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June 25, 2012

Mr. Dominick Orlando
U.S. Nuclear Regulatory Commission
Fuel Cycle Facilities Branch
Division of Fuel Cycle Safety and Safeguards
Office of Nuclear Material Safety and Safeguards
Mail Stop T-8-A-33
Two White Flint North, 11545 Rockville Pike
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Subject: Umetco Minerals Corporation Gas Hills, Wyoming, Groundwater Evaluation
Reference: Materials License SUA-648; Docket No. 40-0299

Dear Mr. Orlando:

In Umetco Minerals Corporation's (Umetco) letter to the Nuclear Regulatory Commission (NRC) dated January 24, 2012, Umetco committed to perform a detailed evaluation of target levels for groundwater model validation constituents to ensure that the Alternate Concentration Limit (ACL) model predictions accurately represent current conditions. In addition, Umetco committed to submit the evaluation to the NRC for review along with any applicable request to modify target values, if necessary (i.e., license amendment).

Attached is a Technical Memorandum, prepared by URS Corporation, dated May 2012, which provides the details of this evaluation. In review of the attached memorandum and associated monitoring data, Umetco concludes the following:

- The groundwater flow model was developed and calibrated according to standard practice and continues to provide a reasonable simulation of the hydrogeologic features of the water-bearing strata beneath the site.
- Licensed constituents at Point of Compliance (POC) wells are well below established ACLs and do not exhibit any trend of concern.
- Use of model validation constituents (chloride and sulfate) as described in the monitoring plan (Appendix M of the ACL application) accounts for uncertainty/variability associated with analytical measurements by use of 95% upper confidence limit (UCL) but does not identify or discuss uncertainty associated with heterogeneous site hydrogeologic and geochemical conditions.

Based on this evaluation, Umetco has not identified any justification to propose changes to the current model or monitoring plan. While some deficiencies were identified with respect to model validation methodology, any proposed changes would remove conservatism built into the monitoring plan. Details associated with this conclusion are discussed herein.

The target values associated model validation constituents (chloride and sulfate) are based on model predicated trends for these constituents. A 95% UCL is associated with the predicted trend to account for variability in analytical data as stated in Attachment M-1, *Target Level Deviation and Model Validation Approach for Chloride and Sulfate*. As identified in the attached memorandum, the 95% UCL does not account for uncertainty due to the heterogeneous site hydrogeologic and geochemical condition. However, this uncertainty is recognized in the monitoring plan and associated with subsequent actions to be taken following an exceedance of a target value, i.e., re-sampling at intervals to identify trends. Essentially, spikes of indicator parameters are anticipated, subsequent re-sampling of specific intervals facilitates evaluation over time to identify trends as it relates to model predictions and use of significant figures when comparing predicted values with target values. In addition, the monitoring plan requires consideration given to the degree of target value exceedance and the potential impacts to water quality at the Point of Exposure (POE).

With the exception of MW monitoring well MW 28, monitoring data has resulted in trend lines that are well below model predicted concentrations for indicator parameters in the specified wells. NRC staff/inspectors have also indicated that monitoring data should fall between the predicted target value and the 95% UCL, if not; the predicative model must be in error. To the contrary, monitoring data trending below model predicted values is evidence of the conservatism of the model as discussed in Attachment M-1 and as necessary for ground-water modeling at Title II sites, i.e., NUREG 1620, 4.4.2(3) requires, ".... assumptions used in the modeling are realistic or reasonably conservative....".

With respect to well MW 28, chloride and sulfate concentrations have increased upward, as predicted, and appear to be trending near the 95% UCL. However, these concentrations are several times less than concentrations associated with upgradient well MWI 64, located adjacent to the impoundment, and have shown a sharp decline since 2007. ACL constituent concentrations in the nearby POC well MW 21A have remained low and stable with no increase to trends. Accordingly, the chloride and sulfate trend in MW 28 indicate elevated concentrations of these constituents have arrived, as predicted, and are in reasonable agreement with predicted concentrations which are far less than Wyoming Department of Environmental Quality WDEQ Class III standard for sulfate and Class I standard for chloride applicable at the POE. Considering the sharp reduction in chloride and sulfate concentrations at the upgradient well MWI 64, there is no indication that concentrations in MW 28 will not trend downward as predicted.

Considering the monitoring data acquired to date and identification of various uncertainties associated with the model validation methodology, Umetco believes that the existing monitoring plan provides the earliest, most conservative, approach to model validation. Umetco has not identified any modification of the model which would enhance the predictive capabilities considering the heterogeneous nature of the site. Modification of the existing monitoring plan would move toward a less conservative approach, such as, evaluation of trends over longer period of time. Continuation of the existing monitoring program enables a more continuous evaluation of the plume if indicator constituents approach target values.

Please contact me at 970-256-8889 or by e-mail at gieckte@dow.com if you have any questions or concerns.

Regards,

Thomas E. Gieck
Remediation Leader

TO: Umetco Minerals Corporation

FROM: URS Corporation

DATE: May 2012

SUBJECT: Gas Hills Groundwater Model and Data Review

1.0 INTRODUCTION

The East Gas Hills reclamation site ("the site") is located in Fremont and Natrona Counties, Wyoming, approximately 60 miles east of Riverton in a remote area of central Wyoming. Umetco Minerals Corporation (Umetco) and its former parent company (Union Carbide Corporation) operated a uranium mine and mill at the site from the late 1950s until 1984. The mining process exposed uranium ore to oxidation and water while milling and tailing disposal activities resulted in infiltration of licensed constituents to the site groundwater.

Reclamation activities at Umetco's East Gas Hills site began in 1983 and continued through 2006, with additional erosion repair work performed in 2011. Following implementation of the approved groundwater remedial action plan, Umetco submitted an Application for Alternate Concentration Limits (ACLs) for the licensed constituents in groundwater (Umetco, 2001). The ACL application was based on an evaluation of site conditions, a hazard assessment, and corrective action assessment, as well as groundwater and geochemical modeling that resulted in NRC acceptance of ACLs for the licensed constituents (i.e., arsenic, beryllium, lead-210, nickel, combined radium-226 and 228, selenium, thorium-230, and uranium-natural). A groundwater flow and solute transport model was developed as part of the ACL Application and was used to predict future groundwater chloride and sulfate concentrations and plume extents. Chloride and sulfate, although naturally occurring, are elevated at the site as a result of mining and milling activities. Chloride and sulfate behave conservatively in groundwater and are used as index chemicals to provide indications of potential concentration changes of the other licensed constituents in groundwater.

A post-closure monitoring plan was submitted as Appendix M of the ACL Application (Umetco, 2002), and subsequently revised (Umetco, 2011a). To address NRC concerns about the groundwater model and provide an indication of ACL constituent attenuation, the monitoring plan proposed an approach to compare future groundwater chloride and sulfate sampling results with the model predicted chloride and sulfate concentrations in order to validate the model predictions at four monitoring wells. The approach suggested that if chloride and sulfate concentrations in three consecutive samples exceeded the predicted chloride and sulfate concentrations at any of the four "model validation" wells, response actions would need to be taken, including but not limited to reassessment of the model simulations and assumptions.

Since 1998, groundwater sampling has been conducted at 13 monitoring wells, including the four "model validation" wells (MW71B, MW28, MW72, and MW82). Comparisons between the model predicted chloride and sulfate concentration trends and the sample results are shown on Figures 1b through 8b from Appendix M, Attachment M-1 (Umetco, 2011a) (these figures are provided in Attachment A of this tech memo). The chloride and sulfate concentrations measured at monitoring well MW28 (Figures 2b and 6b) in 2010 and 2011 exceeded the predicted concentration, and the chloride and sulfate concentrations measured at monitoring well MW72 (Figures 3b and 7b) showed an upward trend in 2010–2011 compared to the predicted trends. Thus, a reassessment of the groundwater flow and solute transport model assumptions and simulations was performed. The assessment findings are provided in this report. The assessment included:

- An evaluation of whether the groundwater flow and transport model was developed appropriately to represent the site groundwater conditions;
- An evaluation of the potential uncertainties associated with the groundwater transport model results;
- An evaluation of the model validation approach described in the post-closure monitoring plan (Appendix M);
- A review of groundwater concentration data from 1998 to 2011 to understand if the observed post-closure groundwater conditions are consistent with the site conceptual model and numerical model developed for the ACL Application.

2.0 REVIEW OF GROUNDWATER MODEL

To evaluate the groundwater model development and the assumptions for model predictions, the ACL Application documents (Umetco, 2001; 2002; and 2011) were reviewed. The groundwater flow and solute transport models were developed using the MODFLOW and MT3D codes, respectively. The conceptual model and the numerical flow model design, including model domain, vertical discretization of model layers, model boundaries, and parameter zonation, were appropriately developed based on available data to meet the specified modeling objectives. The groundwater flow model was reasonably calibrated to the average water levels for the period from 1999 to 2000. Uncertainty of the simulated groundwater flow field was evaluated and incorporated for flow pathways and flow velocity using Monte Carlo simulation. In general, the groundwater flow model appears to provide a reasonable simulation of the main hydrogeologic features of the water-bearing strata beneath the site.

The solute transport model was developed based on the calibrated flow model to predict the future chloride and sulfate concentrations (above background) and plume extents for the next 300 to 450 years in the Western and Southwestern Flow Regimes. The transport model predicted that:

- In the Western Flow Regime (WFR), the chloride and sulfate plumes will migrate to the west along the principal groundwater flow paths. The chloride and sulfate plumes will migrate west of the Land Transfer Boundary (LTB) in approximately 75 years with plume concentrations substantially below the site-specific standards (chloride: 250 mg/L,WDEQ Class I; sulfate: 3,000 mg/L, WDEQ Class III), and will migrate out of the mine area in approximately 150 years.
- In the Southwestern Flow Regime (SWFR), the chloride and sulfate plumes will migrate to the southwest along the principal groundwater flow paths. The chloride and sulfate plumes will migrate southwest of the LTB in approximately 75 years with plume concentrations substantially below the site-specific standards, and will migrate out of the mined area in approximately 150 years.

The one deficiency that URS noted with respect to the modeling report (Appendix C, Umetco, 2001) was the lack of evaluation and discussion of the transport model uncertainty, particularly as it relates to the model predicted plume migration and concentration trends associated with chloride and sulfate. This uncertainty is discussed below in Section 3.

3.0 UNCERTAINTIES OF GROUNDWATER TRANSPORT MODEL RESULTS

The uncertainty of the transport model results is likely high because of the (1) simplifying assumptions used to develop the transport model and (2) the complex hydrogeologic and geochemical conditions at the site.

The transport model prediction simulations assumed that:

- Calibrated steady state groundwater flow conditions were representative of future conditions, implying that groundwater levels and areal recharge do not change with time. However, natural groundwater conditions vary in time and space, which influences the predicted constituent concentrations and plume extents.
- Interpreted chloride and sulfate concentration distributions for the first quarter of 2000 were assumed to be representative of the actual distribution of these constituents in the water-bearing strata at the site, and were used as the initial concentration distribution for model predictions. However, the actual chloride and sulfate concentration distributions are likely different because of the hydrogeologic heterogeneity at the site.

- Estimated residual tailings seepage from the Above Grade Tailings Impoundment (AGTI) and A-9 Repository was assumed to be the remaining source of chloride and sulfate at the site. The seepage was assumed to decrease over time until reaching a steady state rate (Shepherd Miller, Inc. 1997; 1998). In the model, the seepage rate was assumed to be uniformly distributed over the entire AGTI and A-9 repository. The actual areal distribution and temporal variation of the seepage may be more complicated than assumed.

These assumptions are appropriate for the transport model predictions given the general understanding of site conditions and data availability. However, as discussed above, the simplifying assumptions do not fully reflect the complex hydrogeologic and geochemical conditions at the site. The actual site conditions, particularly the groundwater constituent concentrations, likely vary in space and in time as discussed in Appendix A of the ACL Application (Umetco, 2001) and in Section 5. These variations in constituent concentrations can be attributed to subsurface hydrogeologic heterogeneities, impacts of former adjacent mining operations, and the presence of extensive uranium ore bodies south of the site. General uncertainties of the model prediction results may be estimated, such as for the average groundwater flow path and velocity (Appendix C, Umetco, 2001), and for the general groundwater contaminant plume migration direction and extent. However, uncertainties of the predicted groundwater concentrations at specific monitoring wells at specific times cannot be reasonably quantified for the site due to the heterogeneous hydrogeologic and geochemical conditions.

For example, the initial constituent concentrations used in the transport model were assumed to represent the worst-case conditions that occurred prior to final surface reclamation activities at the site. The concentration distributions for chloride and sulfate in the first quarter 2000 were interpreted based on samples from available monitoring wells. Where there are no monitoring wells, there could be substantial unknown concentrations of these constituents. In addition, the concentration distributions in the first quarter 2000 do not necessarily represent the highest chloride and sulfate concentrations at the site. Groundwater samples collected at monitoring wells GW7 and GW8 during the first quarter 2000 were around 100 mg/L and 1,500 mg/L for chloride and sulfate, respectively, but subsequently increased to 500 mg/L and 3,000 mg/L during the time period when reclamation activities were initiated on the adjacent below-grade A-9 Repository (Section 5.2.1).

Due to these limitations, the transport model predictions should only be taken to represent average approximations of future contaminant concentrations and distributions. Likewise, the model predicted temporal constituent concentration trends can only represent the general concentration trends in the constituent plumes, but may not represent the specific concentration trends at selected monitoring wells.

4.0 REVIEW OF MODEL VALIDATION APPROACH

The post-closure groundwater monitoring plan (Appendix M and Attachment M-1) was developed in 2002 and revised in 2011 based on the groundwater model prediction results and data collected up to 2010. The plan proposed to compare the future observed chloride and sulfate concentrations with the model predicted concentration trends and the 95 percent upper confidence limit (UCL) trends at four "model validation" wells. This methodology was proposed with the intent to provide early detection of potential ACL exceedances, if chloride and/or sulfate concentrations exceeded the predicted UCL at a "model validation" well. However, this method did not consider the limitations of the model predicted future concentrations and did not consider the hydrogeologic and geochemical heterogeneity at this site.

The predicted 95 percent UCL trends for the "model validation" wells were developed by calculating the standard deviation of the observed concentration dataset from 1997 to 2001, and then adding 1.96 standard deviations to the model predicted concentration trends (Attachment M-1, Umetco, 2002, revised 2011). This method assumes that the concentration dataset is normally distributed, and that the variability of concentrations does not change with time after mine closure.

Both assumptions for the predicted 95 percent UCL are not valid. The assumption about the normal distribution of the dataset was not verified. As discussed in Appendix A of the ACL Application (Umetco, 2001), the heterogeneity inherent in the background groundwater environment could not be addressed by defining subpopulations. In addition, the concentration variation that was observed during 1997 to 2001 only represents the background concentration variability when the area was not impacted by the mining related plume. It does not represent the concentration variability within the groundwater plume itself. The concentrations collected since 2001 show that the site conditions changed after the initial reclamation period. If the standard deviation were recalculated using an expanded concentration dataset collected between 1997 and 2011, the standard deviation would be substantially greater than the ones used in Attachment M-1 for the "model validation" wells.

5.0 REVIEW OF OBSERVED GROUNDWATER LEVELS AND CONCENTRATIONS

The groundwater levels and constituent concentrations collected from 1998 to 2011 were reviewed to evaluate if the post-closure conditions are consistent with the conceptual model and the numerical model predictions, in terms of general chloride and sulfate plume migration directions and temporal trends. URS reviewed groundwater levels and constituent concentrations monitored since 1998 at eight wells in the WFR (MW1, MW21A, MW25, MW28, MW70A, MW71B, MW77, and MWI64) and at five wells in the SWFR (GW7, GW8, PW4, MW72, and MW82 [MW82 has been sampled since it was constructed in 2002]). Locations of these wells are shown on Figure 1.

Per the groundwater monitoring plan, chloride, sulfate, and all licensed constituents were sampled at the four point-of-compliance (POC) wells (i.e., MW1, MW21A, GW7, and GW8). For the non-POC wells, only chloride, sulfate, and natural uranium were sampled. The concentrations of the licensed constituents have been consistently well below the ACLs since 1998 (Umetco, 2011b).

The discussion below focuses on review of the groundwater levels and the temporal and spatial concentration trends of chloride, sulfate, and natural uranium at site monitoring wells in comparison to the conceptual model and numerical model results.

5.1 Western Flow Regime

The groundwater levels and concentrations of chloride, sulfate, and natural uranium for the WFR wells are presented on Figures 2 to 5. A summary of the observed trends for the water levels and concentrations for each individual well is provided in Table 1.

5.1.1 General Trends

The observed groundwater level and chloride, sulfate, and natural uranium concentration trends at monitoring wells in the WFR are summarized below:

- In general, groundwater levels in the WFR wells (Figure 2) remained relatively stable from 1998 to 2011, except for the increase at MWI64 from 2000 to 2001 and the recent increase at MW1.
- The chloride concentrations from 1998 to 2011 (Figure 3) are all below 200 mg/L, except for one sample collected at MWI64 in 2002. The chloride concentration spike may be related to the 12-foot water level increase that occurred at this well from 2000 to 2001.
- The sulfate concentrations from 1998 to 2011 (Figure 4) at most wells are below 3,000 mg/L, except for MWI64 prior to 2009 and for MW70A prior to 2005.
- The natural uranium concentrations from 1998 to 2011 (Figure 5) are all below 10 mg/L, which is less than the ACL of 11.9 mg/L. The natural uranium trends display a similar pattern to the sulfate concentrations (Figure 4).
- The temporal concentration trends for chloride, sulfate, and natural uranium are consistent at most individual wells, except at MW70A, where there are some differences in the trends for these constituents.

5.1.2 Variation of Concentration Trends

The variations of the constituent concentration trends at the monitoring wells appear to be consistent with the model predicted plume migration direction in comparison with the monitoring well locations (Figure 1).

Decreasing constituent concentration trends have occurred at monitoring wells MW1, MWI64, and MW25 (Table 1). These wells are located immediately downgradient of the source area in the vicinity of the AGTI and other former mining units (Figure 1). The initial constituent concentrations prior to final surface reclamation (Figures 3 to 5) were greater than their standards, indicating that the area was impacted by past mining activities. A sharp decrease in chloride, sulfate, and natural uranium concentrations occurred at MWI64 after 2007, which suggests that the constituent plume has migrated out of this area. It is reasonable to expect that the mining impacts are gradually decreasing at these wells, suggesting that the groundwater constituent plumes are gradually moving downgradient.

Increasing constituent concentration trends have been observed at monitoring wells MW21A, MW28, MW71B, and MW77 (Table 1). Monitoring wells MW28, MW71B, and MW77 are located downgradient of the former mining area and downgradient of the wells where decreasing constituent concentrations were observed. The initially low constituent concentrations suggest that these locations had not been impacted by mining at the time of final surface reclamation. The gradual increase of the concentrations at these wells suggests that the upgradient constituent plume near the AGTI and other previous mining units is migrating into this area as predicted by the model.

5.1.3 Concentration Trends at MW28

As shown in Attachment A (Figures 2b and 6b), monitoring well MW28 is the "model validation" well where chloride and sulfate concentrations exceeded the model-predicted trends and the 95 percent UCL in 2010 and 2011. Considering the concentration trends observed at other surrounding wells in the WFR, the recent increasing constituent concentration at MW28 is expected as the result of constituent plume movement as predicted by the model. The recent constituent concentration increase at monitor well MW28 may correspond to the recent decreasing concentration trend observed at monitoring well MWI64 since 2007. This indicates that the constituent plume is moving from the source area to the downgradient area as a slug plume. It is expected that the concentration trend at well MW28 will change in the future from increasing to decreasing similar to the observations at well MWI64.

5.2 Southwestern Flow Regime

The groundwater levels and concentrations of chloride, sulfate, and natural uranium for the SWFR wells are presented on Figures 6 through 9. A summary of the observed trends at each individual well is provided in Table 2.

5.2.1 Variation of Water Level and Concentration Trends

The observed groundwater level and chloride, sulfate, and natural uranium concentration trends at the monitoring wells in the SWFR are summarized below:

- The groundwater levels in the SWFR have fluctuated over the last 14 years (Figure 6). An increase in groundwater levels of approximately 10 feet was observed at three wells (GW7, GW8, and PW4) from 2001 to 2005. Since then the groundwater levels have decreased and then increased slightly. The increasing and decreasing groundwater level at monitoring well MW72 is similar to the temporal trend at GW7, GW8, and PW4, but with a different magnitude.
- The groundwater level increase at monitoring wells GW7, GW8, and PW4 from 2001 to 2005 may be associated with surface reclamation activities conducted on the adjacent below-grade A-9 Repository during this time period. Additional conditions which likely influenced the groundwater level at these monitoring wells include termination of pumping for the groundwater corrective action plan and sealing of the A-9 decant system.
- The large increase in chloride, sulfate, and natural uranium concentrations at GW8 from 2002 to 2005 and to a lesser extent at GW7 and PW4 (Figures 7 to 9) may be attributed to the A-9 Repository reclamation cover construction. The reclamation activities included loading of saturated tailings which led to consolidation drainage of the tailings. These activities directly increased chloride and sulfate concentrations in groundwater and resulted in rising groundwater levels in the nearby vicinity. The groundwater level increased to approximately 6,800 feet above mean sea level (amsl) at GW8, GW7, and PW4 during this period, which brought groundwater in contact with a discrete naturally-occurring uranium roll front. As shown on a site cross-section (Figure 1.13, Umetco, 2001), uranium roll fronts are present between 6,793 and 6,817 feet amsl at GW7 and GW8.
- The large decrease in chloride, sulfate, and natural uranium concentrations in recent years at monitoring well GW8 may be related to the slight decrease or stabilization in groundwater levels that occurred at this well from 2005 to 2008 upon completion of surface reclamation. It is also possible that the majority of soluble minerals have been leached out of the uranium roll front that is present at the water table elevation.
- The large increase in chloride, sulfate, and natural uranium concentrations at monitoring well GW8 occurred during the same period when the concentration of lead-210 increased substantially at this well and at monitoring well GW7 (Figure 10). The increase in lead-210 concentrations stimulated an investigation and eventual revision of the lead-210 ACL. The ACL for this constituent was revised upward from

its original value of 46.7 picocuries per liter (pCi/L) to 189 pCi/L (NRC, 2006). However, the lead-210 concentrations at GW7 and GW8 have since decreased to less than 10 pCi/L in 2011, along with the decreasing chloride, sulfate, and natural uranium concentrations at monitoring well GW8.

- Although monitoring wells GW7, GW8, and PW4 are located together within a small area (Figure 1) and have similar well screen elevations (GW7: 150 to 190 feet below ground surface, GW8: 132 to 172 feet below ground surface, and PW4: 96 to 136 feet below ground surface), there are substantial differences in the observed constituent concentrations among the three wells. This indicates that significant heterogeneities exist in the subsurface geological materials and geochemical conditions within the SWFR.
- Chloride and sulfate concentrations at monitoring well MW72 have decreased between 2004 and 2010. In late 2010, the concentrations abruptly increased. The MW72 concentration trends do not appear similar to the upgradient concentration trends at GW7, GW8, and PW4. Concentration trends at MW72 are discussed further in Section 5.2.2.
- Monitoring well MW82 is a newer well installed in 2002. The groundwater level at MW82 is substantially lower than other wells within the SWFR (Figure 6). The constituent concentrations at monitoring well MW82 have slightly increased since the well was first sampled.

The groundwater level and constituent concentration trends at the SWFR wells suggest that significant increases and decreases in concentrations at GW8 may be related to the naturally-occurring roll-front uranium mineralization zone that occurs at this well, as well as consolidation drainage of tailings from the A-9 Repository. Local uranium mineralization sources were not simulated in the transport model. The inconsistencies of the groundwater level and concentration trends among the SWFR wells suggest that the groundwater flow and transport conditions in the SWFR are more complicated than the WFR.

5.2.2 Concentration Trends at MW72

As shown in Attachment A, the recent increasing chloride and sulfate concentration trends at monitoring well MW72 (Figures 3b and7b) differ from the model predicted trends. The exact reasons for the water level fluctuation, the decreasing concentration trends prior to 2010, and the concentration increase in 2011 at MW72 are not clear. It is likely that the conditions at MW72 are influenced by variations in the upgradient area and related to the local hydrogeologic and geochemical conditions. Overall, the degree of concentration variability at well MW72 is greater than what the model can predict, but is still within an acceptable level of model uncertainty.

6.0 CONCLUSIONS

The evaluation of the East Gas Hills groundwater flow and solute transport models, as well as the groundwater data collected from 1998 to 2011, indicates the following:

- The groundwater flow model was developed and calibrated reasonably well according to standard practice. The transport model was developed based on average constituent concentration distributions at the site.
- Uncertainty of the groundwater flow model was evaluated and addressed in the ACL Application document (Umetco, 2001); however, the uncertainties of the groundwater contaminant transport model were not sufficiently evaluated or discussed in the Appendix M monitoring plan. Due to the heterogeneous site hydrogeologic and geochemical conditions and the simplifying assumptions used to construct the model, the solute transport model prediction results inherently have a high degree of uncertainty. Thus, the model predictions represent average future constituent plume extents, but cannot reasonably predict the variations in constituent concentrations that occur over time at individual monitoring wells.
- The method that was proposed in the Appendix M monitoring plan for comparison of observed chloride and sulfate concentrations to the model predicted trends and the assumed 95 percent UCL trends at selected "model validation" wells is not appropriate because it does not consider the heterogeneous site hydrogeologic and geochemical conditions and the uncertainties of the model predictions.
- The observed groundwater levels and constituent concentrations in the WFR suggest that the groundwater plume from the AGTI is migrating to the west, which is consistent with the site conceptual model and general model predictions.
- The observed groundwater levels and constituent concentrations in the SWFR suggest that the hydrogeologic and geochemical conditions may be more complicated than those in the WFR. The observed fluctuations of the chloride, sulfate, and natural uranium concentrations appear to be the result of rising water levels bringing groundwater in contact with discrete uranium mineralization zones in the vadose zone. Surface reclamation activities at the A-9 Repository have also influenced chloride and sulfate concentrations in the SWFR wells.

7.0 REFERENCES

Shepherd Miller, Inc., 1997, Drainage from Above Grade Tailings Impoundment at Gas Hills, Wyoming, technical memorandum prepared for Umetco Minerals Corporation by Shepard Miller, Inc., September 30.

Shepherd Miller, Inc., 1998, Drainage from the A-9 Repository, Gas Hills, Wyoming, technical memorandum prepared for Umetco Minerals Corporation by Shepard Miller, Inc., August 13.

Umetco, 2001, Final Application for Alternative Concentration Limits for Gas Hills, Wyoming, November.

Umetco, 2002, Appendix M, Groundwater Monitoring Plan, Gas Hills, Wyoming, March.

Umetco, 2011a, Appendix M, Groundwater Monitoring Plan, Gas Hills, Wyoming, Revised October.

Umetco, 2011b, U.S. Nuclear Regulatory Commission Annual Report for Gas Hills, Wyoming, July 2010 through June 2011.

U.S. Nuclear Regulatory Commission (NRC), 2006, Umetco – Gas Hills – Materials License No. SUA-648 – Environmental Assessment of Alternative Concentration Limit (TAC LU0100), March 24.

Tables

Table 1
Observed Water Level and Concentration Trends – Western Flow Regime

Well	Well Location	Observed Trend			
		Water Level	Chloride	Sulfate	Natural Uranium
MW1	Edge of Source Area	Stable with recent increase	Decrease with recent minor fluctuations	Decrease with recent minor fluctuations	Increase but recent minor decrease
MWI64	Edge of Source Area	Early fluctuation then stable	Significant increase in 2002 then rapid decrease	Significant fluctuation before 2007 and then sharp decrease	Significant fluctuation before 2007 and then decrease
MW21A	Edge of Source Area	Stable	Gradual increase	Gradual increase	Stable at low concentration
MW70A	Down-gradient	Stable	Fluctuation with relatively stable trend	Early decrease then fluctuation with slight decrease	Fluctuation with relatively stable trend
MW25	Down-gradient	Stable	Gradual decrease	Stable with minor fluctuation	Stable at low concentration
MW28	Down-gradient	Stable	Increase since 2001	Increase since 2001	Stable at low concentration
MW71B	Down-gradient	Stable	Gradual increase	Gradual increase	Stable at low concentration
MW77	Farther down-gradient	Stable	Stable	Gradual minor increase	Stable at low concentration

Table 2

Observed Water Level and Concentrations Trends – Southwest Flow Regime

Well	Well Location	Observed Trend			
		Water Level	Chloride	Sulfate	Natural Uranium
GW7	Edge of Source Area	Increased by 10 ft from 2001 to 2005	Increase	Decrease	Decrease
GW8	Edge of Source Area	Increased by 10 ft from 2001 to 2005	Significant increase up to 2008 and then sharp decrease	Significant increase up to 2005 and then decrease	Significant increase up to 2005 and then decrease
PW4	Edge of Source Area	Increased by 10 ft from 2001 to 2005	Increase to 2009 then decrease	Gradual increase	Stable at low concentration
MW72	Down-gradient	Increased by 7 ft from 2002 to 2004	Stable and slight decrease followed by recent increase	Slight increase followed by a decreasing period and then a recent sharp increase	Fluctuation then stable at relatively low concentration
MW82	Down-gradient	Increase by 6 feet from 2007 to 2011	Gradual increase, stable since 2008	Gradual increase	Stable at very low concentration

Figures

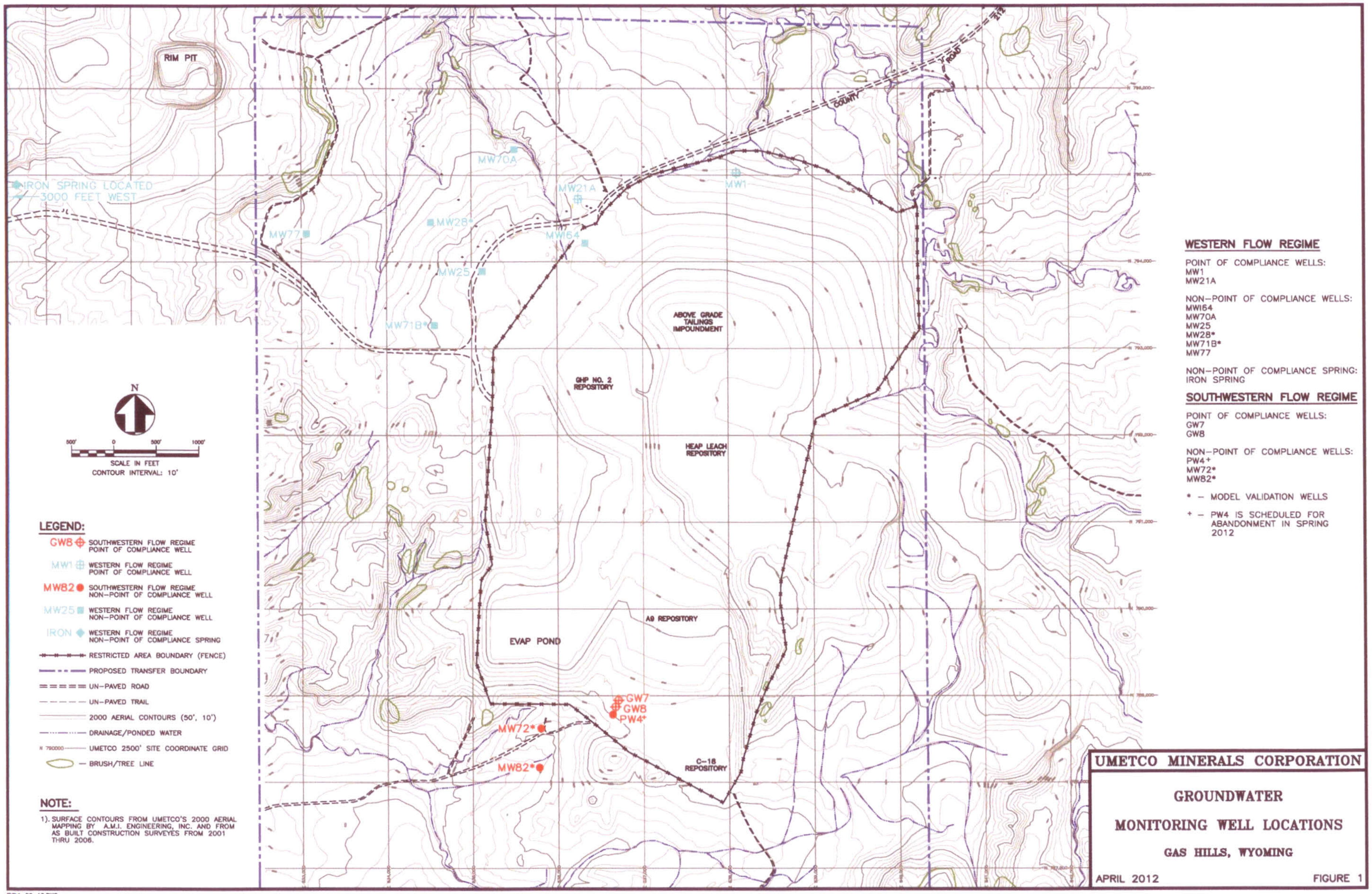
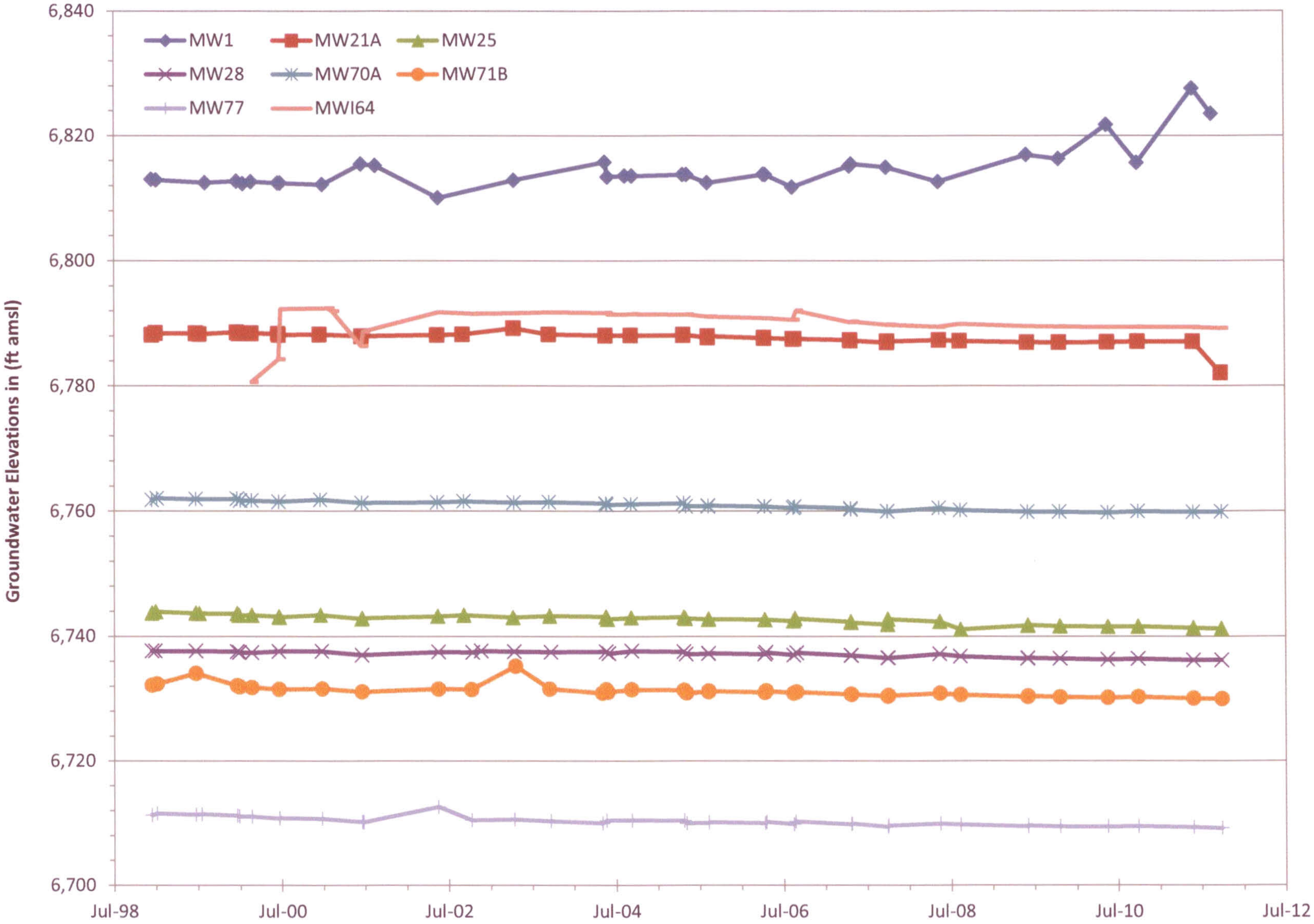


FIG1-09-12.DWG

Figure 2
Observed Groundwater Levels - Western Flow Regime



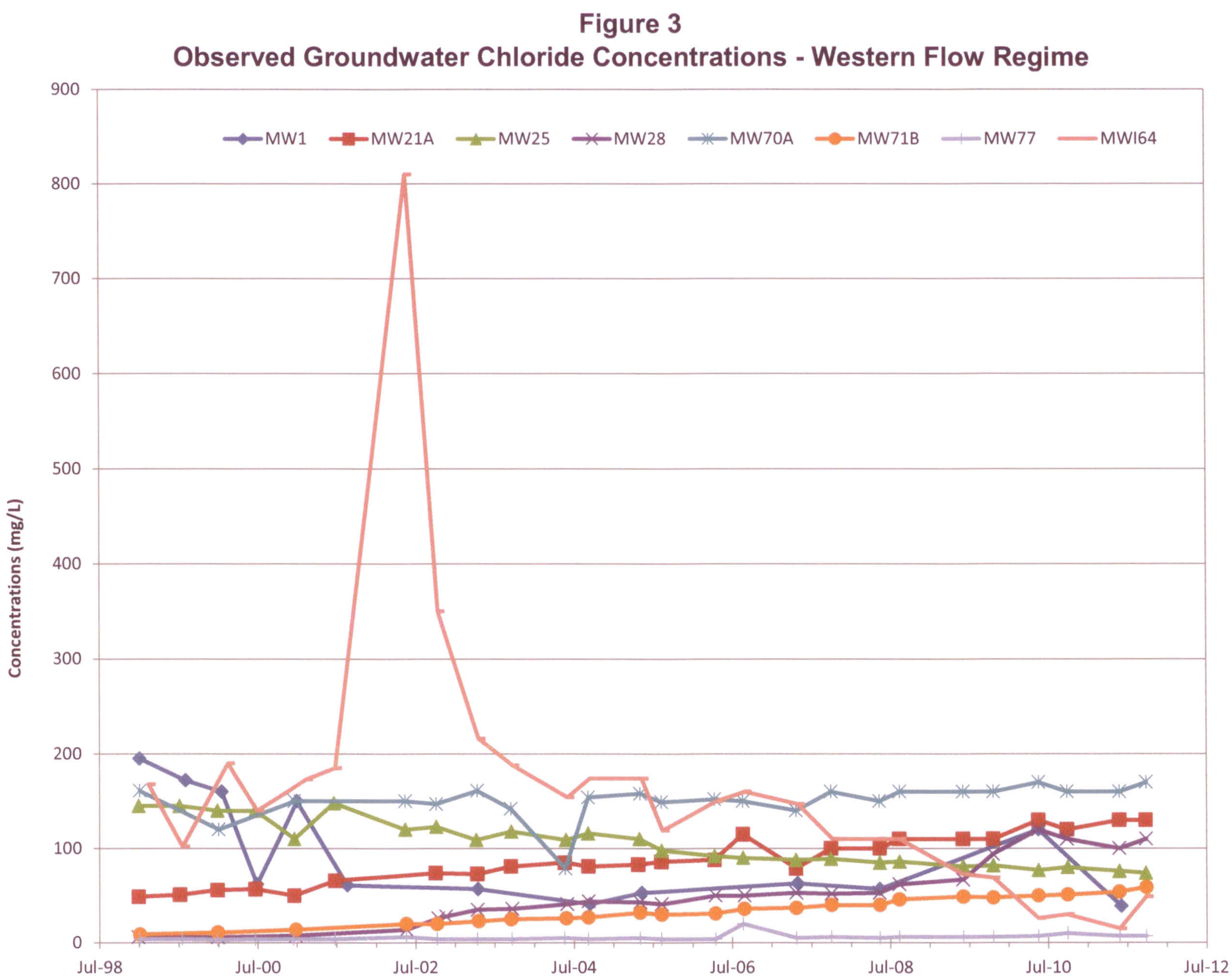


Figure 3
Observed Groundwater Chloride Concentrations - Western Flow Regime
MW1
MW21A
MW25
MW28
MW70A
MW71B
MW77
MWI64
Concentrations (mg/L)
0
100
200
300
400
500
600
700
800
900
Jul-98
Jul-00
Jul-02
Jul-04
Jul-06
Jul-08
Jul-10
Jul-12

Figure 4
Observed Groundwater Sulfate Concentrations - Western Flow Regime

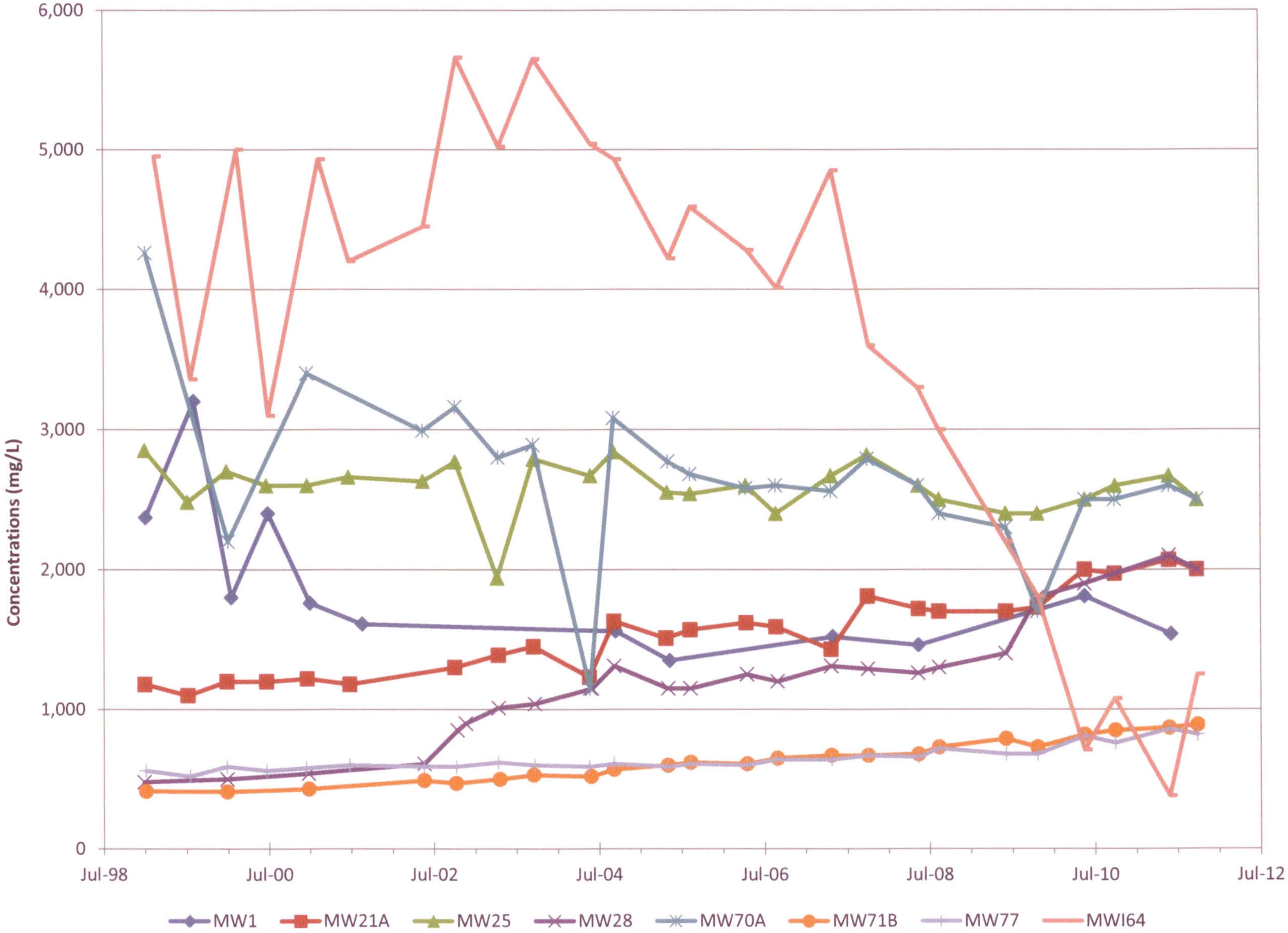


Figure 5
Observed Groundwater Natural Uranium Concentrations - Western Flow Regime

Figure 6
Observed Groundwater Levels - Southwest Flow Regime

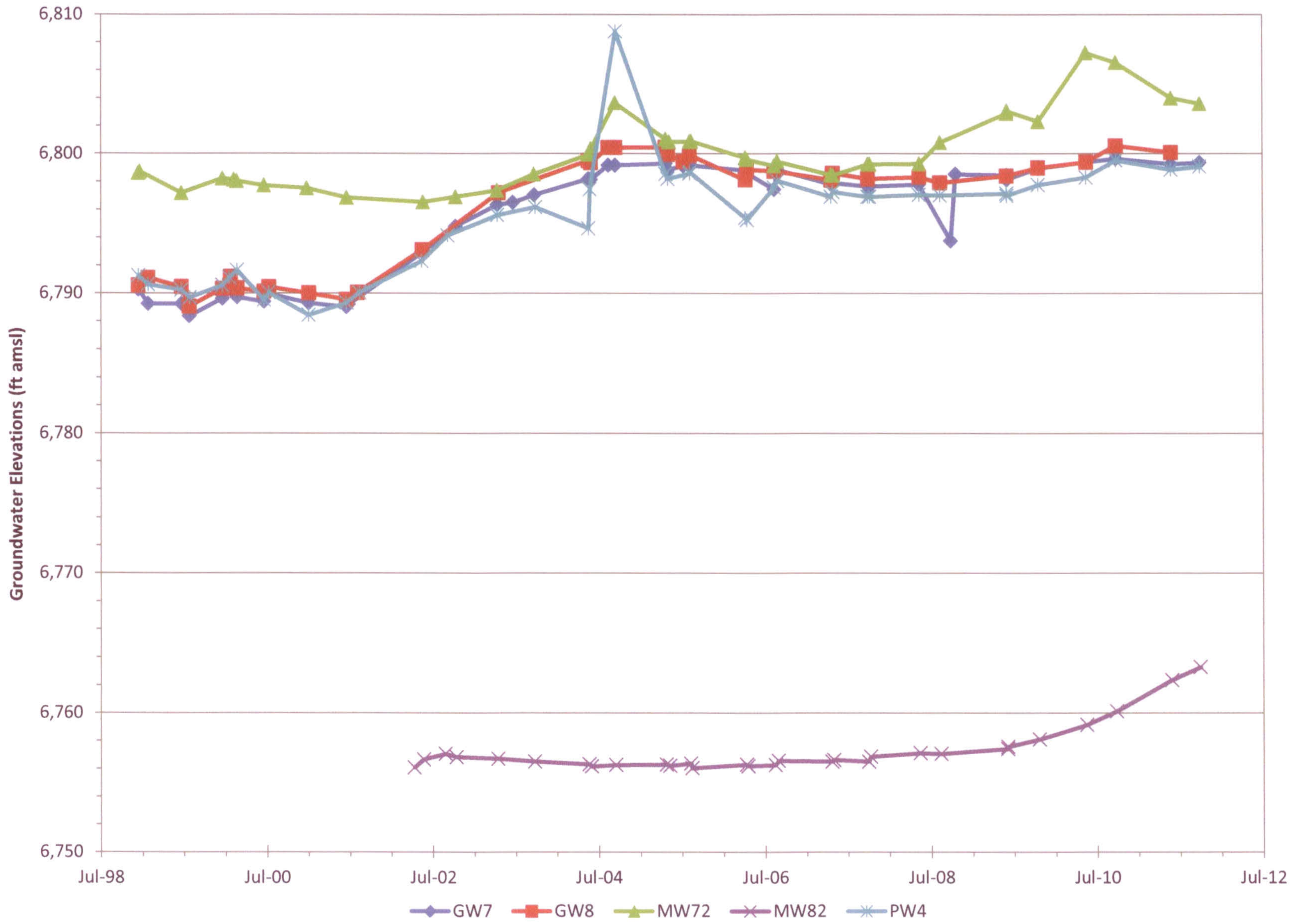


Figure 7
Observed Groundwater Chloride Concentrations - Southwest Flow Regime

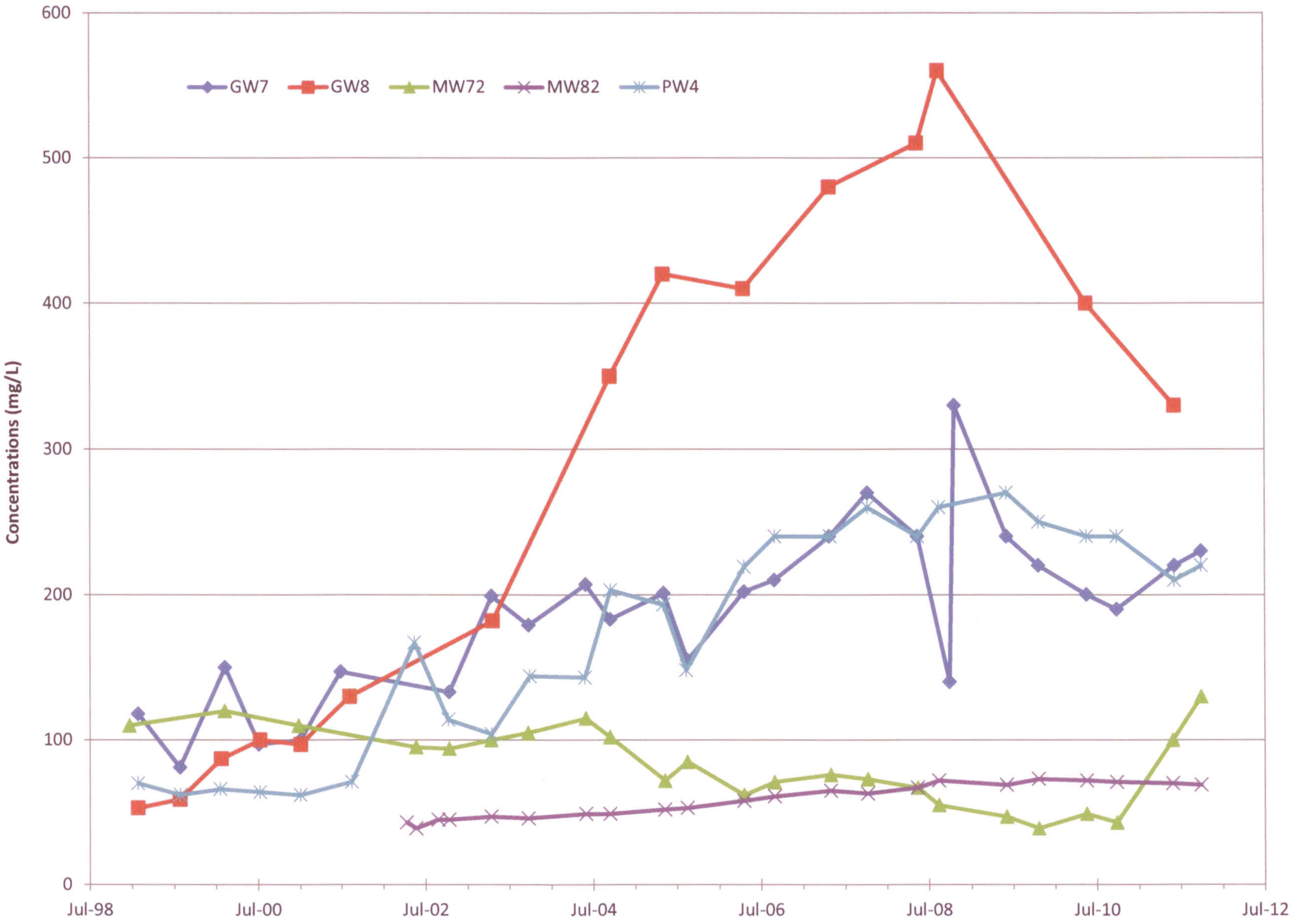


Figure 8
Observed Groundwater Sulfate Concentrations - Southwest Flow Regime

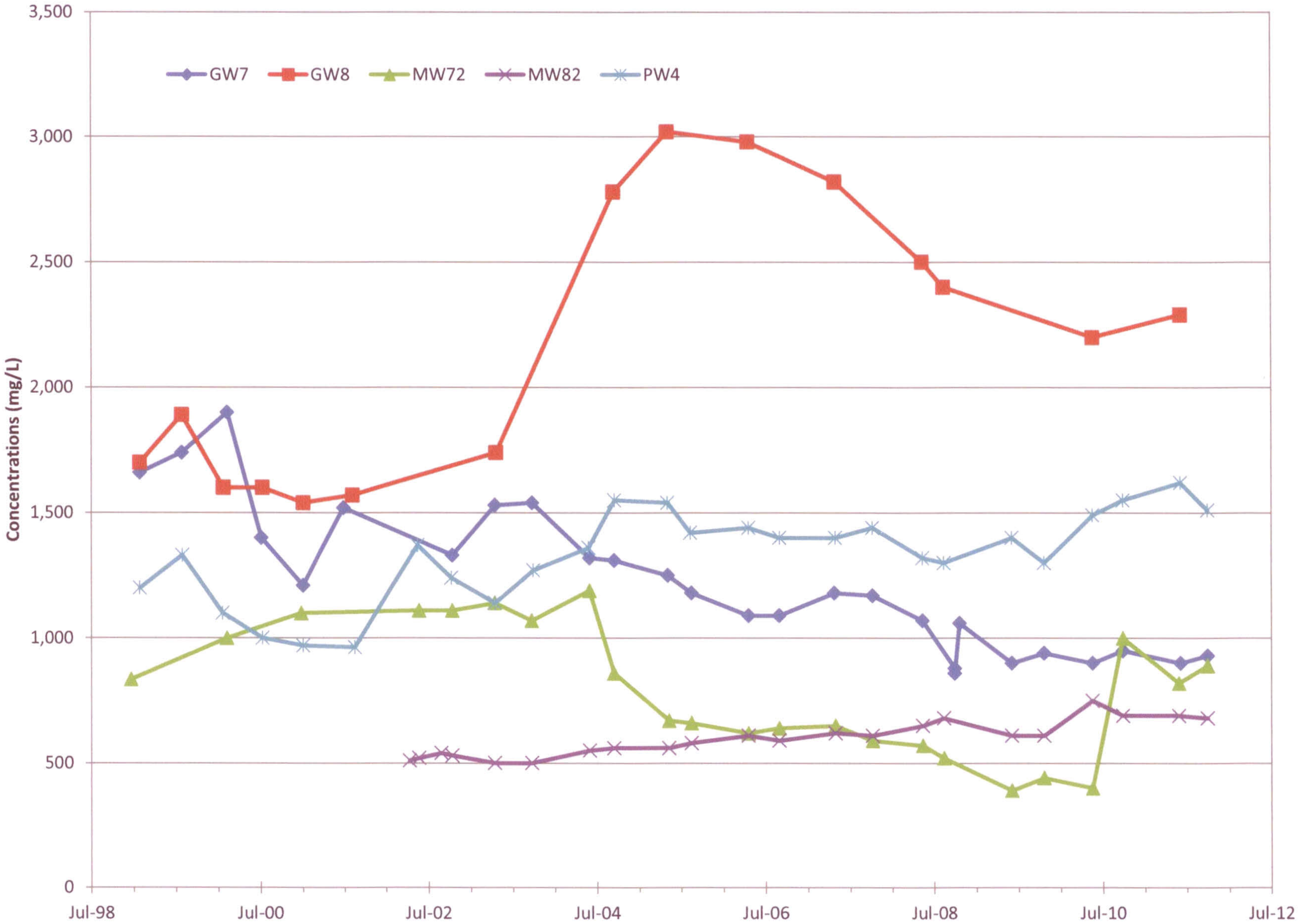


Figure 9
Observed Groundwater Natural Uranium Concentrations - Southwest Flow Regime

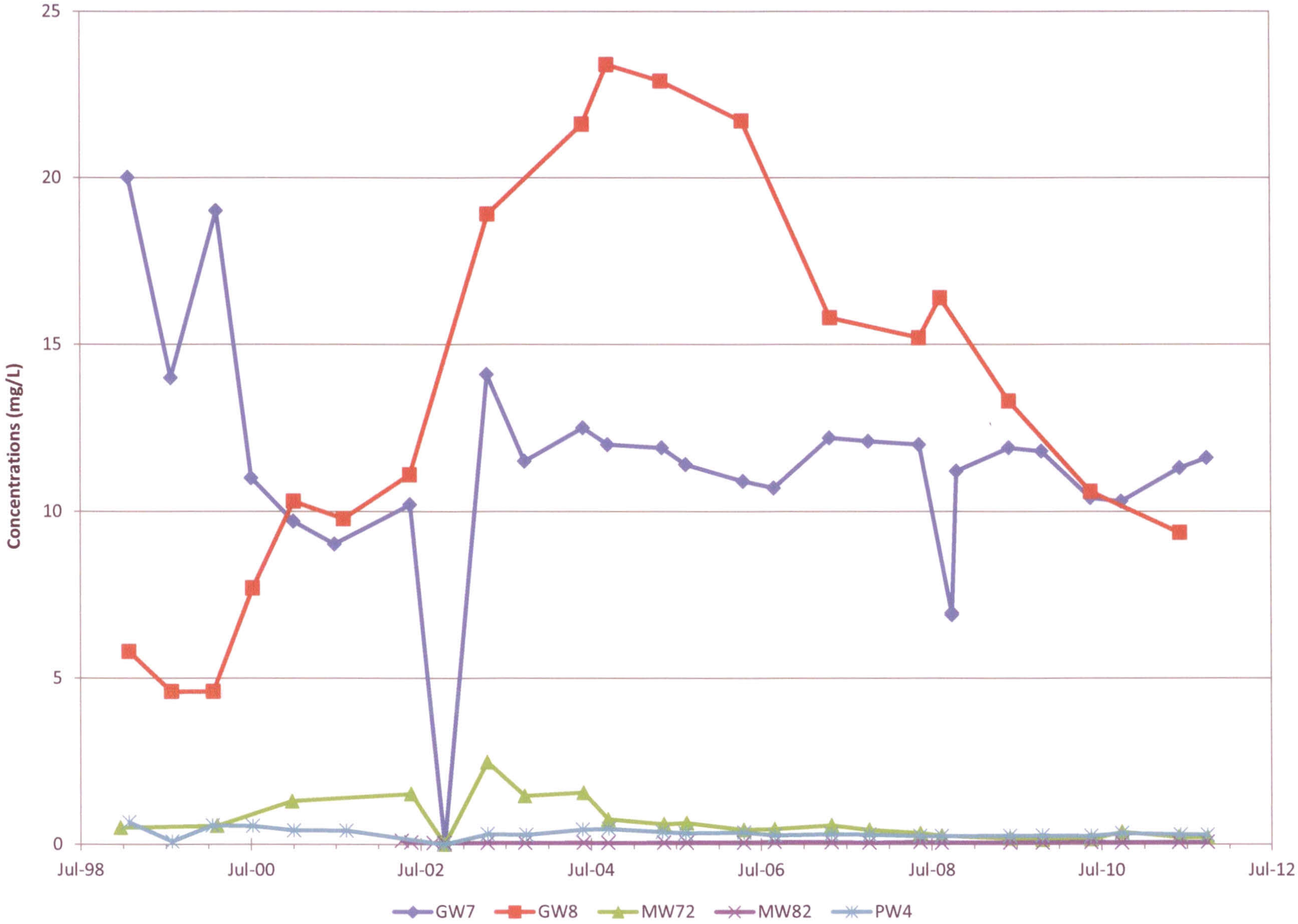
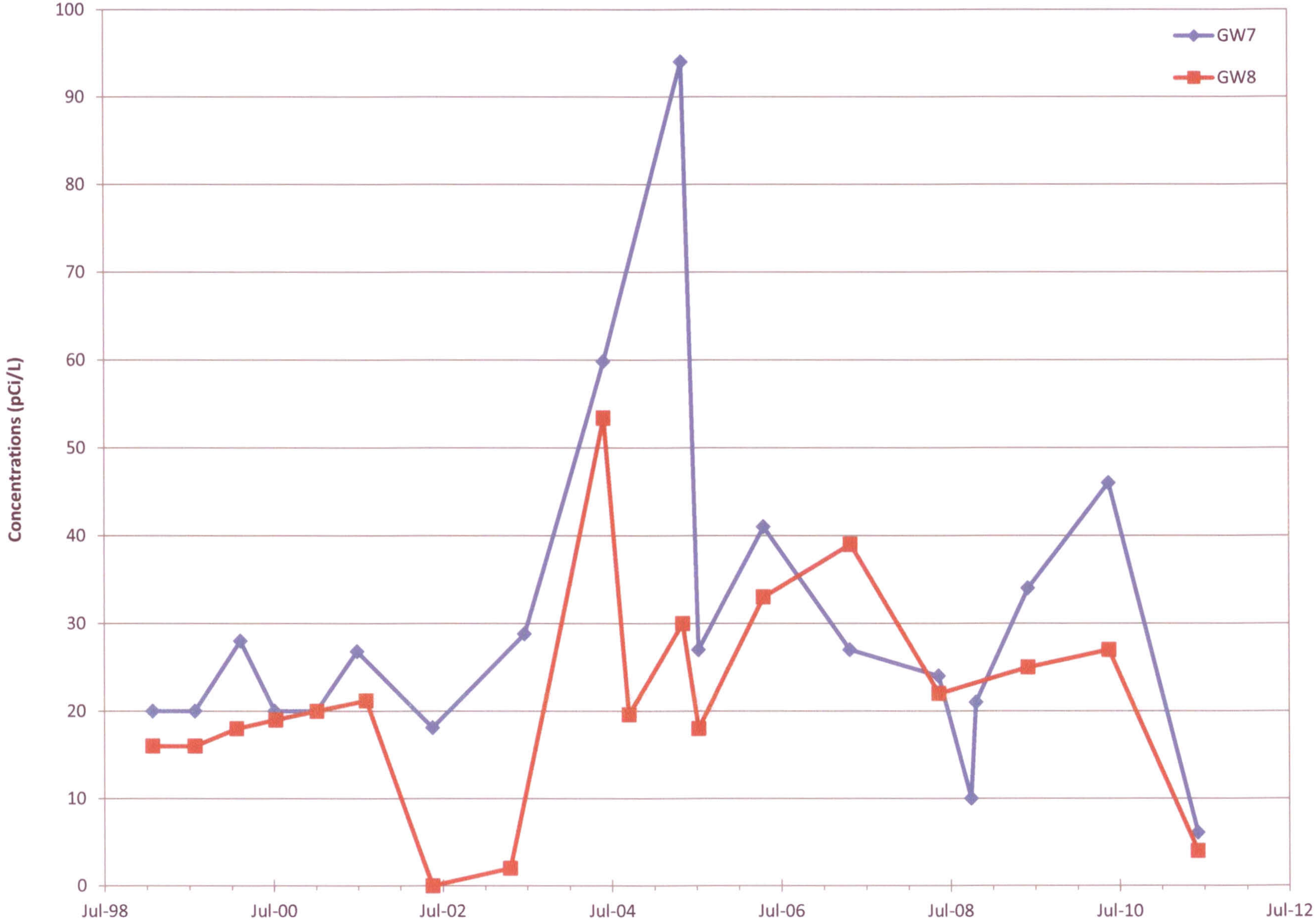


Figure 10
Observed Groundwater Lead-210 Concentrations - Southwest Flow Regime



Attachment A

Figure 1b Simulated Chloride Trends at MW71B (50 Years) Versus Actual Data
Western Flow Regime

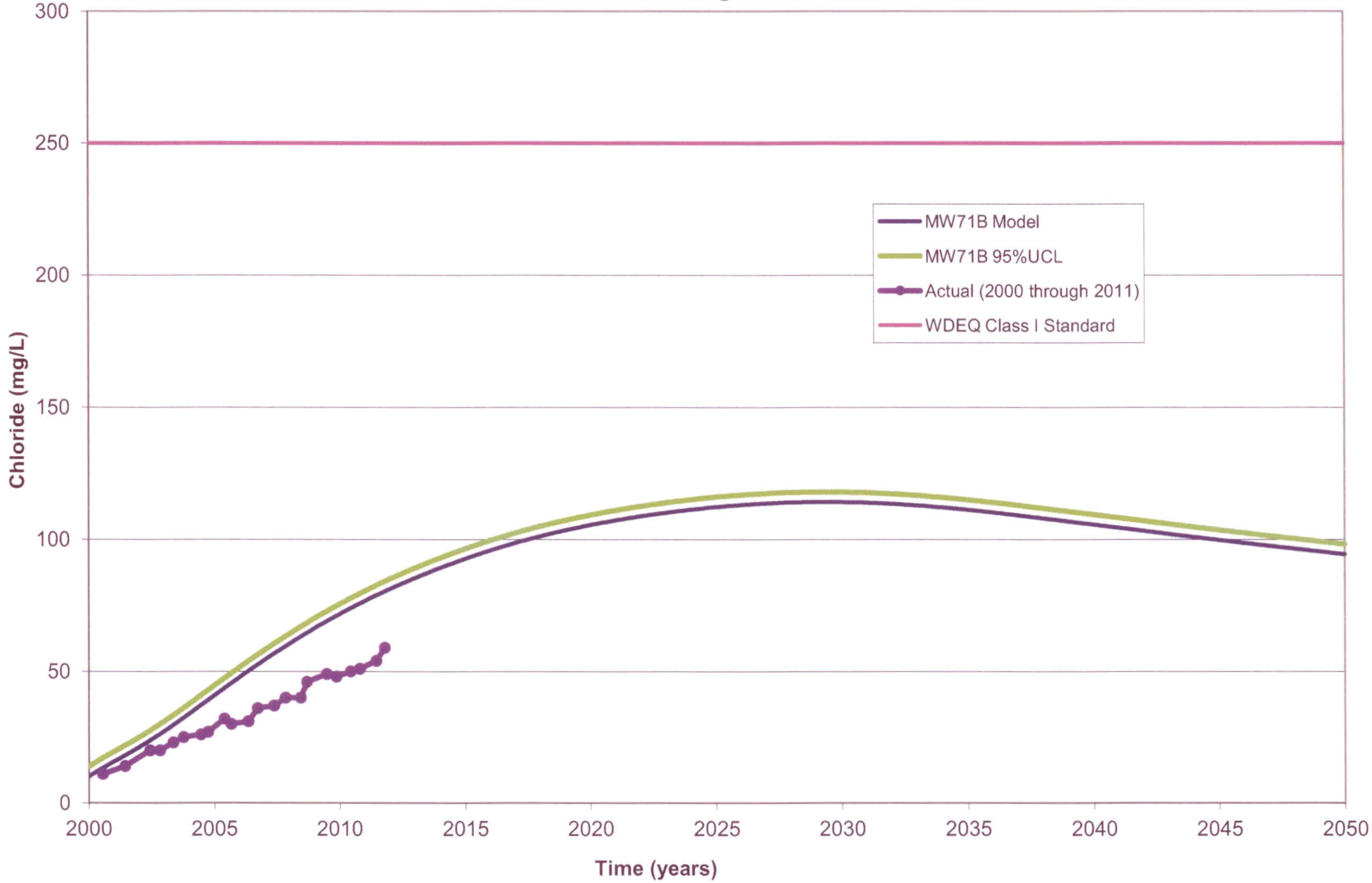
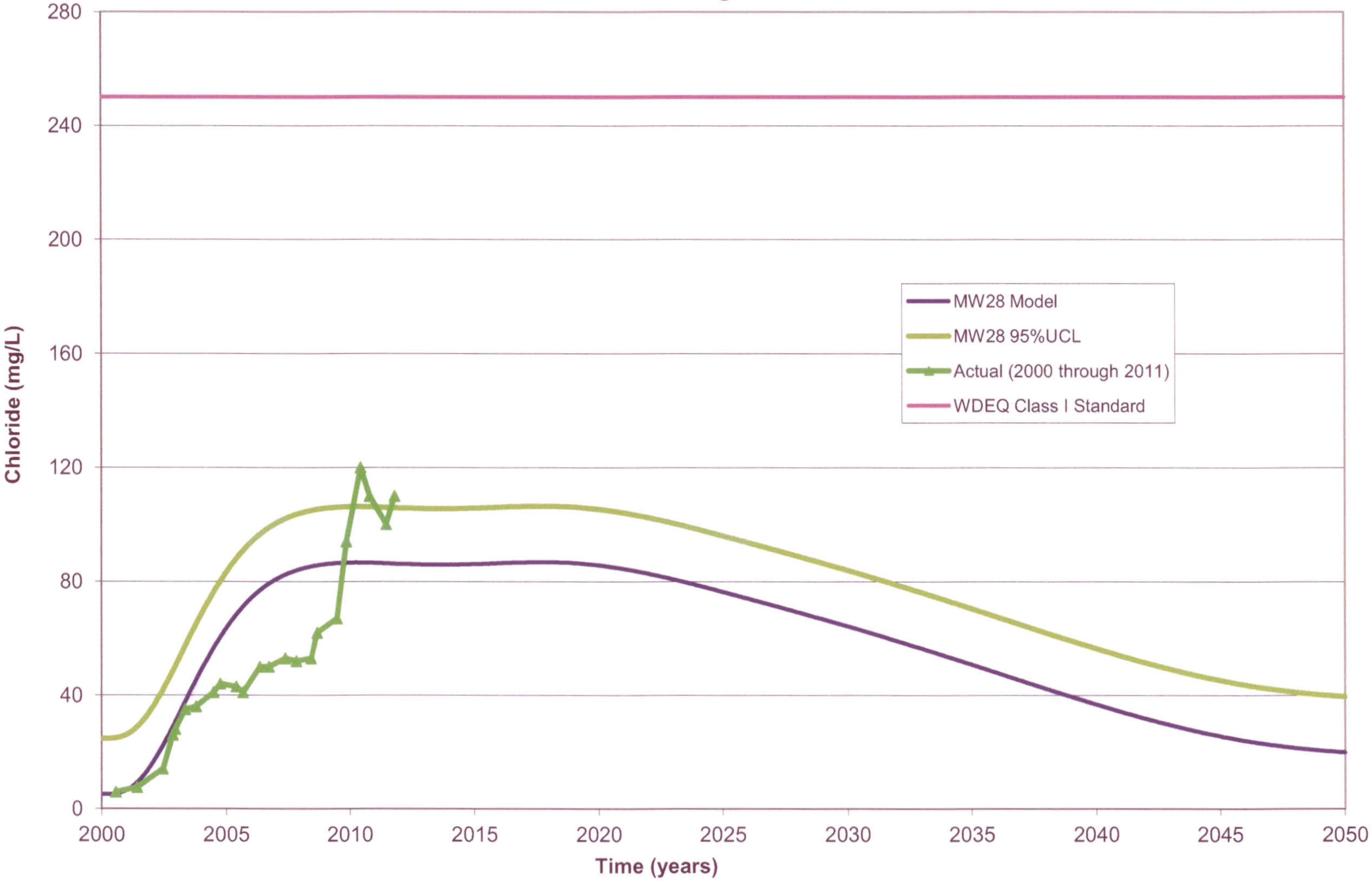


Figure 2b Simulated Chloride Trends at MW28 (50 Years) Versus Actual Data
Western Flow Regime



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Model Revised January 2004
Revised December 2011

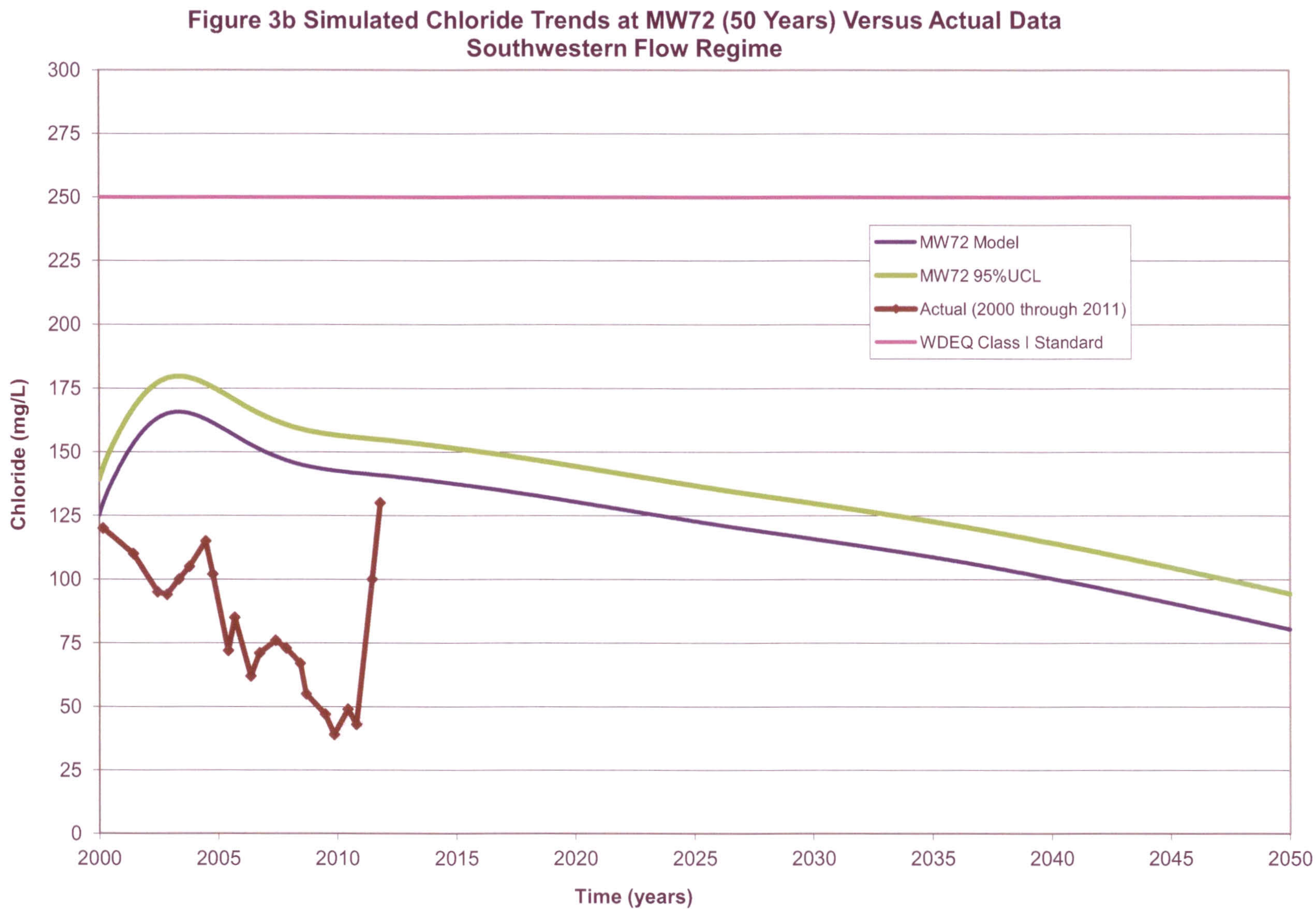
Figure 3b Simulated Chloride Trends at MW72 (50 Years) Versus Actual Data
Southwestern Flow Regime
300
275
250
225
200
175
150
125
100
75
50
25
0
Chloride (mg/L)
2000
2005
2010
2015
2020
2025
2030
2035
2040
2045
2050
Time (years)
MW72 Model
MW72 95%UCL
Actual (2000 through 2011)
WDEQ Class I Standard

Figure 4b Simulated Chloride Trends at MW82 (50 Years) Versus Actual Data
Southwestern Flow Regime

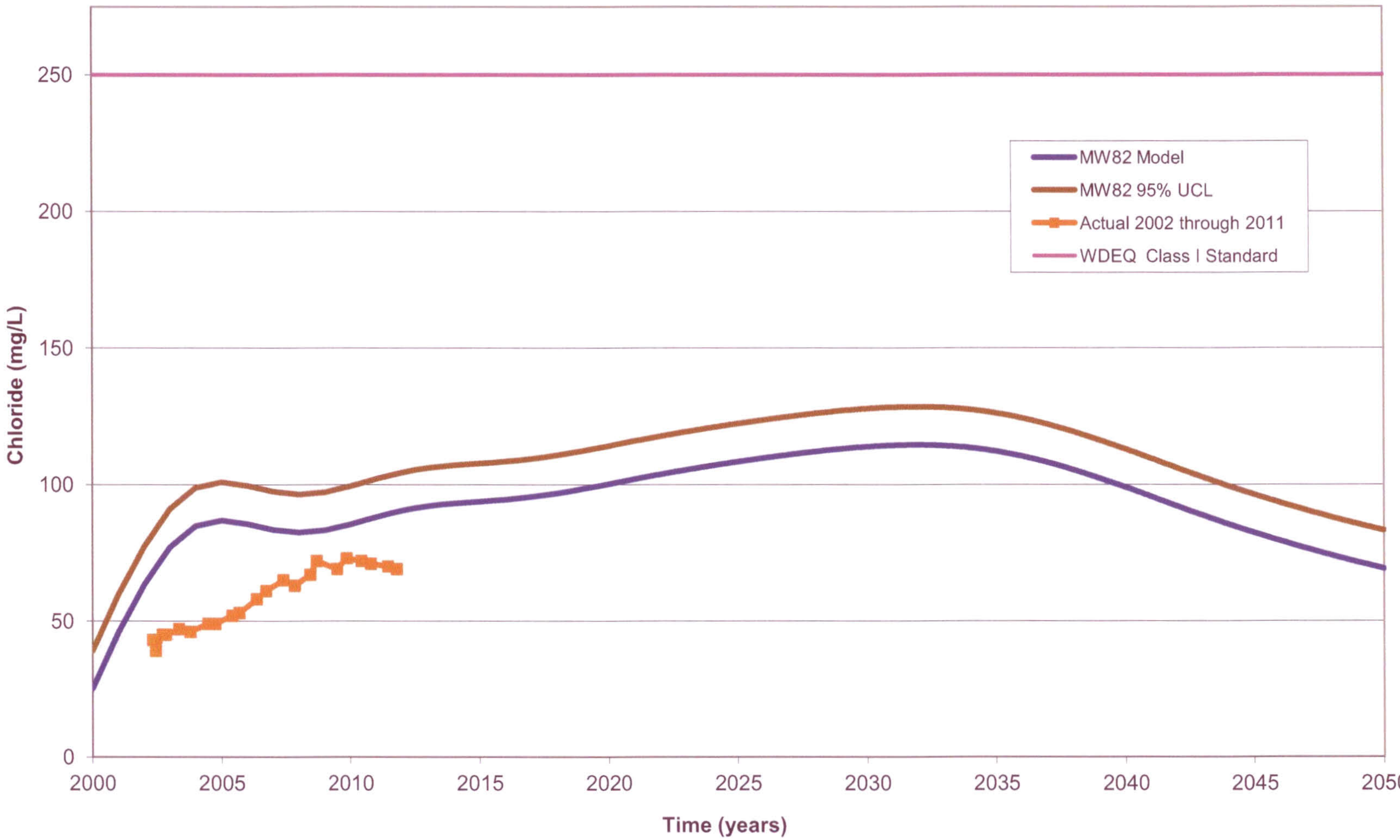

Figure 5b Simulated Sulfate Trends at MW71B (50 Years) Versus Actual Data
Western Flow Regime

Figure 6b Simulated Sulfate Trends at MW28 (50 Years) Versus Actual Data
Western Flow Regime

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Model Revised January 2004
Revised December 2011

**Figure 7b Simulated Sulfate Trends at MW72 (50 Years) Versus Actual Data
Southwestern Flow Regime**

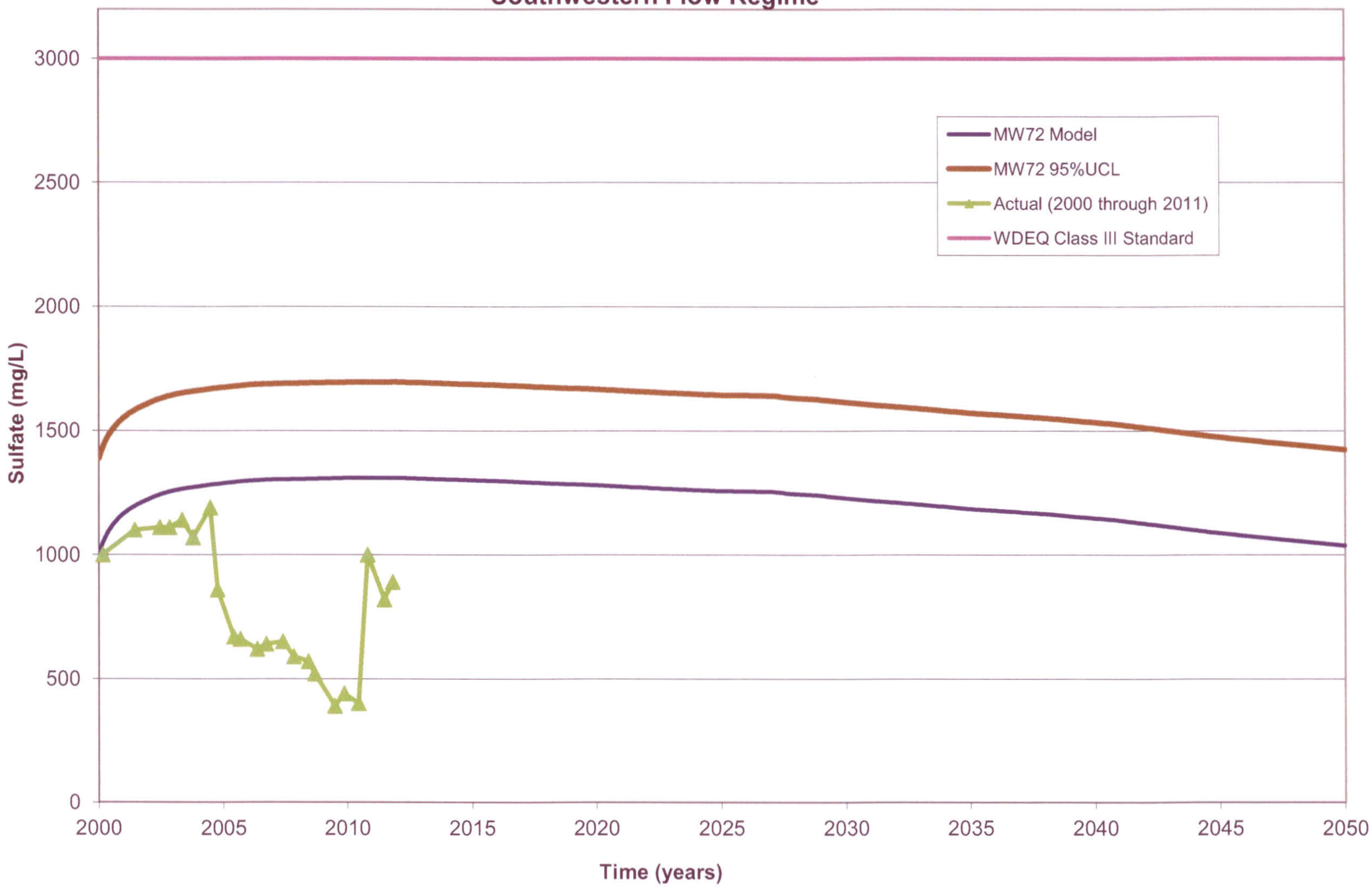

Figure 8b Simulated Sulfate Trends at MW82 (50 Years) Versus Actual Data
Southwestern Flow Regime