOPMENT OF
TAILING IMPOUNDMENT AND
INTERCEPTOR WELLFIELD

ERROL L. MONTGOMERY & ASSOCIATES, INC. 2007
CONSULTANTS IN HYDROGEOLOGY
TUCSON, ARIZONA

FIGURE 2

GIS-Tuc\546.39\TailingImpoundment_Wellfield.mxd 23Feb2007



EXPLANATION

t	TAILINGS
Qal	RECENT ALLUVIUM
QTg	BASIN-FILL DEPOSITS

Bedrock Complex

Kv	CRETACEOUS VOLCANIC ROCKS INCLUDING ANDESITES, DACITES, AND RHYOLITES OF THE DEMETRIE VOLCANICS
Mzs	MESOZOIC SEDIMENTARY AND METASEDIMENTARY ROCKS INCLUDING SANDSTONES, CONGLOMERATES, AND ARKOSES OF THE ANGELICA ARKOSE
Ʀv	TRIASSIC VOLCANICS INCLUDING RHYOLITIC FLOWS OF THE OXFRAME VOLCANICS
Ps	PALEOZOIC SEDIMENTARY ROCKS UNDIFFERENTIATED

IW-12 projected 30 feet east — INDICATES DIRECTION AND DISTANCE OF PROJECTION SECTION IF MORE THAN 10 FEET FROM SECTION LINE

WELL IDENTIFIER

GRAY INDICATES EXPLORATION BOREHOLE

PERFORATED INTERVAL

625 — TOTAL DEPTH, IN FEET

GEOLOGIC CONTACT, approximately located; dashed where uncertain

FAULT; arrows show relative direction of movement; dashed where uncertain

GROUNDWATER LEVEL

HORIZONTAL SCALE

0 2,000 4,000

FEET

VERTICAL EXAGGERATION 5:1

phelps dodge Sierrita Inc.

GENERALIZED HYDROGEOLOGIC SECTION

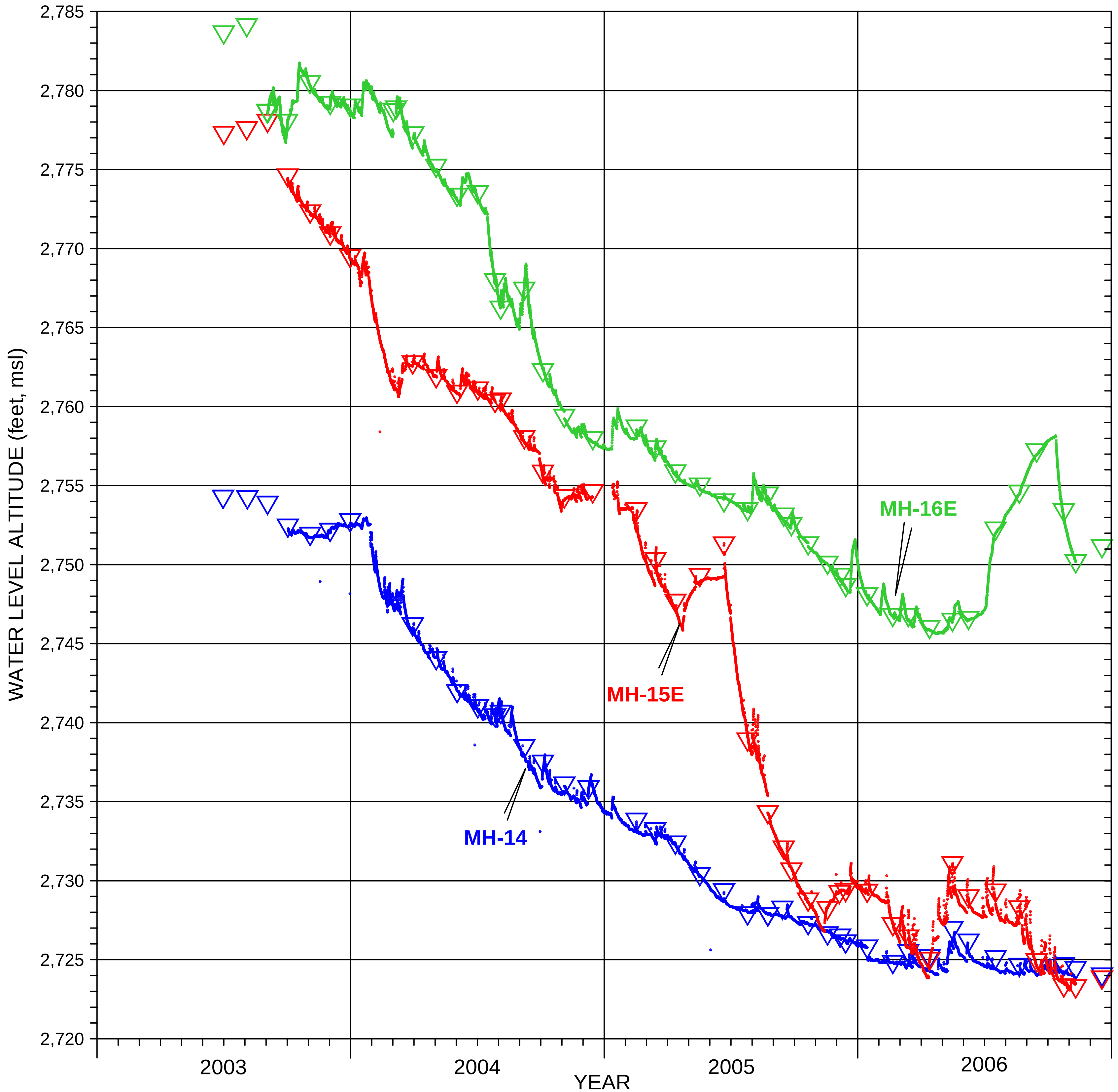
ERROL L. MONTGOMERY & ASSOCIATES, INC. 2007

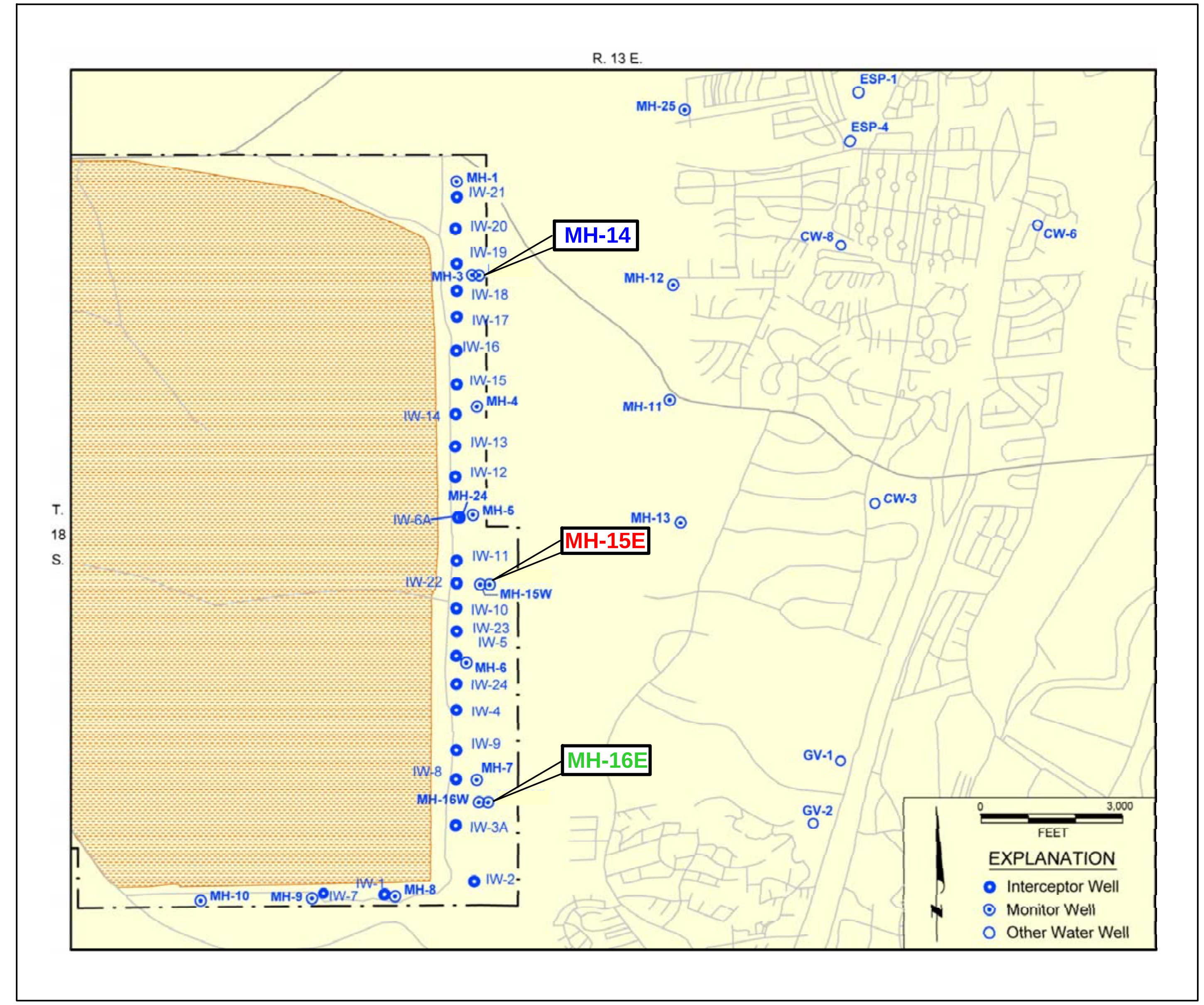
CONSULTANTS IN HYDROGEOLOGY

TUCSON, ARIZONA

FIGURE 3

546.39\xsec-revised\23Feb2007





EXPLANATION

- Groundwater level measurement (datalogger and pressure transducer)
- ▽ Groundwater level measurement (electrical sounder)

FIGURE 4. HYDROGRAPH OF GROUNDWATER LEVELS FOR MONITOR WELLS MH-14, MH-15E, AND MH-16E

ERROL L. MONTGOMERY & ASSOCIATES, INC.

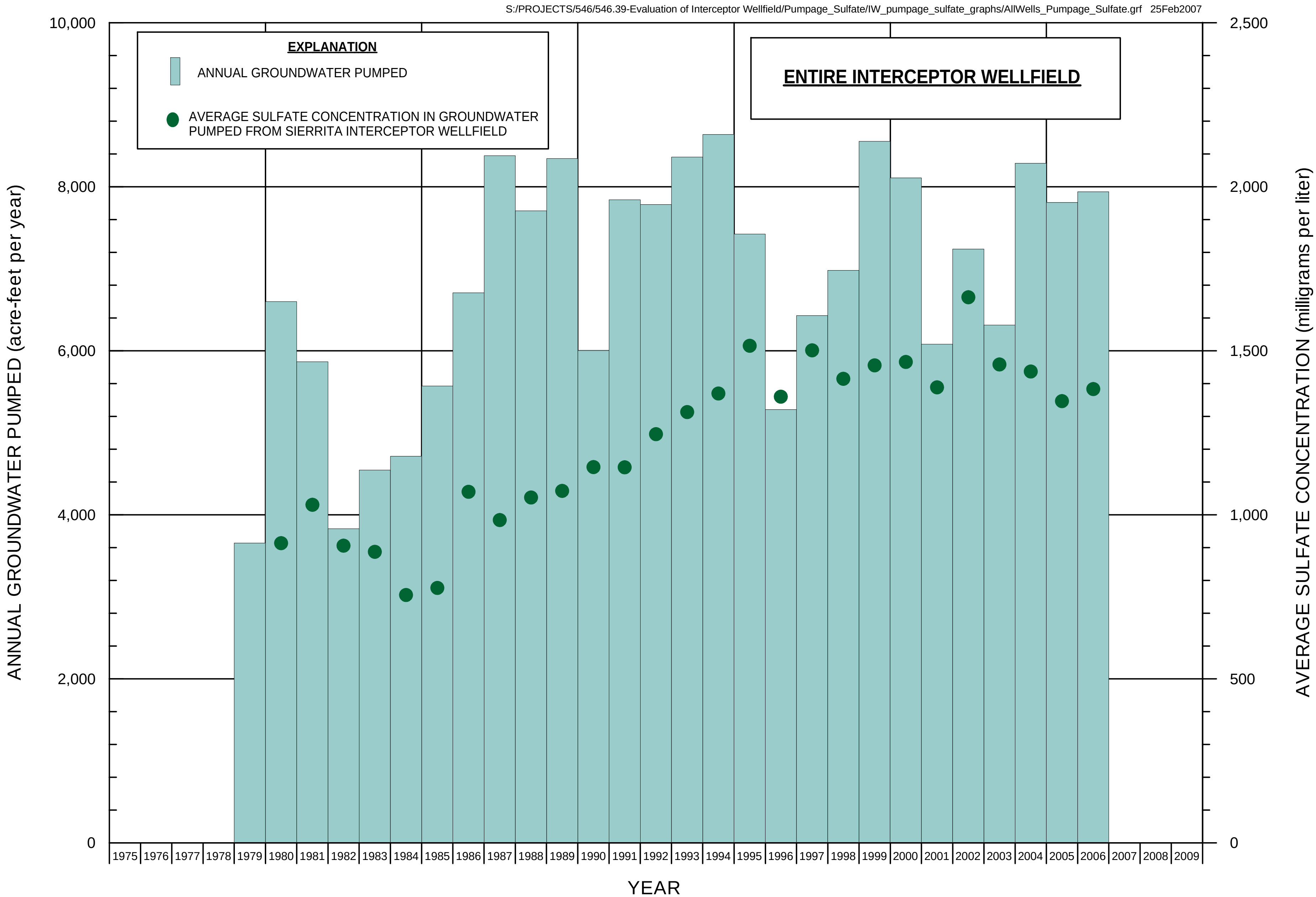


FIGURE 5. ANNUAL GROUNDWATER PUMPED AND AVERAGE SULFATE CONCENTRATION IN GROUNDWATER FOR SIERRITA INTERCEPTOR WELLFIELD

ERROL L. MONTGOMERY & ASSOCIATES, INC.

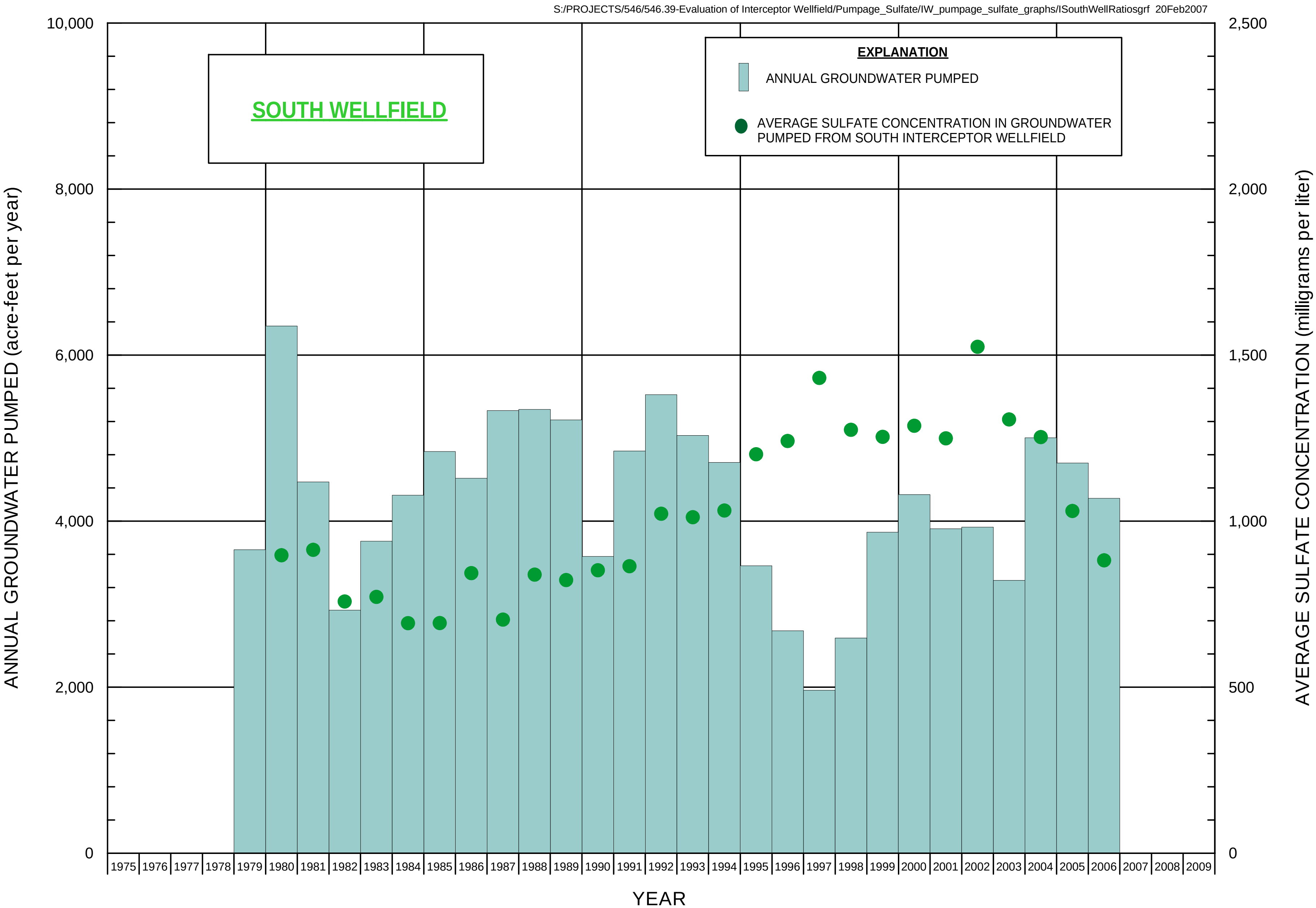


FIGURE 6. ANNUAL GROUNDWATER PUMPED AND AVERAGE SULFATE CONCENTRATION IN GROUNDWATER FOR SOUTH INTERCEPTOR WELLFIELD (WELLS IW-1, IW-2, IW-3, IW-3A, IW-4, IW-7, IW-8, IW-9, AND IW-24)

ERROL L. MONTGOMERY & ASSOCIATES, INC.

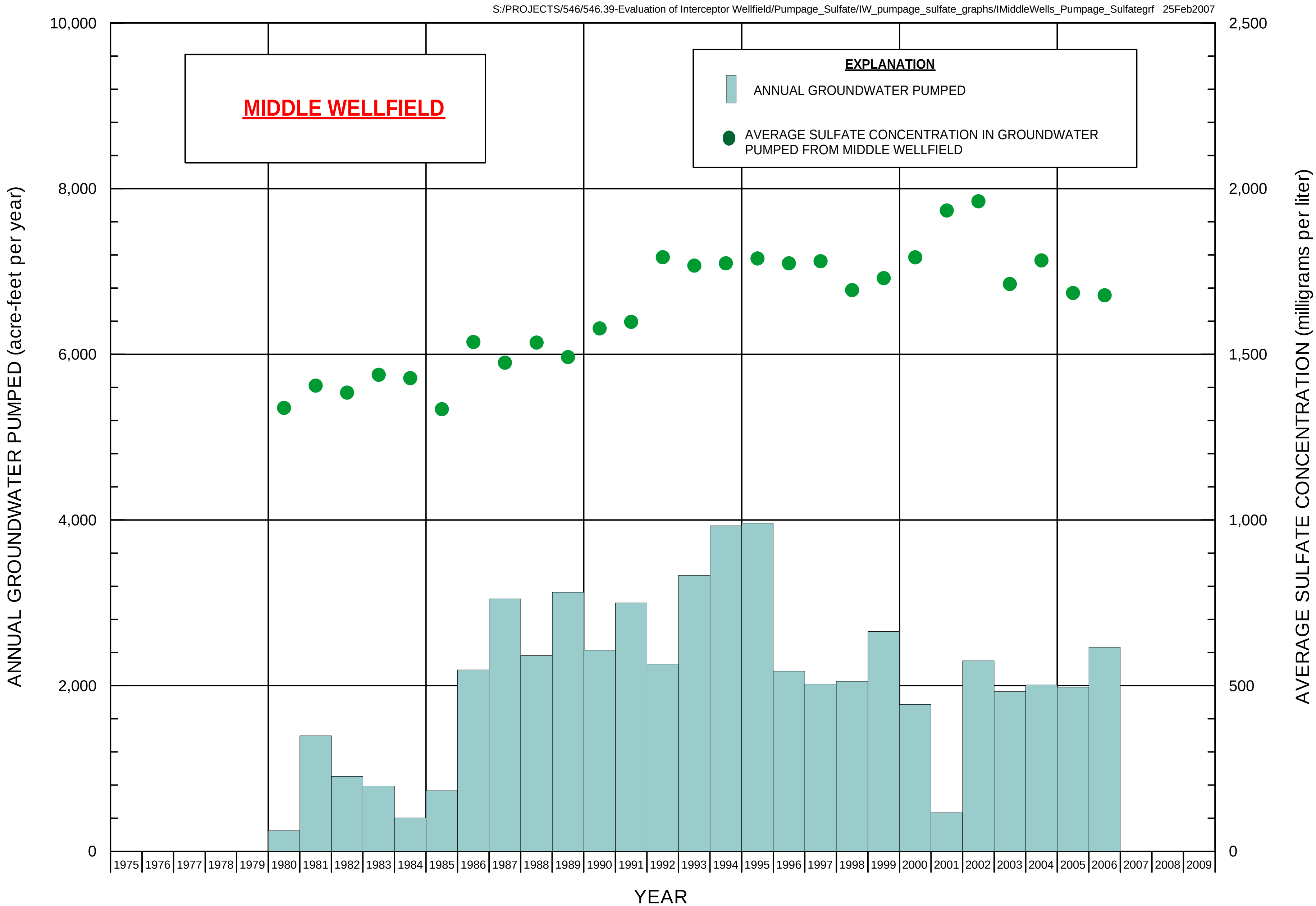


FIGURE 7. ANNUAL GROUNDWATER PUMPED AND AVERAGE SULFATE CONCENTRATION IN GROUNDWATER FOR MIDDLE INTERCEPTOR WELLFIELD (WELLS IW-5, IW-6, IW-6A, IW-10, IW-11, IW-22, AND IW-23)

ERROL L. MONTGOMERY & ASSOCIATES, INC.

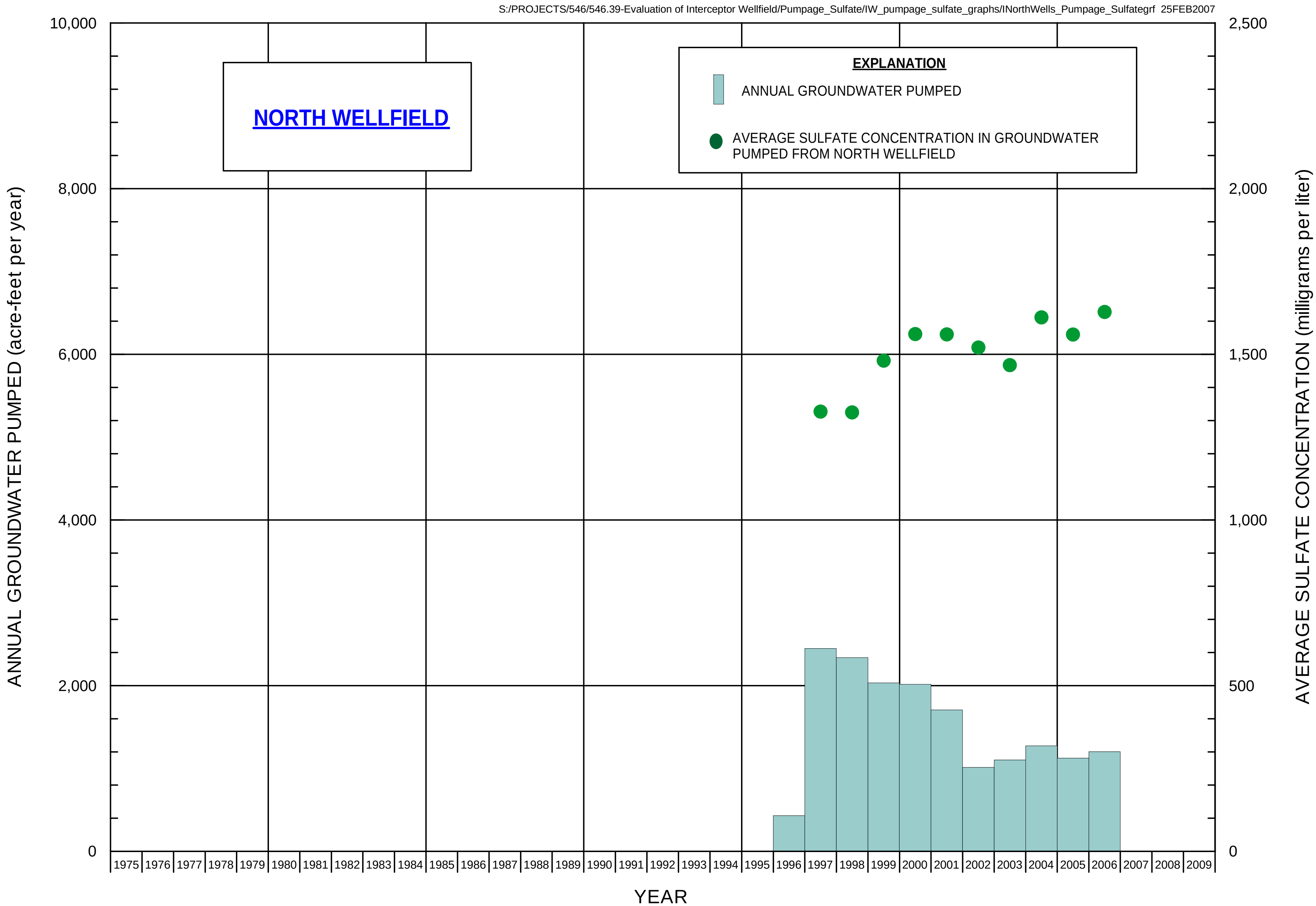


FIGURE 8. ANNUAL GROUNDWATER PUMPED AND AVERAGE SULFATE CONCENTRATION IN GROUNDWATER FOR NORTH INTERCEPTOR WELLFIELD (WELLS IW-12 THROUGH IW-21)

ERROL L. MONTGOMERY & ASSOCIATES, INC.

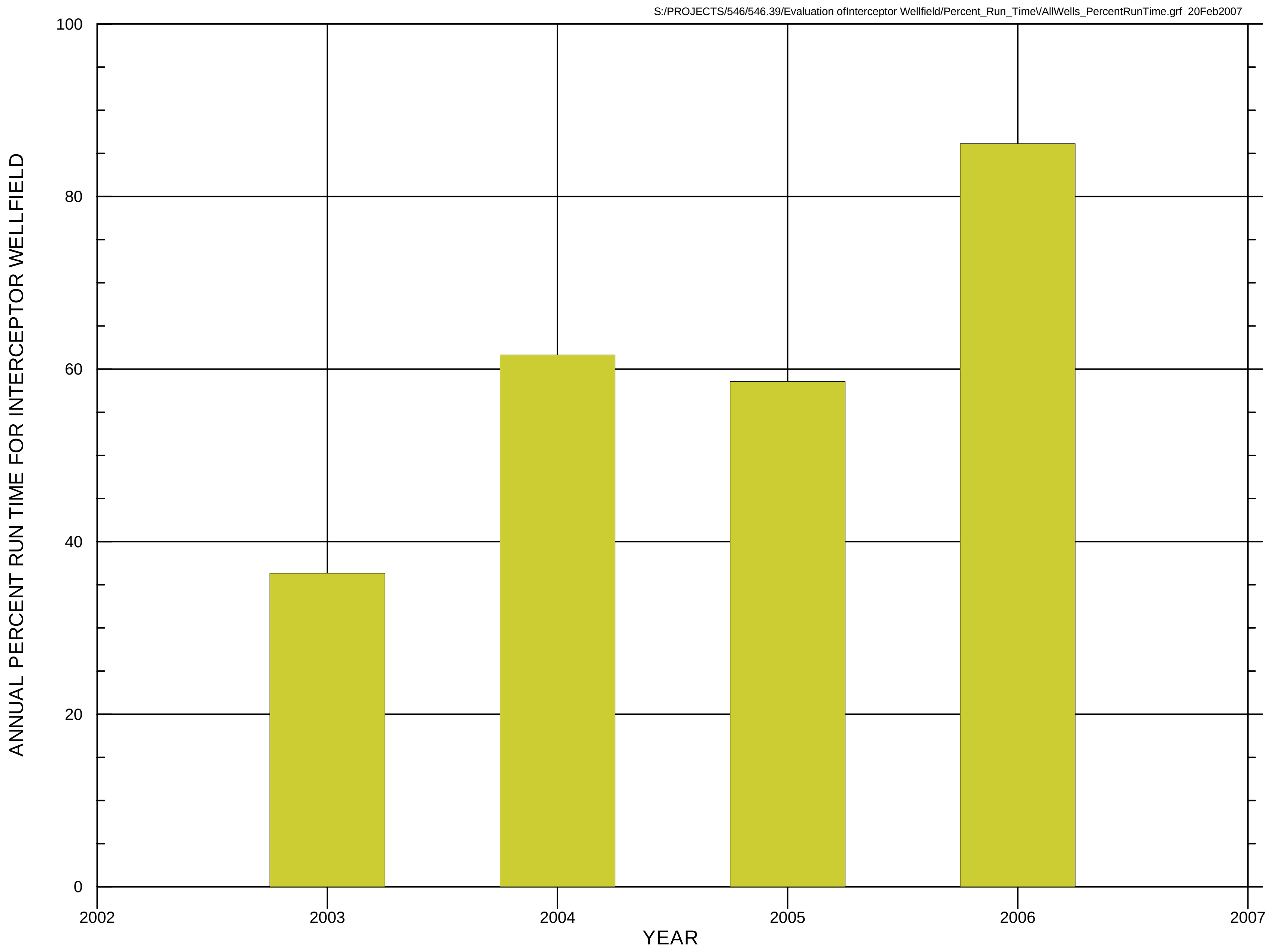


FIGURE 9. ANNUAL PERCENT RUN TIME FOR SIERRITA INTERCEPTOR WELLFIELD, 2003 THROUGH 2006

ERROL L. MONTGOMERY & ASSOCIATES, INC.

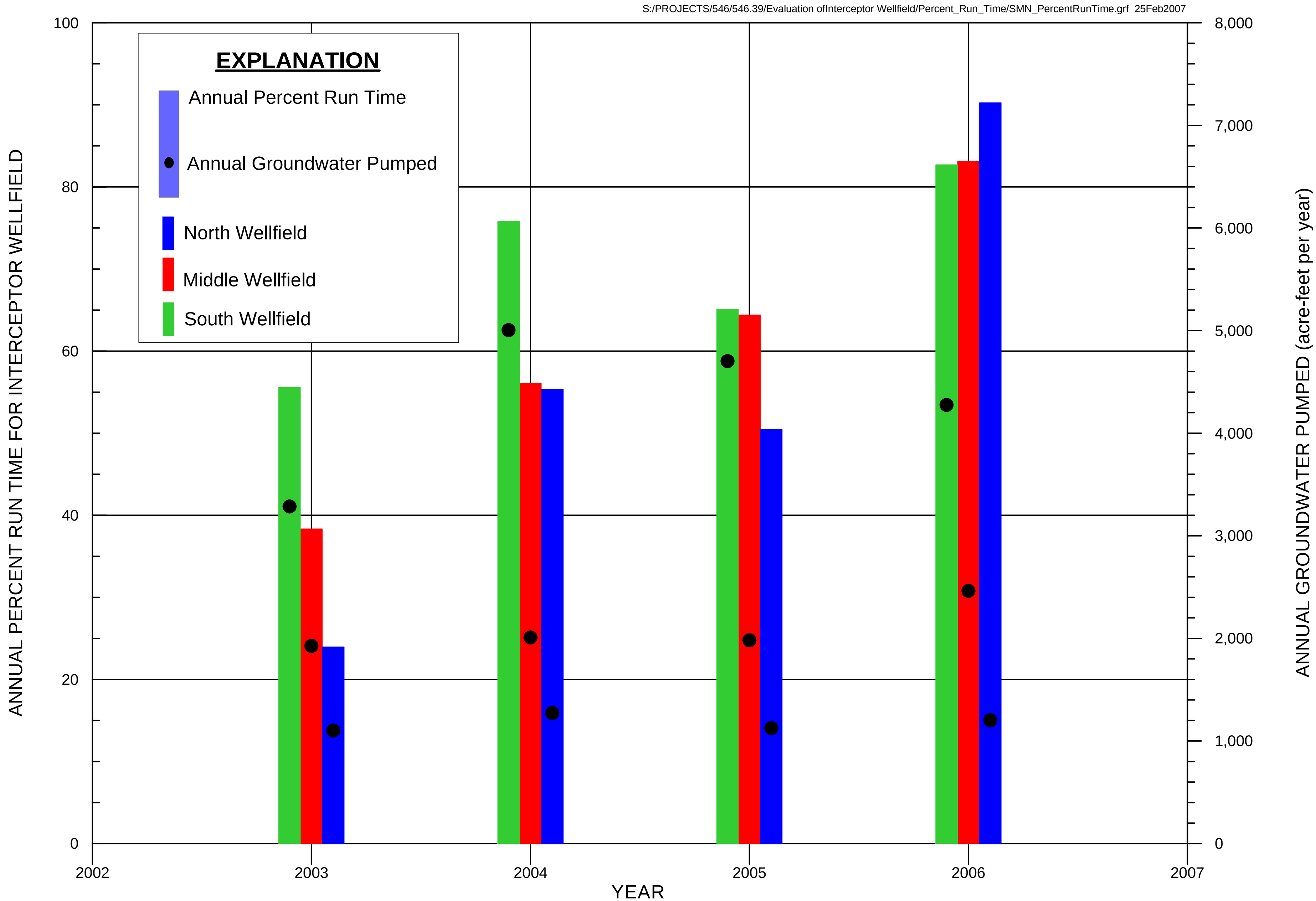


FIGURE 10. ANNUAL PERCENT RUN TIME AND GROUNDWATER PUMPED FOR SOUTH, MIDDLE, AND NORTH INTERCEPTOR WELLFIELDS, 2003 THROUGH 2006

ERROL L. MONTGOMERY & ASSOCIATES, INC.

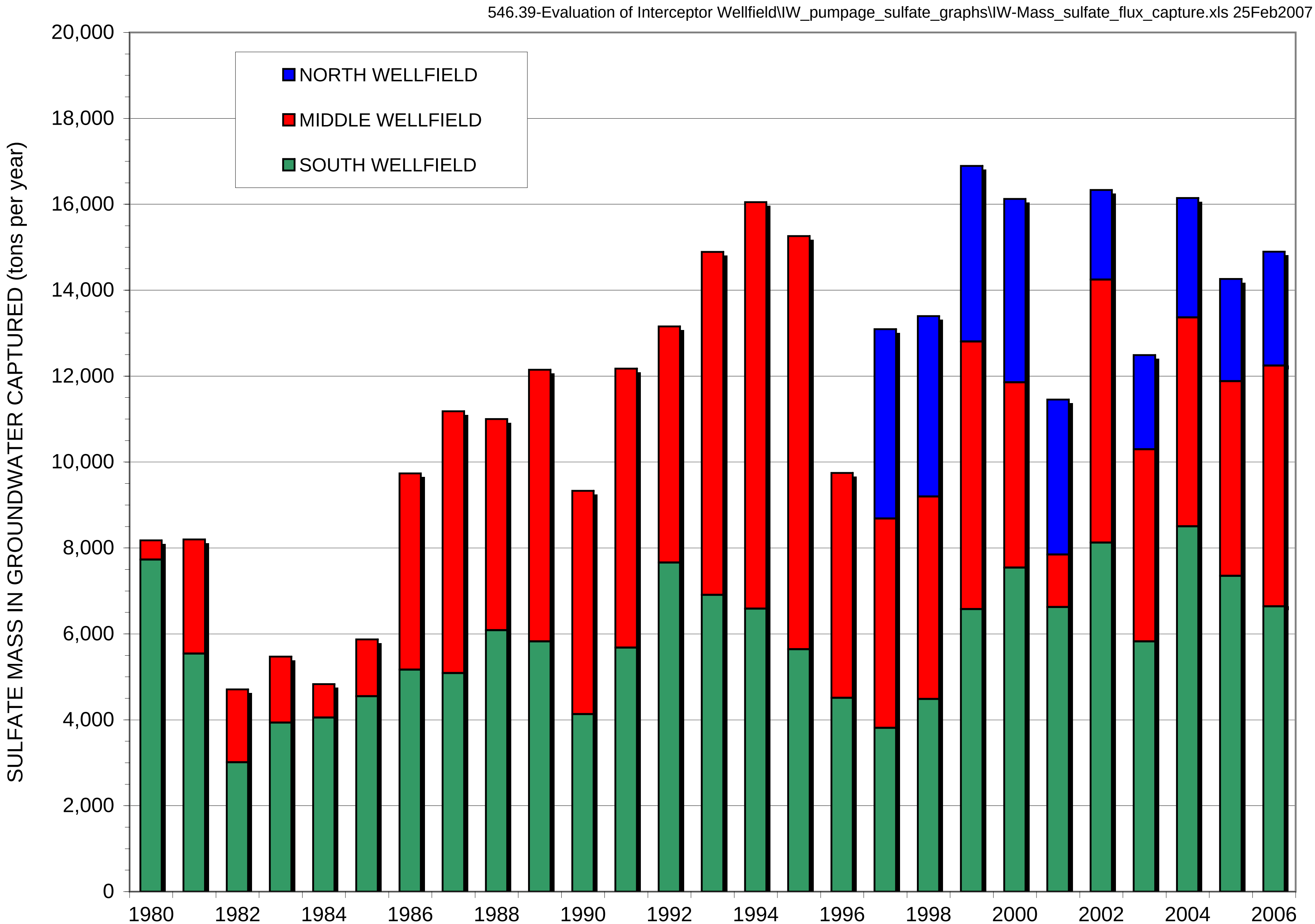
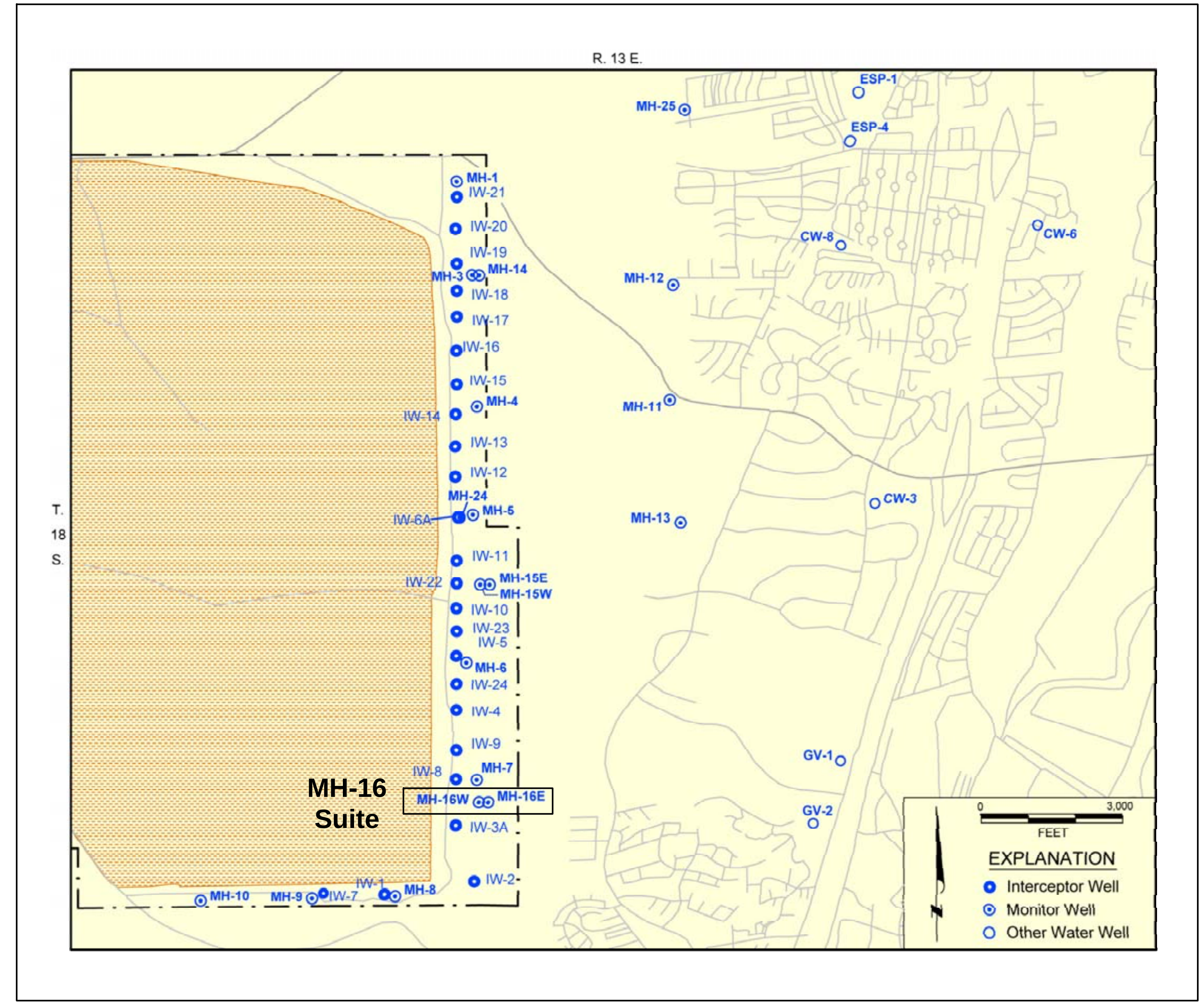


FIGURE 11. SULFATE MASS IN GROUNDWATER CAPTURED BY SOUTH, MIDDLE, AND NORTH INTERCEPTOR WELLFIELDS

ERROL L. MONTGOMERY & ASSOCIATES, INC.

546.21 - Interceptor Wellfield Optimization\05 - Monitoring\Water Levels & Pumping\Paired WellsWL_Hydrographs\Paired wells_MH16 25FEB2007 MPM



E X P L A N A T I O N

- Groundwater level measurement (datalogger and pressure transducer)
- ▽ Groundwater level measurement (electrical sounder)

FIGURE 12. HYDROGRAPH OF GROUNDWATER LEVEL FOR MH-16 MONITOR WELL SUITE

ERROL L. MONTGOMERY & ASSOCIATES, INC.

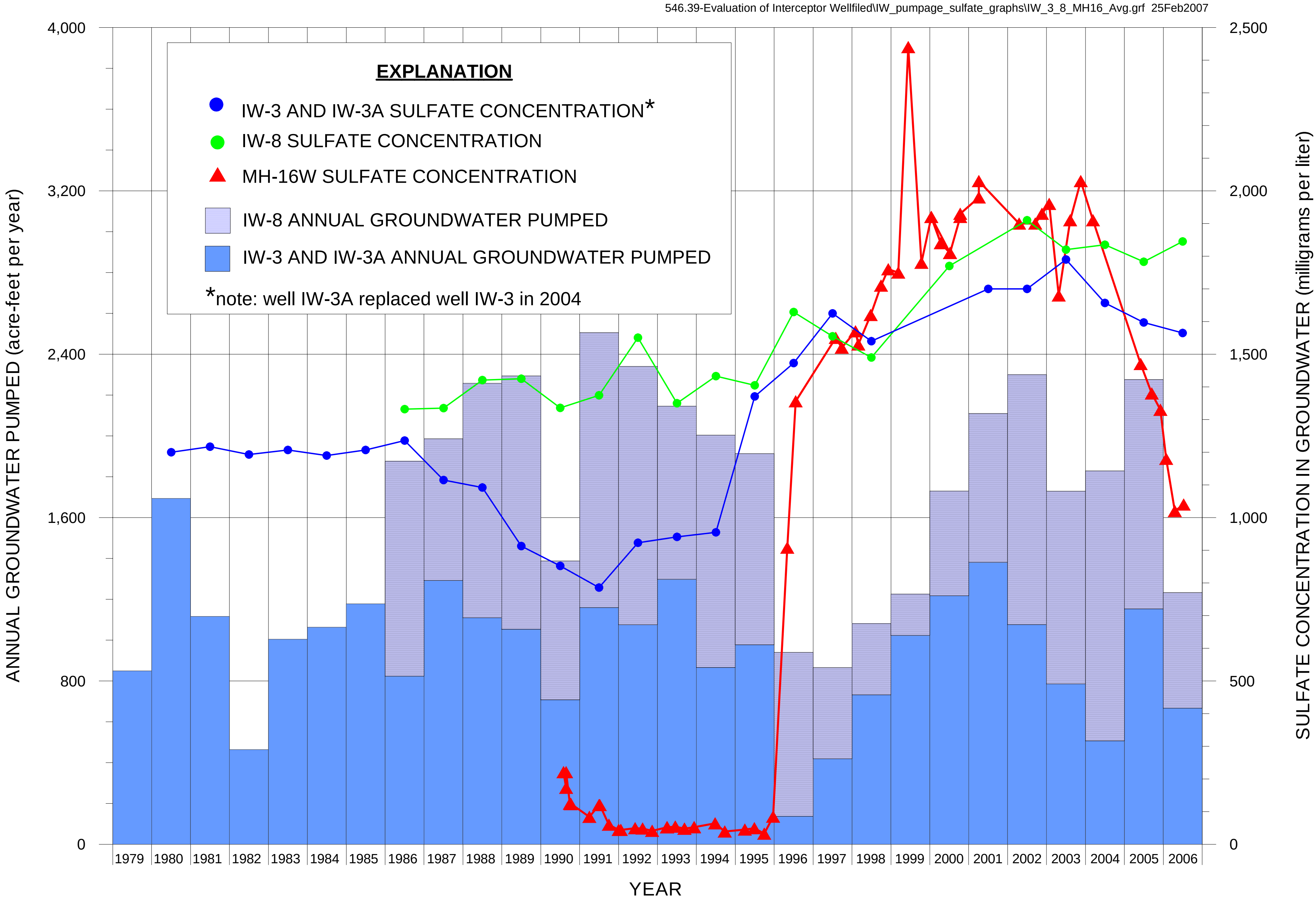
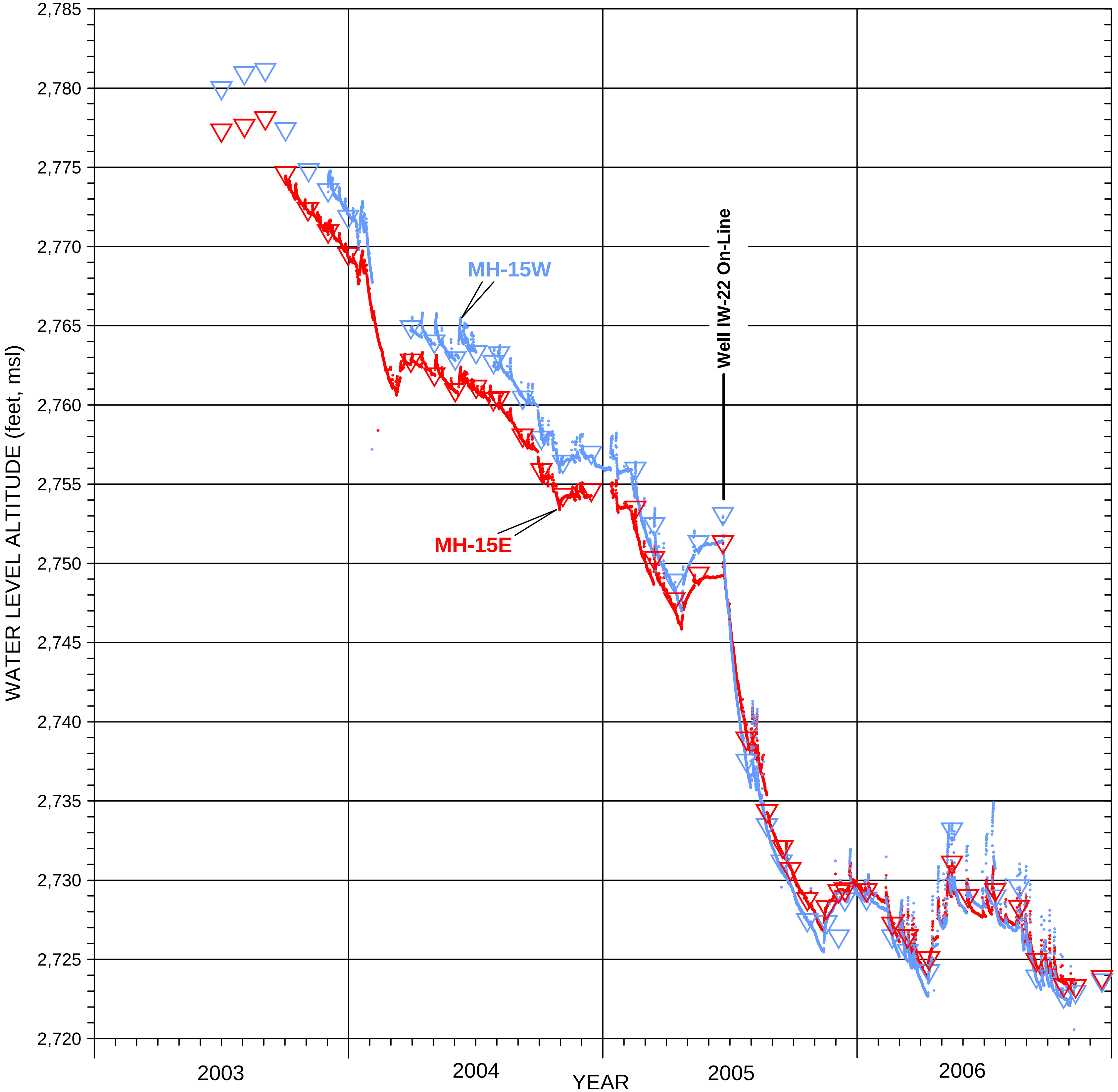
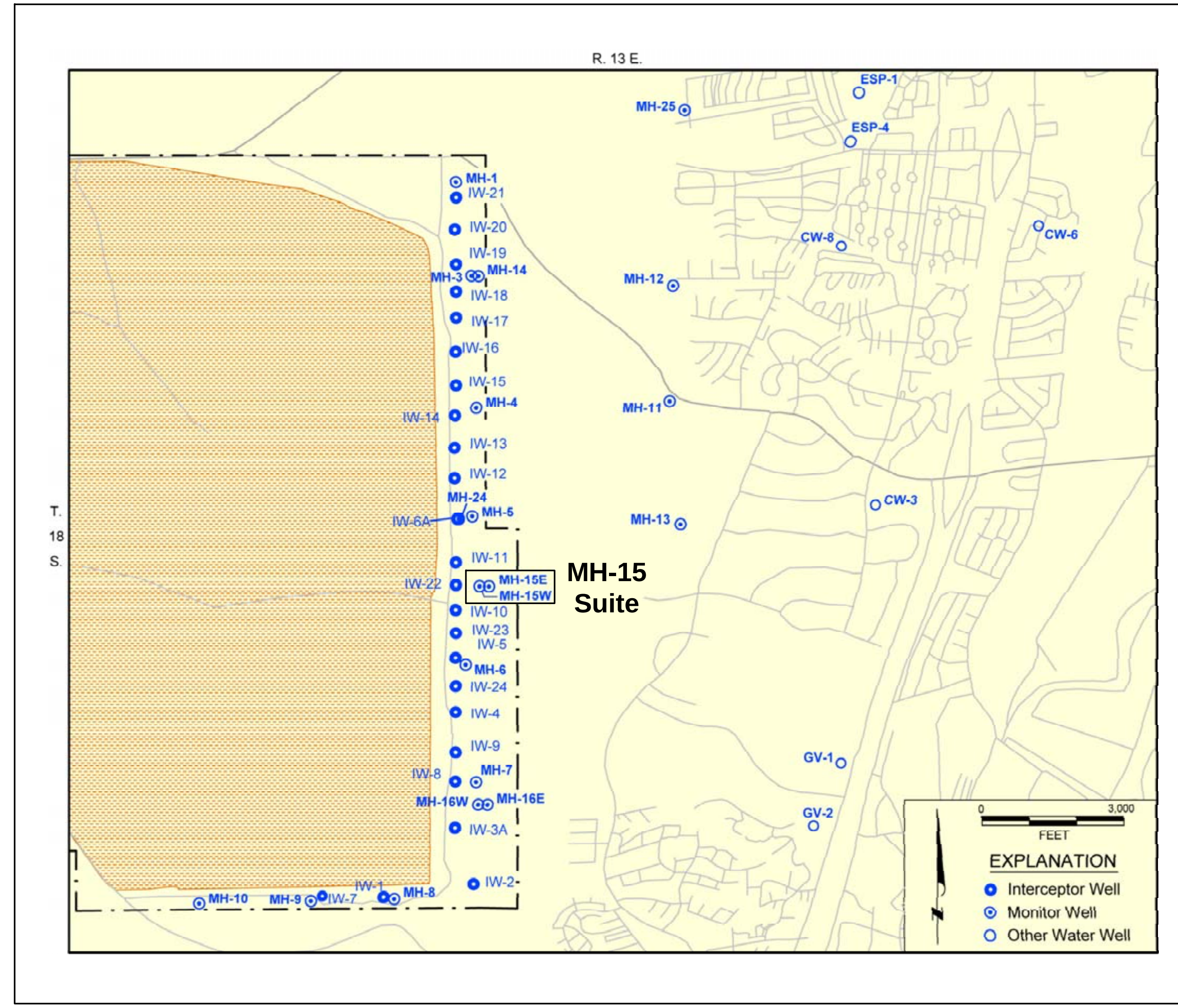


FIGURE 13. ANNUAL GROUNDWATER PUMPED AND AVERAGE SULFATE CONCENTRATIONS IN GROUNDWATER FOR INTERCEPTOR WELLS IW-3A, IW-3 AND IW-8 AND SULFATE CONCENTRATIONS IN GROUNDWATER AT MONITOR WELL MH-16W

ERROL L. MONTGOMERY & ASSOCIATES, INC.





E X P L A N A T I O N

- Groundwater level measurement (datalogger and pressure transducer)
- ▽ Groundwater level measurement (electrical sounder)

FIGURE 14. HYDROGRAPH OF GROUNDWATER LEVEL FOR MH-15 MONITOR WELL SUITE

ERROL L. MONTGOMERY & ASSOCIATES, INC.

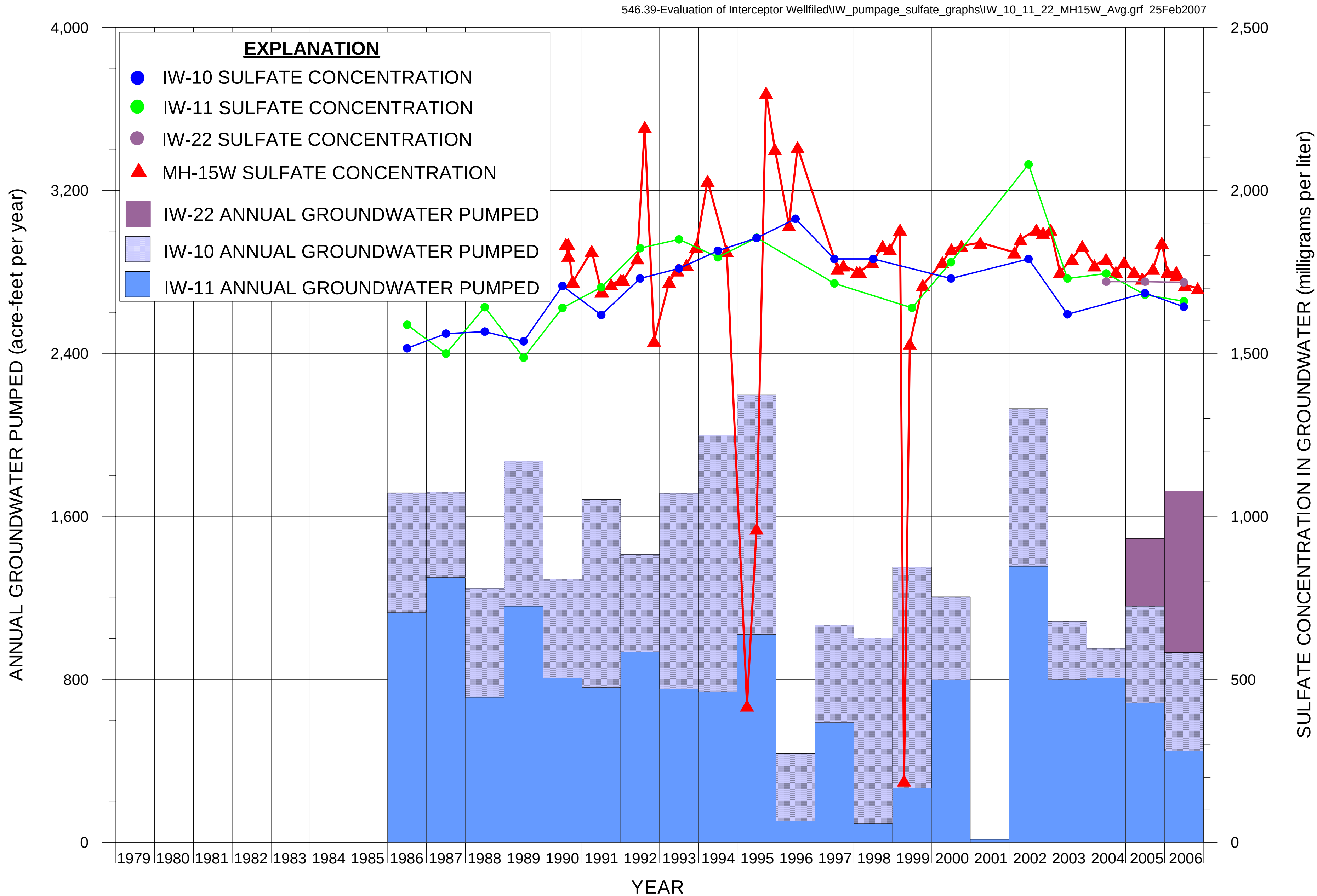
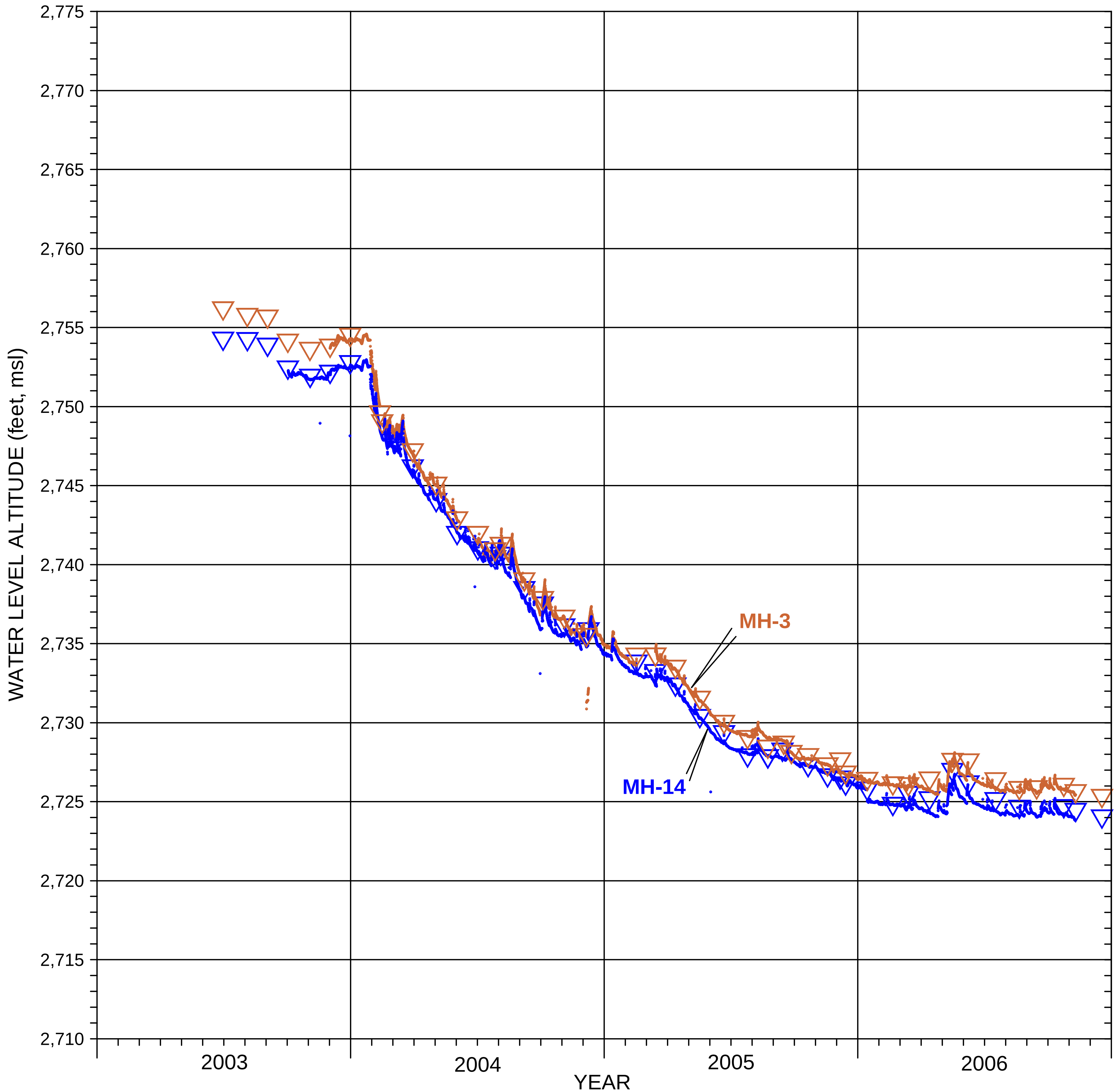
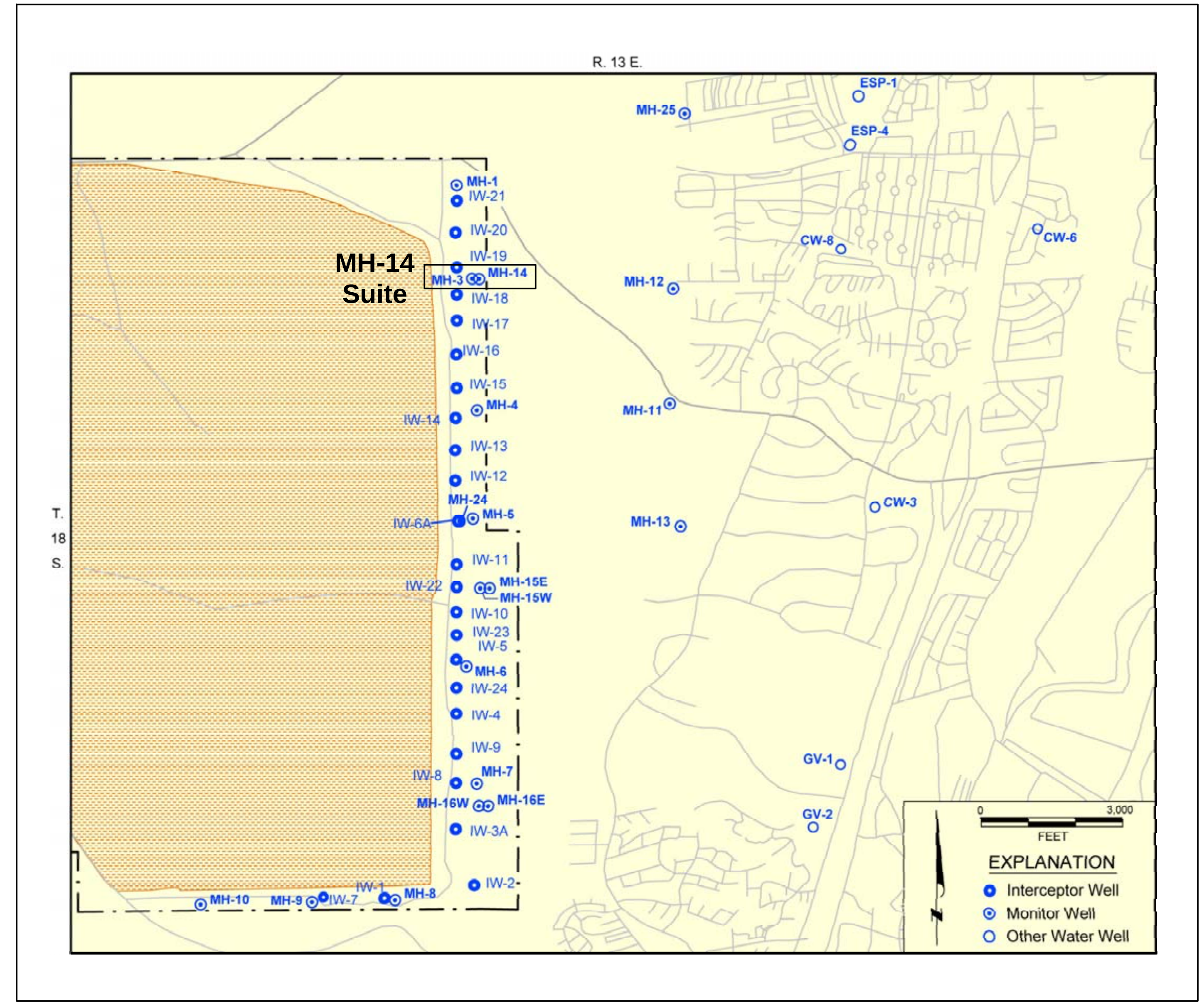


FIGURE 15. ANNUAL GROUNDWATER PUMPED AND AVERAGE SULFATE CONCENTRATIONS IN GROUNDWATER FOR INTERCEPTOR WELLS IW-10, IW-11 AND IW-22 AND SULFATE CONCENTRATIONS IN GROUNDWATER AT MONITOR WELL MH-15W

ERROL L. MONTGOMERY & ASSOCIATES, INC.





EXPLANATION

- Groundwater level measurement (datalogger and pressure transducer)
- ▽ Groundwater level measurement (electrical sounder)

FIGURE 16. HYDROGRAPH OF GROUNDWATER LEVEL FOR MH-14 MONITOR WELL SUITE

ERROL L. MONTGOMERY & ASSOCIATES, INC.

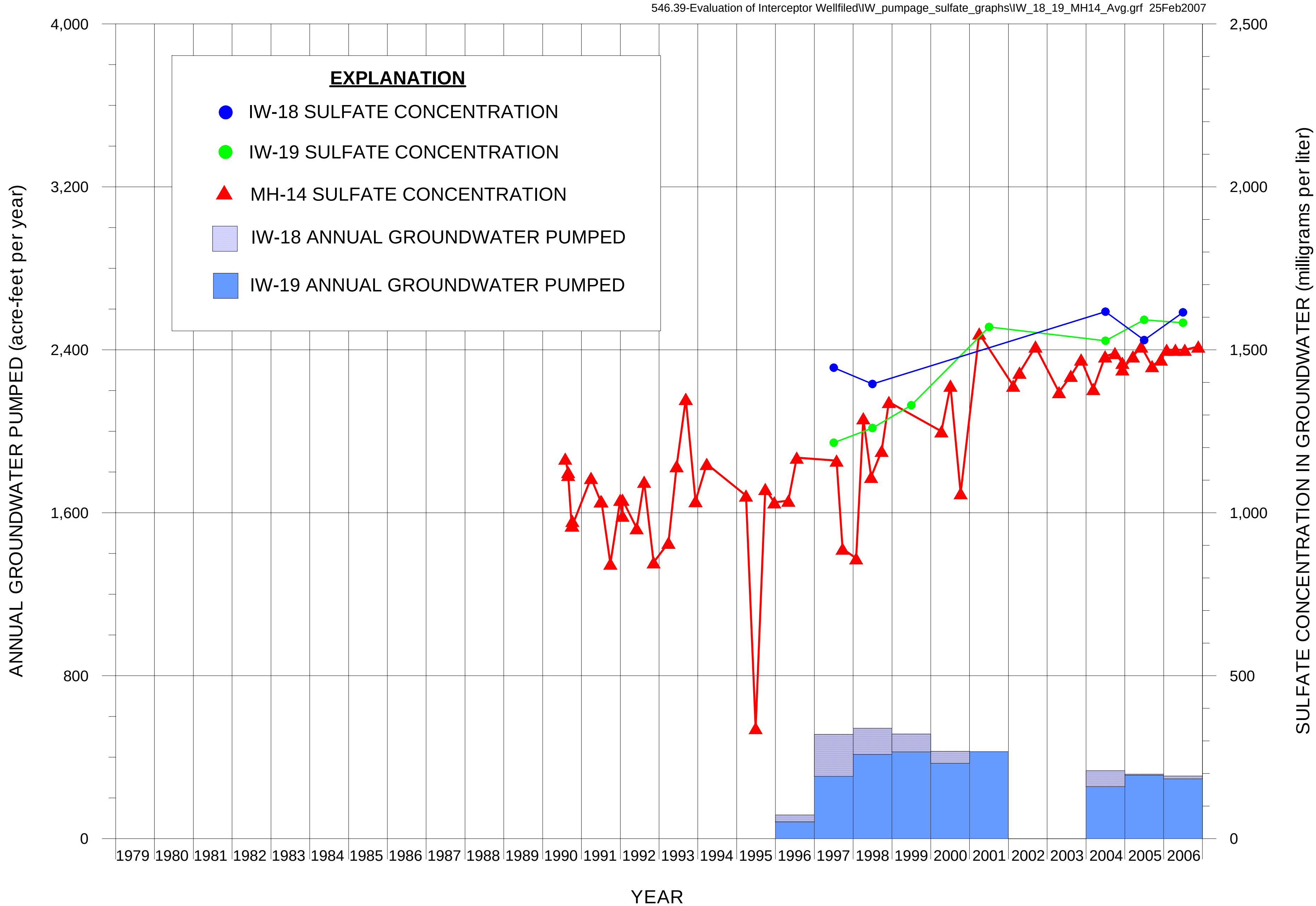
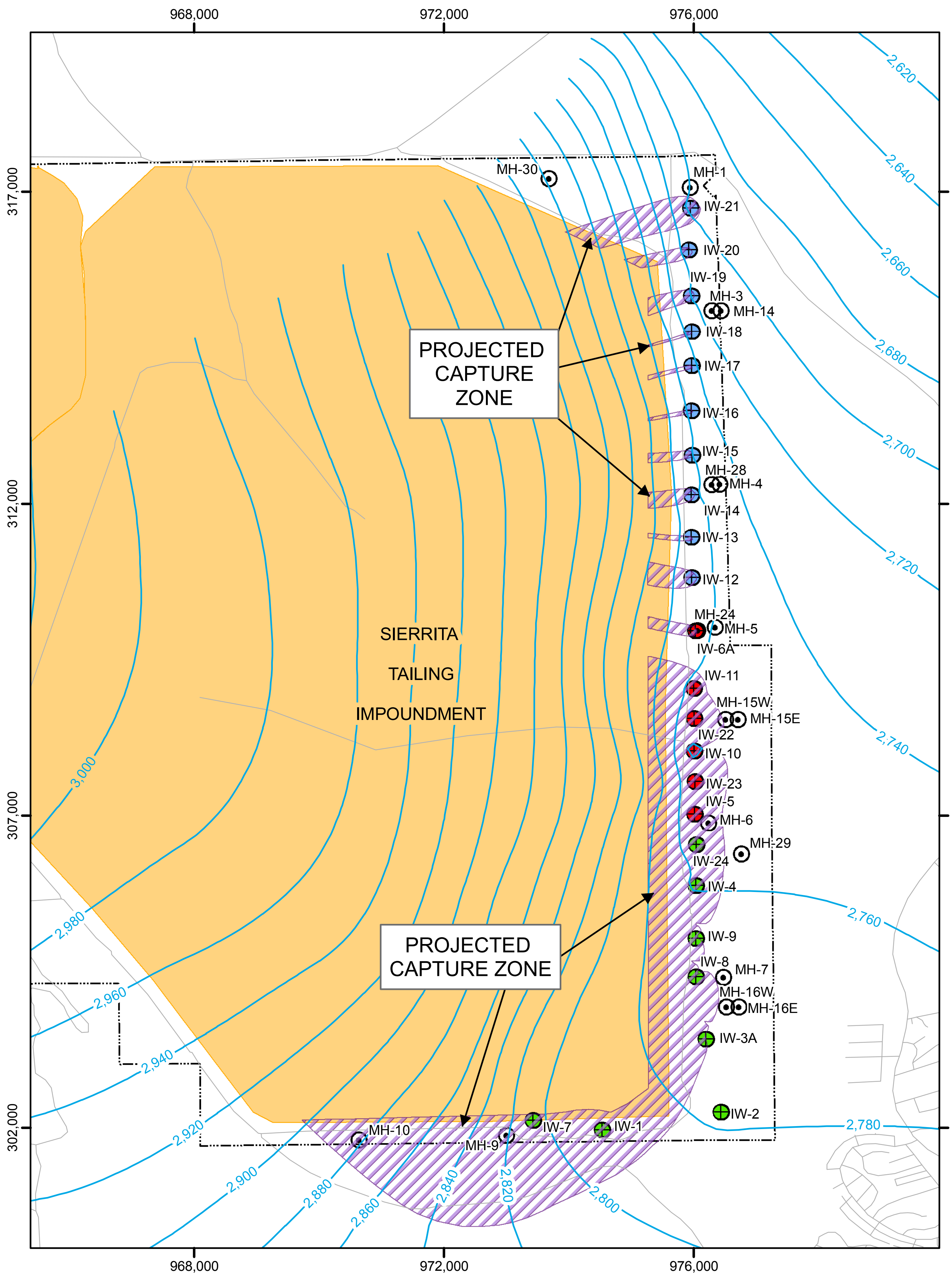


FIGURE 17. ANNUAL GROUNDWATER PUMPED AND AVERAGE SULFATE CONCENTRATIONS IN GROUNDWATER FOR INTERCEPTOR WELLS IW-18 AND IW-19 AND SULFATE CONCENTRATIONS IN GROUNDWATER AT MONITOR WELL MH-14

ERROL L. MONTGOMERY & ASSOCIATES, INC.



EXPLANATION

PROJECTED CAPTURE ZONE

IW-15 INTERCEPTOR WELL AND IDENTIFIER, NORTH WELLFIELD

IW-10 INTERCEPTOR WELL AND IDENTIFIER, MIDDLE WELLFIELD

IW-8 INTERCEPTOR WELL AND IDENTIFIER, SOUTH WELLFIELD

2800 CONTOUR OF SIMULATED GROUNDWATER LEVEL ALTITUDE FOR 2007 WELLFIELD PUMPING REGIME, IN FEET ABOVE MEAN SEA LEVEL

TAILING IMPOUNDMENT

PHELPS DODGE SIERRITA PROPERTY

0 2,000 4,000 Feet

N

phelps dodge Sierrita Inc.

DELINEATION OF PROJECTED CAPTURE ZONES FOR SIMULATED WELLFIELD PUMPING

ERROL L. MONTGOMERY & ASSOCIATES, INC. 2007
CONSULTANTS IN HYDROGEOLOGY
TUCSON, ARIZONA

FIGURE 18

GIS-Tuc\546.39\CaptureZones.mxd 23Feb2007 State Plane NAD83, Feet

APPENDIX A

WELL SCHEMATIC DIAGRAMS FOR INTERCEPTOR WELLS
SIERRITA MINE, PIMA COUNTY, ARIZONA

APPENDIX A

CONTENTS

Figure

A-1 SCHEMATIC DIAGRAM OF WELL CONSTRUCTION FOR INTERCEPTOR WELL IW-1

A-2 SCHEMATIC DIAGRAM OF WELL CONSTRUCTION FOR INTERCEPTOR WELL IW-2

A-3 SCHEMATIC DIAGRAM OF WELL CONSTRUCTION FOR INTERCEPTOR WELL IW-3

A-4 SCHEMATIC DIAGRAM OF WELL CONSTRUCTION FOR INTERCEPTOR WELL IW-3A

A-5 SCHEMATIC DIAGRAM OF WELL CONSTRUCTION FOR INTERCEPTOR WELL IW-4

A-6 SCHEMATIC DIAGRAM OF WELL CONSTRUCTION FOR INTERCEPTOR WELL IW-5

A-7 SCHEMATIC DIAGRAM OF WELL CONSTRUCTION FOR INTERCEPTOR WELL IW-6

A-8 SCHEMATIC DIAGRAM OF WELL CONSTRUCTION FOR INTERCEPTOR WELL IW-6A

A-9 SCHEMATIC DIAGRAM OF WELL CONSTRUCTION FOR INTERCEPTOR WELL IW-7

A-10 SCHEMATIC DIAGRAM OF WELL CONSTRUCTION FOR INTERCEPTOR WELL IW-8

A-11 SCHEMATIC DIAGRAM OF WELL CONSTRUCTION FOR INTERCEPTOR WELL IW-9

A-12 SCHEMATIC DIAGRAM OF WELL CONSTRUCTION FOR INTERCEPTOR WELL IW-10

A-13 SCHEMATIC DIAGRAM OF WELL CONSTRUCTION FOR INTERCEPTOR WELL IW-11

CONTENTS – continued

Figure

A-14 SCHEMATIC DIAGRAM OF WELL CONSTRUCTION FOR INTERCEPTOR WELL IW-12

A-15 SCHEMATIC DIAGRAM OF WELL CONSTRUCTION FOR INTERCEPTOR WELL IW-13

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A-17 SCHEMATIC DIAGRAM OF WELL CONSTRUCTION FOR INTERCEPTOR WELL IW-15

A-18 SCHEMATIC DIAGRAM OF WELL CONSTRUCTION FOR INTERCEPTOR WELL IW-16

A-19 SCHEMATIC DIAGRAM OF WELL CONSTRUCTION FOR INTERCEPTOR WELL IW-17

A-20 SCHEMATIC DIAGRAM OF WELL CONSTRUCTION FOR INTERCEPTOR WELL IW-18

A-21 SCHEMATIC DIAGRAM OF WELL CONSTRUCTION FOR INTERCEPTOR WELL IW-19

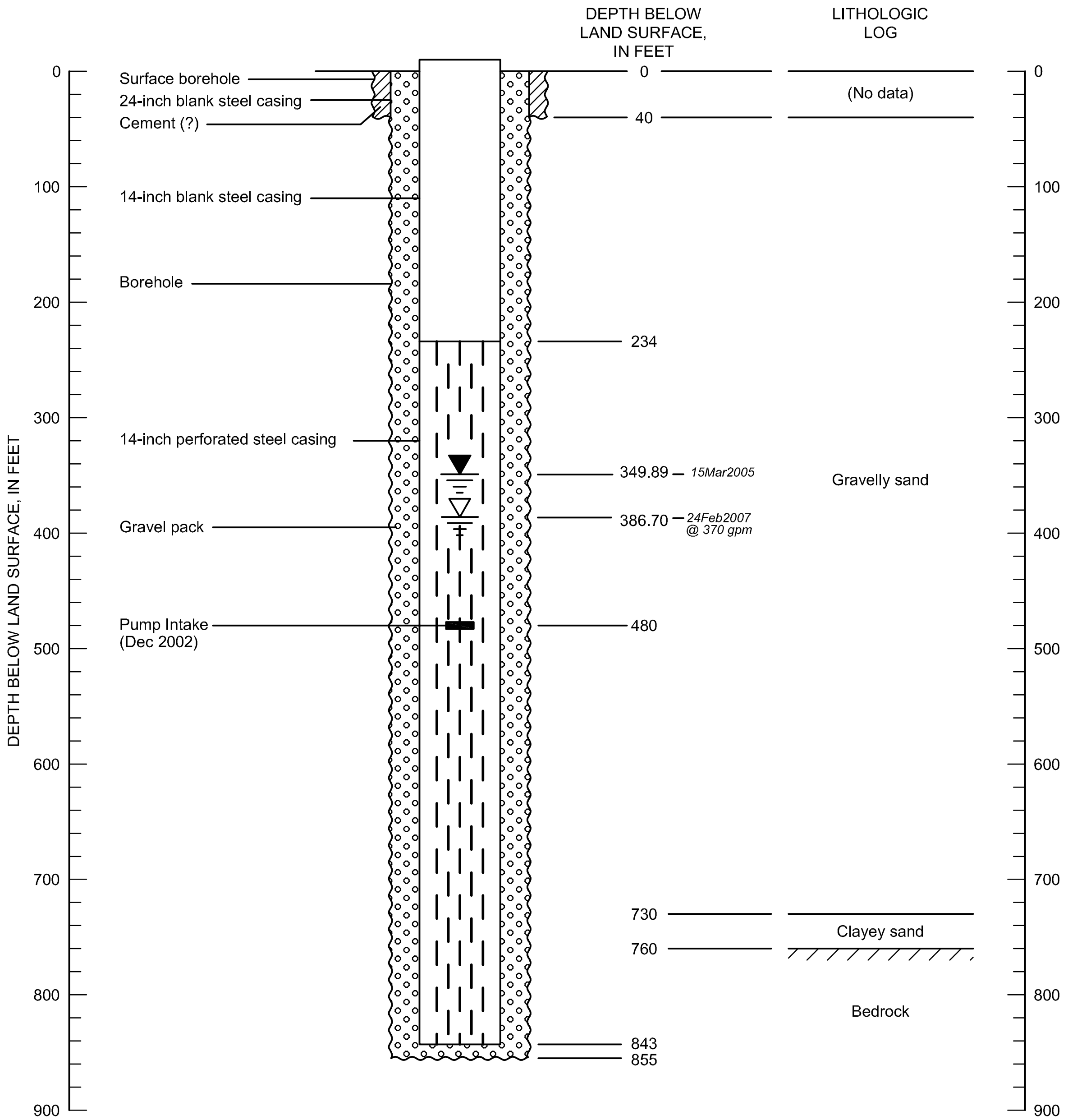
A-22 SCHEMATIC DIAGRAM OF WELL CONSTRUCTION FOR INTERCEPTOR WELL IW-20

A-23 SCHEMATIC DIAGRAM OF WELL CONSTRUCTION FOR INTERCEPTOR WELL IW-21

A-24 SCHEMATIC DIAGRAM OF WELL CONSTRUCTION FOR INTERCEPTOR WELL IW-22

A-25 SCHEMATIC DIAGRAM OF WELL CONSTRUCTION FOR INTERCEPTOR WELL IW-23

A-26 SCHEMATIC DIAGRAM OF WELL CONSTRUCTION FOR INTERCEPTOR WELL IW-24



EXPLANATION

non-pumping water level

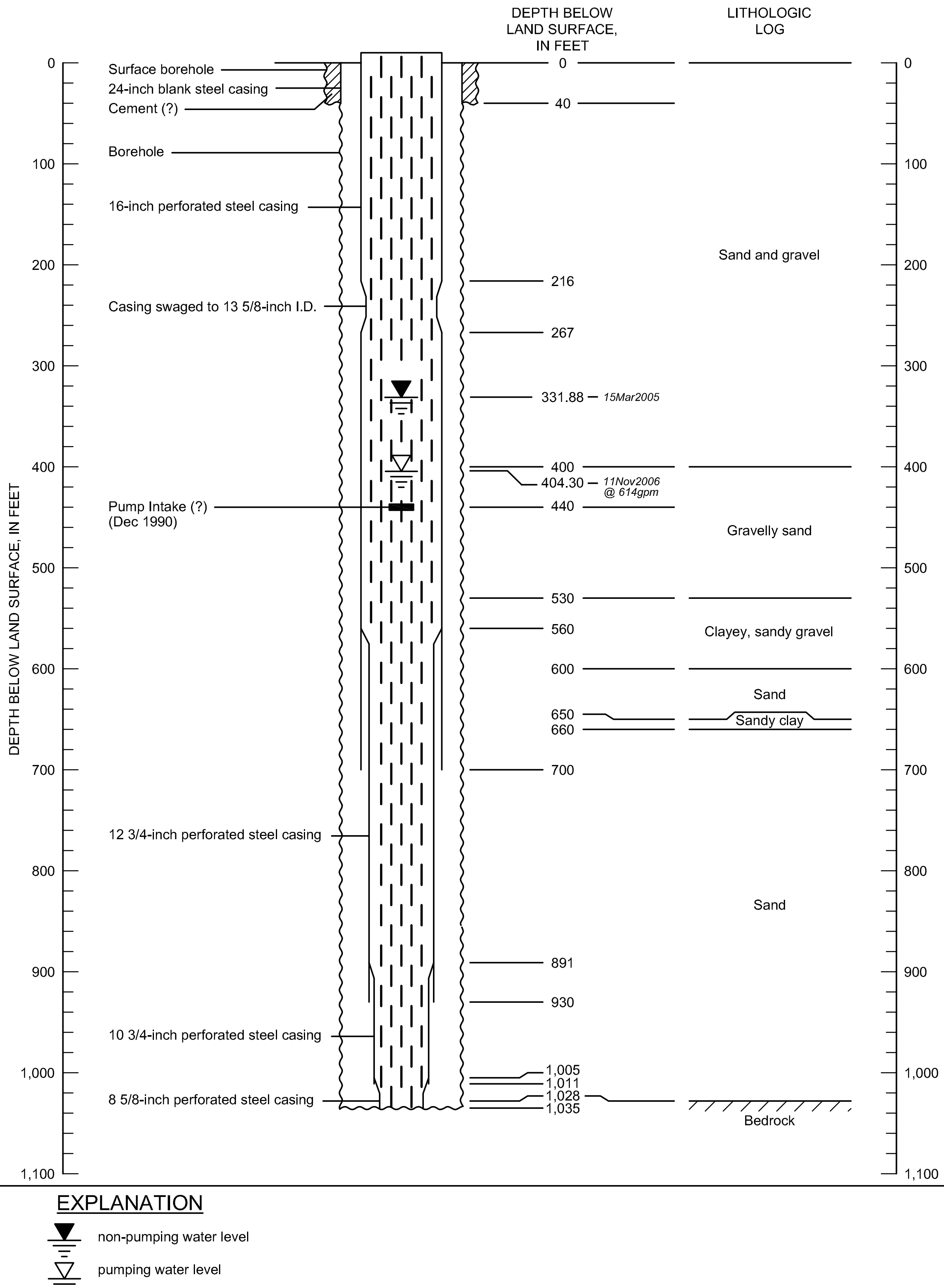
pumping water level

DRAWN BY: CEH	CHECKED BY: DSW	VERSION DATE: February 26, 2007

FIGURE A-1. SCHEMATIC DIAGRAM OF WELL CONSTRUCTION FOR INTERCEPTOR WELL IW-1

ERROL L. MONTGOMERY & ASSOCIATES, INC.

546.39\IW-1 WS_07

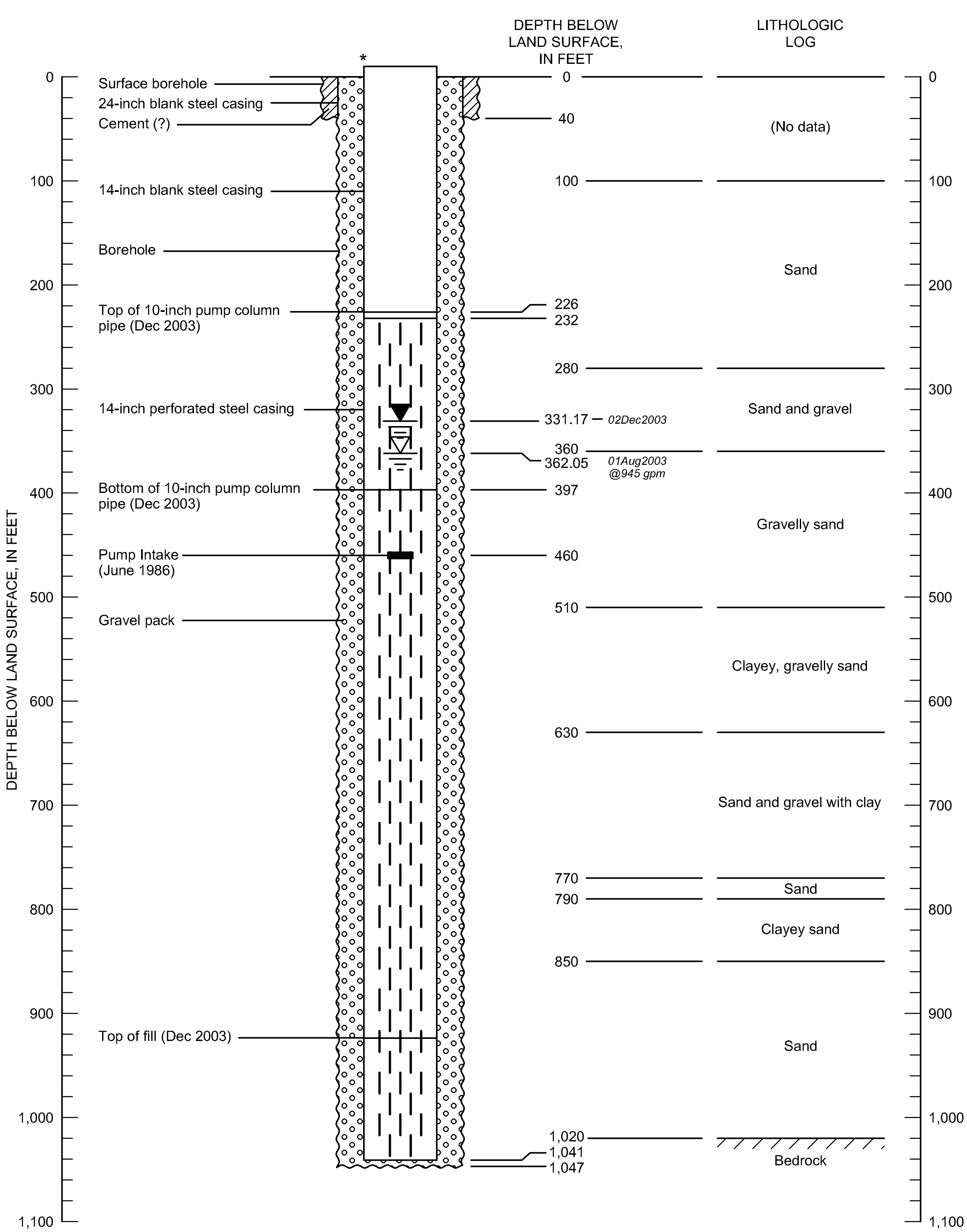


DRAWN BY: CEH	CHECKED BY: DSW	VERSION DATE: February 22, 2007

FIGURE A-2. SCHEMATIC DIAGRAM OF WELL CONSTRUCTION FOR INTERCEPTOR WELL IW-2

ERROL L. MONTGOMERY & ASSOCIATES, INC.

546.39\IW-2 WS_07



EXPLANATION

non-pumping water level

pumping water level

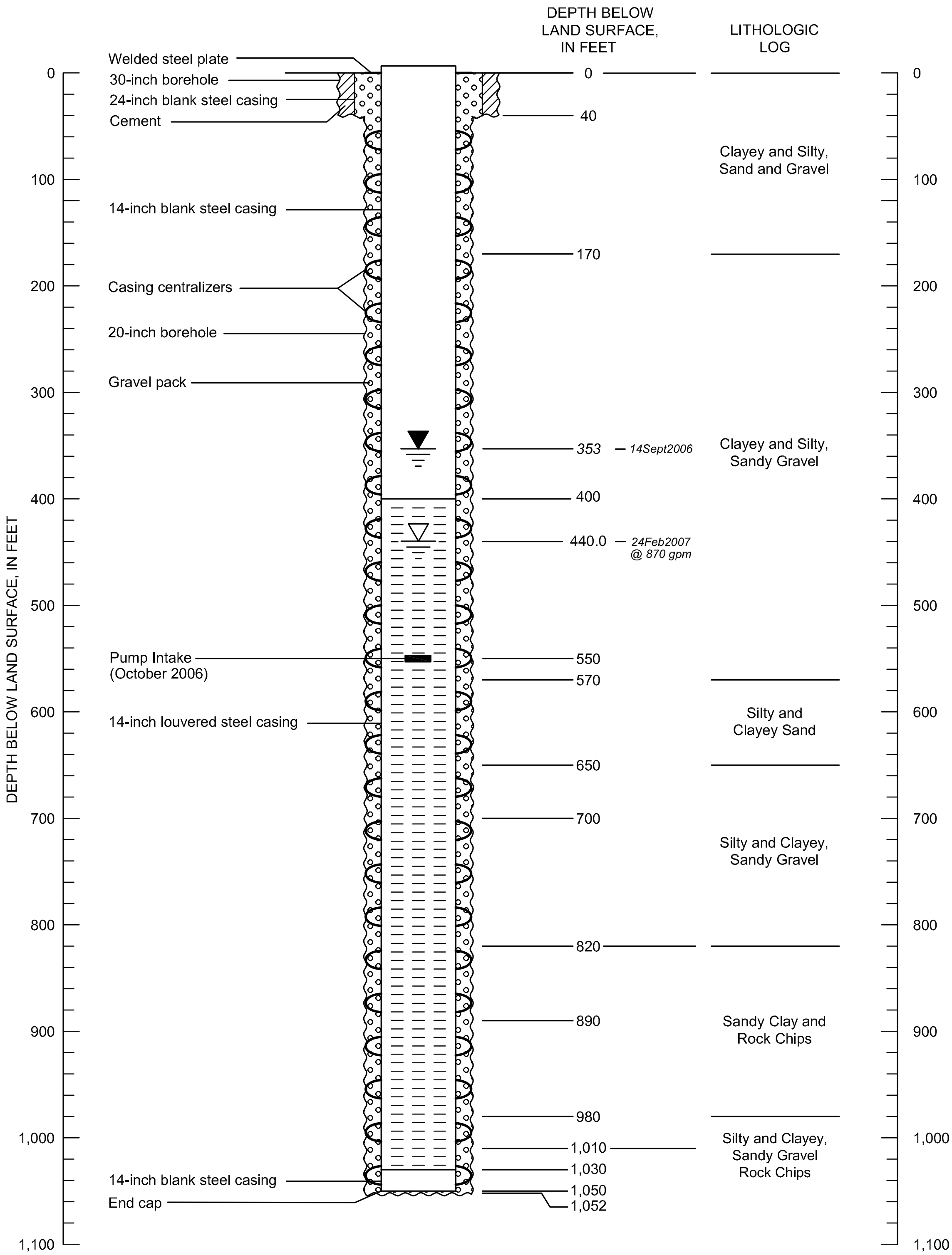
*Pump column pipe wedged in hole based on December 2003 video survey. Casing damaged. Well replacement recommended.

DRAWN BY: AMU	CHECKED BY: DSW	VERSION DATE: February 22, 2007

FIGURE A-3. SCHEMATIC DIAGRAM OF WELL CONSTRUCTION FOR INTERCEPTOR WELL IW-3

ERROL L. MONTGOMERY & ASSOCIATES, INC.

546.39|IW-3 WS_07



EXPLANATION

non-pumping water level

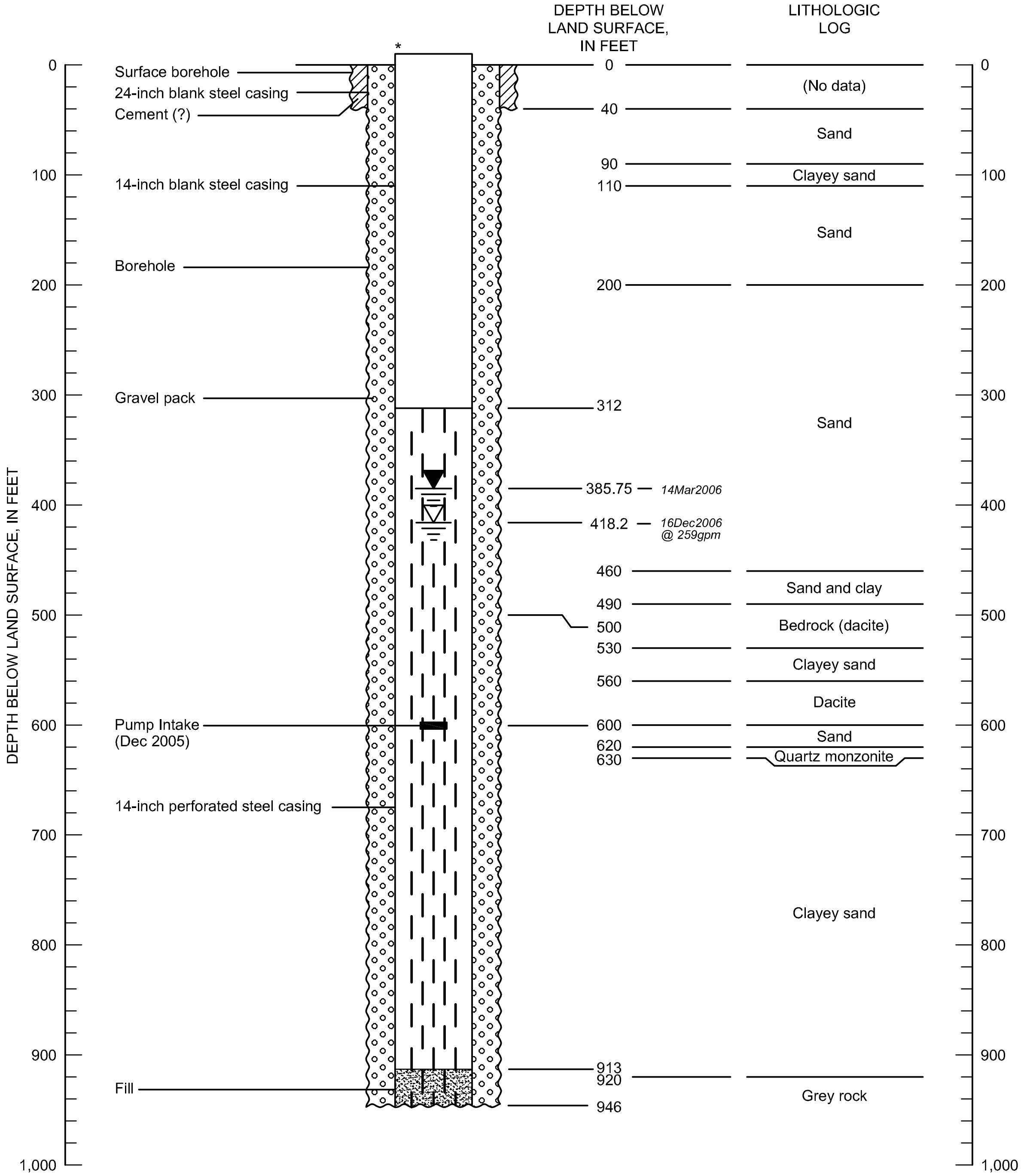
pumping water level

DRAWN BY: CEH	CHECKED BY: DSW	VERSION DATE: February 26, 2007

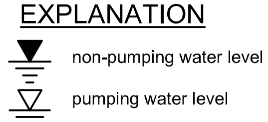
FIGURE A-4. SCHEMATIC DIAGRAM OF WELL CONSTRUCTION FOR INTERCEPTOR WELL IW-3A

ERROL L. MONTGOMERY & ASSOCIATES, INC.

546.39\IW-3A WS_07_Rev



EXPLANATION



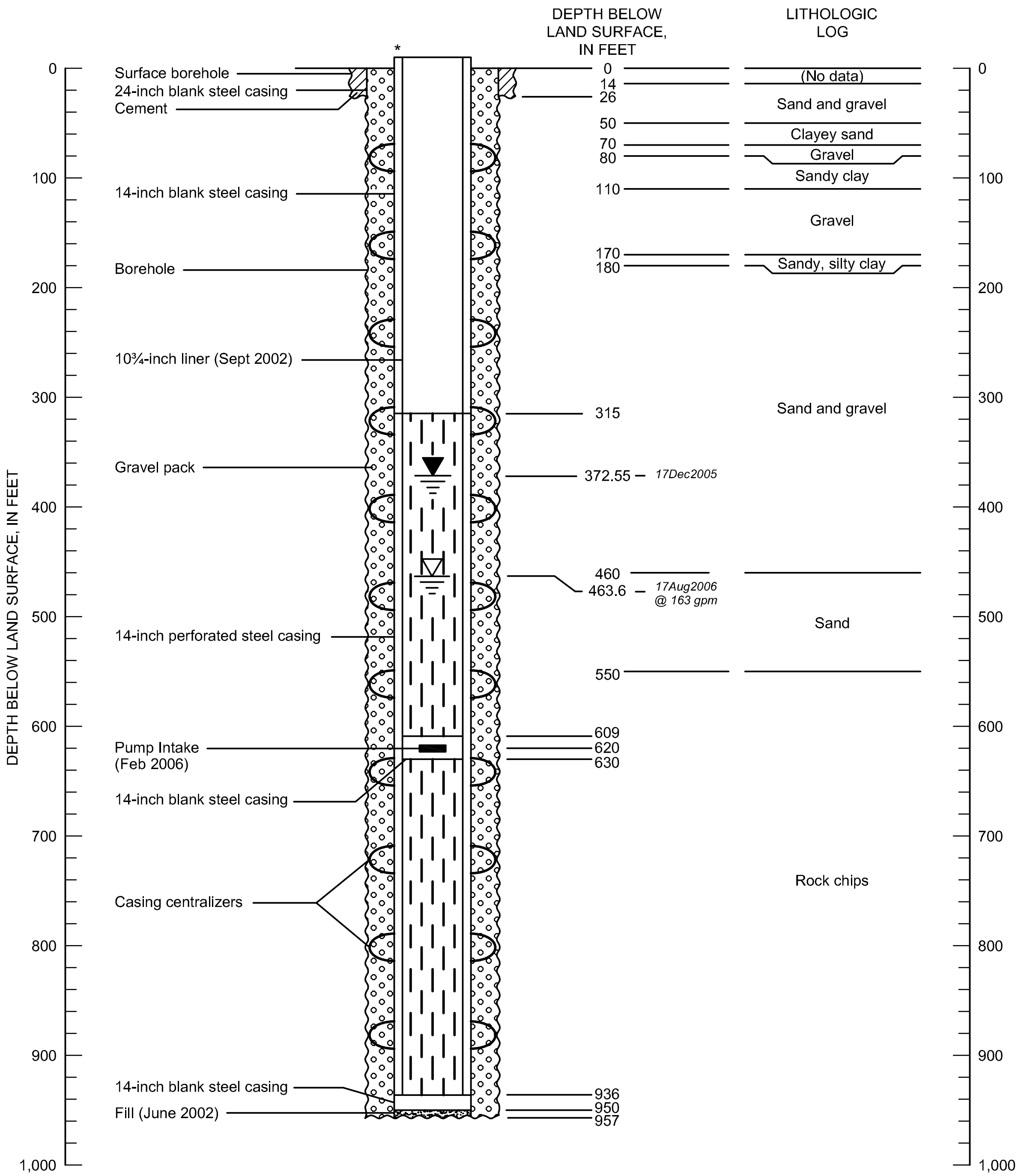
*Casing detail verified using borehole video log obtained 07Sept2005.

DRAWN BY: CEH	CHECKED BY: DSW	VERSION DATE: February 22, 2007

FIGURE A-5. SCHEMATIC DIAGRAM OF WELL CONSTRUCTION FOR INTERCEPTOR WELL IW-4

ERROL L. MONTGOMERY & ASSOCIATES, INC.

546.39\IW-4 WS_07



EXPLANATION

non-pumping water level

pumping water level

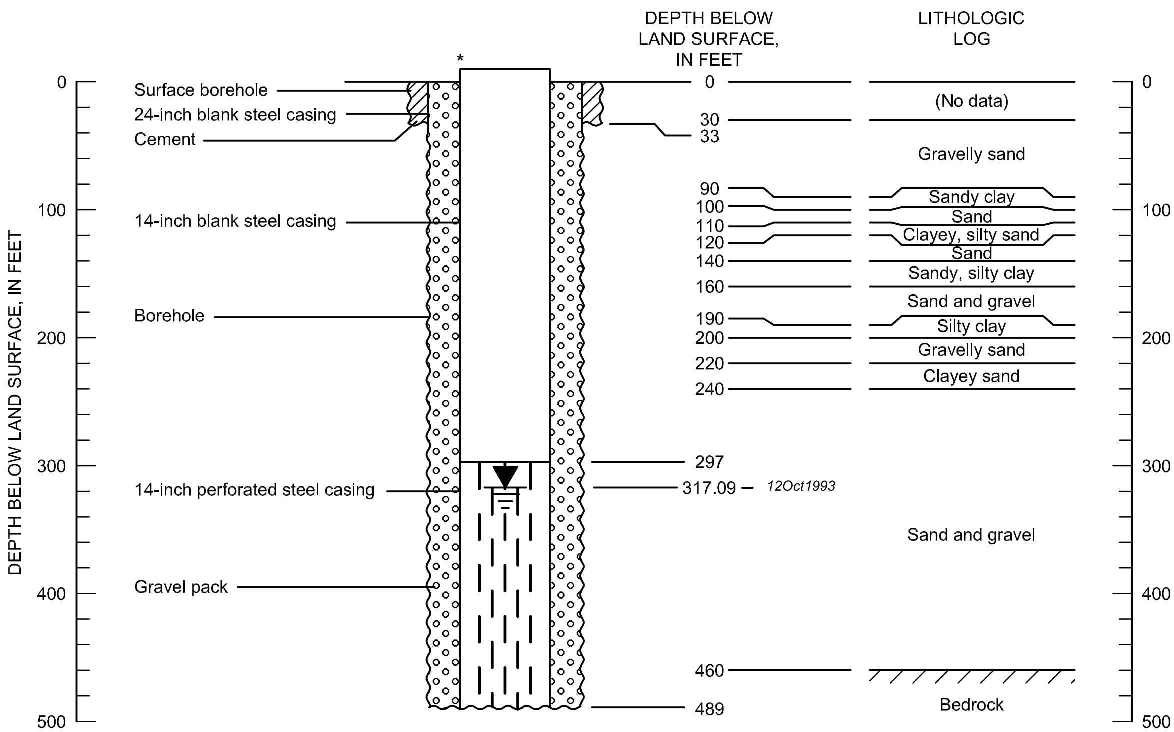
*Casing detail verified using Layne's invoice for well modifications (dated 22July2002)

DRAWN BY: CEH	CHECKED BY: DSW	VERSION DATE:February 22, 2007

FIGURE A-6. SCHEMATIC DIAGRAM OF WELL CONSTRUCTION FOR INTERCEPTOR WELL IW-5

ERROL L. MONTGOMERY & ASSOCIATES, INC.

546.39\IW-5 WS_07



EXPLANATION

* NOT EQUIPPED / CAPPED

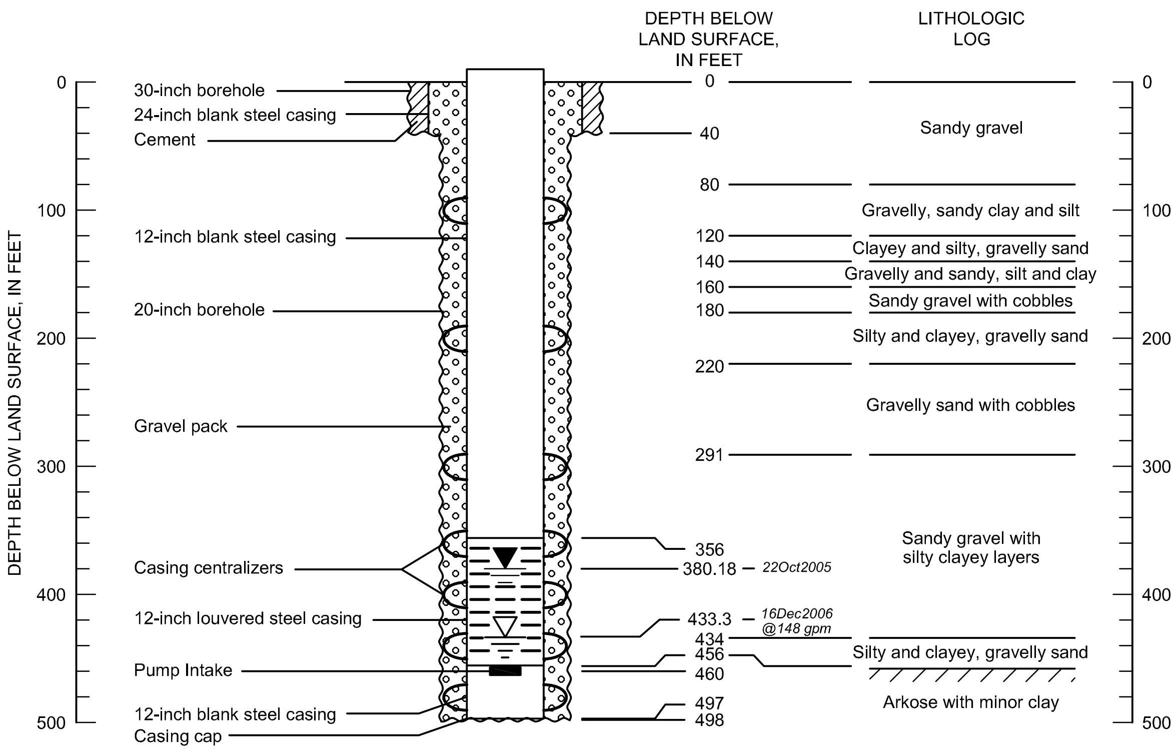
non-pumping water level

DRAWN BY: CEH	CHECKED BY: DSW	VERSION DATE: February 22, 2007

FIGURE A-7. SCHEMATIC DIAGRAM OF WELL CONSTRUCTION FOR INTERCEPTOR WELL IW-6

ERROL L. MONTGOMERY & ASSOCIATES, INC.

546.39\IW-6 WS_07



EXPLANATION

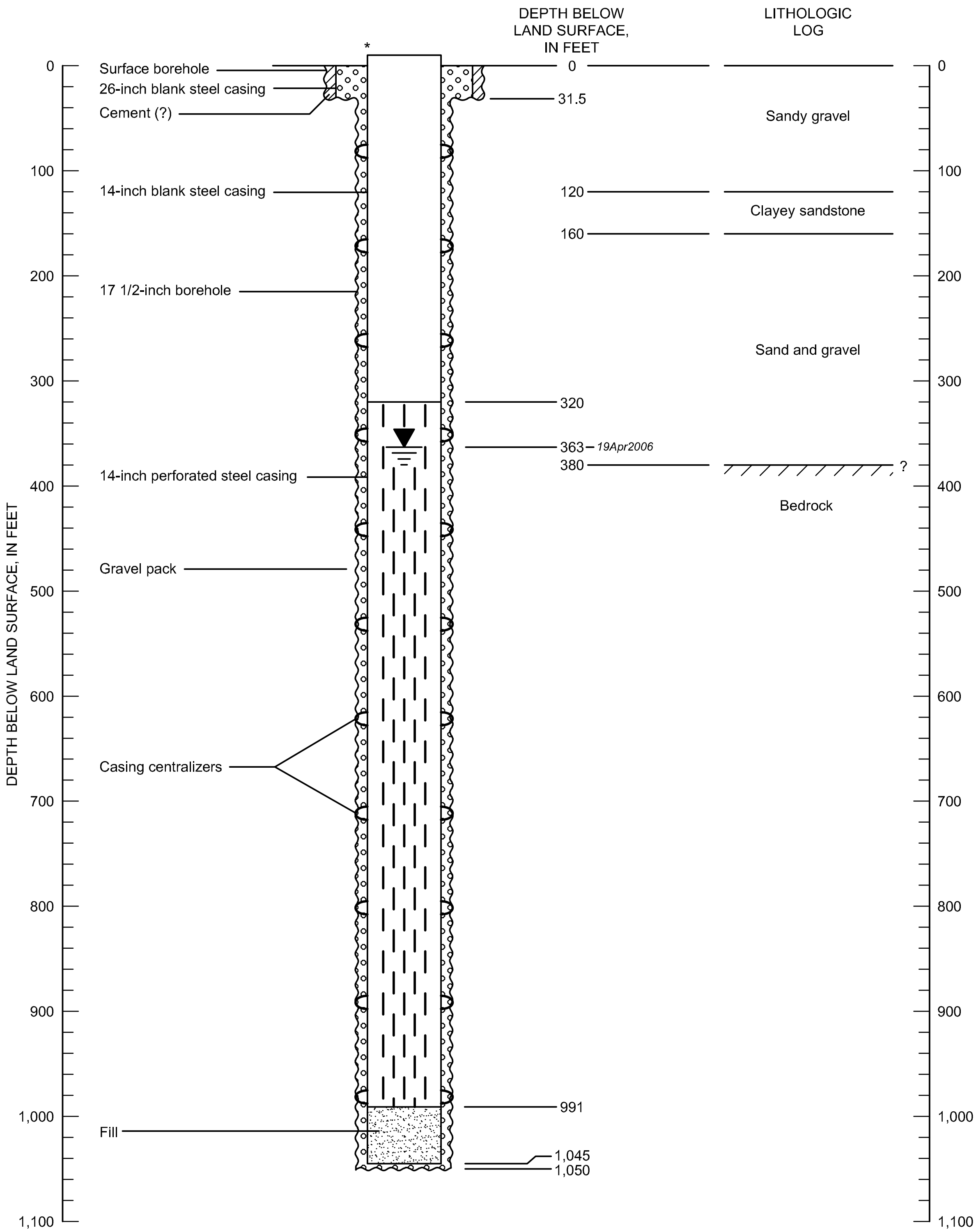
- ▼ non-pumping water level
- ▽ pumping water level

DRAWN BY: CEH	CHECKED BY: DSW	VERSION DATE: February 22, 2007

FIGURE A-8. SCHEMATIC DIAGRAM OF WELL CONSTRUCTION FOR INTERCEPTOR WELL IW-6A

ERROL L. MONTGOMERY & ASSOCIATES, INC.

546.39\IW-6A WS_07



EXPLANATION

* Not Equipped/Capped
Well video-logged 19Apr2006

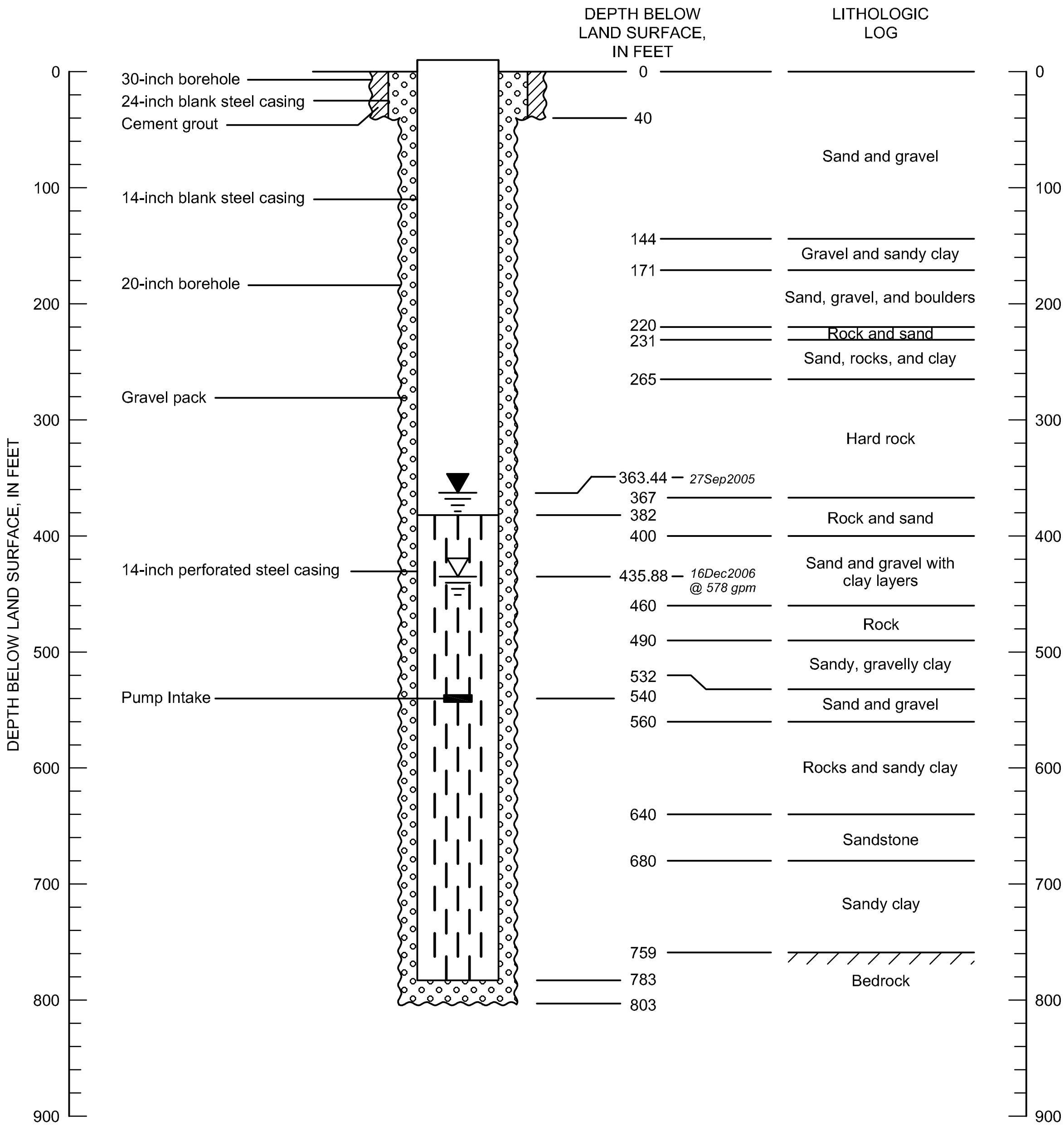
non-pumping water level

DRAWN BY: CEH	CHECKED BY: DSW	VERSION DATE: February 26, 2007

FIGURE A-9. SCHEMATIC DIAGRAM OF WELL CONSTRUCTION FOR INTERCEPTOR WELL IW-7

ERROL L. MONTGOMERY & ASSOCIATES, INC.

546.39\IW-7 WS_07



EXPLANATION

non-pumping water level

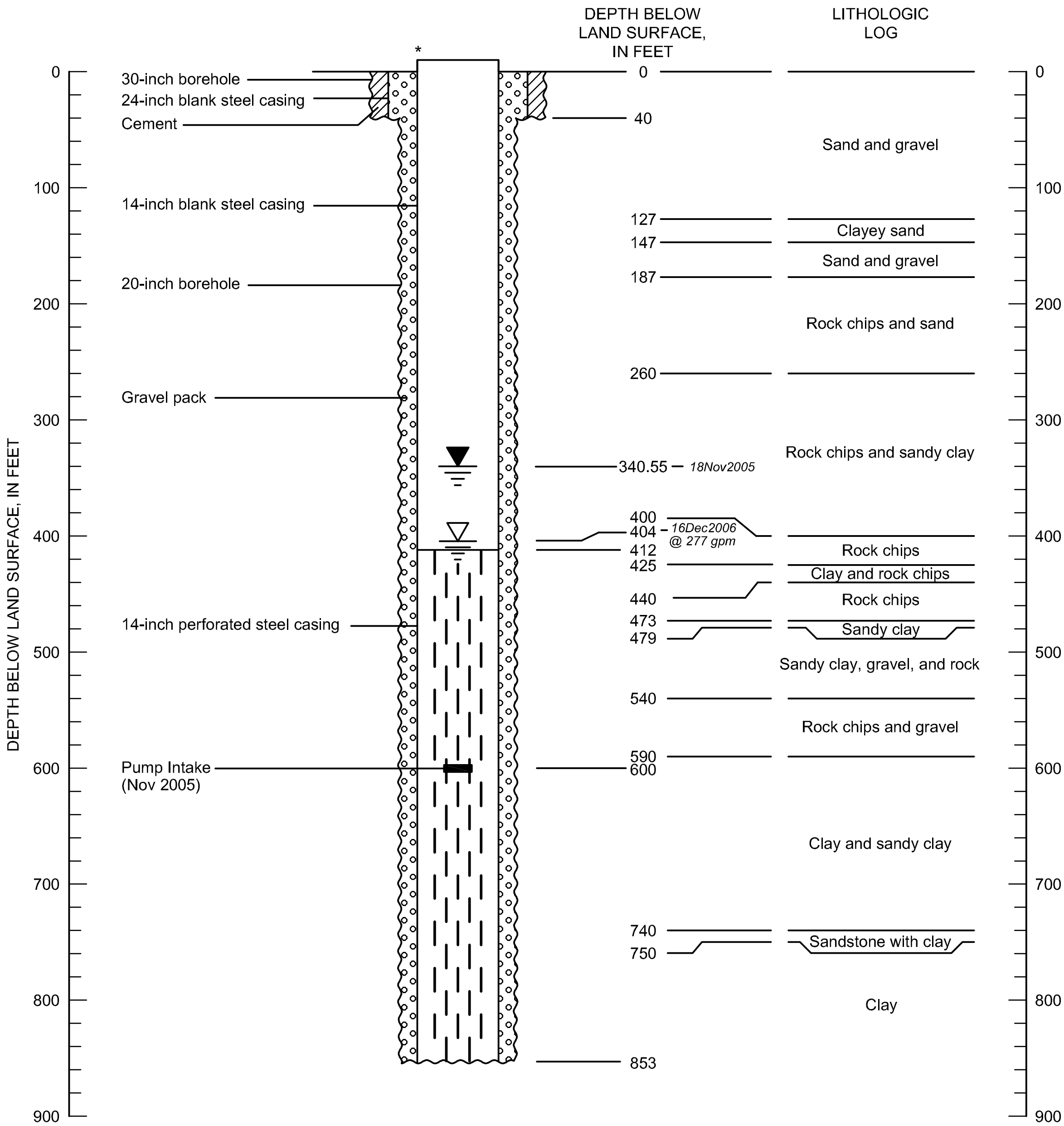
pumping water level

DRAWN BY: CEH	CHECKED BY: DSW	VERSION DATE: February 22, 2007

FIGURE A-10. SCHEMATIC DIAGRAM OF WELL CONSTRUCTION FOR INTERCEPTOR WELL IW-8

ERROL L. MONTGOMERY & ASSOCIATES, INC.

546.39\IW-8 WS_07



EXPLANATION

non-pumping water level

pumping water level

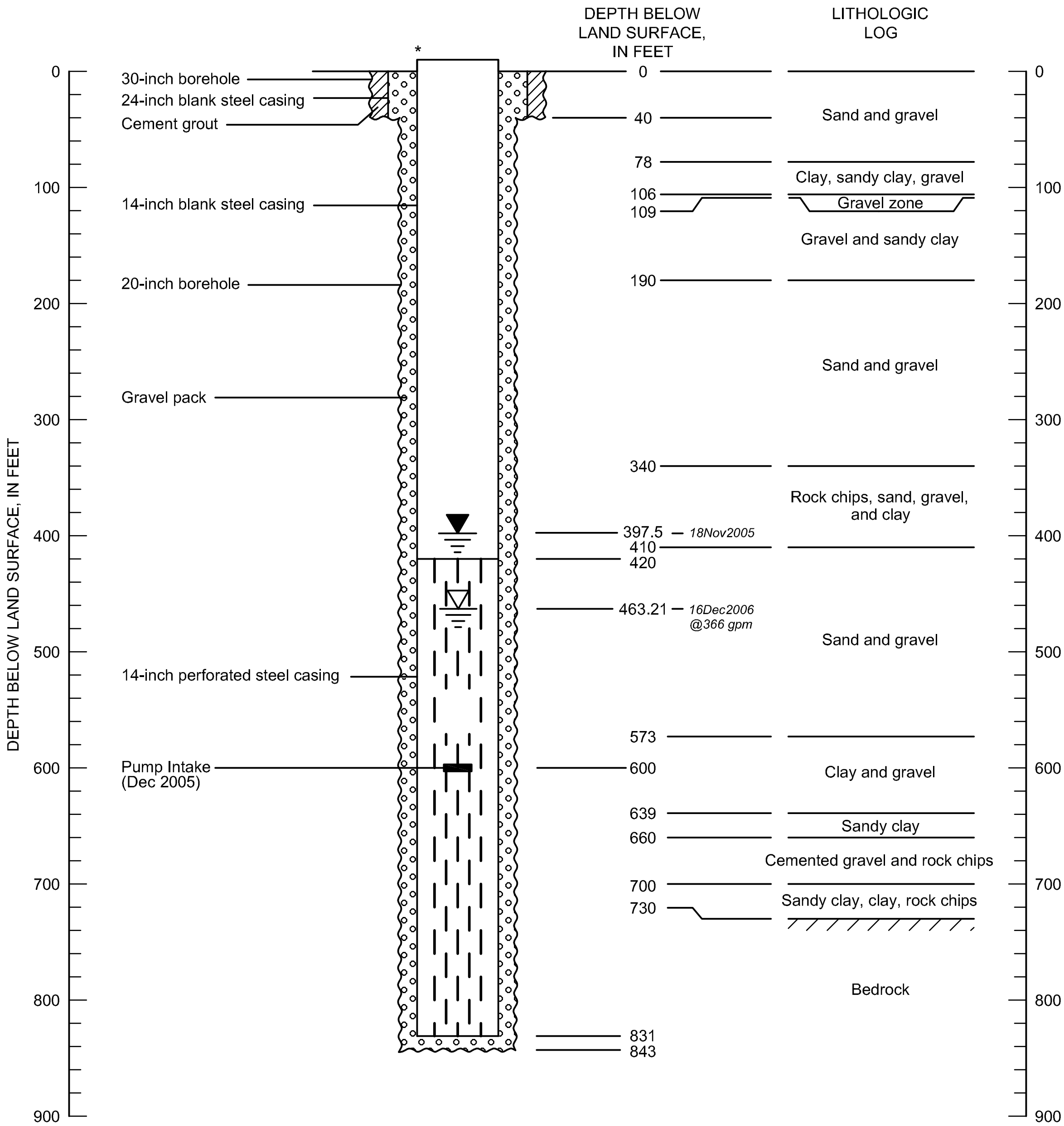
*Casing detail verified
using borehole video log
obtained 30April2003.

DRAWN BY: CEH	CHECKED BY: DSW	VERSION DATE: February 22, 2007

FIGURE A-11. SCHEMATIC DIAGRAM OF WELL CONSTRUCTION FOR INTERCEPTOR WELL IW-9

ERROL L. MONTGOMERY & ASSOCIATES, INC.

546.39\IW-9 WS_07



EXPLANATION

- non-pumping water level
- pumping water level

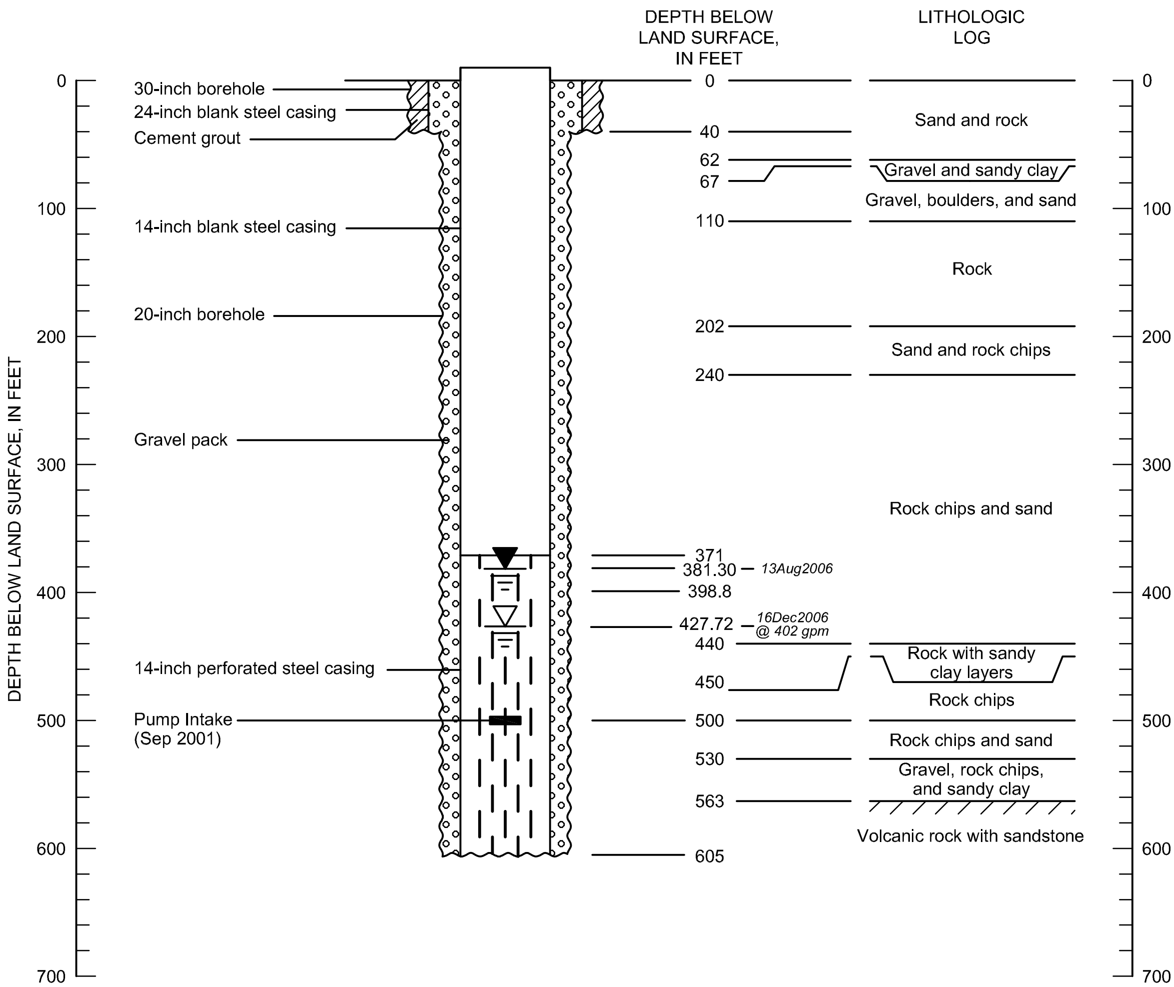
*Casing detail verified using borehole video log obtained 10Nov2003.

DRAWN BY: CEH	CHECKED BY: DSW	VERSION DATE: February 22, 2007

FIGURE A-12. SCHEMATIC DIAGRAM OF WELL CONSTRUCTION FOR INTERCEPTOR WELL IW-10

ERROL L. MONTGOMERY & ASSOCIATES, INC.

546.39\IW-10 WS_07



EXPLANATION

non-pumping water level

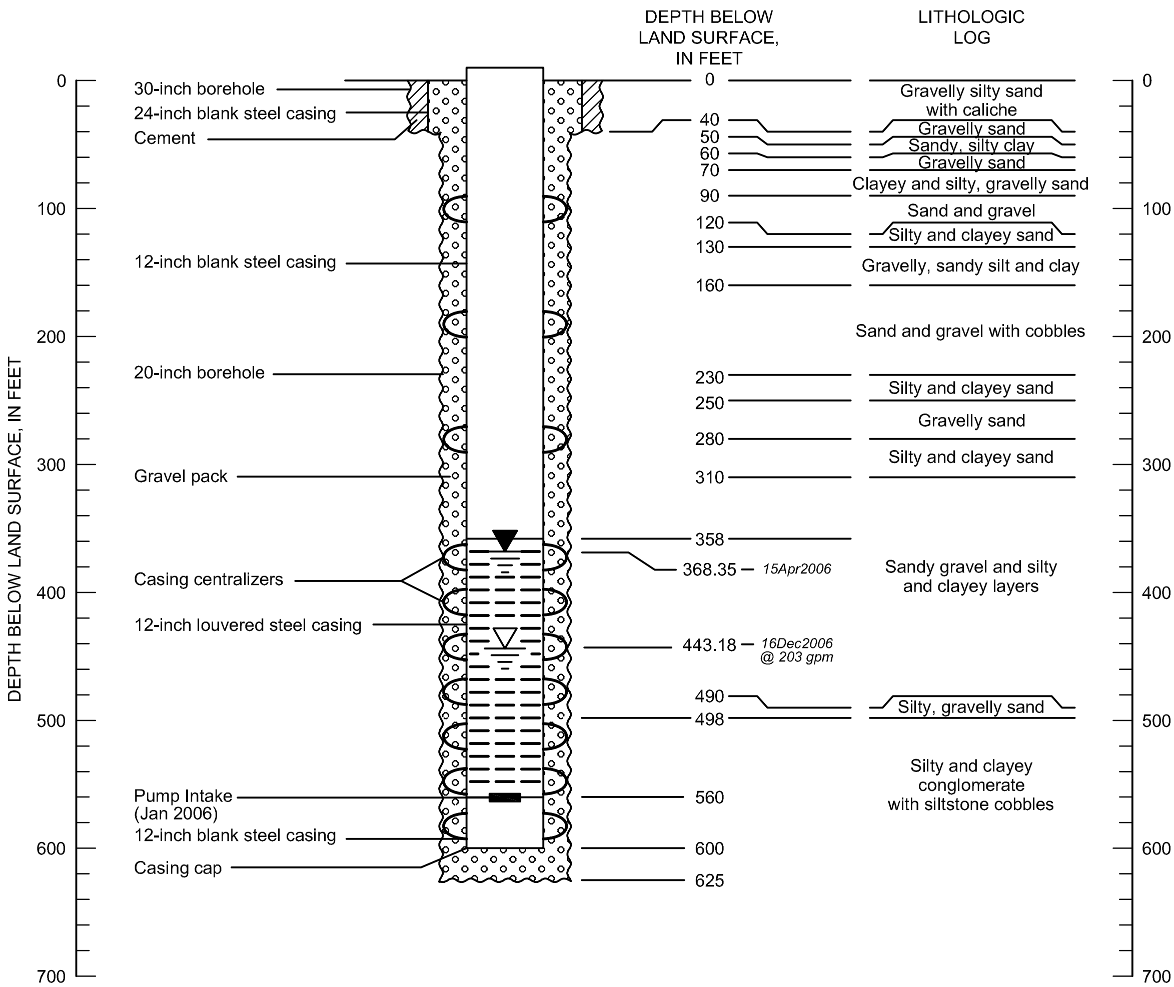
pumping water level

DRAWN BY: CEH	CHECKED BY: DSW	VERSION DATE: February 22, 2007

FIGURE A-13. SCHEMATIC DIAGRAM OF WELL CONSTRUCTION FOR INTERCEPTOR WELL IW-11

ERROL L. MONTGOMERY & ASSOCIATES, INC.

546.39\IW-11 WS_07



EXPLANATION

non-pumping water level

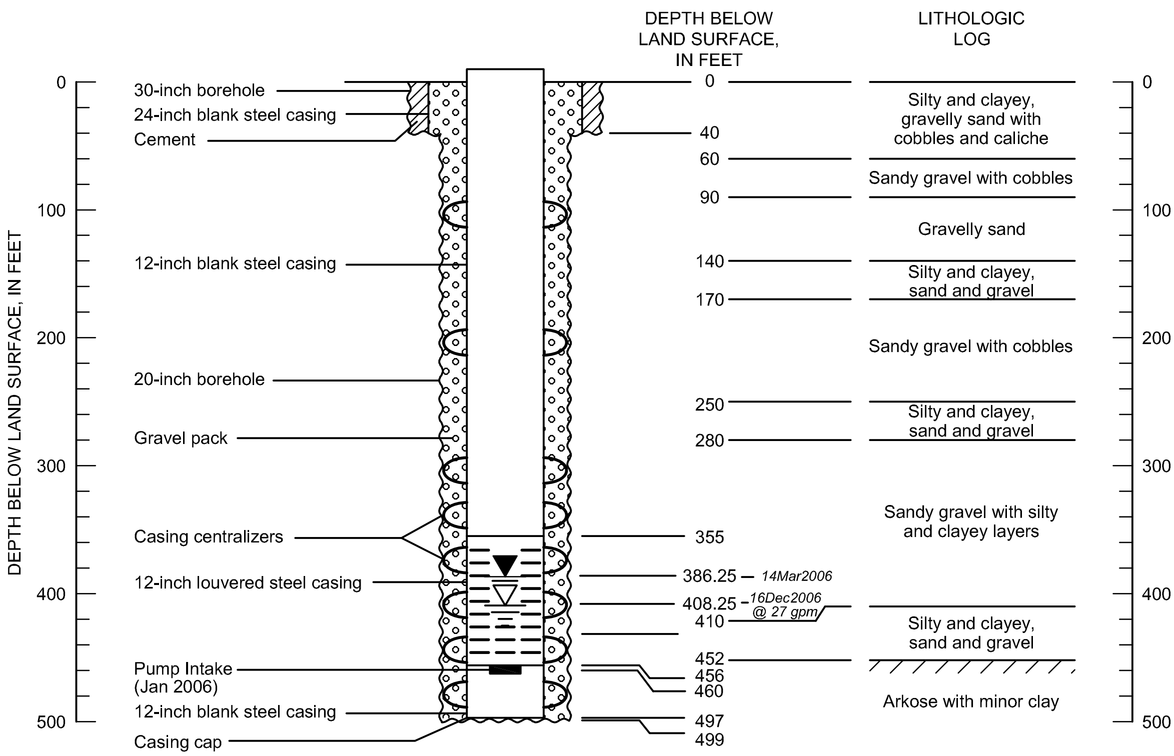
pumping water level

DRAWN BY: CEH	CHECKED BY: DSW	VERSION DATE: February 22, 2007

FIGURE A-14. SCHEMATIC DIAGRAM OF WELL CONSTRUCTION FOR INTERCEPTOR WELL IW-12

ERROL L. MONTGOMERY & ASSOCIATES, INC.

546.39\IW-12 WS_07



EXPLANATION

non-pumping water level

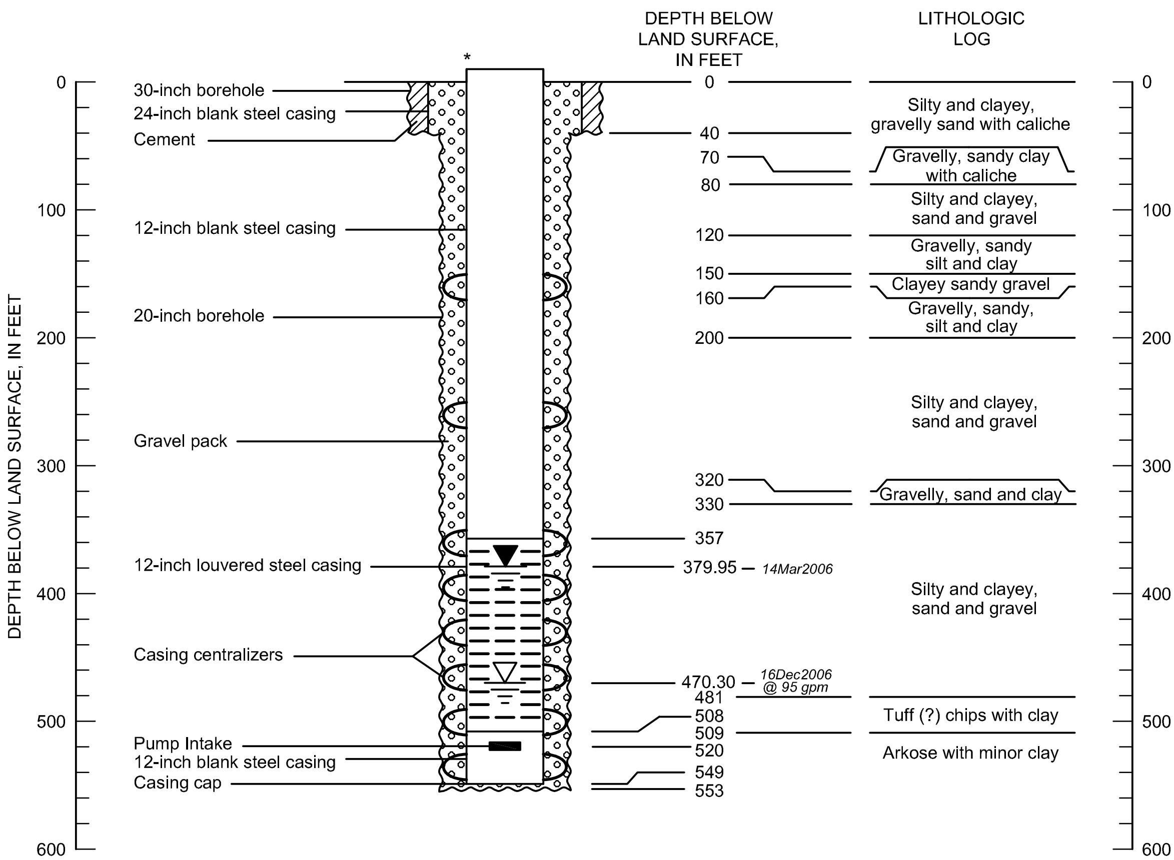
pumping water level

DRAWN BY: CEH	CHECKED BY: DSW	VERSION DATE: February 22, 2007

FIGURE A-15. SCHEMATIC DIAGRAM OF WELL CONSTRUCTION FOR INTERCEPTOR WELL IW-13

ERROL L. MONTGOMERY & ASSOCIATES, INC.

546.39\IW-13 WS_07



EXPLANATION

non-pumping water level

pumping water level

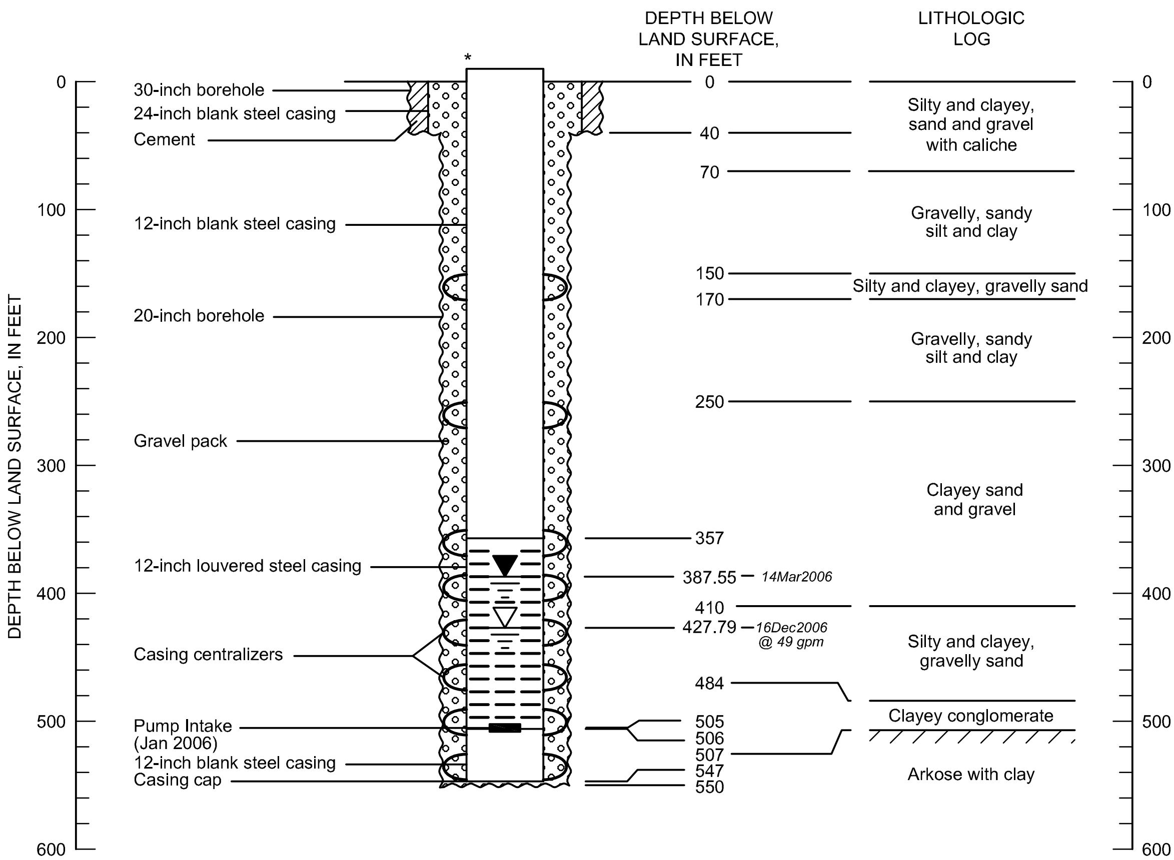
*Casing detail verified using borehole video log obtained 10Dec2003

DRAWN BY: CEH	CHECKED BY: DSW	VERSION DATE: February 22, 2007

FIGURE A-16. SCHEMATIC DIAGRAM OF WELL CONSTRUCTION FOR INTERCEPTOR WELL IW-14

ERROL L. MONTGOMERY & ASSOCIATES, INC.

546.39\IW-14 WS_07



EXPLANATION

non-pumping water level

pumping water level

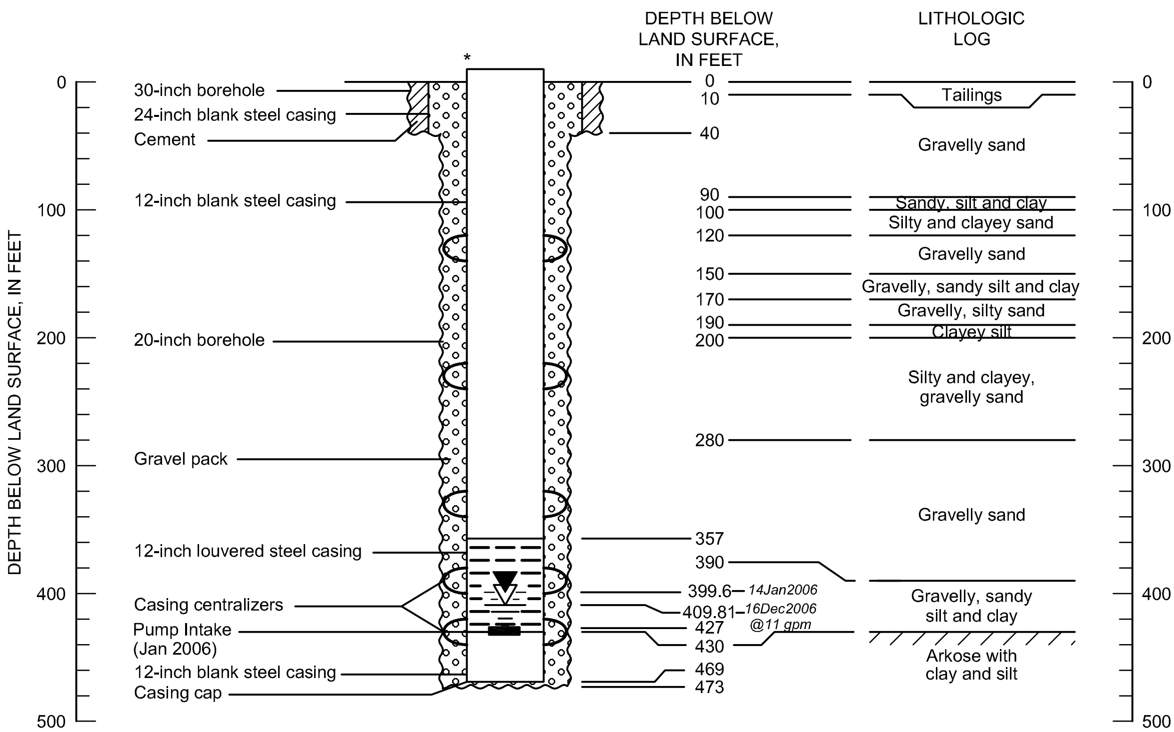
*Casing detail verified using borehole video log obtained 17Oct2003

DRAWN BY: CEH	CHECKED BY: DSW	VERSION DATE: February 22, 2007

FIGURE A-17. SCHEMATIC DIAGRAM OF WELL CONSTRUCTION FOR INTERCEPTOR WELL IW-15

ERROL L. MONTGOMERY & ASSOCIATES, INC.

546.39\IW-15 WS_07



EXPLANATION

non-pumping water level

pumping water level

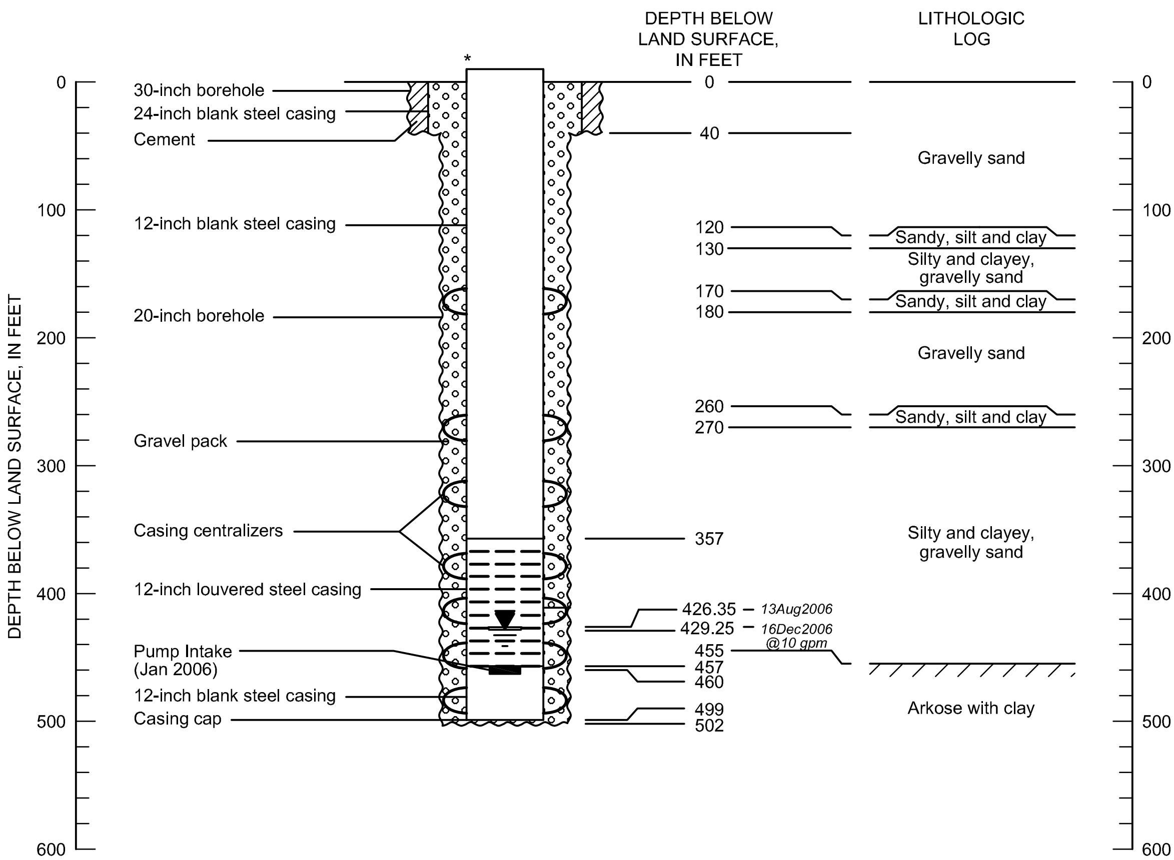
*Casing detail verified using borehole video log obtained 03Nov2005

DRAWN BY: CEH	CHECKED BY: DSW	VERSION DATE: February 22, 2007

FIGURE A-18. SCHEMATIC DIAGRAM OF WELL CONSTRUCTION FOR INTERCEPTOR WELL IW-16

ERROL L. MONTGOMERY & ASSOCIATES, INC.

546.39\IW-16 WS_07



EXPLANATION

non-pumping water level

pumping water level

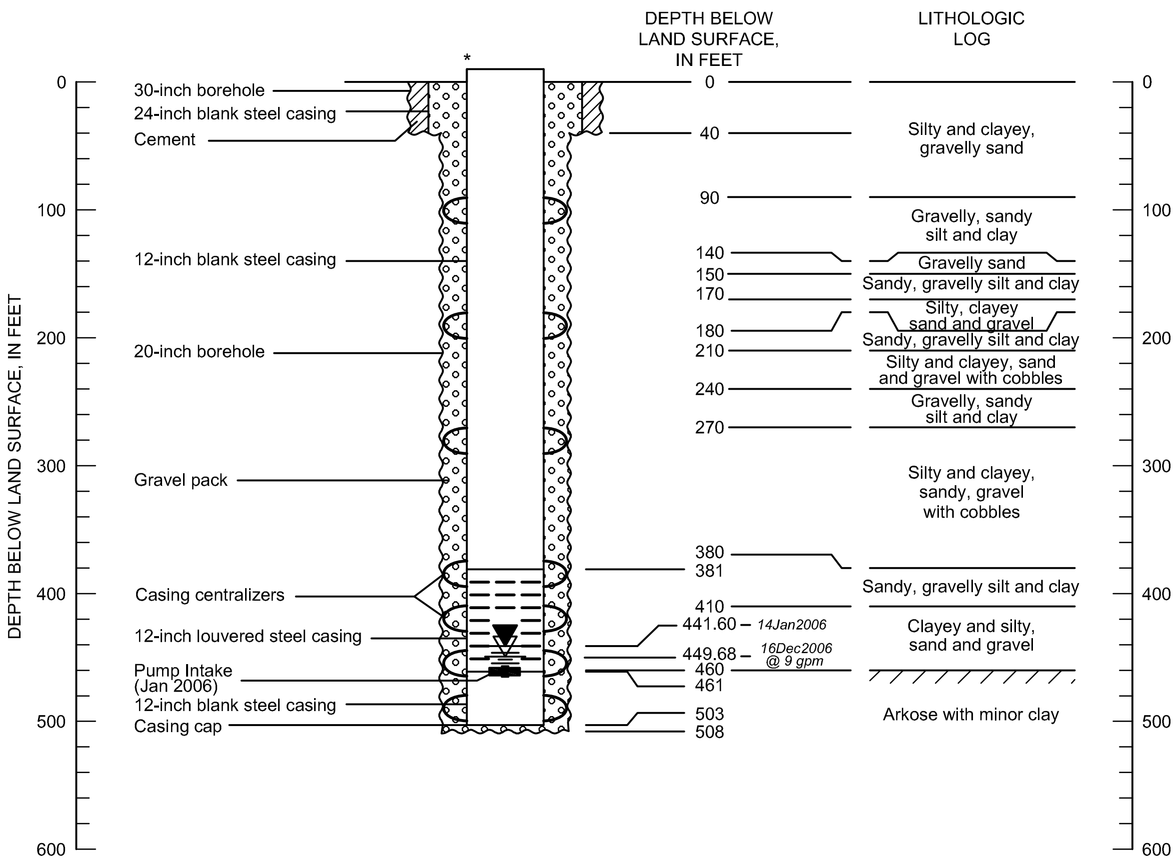
*Casing detail verified using borehole video log obtained 03Nov2005

DRAWN BY: CEH	CHECKED BY: DSW	VERSION DATE: February 22, 2007

FIGURE A-19. SCHEMATIC DIAGRAM OF WELL CONSTRUCTION FOR INTERCEPTOR WELL IW-17

ERROL L. MONTGOMERY & ASSOCIATES, INC.

546.39\IW-17 WS_07



EXPLANATION

non-pumping water level

pumping water level

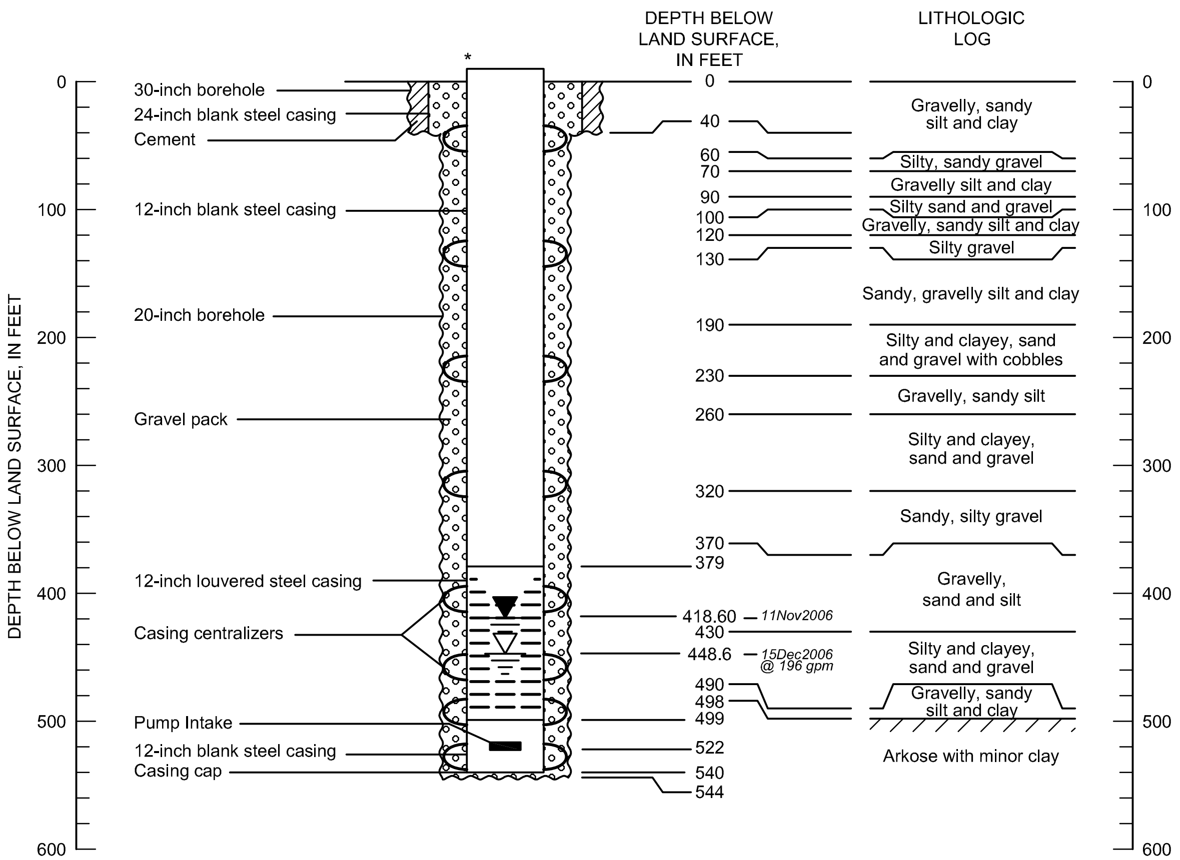
*Casing detail verified using borehole video log obtained 03Nov2005

DRAWN BY: CEH	CHECKED BY: DSW	VERSION DATE: February 22, 2007

FIGURE A-20. SCHEMATIC DIAGRAM OF WELL CONSTRUCTION FOR INTERCEPTOR WELL IW-18

ERROL L. MONTGOMERY & ASSOCIATES, INC.

546.39\IW-18 WS_07



EXPLANATION

non-pumping water level

pumping water level

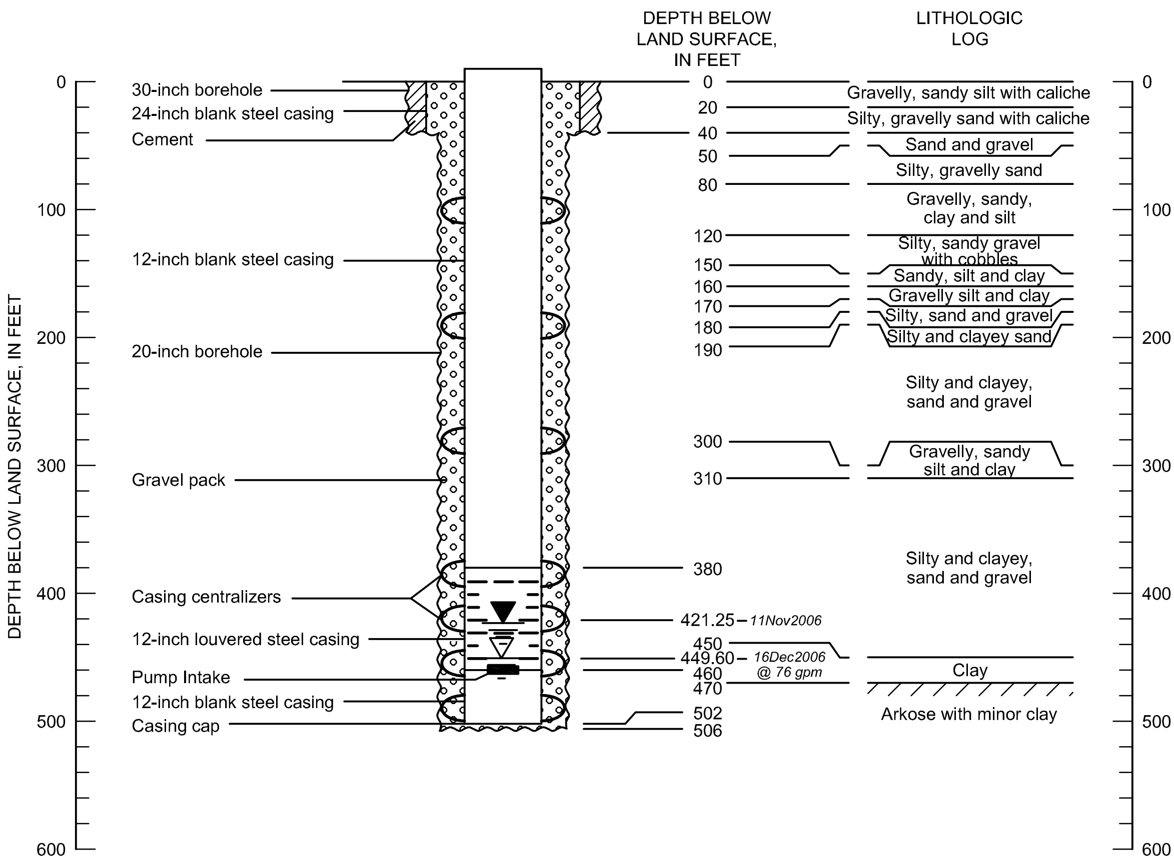
*Casing detail verified using borehole video log obtained 10Dec2005

DRAWN BY: CEH	CHECKED BY: DSW	VERSION DATE: February 22, 2007

FIGURE A-21. SCHEMATIC DIAGRAM OF WELL CONSTRUCTION FOR INTERCEPTOR WELL IW-19

ERROL L. MONTGOMERY & ASSOCIATES, INC.

546.39\IW-19 WS_07



EXPLANATION

non-pumping water level

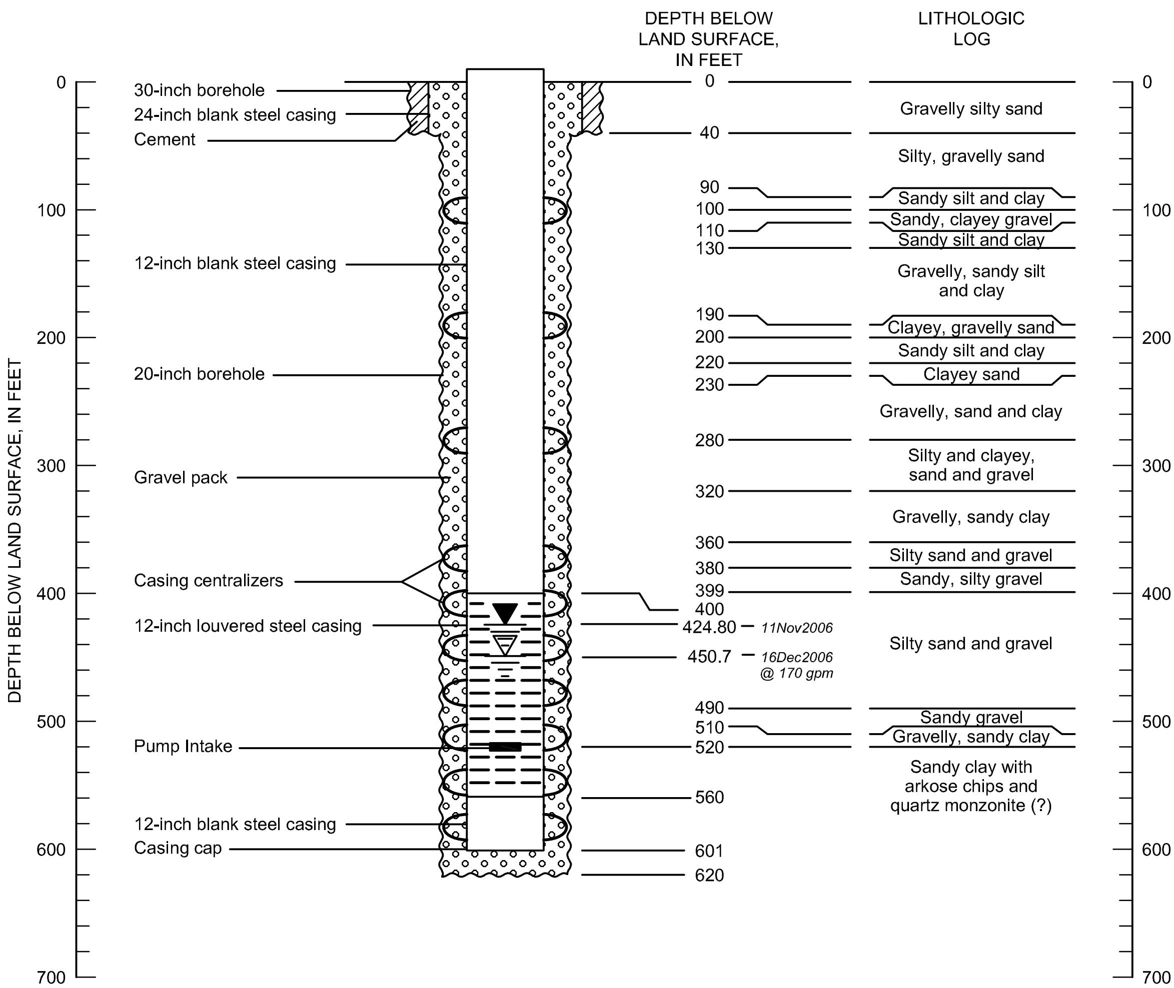
pumping water level

DRAWN BY: CEH	CHECKED BY: DSW	VERSION DATE: February 22, 2007

FIGURE A-22. SCHEMATIC DIAGRAM OF WELL CONSTRUCTION FOR INTERCEPTOR WELL IW-20

ERROL L. MONTGOMERY & ASSOCIATES, INC.

546.39\IW-20 WS_07



EXPLANATION

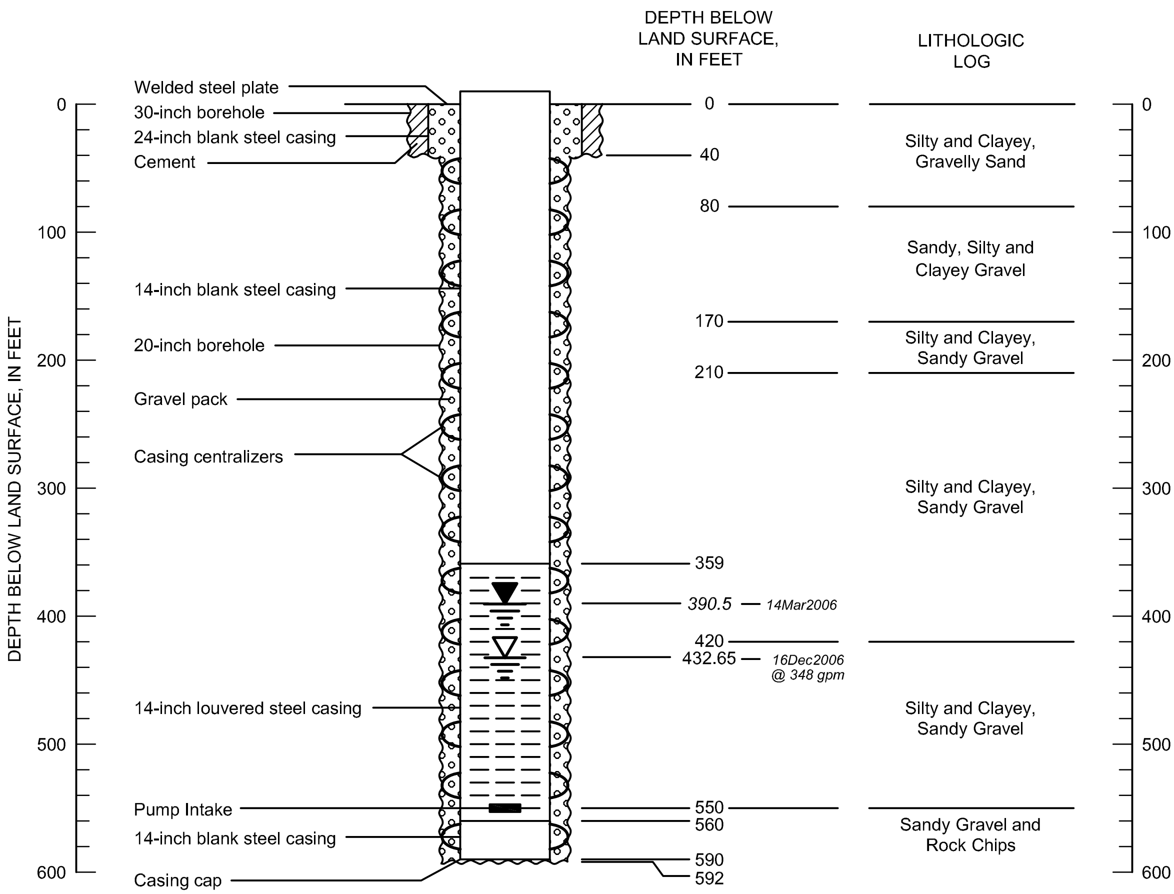
- non-pumping water level
- pumping water level

DRAWN BY: CEH	CHECKED BY: DSW	VERSION DATE: February 22, 2007

FIGURE A-23. SCHEMATIC DIAGRAM OF WELL CONSTRUCTION FOR INTERCEPTOR WELL IW-21

ERROL L. MONTGOMERY & ASSOCIATES, INC.

546.39\IW-21 WS_07



EXPLANATION

non-pumping water level

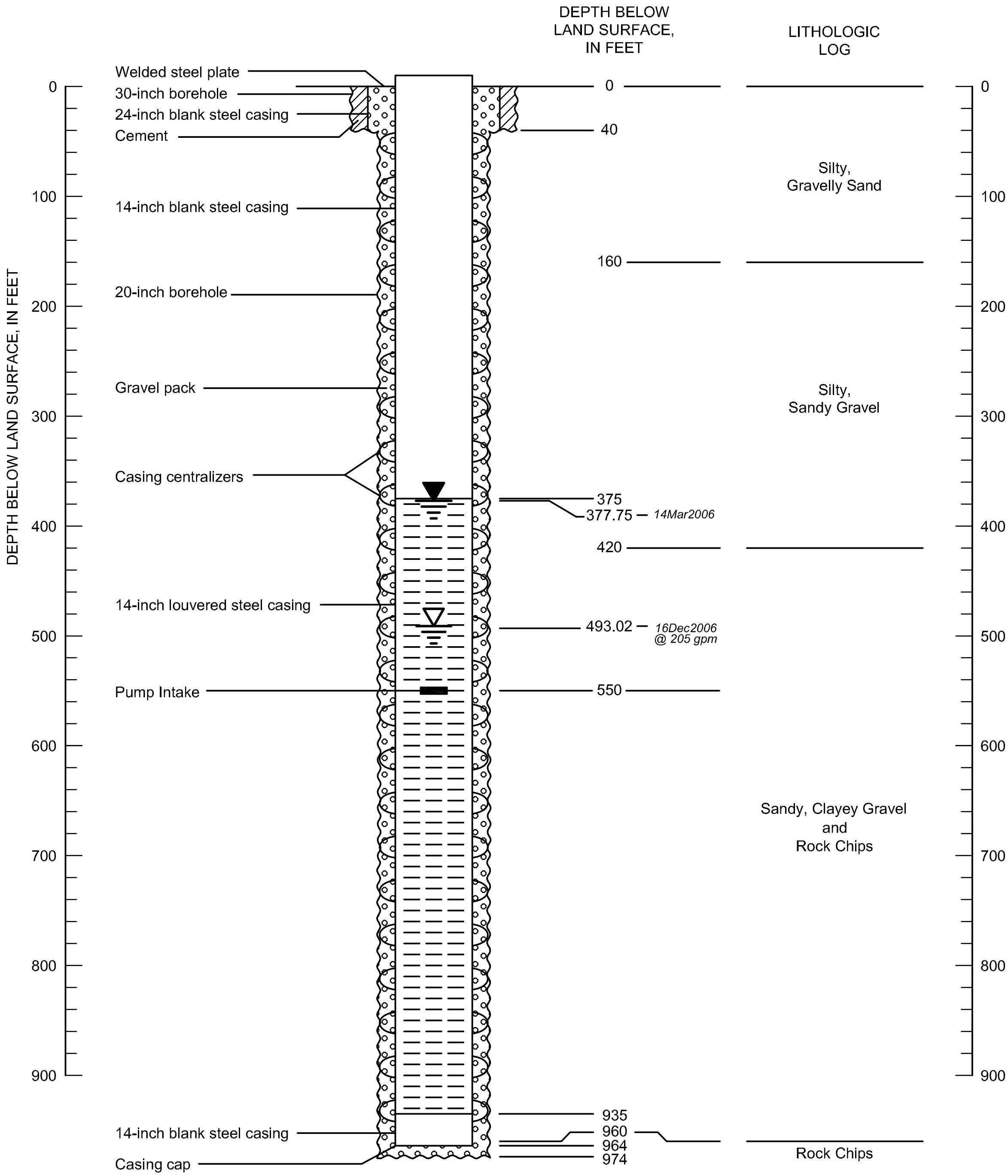
pumping water level

DRAWN BY: CEH	CHECKED BY: DSW	VERSION DATE: February 22, 2007

FIGURE A-24. SCHEMATIC DIAGRAM OF WELL CONSTRUCTION FOR INTERCEPTOR WELL IW-22

ERROL L. MONTGOMERY & ASSOCIATES, INC.

546.39\IW-22 WS_07



EXPLANATION

non-pumping water level

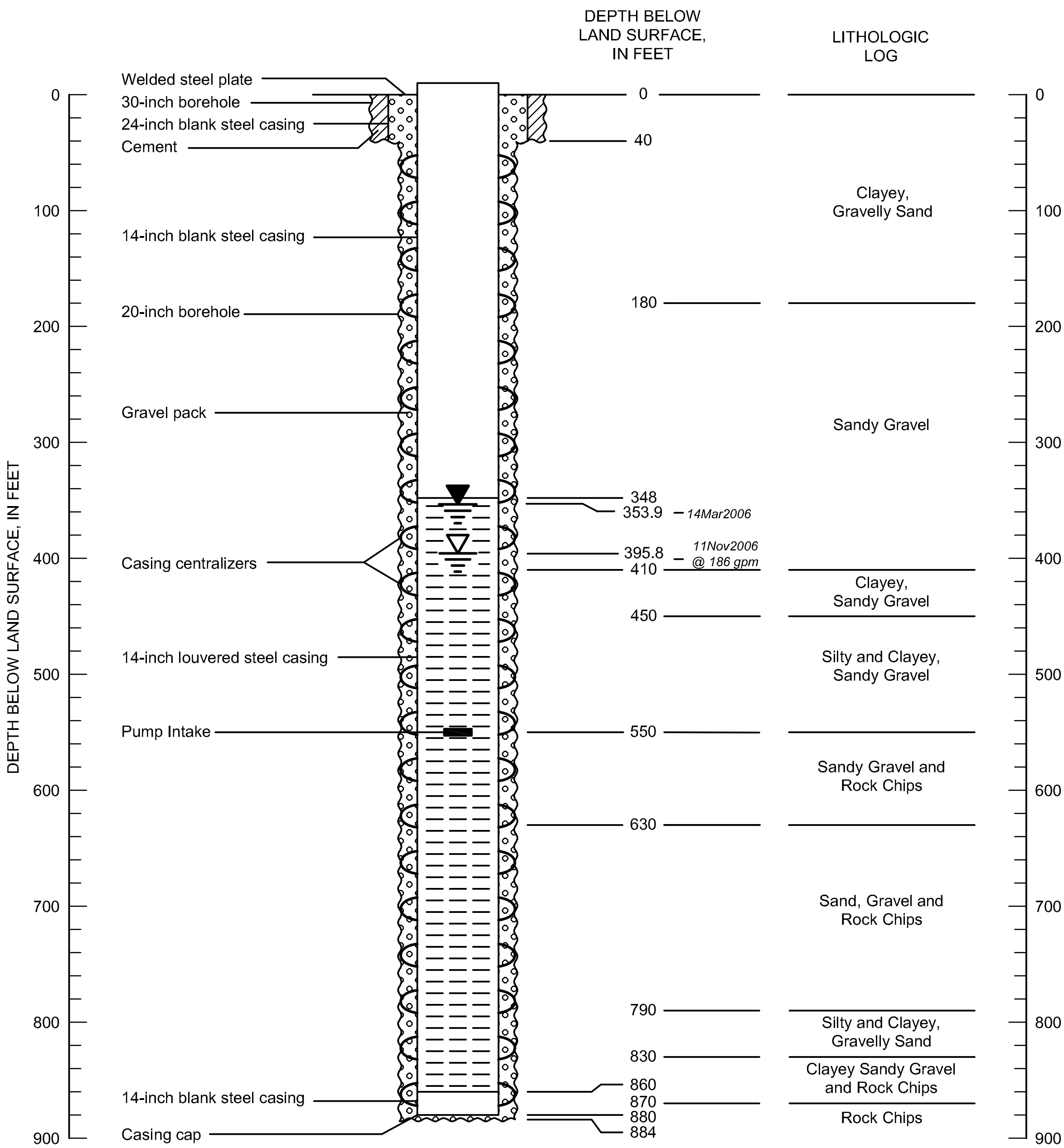
pumping water level

DRAWN BY: CEH	CHECKED BY: DSW	VERSION DATE: February 22, 2007

FIGURE A-25. SCHEMATIC DIAGRAM OF WELL CONSTRUCTION FOR INTERCEPTOR WELL IW-23

ERROL L. MONTGOMERY & ASSOCIATES, INC.

546.39\IW-23 WS_07



EXPLANATION

non-pumping water level

pumping water level

DRAWN BY: CEH	CHECKED BY: DSW	VERSION DATE: February 26, 2007

FIGURE A-26. SCHEMATIC DIAGRAM OF WELL CONSTRUCTION FOR INTERCEPTOR WELL IW-24

ERROL L. MONTGOMERY & ASSOCIATES, INC.

546.39\IW-24 WS_07

APPENDIX B

ANNUAL GROUNDWATER PUMPED AND AVERAGE SULFATE CONCENTRATION IN GROUNDWATER FOR INTERCEPTOR WELLS SIERRITA MINE, PIMA COUNTY, ARIZONA

APPENDIX B

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B-3 ANNUAL GROUNDWATER PUMPED AND AVERAGE SULFATE CONCENTRATION IN GROUNDWATER FOR INTERCEPTOR WELLS IW-3 AND IW-3A

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B-5 ANNUAL GROUNDWATER PUMPED AND AVERAGE SULFATE CONCENTRATION IN GROUNDWATER FOR INTERCEPTOR WELL IW-5

B-6 ANNUAL GROUNDWATER PUMPED AND AVERAGE SULFATE CONCENTRATION IN GROUNDWATER FOR INTERCEPTOR WELLS IW-6 AND IW-6A

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B-9 ANNUAL GROUNDWATER PUMPED AND AVERAGE SULFATE CONCENTRATION IN GROUNDWATER FOR INTERCEPTOR WELL IW-9

B-10 ANNUAL GROUNDWATER PUMPED AND AVERAGE SULFATE CONCENTRATION IN GROUNDWATER FOR INTERCEPTOR WELL IW-10

B-11 ANNUAL GROUNDWATER PUMPED AND AVERAGE SULFATE CONCENTRATION IN GROUNDWATER FOR INTERCEPTOR WELL IW-11

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B-18 ANNUAL GROUNDWATER PUMPED AND AVERAGE SULFATE CONCENTRATION IN GROUNDWATER FOR INTERCEPTOR WELL IW-18

B-19 ANNUAL GROUNDWATER PUMPED AND AVERAGE SULFATE CONCENTRATION IN GROUNDWATER FOR INTERCEPTOR WELL IW-19

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B-21 ANNUAL GROUNDWATER PUMPED AND AVERAGE SULFATE CONCENTRATION IN GROUNDWATER FOR INTERCEPTOR WELL IW-21

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B-24 ANNUAL GROUNDWATER PUMPED AND AVERAGE SULFATE CONCENTRATION IN GROUNDWATER FOR INTERCEPTOR WELL IW-24

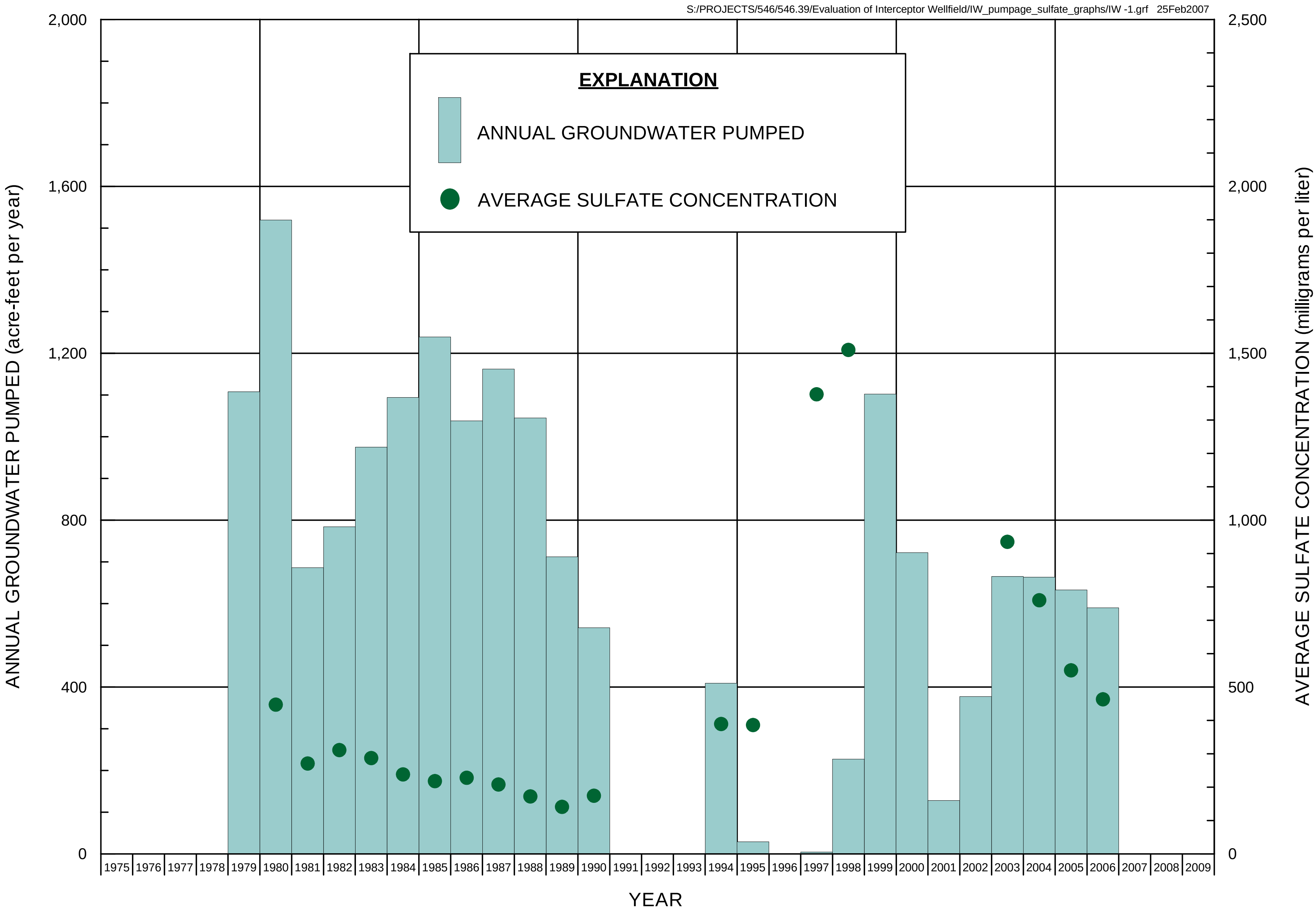

FIGURE B-1. ANNUAL GROUNDWATER PUMPED AND AVERAGE SULFATE CONCENTRATION IN GROUNDWATER FOR INTERCEPTOR WELL IW-1

ERROL L. MONTGOMERY & ASSOCIATES, INC.

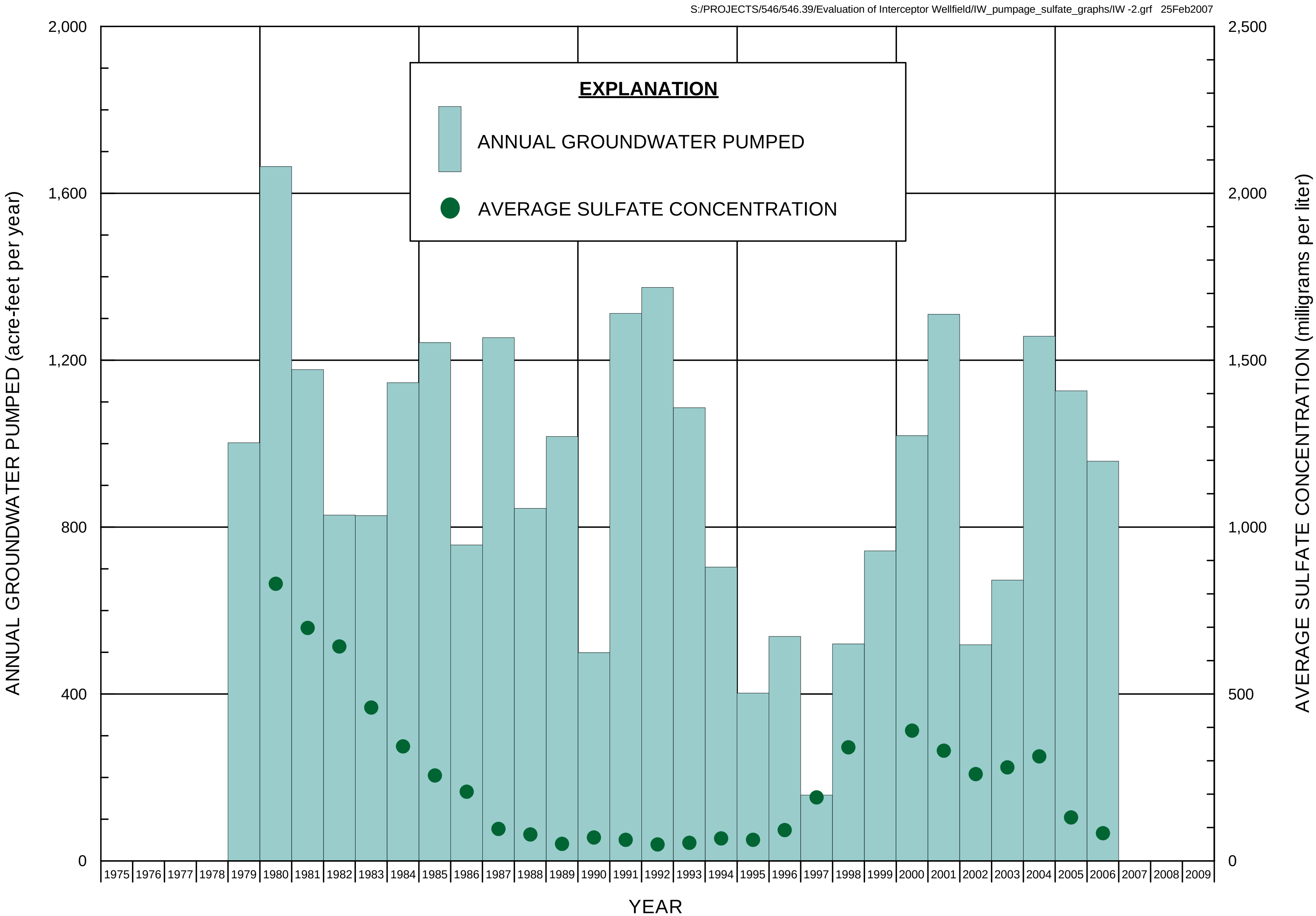

FIGURE B-2. ANNUAL GROUNDWATER PUMPED AND AVERAGE SULFATE CONCENTRATION IN GROUNDWATER FOR INTERCEPTOR WELL IW-2

ERROL L. MONTGOMERY & ASSOCIATES, INC.

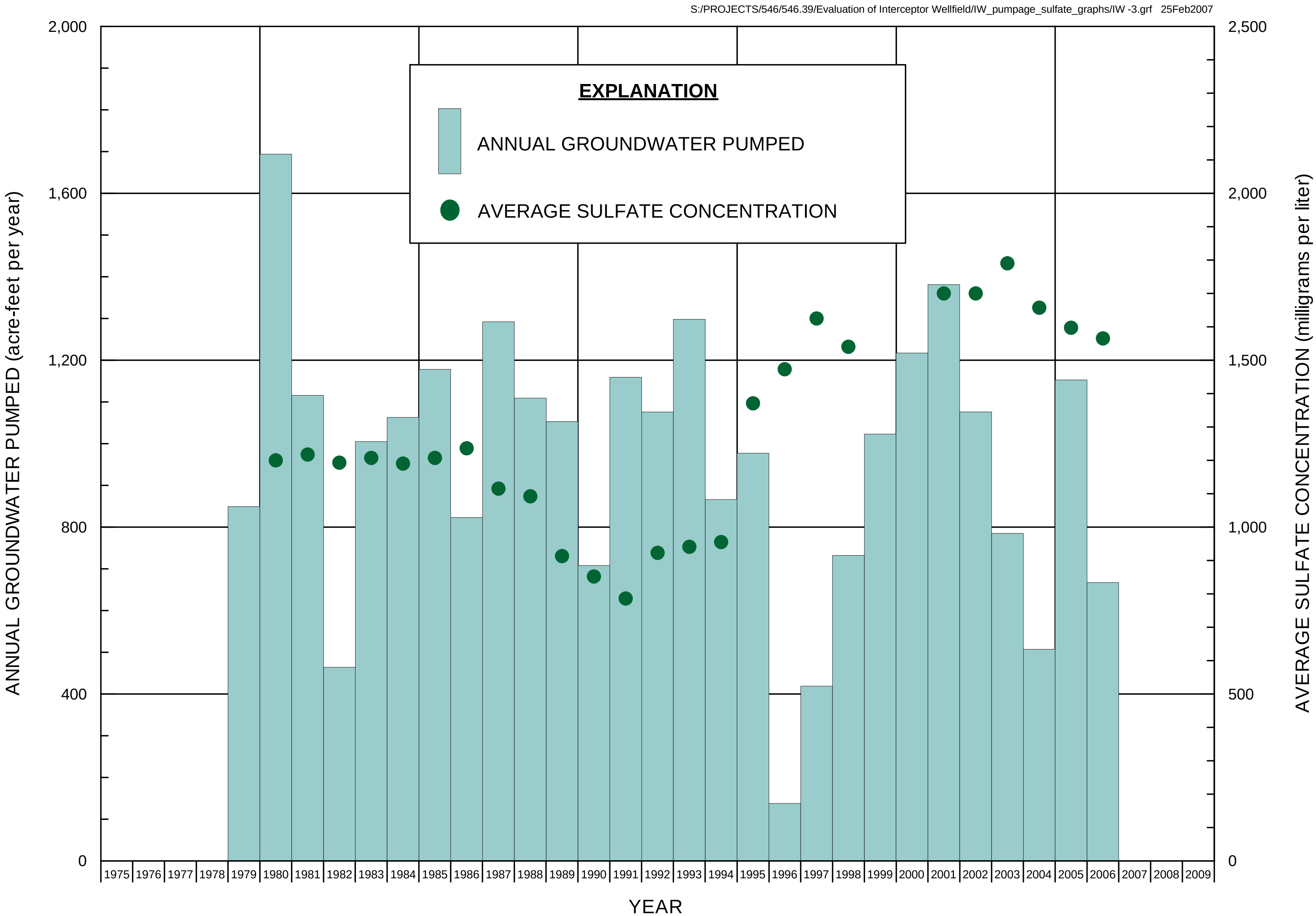

FIGURE B-3. ANNUAL GROUNDWATER PUMPED AND AVERAGE SULFATE CONCENTRATION IN GROUNDWATER FOR INTERCEPTOR WELLS IW-3 AND IW-3A

ERROL L. MONTGOMERY & ASSOCIATES, INC.

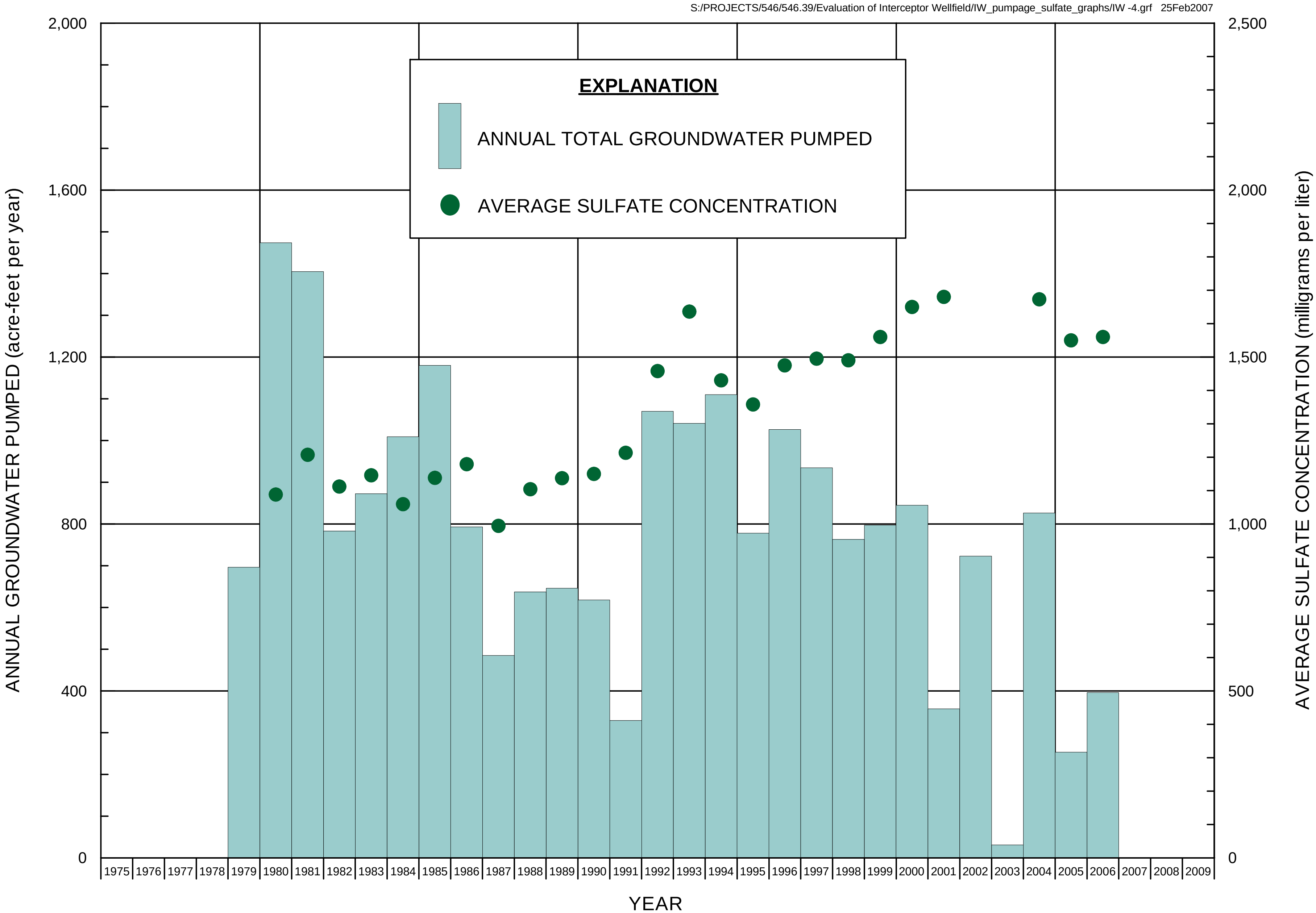

FIGURE B-4. ANNUAL GROUNDWATER PUMPED AND AVERAGE SULFATE CONCENTRATION IN GROUNDWATER FOR INTERCEPTOR WELL IW-4

ERROL L. MONTGOMERY & ASSOCIATES, INC.

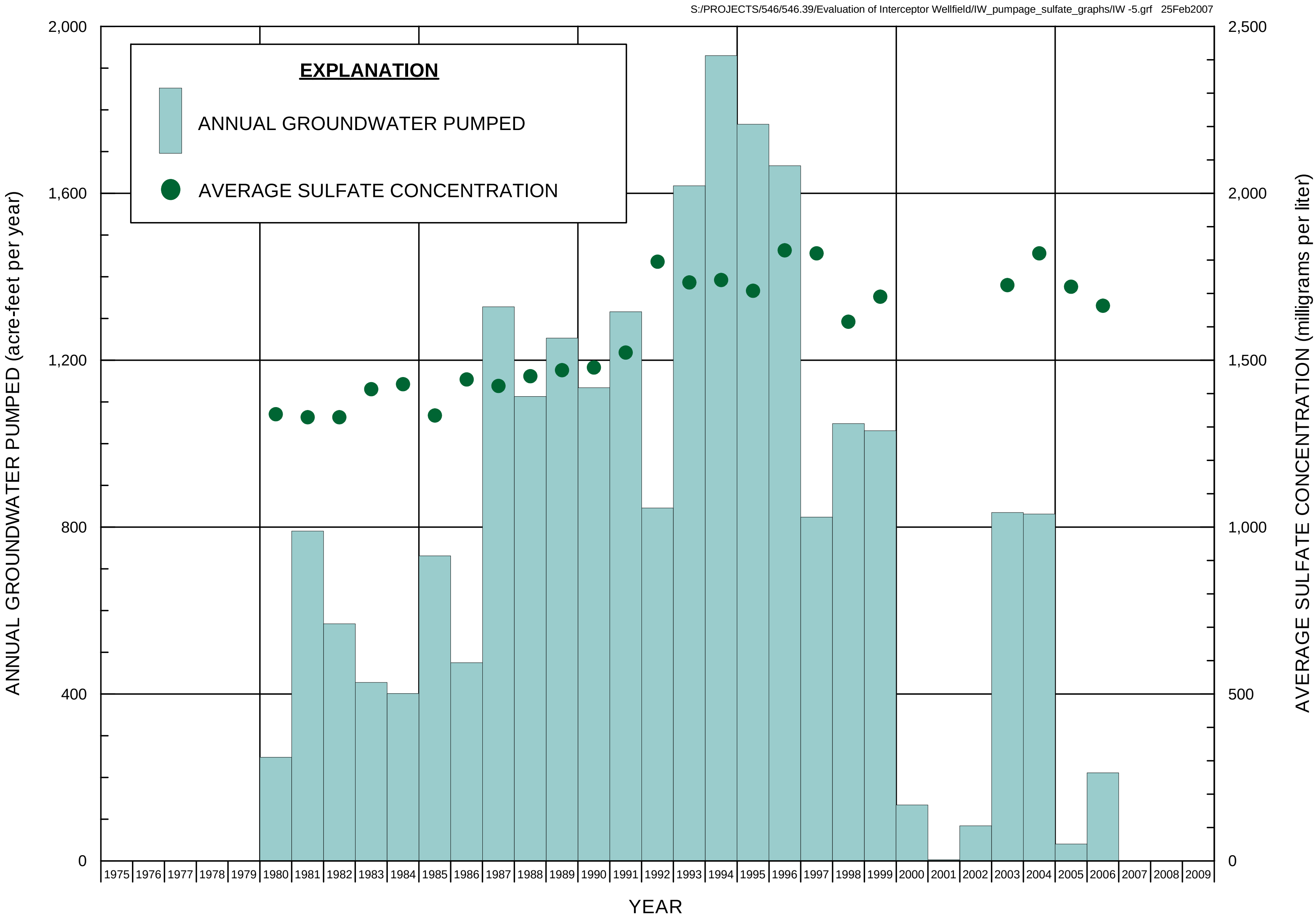

FIGURE B-5. ANNUAL GROUNDWATER PUMPED AND AVERAGE SULFATE CONCENTRATION IN GROUNDWATER FOR INTERCEPTOR WELL IW-5

ERROL L. MONTGOMERY & ASSOCIATES, INC.

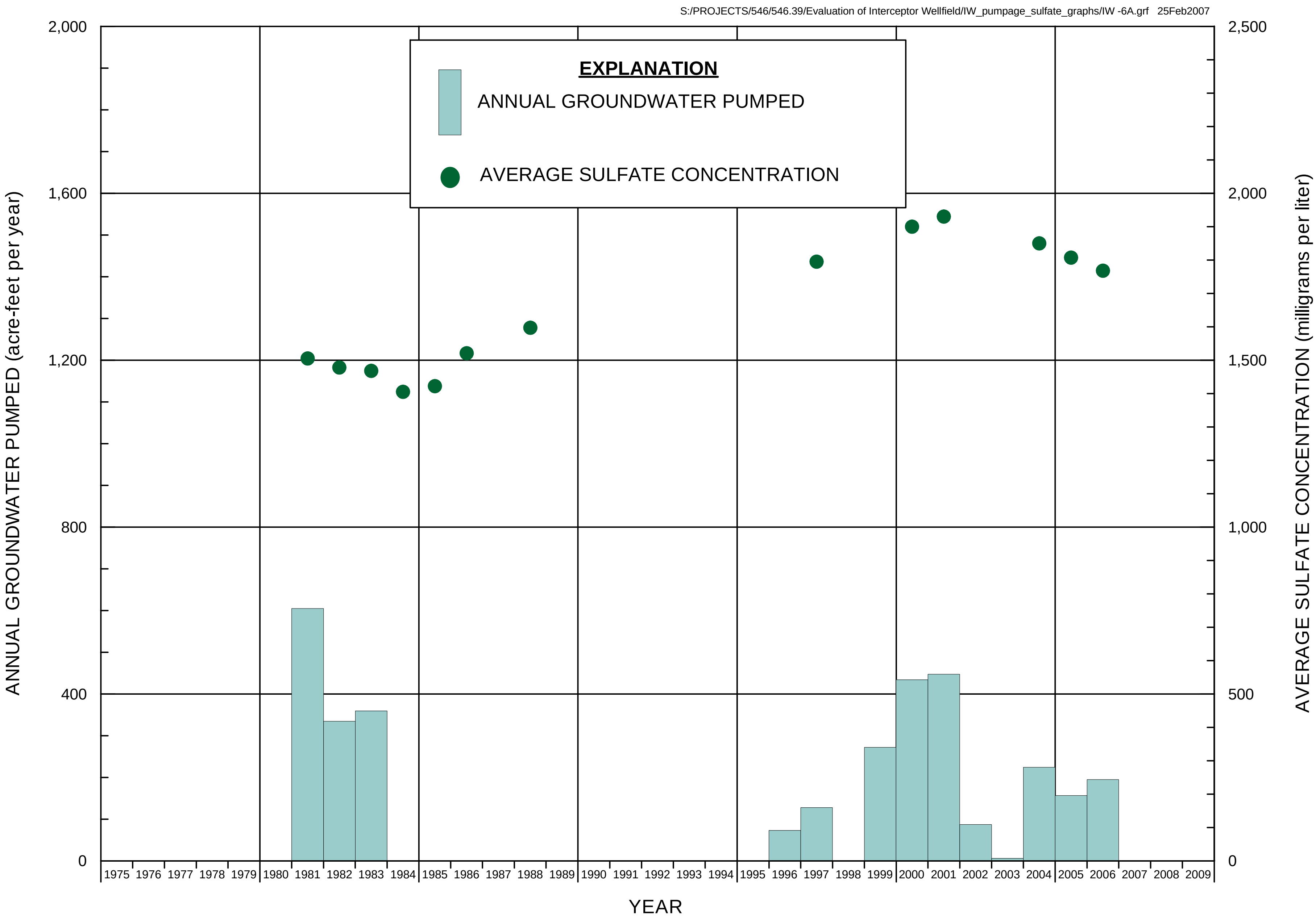

FIGURE B-6. ANNUAL GROUNDWATER PUMPED AND AVERAGE SULFATE CONCENTRATION IN GROUNDWATER FOR INTERCEPTOR WELLS IW-6 AND IW-6A

ERROL L. MONTGOMERY & ASSOCIATES, INC.

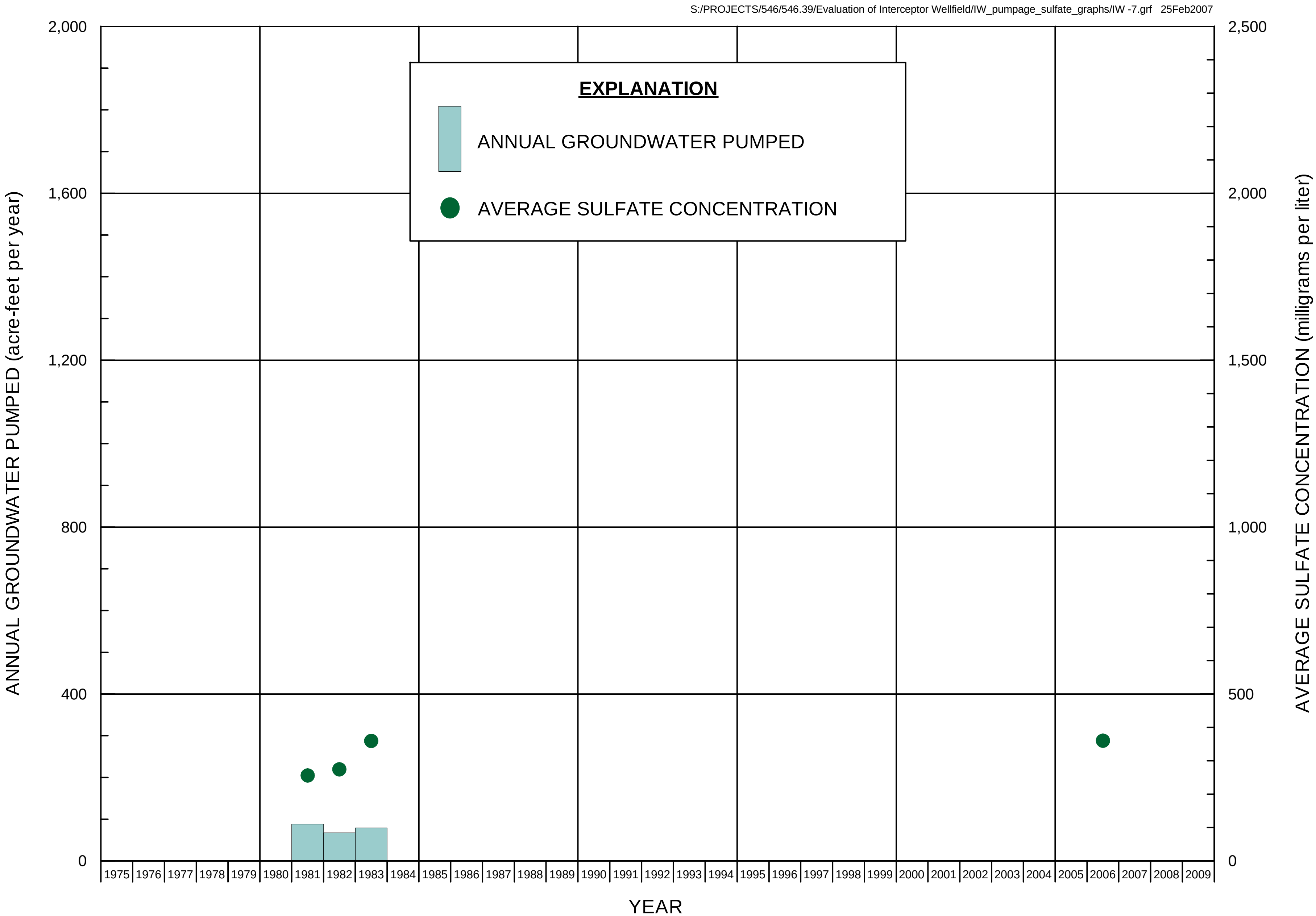

FIGURE B-7. ANNUAL GROUNDWATER PUMPED AND AVERAGE SULFATE CONCENTRATION IN GROUNDWATER FOR INTERCEPTOR WELL IW-7

ERROL L. MONTGOMERY & ASSOCIATES, INC.

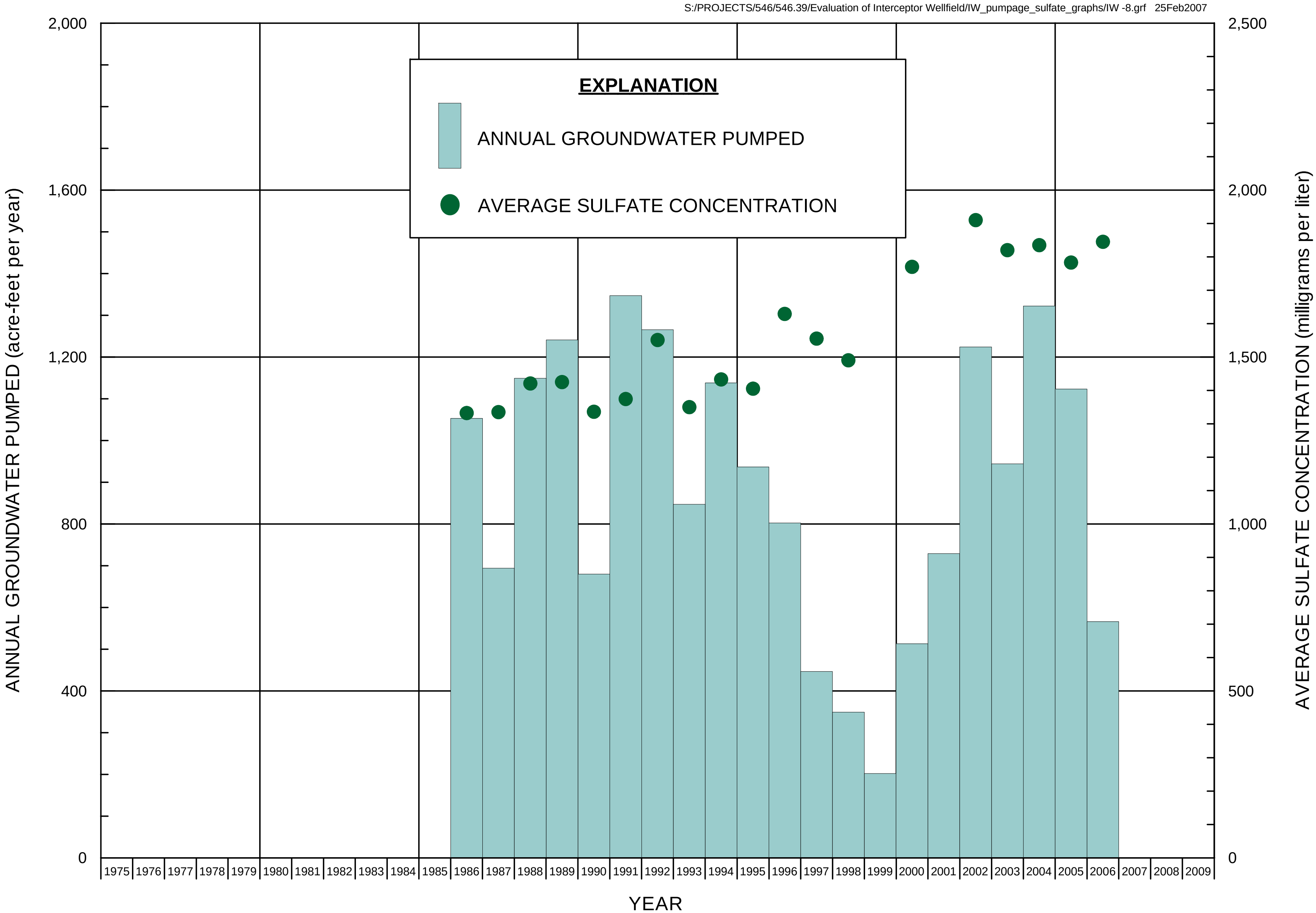

FIGURE B-8. ANNUAL GROUNDWATER PUMPED AND AVERAGE SULFATE CONCENTRATION IN GROUNDWATER FOR INTERCEPTOR WELL IW-8

ERROL L. MONTGOMERY & ASSOCIATES, INC.

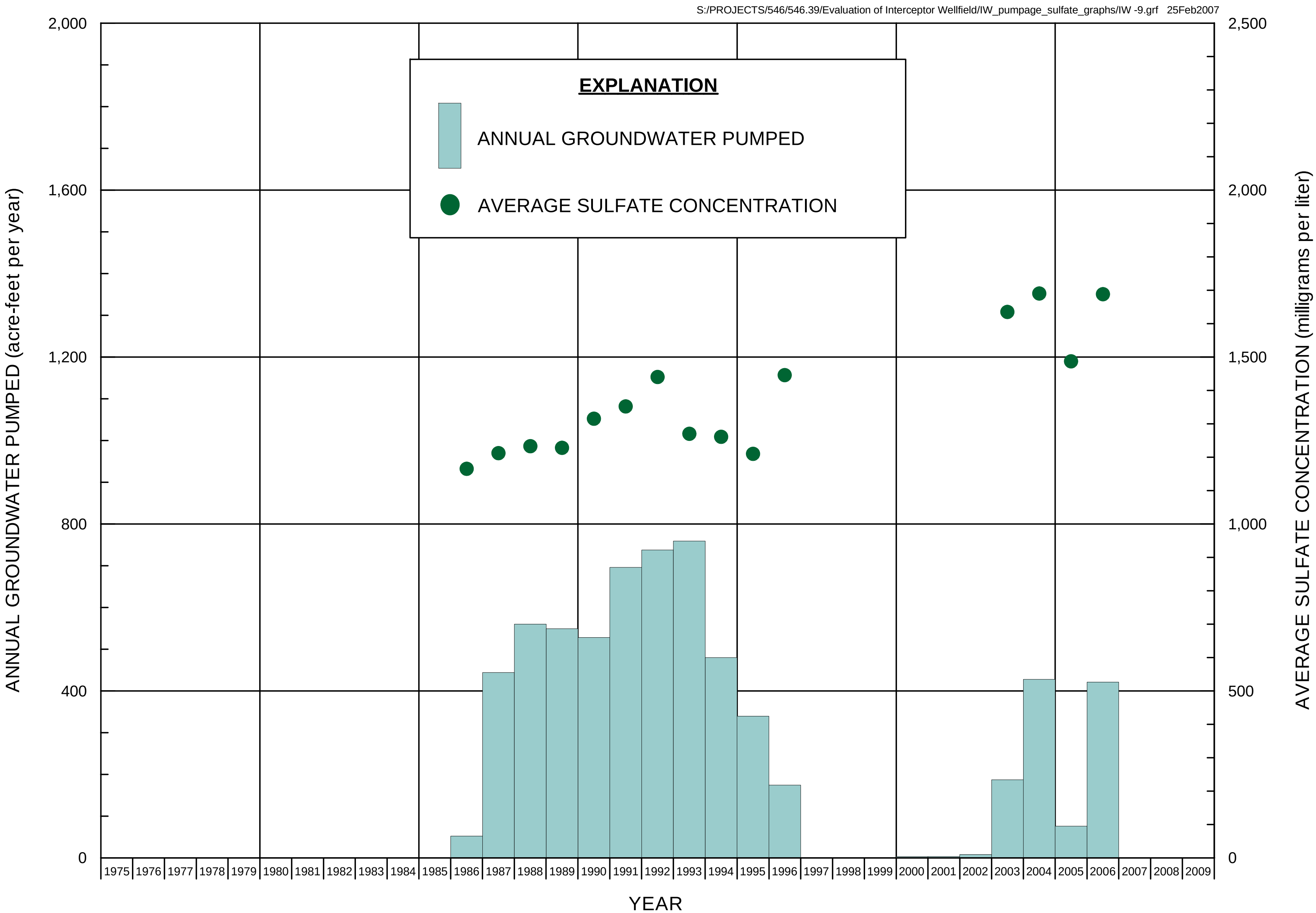

FIGURE B-9. ANNUAL GROUNDWATER PUMPED AND AVERAGE SULFATE CONCENTRATION IN GROUNDWATER FOR INTERCEPTOR WELL IW-9

ERROL L. MONTGOMERY & ASSOCIATES, INC.

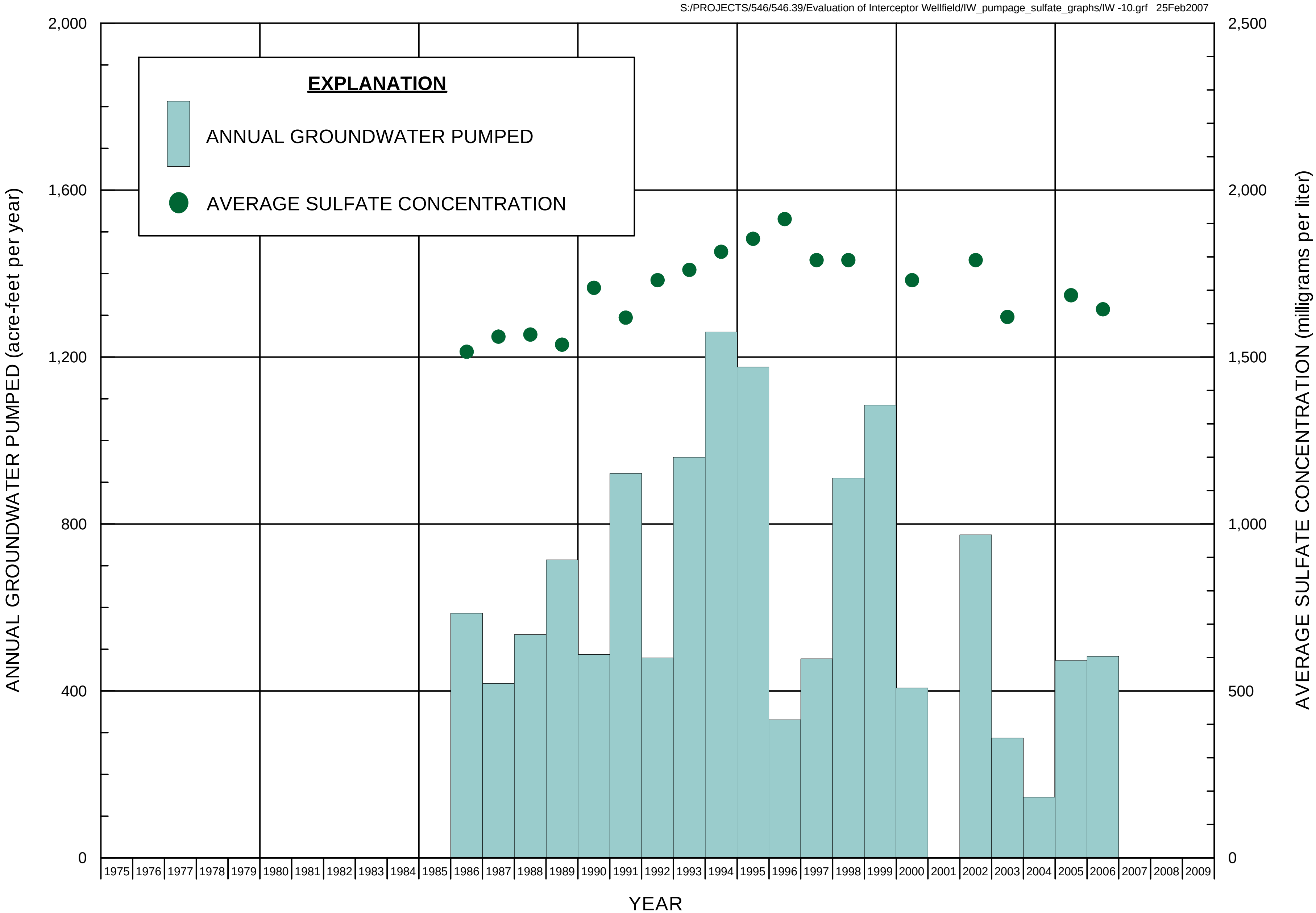

FIGURE B-10. ANNUAL GROUNDWATER PUMPED AND AVERAGE SULFATE CONCENTRATION IN GROUNDWATER FOR INTERCEPTOR WELL IW-10

ERROL L. MONTGOMERY & ASSOCIATES, INC.

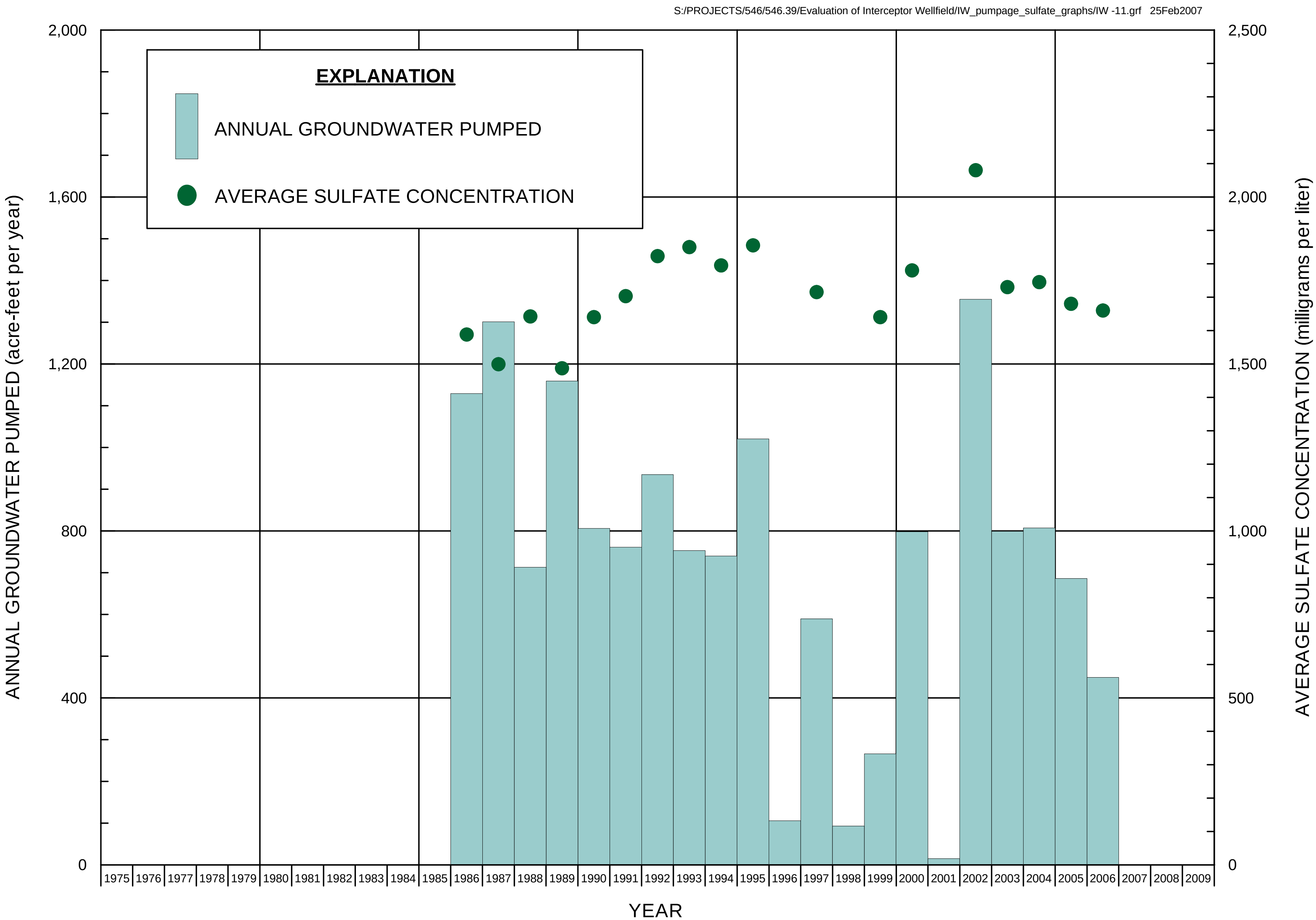

FIGURE B-11. ANNUAL GROUNDWATER PUMPED AND AVERAGE SULFATE CONCENTRATION IN GROUNDWATER FOR INTERCEPTOR WELL IW-11

ERROL L. MONTGOMERY & ASSOCIATES, INC.

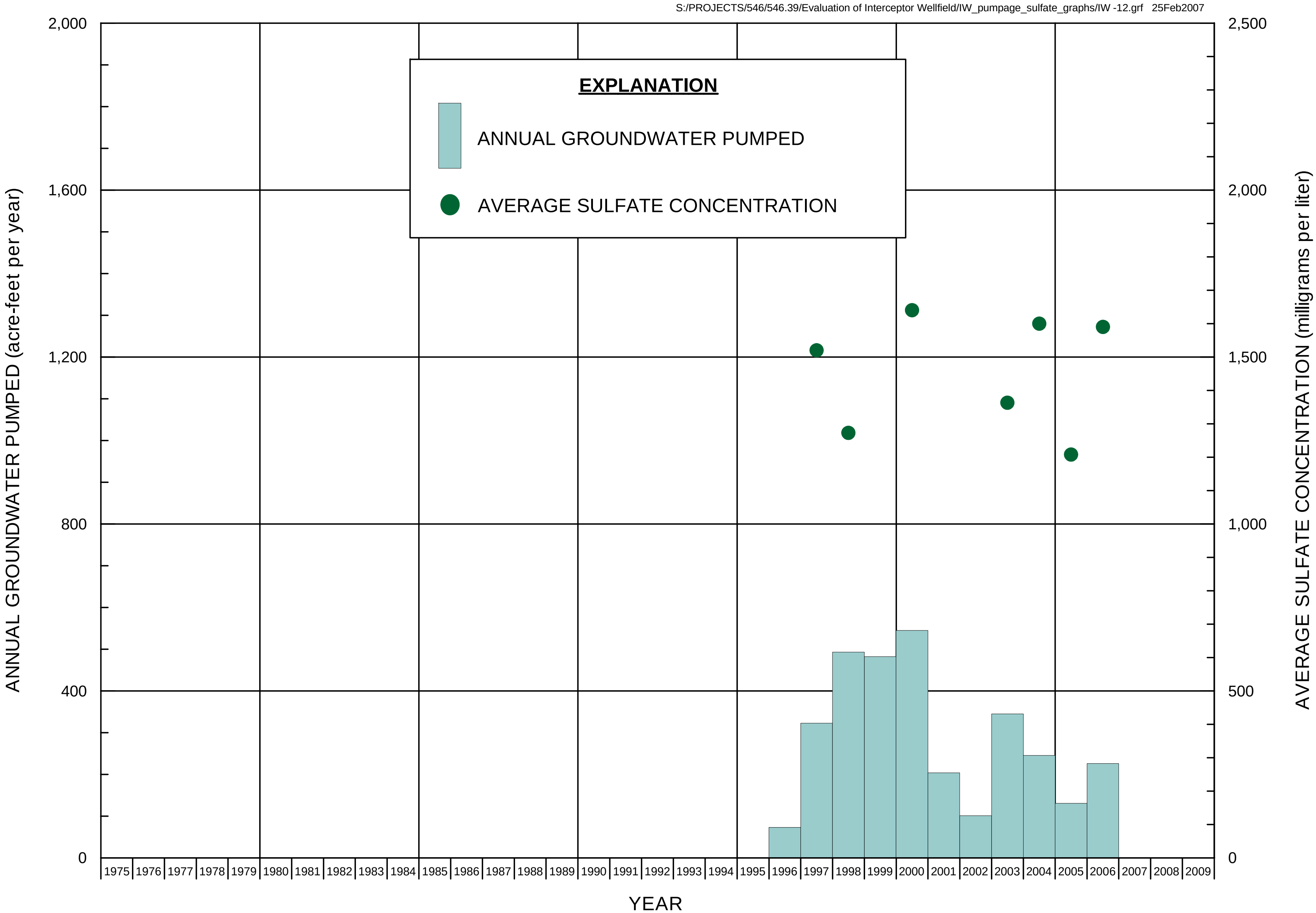

FIGURE B-12. ANNUAL GROUNDWATER PUMPED AND AVERAGE SULFATE CONCENTRATION IN GROUNDWATER FOR INTERCEPTOR WELL IW-12

ERROL L. MONTGOMERY & ASSOCIATES, INC.

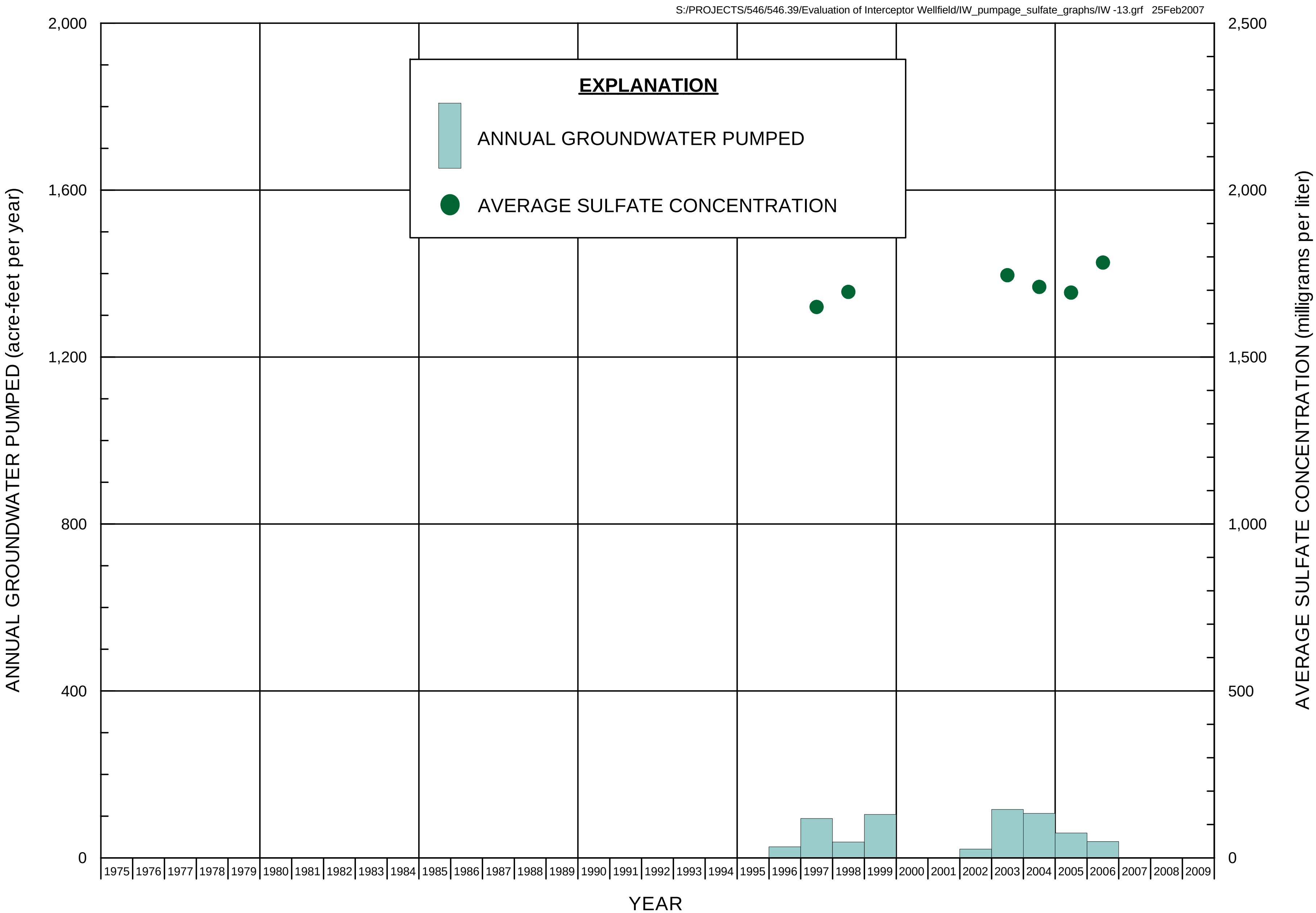

FIGURE B-13. ANNUAL GROUNDWATER PUMPED AND AVERAGE SULFATE CONCENTRATION IN GROUNDWATER FOR INTERCEPTOR WELL IW-13

ERROL L. MONTGOMERY & ASSOCIATES, INC.

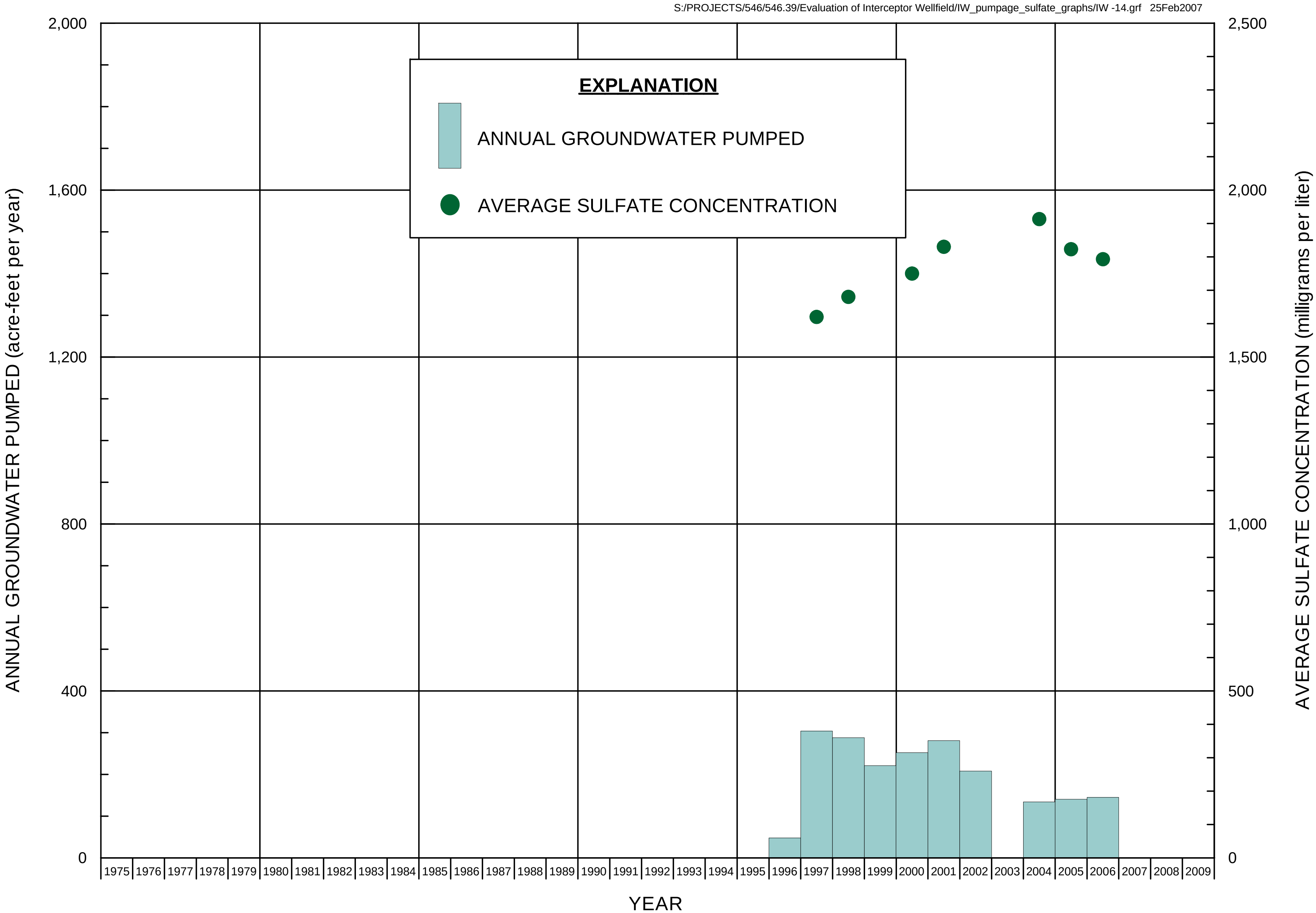

FIGURE B-14. ANNUAL GROUNDWATER PUMPED AND AVERAGE SULFATE CONCENTRATION IN GROUNDWATER FOR INTERCEPTOR WELL IW-14

ERROL L. MONTGOMERY & ASSOCIATES, INC.

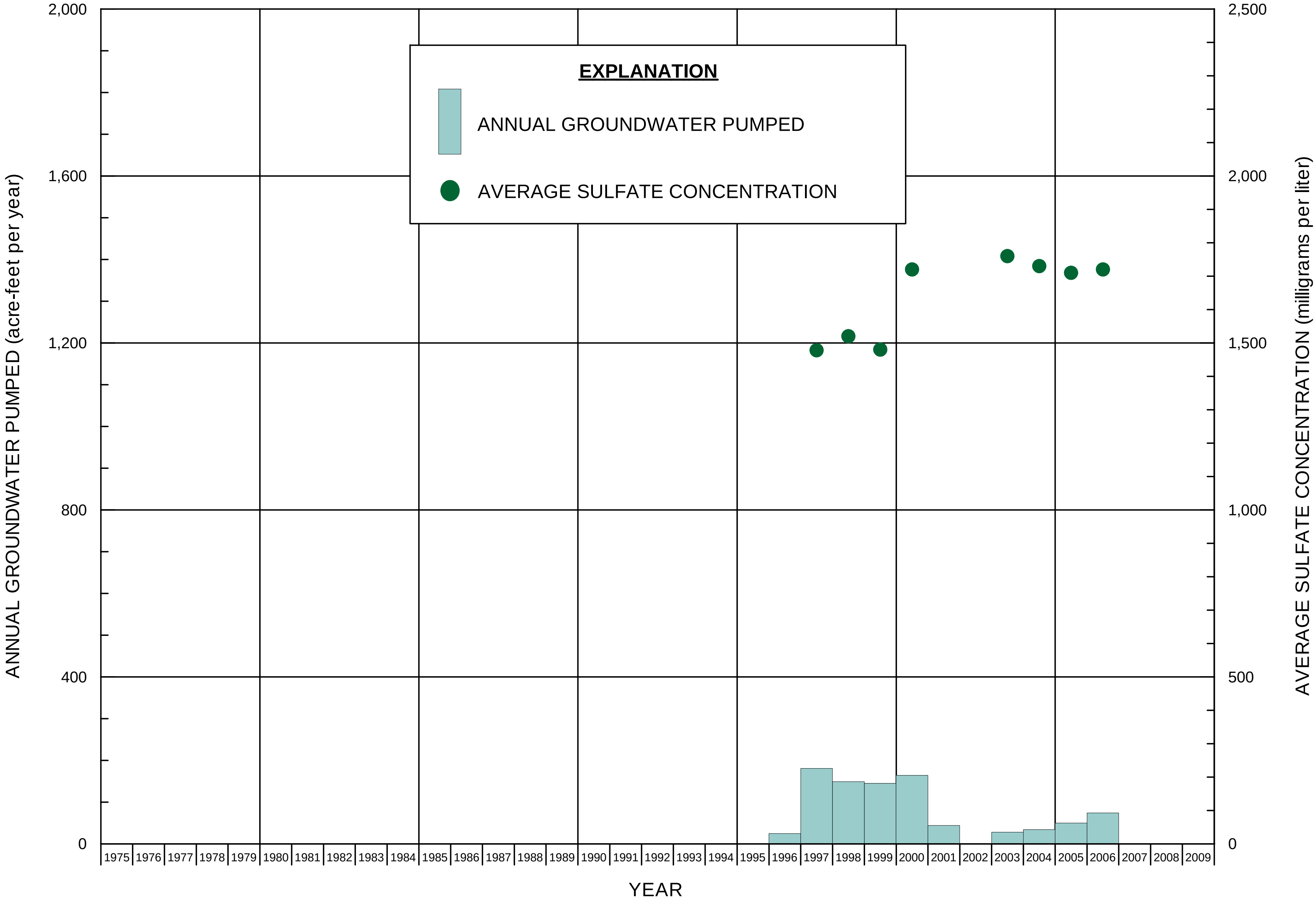

FIGURE B-15. ANNUAL GROUNDWATER PUMPED AND AVERAGE SULFATE CONCENTRATION IN GROUNDWATER FOR INTERCEPTOR WELL IW-15

ERROL L. MONTGOMERY & ASSOCIATES, INC.

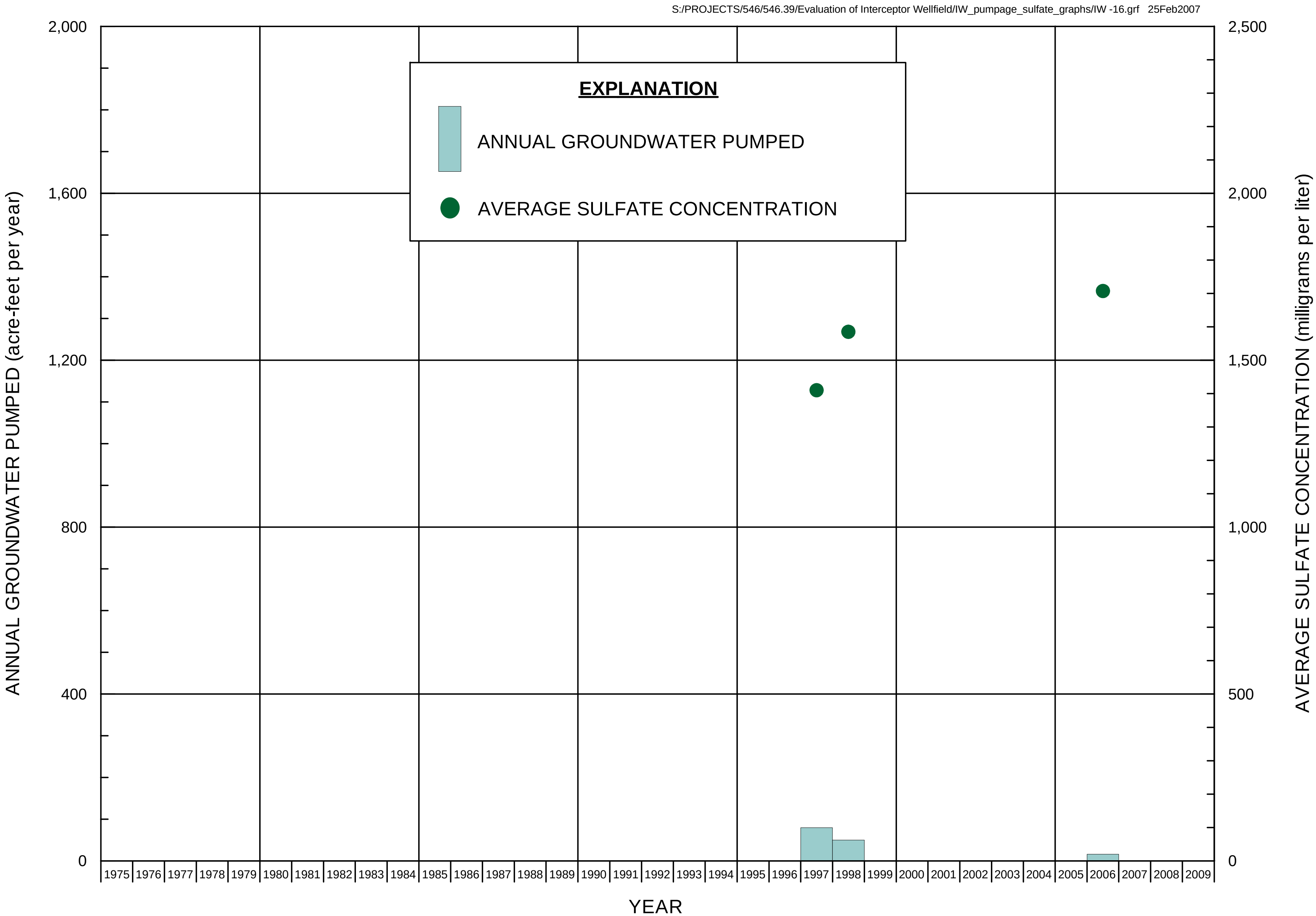

FIGURE B-16. ANNUAL GROUNDWATER PUMPED AND AVERAGE SULFATE CONCENTRATION IN GROUNDWATER FOR INTERCEPTOR WELL IW-16

ERROL L. MONTGOMERY & ASSOCIATES, INC.

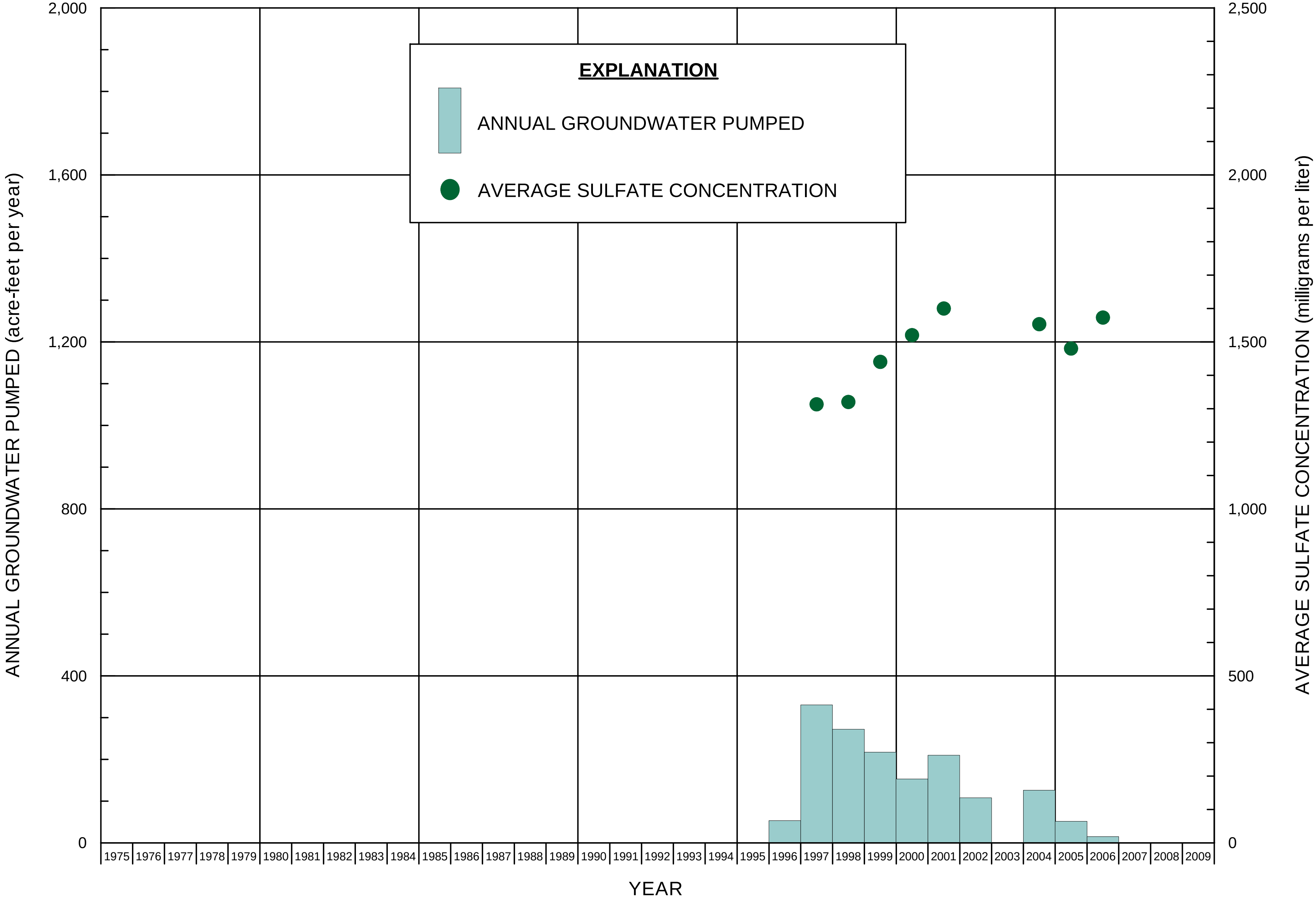

FIGURE B-17. ANNUAL GROUNDWATER PUMPED AND AVERAGE SULFATE CONCENTRATION IN GROUDNWATER FOR INTERCEPTOR WELL IW-17

ERROL L. MONTGOMERY & ASSOCIATES, INC.

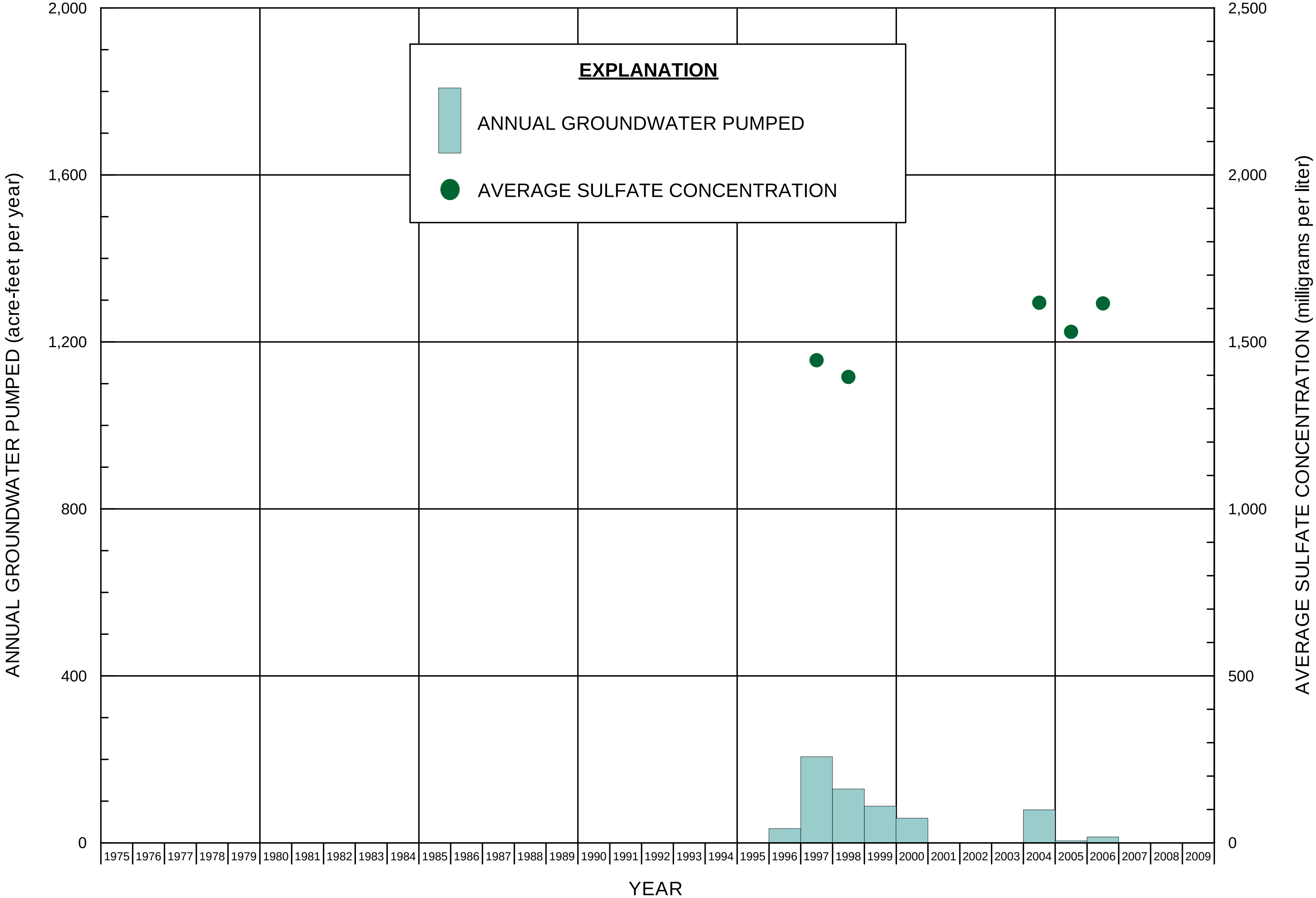

FIGURE B-18. ANNUAL GROUNDWATER PUMPED AND AVERAGE SULFATE CONCENTRATION IN GROUNDWATER FOR INTERCEPTOR WELL IW-18

ERROL L. MONTGOMERY & ASSOCIATES, INC.

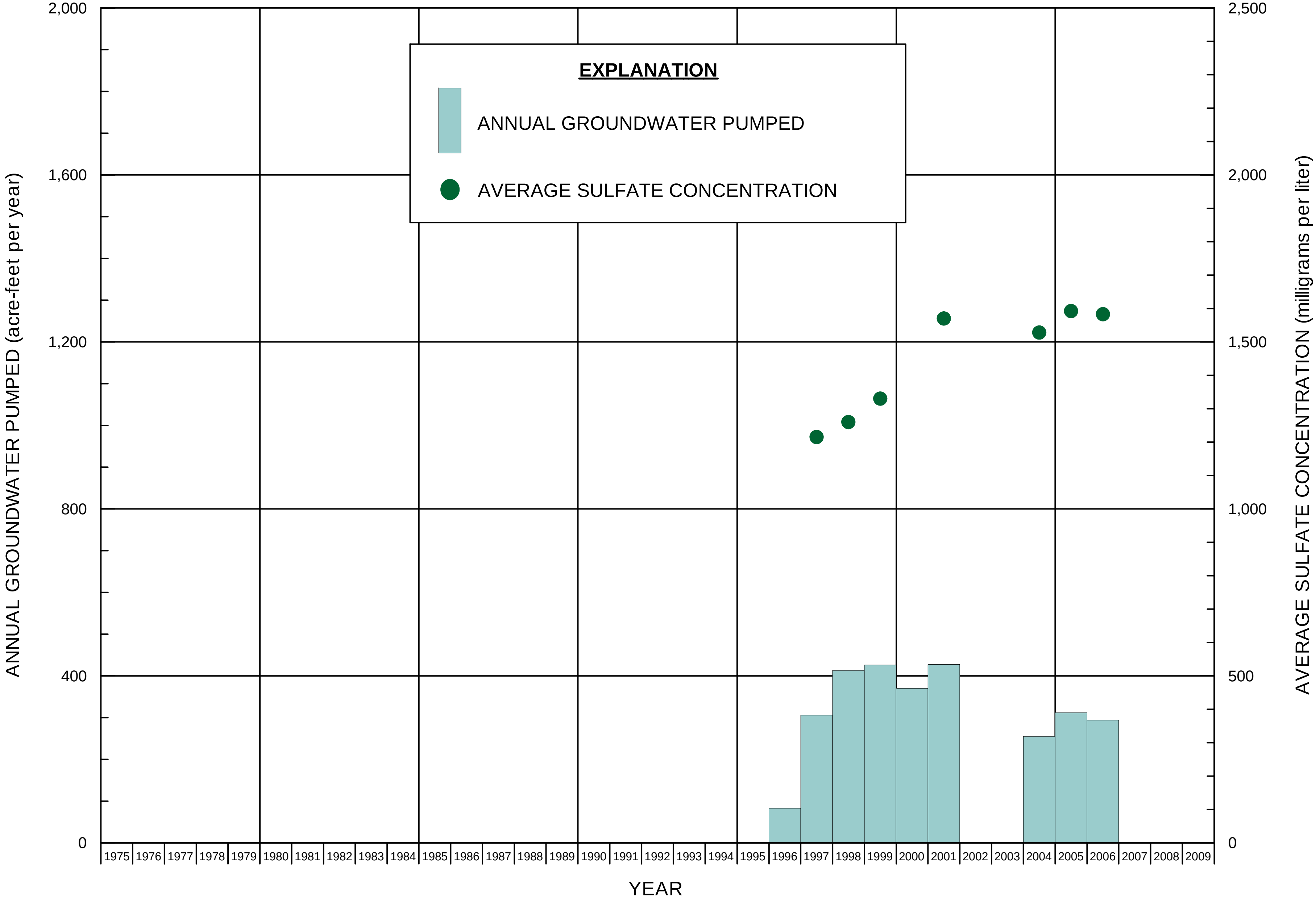

FIGURE B-19. ANNUAL GROUNDWATER PUMPED AND AVERAGE SULFATE CONCENTRATION IN GROUNDWATER FOR INTERCEPTOR WELL IW-19

ERROL L. MONTGOMERY & ASSOCIATES, INC.

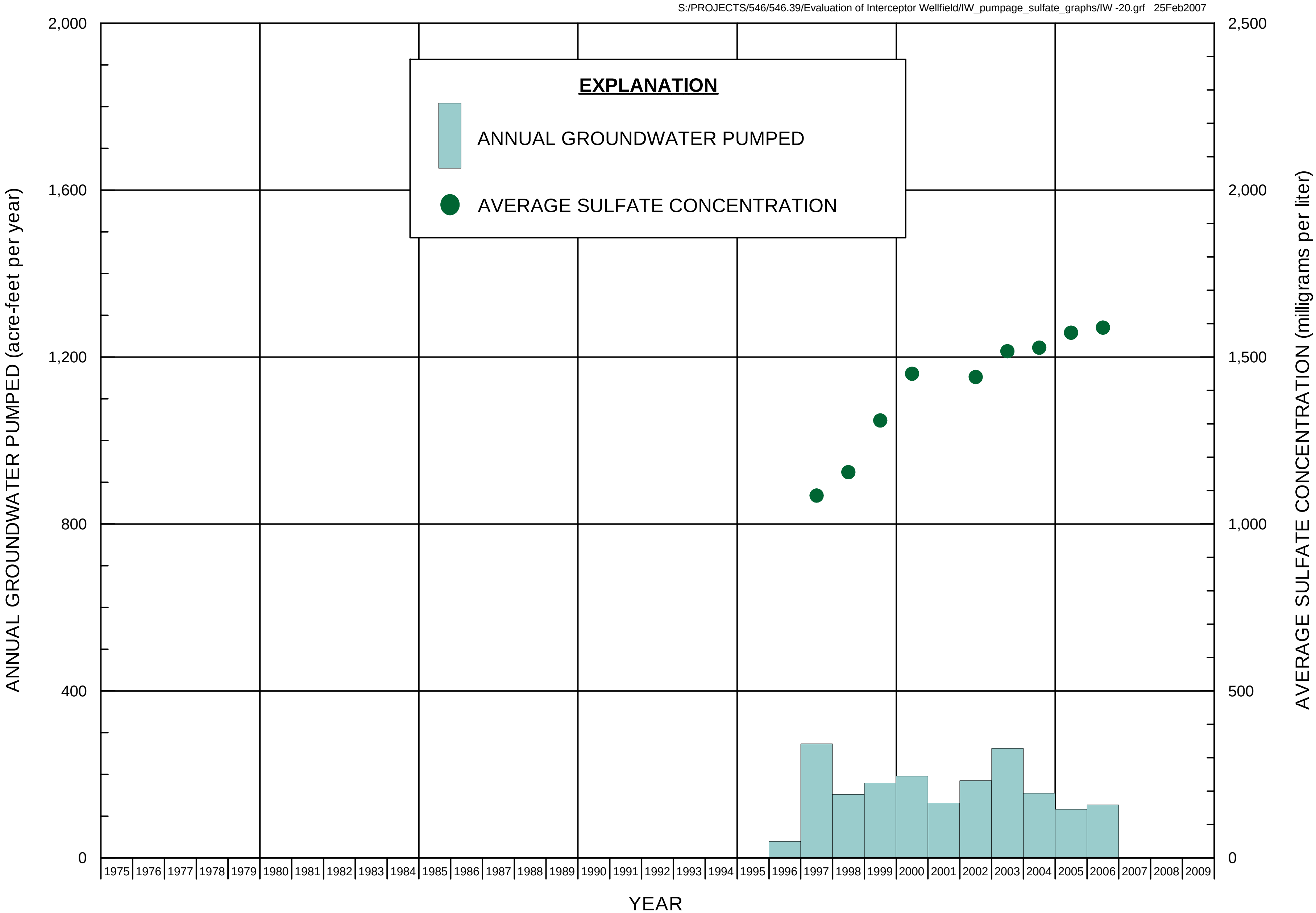

FIGURE B-20. ANNUAL GROUNDWATER PUMPED AND AVERAGE SULFATE CONCENTRATION IN GROUNDWATER FOR INTERCEPTOR WELL IW-20

ERROL L. MONTGOMERY & ASSOCIATES, INC.

S:/PROJECTS/546/546.39/Evaluation of Interceptor Wellfield/IW_pumpage_sulfate_graphs/IW -21.grf 25Feb2007

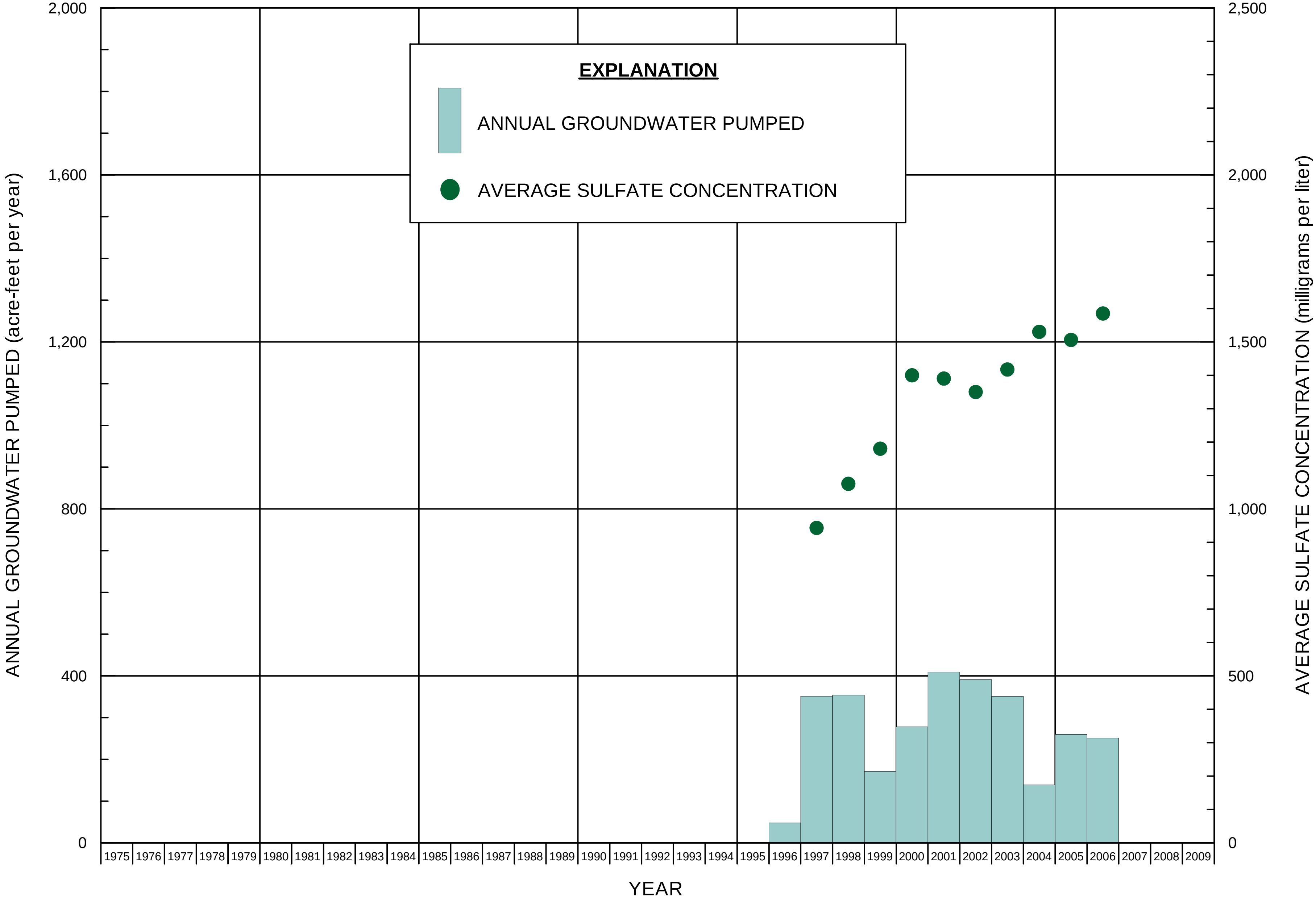

FIGURE B-21. ANNUAL GROUNDWATER PUMPED AND AVERAGE SULFATE CONCENTRATION IN GROUNDWATER FOR INTERCEPTOR WELL IW-21

ERROL L. MONTGOMERY & ASSOCIATES, INC.

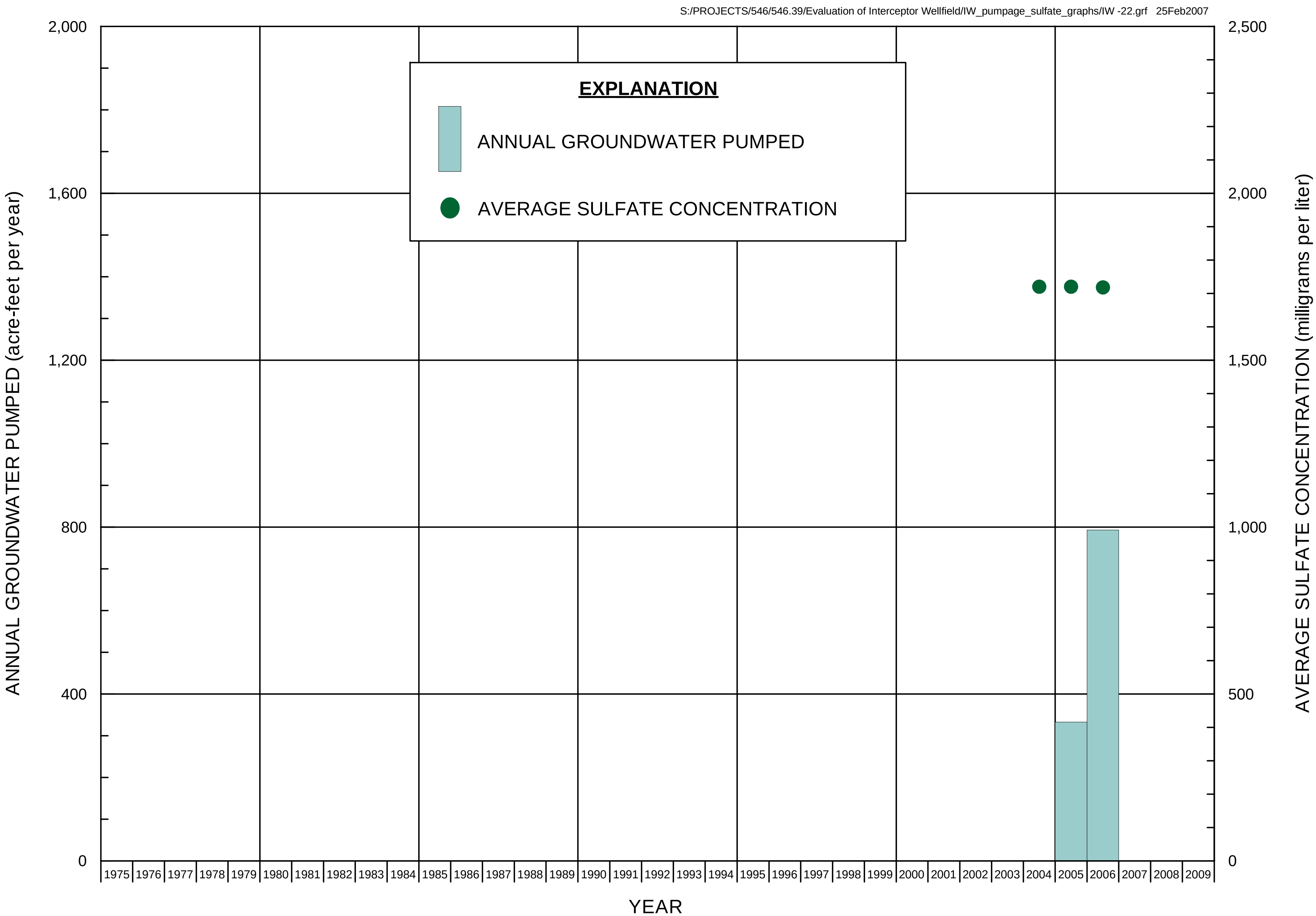

FIGURE B-22. ANNUAL GROUNDWATER PUMPED AND AVERAGE SULFATE CONCENTRATION IN GROUNDWATER FOR INTERCEPTOR WELL IW-22

ERROL L. MONTGOMERY & ASSOCIATES, INC.

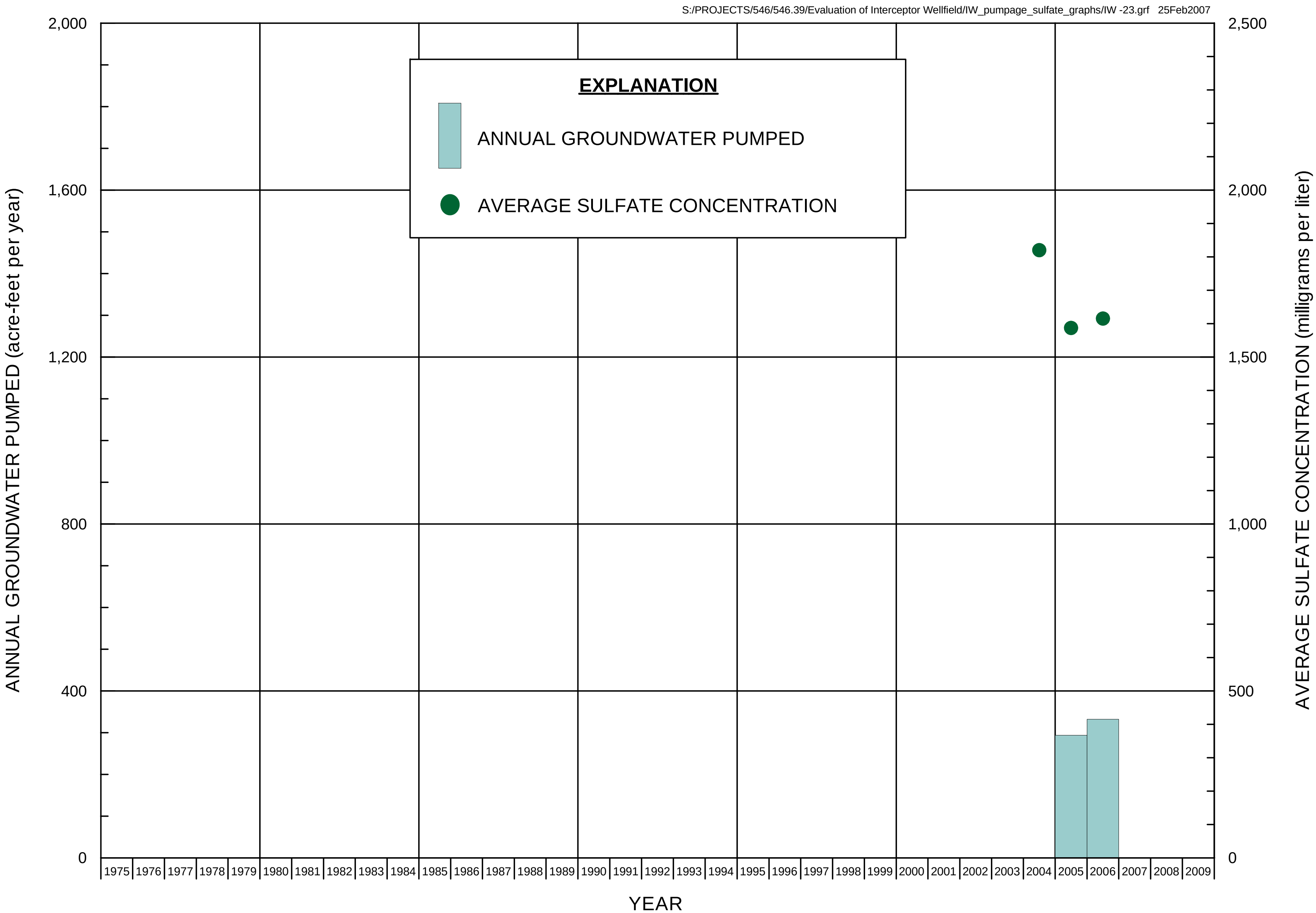

FIGURE B-23. ANNUAL GROUNDWATER PUMPED AND AVERAGE SULFATE CONCENTRATION IN GROUNDWATER FOR INTERCEPTOR WELL IW-23

ERROL L. MONTGOMERY & ASSOCIATES, INC.

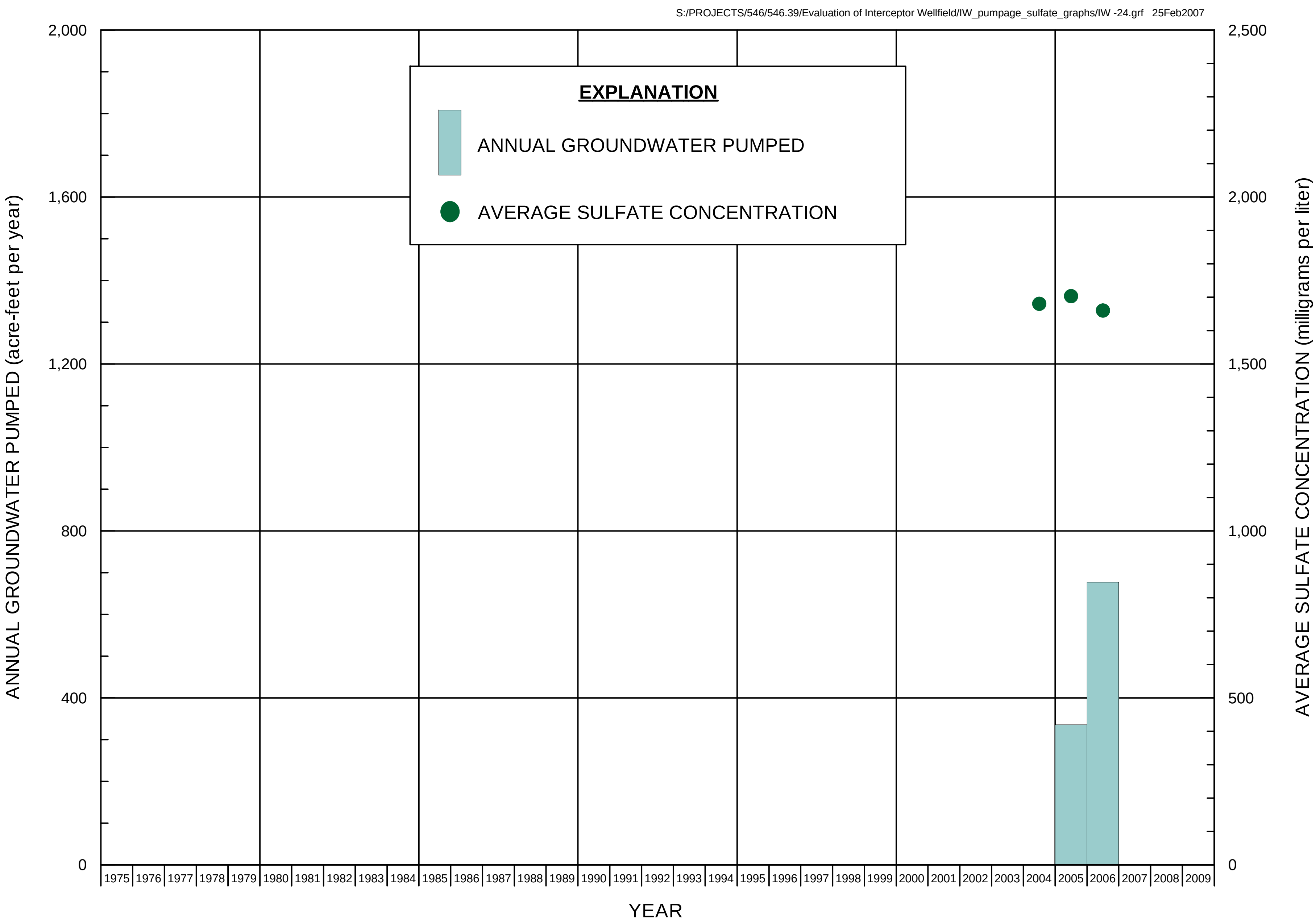

FIGURE B-24. ANNUAL GROUNDWATER PUMPED AND AVERAGE SULFATE CONCENTRATION IN GROUNDWATER FOR INTERCEPTOR WELL IW-24

ERROL L. MONTGOMERY & ASSOCIATES, INC.