APPENDIX 6A:
Groundwater Transport Modeling In Support of Alternatives Evaluation

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES (cont'd.)

LIST OF FIGURES (cont'd.)

APPENDIX 6A
GROUNDWATER MODELING IN SUPPORT OF ALTERNATIVE EVALUATION

6A.1 INTRODUCTION

This appendix presents a summary of modeling efforts completed in support of alternatives considered within the Luckey Feasibility Study (FS). The efforts focus on providing information on current or future groundwater conditions under each alternative. The results are used in the evaluation of each alternative with respect to groundwater. Three constituents, beryllium, lead, and uranium, have been detected in groundwater above their respective cleanup goals. Information from modeling efforts was used to develop a better understanding of how the constituents were released to the groundwater and then to predict their fate within the flow system. Additional modeling efforts also were completed to evaluate the potential migration of other Atomic Energy Commission (AEC)-related constituents from the impacted soils to groundwater

Within this introduction, a brief description of modeling completed for each alternative is presented, followed by a brief summary of the nature and extent of contamination at the site. Section 6A.2 provides an assessment of the leaching potential of AEC-related constituents through soil to groundwater. Together, Sections 6A.1 and 6A.2 provide the basis for the modeling efforts completed for evaluation of the alternatives.

Section 6A.3 lists the models and assumptions utilized to evaluate the alternatives. References for the models used are also presented in Section 6A.3. The models used include the following:

- SESOIL to evaluate the migration of constituents through soil and predict ongoing or future impacts to groundwater (Section 6A.4);
- PHREEQC to provide input on constituent groundwater geochemistry for use in groundwater transport modeling (Section 6A.5);
- MT3DMS to evaluate the transport of contaminants within the groundwater (Section 6A.6).

A summary of the modeling results with respect to the remedial alternatives is presented in Section 6A.7.

The modeling results presented here should be considered in light of the uncertainties associated with past activities at the facility and those associated with model input parameters. For example, conditions in the past that resulted in the current observed contamination have a large amount of uncertainty associated with them. The primary AEC-related operations at Luckey occurred from 1950 to 1959. Records of facility operations and waste disposal operations are sparse, sometimes contradictory, and contain little or no information on the volume of materials released or the concentrations of AEC-related constituents. In addition, historical groundwater flow conditions are not well known, especially with respect to periodic operation of the on site production wells and the France Stone Quarry immediately south of the facility. Remedial Investigation (RI) data in conjunction with historical records provide a conceptual understanding of site processes to be simulated through transport modeling. Based upon this understanding, a qualitative calibration of groundwater transport was performed to verify input parameters were reasonable. The current distribution of contaminants was then modeled to predict the time required for attainment of groundwater Applicable or Relevant and Appropriate Requirements (ARARs). The results from the modeling efforts permit a relative evaluation of potential time frames and groundwater concentrations for each alternative.

6A.1.1 Remedial Alternatives

Eight remedial alternatives are developed in this FS (Sections 5 and 6):

- Alternative 1: No Action (Soils and Groundwater)
- Alternative 2: Limited Action (Soils and Groundwater)
- Alternative 3: Consolidation and Capping (Soils)
- Alternative 4: Excavation of Soils and Off-site Disposal (Soils) ~ Industrial Land Use
- Alternative 5: Excavation of Soils and Off-site Disposal (Soils) ~ Unrestricted Land Use
- Alternative 6: Excavation of Soils, Treatment, and Off-site Disposal (Soils) ~ Unrestricted Land Use
- Alternative 7: Monitored Natural Attenuation (Groundwater) ~ Unrestricted Land Use
- Alternative 8: Active Groundwater Treatment – Ex Situ (Groundwater) ~ Unrestricted Land Use
- Alternative 9: Electrokinetics (Groundwater) ~ Unrestricted Land Use.

Alternatives 1 and 2 do not actively (no source removal, no active treatment, etc.) reduce the contaminants in the impacted soils or groundwater at the site. Alternatives 3, 4, 5, and 6 primarily address the impacted soils at the site. Alternatives 7, 8, and 9 target groundwater contamination and would be used in conjunction with one of the soil alternatives (Alternatives 3, 4, 5, and 6).

With respect to groundwater transport, Alternatives 1 and 2 are identical. Contaminants in the soils and/or trenches are expected to continue to cause groundwater impacts into the future. Contaminants within the groundwater are expected to continue to migrate from their currently observed locations. The potential for contaminants to migrate through the soil and impact groundwater is assessed with SESOIL, using current contaminant distributions in the soil. Where appropriate, groundwater transport modeling (using MT3DMS) incorporates SESOIL results and observed groundwater contamination to predict future conditions.

Alternatives 3, 4, 5, and 6 act to reduce or eliminate current and future groundwater impacts from the impacted soils at the site. Constituent concentrations above background will be left behind and could have the potential to leach to groundwater in the future. This is assessed using SESOIL. Alternatives 3, 4, 5, and 6 do not actively address the currently observed groundwater contamination. Potential impacts to the groundwater after implementation of one of these alternatives is included in modeling completed for Alternatives 7 and 8.

Alternative 7 consists of monitored natural attenuation coupled with one of the soils (Alternatives 3, 4, 5, or 6) alternatives. Groundwater under this alternative would be remediated by the natural processes of dispersion, diffusion, and sorption. Chemical reactions also may play a role in the reduction of contaminant concentrations and mobility. Alternatives 8 and 9 are both active groundwater treatment remedies. Alternative 8 consists of active groundwater treatment through traditional pump and treat methods to remediate the observed groundwater contamination at the site. Alternative 9 consists of electrokinetics to remediate groundwater, primarily within the tighter silty to clayey soils that occur above the carbonate bedrock aquifer. Modeling the effects of electrokinetics in the clay-rich tills was not completed, estimated remediation periods for eletrokinetics were based upon vendor experience for the clay-rich tills and results from the MNA evaluation for groundwater in the carbonate bedrock.

6A.1.2 Site Description and Current Distribution of Constituents

An understanding of the historical operations, along with current site conditions, forms the basis for predictive modeling. The Luckey site is comprised of a large production building and warehouse, two abandoned railroad spurs, and several smaller process and ancillary buildings. The area surrounding the site to the west, north, and east is primarily residential farmland. An abandoned railroad bed runs along the eastern boundary. A former quarry (France Stone Quarry) and municipal dump (Troy Township Landfill) border the site to the south and southeast, respectively. Site features are depicted in Figure 6A.1. Four disposal trenches (trenches 1 through 4) are located in the northeast corner of the site. This area also is referred to as the disposal area. Two trenches (5 and 6) occur west of trenches 1 through 4. Trench 7 is located south of trenches 1 through 4. Three lagoons occur in the southeastern portion of the property. The former ore staging and spoils areas were located south and west of the filter beds. There also is a former scrap steel storage area located alongside the railroad spur north of the maintenance and bulk storage buildings. In the western portion of the site is a cistern filled with crushed brick (reportedly from the main stack). Several areas devoid of vegetation also are identified on Figure 6A.1. A discussion of historical operations, including past waste disposal activities, is included in Section 2.3.

Soil and groundwater samples were collected during the RI (USACE 2000) to determine the nature and extent of AEC-related constituents and to identify constituents of concern. For soils, the constituents of concern include beryllium, lead, radium-226, thorium-230, uranium-234, and uranium-238. For groundwater, beryllium, lead, and uranium were detected above their respective cleanup goals. The analytical results define the nature and extent of contaminants exceeding their respective cleanup goals, and serve as input for source term definition in the fate and transport modeling process. The volume of soils contaminated with AEC-related constituents above their respective cleanup goals is presented in Appendix 3B. Appendix 3B also includes figures depicting the distribution of AEC-related constituents of concern with depth based upon the RI (USACE 2000) sampling efforts.

Elevated beryllium, lead, and uranium values have occurred in a number of monitoring wells, but do not define a "plume" of groundwater contamination. Contaminants were typically detected in the groundwater encountered immediately above bedrock or in the shallow bedrock (with the exception of the West Production Well). Beryllium, lead and uranium were detected above cleanup goals in the groundwater beneath the site. Beryllium was consistently detected above cleanup goals in wells MW-01(I), MW-02(S), and the West Production Well. Recent sampling, from June and November 2001, also detected elevated concentrations in MW-26(S), which had formerly been dry. Water levels in June 2001 also were at their highest recorded levels. Beryllium concentrations recorded in two shallow wells (MW-02(S) at 70.8 μg/L and MW-26(S) at 137 μg/L) during June 2001 were the highest recorded to date. Both water levels and beryllium concentrations dropped significantly in these shallow wells by November 2001 (MW-02(S) at 35.1 μg/L and MW-26(S) at 38.6 μg/L). Beryllium also was detected slightly above cleanup goals in MW-19(I). Lead was consistently detected above cleanup goals in MW-21(I), with a maximum detected value of 47 μg/L. Lead concentrations in MW-21(I) exhibited a decreasing trend in both filtered and unfiltered samples. Only one other well, MW-24(S), had a filtered result of 15.9 μg/L, above the 15 μg/L cleanup goal. The remaining lead detections above cleanup goals were from unfiltered samples whose filtered counterparts were all below the cleanup goal for lead. Uranium was consistently detected above cleanup goals in MW-24(S), with a maximum detected value of 390 μg/L (converted from U-238 pCi/L result). No other detections above the uranium cleanup goal were reported. The wells in which the cleanup goal or MCL is exceeded for beryllium, lead, and uranium are shown Figure 6A.2.

Contamination in the groundwater at Luckey is spotty and not readily traced back to any single source. This observation suggests continuous leaching from impacted soils, which would result in a continuous plume in the groundwater, is not the source of the observed contamination. Rather, the observed distribution suggests the release of a slug or pulse of contamination from original disposal activities or potentially periodic pulses from ongoing interactions with the groundwater. Potential sources of constituents in groundwater are a particular concern, since the remediation of the site will have to consider the alternatives in light of their ability to correct potential groundwater contamination. Potential sources for beryllium, lead, and uranium in the groundwater are described below.

Potential sources of beryllium in groundwater include:

- Elevated soil concentrations of beryllium occur in 4 areas of the site. The disposal area and adjoining area to the west, [Investigative Area (IA) 01 and IA05] the lagoons (IA02), and the bare spot north of MW-21(I) (IA07) show significantly elevated concentrations of beryllium.
- Elevated beryllium concentrations in groundwater occur in 6 wells onsite, MW-01(I), MW-02(S), MW-13(S), MW-19(I), MW-26(S) and the West Production Well. Concentrations in MW-01(I), MW-2(S), MW-26(S) and the West Production Well commonly exceed the maximum containment level (MCL) of 4 ug/l.
- MW-01(I) & MW-02(S) are northeast of the bare spot in IA07 and just west of a trench 5 IA05. These could both be sources of the beryllium in groundwater. Groundwater would have to flow northeast from the bare spot or north from trench 6 in the southern portion of IA 5 for MW-01(I) and MW-02(S) to be impacted. Beryllium would have to flow northwest, beneath the filter beds, to get from the highest soil concentrations (just east of trench 6) in IA05 to MW-01(I) and MW-02(S).
- MW-13(S) and MW-19(I) are installed at the north end of IA01. Groundwater flowing north from any of the trenches in IA01 could have impacted these wells. Concentrations of beryllium in these wells range from below detection limits to just over 4 ug/L. Soil concentrations of beryllium [up to 335 parts per million (ppm) and 6-7 feet deep] are present in the immediate vicinity.
- MW-26(S) had elevated concentrations of beryllium in the last two sampling events. Filtered results indicated concentrations of 137 ug/L in J une 2001 and 38.6 ug/L in November 2001. The samples represent the only samples collected from MW-26(S). Previous sampling efforts were unable to obtain samples because the well was dry. MW-26(S) is located immediately north of trench 5 in IA05 and just west of a trench 4 in IA01. The rise in water levels in J une 2001 may have encountered beryllium in or immediately beneath the trenches, resulting in the observed beryllium concentrations at MW-26(S).
- The West Production Well is on the western portion of the site well away from the disposal areas or process lagoons. A fracture just below the casing in the West Production Well may be allowing shallow overburden groundwater to impact the well. Sampling results indicate previous discharges from Lagoon A contaminated sediments and surface water in the Luckey Road ditch, just west of the production well.

Potential sources of lead in groundwater include the following:

- Lead is present in high soil concentrations in 4 areas of the site. In IA01, trenches 2 and 4 show high concentrations [> 1000 parts per million (ppm)] of lead, as well as the bare spot north of MW-21(I) in IA07. Also, the southeastern portion (east of trench 6) of IA05 has two high lead measurements.
- MW-21(I) shows elevated lead concentrations also could have come from the bare spot in IA07. However, groundwater flow would need to be to the south. Alternatively, the proximity of unpaved roadways near MW-21(I) could allow lead added to gasoline (until the 70's) to accumulate and leach to the well. There is some support for this in that lead concentrations along the edge of the parking area and the old rail spur are elevated. One alternative is that lead from the high concentrations in southeastern IA05 may have migrated west to impact MW-21(I) or that high concentrations exist in trench 6 (which is covered with concrete rubble) in southern IA05 and have migrated west to the well.

- Lead concentrations are elevated just slightly above cleanup goals in MW-24(S). MW-24(S) is between the annex and Lagoon B. At least a portion of Lagoon B was 5-6 feet deep during its operation. MW-24(S) is located in an area where pipes leading to the lagoons were present and where currently a boggy area with frequent standing water exists. Lead concentrations are not elevated in the lagoon areas to the south.

Uranium is consistently detected above cleanup goals in MW-24(S). One occurrence above cleanup goals also was detected at MW-21(I). Listed below are some potential reasons why it is elevated at only those wells.

- Soluble (mobile) uranium may have been present in the past, but has now been converted in the area of MW-24(S) to a less soluble form. It is known from historical records that uranium contaminated beryllium scrap was returned to Luckey for reprocessing. The process used was very conducive to removing impurities, and the uranium thus removed would have been discharged to the lagoons. As noted above, a portion of Lagoon B was 5-6 feet deep during its operation.
- MW-24(S) is located in an area where potentially leaking pipes leading to the lagoons were present and where currently a boggy area with frequent standing water exists. This may have caused unusual conditions regarding the migration of uranium.

To further evaluate potential sources, three cross sections were constructed at the location illustrated on Figure 6A.1. Two west-east sections, A-A' and B-B' were constructed through the trenches and are illustrated in Figures 6A.3 and 6A.4. Water levels from J une 2001 are included on the figures to illustrate its proximity to the base of the trenches. The base of the trenches, as illustrated in the figures, is derived from the RI (USACE 2000) data. Reported depths for the trenches were generally several feet deeper based upon interviews of past activities at the facility. Therefore, it is possible that the trenches or portions of the trenches extend to depths beyond those indicated in Figures 6A.3 and 6A.4. Figure 6A.3 shows both trenches 2 and 4 intersect sand and gravel near their bases. The base of trench 4 also is nearly in contact with the J une 2001 water level, while both trenches 2 and 5 are several feet above the water table. With respect to trench 2 it is important to note the cross section intersects the north end of the trench where it is relatively shallow. The depth shown for trench 5 is based upon RI (USACE 2000) sampling efforts. Trench 5 was reported to be 14-18 feet deep, where as sample borings bottomed out in what appeared to be native materials at depths of 6-8 feet. Figure 6A.4 illustrates the depth of the southern end of trench 2 and intersects the location of trench 3 and trench 6 to the west. Trench 6 is not depicted on the section, as sampling efforts in the area of the reported trench were limited in part because of the rubble piles on the surface. J ust east of trench 6, some of the highest concentrations of beryllium and lead were detected in the subsurface.

Figures 6A.3 and 6A.4 suggest interactions between groundwater and the base of the trenches (or immediately beneath the trenches) may periodically occur. The intersection of sand lenses with the trenches also may permit the migration of contaminants to the underlying water table. Monitoring results from the wells installed around trenches 1 through 4 suggest these trenches are not contributing the elevated concentrations of beryllium observed at MW-26(S), MW-01(I), and MW-02(S). Rather, the uncertainty associated with the base of trench 5, its proximity to these three wells, soil sampling results, and its reported construction suggest this is the most likely source of the elevated concentrations.

Figure 6A.5 illustrates a south-north cross section through Lagoon B and MW-24(S). The approximate base of the former Lagoon is included on the figure and is in close proximity to the J une 2001 water table surface. The soil boring information in the area does not indicate the presence of shallow sands and gravels near the base of Lagoon B, but the data are somewhat limited. Figure 6A.5

indicates the materials beneath the lagoon consist primarily of silts and sitly clays, both of which comprise the clay-rich till at the site.

6A.2 ASSESSMENT OF LEACHING POTENTIAL

The potential for AEC-related constituents to migrate from impacted soils to groundwater was evaluated by investigative area in several stages. An initial screening, detailed below, was performed to identify constituents with potential to impact groundwater. Any constituents determined to have potential to cause groundwater impacts were further evaluated using SESOIL. SESOIL results are discussed in Section 6A.4.

All of the soil data from the site was screened for its potential to leach to groundwater. The following presents the methodology used to determine a preliminary list of AEC-related constituents that could present future groundwater concerns and are subsequently evaluated in SESOIL.

Screening methodology:

1. Screen against background
   a. Onsite soil data were screened against the 95% upper tolerance limit (UTL) of background. A record of the number of times a constituent exceeded background was kept for use in the weight of evidence screening.
   b. Constituents for which the 95% upper confidence limit (UCL) is greater than background for each IA are passed to the next step.
2. Screen against dilution attenuation factor (DAF20) as presented in Region 9 preliminary remediation goal (PRG) table (http://www.epa.gov/Region9/waste/sfund/prg/index.htm).
   a. Constituents in each IA that exceed the DAF20 as presented in the Region 9 United States Environmental Protection Agency (EPA) PRG table are passed to the next step. The DAF20 presented by Region 9 is a value in soil considered to be protective of groundwater from a risk perspective for a Dilution Attenuation Factor of 20. Considering leaching from impacted soils to groundwater a factor of 20x the maximum concentration for a 10-6 risk in groundwater is considered protective. Therefore those constituents not above the DAF20 are removed from further consideration.
3. Screen for frequency of detection
   a. If a constituent was detected in less than 5% of the analyses for an IA it was eliminated from further consideration.
4. Weight of evidence.
   a. <u>Data Indistinguishable from background</u>. Data that only slightly exceeds background for less than 5% of the data are removed as being sufficiently like background (above the 95% but not above the 99.99% point of the background distribution) (Ra-228, Th-228)
   b. <u>Mobility</u>: Constituents that have not migrated below 2 feet in the 40 years since operations ceased are removed as being immobile at the site.
   c. <u>Short half lives</u>: Constituents that are radionuclides with short half-lives are removed since they would have decayed away in the 40 years since operations ceased (Ac-228, Th-227 & Th-234).
   d. <u>Solubility</u>: Constituents that are naturally very soluble, or have a short residence time in soil, are removed (ammonia).
   e. Constituents that form insoluble compounds with common elements in the Luckey bedrock are removed (fluoride).

Further details on the weight of evidence screening are contained below.

a. Data Indistinguishable from background. (Ra-228 and Th-228): The use of a 95% UTL as a screening value allows for 5% of a distribution to exceed the value and still be considered within the range of the background distribution. This means constituents which only slightly exceed the background, less than 5% of the time, can be considered as still being equivalent to background. Constituents removed from consideration include Ra-228 and Th-228.
b. Mobility. The purpose of the screening is to determine which constituents are likely to present a problem by migrating to groundwater. Since any constituent that has not migrated below the 2 foot level has already shown minimal tendency to move, it was removed from consideration as a constituent of potential concern (COPC).
c. Short half lives (Actinium-228, Thorium-227 and Thorium-234). These are all isotopes with short half lives (6.18 hrs, 18.7 days, 24 days). Any original amounts would have decayed to background long ago. Only those amounts resulting from in-growth would be present and when using appropriate cancer slope factors, is part of the risk calculations for the entire chain.
d. Uranium-233/234 and Uranium-235/236. Uranium-233 and uranium-236 are not present at the site but should be included with their close partner's, uranium-234 and uranium-235, respectively.
e. Solubility.
    a. Ammonia. Ammonia is very soluble in water. The lifetime of ammonia in soils is relatively short, on the order of a few days (ATSDR 1990). No original ammonia (or ammonium) would be expected to remain in the soils after 40 years.
    b. Fluoride. Fluoride is a natural component of soils and is present in varying amounts in natural waters. Calcium fluoride is almost insoluble and the formation of the compound is an effective way of reducing the concentration of fluoride in groundwater (Fetter 1993). This indicates that, in the current situation, with groundwater in a dolomite bedrock, an excess of fluoride in groundwater is unlikely to last any length of time.

       Further, according to Army TM 5-813-3, Water Supply, Water Treatment (page 2-17), fluoride concentrations of 0.7 to 1.2 mg/L are considered beneficial for children's teeth. (Department s of the Army and the Air Force) A brief perusal of fluoride concentrations listed in FS Appendix 2A show very few concentrations greater than the maximum value of 1.2 mg/L in the above range. In fact, most concentrations are at or less than 1 mg/L. This TM is available at:

       http://www.usace.army.mil/inet/usace-docs/armytm/tm5-813-3/entire.pdf.

       From a geologic and geochemical perspective there are several considerations. Both dolomite and limestone have been used to reduce fluoride in groundwater. In addition, there is very little interstitial space to work with in the dolomite at the Luckey site (as compared to sandstone for instance). Groundwater is typically withdrawn from secondary porosity features (e.g., fractures). These fractures provide more than ample space for fluoride to precipitate out of solution, particularly in the upper five to ten feet of the formation. The primary geochemical consideration is that the solubility product of fluorite ($10^{-10.4}$) is less than that of calcite ($10^{-8.35}$). Also, the concentration of calcium in groundwater at the site ranges from 20 to 200 mg/L; alkalinity (which generally includes available carbonate and bicarbonate) is about the same concentration as calcium; and fluoride concentrations are two to three orders of magnitude less than the concentration of calcium. This means there is ample calcium available to take up the fluoride and precipitate as fluorite, and that fluorite would precipitate before calcite based on the solubility product. The free energy of formation for fluorite and calcite indicates these reactions would take place spontaneously without the addition of energy to the system. In addition, the solubility product constant of fluorite ($10^{-10.4}$) is less than that of the sulfates gypsum ($10^{-4.6}$) and anhydrite ($10^{-4.5}$). Therefore, fluorite also will precipitate out of solution before gypsum and anhydrite.

Upon completion of the screening, the AEC-related constituents that have the potential to leach to groundwater and exceed regulatory limits were reduced to three metals (beryllium, lead, and barium) and four radionuclides (radium-226, thorium-230, uranium-234, and uranium-238). Table 6A.1 presents the results of this initial screening by investigation area.

6A.3 MODELS AND ASSUMPTIONS

As noted in the introduction to this appendix, a number of different models were used to evaluate the potential impact to groundwater from contaminants in the soil and to predict the fate of these contaminants within the groundwater. The results of these analyses are used to support the evaluation of remedial alternatives in Section 6 of this FS report.

6A.3.1 Models

Brief descriptions of the models employed for the groundwater evaluation are summarized below. All codes used as part of this effort are widely used, validated, and peer reviewed.

- The calibrated groundwater flow model developed for the Luckey site forms the basis for predictions of contaminant transport within the groundwater. Model development and calibration are discussed in detail in "*Luckey Site, Luckey, Ohio, Final Groundwater Model Report"* prepared for U.S. Army Corps of Engineers, Buffalo District, by SAIC, February 2001. The model was developed using the U.S. Geological Survey (USGS) MODFLOW code. Complete documentation of the MODFLOW code is presented in "*A Modular Three-Dimensional Finite-Difference Ground-Water Flow Model,"* Techniques of Water-Resources Investigations 06-A1, U.S. Geological Survey Open-File Report 83-875, by M.G. McDonald and A. W. Harbaugh, 1988. The groundwater flow model also provides predicted flow fields in response to changes in stresses to the flow field, such as extraction of contaminated groundwater or discontinued use of the facility's on-site production well.
- SESOIL, a *Seasonal Soil Compartment Model*, represents the computer code or model used to simulate transport of constituents through the soil to the groundwater. Documentation of SESOIL is presented in "*SESOIL Reference Guide and User's Guide,"* RISKPRO® SESOIL for Windows, Version 3.0, May 1998 developed by General Sciences Corporation.
- PHREEQC (Version 2) –The USGS' Computer Program for Speciation, Batch-Reaction, One-Dimensional Transport, and Inverse Geochemical Calculations, was used to model the geochemistry of the site for the purpose of modeling the solubility and ion exchange behavior. Parkhurst, D.L. and C.A.J . Appelo,*User's Guide to PHREEQC (Version 2) – A Computer Program for Speciation, Batch-Reaction, One-Dimensional Transport, and Inverse Geochemical Calculations*, Water-Resources Investigations Report 99-4259, U.S. Geological Survey, Denver, CO, 1999
- MT3DMS represents the computer code or model used to simulate contaminant transport within the groundwater flow field. Complete documentation of the model is presented in "*MT3DMS: A Modular Three-Dimensional Multispecies Transport Model for Simulation of Advection, Dispersion, and Chemical Reactions of Contaminants in Groundwater Systems;*

Documentation and User's Guide," Contract Report SERDP-99-1, U.S. Army Engineer Research and Development Center, Vicksburg, MS, prepared by Chunmiao Zheng and P. Patrick Wang, University of Alabama, December 1999.

6A.3.2 Assumptions

As with any modeling effort, there are a number of assumptions made to simplify the groundwater flow system and transport processes so both can be represented numerically. Because the groundwater flow model previously developed for the Luckey site forms the basis for fate and transport analysis, the assumptions and limitations associated with the construction of the model are included below:

- The Lockport Dolomite can be modeled as an equivalent porous medium, which is an oversimplification due to the known presence of secondary porosity features (dissolution along fractures, joints, bedding planes).
- Pumping from the Uretech East Production Well produces a steady-state effect on monitoring wells at the site and does not create transient (or time varying) effects on the water levels. Transient effects may be caused by changes in production well pumping rates.
- Localized variations in flow directions observed in measured data may not be reproduced by the model.
- The bedrock potentiometric surface developed from the residential well survey is representative of steady-state flow conditions in the Lockport Dolomite and can therefore be used to assign model boundary conditions.
- Hydraulic parameters measured on site are assumed representative of the respective units, and these parameters can be used in offsite areas.
- Unsaturated flow from the vadose zone to the water table is not incorporated in the simulations performed as part of this study.
- The long term, historical pumping rates for the Uretech production wells have not been accurately quantified.
- The quarry serves as a source of recharge to the groundwater flow system at the Luckey site.
- Higher recharge rates occur in areas where the overlying till is thin (< 20 ft thick) or absent.
- Site characterization data are representative of all pertinent and important site features associated with the groundwater flow system.
- Uncertainties in the existing geologic and hydrogeologic data for the model area also create limitations in the numerical model. These uncertainties include the hydraulic conductivity distribution in each of the model layers and heterogeneities within the geologic units (e.g. extent, thickness, water levels).

The following is a list of additional assumptions associated with the transport modeling efforts completed in for this FS:

- Soil and groundwater analytical results provide the current distribution of constituents in both the soil and groundwater at the site.
- The calibrated, steady-state groundwater flow fields developed for pumping and non-pumping conditions will be used—assumes the average flow conditions will remain unchanged over the entire simulation period.
- Only AEC-related constituents of concern (COCs) will be evaluated.
- The effects of consolidation/capping and excavation (Alternatives 3, 4, 5, and 6) will result in similar reduction or elimination of mass flux of COCs to the groundwater.

- Results from groundwater monitoring events provide an accurate representation of the nature and extent of existing groundwater contamination and can be used to define source term concentrations that currently exist in the groundwater.
- Observed concentrations within the groundwater that are below cleanup goals will remain below cleanup goals at down gradient receptor/observation locations, and therefore, do not require predictive modeling.
- Filtered sample results for AEC-related constituents are representative of their respective concentrations in groundwater.
- Site-specific determinations of partition coefficients have not been determined. Representative values from the literature are appropriate for use in predictive transport simulations.
- Seasonal fluctuations in groundwater and contaminant concentrations are not accounted for in the transport modeling.
- Data gaps associated with past facility operations, including waste disposal activities, on site production well withdrawal rates, and dewatering activities associated with the former France Stone Quarry preclude development of a defensible, quantitative re-creation of observed contaminant distributions in the groundwater.

6A.3.3 Modeling Approach

The modeling approach in support of the alternative evaluation varies depending upon the alternative. The process consists of two basic steps, modeling contaminant migration through the soils followed by modeling contaminant migration through the groundwater. Geochemical modeling was completed in support of the groundwater transport simulations. Within each step, both quantitative and qualitative calibration of the models is performed by evaluating model predictions against observed conditions. Details associated with each step of the process are included in the respective sections describing the simulations. Several alternatives can be grouped with respect to their impact on contaminant migration to and within groundwater.

Modeling efforts in support of Alternative 1-No Action and Alternative 2-Limited Action are the same. Neither alternative actively treats contamination observed in the soil or groundwater. Modeling for both alternatives evaluates the migration of soil and groundwater COCs where no remedial measures are taken. Mass flux of contaminants to groundwater along with the existing distribution is modeled forward through time to evaluate potential groundwater impacts associated with these alternatives.

Alternatives 3, 4, 5, and 6 are expected to have a similar impact on the potential leaching of constituents to the groundwater. In each case, the mass flux to the groundwater will be reduced and, for modeling purposes, has been assumed to be negligible—meaning any additional flux to groundwater will not result in groundwater concentrations above cleanup goals. Therefore, modeling performed for these three alternatives consists of predicting future distributions of the existing contaminants in groundwater.

Modeling in support of Alternative 7 evaluates the ability of monitored natural attenuation as an effective remedial measure. Alternative 7 is used in conjunction with one of the soil alternatives, which have the effect of reducing or eliminating any additional contamination to the groundwater from impacted soils.

Active treatment of groundwater via pump and treat methods is evaluated in Alternative 8. Again, this alternative is used in conjunction with one of the soil alternatives, which have the effect of reducing or eliminating any additional contamination to the groundwater from impacted soils.

Alternative 9 consists of electrokinetics. Simulations of contaminant transport in groundwater were not completed for the evaluation of Alternative 9.

6A.4 SESOIL MODELING RESULTS

The potential for migration of AEC-related constituents from the impacted soils to groundwater was evaluated using SESOIL. SESOIL is a one-dimensional vertical transport model that uses meteorological data and soil parameters to develop a water budget, including the volume of water migrating through the soil. Contaminant and soil properties are included to permit calculation of contaminant mass flux through the soil column to the upper most water-bearing zone. Contaminant transport in the unsaturated zone is simulated by using equations of mass balance and equilibrium partitioning of the chemical between four different phases (dissolved, sorbed, vapor, and pure). The water balance for simulations was calibrated to 2 inches per year of groundwater recharge. A sensitivity analysis also was completed to evaluate uncertainty in model input parameters.

Two basic sets of simulations were done in support of the eight alternatives. One set of simulations was completed to evaluate the impacts as if no soil remediation were completed. These simulations used data from the most impacted investigative area (the highest 95% UCL from an investigative area) to define the initial concentration for the evaluation. The results from these simulations were used in the evaluation of Alternatives 1 and 2.

Another set of simulations were completed to evaluate the cleanup goals for AEC-related constituents in the soils at Luckey. Each of these simulations used an initial concentration equal to the soil cleanup goal. The results from these simulations are used to demonstrate cleanup goals are protective of groundwater and are in support of Alternatives 3, 4, 5, and 6 (can be thought of as soils alternatives). By demonstrating cleanup goals are protective, results from this set of simulations can also be used to support the assumption of no additional contaminant flux to the groundwater in simulations completed for Alternatives 7 and 8.

Simulations were developed to help predict the future migration of barium, beryllium, lead, actinium, radium, thorium, and uranium through the soil at the Luckey Formerly Utilized Sites Remedial Action Program (FUSRAP) site. Arsenic and protactinium also were considered, but not simulated with SESOIL. Descriptions of the general model development and contaminant specific parameters are described below. These descriptions include reasoning for not including arsenic and protactinium in the simulations.

6A.4.1 General SESOIL Set-Up

Parameters used in the simulations for all contaminants are presented in Table 6A.2. Table 6A.2 was developed to ensure consistent use of parameters across the different model applications. Table 6A.2 also was presented to Ohio Environmental Protection Agency (Ohio EPA) for their review and incorporates their input with respect to distribution coefficients. In addition to those parameters, all the simulations were set up with 2 model layers. Individual layers can be used in SESOIL models to help control the initial distribution of contaminants within the soil column. The upper layer in all runs, other than a few uranium simulations, is 168 cm thick (about 5.5 ft) and the lower layer for all runs is 61 cm (2 ft) thick. The soil column in SESOIL is limited to one set of properties. Since the unsaturated zone at the Luckey site is dominated by clay till, the limitation of using one hydrogeologic zone does not greatly impact the ability to apply SESOIL to contaminant simulations in this area. In addition, most of the sand and gravel seams identified by borings on the site lie below the water table.

Initial concentrations were assumed to be one foot above the water table in all the SESOIL runs (the top foot of layer 2 had contamination in it, the bottom half initially had clean soil). A number of simulations were completed with initial contamination at varying heights above the water table to correspond with observed soil sampling results. However, results from these simulations indicated very little movement through the clay-rich tills at the site. Since some wells on-site have measurements of constituents that exceed acceptable concentrations, contaminants have obviously migrated into the groundwater within the past 50 years, or were placed in direct contact with the groundwater at some point during the facility's operation. To evaluate which case was most likely, contamination was placed within a foot of the water table. If observed groundwater concentrations can not be reproduced by simulating transport through one foot of clean clay-rich till, then leaching of constituents through the till is not responsible for the observed groundwater contamination. In this case, direct contact between groundwater and contaminated soils represents the most viable mechanism for contamination of groundwater.

Table 6A.3 summarizes values used for initial soil concentrations for each constituent. For some constituents, two initial concentrations are shown and reflect simulations completed for the most impacted investigative area or for the evaluation of soil cleanup goals. Not all AEC-related constituents have cleanup goals. Only those identified as COCs have cleanup goals. The maximum 95% UCL calculated for each investigative area at the site was used to evaluate AEC-related constituents that do not have cleanup goals. All constituents with a cleanup goal for the Luckey site were simulated with initial concentrations of both the cleanup goal and of their 95% UCL value.

Concentrations in groundwater were calculated within SESOIL using Summers Model. Parameters for Summers Model are presented in Table 6A.4. The parameters were defined to represent the upper 10 feet of bedrock at the site. The contaminated area was assumed to be 4,000 m^2 (43,000 ft^2) in most runs. This is roughly the area covered by Lagoon B and also is about the total area of the trenches in IA01. Lagoon B and the trenches in IA01 contain some of the most widespread potentially contaminated soil near the water table. The length of contaminated soil perpendicular to groundwater flow for most runs is equal to the square root of 4,000 m^2 (63.25 m), since both IA01 and Lagoon B are approximately as wide as they are long. A 10 ft mixing zone depth in the saturated zone was assumed for calculation of the concentration of each constituent in groundwater immediately above and within the few feet of the bedrock aquifer. This depth of mixing was used because it is similar to the thickness of observed groundwater contamination. A hydraulic gradient of 0.02 ft/ft was used in the Summers Model calculations based on Table 5.3 of the RI (USACE 2000) Report. The final Summers Model parameter is the hydraulic conductivity of the saturated zone. This value was set to 167 m/yr (1.5 ft/d) in all simulations. This conductivity lies between the values used in the groundwater flow model for the hydraulic conductivity of silty clay (0.05 ft/d) and sand and gravel (20 ft/d). It also is equal to the conductivity used for layer 5 (upper mid-section of the bedrock) in the groundwater flow model. Results for each AEC-related constituent are summarized below.

Beryllium

Two individual simulations were run for beryllium. The first simulation placed beryllium in the soil at a concentration equal to its cleanup goal for the site (131 μg/g). The solubility of $BeSO_4$ was used in both simulations (425,000 mg/L). Due to beryllium's high Kd value (8,000 ml/g), the model was set up to simulate beryllium's migration over a 1,000 year period. After the 1,000 year simulation time, the beryllium still had not reached the water table.

The second beryllium simulation increased the initial concentration to the maximum 95% UCL concentration found in any of the investigative areas on-site (757 μg/g). All other parameters were identical to those used in the first beryllium simulation described above. The results in this simulation also were the same. After a 1,000 year simulation period, beryllium failed to migrate through 1 ft of soil into the groundwater.

Lead

Two individual models also were used to simulate the migration of lead through the unsaturated zone at Luckey. The first simulation used the cleanup goal of lead in the soil as the initial concentration (400 μg/g). Lead's solubility was set to 17 mg/L (the solubility of PbO). Since lead's Kd value also is very large (1,830 ml/g), a 1,000 year simulation was used. After 1,000 years of simulated migration, the lead still had not migrated through the 1 ft of clean soil to reach the groundwater.

In the second simulation, the highest 95% UTL value for lead found in any of the investigative areas on-site was used (228 μg/g). With all other parameters held constant from the previous lead simulation, the lead failed to reach the groundwater after 1,000 years of simulated migration.

Uranium

Uranium also was simulated with two different initial concentrations. The first concentration represented the cleanup goal of 28.63 pCi/g. SESOIL requires input concentrations to be relative to mass, not activity. In order to convert pCi/g to μg/g (mg/kg), the equations shown in the footnote of Table 6A.3 were used. Solving these equations yielded a concentration for uranium of 85.03 μg/g. With a solubility of 500 mg/L and a Kd value of 500 ml/g, a SESOIL simulation was run for 1,000 years. Uranium did not migrate far enough to reach the groundwater throughout the 1,000 year simulation.

For the second uranium simulation, all parameters were held constant from the first simulation, except for the initial concentration of uranium in soil. In this run, the concentration was changed to 6.27 pCi/g, which is the maximum 95% UCL value from any of the investigative areas for all measured isotopes of uranium. Using the equations shown with Table 6A.3, 6.27 pCi/g is equivalent to 18.63 μg/g. With all other parameters remaining unchanged, this scenario with a lower concentration of uranium also did not reach the groundwater over the 1,000 year simulation.

Two additional simulations were completed to evaluate a lower Kd on predicted transport of uranium through the unsaturated zone. Both of the SESOIL simulations noted above were run with a Kd value of 250 ml/g while maintaining all of the other input parameters at their respective values. For both cases, uranium did not reach groundwater within the 1000 year simulation period.

Radium

The migration of radium was simulated with two different input concentrations. The first concentration represented the soil cleanup goal of 5.01 pCi/g. Using the equations listed with Table 6A.3, this is equivalent to 5.07×10^{-06} μg/g. Using a solubility of 36 mg/L and a Kd value of 450 ml/g, the radium did not reach the groundwater table in a 1,000 year simulation. The same results were obtained when the initial concentration was increased to 14.5 pCi/g (1.47×10^{-5} μg/g) to reflect the maximum 95% UCL measured in any of the investigative areas on site.

Thorium

Thorium was simulated with two different initial concentrations. The first input concentration was set to 9 pCi/g. This concentration is the soil cleanup goal for thorium at the site. Using the equations shown with Table 6A.3, 9 pCi/g corresponds to 82.37 μg/g of thorium. Using a solubility for thorium of

650 mg/l and a Kd value of 50,000 ml/g, the thorium does not reach the groundwater table throughout a 1,000 year simulation. Using the maximum 95% UCL value measured in any of the investigative areas on site actually reduces the initial soil concentration to 4.91 pCi/g (44.94 μg/g). All other parameters were identical to those in the previous run, and thorium does not reach the groundwater during a 1,000 year simulation, either.

Barium

Barium does not have an established soil cleanup goal for the site, so only one simulation was run for this constituent. An initial concentration of barium in the soil was set at 238 μg/g. This concentration is equal to the maximum 95% UCL measured in any of the investigative areas on site. Using a solubility of 3,000 mg/L and a Kd of 16,000 ml/g, the barium does not reach the groundwater table in a 1,000 year simulation.

Actinium

For actinium, the maximum 95% UCL value of 1.14 pCi/g was used as an initial soil concentration in layer 2 of the model. This activity corresponds to 1.56×10^{-08} μg/g for actinium according to the equations listed at the end of Table 6A.3. With a Kd of 1,500 ml/g and a solubility of 10,000 mg/L, actinium does not reach the groundwater table in a 1,000 year simulation.

Protactinium

Protactinium has very similar characteristics at the site as actinium. It is not very wide-spread throughout the site, and it has a very similar Kd (1,800 ml/g versus actinium's 1,500 ml/g). Since actinium did not reach the groundwater in a 1,000 year simulation, there is no reason to believe protactinium will, especially since it has a slightly larger distribution coefficient. For this reason, protactinium's migration through the soil was not simulated using SESOIL.

Arsenic

Arsenic's maximum 95% UCL in any investigative area on-site is 14.4 μg/g. The background value for arsenic in the region's soil is 24.1 μg/g. Since the maximum 95% UCL found in any investigative area on-site is well below background, there were not any SESOIL simulations designed for this constituent.

6A.4.2 Beryllium and Uranium Sensitivity Analysis

In addition to the simulations completed above, a number of SESOIL runs were completed for beryllium using a range of input parameters. The simulations were completed to evaluate the sensitivity of input parameters to predicted groundwater concentrations. These simulations were an attempt to evaluate parameter sensitivity and to determine what parameters combinations produce results consistent with the observed groundwater concentrations. Input parameters for SESOIL, such as infiltration rate and Kd, were varied over orders of magnitude as shown in Table 6A.5. Input values include solubility, disconnectedness index, and run time, as well as thickness of the layers of soil in the subsurface. Table 6A.5 shows the results of the runs using the input.

As can be seen, the concentrations for those runs where beryllium reaches the groundwater vary from more than 2000 ug/L to below detection. The maximum concentration in the groundwater is generally reached near the time of breakthrough and declines thereafter. High concentrations are associated with unrealistically low Kd values (0.79 and 7.9 ml/g). A Kd value of 10 ml/g could be representative of relatively clean sands and gravels at the site. A Kd value of 790 ml/g could be representative of sand and gravel intermixed with silt and clay. Using these values, beryllium reaches the groundwater in a reasonable time, but below observed concentrations. This suggests beryllium migration through sand and gravel to the water table is a possible mechanism for at least a portion of the observed groundwater contamination.

The model shows fairly little sensitivity to the recharge rate through the pairs of runs 1 and 2, 3 and 4, 5 and 6, and 7 and 8 with respect to beryllium transport. The effective porosity value shows slightly more impact on migration of the contaminant in runs 6 and 19. The Kd is the most sensitive parameter, which is apparent in the difference in migration times and groundwater concentrations in runs 1 through 8, where the Kd value is being changed. The runs did not produce the concentrations found on the site currently using reasonable inputs. Runs 3 and 4 produce roughly the correct concentrations [~ 34 parts per billion (ppb)]. However, the inputs for those runs include Kds that are 2 orders of magnitude lower than representative values. A comparison of SESOIL models and groundwater data indicates normal infiltration and leaching through the soils does not account for the observed beryllium concentrations.

For uranium, several SESOIL simulations were completed to evaluate parameter sensitivity and to determine possible parameter combinations would permit uranium migration through the clay-rich tills. Tables 6A.6 and 6A.7 list the input parameters used in 18 different simulations. As with beryllium, the Kd value seemed to have the most influence on the movement of uranium in the simulations. Sources provided by the Ohio EPA suggest an acceptable Kd value for uranium in soils like those found at Luckey should be on the order of 500 ml/g. When that value is used (see runs 10_01v01, v02, v03, v07, and v08) uranium does not migrate through 1 foot of clean soil to reach the groundwater in 1,000 years. However, groundwater samples at wells such as MW-24(S) suggest uranium has already migrated into the groundwater at the site (which must have happened within the past 50 years or less). In an attempt to recreate this in SESOIL, uranium's Kd value was decreased to determine what values would produce uranium in groundwater within a reasonable time.

With Kd values of 10 or 15 ml/g, SESOIL modeling indicates uranium still takes at least 59 to 60 years to migrate through 1 foot of clean soil to reach groundwater. Furthermore, notice in run 10_01v10 the initial concentration of uranium set 1 foot above the groundwater table is 5 μg/g. This concentration is less than the background concentration of uranium in the soils surrounding the Luckey site (background values of U-238 in the soil is 2.63 pCi/g = 7.81 μg/g). Despite starting with a concentration below the region's background, the groundwater concentration reaches 59.78 μg/L using a Kd of 15 ml/g (see Table 6A.8 for results of all uranium runs). This groundwater concentration is almost two times higher than the acceptable concentration of 30 μg/L and should be observed in groundwater throughout the region. This suggests such low values of Kd are unrealistic for uranium in clay-rich till, but still do not allow the uranium into the groundwater in the time frame actually observed at the site.

Since uranium does not migrate into the groundwater within 1,000 years when using the accepted Kd of 500 ml/g and an initial soil concentration of 85.03 μg/g equal to the soil cleanup goal (i.e. 26.8 pCi/g), it appears this cleanup goal is protective of groundwater at the Luckey site.

6A.4.3 SESOIL Discussion

In SESOIL runs initially placing contamination within 1 foot of the groundwater table, migration of contaminants through that foot of clean soil to the groundwater does not occur unless distribution coefficients at least one to two orders of magnitude lower than generally accepted values found in the literature are used. Using very low Kd values, the contaminants do not seem to migrate to the groundwater fast enough to have had the impact seen at wells on-site such as MW-01(I). These findings suggest a mechanism other than leaching through the clay-rich till is responsible for the contamination seen in the groundwater today.

One possible explanation is the presence of sand and gravel lenses in direct contact with the trenches. The trenches were constructed using a bulldozer and could have intersected a thin sand and gravel seam. Boring logs from near the trenches in IA01 indicate this could easily be the case at least in trench 2. The sludge removed from the lagoons was saturated. At least some of this water could have rapidly seeped out of the trench through these sand and gravel seams. The lower distribution coefficients and higher conductivities associated with sand and gravel could have created a much more favorable path for contamination to enter the groundwater.

Another possibility is that groundwater periodically may come into contact with the bottom of the trenches. The water table was noticeably higher in J une 2001, than at any other time during monitoring of groundwater elevations at the site. This rebound elevated the groundwater table within a foot of the bottom of many of the trenches, and actually reached trench 2. Since the bottoms of the trenches are not precisely known, the groundwater table during this time period may have been up above the bottom of several trenches on site.

6A.5 GEOCHEMICAL MODELING USING PHREEQC

Modeling of the chemical speciation and solubility of beryllium and uranium was done to support transport modeling of these constituents based upon conditions at the site. The approach included a review of geohydrologic characterization and modeling at the site and use of the USGS PHREEQC geochemical model (Parkhurst and Appelo, 1999) to investigate solubility and ion exchange behavior of beryllium and uranium in groundwater at the site. Results from the geochemical modeling identify the predominant dissolved species and thereby permit selection of appropriate input parameters for modeling with MT3DMS. These topics are discussed in the following paragraphs.

6A.5.1 Site Conditions for Geochemical Modeling

The primary cations present in groundwater at the site are calcium, magnesium and sodium with lesser amounts of potassium and iron. The primary anions present at the site are bicarbonate (HCO_3^{-1}), carbonate (CO_3^{-2}), chloride (Cl^{-1}) and sulfate (SO_4^{-2}). Groundwater temperatures range from 9 to 18 ^oC with most values near 13 ^oC. Most measurements of Eh are in the range of –100 to +100 mV while most measurements of pH are between 7 and 8. The major variability in groundwater composition affecting solubility is in the concentration of dissolved solids, the distribution of cations between calcium and sodium and the distribution of anions between alkalinity (bicarbonate plus carbonate) and sulfate. Compositions for a groundwater monitoring well (MW-24) and a groundwater production well (GW-004) that represent site conditions are summarized in Table 6A.9.

Results generated in the geochemical modeling using the PHREEQC computer code included identification of important aqueous and solid phase components at the site, estimation of the solubility of uranium and beryllium, and investigation of the ion exchange behavior of beryllium in site groundwater. The initial step in the analysis for each metal was identification of the distribution of elements among ionic species in the groundwater. For both MW-24 and GW-004 groundwater, univalent sodium, divalent calcium and univalent bicarbonate were the dominant aqueous species. For both wells, calcite ($CaCO_3$) and dolomite ($CaMgCO_3$) were near saturation while goethite (FeOOH) and hematite (Fe_2O_3) were over-saturated. Additional results of the analysis for each metal are presented in the following paragraphs.

Beryllium

The initial step in the modeling process for beryllium was calculation of the aqueous and solid phase components important at the site. For base case conditions, beryllium was present as the divalent ion, bicarbonate was the predominant anion, and bromellite (BeO) was the controlling phase for precipitation of beryllium. Conditions were under-saturated with respect to the condensed phases, beryllium carbonate and beryllium sulfate. Estimates of solubility of beryllium were developed for the composition of GW-004 groundwater and for the range of conditions likely present at disposal trenches. Results developed using PHREEQC are summarized in Table 6A.10. The dominant aqueous phase species were Be^{+2} and $Be_3(OH)_3^{+3}$ at low pH and Eh, Be^{+2} at moderate pH and Eh, and $Be(OH)_3^{-1}$ at high pH. Solubility was a strong function of pH and a weak function of Eh. For systems containing compounds of alkaline earth metals, such as dolomite, recrystallization has been proposed as an important mode of retention (NEA, 1982). The low values of estimates of beryllium solubility at neutral conditions are consistent with this observation.

Investigation of ion exchange behavior using PHREEQC included estimation of solid and liquid phase compositions at equilibrium with an ion exchanger with cation exchange capacity (CEC) of 10 meq/100g. For neutral pH, beryllium exists primarily as positively charged species, concentration of calcium is high, and concentration of beryllium is low. For these conditions, PHREEQC predicted the ratio of concentration of beryllium in the solid and liquid phases was constant, a result consistent with a partition coefficient of magnitude 13 ml/g. Ion exchangers with higher CEC would show proportionately higher values of partition coefficient. Clay minerals exhibit CECs that range from a 3-15 meq/100g for kaolinite clays to 70-100 meq/100g for montmorillonite clays (Faure 1991). Literature values of partition coefficient for beryllium range from 250 ml/g for sand to 1,300 ml/g for clay (Sheppard and Thibault, 1990). An interoffice memo from Ohio EPA (2001) indicated a range in partition coefficients of 70 ml/g (clay content < 10%) to 8000 ml/g (clay content >30%) for pH between 5 and 9. Therefore, the partition coefficient predicted using PHREEQC appears low relative to published literature values for the same pH range and clay content observed in soils at Luckey. At high values of pH, beryllium exists primarily as a negatively charged hydroxide and the expected minimal ion exchange was verified by PHREEQC analysis.

Uranium

The solubility of uranium in MW-24 and GW-004 groundwater was estimated using the PHREEQC computer code. Results for temperature of 13 ^{o}C and mildly reducing conditions (Eh = -100 mV) are presented in Table 6A.11. For each case, a uranium hydroxide ion [$U(OH)_5^{-1}$] was the dominant aqueous phase specie and uraninite (UO_2) was the controlling solid phase. The trend of low solubility near neutral conditions with an increase to high solubility values at moderately elevated pH followed by decrease in solubility at high pH has been predicted using alternate methods (NEA, 1982). For oxidizing conditions, PHREEQC estimates of solubility of uranium were high for the range of pH found at the site. At high pH, for both reducing and oxidizing conditions, formation of uranyl carbonates contributes to the predicted increase in solubility.

6A.6 GROUNDWATER TRANSPORT WITH MT3DMS

The fate and transport of constituents in the groundwater was evaluated using the groundwater flow model (USACE 2001) coupled with MT3DMS. The groundwater flow model provides the flow field in which the constituents move and allows for performing simulations under current conditions and under conditions that may have existed in the past or could be reasonable in the future. Constituents within the simulated flow fields were defined based upon their current observed concentrations and upon predicted leaching rates to the groundwater. Transport of the constituents within the groundwater was performed using MT3DMS.

The results from the transport simulations provide information on the time frames required for attainment of ARARs, potential migration pathways, and regions where groundwater impacts above ARARs may occur in the future. Flow and transport conditions for each alternative were simulated to predict the fate of AEC-related constituents. Time frames associated with the results for each alternative are summarized by location and aquifer matrix (sand and gravel, bedrock).

Since on-site monitoring wells have indicated beryllium, lead, and uranium are present at concentrations exceeding groundwater cleanup goals in some areas of the site, contaminant transport modeling was conducted for these COCs to help predict their movement under various conditions. MT3DMS was selected for the transport simulations, using the calibrated MODFLOW model described in USACE's " Final Groundwater Model Report for the Luckey Site, Luckey, Ohio (February 2001)" and updated in the Draft Addendum to the Final Groundwater Model Report for the Luckey Site, Luckey, Ohio (J anuary 2002) for the flow field simulations.

6A.6.1 Input Parameters and Transport Model Calibration

Input parameters were selected to be consistent with those presented in Table 6A.2. Table 6A.12 lists the distribution coefficient (Kd) values used in the MT3DMS simulations for each constituent in each zone of the model. These values are based on information provided by Strenge, D.L. and S.R. Peterson (1989) in a memo from Ohio EPA (2001). Based on the reference above, uranium's Kd in silty clay should actually be about 500 ml/g. The value of 10 ml/g was used as an extremely conservative estimate in early runs that started uranium in the silty clay. The very low Kd value was used in an attempt to recreate the current conditions known to exist from the monitoring wells on site by migrating uranium through the silty clay. Even with this extremely low Kd value, however, both SESOIL and MT3DMS simulations suggest uranium could not appear in MW-24(S) within the time period required if migration through the silty clay is responsible. Alternative mechanisms that may have been responsible for transporting uranium to the groundwater are discussed in previous sections.

Dispersivities in the simulations were set at 15 ft in the silty clay and 60 ft in both the sand and gravel and in the bedrock. These values are based in part by sources compiled in Waterloo Hydrogeologic, Inc.'s Envirobrowser Registered Version 2.1. A range of dispersivities based on the published values listed in Envirobrowser were used in the analytical contaminant transport software package AT123D. A series of simulations was run and the outputs analyzed to help determine what dispersivity values were representative based upon published literature. Longitudinal dispersivities were set at 15 feet for the silty clay and 60 feet for both the sand and gravel and the bedrock. Transverse dispersivities were set at one tenth the longitudinal values.

Results from the SESOIL modeling suggest that other mechanisms besides leaching through the soil column to groundwater are likely responsible for the observed contaminant concentrations in groundwater. Several simulations were performed using concentrations from SESOIL as input to the groundwater flow field beneath IA01. Results indicate contaminants did pass through the areas of highest concentrations (at MW-01[I]). However, in using a continuous source or a slug source, predicted concentrations in monitoring wells between the source zone and the disposal pits and trenches in IA01 were elevated well above observed concentrations. In addition, uncertainties associated with the past operation of the East and West Production Wells, and quarry dewatering make it difficult to precisely recreate current conditions based on past operations at the site. However, these simulations indicate how elevated concentrations of uranium and beryllium observed in MW-19(I) and MW-13(S) could be a result of contamination leaching out of the IA01 trenches in fairly low concentrations. Contaminants passing through these two wells become too dilute by time they reach other down gradient wells (i.e. MW-22(I)) to have a noticeable impact on the groundwater concentrations in these wells.

Based on results from those simulations, a more likely source for the contamination observed in MW-01(I), MW-02(S), and MW-26(S) is trench 5 in the northern section of IA05. Simulations were designed and run to help find a potential source of contamination observed today in the groundwater at these locations. It seems unlikely the source of beryllium was from the trenches in IA01, since MW-22(I) would then be expected to have contamination in it and the two wells north of IA01 (MW-19(I) and MW-13(S)) should be more highly impacted than they are. Previous simulations releasing contamination from IA01 confirm these wells should have higher concentrations of contaminants than what has been observed if IA01 was the source of contamination in MW-01(I), MW-02(S), and MW-26(S). A more likely source that could cause beryllium to get into the groundwater at concentrations observed at these wells would be trench 5. As mentioned earlier, contaminants move very slowly through the silty clay. Releasing contaminants from the silty clay near trench 5 would result in required travel times much longer than the 30 to 50 years since potential placement of contaminants in the trench. For this reason, initial beryllium contamination was started in the sand and gravel layer modeled beneath the trench. Contamination may have gotten to this point through sand and gravel lenses or through direct contact with the trench if it was dug deep enough.

A series of simulations were performed in an attempt to recreate observed concentrations by reverse engineering the locations and concentrations beneath source zones that would reproduce observed groundwater concentrations for beryllium. By releasing beryllium into the 1 foot thick sand and gravel layer below trench 5 at an initial groundwater concentration in this area of 800 μg/L), concentrations 20 to 50 years later matched fairly closely with concentrations observed today at the three impacted wells (see Figure 6A.6). This qualitative calibration suggests the input parameters used for beryllium transport are viable under this scenario. With trench 5 being the last created and associated with closure activities, the types of materials disposed of in the trench could have been different than the materials placed in trenches 1 through 4 to the east.

Additional simulations were run in an effort to show how contaminants may have migrated through the groundwater to reach MW-21(I). The contaminant transport model shows potential contamination could have migrated from trench 6 to MW-21(I) in the time frames required (30 to 50 years) while either the East Production Well or the West Production Well was pumping. Very little data exists for this trench since it is buried beneath a pile of rubble, but data that has been collected from within what is assumed to be the trench's extent have shown high concentrations of lead and beryllium along with some uranium. A slow migration of contaminants out of this trench could account for the detections of lead found in the groundwater at MW-21(I), according to the migration pathways simulated in the model.

Even though the contaminant transport model has been able to somewhat accurately reproduce current conditions at the site, it is very important to recognize the uncertainties in historic events at and near the site and how they impact the modeling results. The best approach is to reproduce current contaminant extents based on historical knowledge of the site, sources of contamination, time periods, and rates of contaminant releases. Knowledge of significant stresses to the groundwater flow field, such as periodic operation of the East or West Production Wells or the France Stone Quarry to the south also is important. Currently, there are significant gaps in our historical knowledge of the site that prevent a reliable reconstruction of current conditions. Most significantly, accurate knowledge of past groundwater flow conditions at the site (as influenced by the operation of the production wells and the France Stone Quarry to the immediate south of the facility). As a result of these gaps in our knowledge, the transport simulations have an additional set of limitations that must be considered when evaluating the results. Some of these include the possibility of groundwater contamination in areas not currently monitored by the well network at the site and less confidence overall in transport modeling results. However, with this in mind, the transport modeling results can be used to provide valuable input to the FS process.

6A.6.2 Uncertainty

Overall, uncertainties in past conditions at the site make it impossible to determine with absolute certainty how materials observed in the groundwater today got there. Reconstruction of these conditions is beyond the current scope of this effort, but they are important considerations when evaluating model output. Several gaps in our knowledge are summarized below.

Production well pumping rates are unknown prior to the installation of a totalizing flow meter on Uretech's East Production Well in 1999. What is known is that the West Production Well was used as the primary well for the facility until the early to mid 1980's. It is not known exactly when primary production was switched to the East Production Well. When production was switched to the East Well, the West Well was still in service and periodically was used to draw water. The frequency and rate of production during this intermittent use are unknown. It also is unknown what the production rate of the West Production Well was prior to the East Production Well being switched to the primary well.

The annual production rate of the East Production Well also is unknown up until a totalizing flow meter was installed on the piping in 1999. Prior to the totalizing flow meter being installed, Uretech representatives estimated the well to be pumping no more than 50 gallons per minute (gpm). The totalizing flow meter showed the well pumped at an average rate of 70 gpm or more each month.

Another source of uncertainty that could have impacted the migration of contaminants in the past is the quarry just south of the site. The quarry was put into operation in the 1940's and was abandoned sometime in the early 1970's. Little else is known about the operation of the quarry, however. A sump collection system was used to keep the quarry dry, but it is not known how deep the quarry was from one year to the next, or from one decade to another. At the time of its abandonment, the quarry was about 70 feet deep. In interviews with representatives from France Stone Quarry, it has been found the quarry was a favorable one because it was easy to dewater, but no information is available on exactly what flow rates were required to keep it dewatered.

Another source of uncertainty that could have a major impact on the movement of contaminants both in the past and present is the exact layout and depth of the trenches. Eyewitness accounts from people present during the time the trenches were constructed do not match exactly with what has been observed at the site through the analysis of boring logs drilled through some of the trenches. Both the exact layout and the exact depth of the trenches are not completely known. If the trenches are slightly deeper than eyewitnesses recall, many of them could sit within the water table during certain times of the year when Uretech's production rate has been decreased.

The recent seasonal fluctuation in water levels and contaminant concentrations were the first significant variations observed in these conditions in four years of monitoring at the site. These seasonal variations are not accounted for in the groundwater flow model, which calculates a steady-state or average flow field for the site. Contaminant concentrations also indicated decreasing trends. With the rise in water levels, contaminant concentrations also have risen, suggesting the potential for a smear zone from seasonal water fluctuations. The contaminant concentrations also may be reflective of a pulse of contamination in the flow system.

In addition to uncertainty associated with site conditions, uncertainty also is associated with model input parameters. A detailed sensitivity analysis was completed as part of the groundwater flow model development (USACE 2001). Transport model results are highly sensitive to the value of Kd and dispersivity. A range of dispersivity values was simulated both within MT3DMS and verified in 2D transport calculations. Several simulations using different values for Kd that fall within the reported literature range also were evaluated. Results indicated Kd values used in the overburden materials (sand and gravel, clay-rich till) can have a dramatic influence on time frames and distances traveled for constituents within these materials. As a result, transport simulations were completed under advection, advection with dispersion, and advection with dispersion and sorption (includes effect of Kd).

6A.6.3 Alternative Evaluation

Model runs were performed under both pumping and non-pumping conditions (assuming both the continued and discontinued operation of the East Production Well). Pumping conditions or pumping scenarios refer to those scenarios in which the East Production Well is removing water from the aquifer at 70 gpm. Non-pumping conditions or non-pumping scenarios refer to those scenarios in which the East Production Well is not in operation. As a result, two distinctly different flow fields are generated, which form the basis for transport calculations.

Simulations were run under advective transport, transport with advection and dispersion, and transport including the effects of advection, dispersion, and sorption for the non-pumping scenarios. Advective transport simulations were performed to provide a baseline for the worst-case situation. Under advective transport, the constituents migrate within the groundwater flow field essentially as a non-reactive tracer and produce the highest concentrations at any given location down-gradient from the source locations. Transport including the combined effects of dispersion and sorption act to reduce overall contaminant concentrations and increase travel times during transport.

Initial contaminant conditions in the model used the contaminant measurements collected in on-site monitoring wells and in the West Production Well prior to the J une 2001 sampling round and input parameters consistent with those developed as part of the qualitative calibration. Table 6A.13 shows the area, concentration, and total mass of each COC initially loaded into the transport model.

Results are presented in the form of a series of charts illustrating concentrations at selected locations over time. The locations were selected in areas exhibiting the highest concentrations predicted through modeling (generally at source locations and along the primary axis of contaminant migration). The locations of the observation points have been included as Figure 6A.7 for beryllium results, Figure 6A.8 for lead results, and Figure 6A.9 for uranium results. Contaminant distribution maps over time under each scenario have not been included; however, Figures 6A.7a and 6A.7b have been included to illustrate beryllium distribution in upper bedrock (layer 4, upper 20 feet) over time to facilitate understanding of the contaminant distribution as illustrated in the observation point plots of constituent concentration versus time (Table 6A.14 – Figures 6A.28 through 6A.36).

Summary tables of the results are presented in Tables 6A.14 through 6A.16. Table 6A.14 presents the transport results under non-pumping conditions with no active treatment and directly supports the evaluation of Alternative 7 Monitored Natural Attenuation. Included in the table are the observation points illustrated in Figures 6A.3 through 6A.5 and the time period in years required for the beryllium, lead, and uranium to drop below their respective cleanup goals in both the overburden and bedrock. Overburden refers to the sand and gravel in the unconsolidated sediments above the bedrock, while bedrock refers to the carbonate aquifer. Results for advection, advection and dispersion, and advection with dispersion and sorption are presented in Table 6A.14. Figure numbers for the charts showing the predicted concentrations over time at each monitoring point also are included in the table.

Table 6A.15 presents results for Alternative 8 Active Treatment under non-pumping conditions at each of the respective observation points. Table 6A.16 presents the results for both alternatives (monitored natural attenuation and active treatment) with the East Production Well pumping. In the active treatment scenarios, up to two extraction wells were installed in or adjacent to the areas of observed groundwater concentrations. Simulated withdrawal rates were generally on the order of 0.5 to 5 gpm depending on the available saturated thickness and conductivitiy of the aquifer materials.

Contaminants (beryllium, lead, and uranium) occur in the bedrock and shallow overburden. In order to effectively extract these contaminants, these features should remain saturated during extraction. If the bedrock or overburden are de-watered in impacted zones, the contaminants will simply remain in the de-watered portions and will be released when the target layers are re-saturated once pumping is stopped.

The potentiometric surface in the bedrock under non-pumping conditions is roughly 10 to 12 ft above the bedrock surface in potentially impacted zones. Under pumping conditions (i.e., operation of the East Production Well), the potentiometric surface is 2 to 4 ft above the bedrock surface in potentially impacted zones. The model was used to predict withdrawal rates that do not dewater upper bedrock under these scenarios using a hydraulic conductivity of 3 ft/d in the upper section of the bedrock.

Similar conditions exist for extraction of impacted groundwater in the unconsolidated materials overlying bedrock. Impacted groundwater has been observed in unconsolidated materials ranging from sand and gravel with a hydraulic conductivity of 20 ft/d to silty clay areas with a hydraulic conductivity of only 0.05 ft/d. Results indicated groundwater pump and treat was effective at removing contaminants from the carbonate bedrock and sand and gravel, but ineffective at removing contaminants from the clay-rich tills.

The time frames presented in Tables 6A.14 through 6A.16 were used to support the alternatives evaluation. Results indicate during pumping conditions, contaminants will reach the East Production Well, but only at concentrations well below their respective groundwater cleanup goals. Neither lead nor uranium is predicted to ever move off site at concentrations exceeding their cleanup goals. Only beryllium, which occurs above its cleanup goal at the northern property boundary, is expected to migrate off site. Even so, concentrations are well below cleanup goals within 250 to 300 feet down gradient. Results also indicate beryllium, lead, and uranium will remain above cleanup goals for substantial periods of time in the within the clay-rich tills. Maximum times for natural attenuation of AEC-related constituents in the sand and gravel are 150 years for beryllium at the northern property boundary, and 40 years for beryllium in the bedrock at the same location. Active treatment of groundwater reduced the time frames to 80 years and 25 years for the same respective locations. Under Alternative 7 MNA, lead is predicted to drop below its cleanup goal in less than 5 years, and uranium within 30 years. Under Alternative 8 Active Groundwater Treatment, time frames for remediation of lead and uranium are roughly 1 and 10 years, respectively.

6A.7 SUMMARY OF MODELING RESULTS FOR ALTERNATIVE EVALUATION

Modeling efforts to predict the migration of contaminants through the soils and groundwater were simulated to provide input for evaluation of FS alternatives. Past operations at the facility, in conjunction with RI and post-RI (USACE 2000) sampling results, form the basis for the modeling efforts. Transport through the soil was simulated using SESOIL. Initial concentrations included both the UCL from the most impacted area and the cleanup goals, if determined, for AEC-related constituents. Transport through the groundwater was simulated using MT3DMS coupled with the Luckey groundwater flow model (USACE 2001, 2002). Geochemical modeling was used to identify speciation, solubility, and mobility characteristics for beryllium and uranium in support of groundwater transport calculations.

Result from the SESOIL evaluations indicate leaching through the clay-rich tills does not reproduce the observed groundwater concentrations. Observations on the discrete and discontinuous nature of groundwater contamination support periodic release(s) of contaminants rather than continual leaching through the soils. Soil cleanup goals for AEC-related constituents were found to be protective of groundwater. Leaching through sand and gravel could be a viable transport mechanism. However, boring logs indicate most of the overburden at the site consists of clay-rich tills. Only thin seams of sand and gravel were typically encountered and usually occurred immediately above the bedrock. As a result, direct contact with materials placed in the trenches or lagoons (particularly lagoon B which was 5-6 feet deep) or intersection of portions of the trenches and lagoons with sand seams represents the most viable mechanism for introduction of contaminants into the groundwater.

A qualitative calibration of groundwater transport simulations indicates that input parameters are viable. A quantitative reconstruction of current observed contaminant distributions would require substantial assumptions associated with past facility operations, waste disposal activities, and groundwater flow conditions. As a result, groundwater transport results focused on ensuring that input parameters were representative and viable through more qualitative calibration efforts. Input parameters also were selected to maintain consistency with agreements made with Ohio EPA.

Transport modeling was completed under both pumping (East Production Well operating) and non-pumping (East Production Well shut down) conditions. Non-pumping conditions are believed to be more conservative, since contaminants would no longer be contained and could migrate off site. Contaminants were simulated as a pulse released to the groundwater. Lead and uranium did not migrate off site above cleanup goals. Beryllium detected at the northern boundary of the facility migrated off site, but had attenuated to below cleanup goals within 300 feet of the facility boundary. Because of the proximity of beryllium to the site boundary, little difference in cleanup times between on site and off site groundwater are expected. None of the AEC-related constituents are predicted to impact the East Production Well at concentrations exceeding cleanup goals.

Results from the groundwater transport simulations are summarized in Table 6A.17, which illustrates the time frames attainment of ARARs for Alternatives 7 and 8. Transport modeling activities were not completed in support of Alternative 9. The occurrence of significant contamination in groundwater within the clay-rich till could result in long times for attainment of ARARs. However, it is likely that most of the contamination observed in groundwater samples moves through the more permeable sand and gravel or upper weathered bedrock. Therefore, the time frames illustrated for sand and gravel and bedrock are believed to be most representative. These time frames are recommended for use in the evaluation of the FS alternatives. For Alternatives 1 and 2, materials within the trenches and lagoons are left behind and could periodically release pulses of contamination in the future. Therefore, rather than simulate random pulses through time, the results presented for Alternative 7 Monitored Natural Attenuation are expected to recur into the foreseeable future, resulting in non-attainment of ARARs. Alternative 9 Electrokinetics addresses contamination in the clay-rich till and sand and gravel of the overburden, but does not address contamination in the carbonate bedrock. Therefore, time frames shown for Alternative 7 Monitored Natural Attenuation in the bedrock should be included in the evaluation of this scenario.

The predicted timeframes for attainment of ARARs under the different alternatives as shown in Table 6A.17 are provided to permit comparison of the alternatives. There are a number of sources of uncertainty associated with the modeling predictions. Model predictions must be considered in light of the inherent uncertainties. For example, the actual time for attainment of ARARs will likely occur over a range of times rather than over an exact period of time. Several of these sources of uncertainty include:

- Variation over several orders of magnitude of site specific input parameters (e.g. hydraulic conductivity),
- Uncertainties associated with historical activities and groundwater flow conditions at the site,
- The degree to which the clay-rich tills are contaminated and whether or not the process is reversible,
- And uncertainties associated with the future land use of the site and the potential impacts of source removal on contaminant migration rates.

6A.8 REFERENCES

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Table 6A.1. Results of Initial Screening for Soil Constituents Leaching to Groundwater

OU	MED	FRAC	PARAMETER	MIN	MAX	UNITS	BKG	UCL	DAF20	BKGRATIO	FREQRATIO
IA01	SB	M	Beryllium	0.17	8570	MG/KG	1.13	252.00	63.00	91/159	159/159
IA01	SB	M	Lead	4.9	2110	MG/KG	23.20	155.00	0.00	11/49	49/49
IA01	SB	RAD	Radium-226	0.891	193	PCI/G	2.97	14.50	0.00	8/49	49/49
IA01	SB	RAD	Thorium-230	1.06	17.6	PCI/G	3.20	3.69	0.00	6/49	49/49
IA01	SB	RAD	Uranium-234	0.554	21.4	PCI/G	2.61	3.57	0.00	7/49	49/49
IA01	SB	RAD	Uranium-238	0.708	21.3	PCI/G	2.63	3.51	0.00	7/49	49/49
IA02	SB	M	Barium	17.8	2250	MG/KG	209.00	238.00	1600.00	1/37	37/37
IA02	SB	M	Beryllium	0.31	7880	MG/KG	1.13	490.00	63.00	41/89	89/89
IA02	SB	M	Lead	5.9	135	MG/KG	23.20	30.20	0.00	6/37	37/37
IA02	SB	RAD	Radium-226	1.05	37.4	PCI/G	2.97	6.91	0.00	6/37	37/37
IA02	SB	RAD	Thorium-230	0.872	25.6	PCI/G	3.20	4.91	0.00	4/37	37/37
IA02	SB	RAD	Uranium-234	0.738	52.3	PCI/G	2.61	6.24	0.00	7/37	37/37
IA02	SB	RAD	Uranium-238	0.658	51.1	PCI/G	2.63	6.27	0.00	8/37	37/37
IA03	SB	M	Beryllium	0.19	274	MG/KG	1.13	18.40	63.00	25/85	85/85
IA05	SB	M	Beryllium	0.07	13300	MG/KG	1.13	757.00	63.00	55/78	78/78
IA05	SB	M	Lead	6.9	2670	MG/KG	23.20	228.00	0.00	10/41	41/41
IA05	SB	RAD	Thorium-230	0.42	15.7	PCI/G	3.20	3.53	0.00	3/39	39/39
IA07	SB	M	Beryllium	0.25	495	MG/KG	1.13	65.00	63.00	34/62	62/62
IA08	SB	M	Lead	7.3	42.1	MG/KG	23.20	31.00	0.00	3/7	7/7
IA10	SB	M	Barium	30.4	3460	MG/KG	209.00	988.00	1600.00	5/22	22/22
IA10	SB	M	Beryllium	0.08	81.2	MG/KG	1.13	7.65	63.00	15/54	53/54
IA10	SB	M	Lead	1.1	114	MG/KG	23.20	53.20	0.00	4/22	21/22

OU = Investigative area
SB = Sample from soil boring
FRAC = Indicates either metal (M) or radionuclide (RAD)
MIN = Minimum measured value
MAX = Maximum measured value
BKG = Background concentration
UCL = 95% UCL for sample results for each investigative area
DAF20 = EPA Region 9 dilution factor
BKGRATIO = number of samples >background/number of samples
FREQRATIO = Frequency of detection

Table 6A.2. Input Parameters for Modeling at the Luckey Site

Input Parameter	Units	Selected Value	Range	Explanation
Area of contaminated zone	m^2	N/A	1000 - 30,000	Varies depending upon constituent and source modeled
Thickness of contaminated zone	m	N/A	0.15 - 3.3	Varies depending upon constituent and source modeled
Time since placement of material	yr	0	N/A	Modeled as if emplaced now
Cover depth	m	0	N/A	Assumes no clean soil over contaminated zone
Density of contaminated zone	g/cm^3	1.84	N/A	Consistent with groundwater model and measured site data presented in RI Report
Contaminated zone hydraulic conductivity	m/yr	5.6	5.6 – 2225	Majority of contamination in silty clay, same hydraulic conductivity used for silty clay in groundwater model
Humidity in air	g/m^3	7.05	N/A	Based on 10 years climatic data from SESOIL database
Precipitation	m/yr	0.816	N/A	Based on 10 years climatic data from SESOIL database
Saturated zone hydraulic conductivity	m/yr	167	5.6 – 2225	Conservative value between very low conductivity for silty clays and the high conductivity for sand and gravel
Saturated zone hydraulic gradient	unitless	0.02	0.01-0.03	Based upon observed water levels measured at the site
Number of unsaturated zone strata	unitless	1	N/A	In RESRAD: represents the number of zones beneath the contaminated soil; in SESOIL: represents the entire vadose zone that may be further subdivided to provide more detail on contaminant distributions
Uncontaminated Unsaturated zone thickness	m	N/A	0.15 - 3.3	Varies depending upon constituent and source modeled
Unsaturated zone soil density	g/cm^3	1.84	N/A	Consistent with groundwater model and measured site data presented in RI Report
Unsaturated zone total porosity	unitless	0.37	0.19-0.61	Measured site date from geotechnical testing and reported literature values
Unsaturated zone effective porosity	unitless	0.05	0.05 - 0.24	Consistent with values used in groundwater model and reported literature values for clayey sediments where most of the contamination occurs
Unsaturated zone hydraulic conductivity	m/yr	5.6	5.6 - 2225	Majority of vadose zone sediments at the site are silty clay tills
Infiltration Rate	m/yr	0.05	0.01 - 0.1	Selected value corresponds to a recharge rate of 2 inches per year
Concentration of Contaminant per Model Layer	mg/g	N/A	N/A	Varies depending upon constituent and source modeled, 95% UCL will be used for each source modeled
Number of Years of Climate Data Used	years	10	N/A	SESOIL Database
Distribution coefficient (Kd) AEC Constituents				
Arsenic		19.4	N/A	Table 1 from Ohio EPA Interoffice Memo dated 07/27/01
Beryllium		8,000	70 - 8000	Selected value from USEPA Soil Screening Guidance Document
Barium		16,000	530 - 16,000	Table 1 from Ohio EPA Interoffice Memo dated 07/27/01
Lead	cm^3/g or ml/g	1,830	234 - 1830	Table 1 from Ohio EPA Interoffice Memo dated 07/27/01
Radium		450	60-2,400	USEPA Superfund chemical data matrix/RESRAD Manual for range
Thorium		50,000	50,000 - 160,000	Table 1 from Ohio EPA Interoffice Memo dated 07/27/01
Uranium		500	10 - 4,400	Table 1 from Ohio EPA Interoffice Memo dated 07/27/01

Table 6A.3. Constituent Concentrations at the Luckey Site

Constituent	Cleanup Goal	Units	Cleanup Goal (µg/g)*	95% UCL	Units	95% UCL (µg/g)*	Background	Units	Isotope With Max UCL (Also Used For Background)
Arsenic	N/A	mg/kg	N/A	14.4	mg/kg	14.4	24.1	mg/kg	N/A
Beryllium	131	mg/kg	131	757	mg/kg	757	1.13	mg/kg	N/A
Barium	N/A	mg/kg	N/A	238	mg/kg	238	209	mg/kg	N/A
Lead	400	mg/kg	400	228	mg/kg	228	23.2	mg/kg	N/A
Radium	5.01	pCi/g	5.07E-06	14.5	pCi/g	1.47E-05	2.97	pCi/g	Ra-226
Thorium	9	pCi/g	82.37	4.91	pCi/g	44.94	3.2	pCi/g	Th-230
Uranium	28.63	pCi/g	85.03	6.27	pCi/g	18.63	2.61	pCi/g	U-238
Actinium	N/A	pCi/g	N/A	1.14	pCi/g	1.56E-08	1.35	pCi/g	Ac-228
Protactinium	N/A	pCi/g	N/A	0.7	pCi/g	-	0	pCi/g	Pr-231

*: Conversion from pCi/g to mg/g was performed using the following set of equations:

Activity (Atoms_Decay/yr/g) = Activity (pCi/g) * 3.7E+10 dis/sec * (1E-12 Ci/pCi) * 31,557,600 sec/yr

Atoms/gram = Activity/[Decay Constant (1/y)]

mg/atom = (Atomic Weight/6.022E+23) * 1000 mg/kg

Concentration (mg/g) = mg/atom * Atoms/gram * 1000 mg/mg

For elements with multiple isotopes, the isotope resulting in the largest mg/g calculation is used in the equations.

Note: No cleanup goal in soil specified for arsenic, barium, actinium and protactinium because observed levels in soil were below acceptable risk or background levels.

Table 6A.4. Summer's Model Parameters

Constituent	Initial Soil Concentration (µg/g)	Source Zone Area (m^2)	Saturated Zone K (cm/day)	Hydraulic Gradient	Thickness of Mixing Zone (m)	Width of Contaminated Zone Perpendicular to GW Flow (m)	Maximum Groundwater Concentration in 1000 yr Simulation (µg/L)
Beryllium - UCL95	757	1000	45.75	0.02	3.048	100	0
Beryllium - Cleanup	131	1000	45.75	0.02	3.048	100	0
Barium	238	4000	45.75	0.02	3.048	63.25	0
Lead - UCL95	228	4000	45.75	0.02	3.048	63.25	0
Lead - Cleanup	400	4000	45.75	0.02	3.048	63.25	0
Radium - UCL95	1.47E-05	4000	45.75	0.02	3.048	63.25	0
Radium - Cleanup	5.07E-06	4000	45.75	0.02	3.048	63.25	0
Thorium - UCL95	44.94	4000	45.75	0.02	3.048	63.25	0
Thorium - Cleanup	82.37	4000	45.75	0.02	3.048	63.25	0
Uranium - UCL95	18.63	4000	45.75	0.02	3.048	63.25	0
Uranium - Cleanup	85.03	4000	45.75	0.02	3.048	63.25	0
Actinium	1.56E-08	4000	45.75	0.02	3.048	63.25	0

Table 6A.5. Beryllium SESOIL Sensitivity Analysis

	Input								
Run #	Disconnectedness Index	Effective Porosity	Kd	Solubility (mg/ml)	Run Length (years)	Layer 1 Depth (cm)/ Number Sublayers	Layer 2 Depth (cm)/ Number Sublayers	Layer 3 Depth (cm)/ Number Sublayers	Layer 4 Depth (cm)/ Number Sublayers
1	6.27	0.05	0.79	425000	50	61/10	110/10	110/10	31/10
2	6.5	0.05	0.79	425000	50	61/10	110/10	110/10	31/10
3	6.27	0.05	7.9	425000	50	61/10	110/10	110/10	31/10
4	6.5	0.05	7.9	425000	50	61/10	110/10	110/10	31/10
5	6.266	0.05	79	425000	50	61/10	110/10	110/10	31/10
6	6.5	0.05	79	425000	50	61/10	110/10	110/10	31/10
7	6.27	0.05	790	425000	50	61/10	110/10	110/10	31/10
8	6.5	0.05	790	425000	50	61/10	110/10	110/10	31/10
9	7.01	0.1	79	425000	100	61/10	110/10	110/10	31/10
10	11	0.1	79	425000	10	61/10	110/10	110/10	31/10
11	7.23	0.1	79	4.25	100	61/10	110/10	110/10	31/10
12	7.23	0.1	79	425000	100	61/10	110/10	110/10	31/10
13	8	0.1	79	425000	25	61/10	110/10	110/10	31/10
14	7.53	0.27	7.9	4.25	100	61/1	244/1	61/1	na
15	7.59	0.27	7.9	4.25	100	61/1	244/1	61/1	na
16	7.77	0.27	7.9	4.25	100	61/1	244/1	61/1	na
17	9	0.27	7.9	4.25	100	61/1	244/1	61/1	na
18	7.58	0.27	79	425000	100	61/1	180/1	61/2	na
19	8	0.27	79	425000	25	61/10	110/10	110/10	31/10
20	8	0.27	79	425000	25	61/10	91/10	91/10	91/10
21	7.59	0.29	0.79	4.25	9999	61/1	240/1	61/1	na
22	7.59	0.29	7.9	4.25	9999	61/1	240/1	61/1	na
23	7.59	0.29	79	4.25	9999	61/1	240/1	61/1	na
24	7.59	0.29	790	4.25	100	61/1	300/1	na	na
25	7.59	0.29	790	4.25	20	61/1	240/1	61/1	na
26	7.59	0.29	790	4.25	9999	61/1	240/1	61/1	na
27	7.59	0.29	790	425000	9999	61/1	240/1	61/1	na

Table 6A.5. Beryllium SESOIL Sensitivity Analysis (continued)

	Output					
Run #	Groundwater Runoff (in/yr)	Maximum Pollutant Depth (m)	Average GW Concentration at end of Run (mg/L)	Time to Reach GW (years)	Maximum Concentration in GW (mg/L)	Time to Reach Maximum Concentration in GW (years)
1	0.07	3.049	2.52E-02	1	2.14E+03	21
2	1.98	3.049	1.77E-01	1	1.98E+03	23
3	0.07	3.049	3.57E+01	4	3.57E+01	50
4	1.98	3.049	3.35E+01	3	3.39E+01	4
5	0.07	3.049	3.38E+00	32	3.61E+00	33
6	1.98	3.049	3.24E+00	30	3.46E+00	32
7	0.07	3.036	na	na	na	na
8	1.98	3.036	na	na	na	na
9	0.09	3.05	3.60E+00	25	4.47E+00	26
10	0.17	3.034	na	na	na	na
11	1.99	3.05	2.00E+00	26	2.00E+00	26
12	1.99	3.05	3.52E+00	26	4.37E+00	26
13	4.75	3.05	5.60E+00	17	5.94E+00	18
14	0.10	3.66	2.86E+00	70	2.86E+00	71
15	0.71	3.66	2.83E+00	71	2.83E+00	72
16	2.17	3.66	2.73E+00	71	2.73E+00	72
17	5.37	3.66	3.17E+00	56	3.17E+00	57
18	-1.50	2.527	na	na	na	na
19	1.43	3.05	5.60E+00	20	5.75E+00	20
20	2.59	3.321	na	na	na	na
21	0.12	3.66	1.93E-06	8	1.64E+03	9
22	0.12	3.66	2.00E-06	69	1.64E+03	70
23	0.12	3.66	8.25E+00	681	1.64E+03	681
24	0.12	2.155	na	na	na	na
25	0.12	3.052	na	na	na	na
26	0.12	3.66	1.47E+02	7404	1.86E+02	7404
27	0.12	3.66	1.47E+02	7404	1.86E+02	7404

Table 6A.6. Uranium Input Parameters Similar Through Most Simulations

	Run			
Parameter	10_01v01 to v15	10_01v16	10_01v17	10_01v18
Disconnectedness Index	7.14	7.41	6.03	4.93
Effective Porosity	0.05	0.18	0.05	0.05
Solubility (mg/ml)	500	500	500	500
Intrinsic Permeability (cm^2)	1.77E-10	1.77E-10	1.77E-10	3.53E-10

Table 6A.7. Input for Uranium Simulations in SESOIL

Run #	Kd (ml/g)	Run Length (years)	Application Area (m^2)	Mixing Zone Depth (m)	Length Perp To Flow (m)	Layer 1 Depth (cm)/ Number Sublayers	Layer 2 Depth (cm)/ Number Sublayers	Layer 3 Depth (cm)/ Number Sublayers	Initial Conc Layer 1/ Layer 2 / Layer 3 (g/g)
10_01v01	500	1,000	4,000	3.048	63.25	168	61	na	0/20
10_01v02	500	5,244	4,000	3.048	63.25	168	61	na	0/20
10_01v03	500	5,875	4,000	3.048	63.25	168	61	na	0/10
10_01v04	10	1,000	4,000	3.048	63.25	168	61	na	0/85.03
10_01v05	10	1,000	4,000	3.048	63.25	168	61	na	0/18.63
10_01v06	10	300	40	3.048	6.32	168	61	na	0/85.03
10_01v07	500	1,000	4,000	3.048	63.25	168	61	na	0/85.03
10_01v07a	250	1,000	4,000	3.048	63.25	168	61	na	0/85.03
10_01v08	500	1,000	4,000	3.048	63.25	168	61	na	0/18.63
10_01v08a	250	1,000	4,000	3.048	63.25	168	61	na	0/18.63
10_01v09	15	1,000	4,000	3.048	63.25	168	61	na	0/1
10_01v10	15	1,000	4,000	3.048	63.25	168	61	na	0/5
10_01v11	15	1,000	4,000	20	63.25	168	61	na	0/5
10_01v12	15	1,000	4,000	20	63.25	168	61	na	0/10
10_01v13	15	1,000	4,000	20	63.25	77	152/10	na	0/10 in Sub 5 and 6
10_01v14	15	1,000	4,000	20	63.25	77	152/10	na	0/10 in Sub 3 and 4
10_01v15	15	1,000	4,000	20	63.25	77	152/10	na	0/20 in Sub 3 and 4
10_01v16	15	1,000	2,750	20	52.44	61	183	122	0/10/0
10_01v17	15	1,000	2,750	3.048	52.44	61	183	122	0/10/0
10_01v18	15	1,000	2,750	3.048	52.44	61	183	122	0/10/0

Table 6A.8. Output for Uranium Simulations in SESOIL

Run #	Groundwater Runoff (in/yr) (Recharge)	Maximum Pollutant Depth (m)	Average GW Concentration at end of Run (μg/L)	Time to Reach GW (years)	Maximum Concentration in GW (μg/L)	Time to Reach Maximum Concentration in GW (years)
10_01v01	2.01	2.09	0	na	0	na
10_01v02	2.01	2.29	4.856	2906	7.157	2907
10_01v03	2.01	2.29	1.786	2906	3.562	2907
10_01v04	2.01	2.29	7.85	59	1520	60
10_01v05	2.01	2.29	1.71	59	333	60
10_01v06	2.01	2.29	76.08	59	290.9	60
10_01v07	2.01	2.09	0	na	0	na
10_01v07a	2.01	2.09	0	na	0	na
10_01v08	2.01	2.09	0	na	0	na
10_01v08a	2.01	2.09	0	na	0	na
10_01v09	2.01	2.29	0.3914	88	11.96	89
10_01v10	2.01	2.29	1.938	88	59.78	89
10_01v11	2.01	2.29	0.5333	88	16.45	89
10_01v12	2.01	2.29	3.911	88	119.6	89
10_01v13	2.01	2.29	0.001375	122	20.51	200
10_01v14	2.01	2.29	0.003573	176	19.68	262
10_01v15	2.01	2.29	0.007099	176	39.23	262
10_01v16	2.03	3.66	8.737	287	46.14	287
10_01v17	2.01	3.66	49.56	374	115.9	375
10_01v18	2.02	3.66	19.84	272	161.3	272

Table 6A.9. Characteristics of Groundwater at the Luckey, OH Site

Parameter	**Value**	
	MW-24	**GW004**
Temperature (^oC)	13	13
pH	7.25	7.25
Eh (mV)	100	100
Cation Concentration (mg/L)		
Na	620.0	15.6
K	5.3	3.0
Ca	37.1	94.7
Mg	45.5	39.9
Fe	0.2	1.0
Anion Concentration (mg/L)		
Alkalinity	520.0	258.1
Cl	37.9	32.7
SO_4	941.0	175.0

Table 6A.10. Predicted Solubility of Beryllium (μg/L) in Groundwater

pH	Eh (mV)			
	-490	**-110**	**+110**	**+500**
6.0	200	185	185	185
7.25	0.36	0.36	0.36	0.36
11.5	95	95	95	95

Table 6A.11. Predicted Solubility of Uranium in Groundwater

pH	**MW-24(S)** (g/L)	**GW-0004** (g/L)
6.0	0.004	0.004
7.25	0.087	0.067
9.0	21.8	High

Table 6A.12. Partition Coefficients Used in the MT3D Simulations

Constituent	Kd Silty Clay (ml/g)	Kd Sand and Gravel (ml/g)	Kd Bedrock (ml/g)
Beryllium	8000	62	0
Lead	1830	234	0
Uranium	10	0.06	0

Table 6A.13. Initial Contaminant Distribution for MT3DMS

<table>
<tr><th rowspan="2">Contaminant</th><th rowspan="2">Location</th><th rowspan="2">Extent</th><th rowspan="2">Concentration (µg/L)</th><th colspan="2">Total Mass (lbs)</th></tr>
<tr><th>Pumping</th><th>Non-Pumping</th></tr>
<tr><td rowspan="8">Beryllium</td><td>MW-01 and MW-02
Layer 2</td><td>150 ft East-West
100 ft North-South</td><td>15</td><td rowspan="8">269</td><td rowspan="8">411</td></tr>
<tr><td>MW-01 and MW-02
Layer 3</td><td>150 ft East-West
100 ft North-South</td><td>25</td></tr>
<tr><td>MW-01 and MW-02
Layer 4</td><td>300 ft East-West
250 ft North-South</td><td>40</td></tr>
<tr><td>MW-13 and MW-19
Layer 2</td><td>150 ft East-West
100 ft North-South</td><td>3.3</td></tr>
<tr><td>MW-13 and MW-19
Layer 3</td><td>150 ft East-West
100 ft North-South</td><td>3.3</td></tr>
<tr><td>MW-13 and MW-19
Layer 4</td><td>250 ft East-West
200 ft North-South</td><td>4.2</td></tr>
<tr><td>MW-26(S)
Layer 3</td><td>150 ft East-West
100 ft North-South</td><td>40</td></tr>
<tr><td>West Production Well
Layers 3 and 4 or 5 and 6</td><td>200 ft East-West
150 ft North-South</td><td>10.2</td></tr>
<tr><td>Uranium</td><td>MW-24 Layer 3</td><td>200 ft East-West
200 ft North-South</td><td>390</td><td>240</td><td>243</td></tr>
<tr><td rowspan="2">Lead</td><td>MW-24 Layer 3</td><td>300 ft East-West
300 ft North-South</td><td>15.4</td><td rowspan="2">18</td><td rowspan="2">18</td></tr>
<tr><td>MW-21 Layer 4</td><td>200 ft East-West
200 ft North-South</td><td>47</td></tr>
</table>

Table 6A.14. Groundwater Transport Model Results for Non-Pumping, MNA Evaluation.

Observation Point	Overburden/ Bedrock	ADV	ADV/ DISP	ADV/ DISP/ ChemRxn	ADV	ADV/ DISP	ADV/ DISP/ ChemRxn
Beryllium (Years until concentration < 4ug/L)					**Figure Numbers**		
MW13OBS1	Overburden	0	0	0	6A.10	6A.19	6A.28
	Bedrock	1.5	0.5	0.5			
MW13OBS2	Overburden	0	0	0	6A.11	6A.20	6A.29
	Bedrock	0	0	0			
MW26OBS1	Overburden	3	2	150	6A.12	6A.21	6A.30
	Bedrock	1.5	2.5	40			
MW26OBS2	Overburden	11	8	0	6A.13	6A.22	6A.31
	Bedrock	17	9.5	0			
MW02OBS1	Overburden	2	7	60	6A.14	6A.23	6A.32
	Bedrock	10	9	12			
MW01OBS1	Overburden	0	8	3	6A.15	6A.24	6A.33
	Bedrock	7	8	6			
PWWOBS1	Overburden	0	0	0	6A.16	6A.25	6A.34
	Bedrock	5	3.5	3.5			
PWWOBS2	Overburden	0	0	0	6A.17	6A.26	6A.35
	Bedrock	0	0	0			
OBS4	Overburden	25	20	0	6A.18	6A.27	6A.36
	Bedrock	30	20	0			
Lead (Years until concentration < 15ug/L)							
PbMW21OBS1	Overburden	0	2	0	6A.37	6A.43	6A.49
	Bedrock	6	4	3.5			
PbMW21OBS2	Overburden	0	0	0	6A.38	6A.44	6A.50
	Bedrock	12	0	0			
PbMW21OBS3	Overburden	0	0	0	6A.39	6A.45	6A.51
	Bedrock	0	0	0			
PbMW24OBS1	Overburden	NA	NA	NA	6A.40	6A.46	6A.52
	Bedrock	0	0	0			
PbMW24OBS3	Overburden	0	0	0	6A.41	6A.47	6A.53
	Bedrock	0	0	0			
PbMW24OBS4	Overburden	0	0	0	6A.42	6A.48	6A.54
	Bedrock	0	0	0			
Uranium (Years until concentration < 30ug/L)							
UMW24OBS1	Overburden	NA	NA	NA	6A.55	6A.59	6A.63
	Bedrock	0	0	15			
UMW24OBS4	Overburden	0	0	0	6A.56	6A.60	6A.64
	Bedrock	0	0	0			
UMW24OBS5	Overburden	0	0	0	6A.57	6A.61	6A.65
	Bedrock	0	0	0			
UMW24OBS6	Overburden	0	0	0	6A.58	6A.62	6A.66
	Bedrock	0	0	0			

Table 6A.15. Groundwater Transport Model Results for Non-Pumping, Groundwater Pump and Treat Evaluation.

Observation Point	Overburden/ Bedrock	ADV/ DISP/ ChemRxn	ADV/ DISP/ ChemRxn
Beryllium (Years until concentration < 4ug/L)			**Figure Numbers**
MW13OBS1	Overburden	0	6A.67
	Bedrock	0.5	
MW13OBS2	Overburden	0	6A.68
	Bedrock	0	
MW26OBS1	Overburden	175	6A.69
	Bedrock	25	
MW26OBS2	Overburden	0	6A.70
	Bedrock	0	
MW02OBS1	Overburden	14	6A.71
	Bedrock	2	
MW01OBS1	Overburden	0.5	6A.72
	Bedrock	1	
PWWOBS1	Overburden	0	6A.73
	Bedrock	1	
PWWOBS2	Overburden	0	6A.74
	Bedrock	0	
OBS4	Overburden	0	6A.75
	Bedrock	0	
Lead (Years until concentration < 15ug/L)			
PbMW21OBS1	Overburden	0.2	6A.76
	Bedrock	0.5	
PbMW21OBS2	Overburden	0	6A.77
	Bedrock	0	
PbMW21OBS3	Overburden	0	6A.78
	Bedrock	0	
PbMW24OBS1	Overburden	1.5	6A.79
	Bedrock	0	
PbMW24OBS3	Overburden	0	6A.80
	Bedrock	0	
PbMW24OBS4	Overburden	0	6A.81
	Bedrock	0	
Uranium (Years until concentration < 30ug/L)			
UMW24OBS1	Overburden	NA	6A.82
	Bedrock	35	
UMW24OBS4	Overburden	0	6A.83
	Bedrock	0	
UMW24OBS5	Overburden	0	6A.84
	Bedrock	0	
UMW24OBS6	Overburden	0	6A.85
	Bedrock	0	

Table 6A.16. Groundwater Transport Model Results for Pumping, MNA and Groundwater Pump and Treat Evaluation.

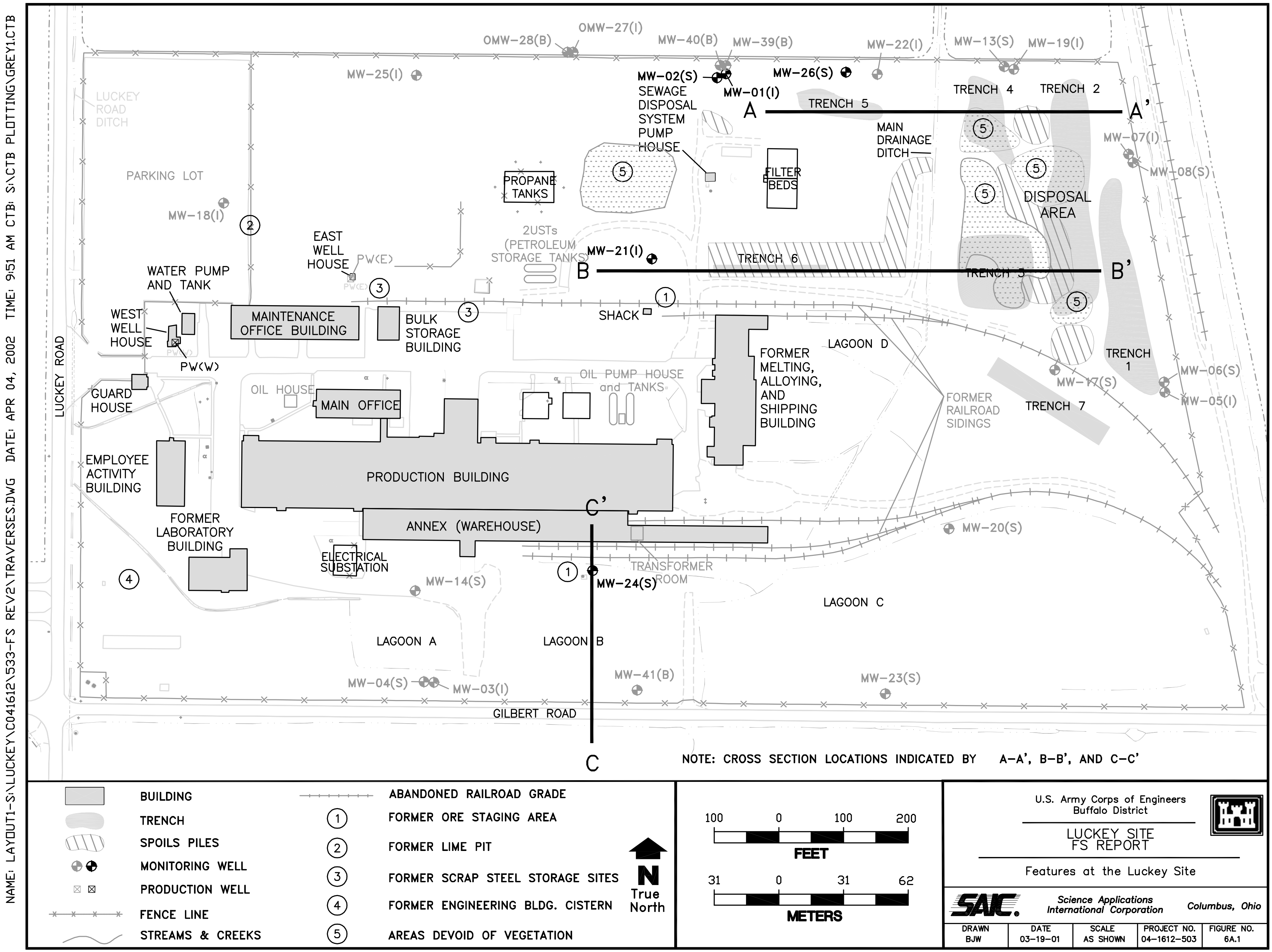
Observation Point	Overburden/ Bedrock	ADV/ DISP/ ChemRxn	ADV/ DISP/ ChemRxn	ADV/ DISP/ ChemRxn	ADV/ DISP/ ChemRxn
		MNA	Pump-and-Treat	MNA	Pump-and-Treat
Beryllium (Years until concentration < 4ug/L)				**Figure Numbers**	
MW13OBS1	Overburden	0	0	6A.86	6A.94
	Bedrock	0.5	0.5		
MW26OBS1	Overburden	175	90	6A.87	6A.95
	Bedrock	40	26		
MW02OBS1	Overburden	90	125	6A.88	6A.96
	Bedrock	90	50		
MW01OBS1	Overburden	1.5	3	6A.89	6A.97
	Bedrock	4.5	3.5		
PWEOBS1	Overburden	0	0	6A.90	6A.98
	Bedrock	0	0		
PWEOBS2	Overburden	0	0	6A.91	6A.99
	Bedrock	3	0		
PWWOBS1	Overburden	0	0	6A.92	6A.100
	Bedrock	1	1		
OBS3	Overburden	0	0	6A.93	6A.101
	Bedrock	0	0		
Lead (Years until concentration < 15ug/L)					
PbMW21OBS1	Overburden	0	0	6A.102	6A.106
	Bedrock	1.2	0.5		
PbMW24OBS1	Overburden	NA	NA	6A.103	6A.107
	Bedrock	0	0		
PbMW24OBS2	Overburden	NA	NA	NA	6A.108
	Bedrock	NA	0		
PbMW24OBS3	Overburden	0	0	6A.104	6A.109
	Bedrock	0	0		
PWEOBS1	Overburden	0	0	6A.105	6A.110
	Bedrock	0	0		
Uranium (Years until concentration < 30ug/L)					
UMW24OBS1	Overburden	NA	NA	6A.111	6A.114
	Bedrock	0	0		
UMWOBS3	Overburden	NA	NA	NA	6A.115
	Bedrock	NA	0		
UMW24OBS4	Overburden	0	0	6A.112	6A.116
	Bedrock	0	0		
PWEOBS1	Overburden	0	0	6A.113	6A.117
	Bedrock	0	0		

Table 6A.17. Time Frames for Alternative 7 - MNA and Alternative 8 - Active Pump and Treat at Luckey Under Non-Pumping and Pumping Conditions

Constituent	Location	Alternative 7 Monitored Natural Attenuation			Alternative 8 Active Groundwater Treatment		
		Clay-Rich Till	Sand & Gravel	Bedrock	Clay-Rich Till	Sand & Gravel	Bedrock
NON-PUMPING CONDITIONS							
Beryllium	MW-01(I)	--	60	12	--	14	2
	MW-26(S)	--	150	40	--	50-80	25
	PW(W)[1]	--	0	3.5	--	0	1
Lead	MW-21(I)[2]	--	0	3.5	--	0	0.5
	MW-24(S)[3]	400-600	--	3.5	200-400	--	1
Uranium	MW-24(S)	>1,000	--	30	200-500	--	10
PUMPING CONDITIONS							
Beryllium	MW-01(I)	--	1.5	4.5	--	3.5	3
	MW-26(S)	--	175	40	--	90	26
	PW(W)[1]	--	0	1	--	0	1
Lead	MW-21(I)[2]	--	0	1.2	--	0	0.5
	MW-24(S)[3,4]	400-600	--	NA	200-400	--	NA
Uranium	MW-24(S) [4]	>1000	--	NA	200-500	--	NA

[1]—Simulations for beryllium at PW(W) were initiated with beryllium in the bedrock only, and concentrations never exceed ARAR-based cleanup goals in the sand and gravel.
[2]—Simulations for lead at MW-21(I) were initiated with lead in the upper weathered bedrock only, and concentration never exceed ARAR-based cleanup goals in the overlying sand and gravel.
[3]—Sand and gravel does not occur at MW-24(S) and therefore, no time frames are reported for both uranium and lead at this location.
[4]—Simulations for lead and uranium under pumping conditions were completed with the source term (starting concentrations) released in the overburden. No simulations were run with the source term released only in the upper bedrock, and therefore, timeframes are not reported for the bedrock for lead and uranium at MW-24(S).

Note: The timeframes in Table 6A.17 are based upon predictive modeling results. Modeling was not performed for electrokinetics. Estimated total time for the completion of groundwater remediation using electrokinetics is 15 years for the clay-rich tills and the sands and gravels. Remediation of groundwater in the carbonate bedrock is assumed to be similar in duration to MNA for achievement of ARARs since electrokinetics may not be effective. Long time frames for achievement of ARARs are possible (as predicted from modeling) for groundwater in the clay-rich till. In particular, the area around MW-24(S) results in significant time frames for both MNA and pump and treat evaluations if constituents occur within the clay-rich till above the weathered bedrock. MW-24(S) is completed across the interface between the clay-rich till and the upper weathered bedrock. Based upon the lithologic log for MW-24(S), clay-rich till occur immediately above the bedrock (there is no significant sand and gravel identified in the log for MW-24(S)). Therefore, no timeframes are reported in Table 6A.17 for sand and gravel at MW-24(S) for either lead or uranium.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OMW-27(I)
MW-40(B)
MW-39(B)
MW-22(I)
MW-13(S)
MW-19(I)
MW-25(I)
MW-02(S)
MW-01(I)
MW-26(S)
SEWAGE DISPOSAL SYSTEM PUMP HOUSE
TRENCH 4
TRENCH 2
TRENCH 5
A
A'
LUCKEY ROAD DITCH
MAIN DRAINAGE DITCH
MW-07(I)
MW-08(S)
PARKING LOT
PROPANE TANKS
FILTER BEDS
DISPOSAL AREA
MW-18(I)
EAST WELL HOUSE
PW(E)
2USTs (PETROLEUM STORAGE TANKS)
MW-21(I)
TRENCH 6
TRENCH 3
B
B'
WATER PUMP AND TANK
WEST WELL HOUSE
PW(W)
MAINTENANCE OFFICE BUILDING
BULK STORAGE BUILDING
SHACK
FORMER MELTING, ALLOYING, AND SHIPPING BUILDING
LAGOON D
TRENCH 1
MW-06(S)
MW-05(I)
MW-17(S)
TRENCH 7
FORMER RAILROAD SIDINGS
LUCKEY ROAD
GUARD HOUSE
OIL HOUSE
MAIN OFFICE
OIL PUMP HOUSE and TANKS
EMPLOYEE ACTIVITY BUILDING
PRODUCTION BUILDING
FORMER LABORATORY BUILDING
C'
ANNEX (WAREHOUSE)
MW-20(S)
ELECTRICAL SUBSTATION
TRANSFORMER ROOM
MW-24(S)
MW-14(S)
LAGOON C
LAGOON A
LAGOON B
MW-41(B)
MW-23(S)
MW-04(S)
MW-03(I)
GILBERT ROAD
C
NOTE: CROSS SECTION LOCATIONS INDICATED BY A-A', B-B', AND C-C'
BUILDING
TRENCH
SPOILS PILES
MONITORING WELL
PRODUCTION WELL
FENCE LINE
STREAMS & CREEKS
ABANDONED RAILROAD GRADE
1 FORMER ORE STAGING AREA
2 FORMER LIME PIT
3 FORMER SCRAP STEEL STORAGE SITES
4 FORMER ENGINEERING BLDG. CISTERN
5 AREAS DEVOID OF VEGETATION
N True North
100 0 100 200
FEET
31 0 31 62
METERS
U.S. Army Corps of Engineers Buffalo District
LUCKEY SITE FS REPORT
Features at the Luckey Site
SAIC
Science Applications International Corporation
Columbus, Ohio
DRAWN BJW
DATE 03-19-01
SCALE AS SHOWN
PROJECT NO. 04-1612-503
FIGURE NO. 6A.1

Figure 6A.1

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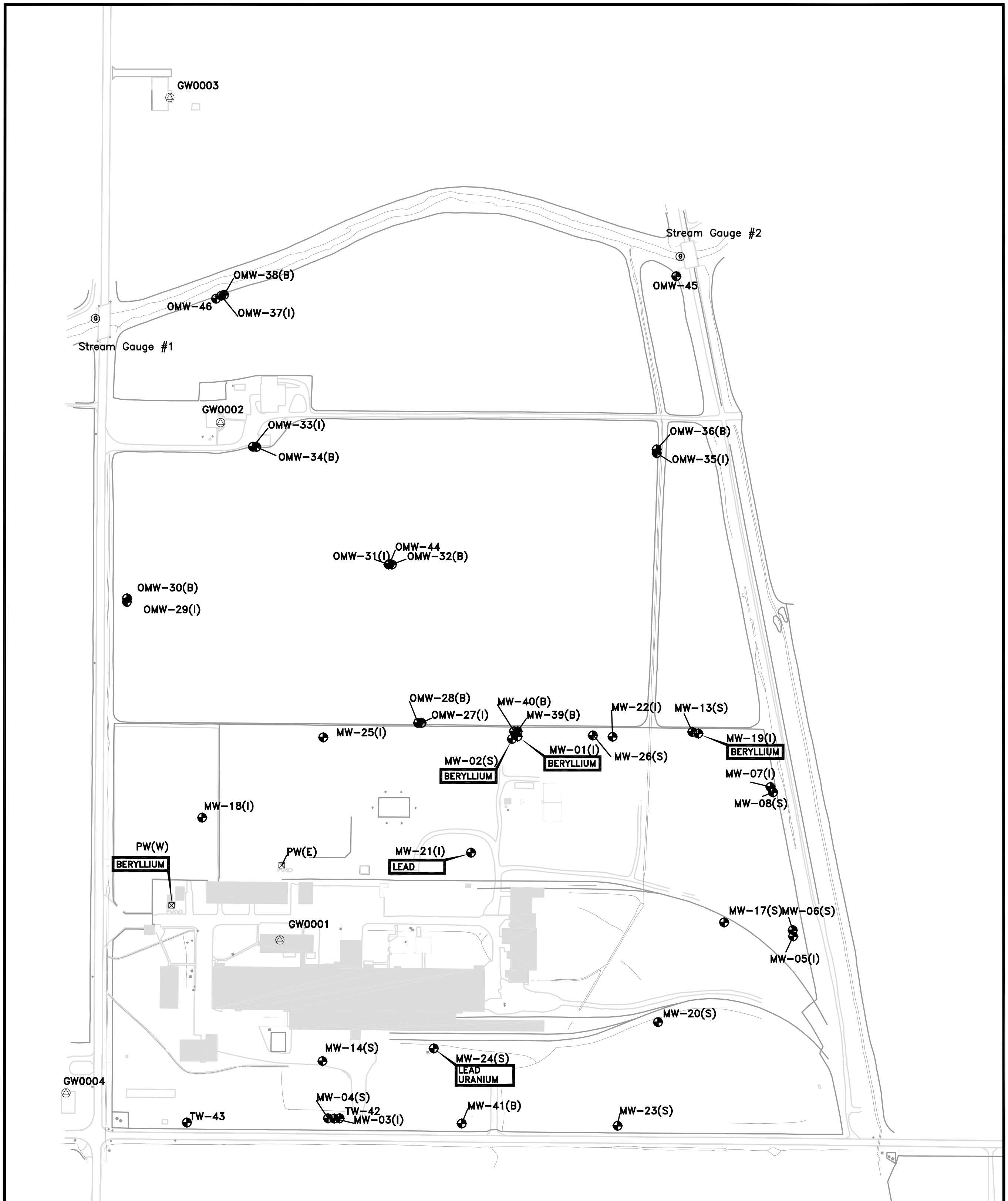


BUILDING
LOW LYING AREAS
FENCE LINE
STREAMS & CREEKS
ABANDONED RAILROAD GRADE
BERYLLIUM WELL CONTAINS ELEVATED BERYLLIUM
LEAD WELL CONTAINS ELEVATED LEAD
URANIUM WELL CONTAINS ELEVATED URANIUM
RESIDENTIAL WELLS/TAP WATER
GROUNDWATER MONITORING WELLS
STREAM GAUGE

N True North

0 175 350 FEET

0 53 106 METERS

U.S. Army Corps of Engineers
Buffalo District

LUCKEY SITE
FS REPORT

Location of Wells at the Luckey Site

SAIC. Science Applications International Corporation Columbus, Ohio

DRAWN	DATE	SCALE	PROJECT NO.	FIGURE NO.
BJW	03-23-01	AS SHOWN	04-1612-503	6A.2

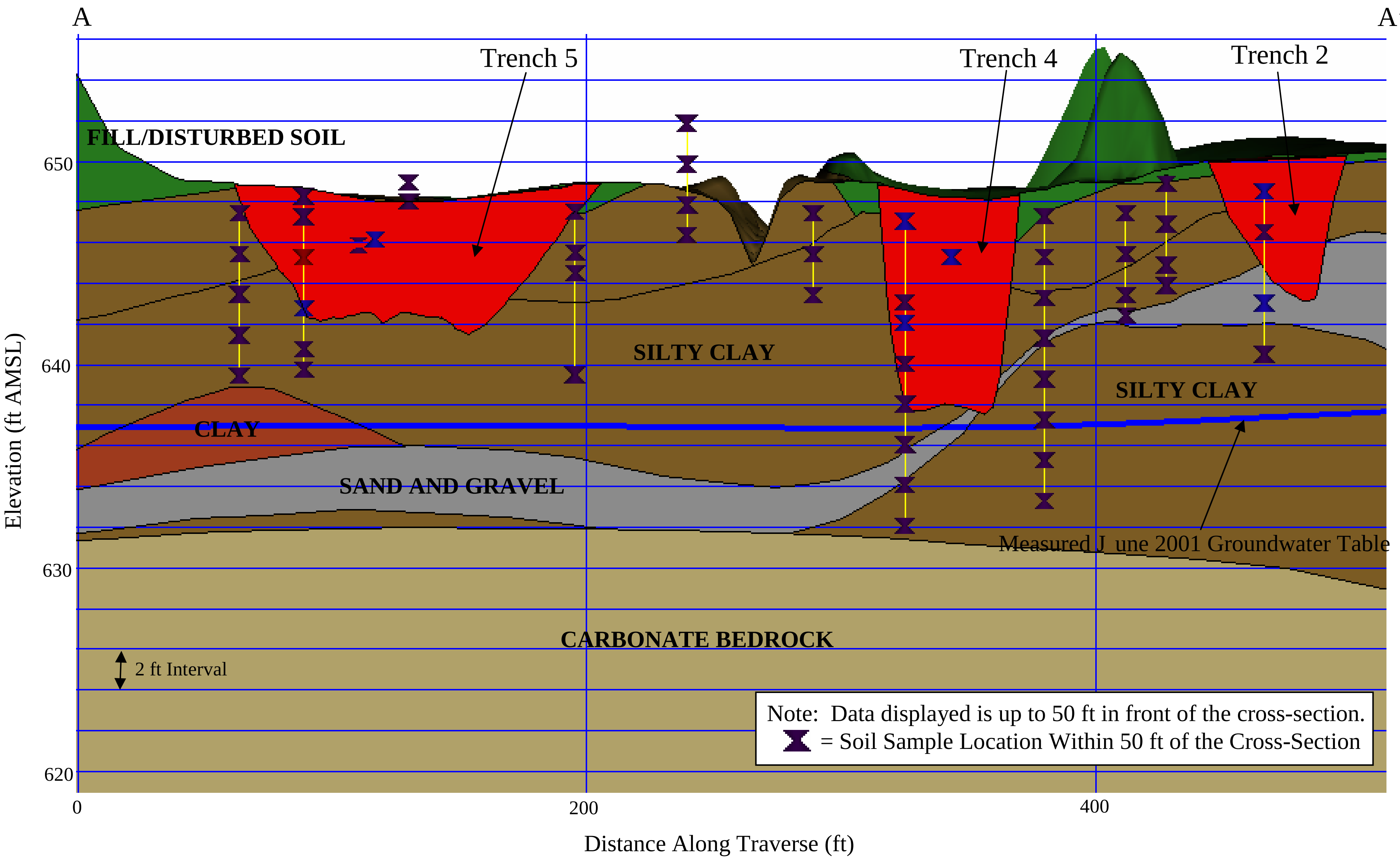


Figure 6A.3. Geologic Cross Section A-A'

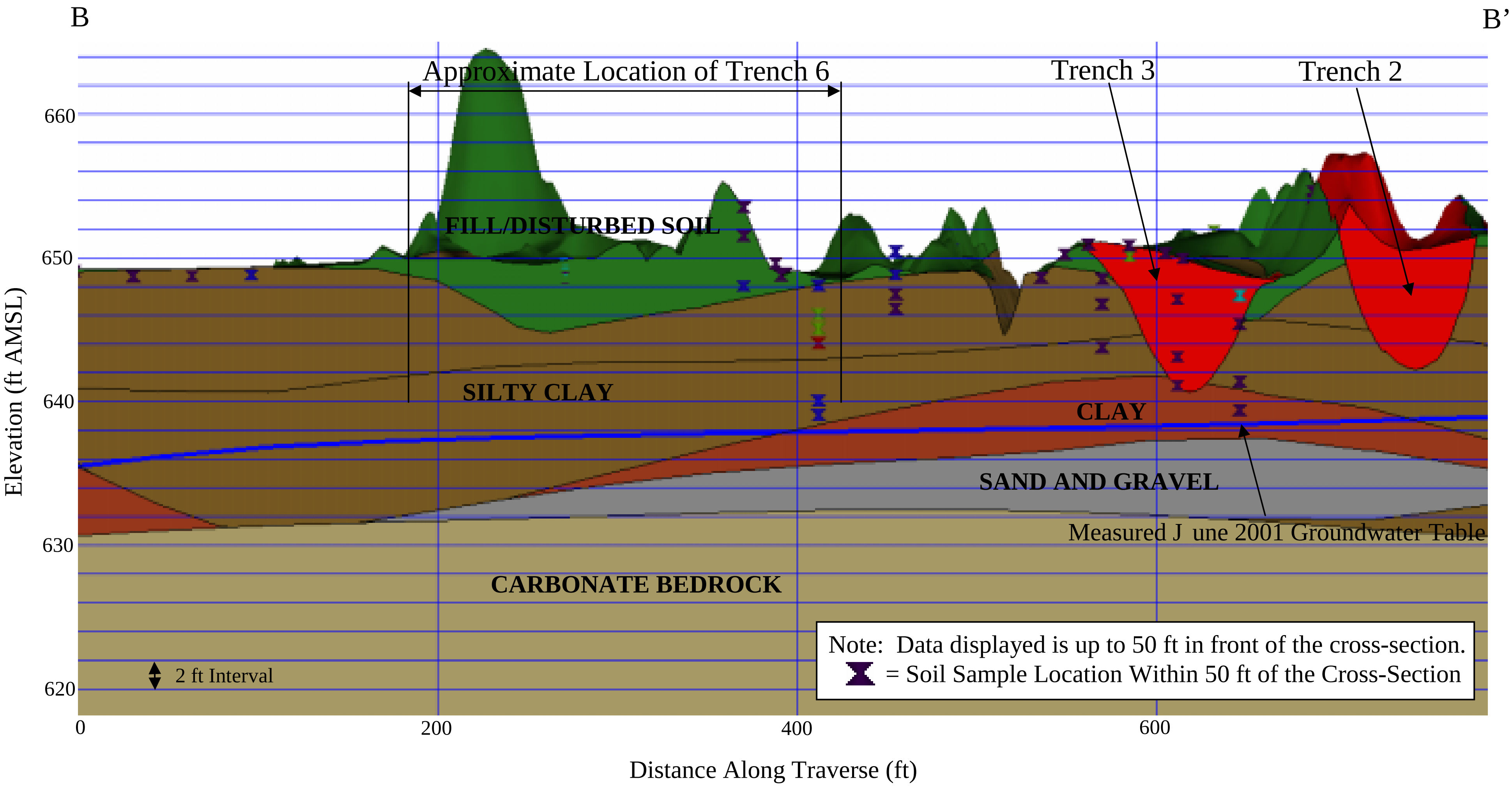


Figure 6A.4. Geologic Cross Section B-B'

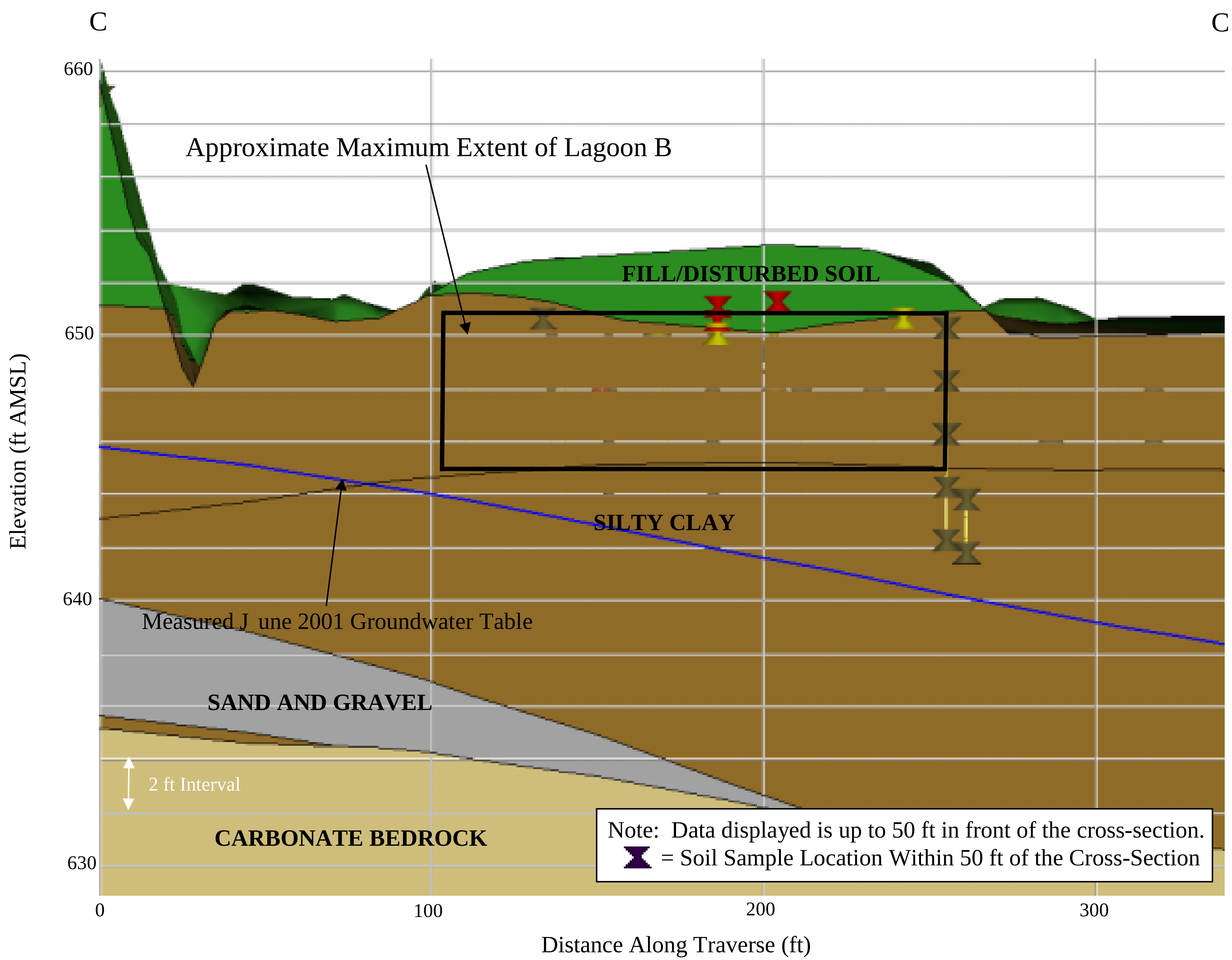


Figure 6A.5. Geologic Cross Section C-C'

Figure 6A.6. Beryllium Transport from Beneath Trench 5

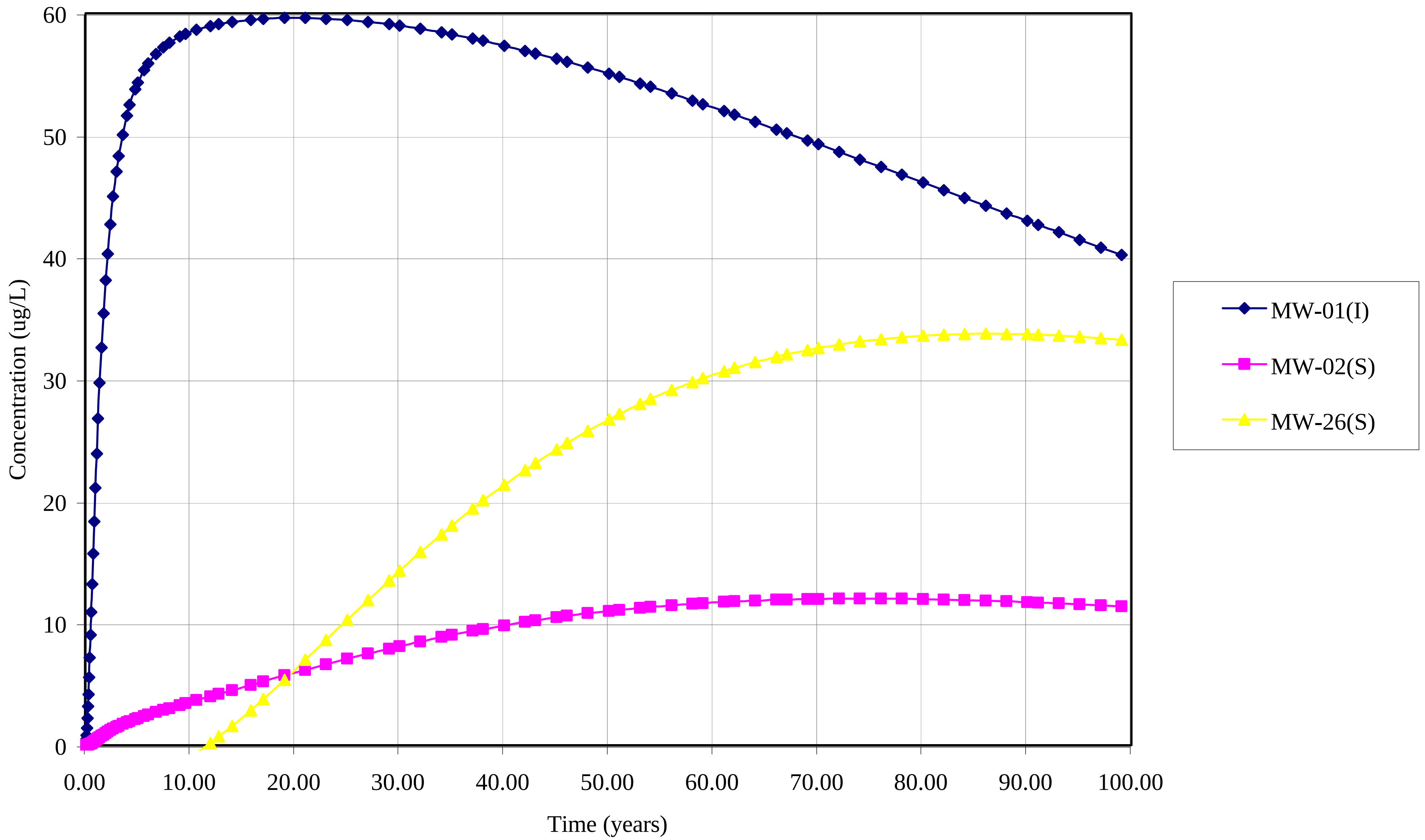


Fig6A6luck420_Be_Pump_Adv_Dis_Chem_PotSource5CHARTS.xls.xls

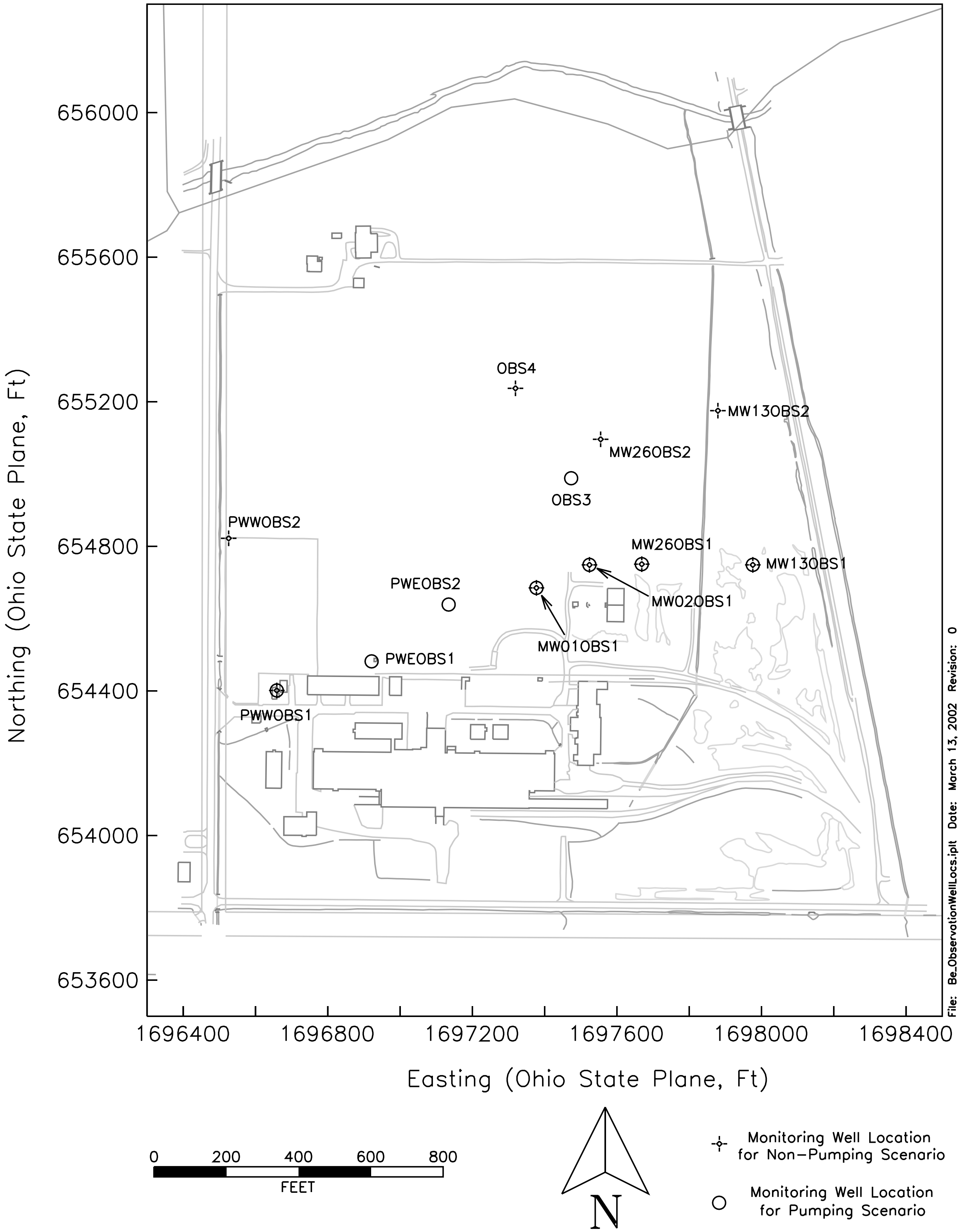


Figure 6A.7. Observation Points for Beryllium in Groundwater Transport Scenarios

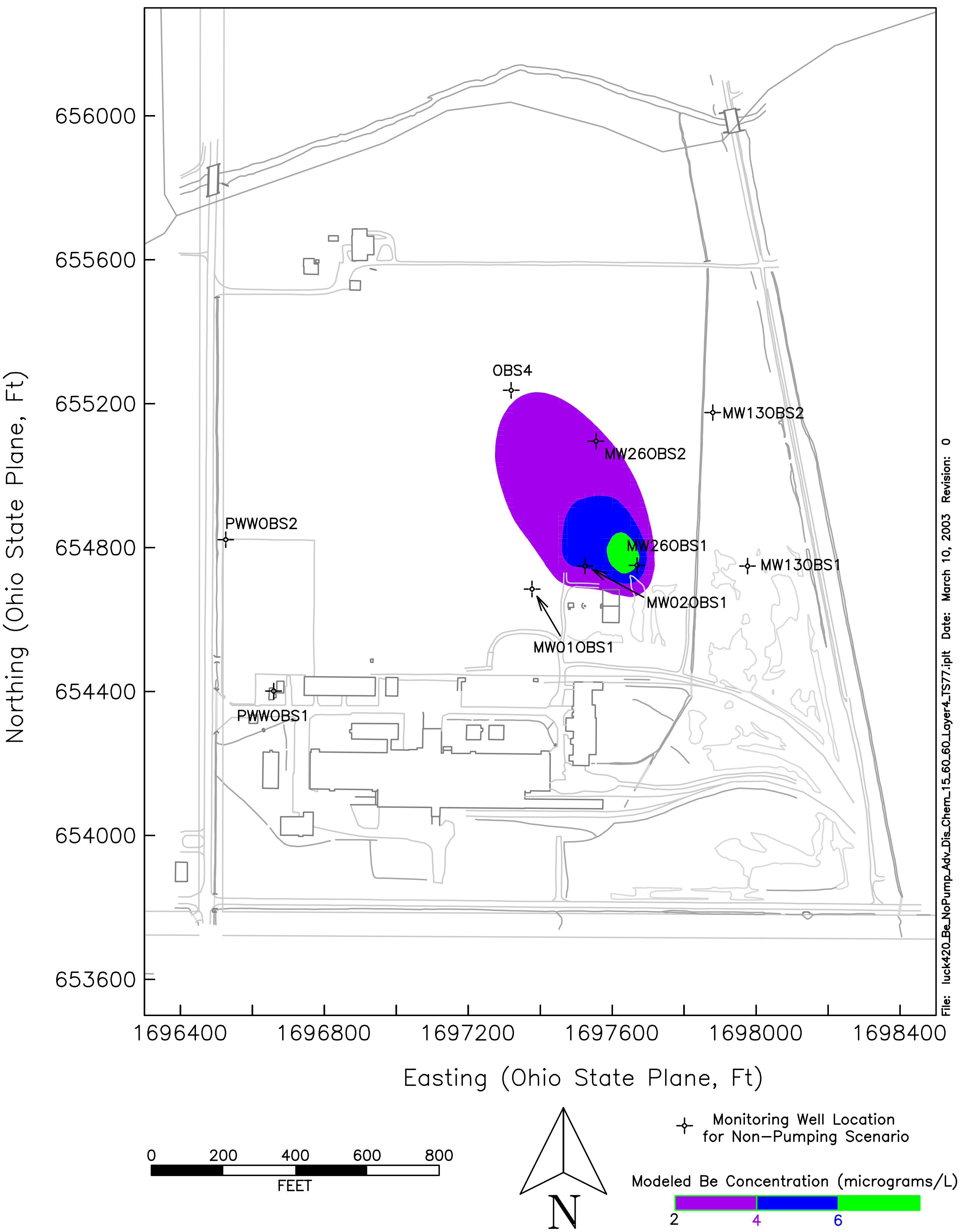


Figure 6A.7a. Beryllium Distribution in Model Layer 4 (Top 20 ft of Bedrock) 10 Years Following Initial Release

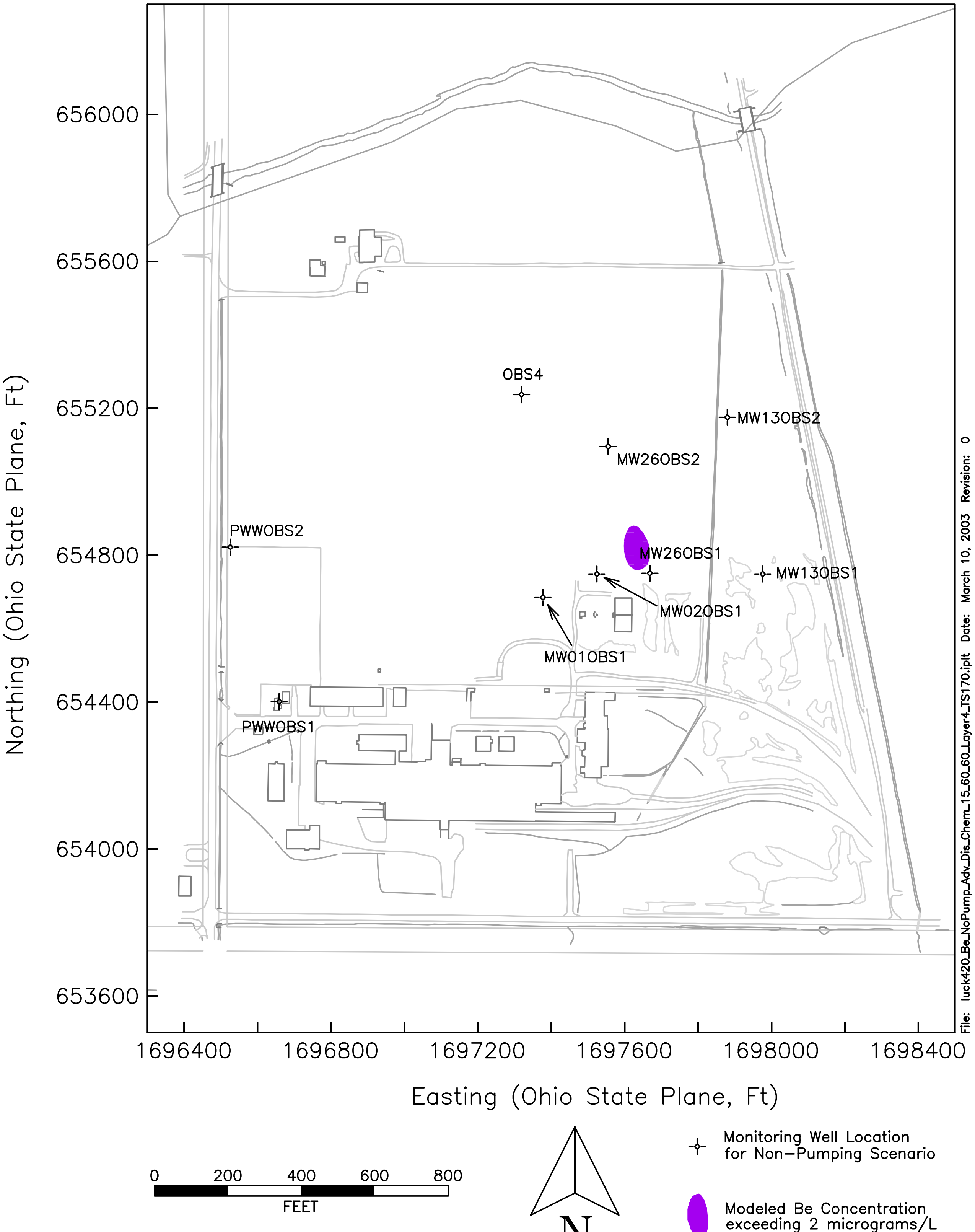


Figure 6A.7b. Beryllium Distribution in Model Layer 4 (Top 20 ft of Bedrock) 100 Years Following Initial Release

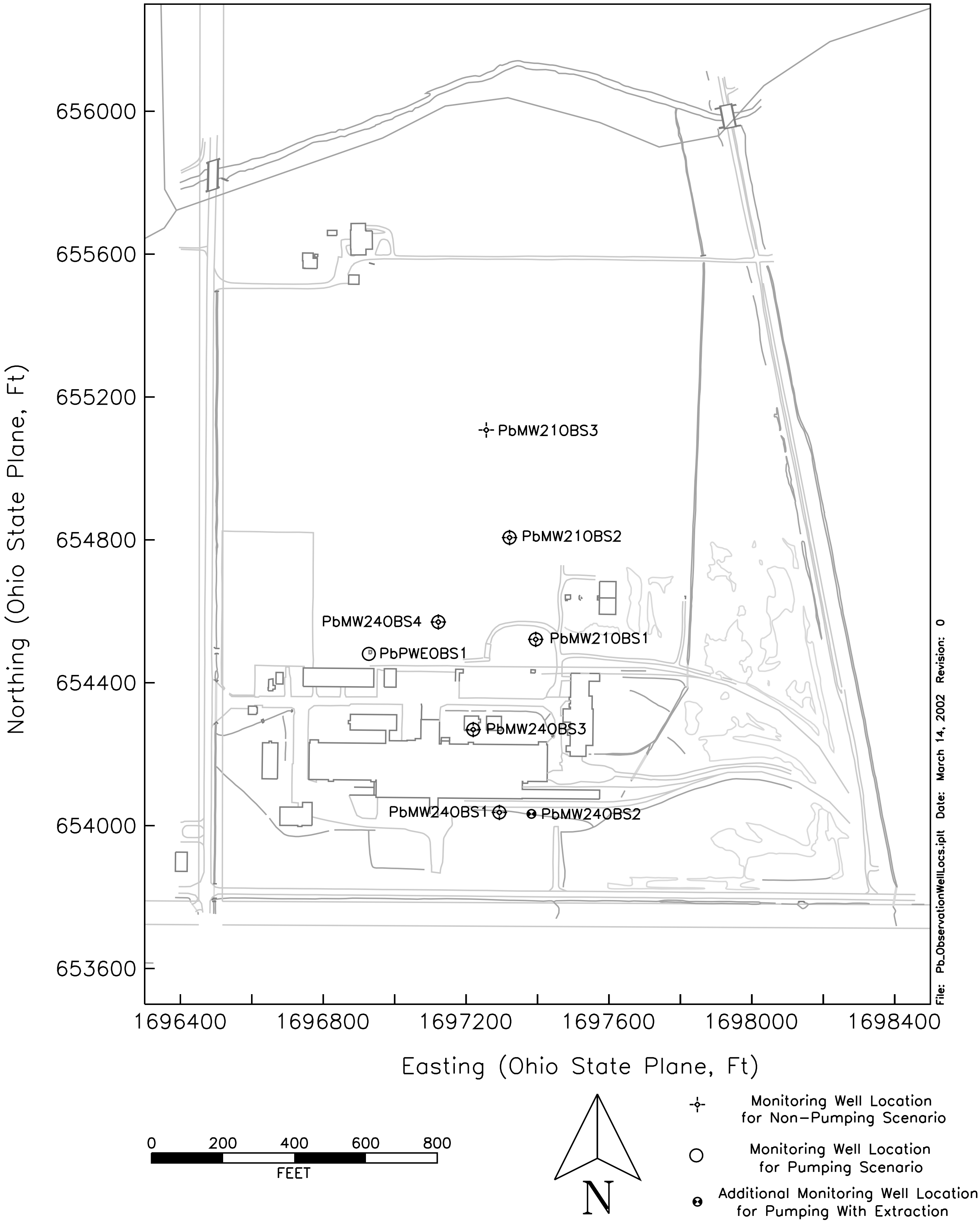


Figure 6A.8. Observation Points for Lead in Groundwater Transport Scenarios

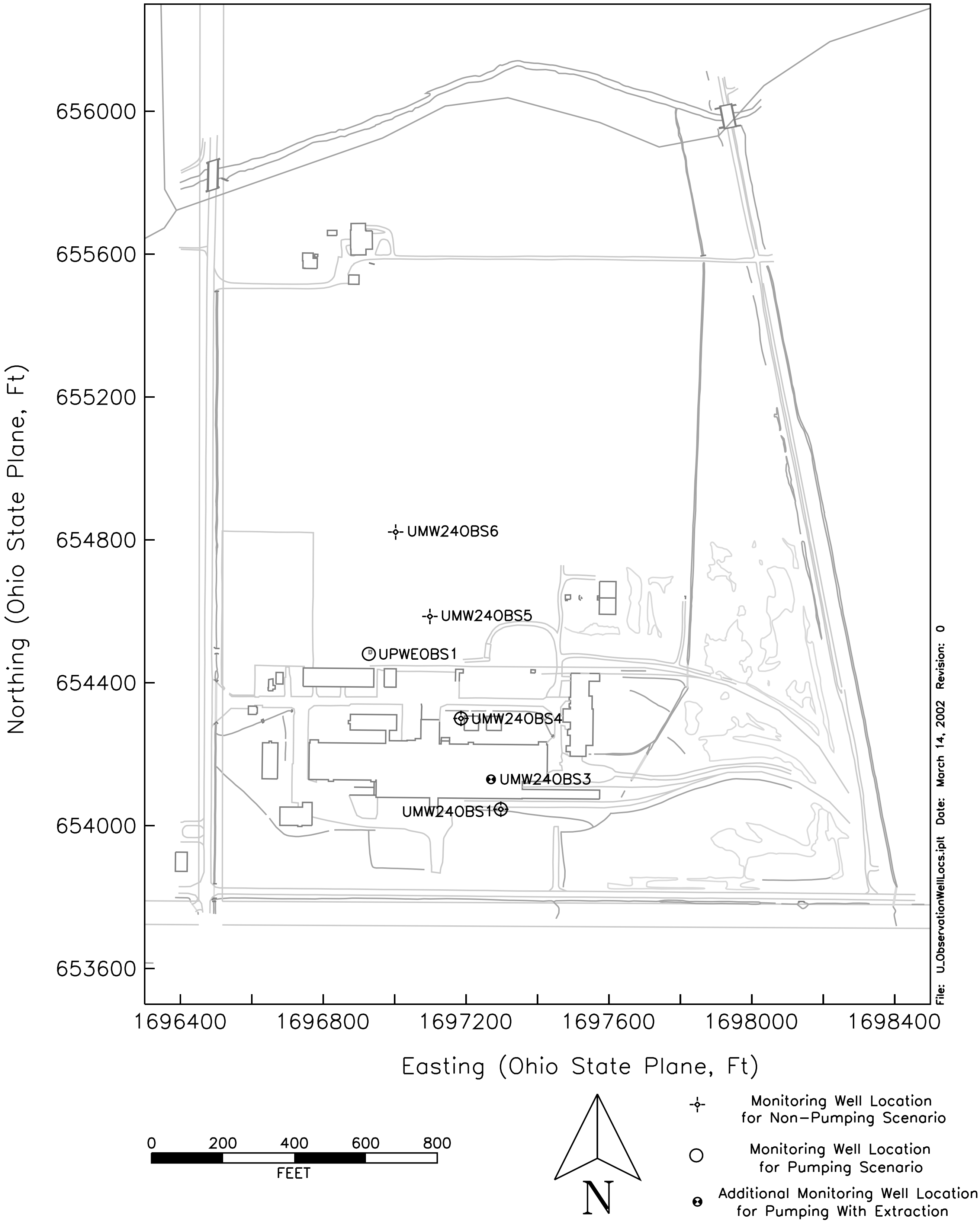
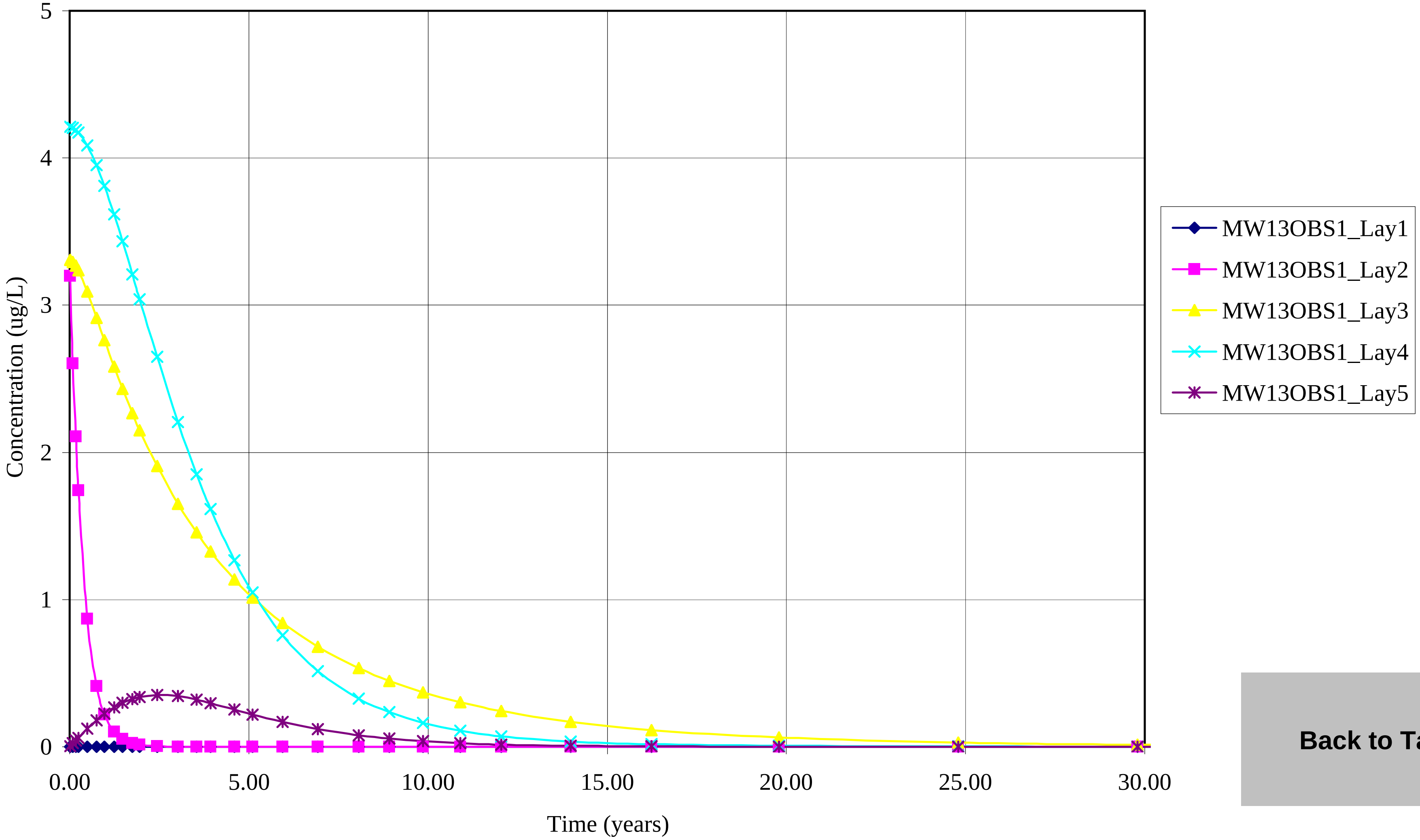


Figure 6A.9. Observation Points for Uranium in Groundwater Transport Scenarios

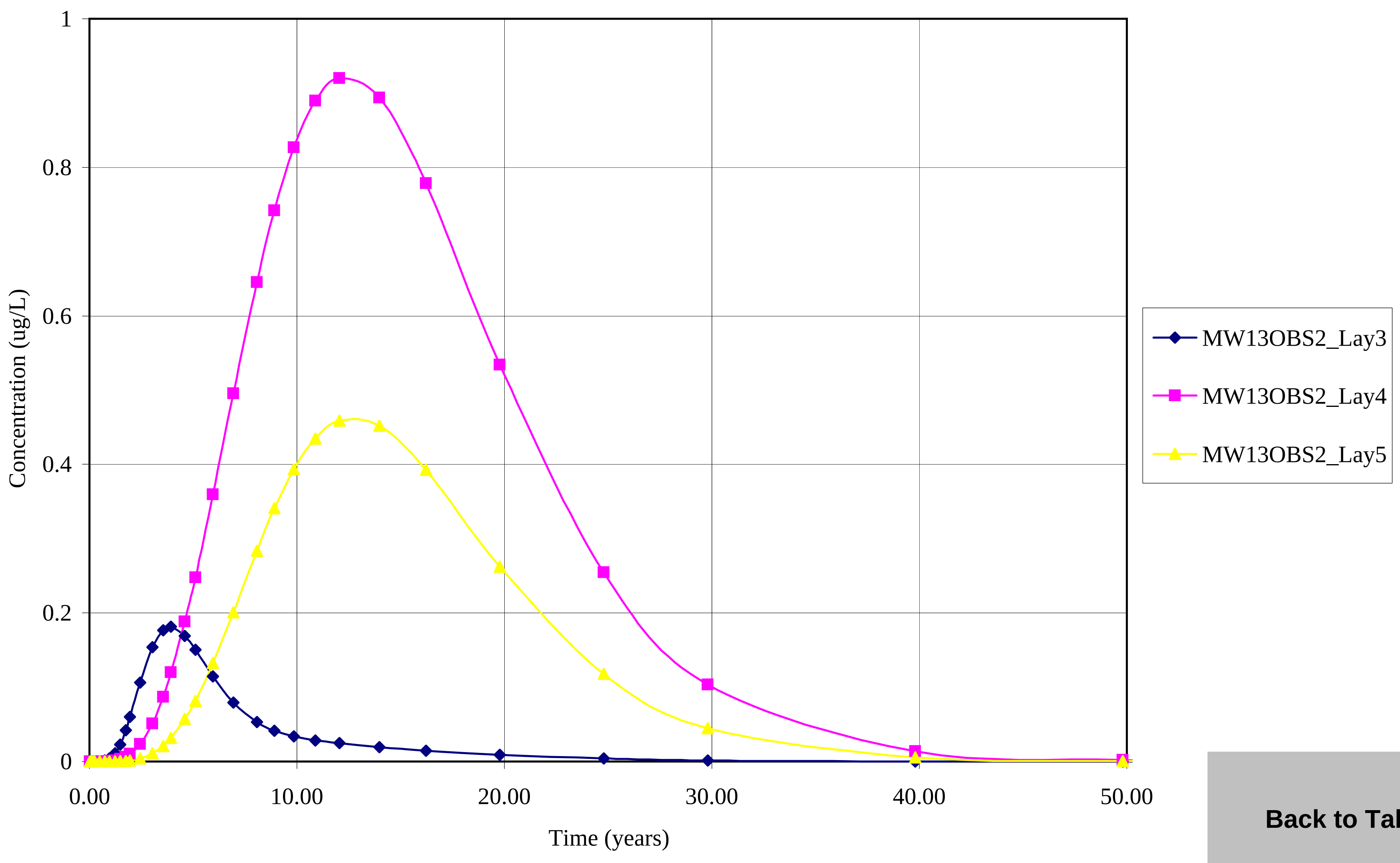
Figure 6A.10. MW13OBS1 Beryllium (Non-pumping) Advection



Back to Table

luck420_Be_NoPump_AdvOnly_15_60_60ObsWellDataCHARTS.xls

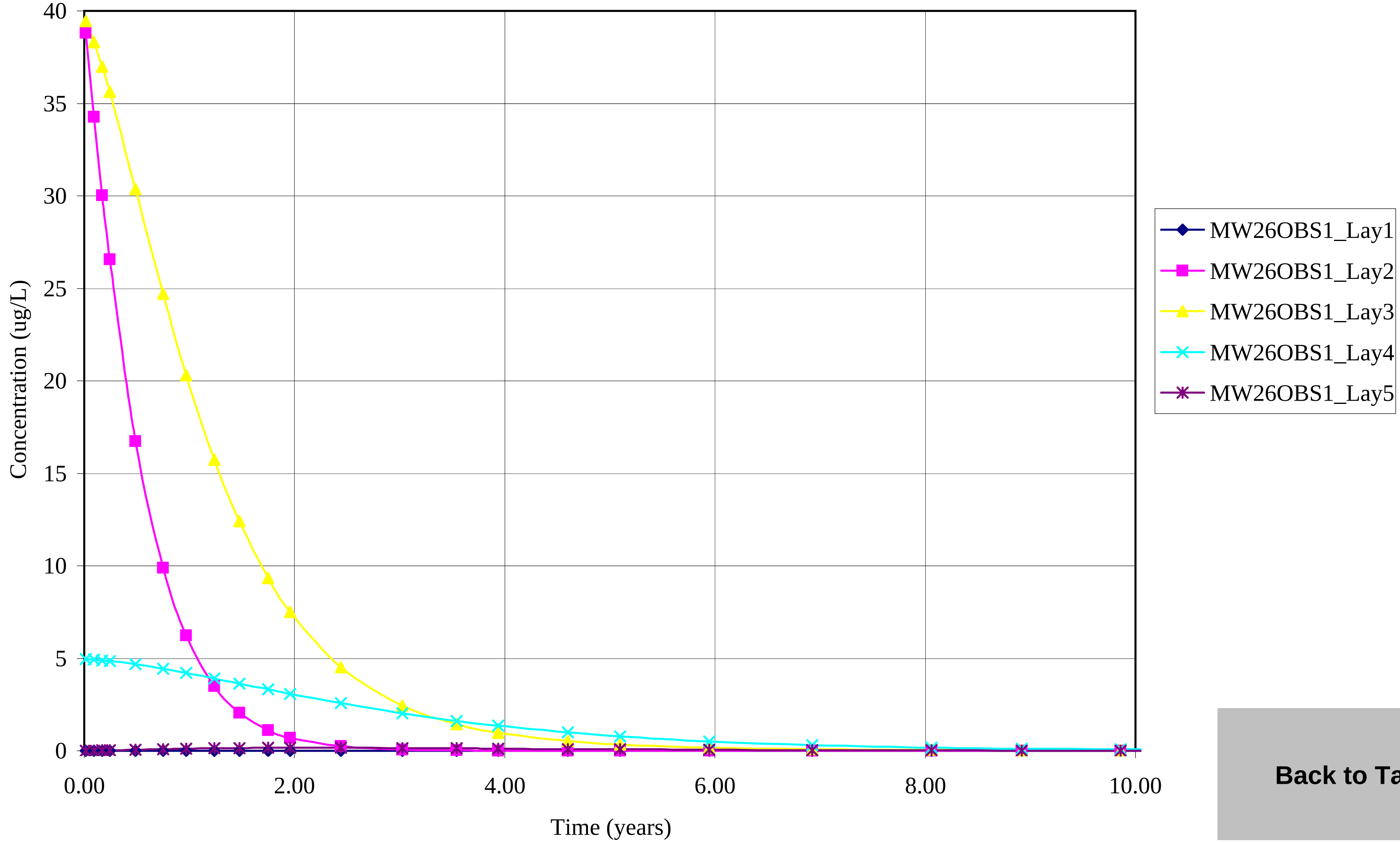
Figure 6A.11. MW13OBS2 Beryllium (Non-pumping) Advection



Back to Table

luck420_Be_NoPump_AdvOnly_15_60_60ObsWellDataCHARTS.xls

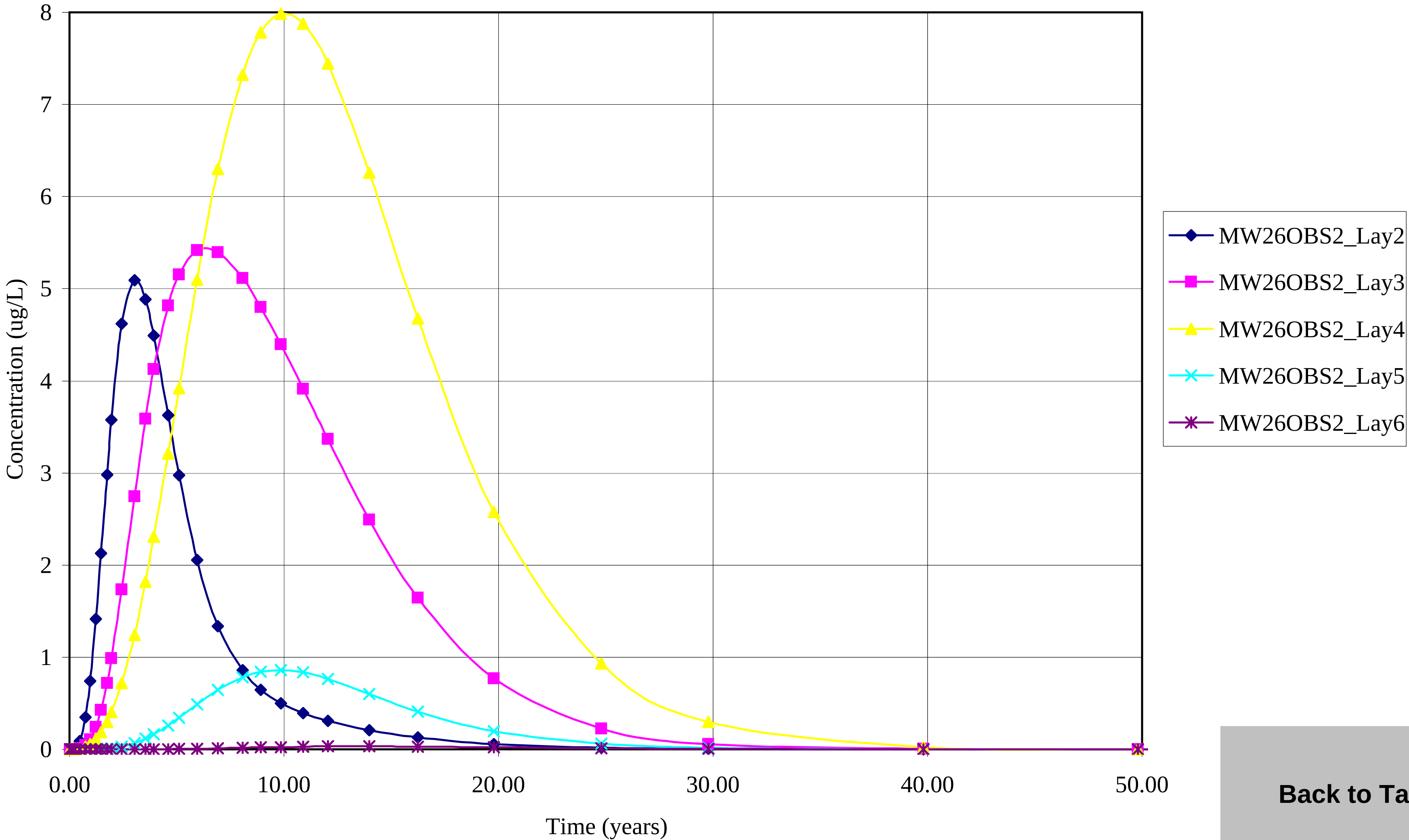
Figure 6A.12. MW26OBS1 Beryllium (Non-pumping) Advection



Back to Table

luck420_Be_NoPump_AdvOnly_15_60_60ObsWellDataCHARTS.xls

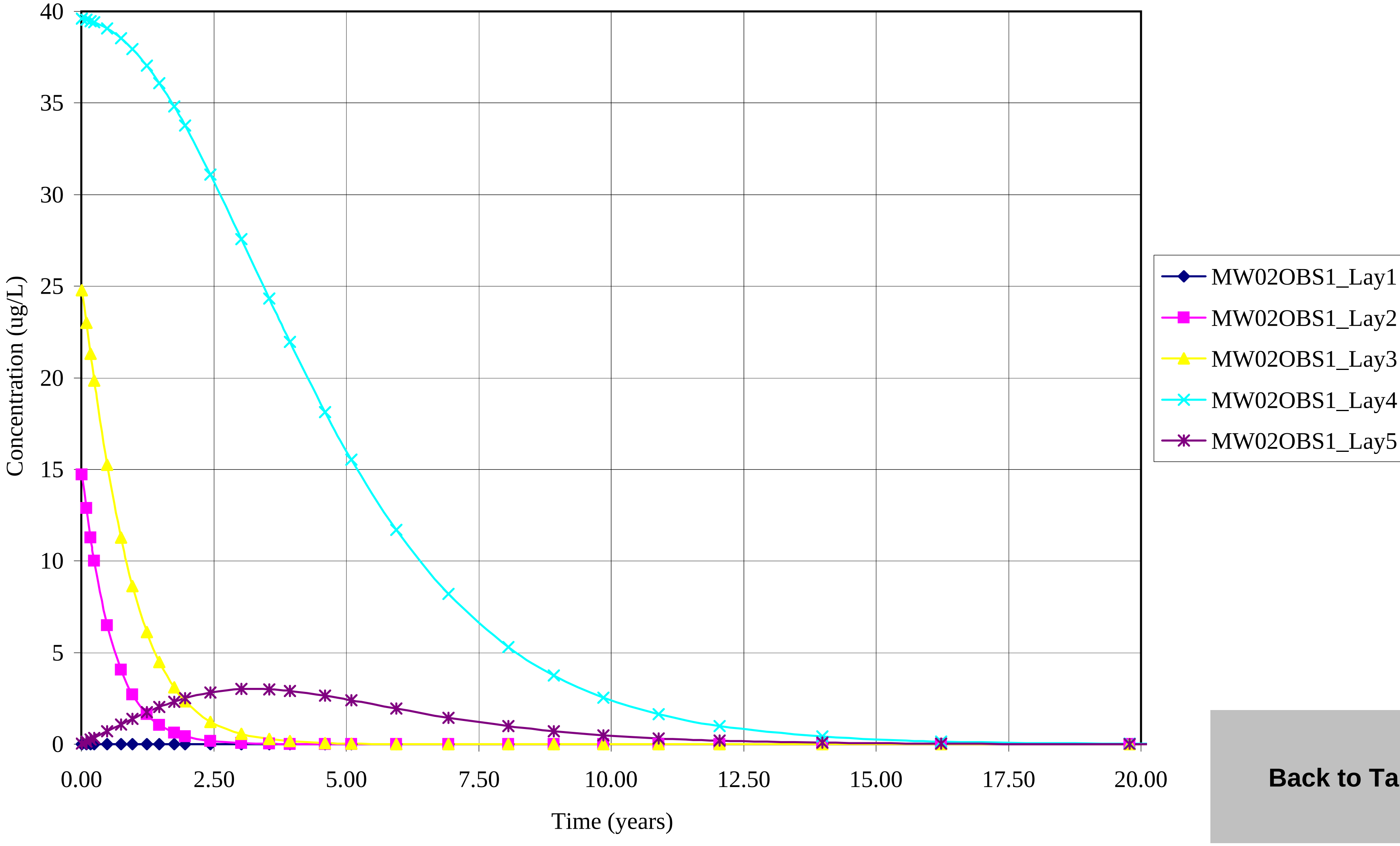
Figure 6A.13. MW26OBS2 Beryllium (Non-pumping) Advection



Back to Table

luck420_Be_NoPump_AdvOnly_15_60_60ObsWellDataCHARTS.xls

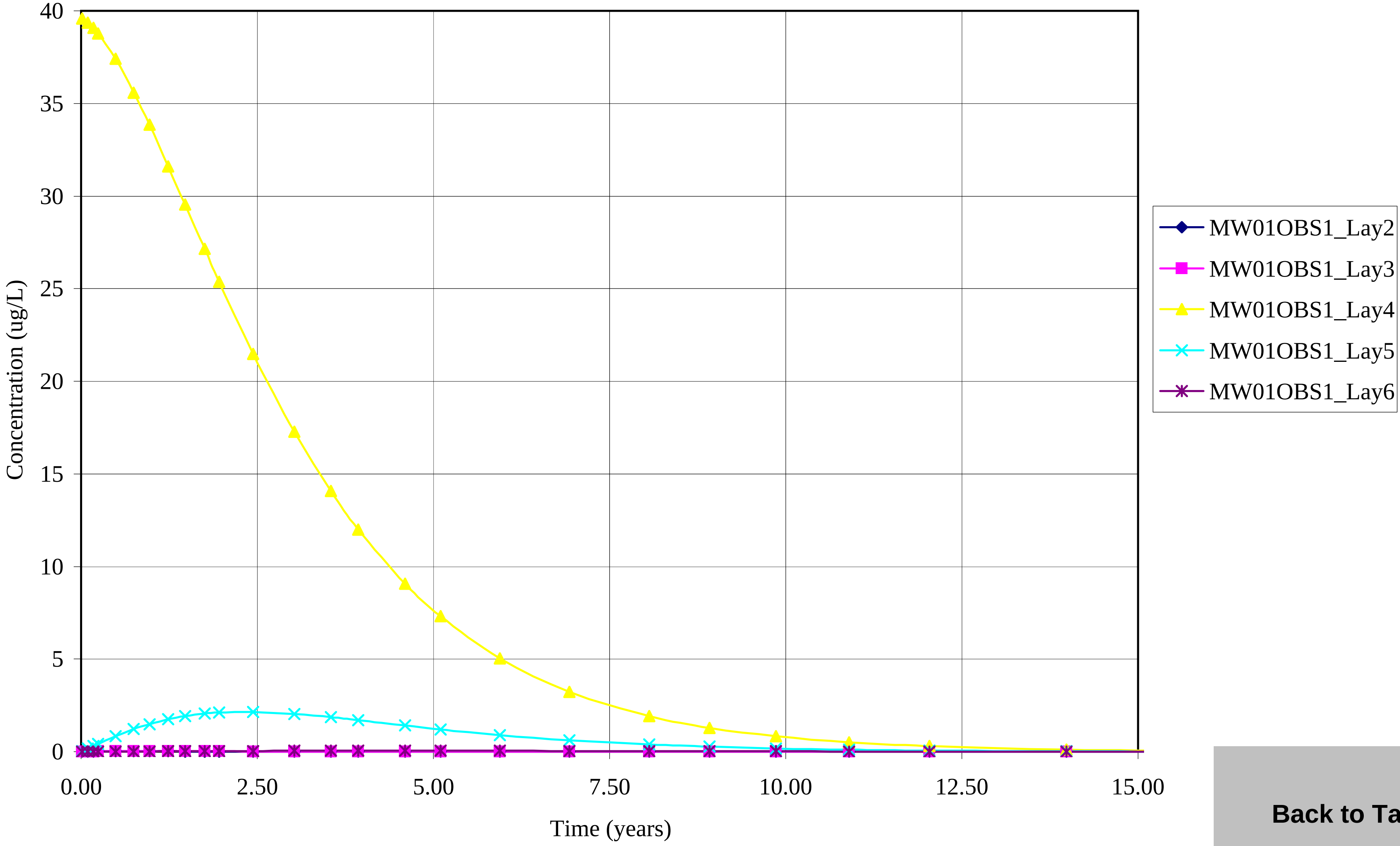
Figure 6A.14. MW02OBS1 Beryllium (Non-pumping) Advection



Back to Table

luck420_Be_NoPump_AdvOnly_15_60_60ObsWellDataCHARTS.xls

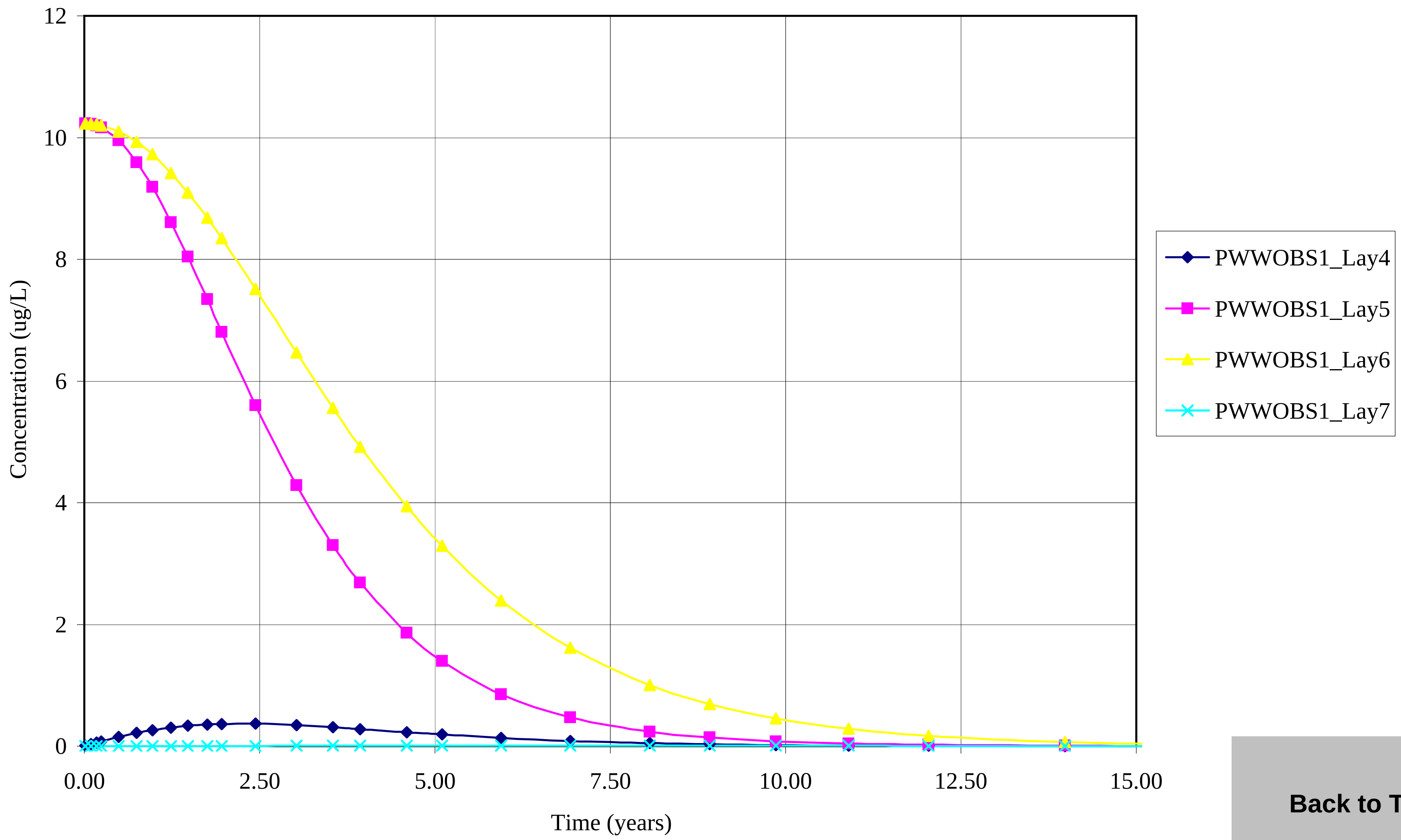
Figure 6A.15. MW01OBS1 Beryllium (Non-pumping) Advection



Back to Table

luck420_Be_NoPump_AdvOnly_15_60_60ObsWellDataCHARTS.xls

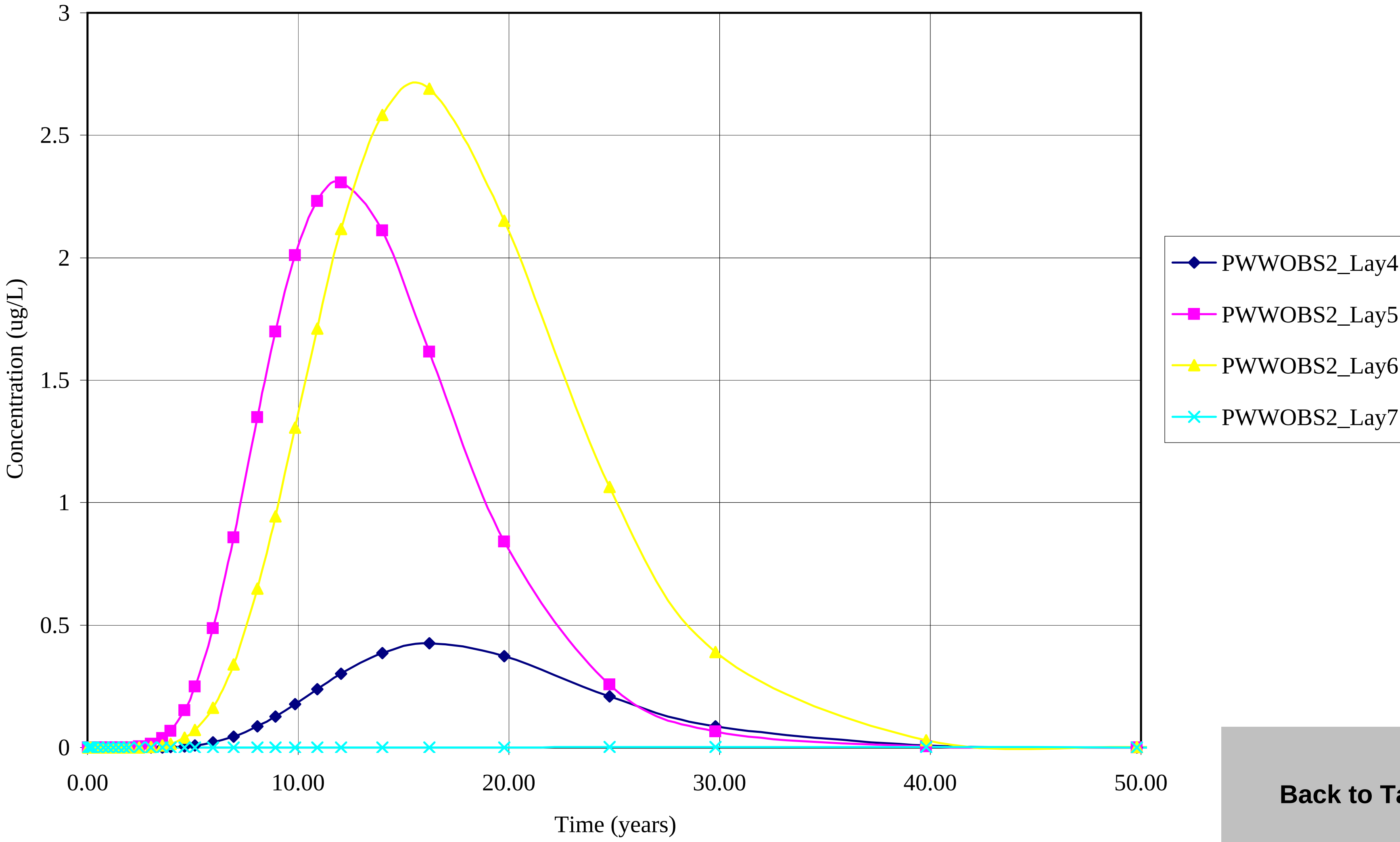
Figure 6A.16. PWWOBS1 Beryllium (Non-pumping) Advection



Back to Table

luck420_Be_NoPump_AdvOnly_15_60_60ObsWellDataCHARTS.xls

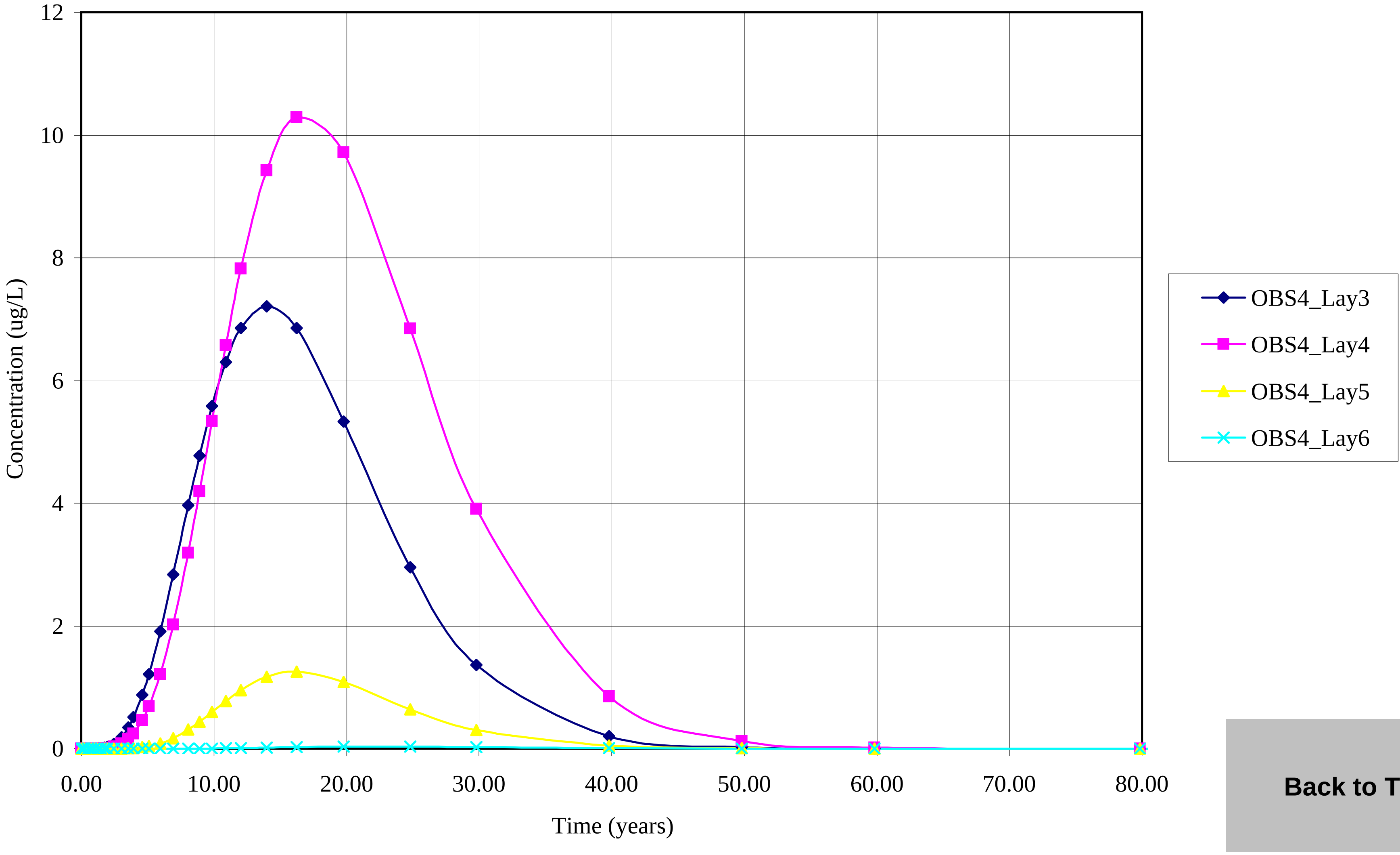
Figure 6A.17. PWWOBS2 Beryllium (Non-pumping) Advection



Back to Table

luck420_Be_NoPump_AdvOnly_15_60_60ObsWellDataCHARTS.xls

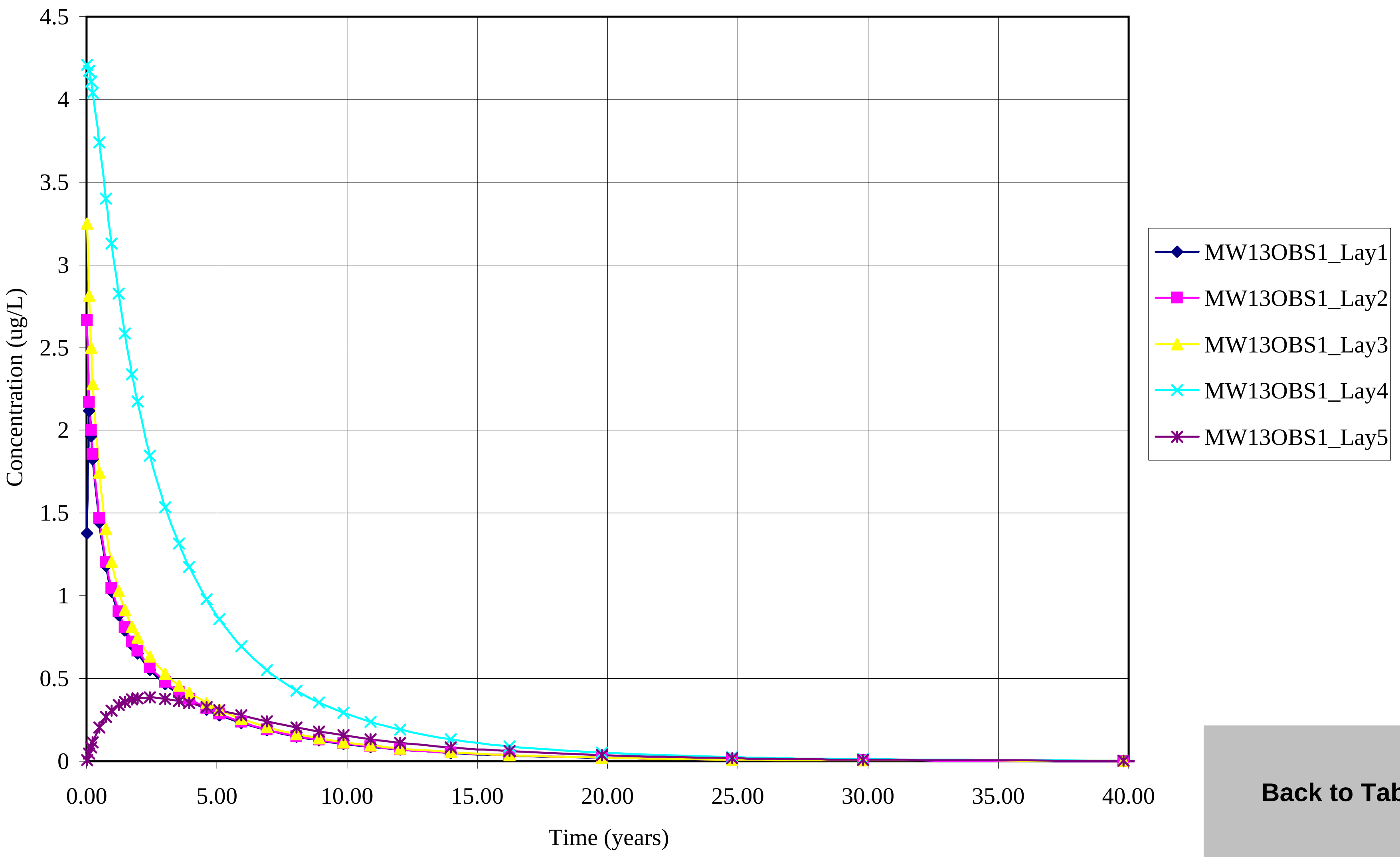
Figure 6A.18. OBS4 Beryllium (Non-pumping) Advection



Back to Table

luck420_Be_NoPump_AdvOnly_15_60_60ObsWellDataCHARTS.xls

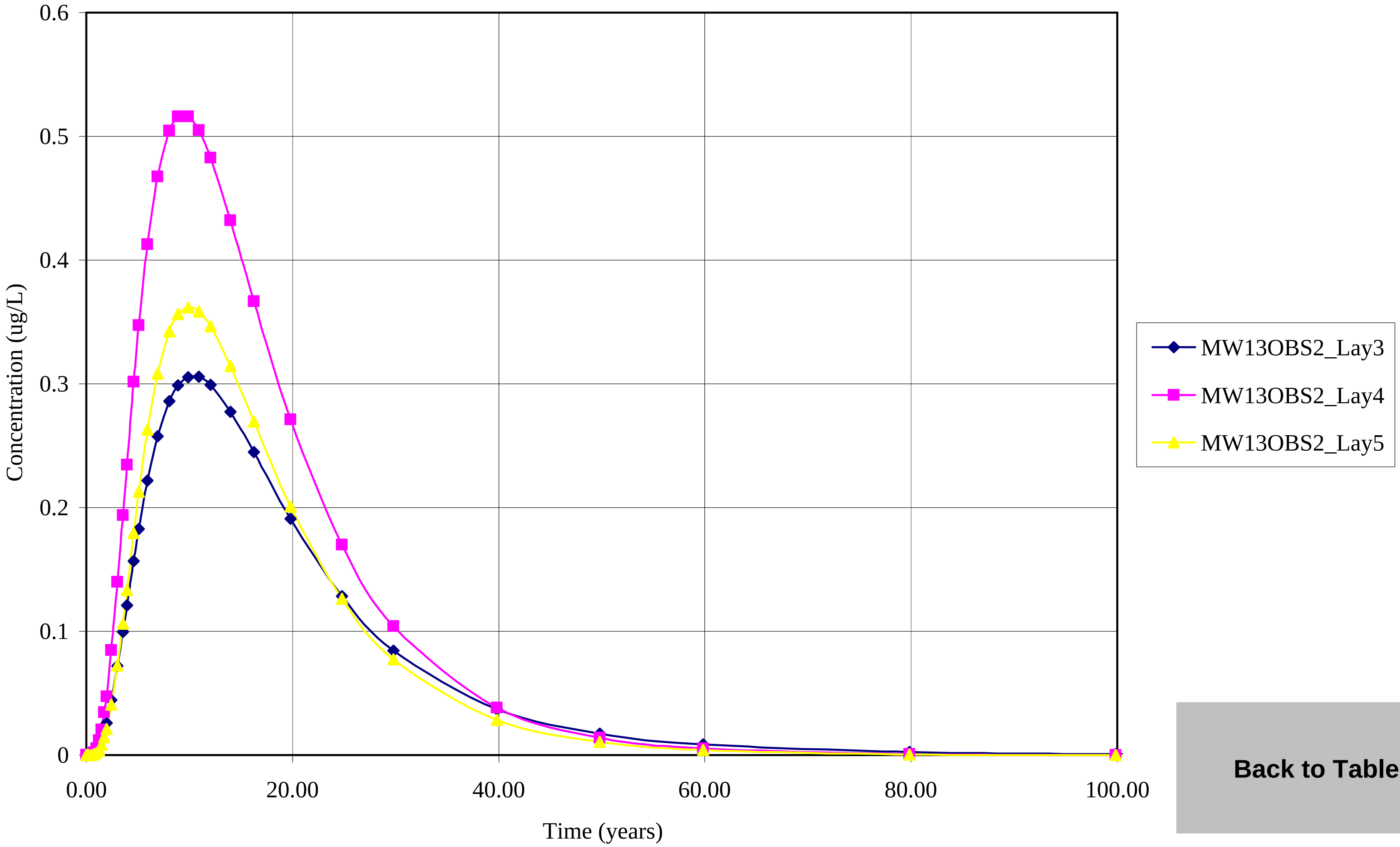
Figure 6A.19. MW13OBS1 Beryllium (Non-pumping) Advection/Dispersion



Back to Table

luck420_Be_NoPump_Adv_DisOnly_15_60_60_ObsWellDataCHARTS.xls

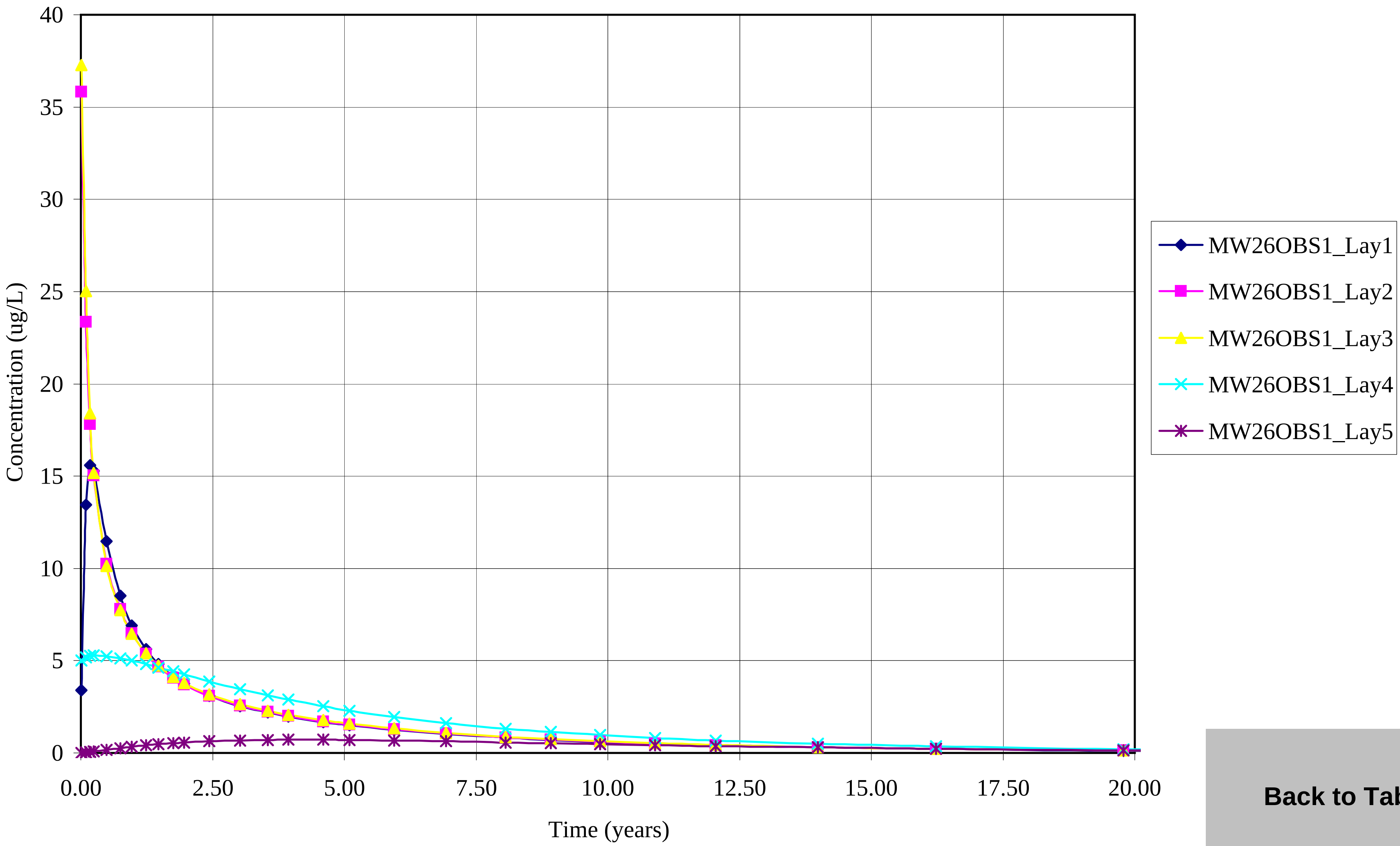
Figure 6A.20. MW13OBS2 Beryllium (Non-pumping) Advection/Dispersion



Back to Table

luck420_Be_NoPump_Adv_DisOnly_15_60_60_ObsWellDataCHARTS.xls

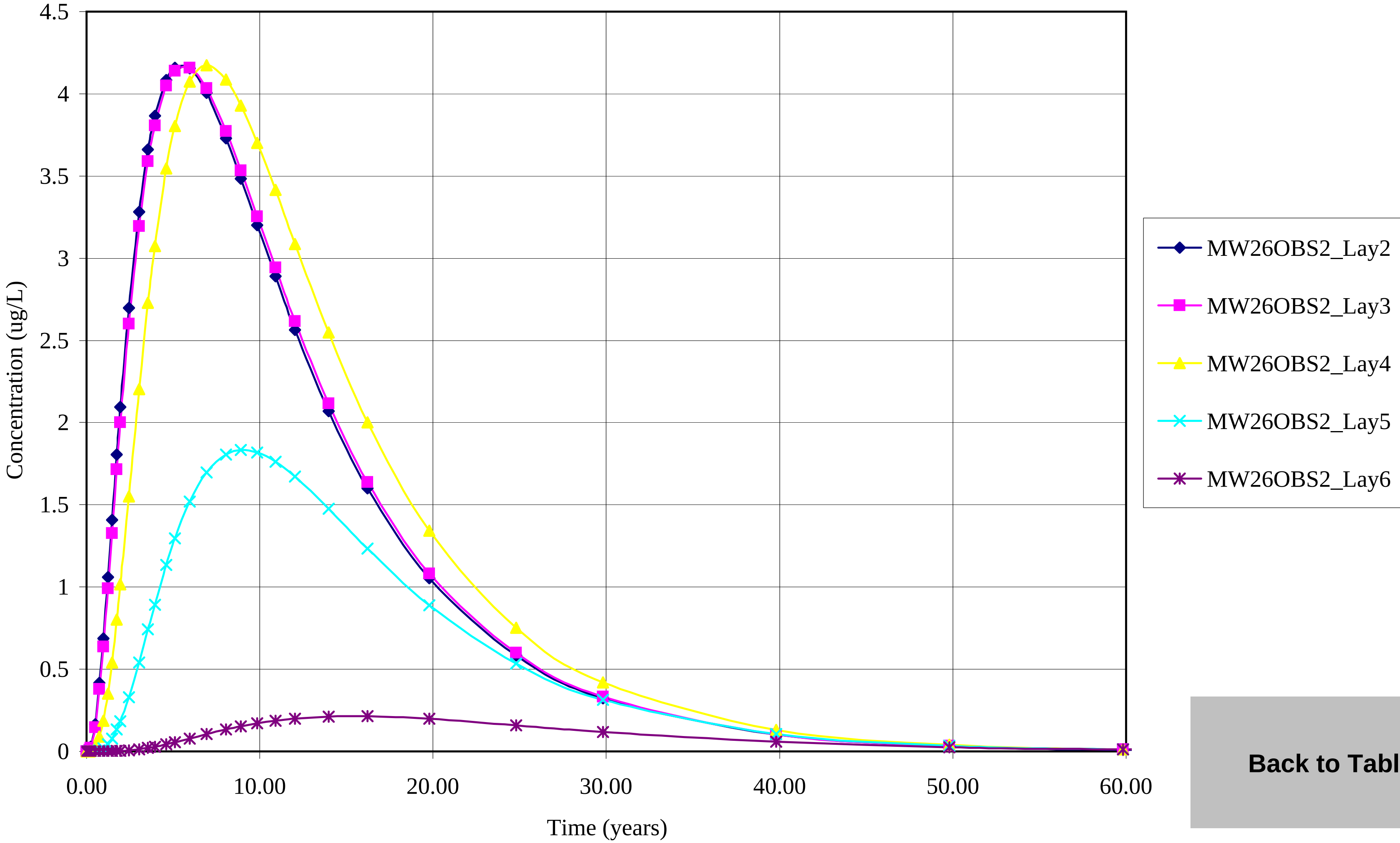
Figure 6A.21. MW26OBS1 Beryllium (Non-pumping) Advection/Dispersion



Back to Table

luck420_Be_NoPump_Adv_DisOnly_15_60_60_ObsWellDataCHARTS.xls

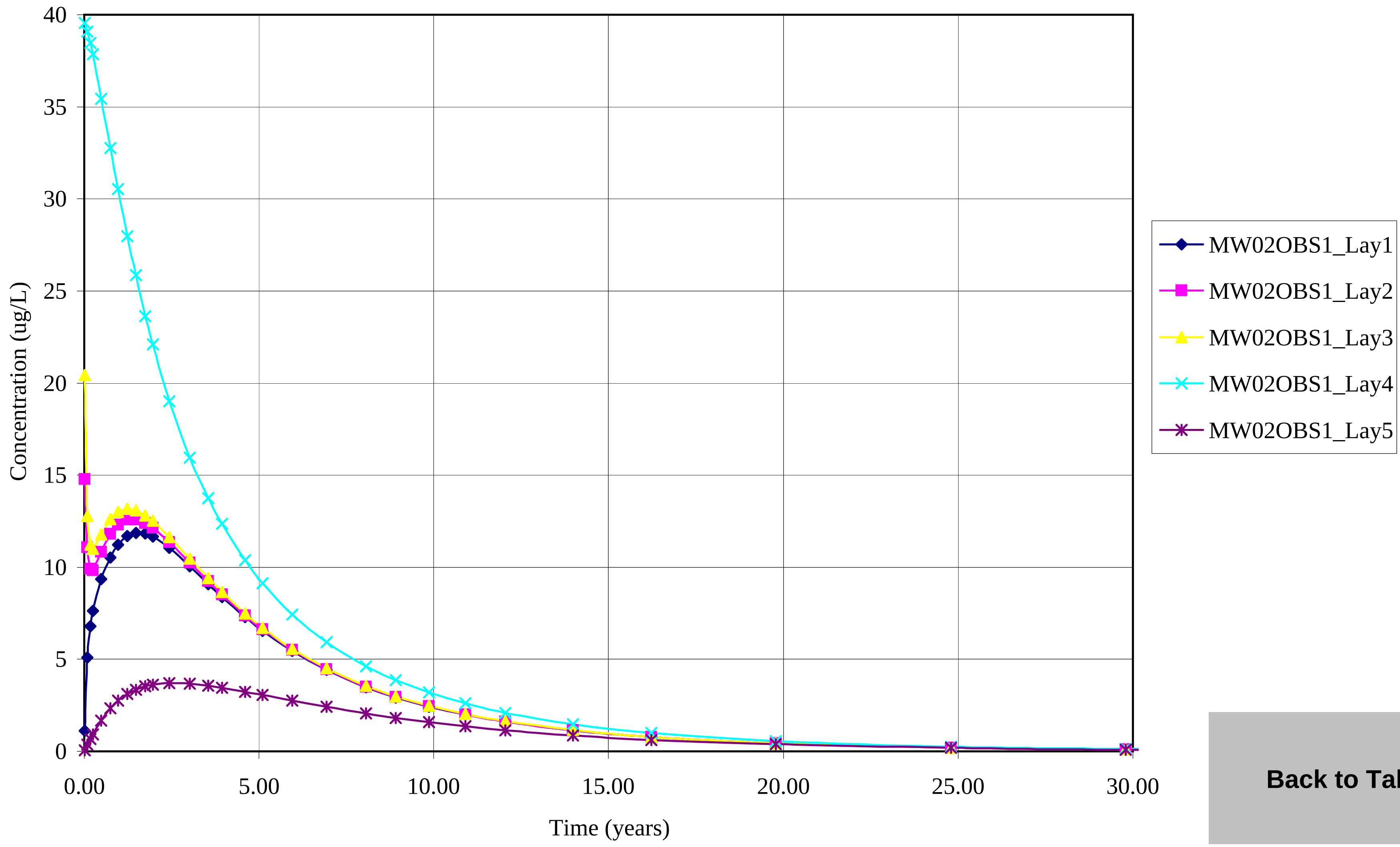
Figure 6A.22. MW26OBS2 Beryllium (Non-pumping) Advection/Dispersion



Back to Table

luck420_Be_NoPump_Adv_DisOnly_15_60_60_ObsWellDataCHARTS.xls

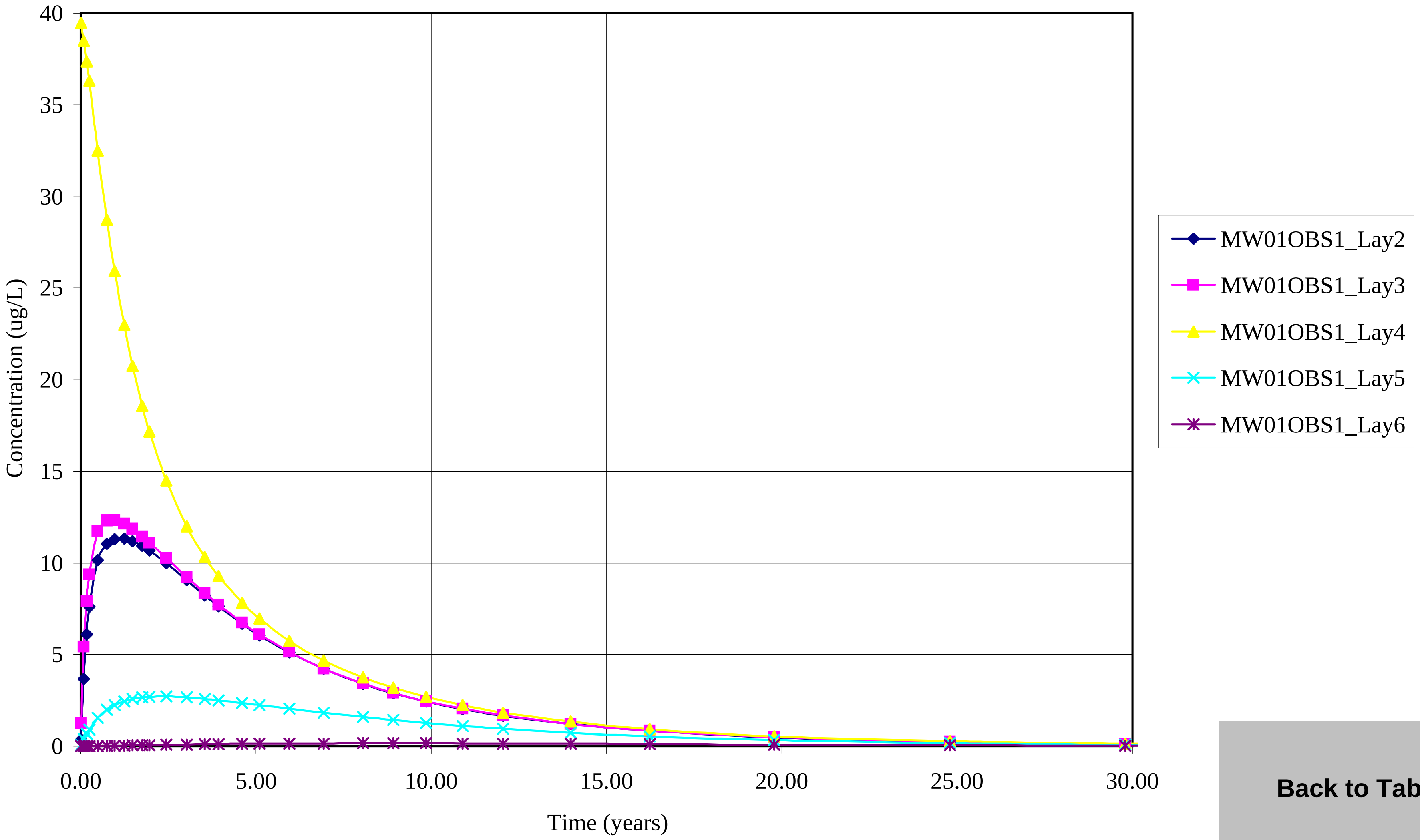
Figure 6A.23. MW02OBS1 Beryllium (Non-pumping) Advection/Dispersion



Back to Table

luck420_Be_NoPump_Adv_DisOnly_15_60_60_ObsWellDataCHARTS.xls

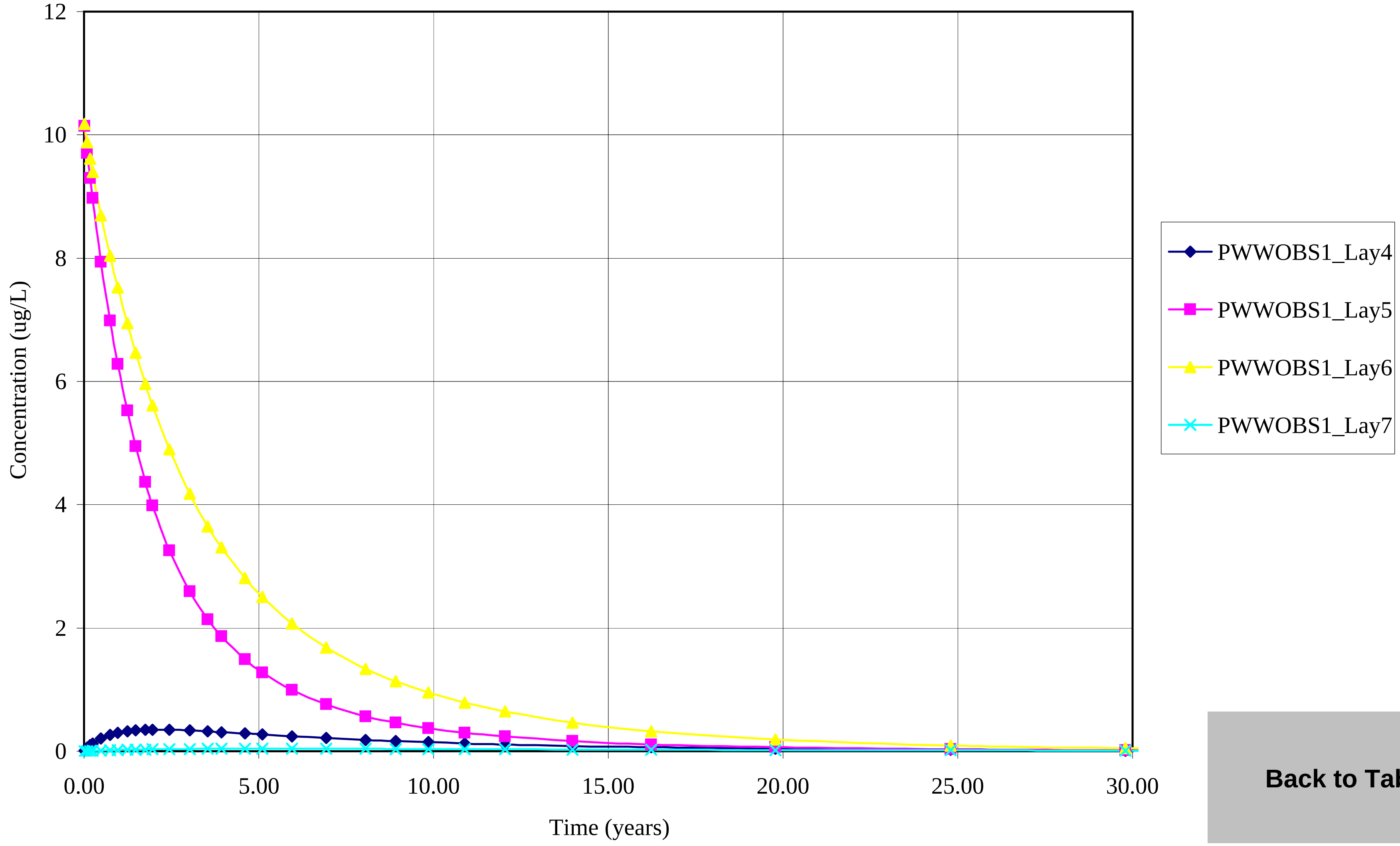
Figure 6A.24. MW01OBS1 Beryllium (Non-pumping) Advection/Dispersion



Back to Table

luck420_Be_NoPump_Adv_DisOnly_15_60_60_ObsWellDataCHARTS.xls

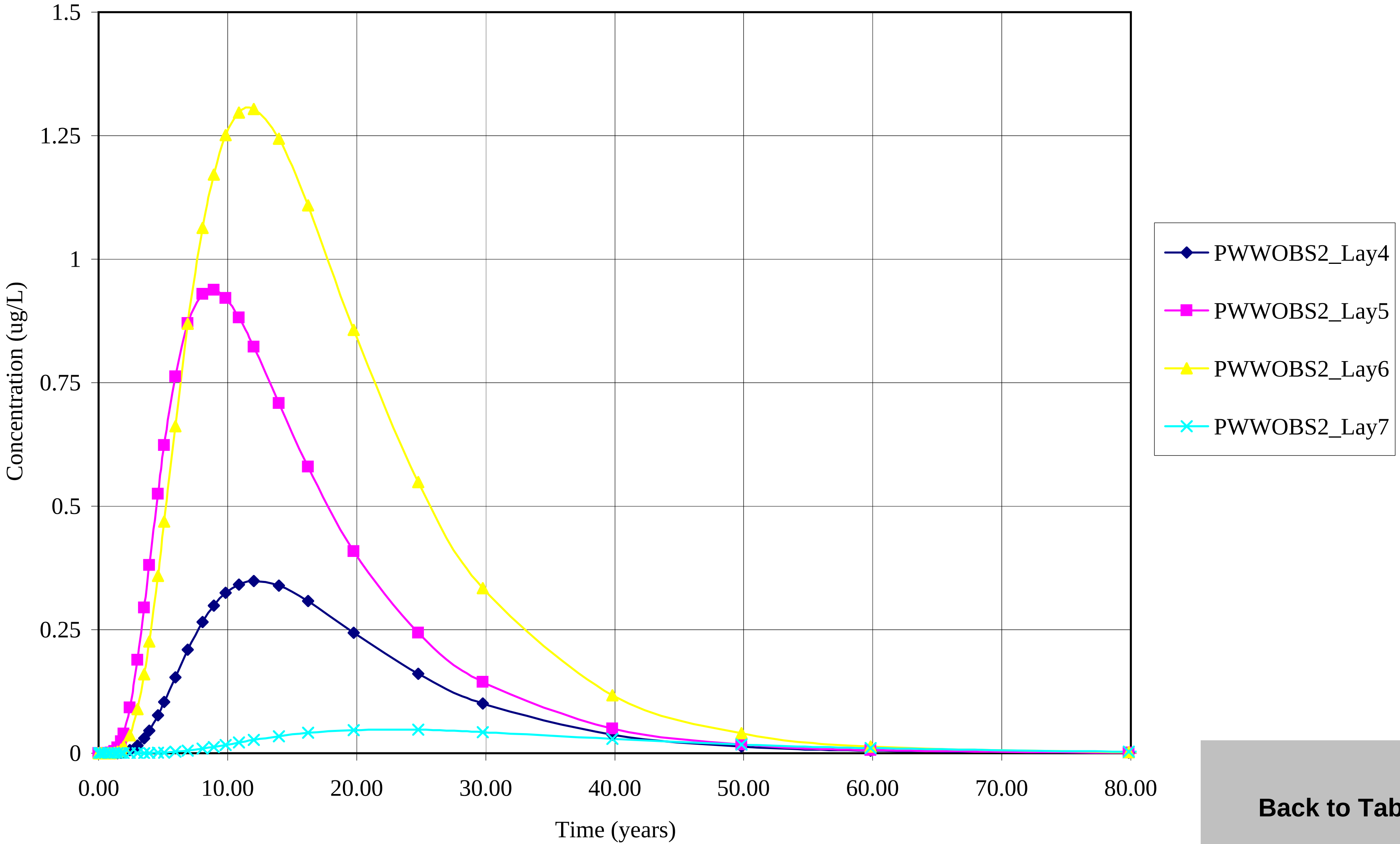
Figure 6A.25. PWWOBS1 Beryllium (Non-pumping) Advection/Dispersion



Back to Table

luck420_Be_NoPump_Adv_DisOnly_15_60_60_ObsWellDataCHARTS.xls

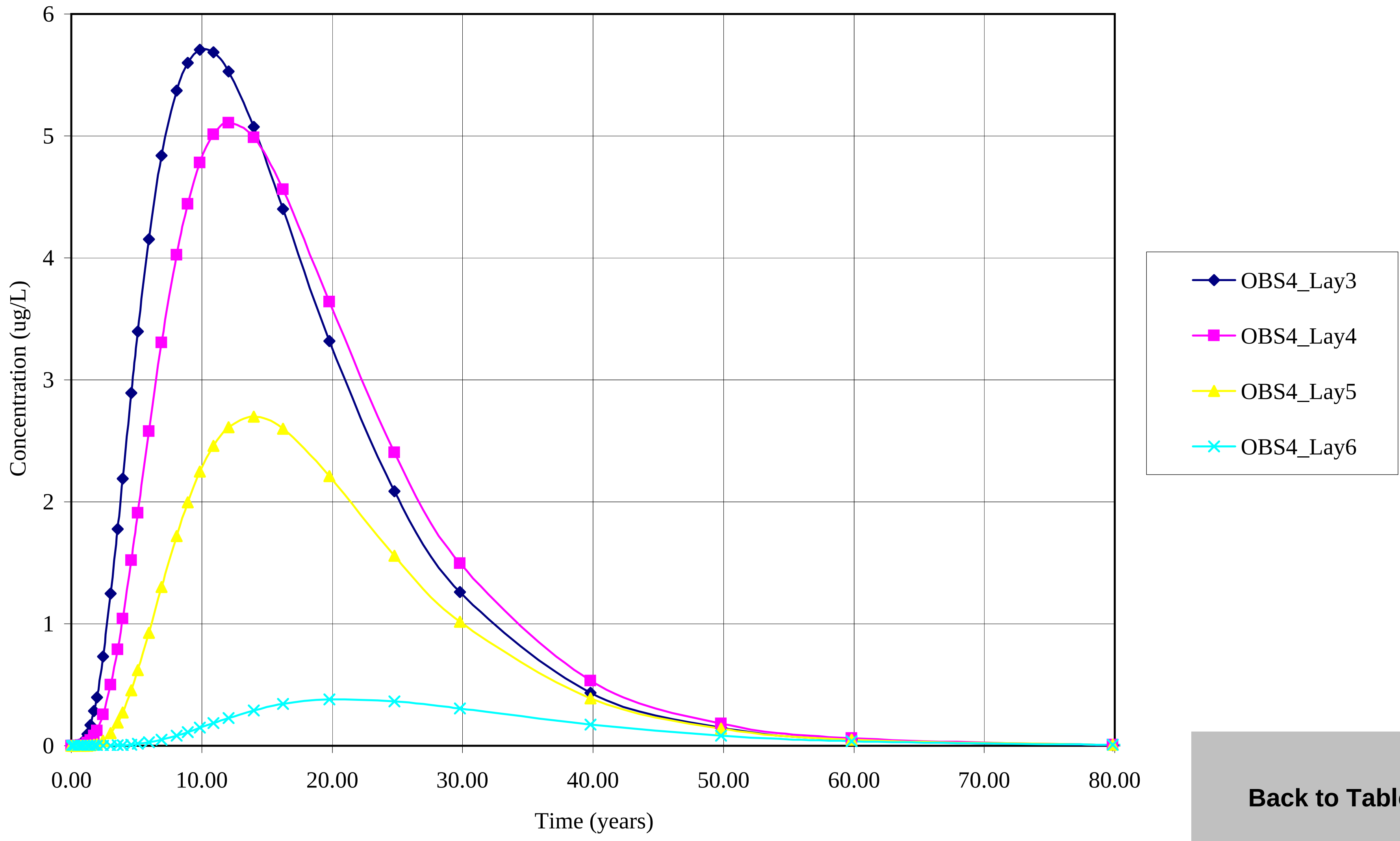
Figure 6A.26. PWWOBS2 Beryllium (Non-pumping) Advection/Dispersion



Back to Table

luck420_Be_NoPump_Adv_DisOnly_15_60_60_ObsWellDataCHARTS.xls

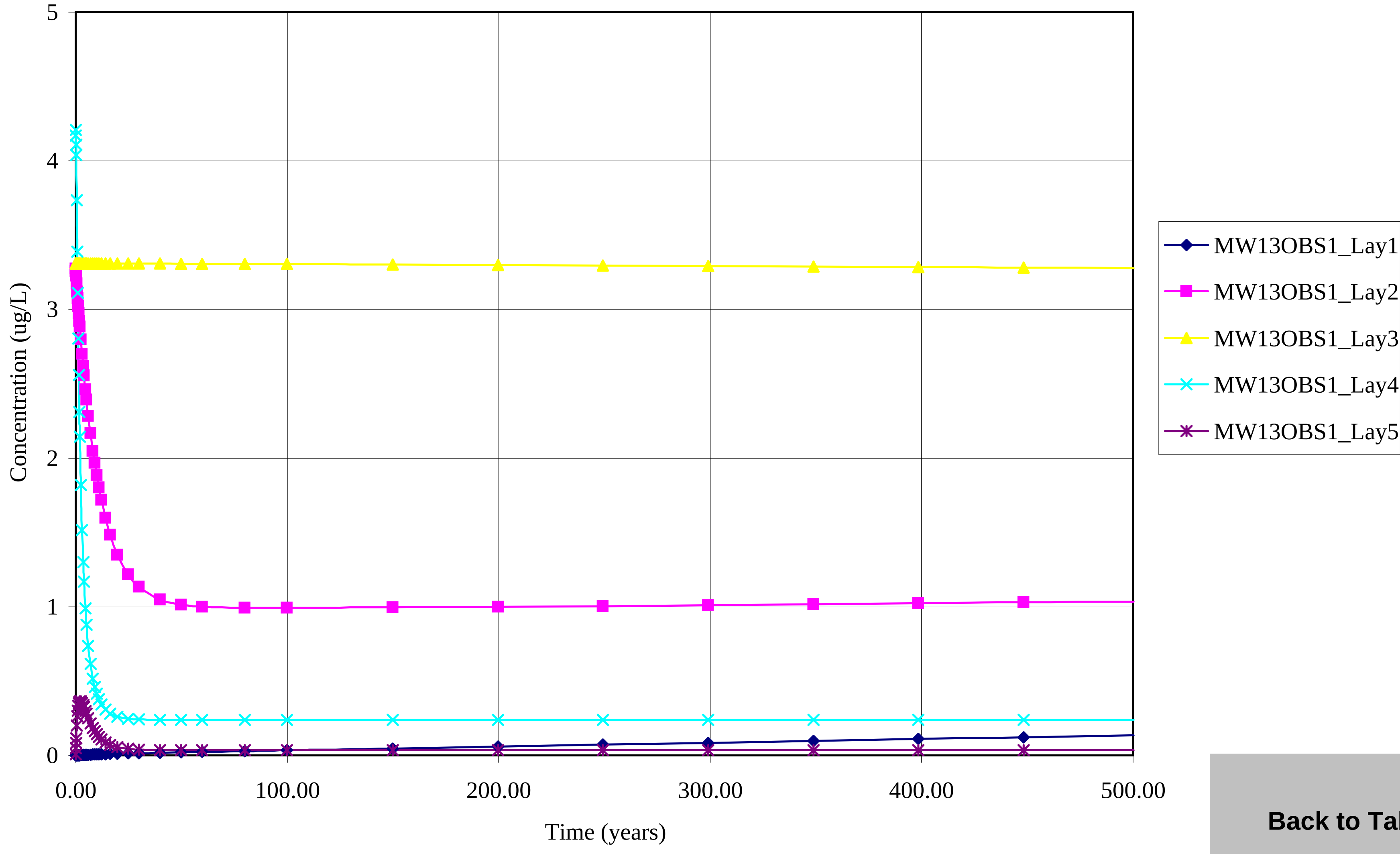
Figure 6A.27. OBS4 Beryllium (Non-pumping) Advection/Dispersion



Back to Table

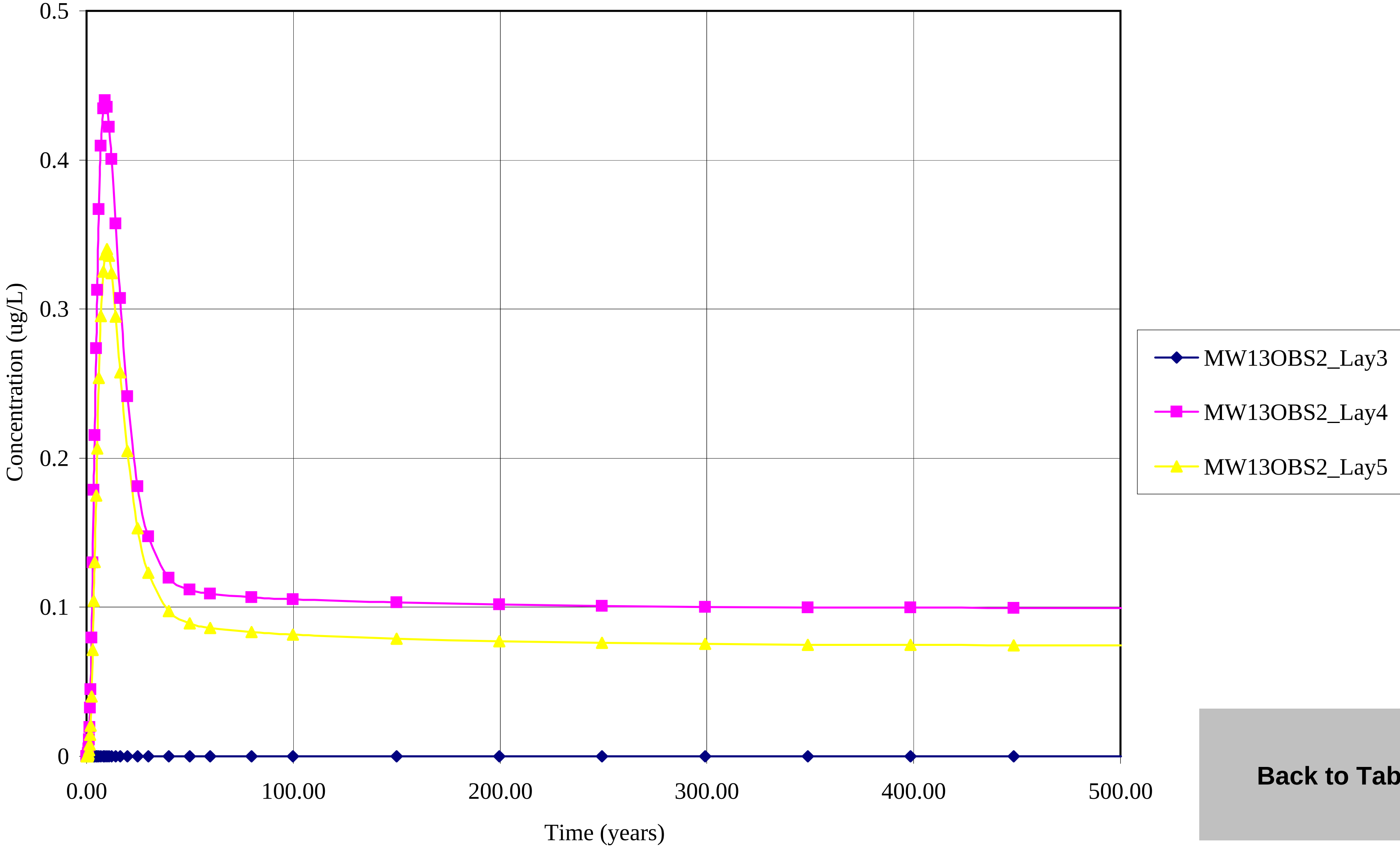
luck420_Be_NoPump_Adv_DisOnly_15_60_60_ObsWellDataCHARTS.xls

Figure 6A.28. MW13OBS1 Beryllium (Non-pumping) Advection/Dispersion/ChemRxn



Back to Table

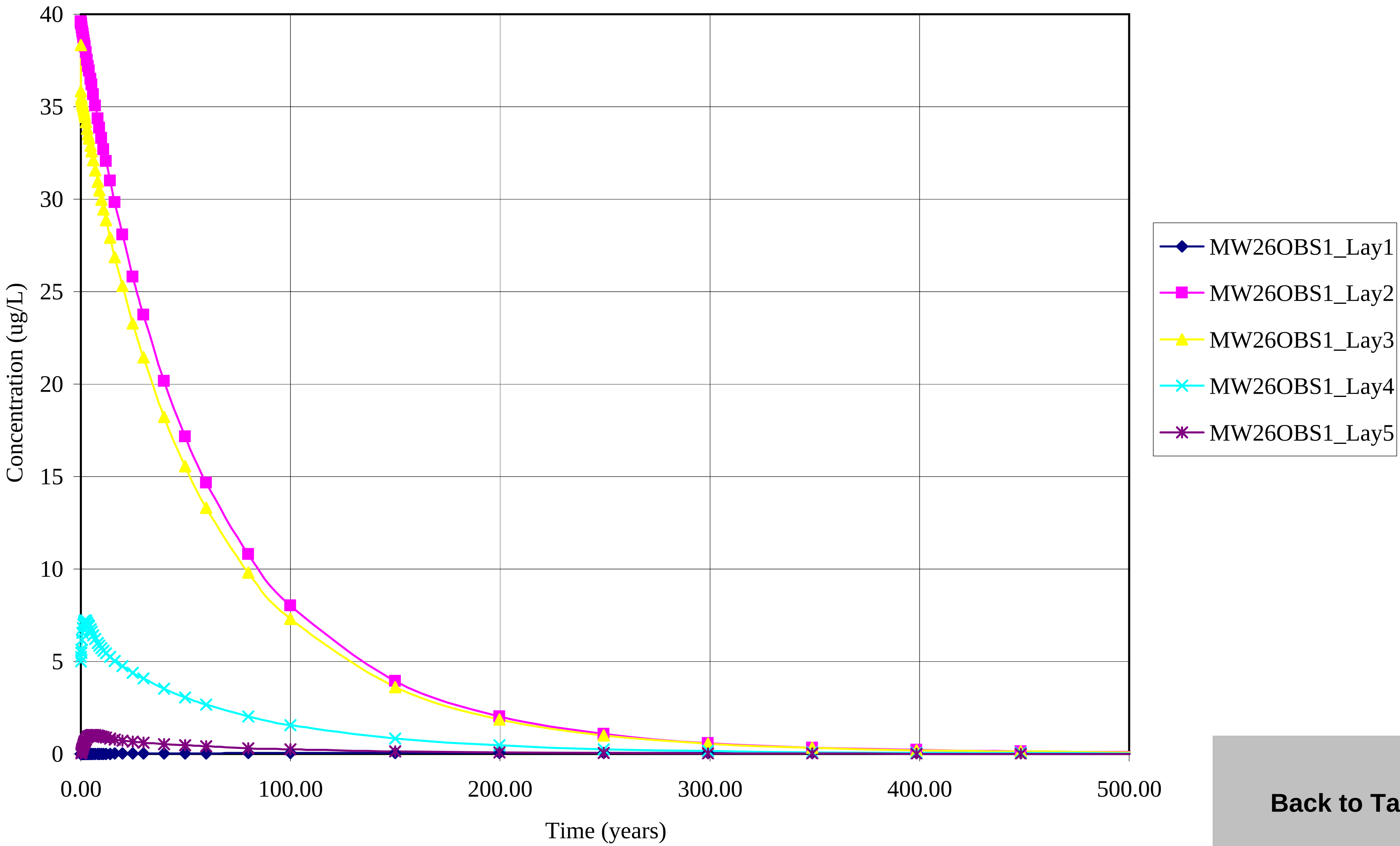
Figure 6A.29. MW13OBS2 Beryllium (Non-pumping) Advection/Dispersion/ChemRxn



Back to Table

luck420_Be_NoPump_Adv_Dis_Chem_15_60_60_ObsWellDataCHARTS.xls

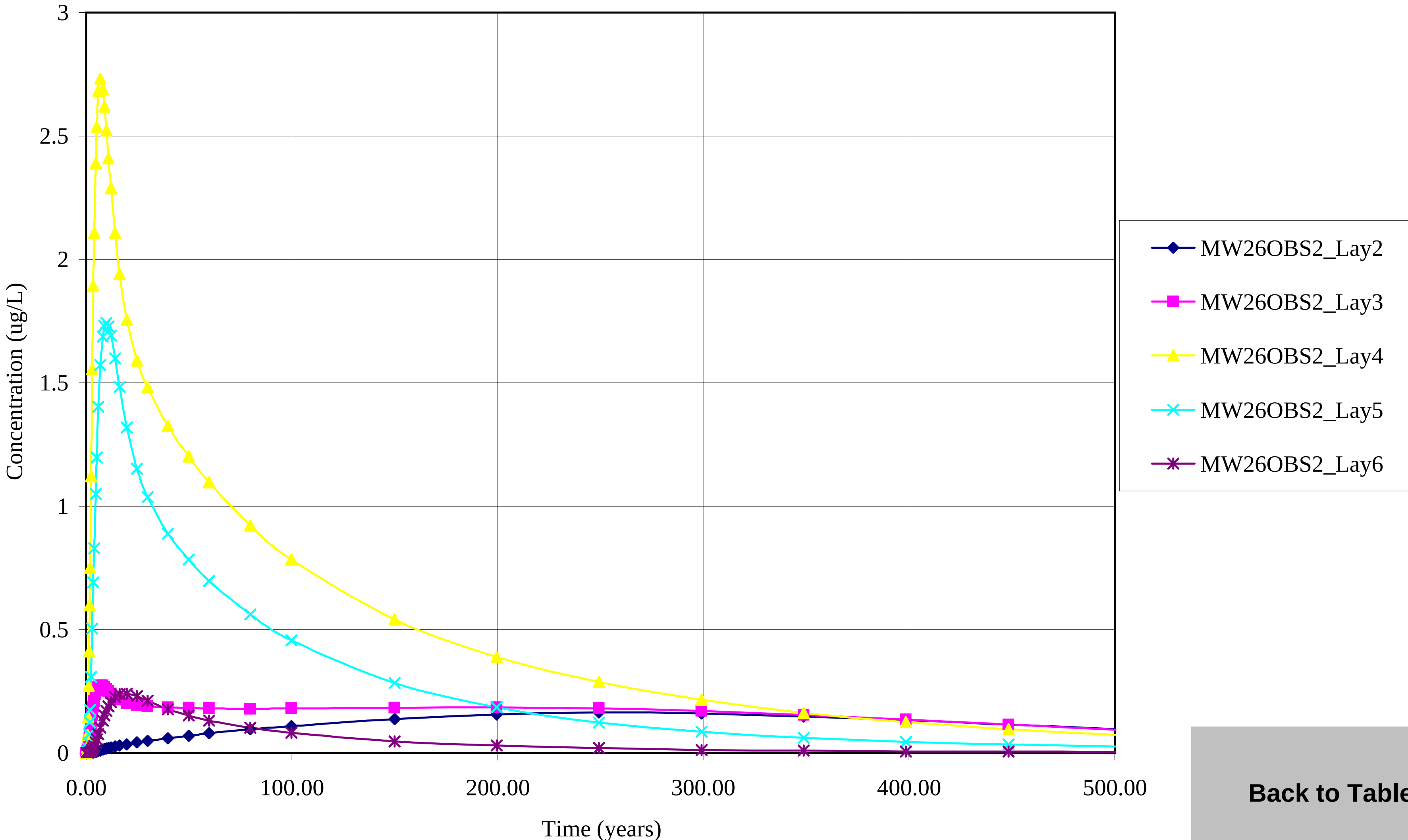
Figure 6A.30. MW26OBS1 Beryllium (Non-pumping) Advection/Dispersion/ChemRxn



Back to Table

luck420_Be_NoPump_Adv_Dis_Chem_15_60_60_ObsWellDataCHARTS.xls

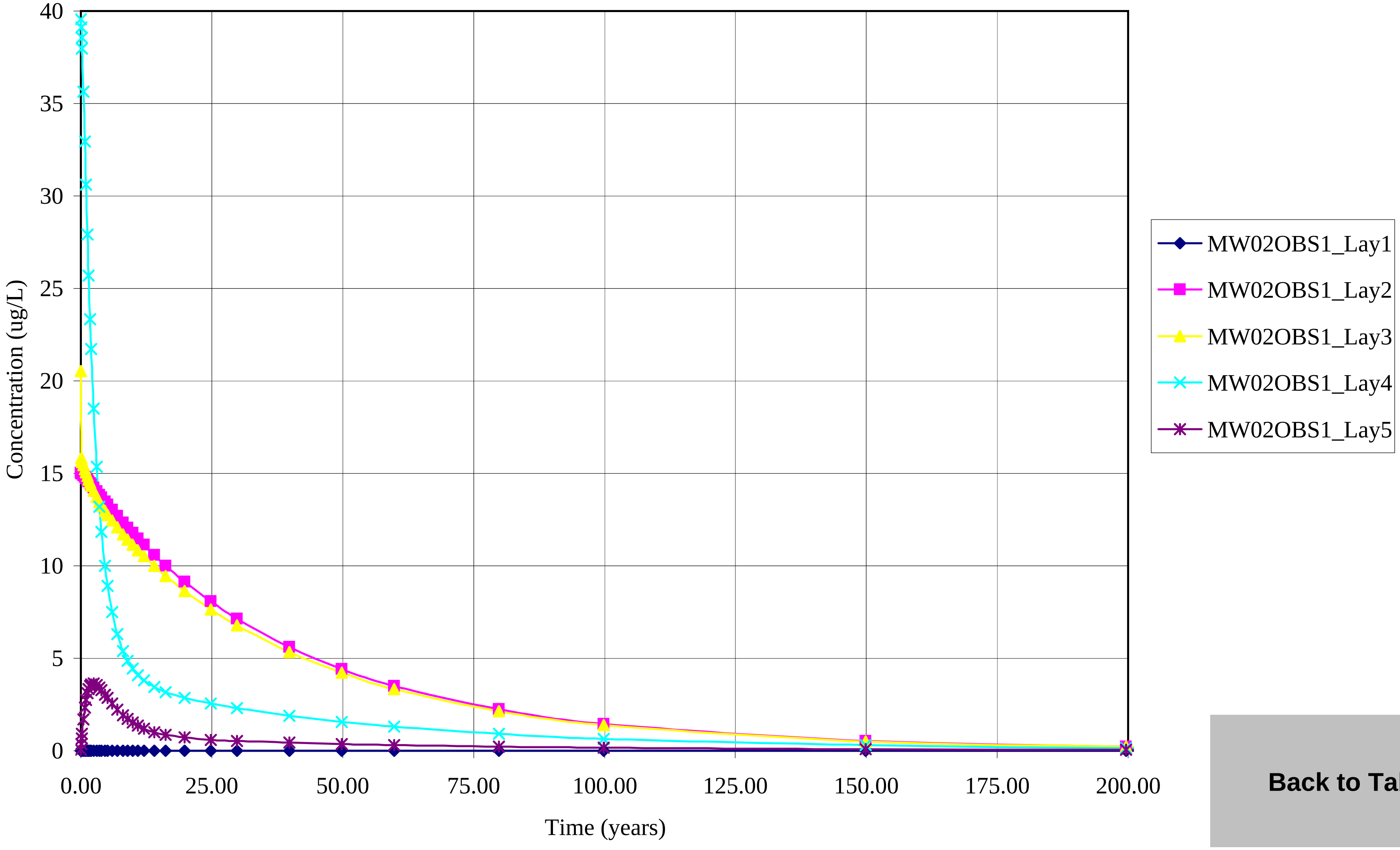
Figure 6A.31. MW26OBS2 Beryllium (Non-pumping) Advection/Dispersion/ChemRxn



Back to Table

luck420_Be_NoPump_Adv_Dis_Chem_15_60_60_ObsWellDataCHARTS.xls

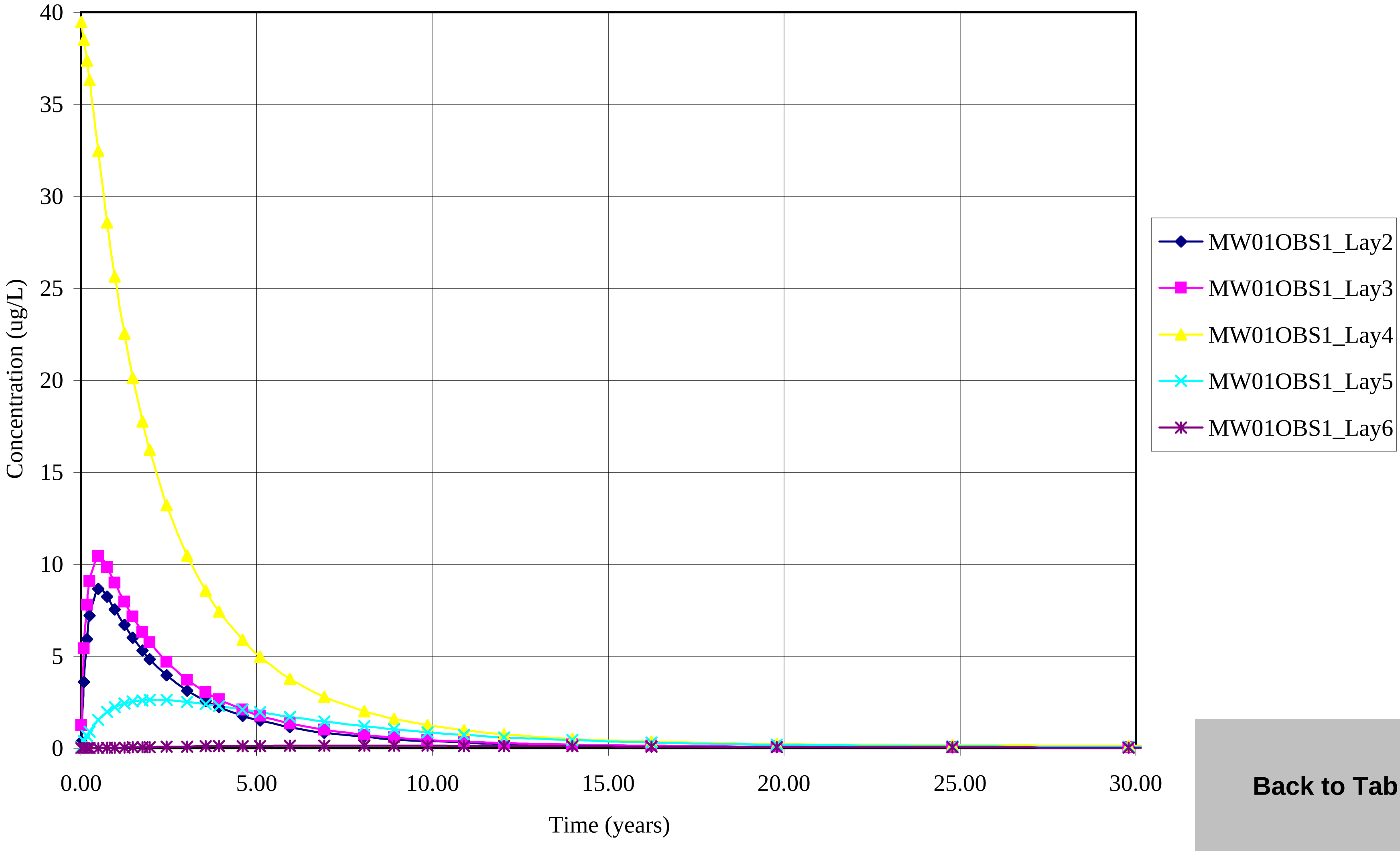
Figure 6A.32. MW02OBS1 Beryllium (Non-pumping) Advection/Dispersion/ChemRxn



Back to Table

luck420_Be_NoPump_Adv_Dis_Chem_15_60_60_ObsWellDataCHARTS.xls

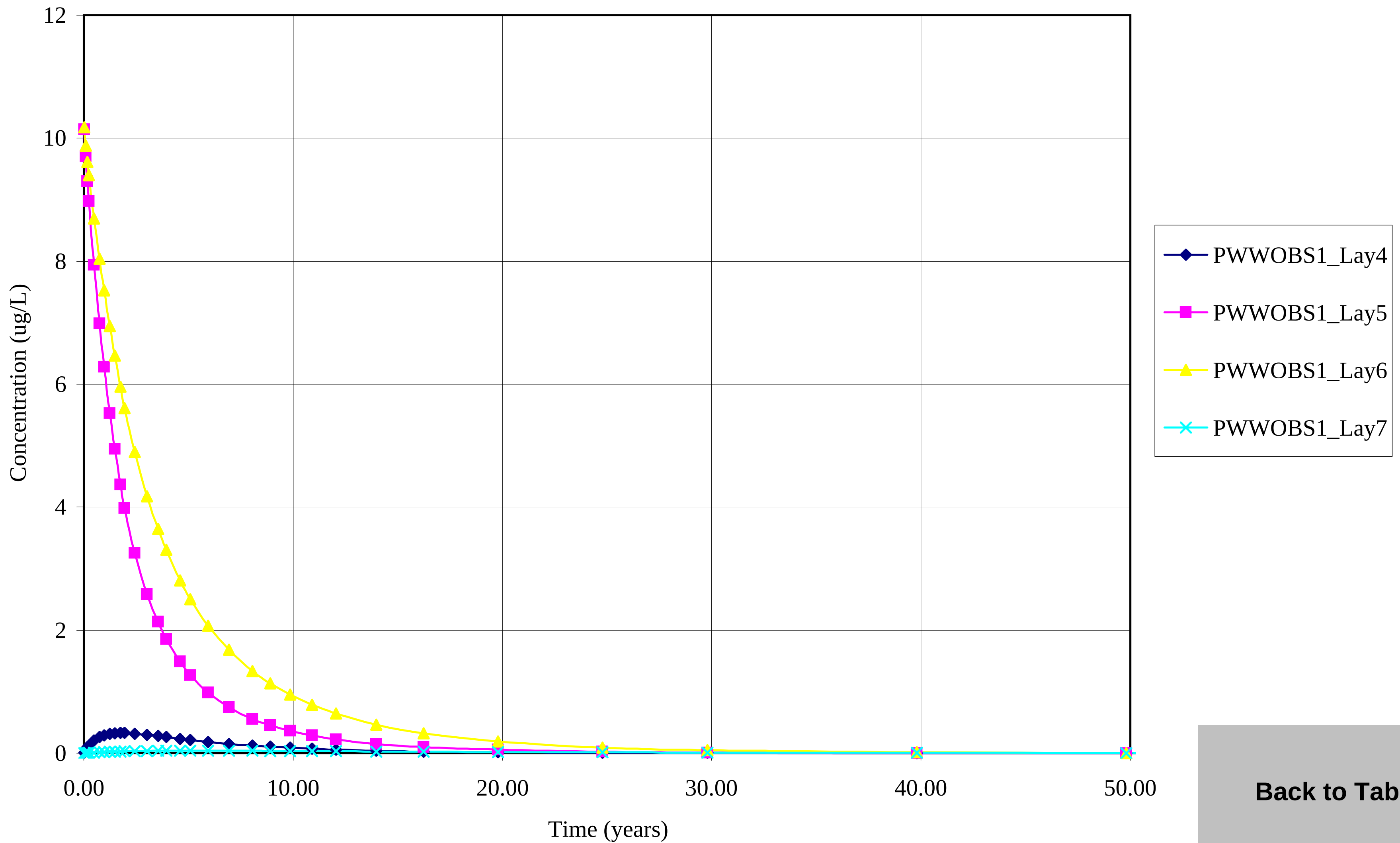
Figure 6A.33. MW01OBS1 Beryllium (Non-pumping) Advection/Dispersion/ChemRxn



Back to Table

luck420_Be_NoPump_Adv_Dis_Chem_15_60_60_ObsWellDataCHARTS.xls

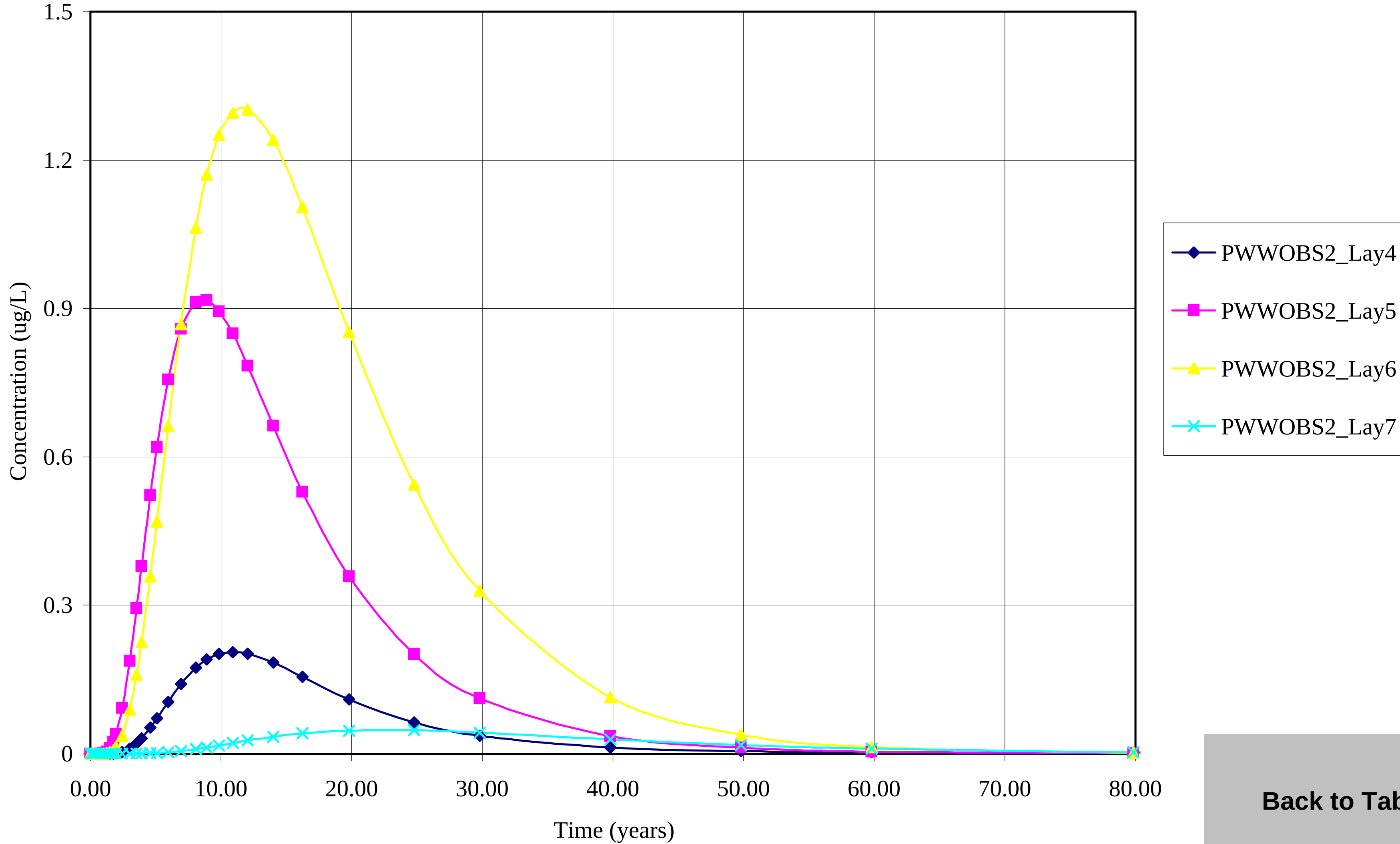
Figure 6A.34. PWWOBS1 Beryllium (Non-pumping) Advection/Dispersion/ChemRxn



Back to Table

luck420_Be_NoPump_Adv_Dis_Chem_15_60_60_ObsWellDataCHARTS.xls

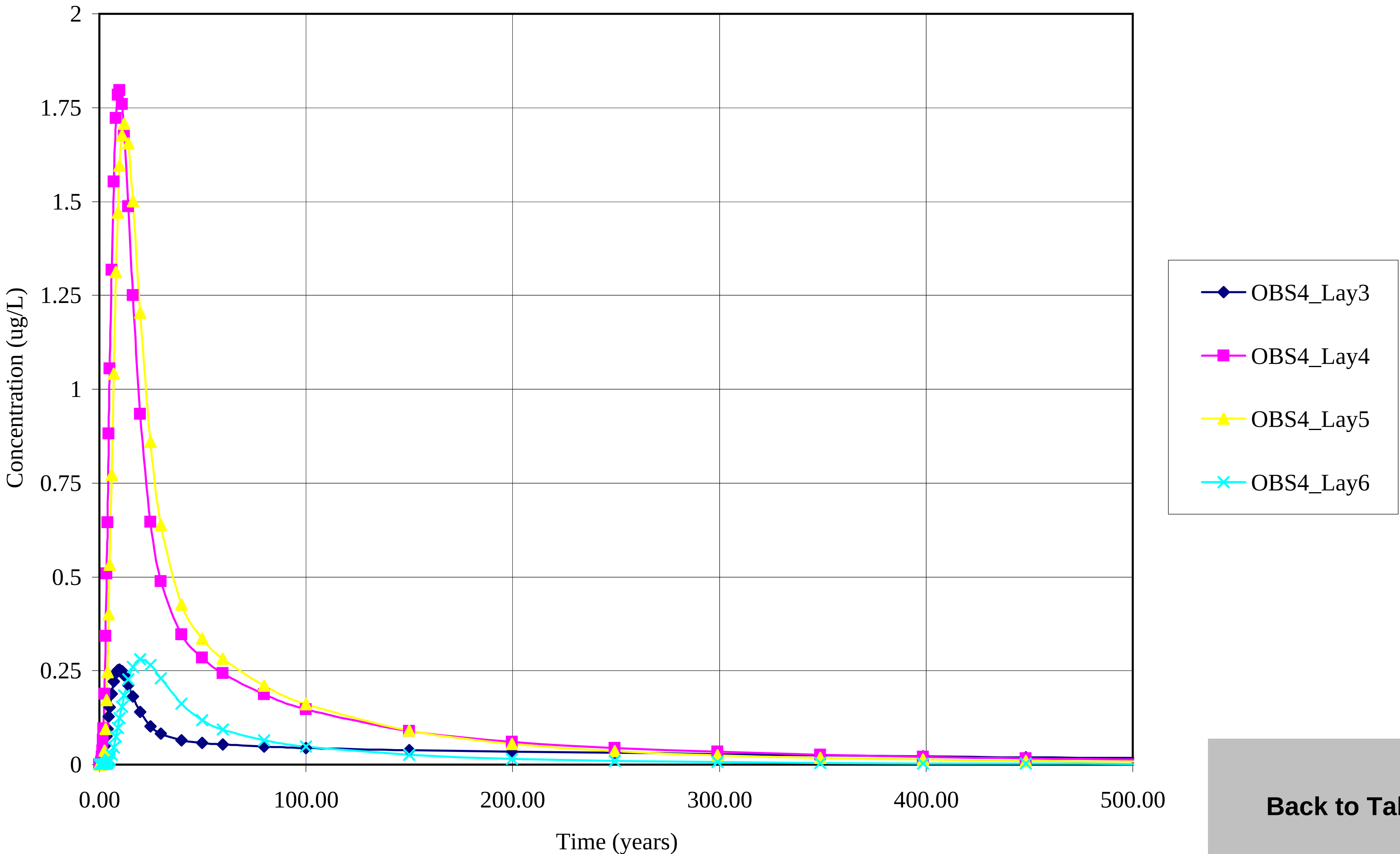
Figure 6A.35. PWWOBS2 Beryllium (Non-pumping) Advection/Dispersion/ChemRxn



Back to Table

luck420_Be_NoPump_Adv_Dis_Chem_15_60_60_ObsWellDataCHARTS.xls

Figure 6A.36. OBS4 Beryllium (Non-pumping) Advection/Dispersion/ChemRxn



Back to Table

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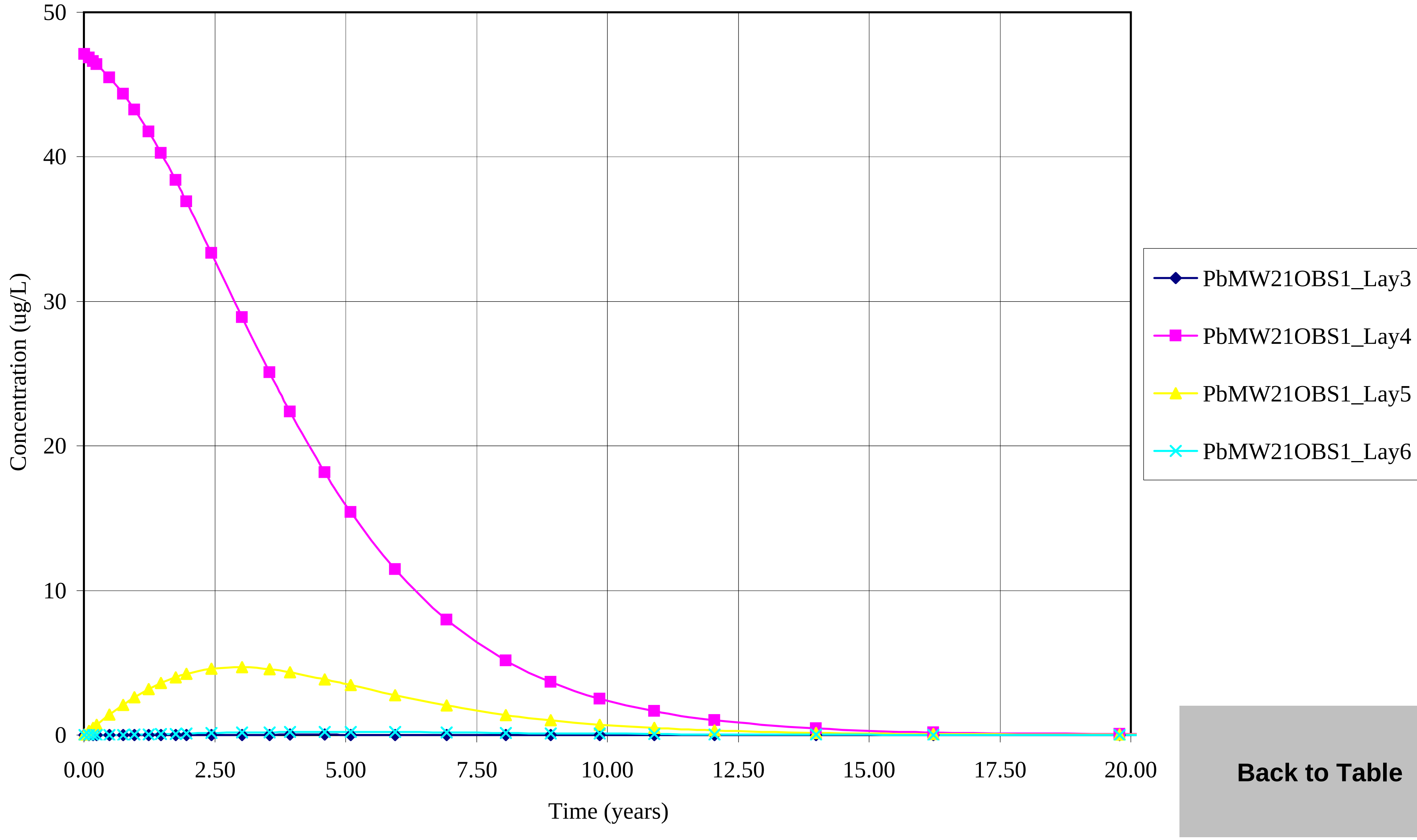
Figure 6A.37. PbMW21OBS1 Lead (Non-pumping) Advection



Back to Table

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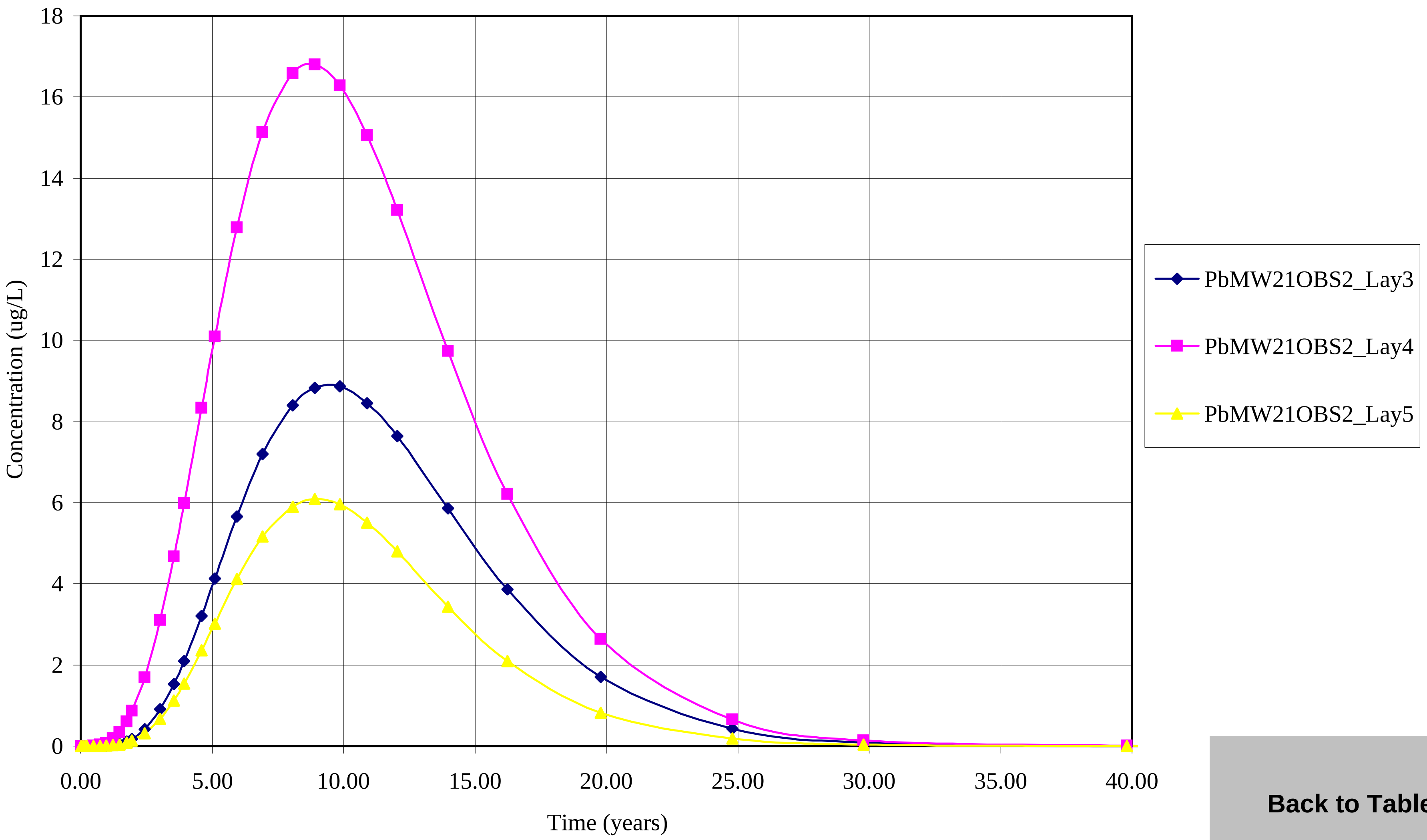
Figure 6A.38. PbMW21OBS2 Lead (Non-pumping) Advection



Back to Table

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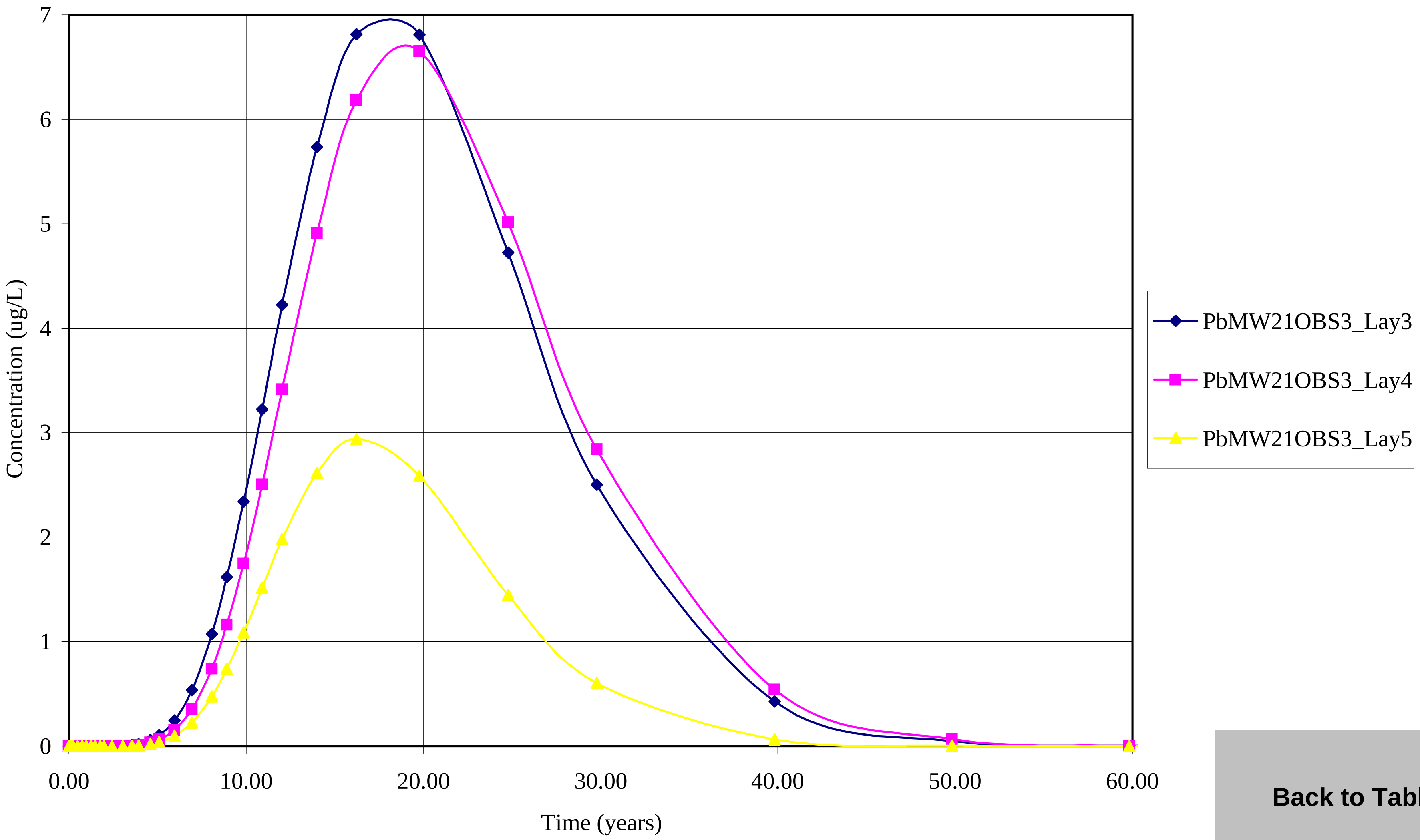
Figure 6A.39. PbMW21OBS3 Lead (Non-pumping) Advection



Back to Table

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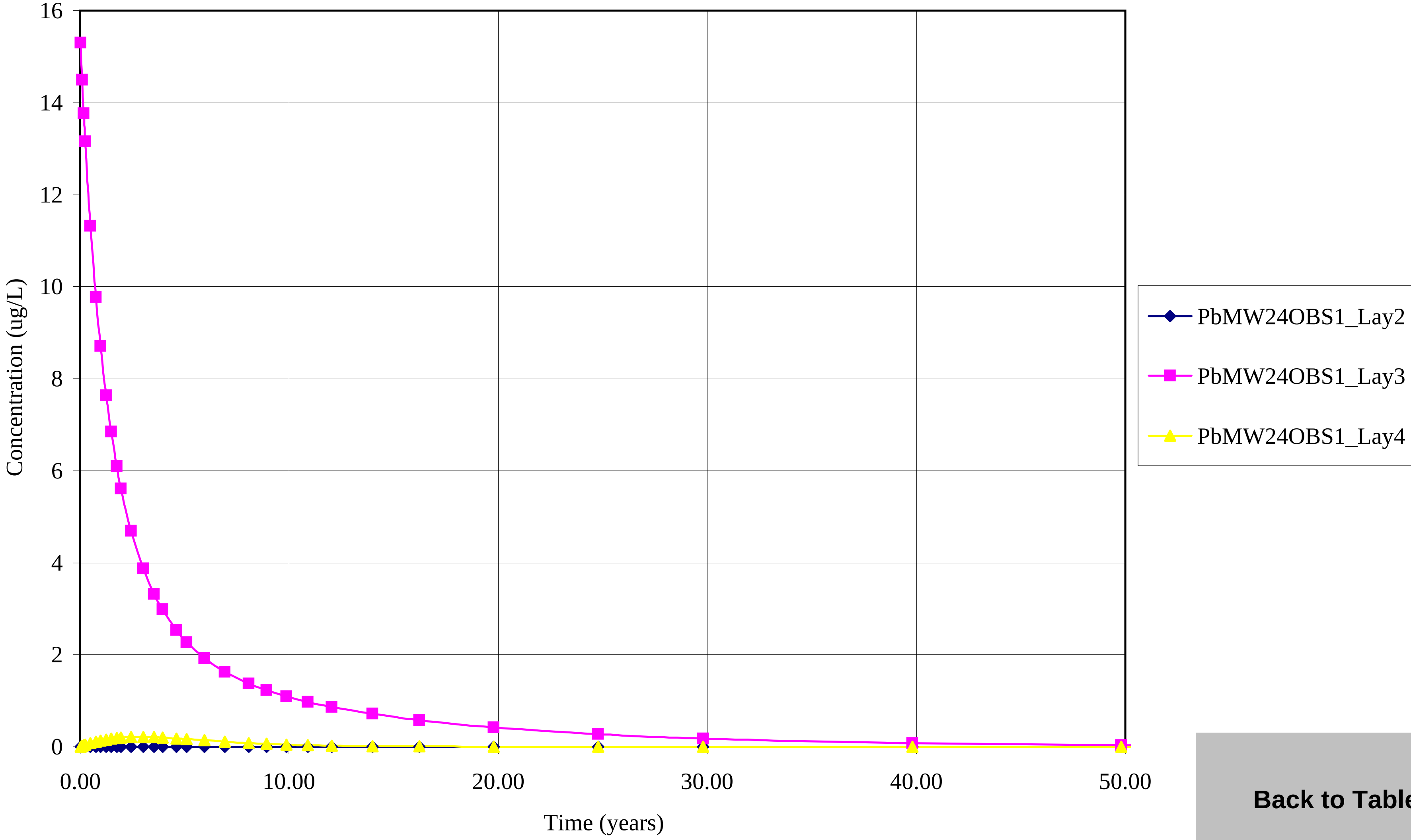
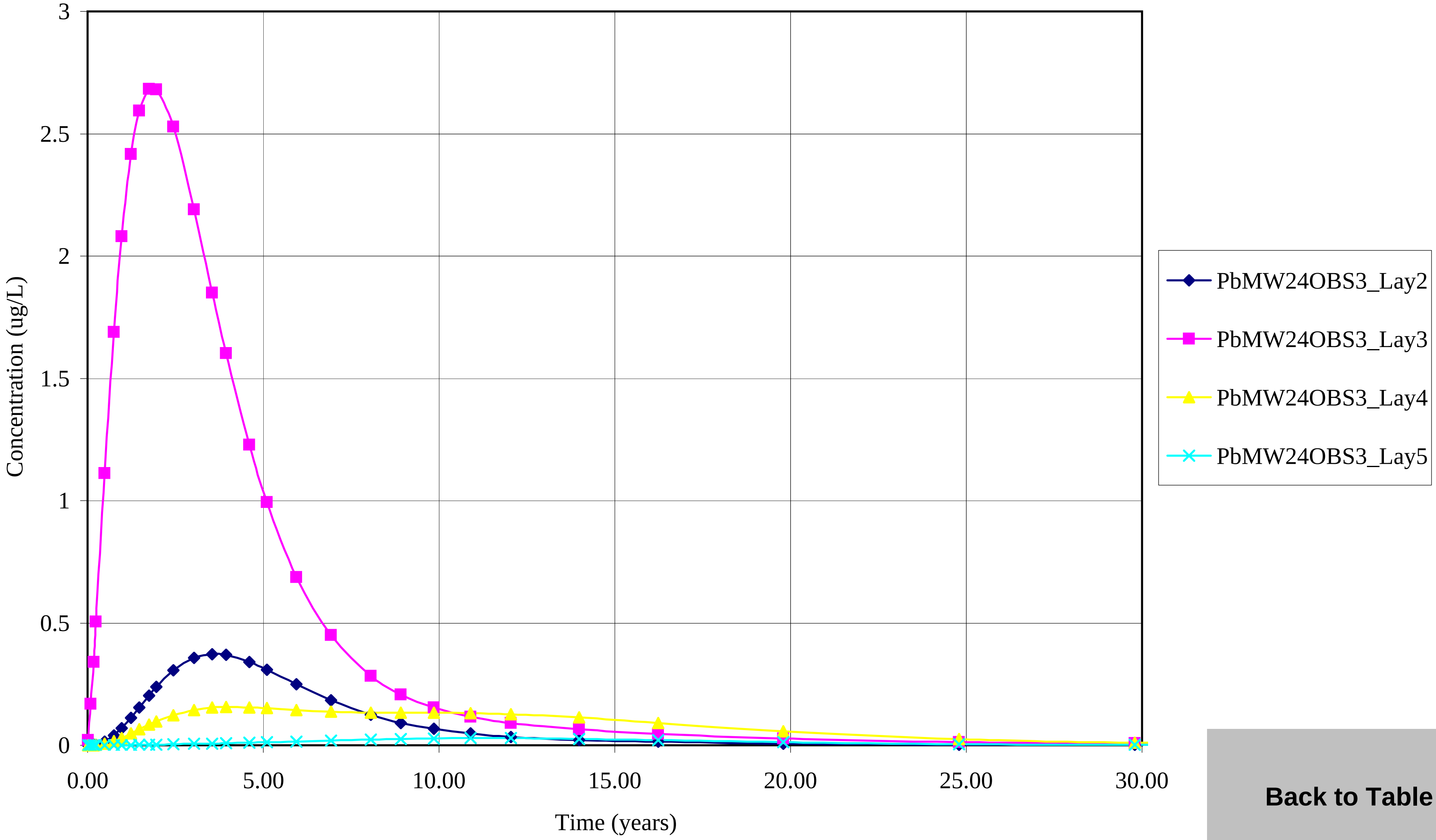
Figure 6A.40. PbMW24OBS1 Lead (Non-pumping) Advection



Back to Table

luck420_Pb_NoPump_AdvOnly_15_60_60_ObsWellDatCHARTS.xls

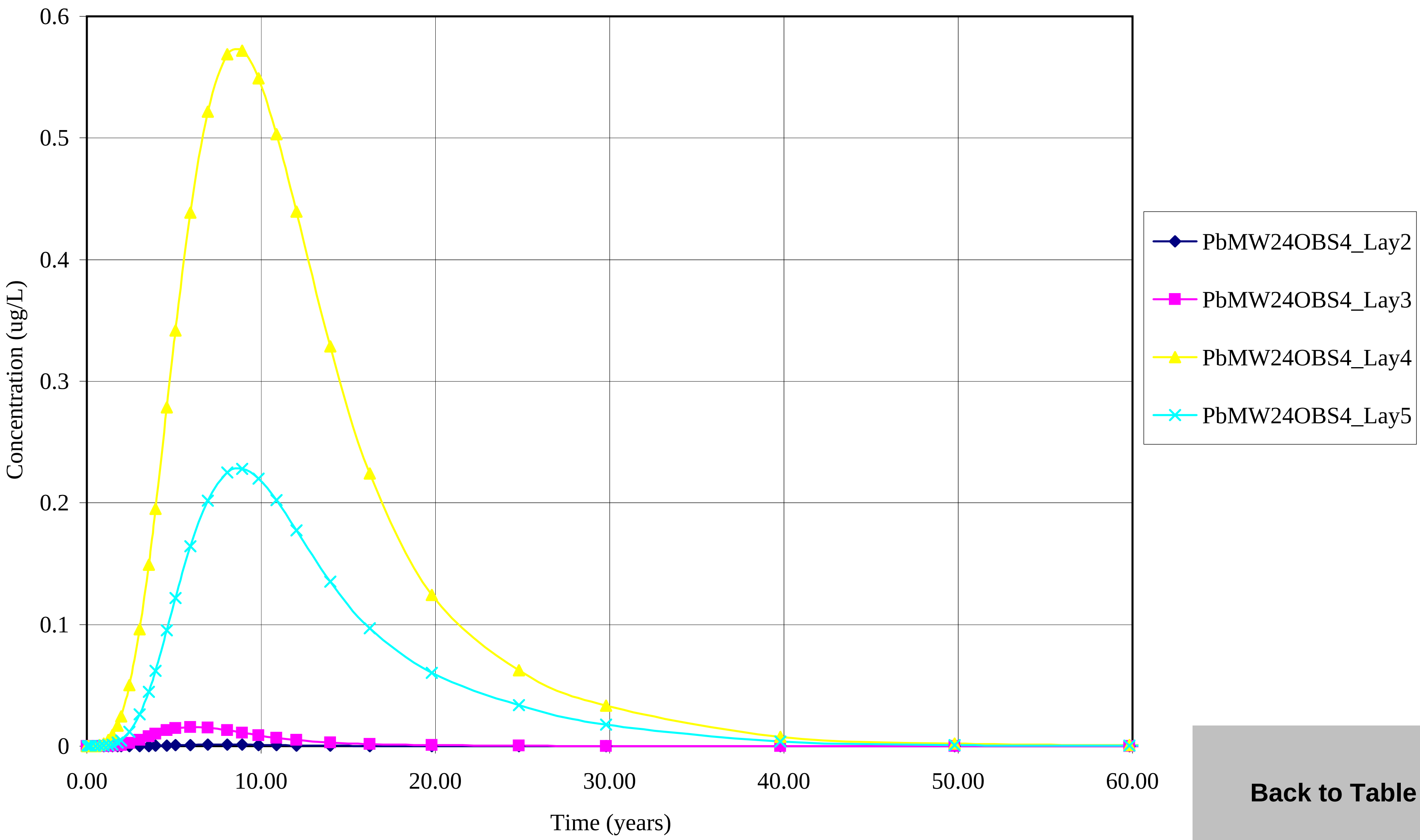
Figure 6A.41. PbMW24OBS3 Lead (Non-pumping) Advection



Back to Table

luck420_Pb_NoPump_AdvOnly_15_60_60_ObsWellDatCHARTS.xls

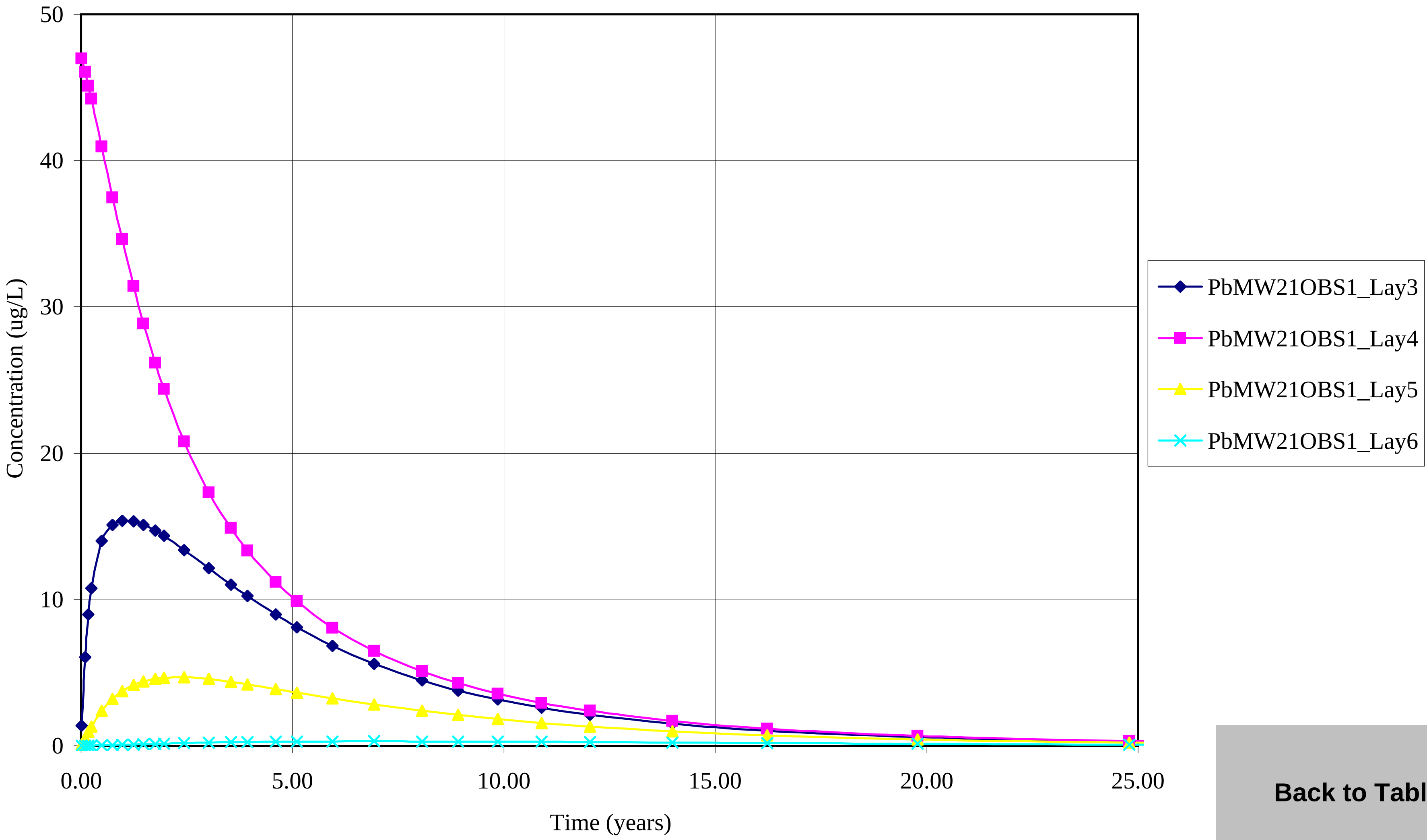
Figure 6A.42. PbMW24OBS4 Lead (Non-pumping) Advection



Back to Table

luck420_Pb_NoPump_AdvOnly_15_60_60_ObsWellDatCHARTS.xls

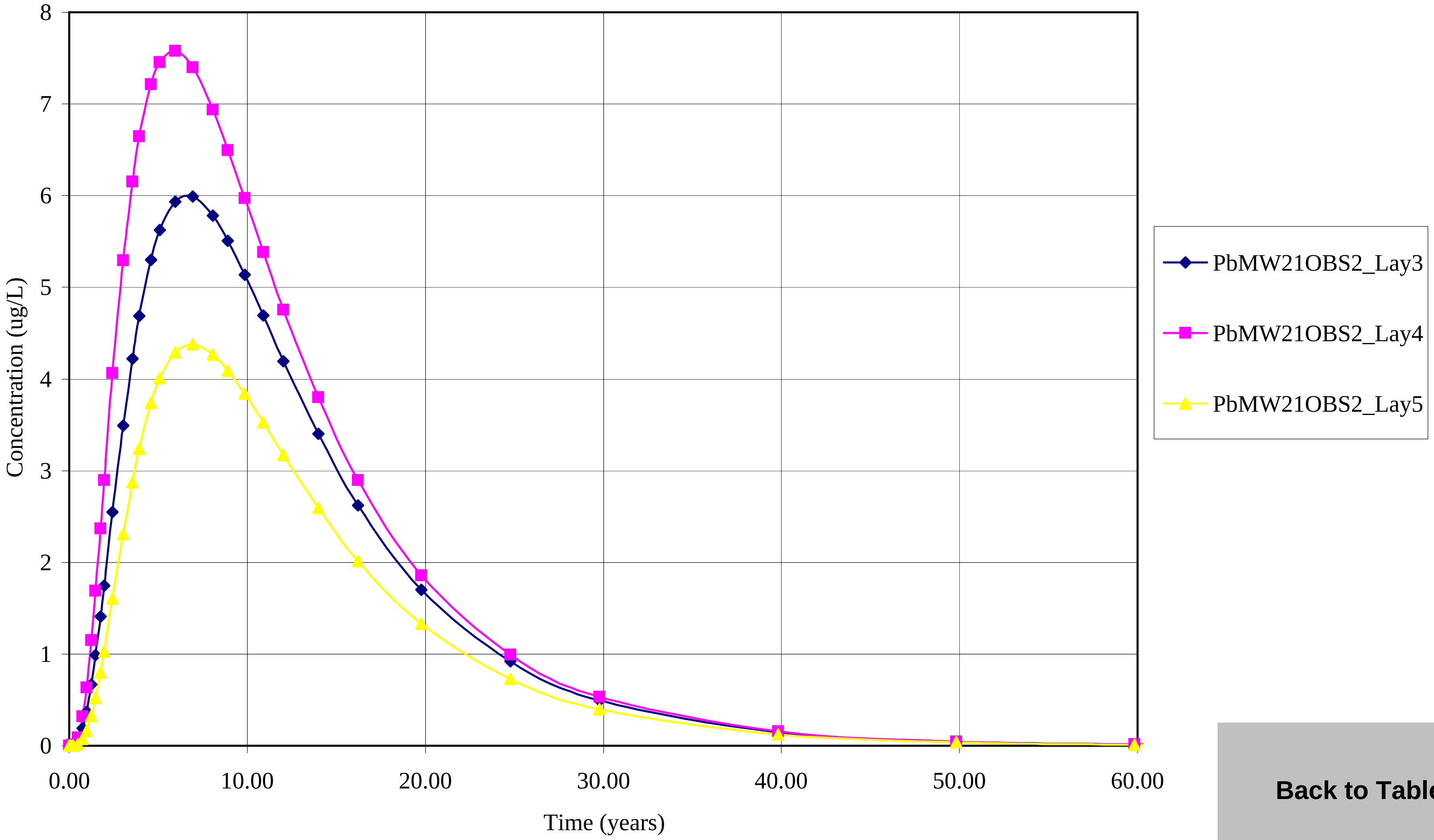
Figure 6A.43. PbMW21OBS1 Lead (Non-pumping) Advection/Dispersion



Back to Table

luck420_Pb_NoPump_Adv_DisOnly_15_60_60_ObsWellDataCHARTS.xls

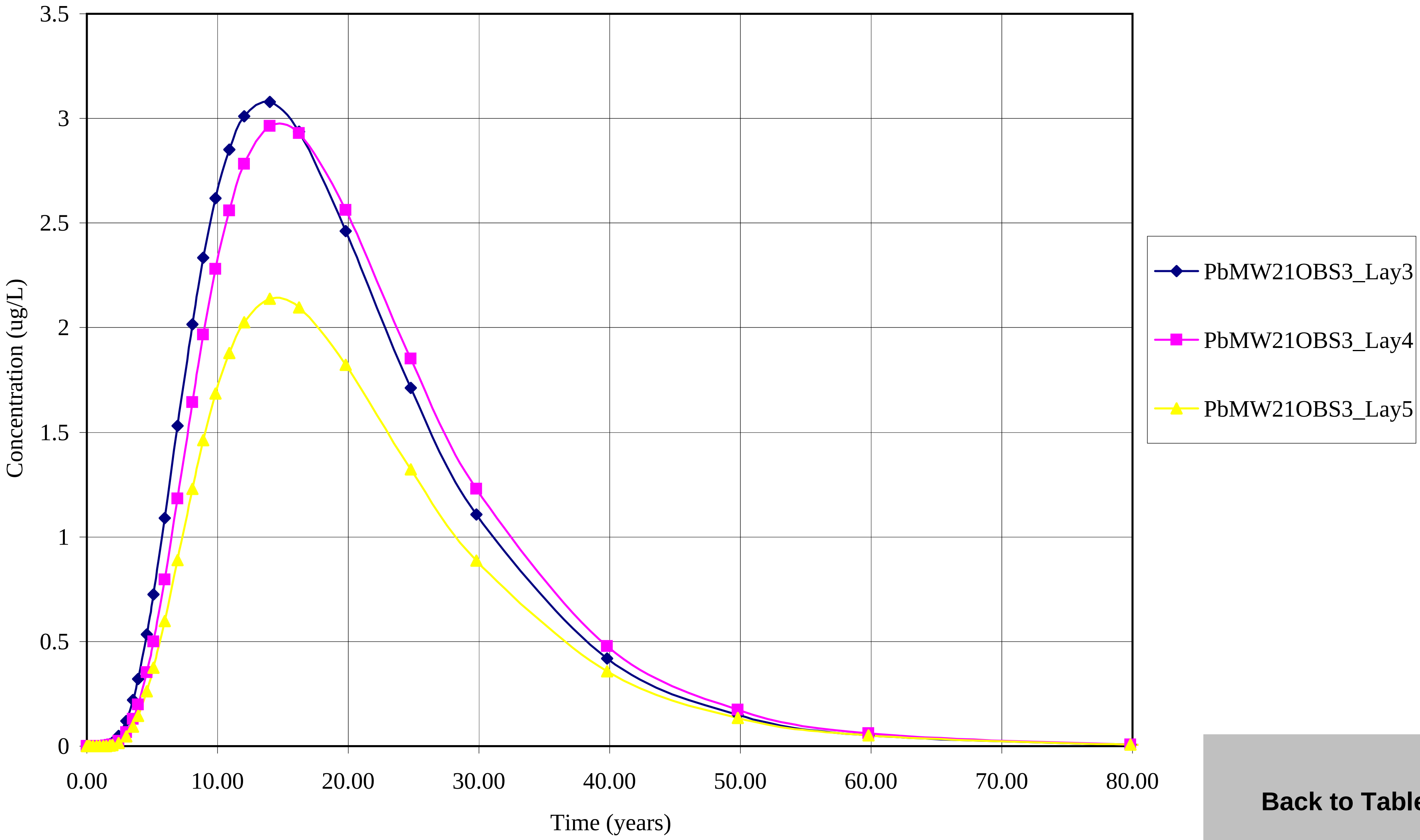
Figure 6A.44. PbMW21OBS2 Lead (Non-pumping) Advection/Dispersion



Back to Table

luck420_Pb_NoPump_Adv_DisOnly_15_60_60_ObsWellDataCHARTS.xls

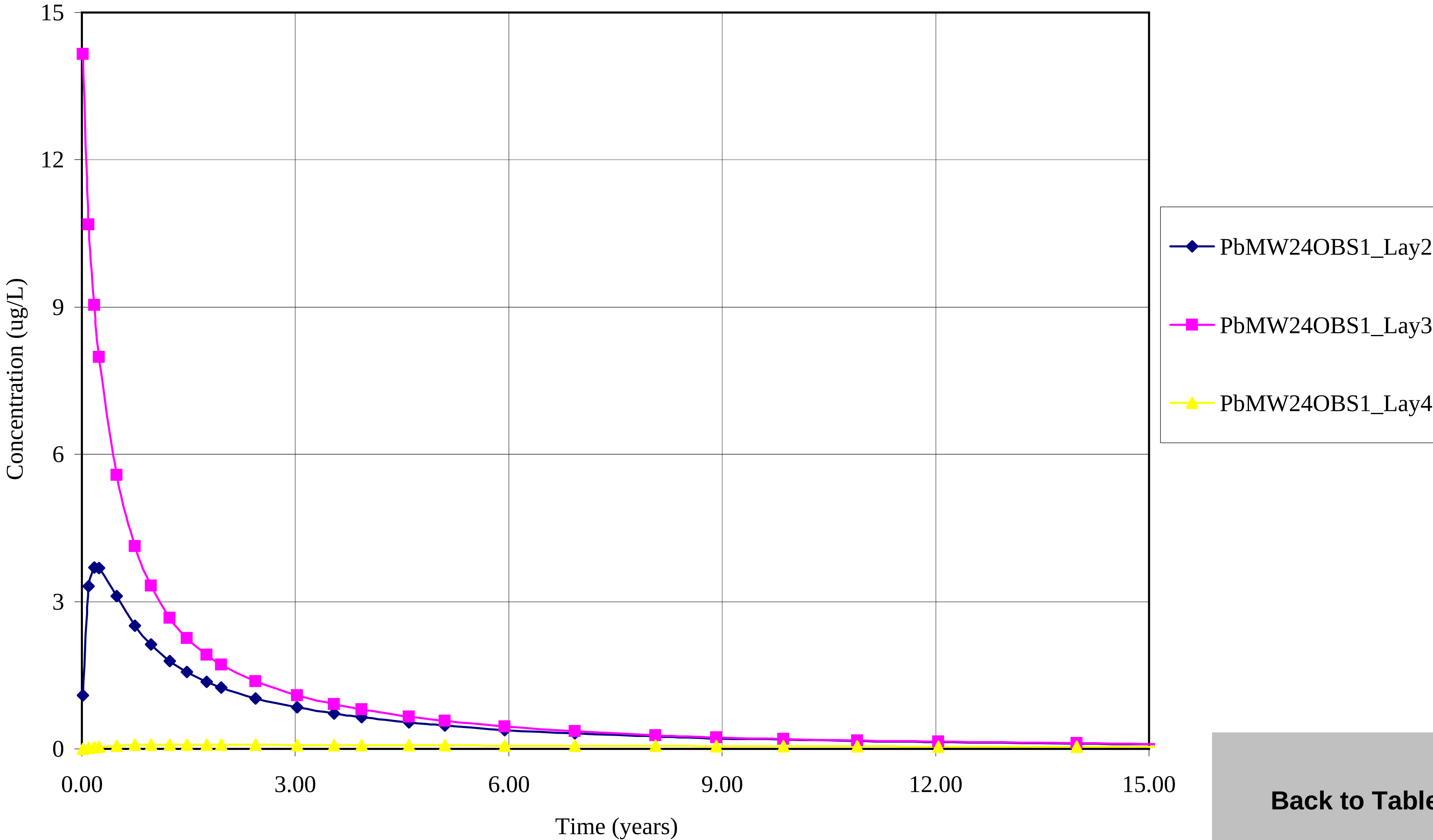
Figure 6A.45. PbMW21OBS3 Lead (Non-pumping) Advection/Dispersion



Back to Table

luck420_Pb_NoPump_Adv_DisOnly_15_60_60_ObsWellDataCHARTS.xls

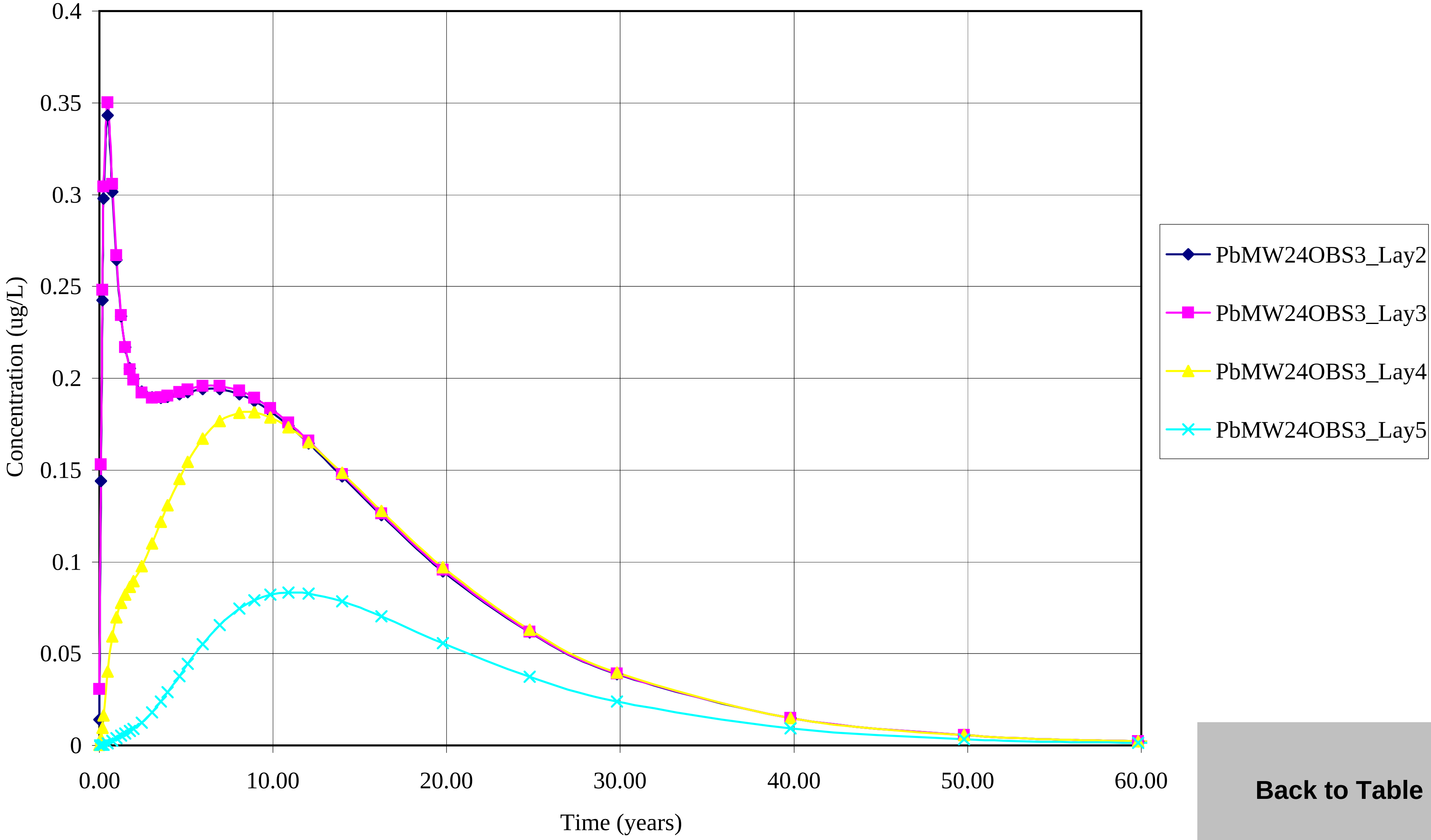
Figure 6A.46. PbMW24OBS1 Lead (Non-pumping) Advection/Dispersion



Back to Table

luck420_Pb_NoPump_Adv_DisOnly_15_60_60_ObsWellDataCHARTS.xls

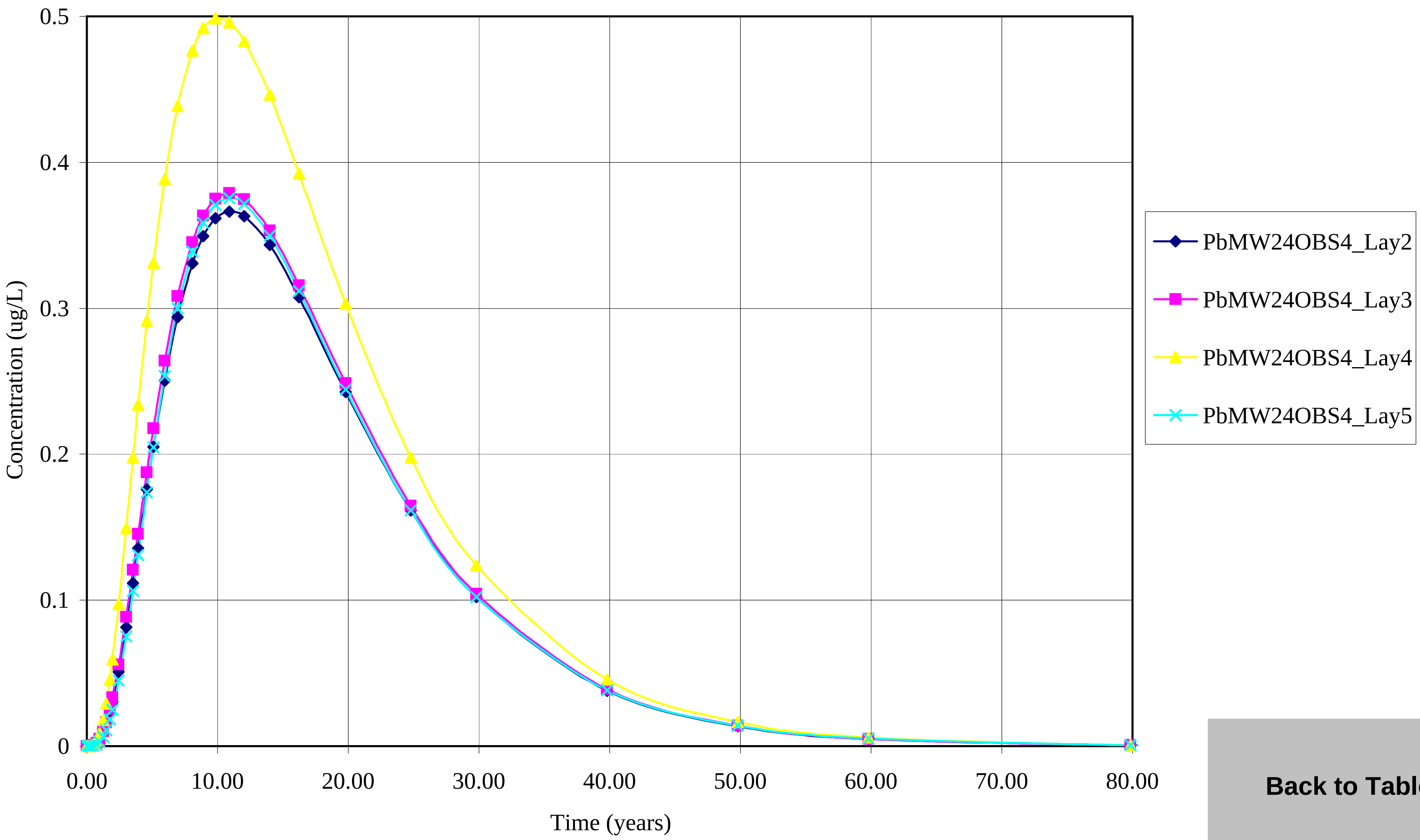
Figure 6A.47. PbMW24OBS3 Lead (Non-pumping) Advection/Dispersion



Back to Table

luck420_Pb_NoPump_Adv_DisOnly_15_60_60_ObsWellDataCHARTS.xls

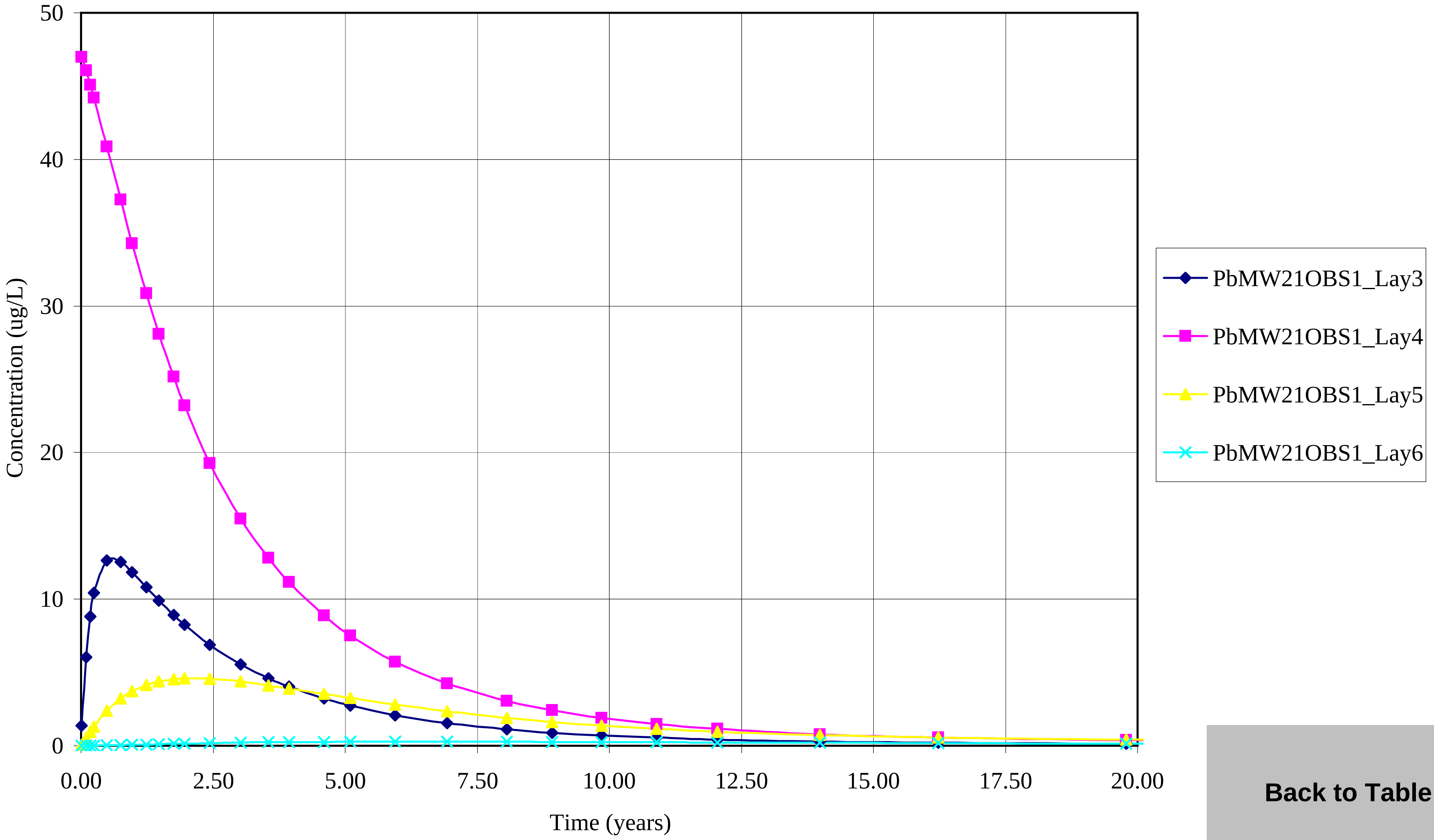
Figure 6A.48. PbMW24OBS4 Lead (Non-pumping) Advection/Dispersion



Back to Table

luck420_Pb_NoPump_Adv_DisOnly_15_60_60_ObsWellDataCHARTS.xls

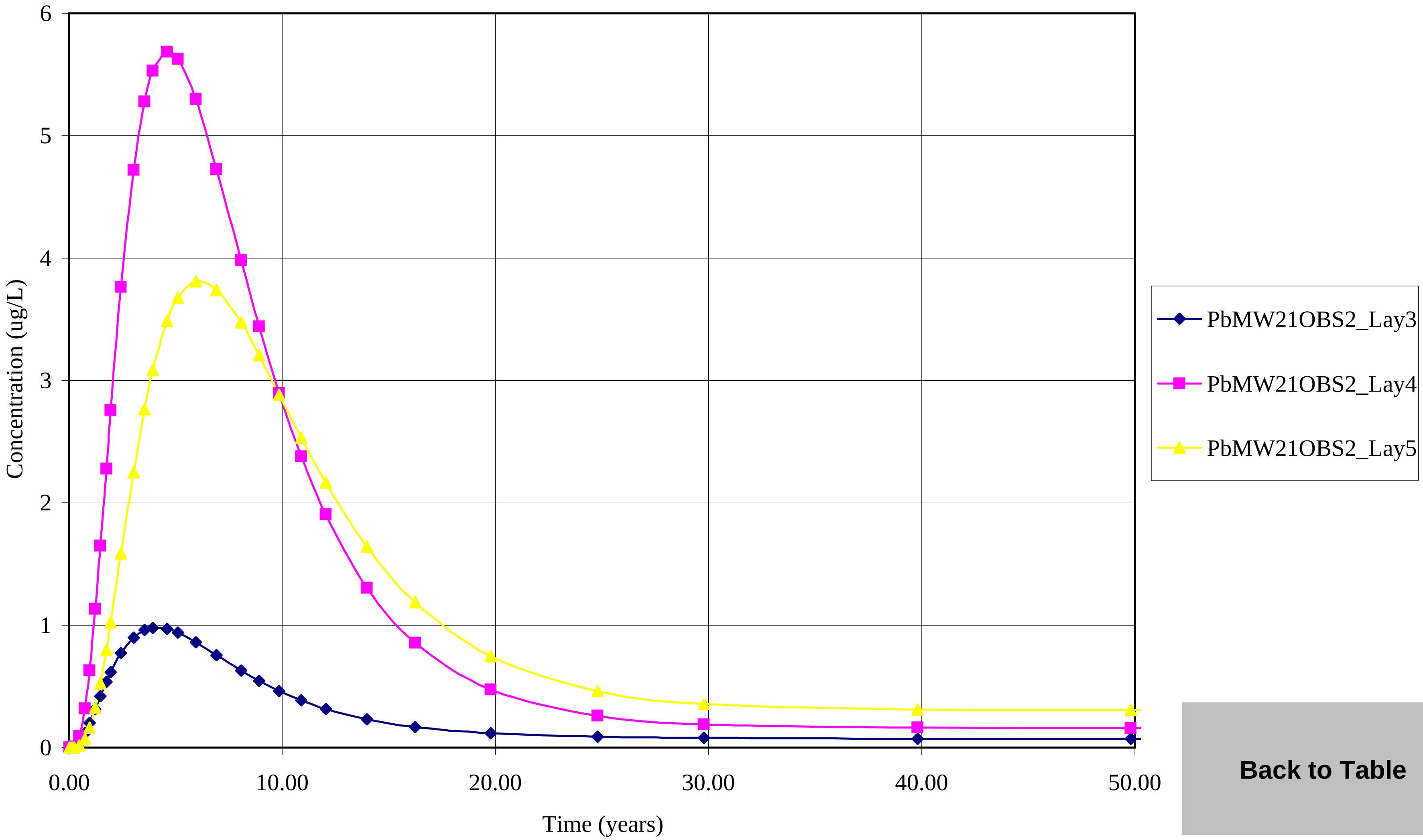
Figure 6A.49. PbMW21OBS1 Lead (Non-pumping) Advection/Dispersion/ChemRxn



Back to Table

luck420_Pb_NoPump_Adv_Dis_Chem_15_60_60_ObsWellDataCHARTS.xls

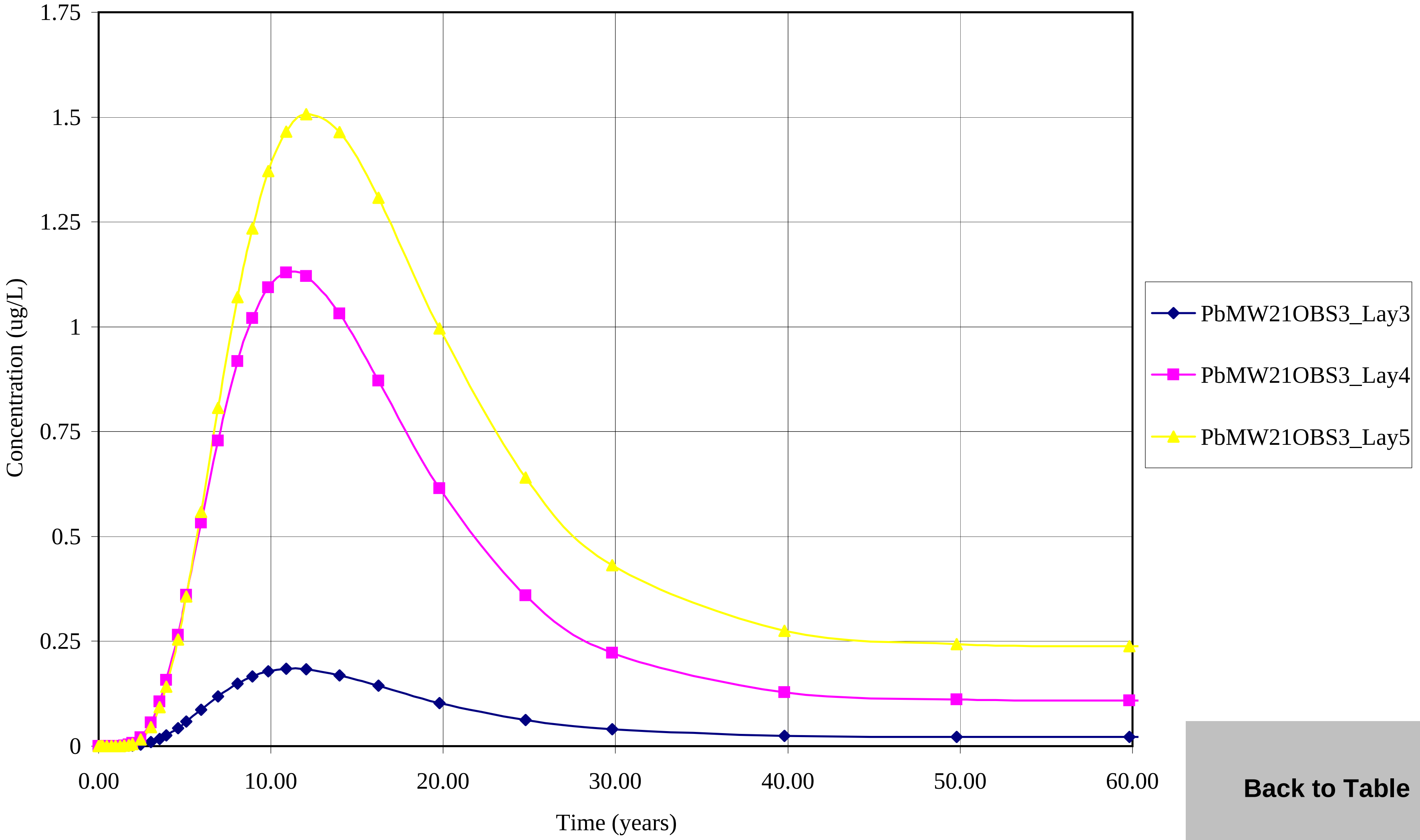
Figure 6A.50. PbMW21OBS2 Lead (Non-pumping) Advection/Dispersion/ChemRxn



Back to Table

luck420_Pb_NoPump_Adv_Dis_Chem_15_60_60_ObsWellDataCHARTS.xls

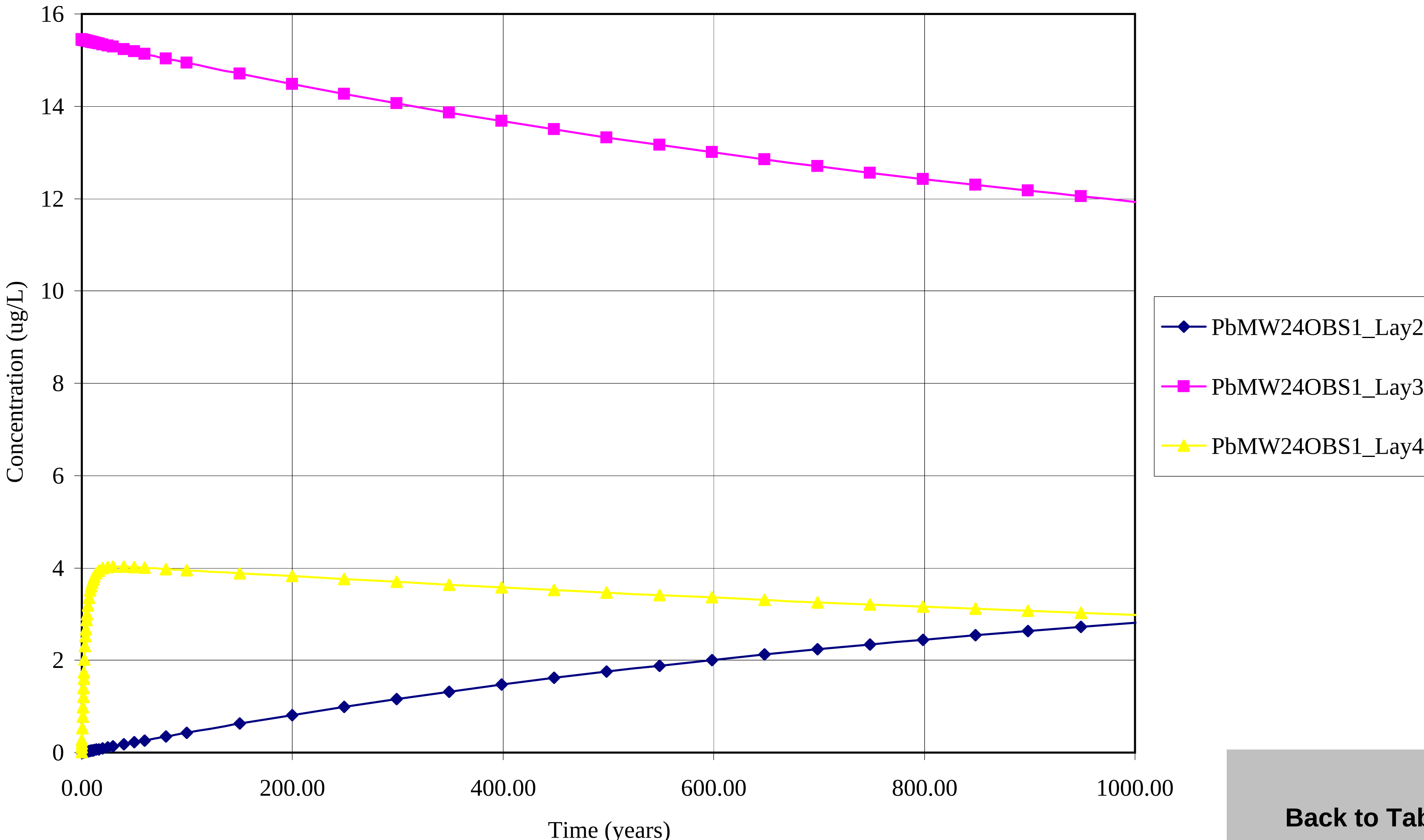
Figure 6A.51. PbMW21OBS3 Lead (Non-pumping) Advection/Dispersion/ChemRxn



Back to Table

luck420_Pb_NoPump_Adv_Dis_Chem_15_60_60_ObsWellDataCHARTS.xls

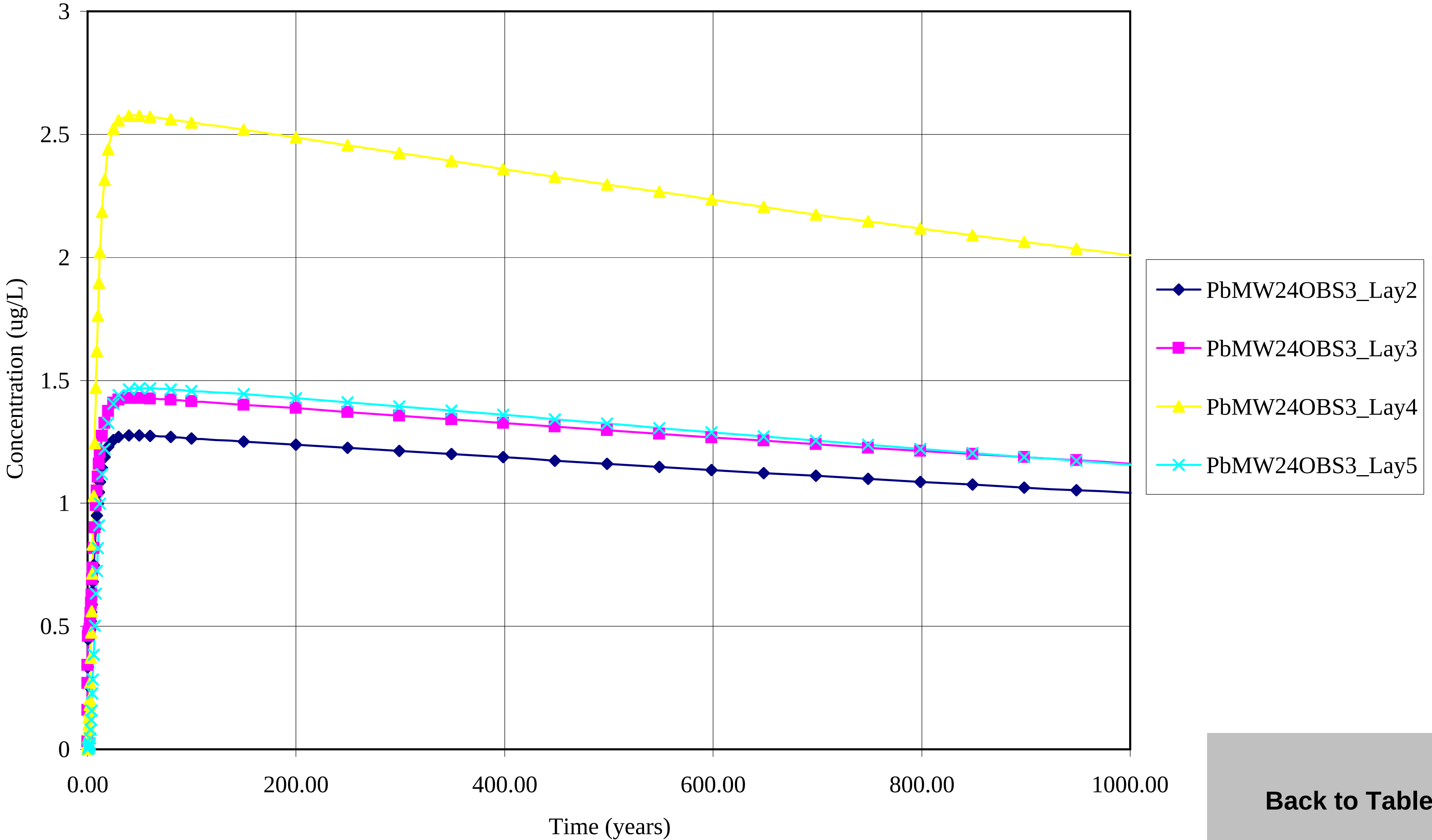
Figure 6A.52. PbMW24OBS1 Lead (Non-pumping) Advection/Dispersion/ChemRxn



Back to Table

luck420_Pb_NoPump_Adv_Dis_Chem_15_60_60_ObsWellDataCHARTS.xls

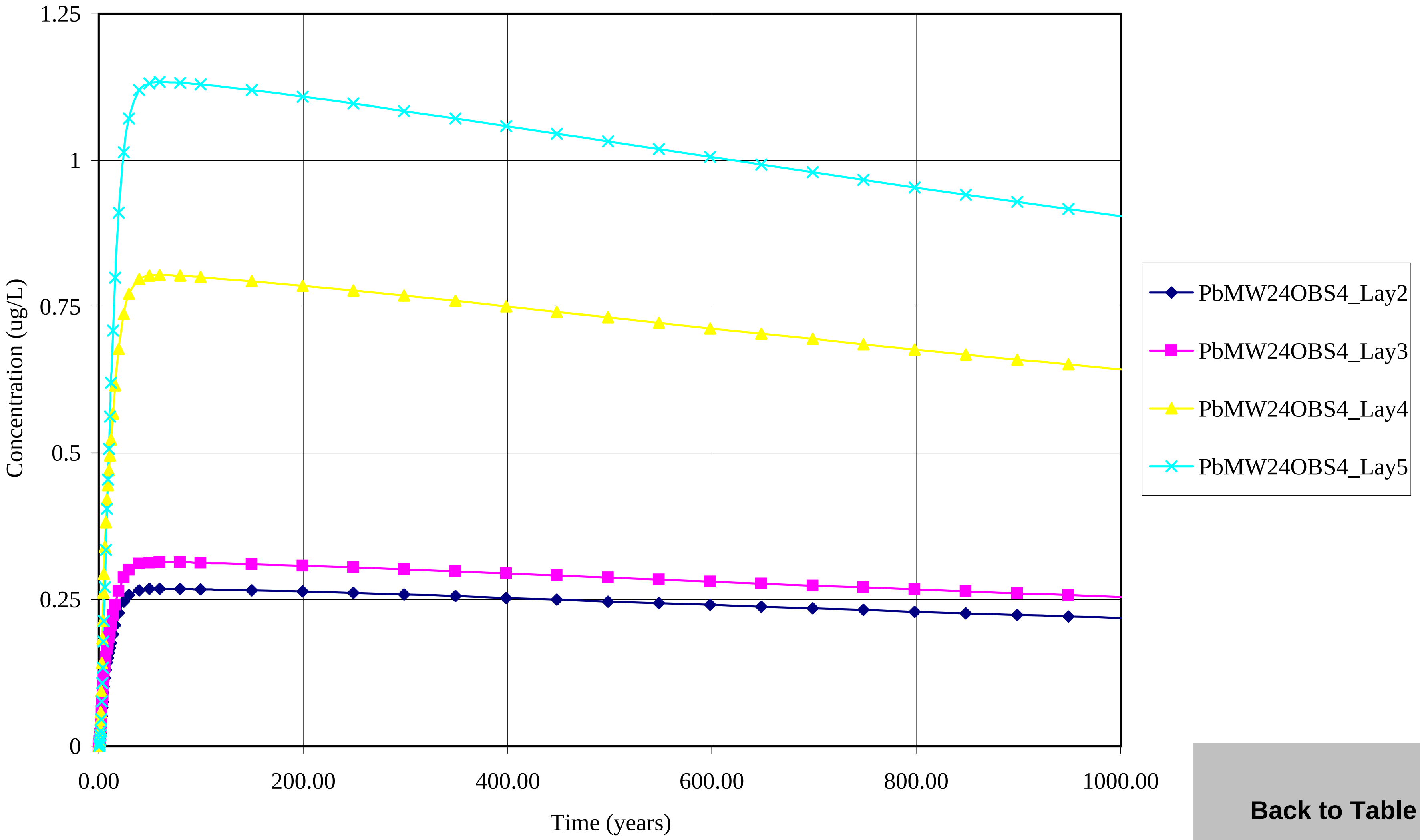
Figure 6A.53. PbMW24OBS3 Lead (Non-pumping) Advection/Dispersion/ChemRxn



Back to Table

luck420_Pb_NoPump_Adv_Dis_Chem_15_60_60_ObsWellDataCHARTS.xls

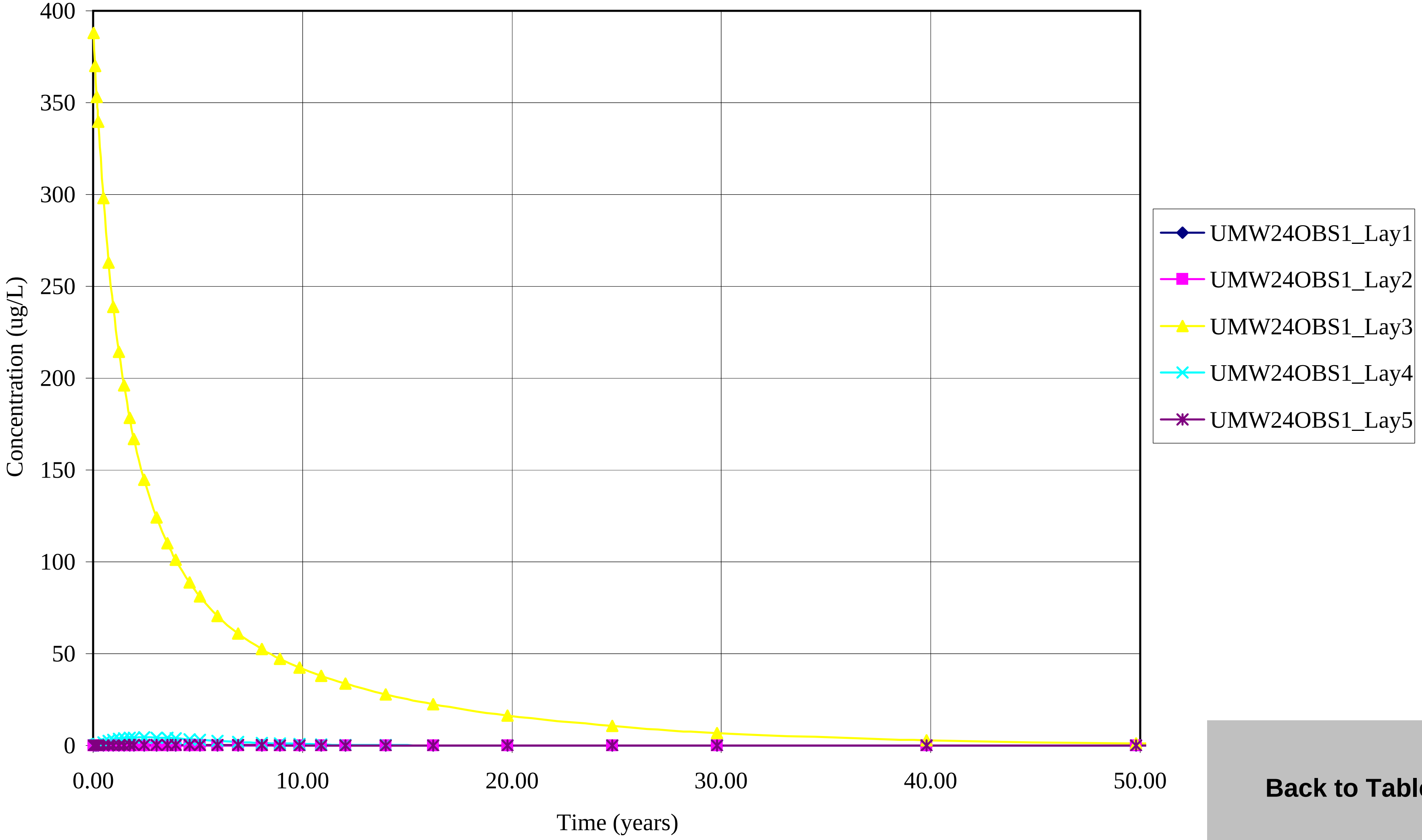
Figure 6A.54. PbMW24OBS4 Lead (Non-pumping) Advection/Dispersion/ChemRxn



Back to Table

luck420_Pb_NoPump_Adv_Dis_Chem_15_60_60_ObsWellDataCHARTS.xls

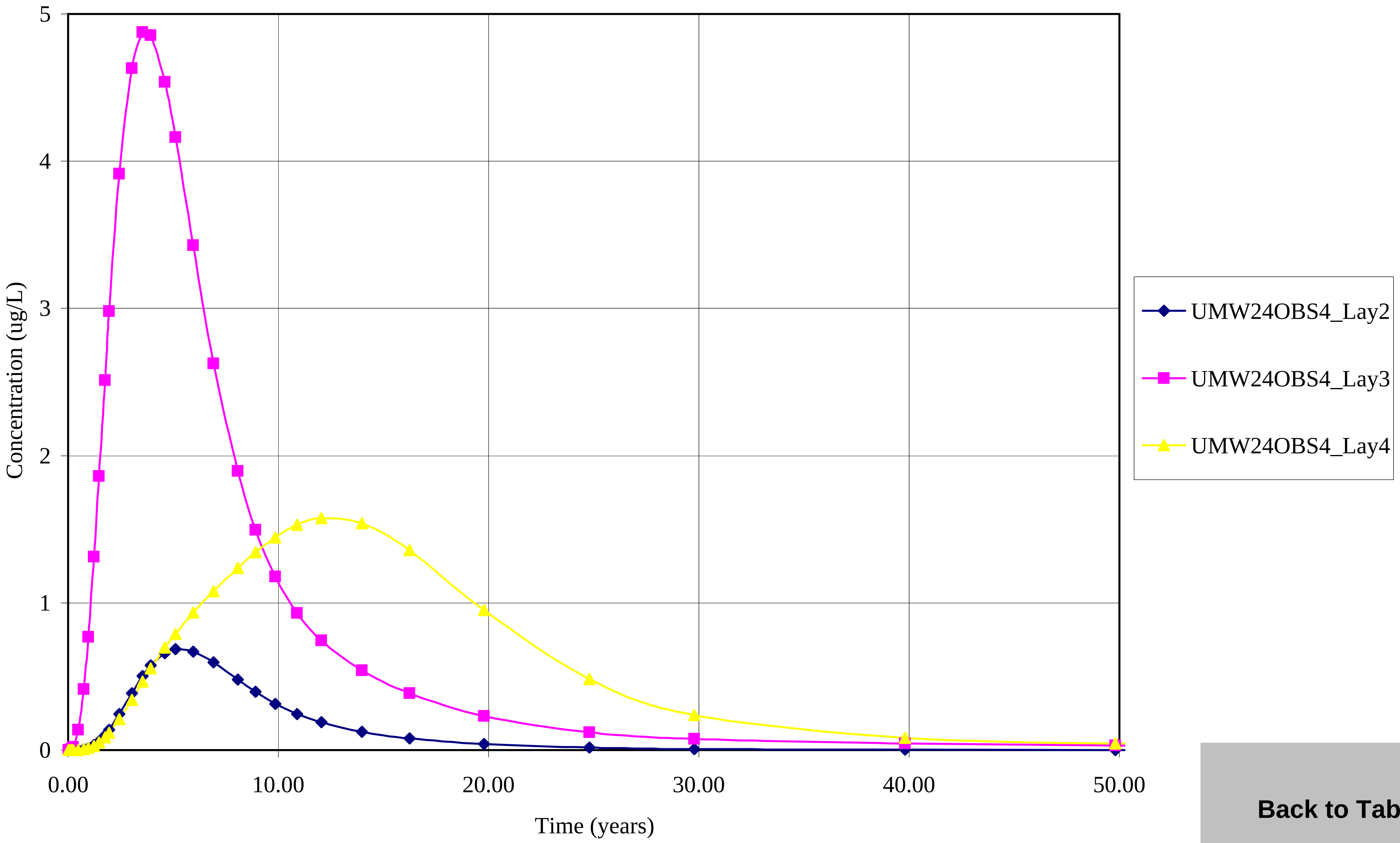
Figure 6A.55. UMW24OBS1 Uranium (Non-pumping) Advection



Back to Table

luck420_U_NoPump_AdvOnly_15_60_60_ObsWellDataCHARTS.xls

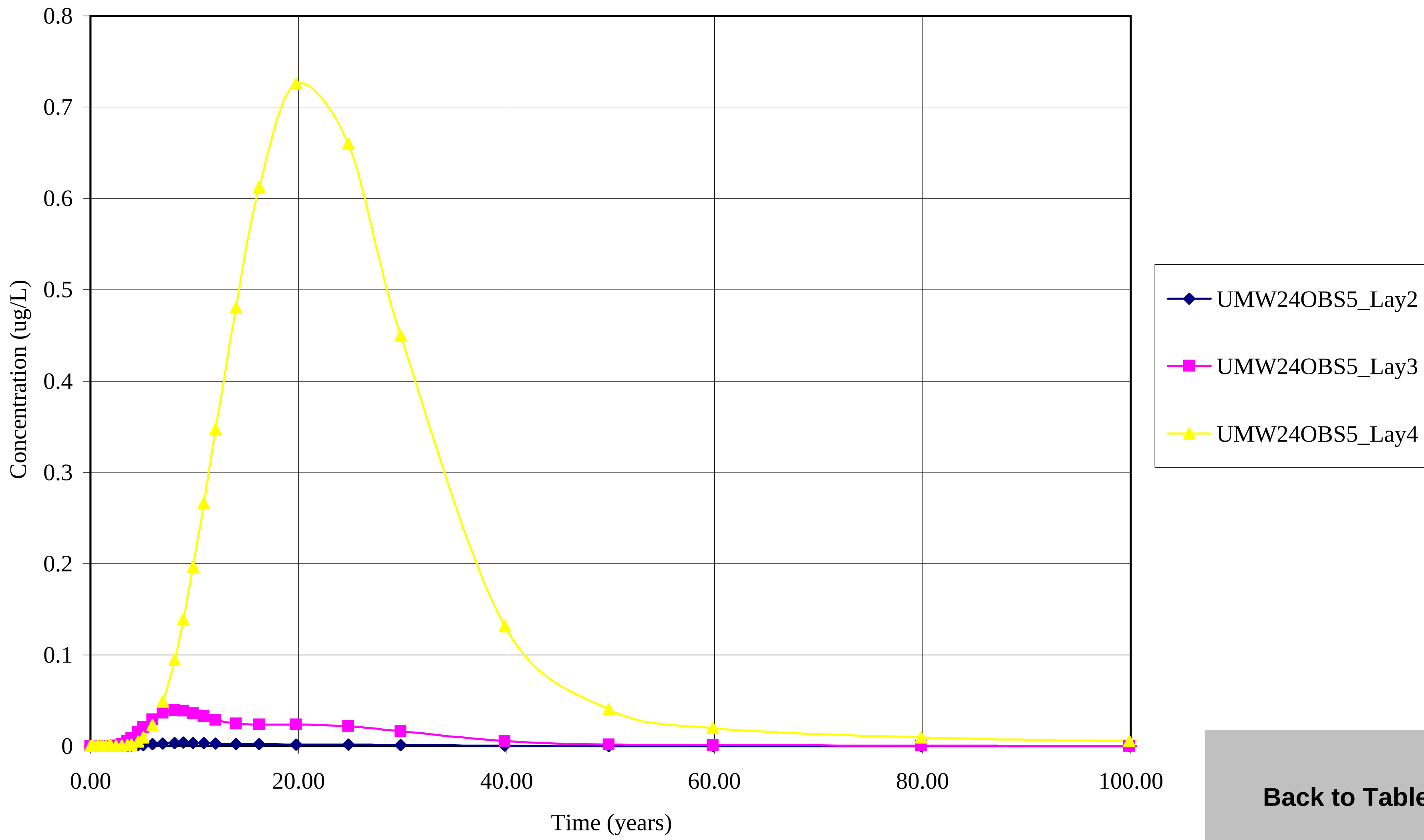
Figure 6A.56. UMW24OBS4 Uranium (Non-pumping) Advection



Back to Table

luck420_U_NoPump_AdvOnly_15_60_60_ObsWellDataCHARTS.xls

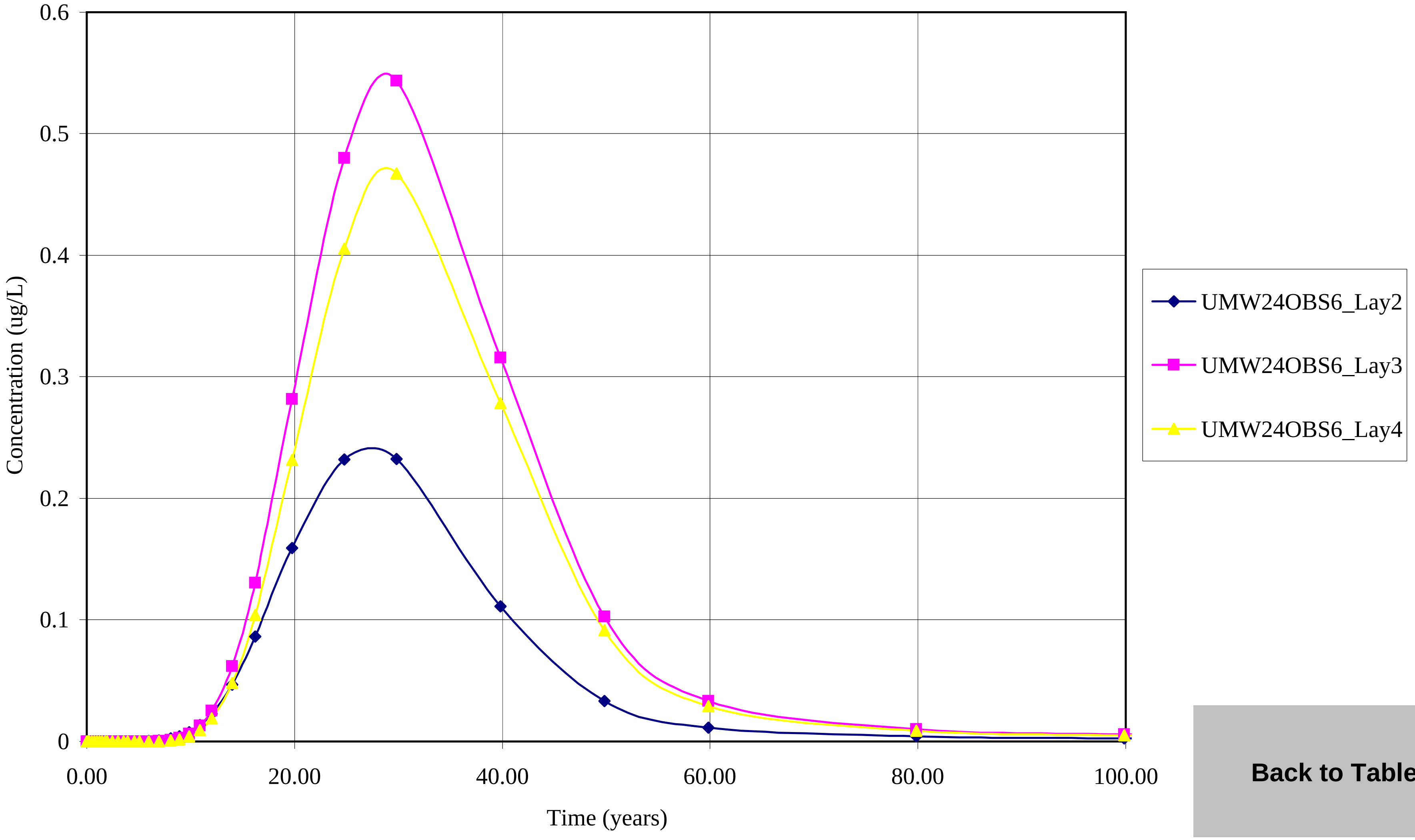
Figure 6A.57. UMW24OBS5 Uranium (Non-pumping) Advection



Back to Table

luck420_U_NoPump_AdvOnly_15_60_60_ObsWellDataCHARTS.xls

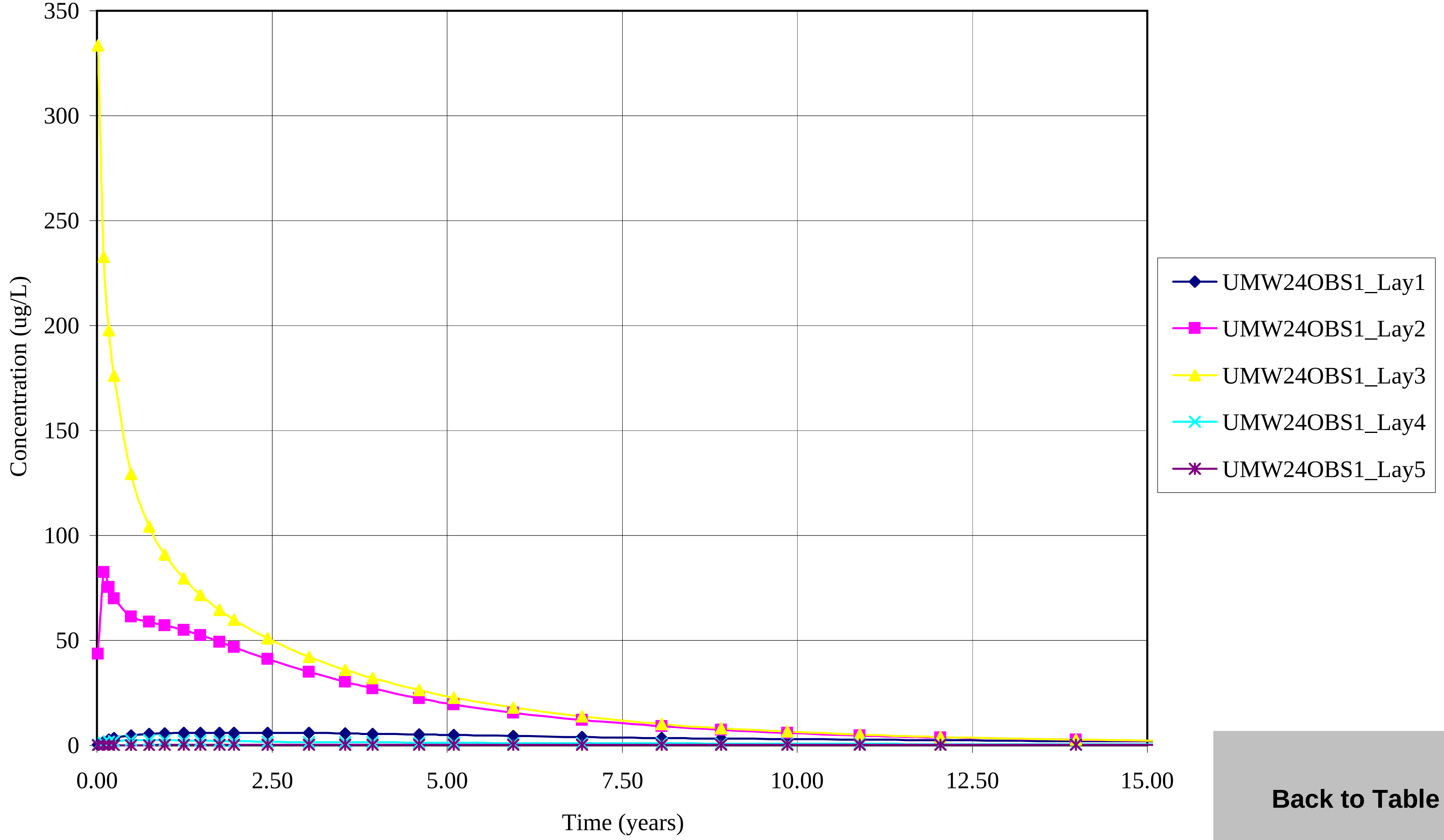
Figure 6A.58. UMW24OBS6 Uranium (Non-pumping) Advection



Back to Table

luck420_U_NoPump_AdvOnly_15_60_60_ObsWellDataCHARTS.xls

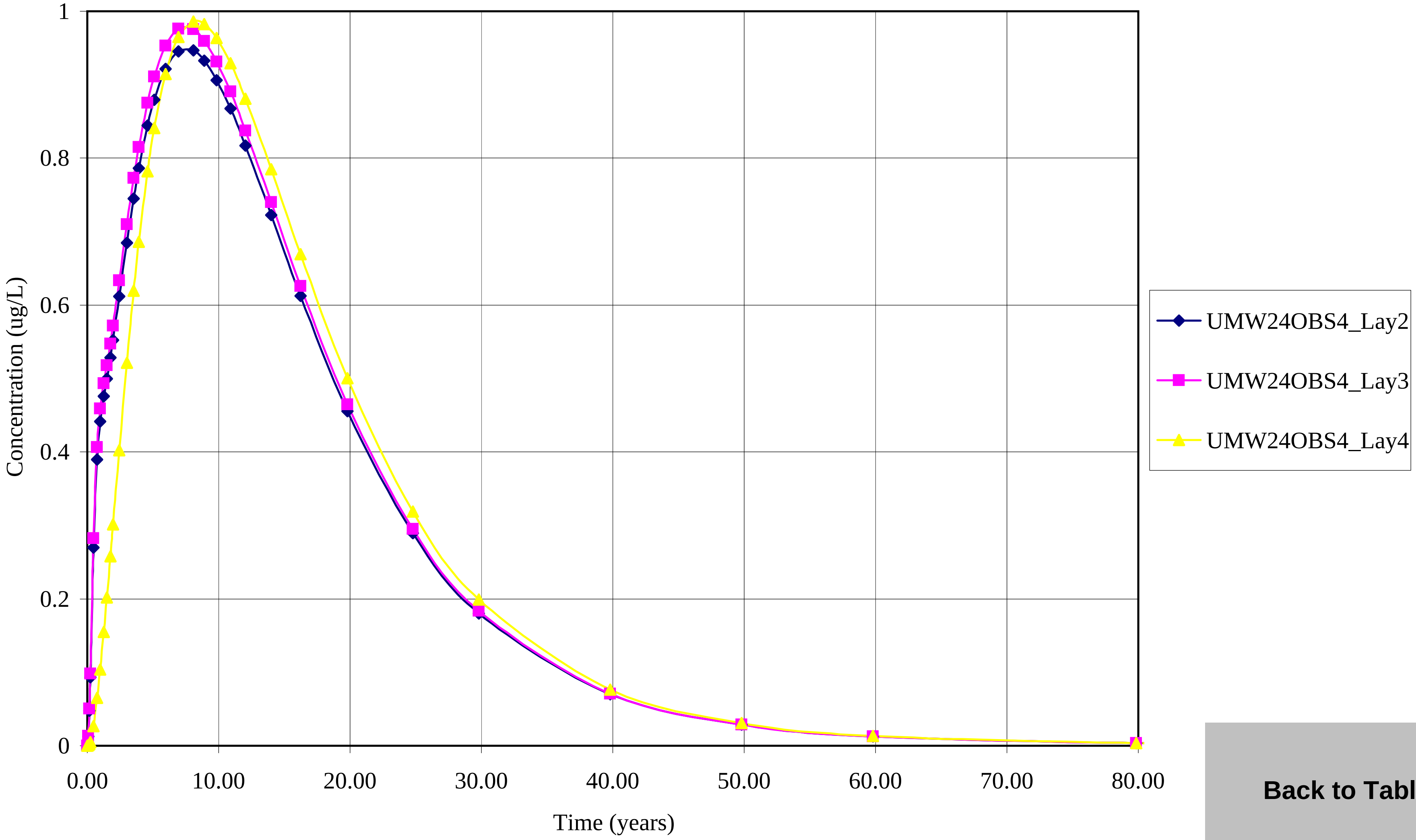
Figure 6A.59. UMW24OBS1 Uranium (Non-pumping) Advection/Dispersion



Back to Table

luck420_U_NoPump_Adv_DisOnly_15_60_60_ObsWellDataCHARTS.xls

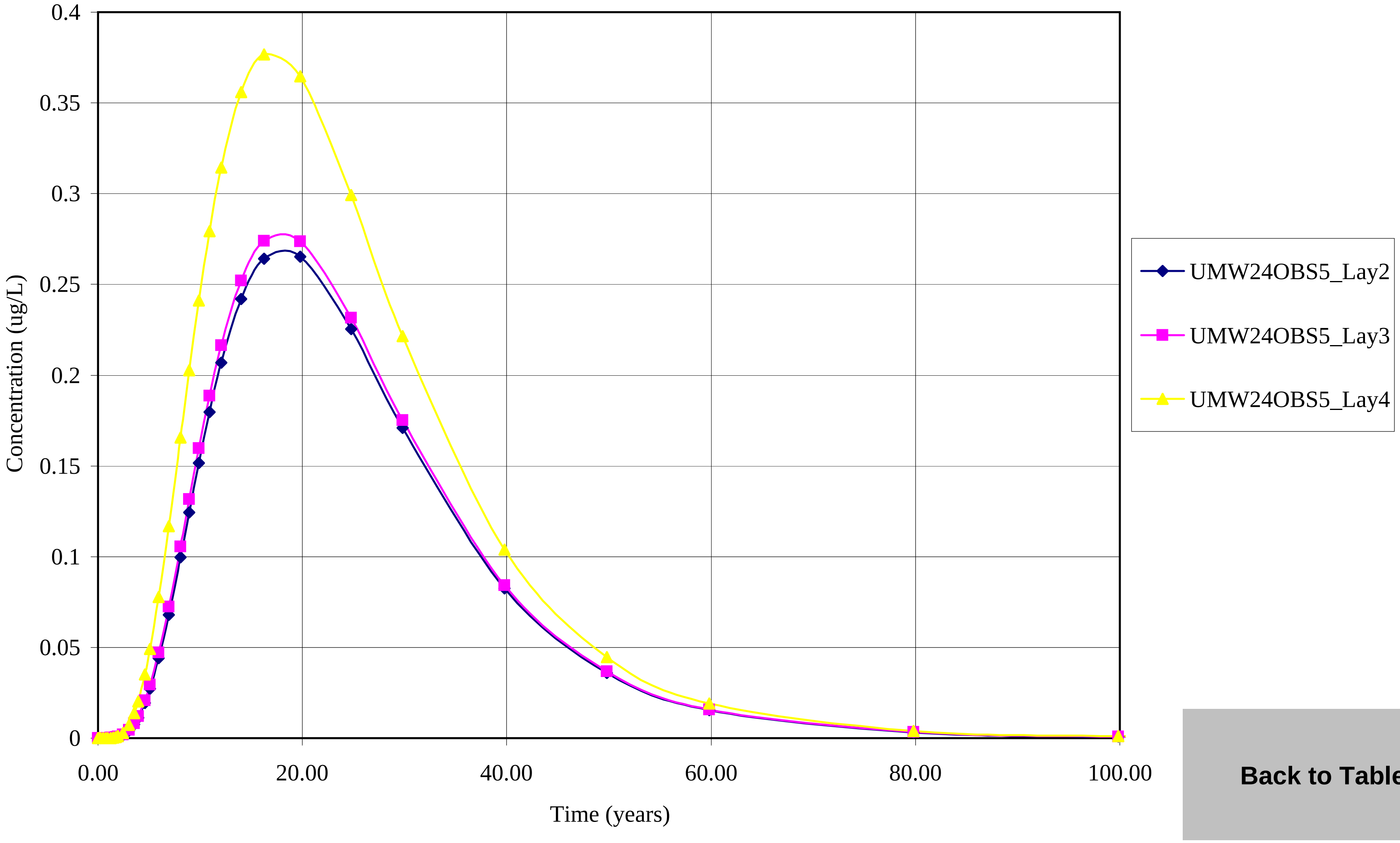
Figure 6A.60. UMW24OBS4 Uranium (Non-pumping) Advection/Dispersion



Back to Table

luck420_U_NoPump_Adv_DisOnly_15_60_60_ObsWellDataCHARTS.xls

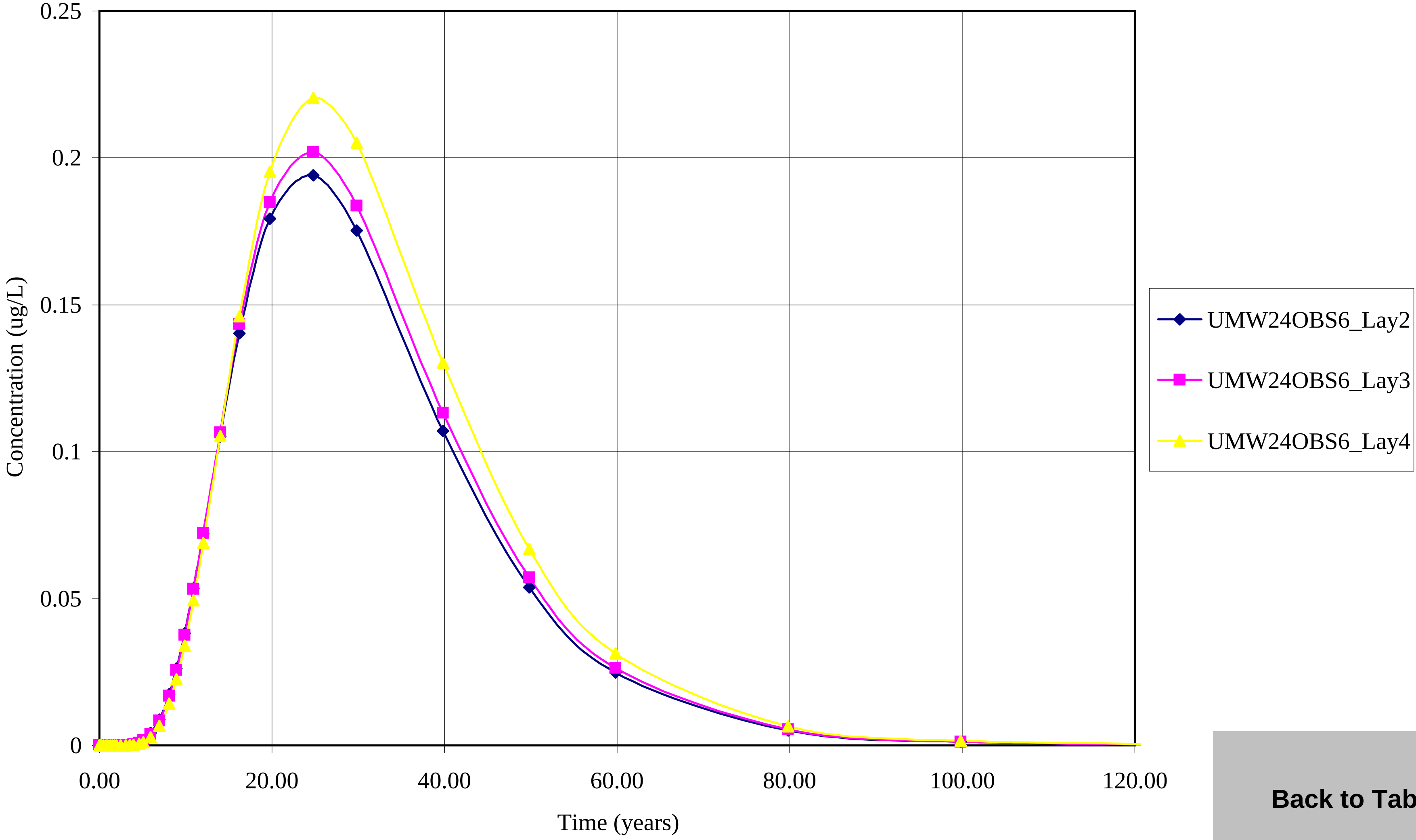
Figure 6A.61. UMW24OBS5 Uranium (Non-pumping) Advection/Dispersion



Back to Table

luck420_U_NoPump_Adv_DisOnly_15_60_60_ObsWellDataCHARTS.xls

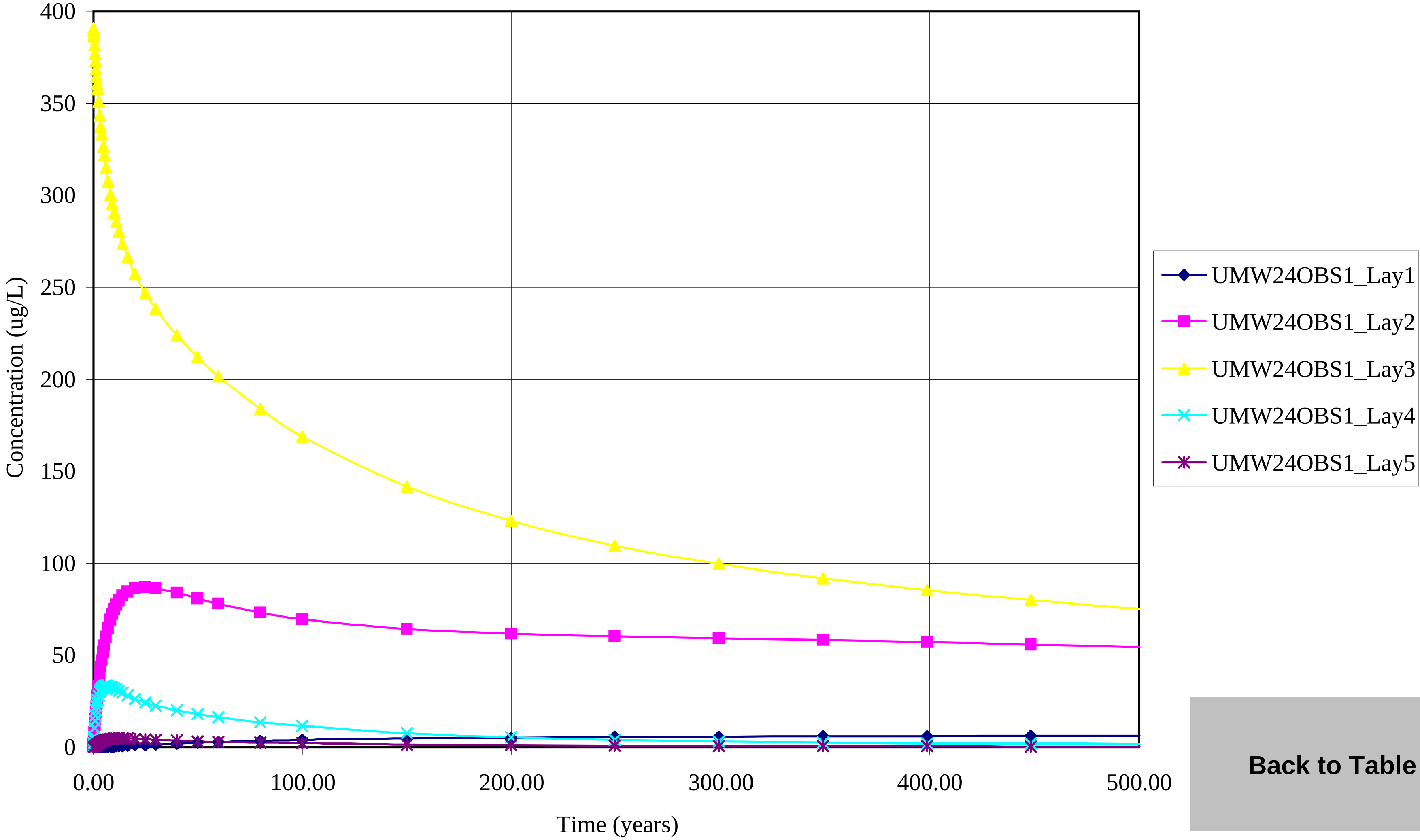
Figure 6A.62. MW24OBS6 Uranium (Non-pumping) Advection/Dispersion



Back to Table

luck420_U_NoPump_Adv_DisOnly_15_60_60_ObsWellDataCHARTS.xls

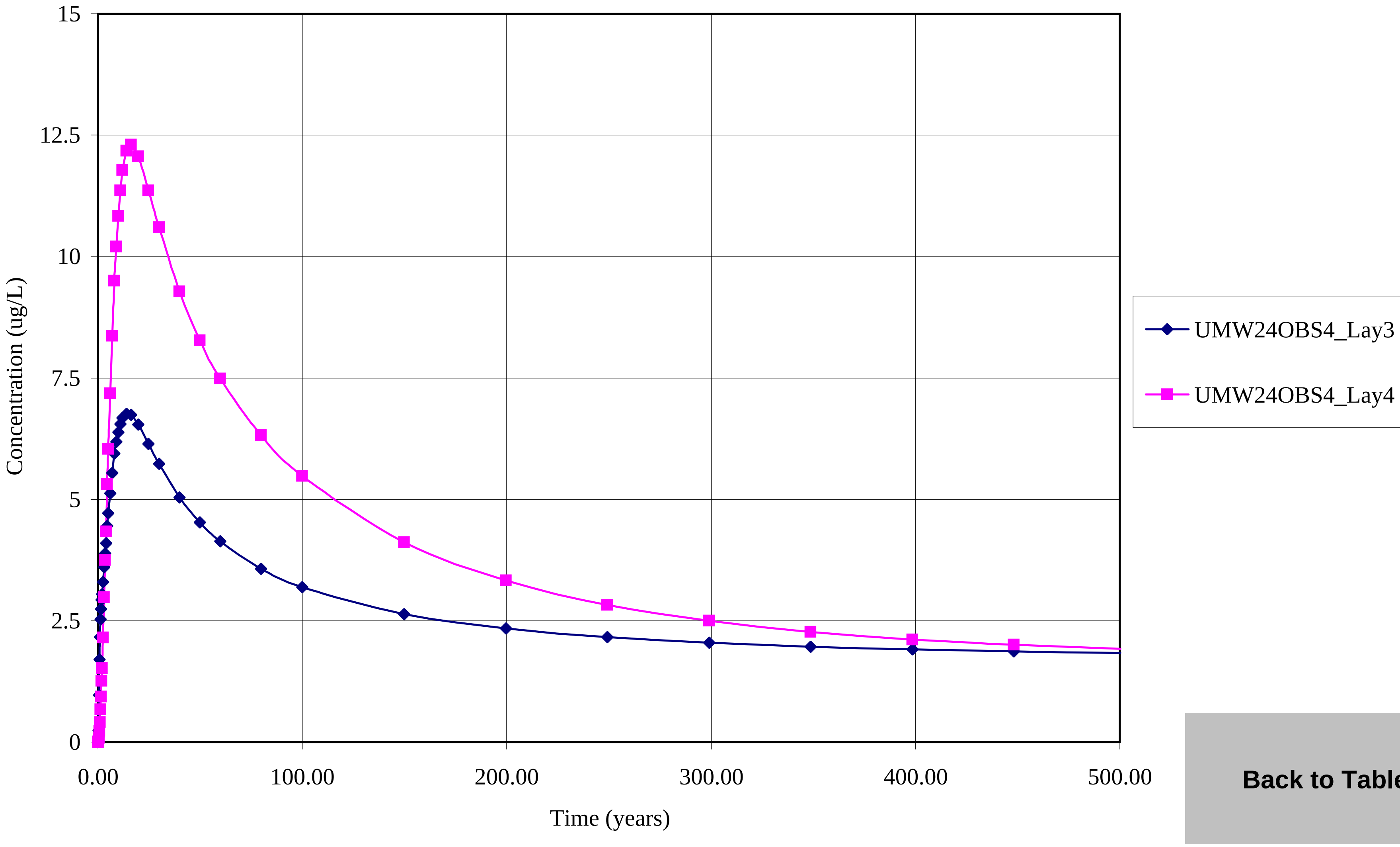
Figure 6A.63. UMW24OBS1 Uranium (Non-pumping) Advection/Dispersion/ChemRxn



Back to Table

luck420_U_NoPump_Adv_Dis_Chem_15_60_60_ObsWellDataCHARTS.xls

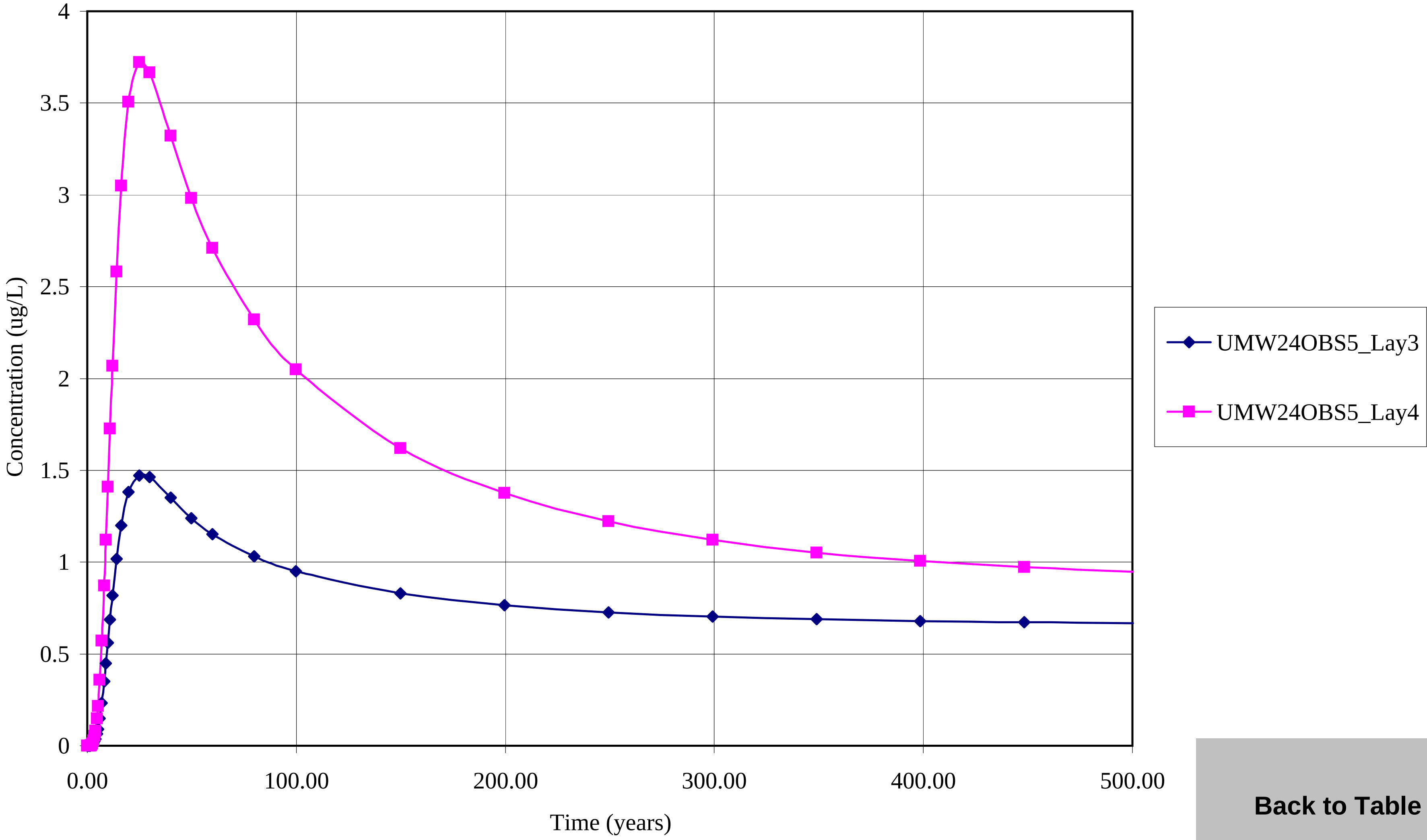
Figure 6A.64. UMW24OBS4 Uranium (Non-pumping) Advection/Dispersion/ChemRxn



Back to Table

luck420_U_NoPump_Adv_Dis_Chem_15_60_60_ObsWellDataCHARTS.xls

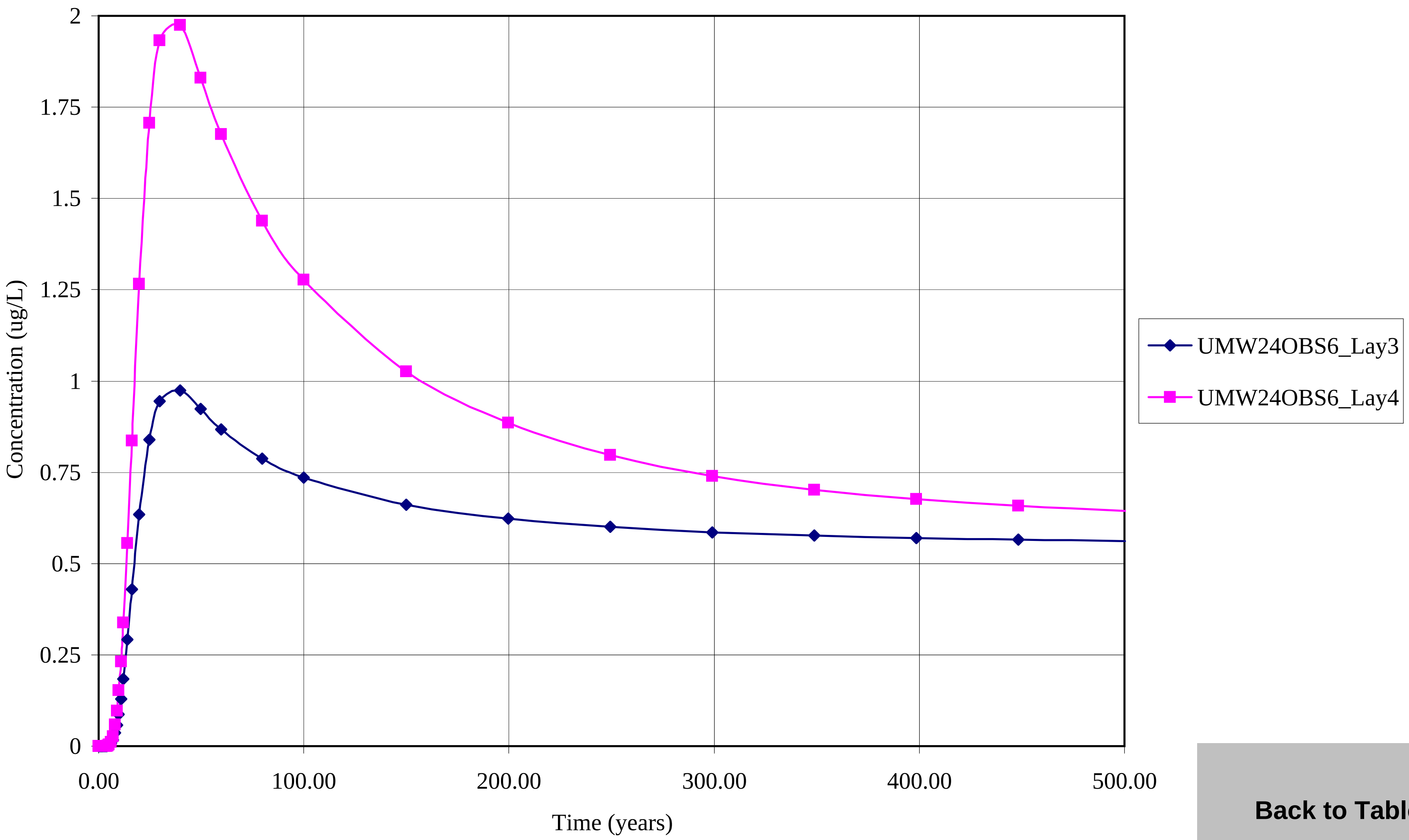
Figure 6A.65. UMW24OBS5 Uranium (Non-pumping) Advection/Dispersion/ChemRxn



Back to Table

luck420_U_NoPump_Adv_Dis_Chem_15_60_60_ObsWellDataCHARTS.xls

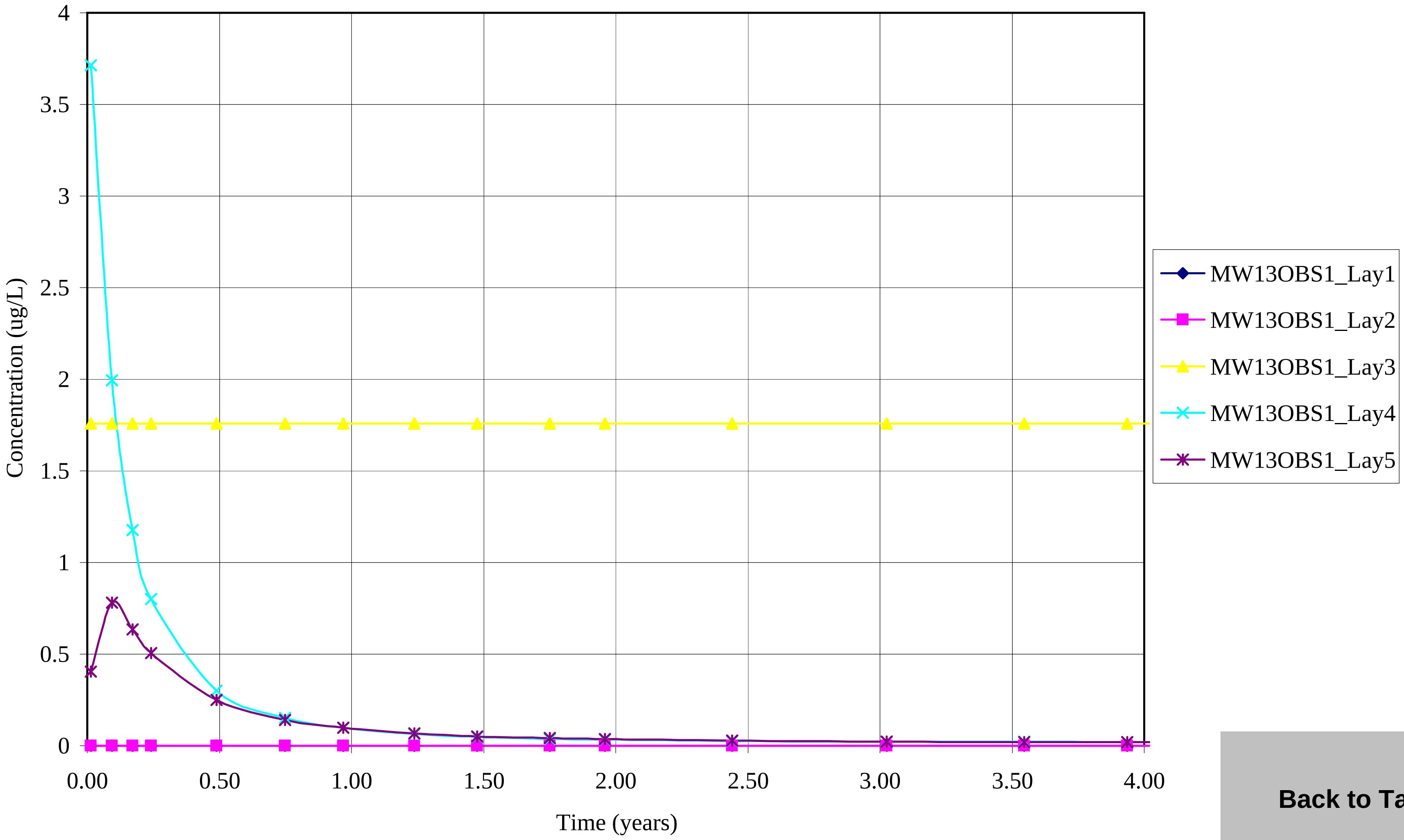
Figure 6A.66. UMW24OBS6 Uranium (Non-pumping) Advection/Dispersion/ChemRxn



Back to Table

luck420_U_NoPump_Adv_Dis_Chem_15_60_60_ObsWellDataCHARTS.xls

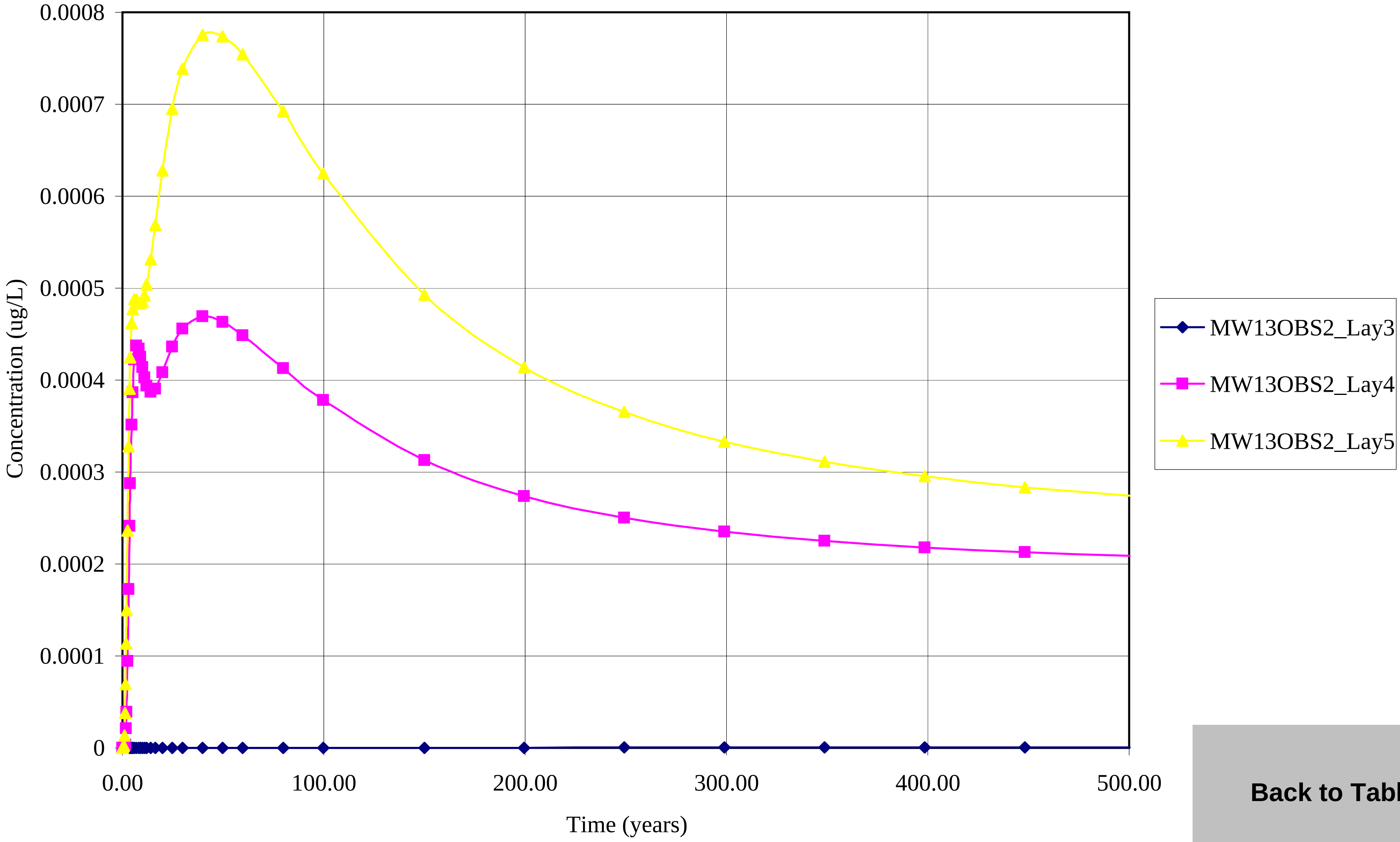
Figure 6A.67. MW13OBS1 Beryllium (Non-pumping) Extraction/Advection/Dispersion/ChemRxn



Back to Table

luck420_Be_NoPump_Extract_Adv_Dis_Chem_15_60_60_ObsWellDataCHARTS.xls

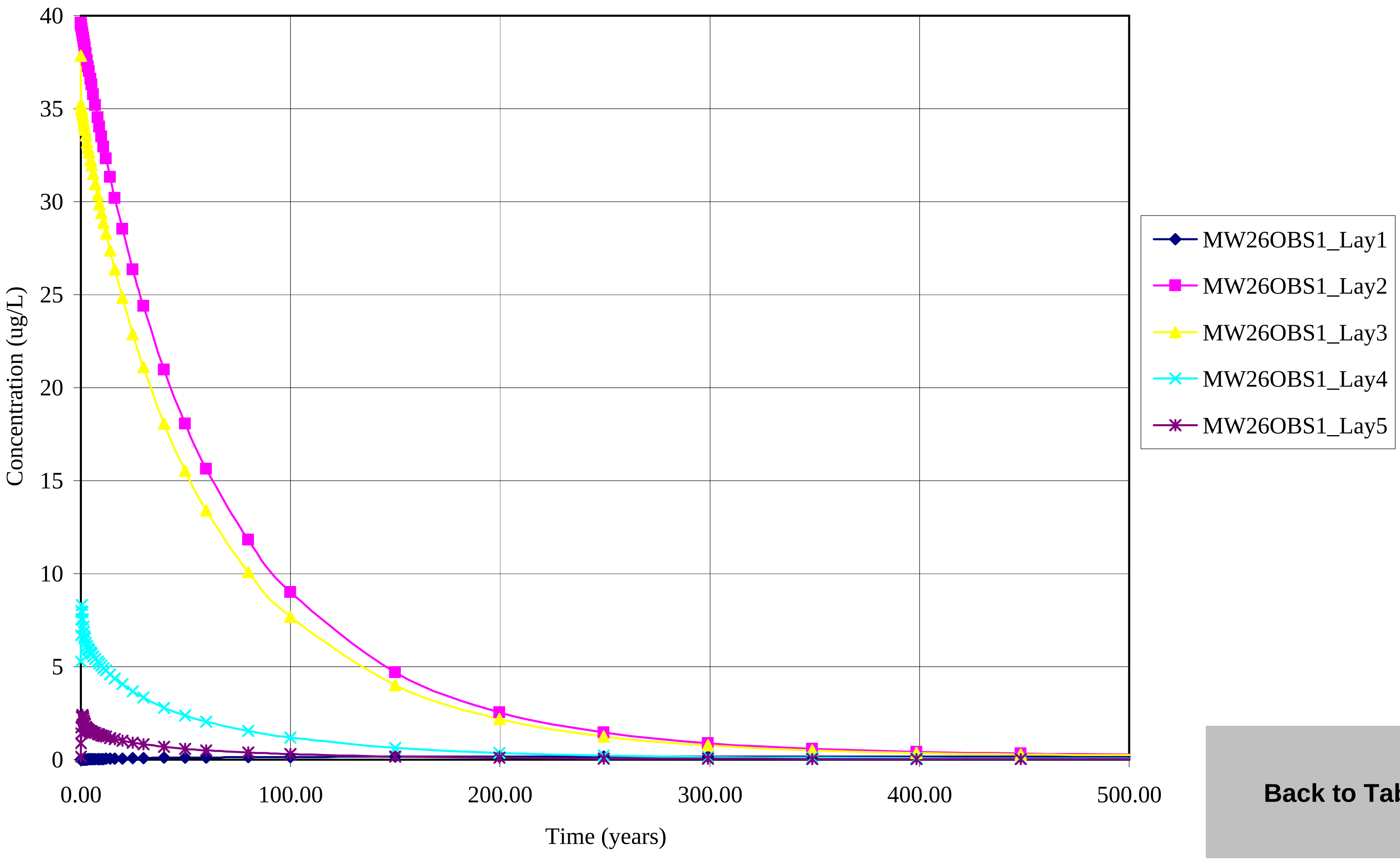
Figure 6A.68. MW13OBS2 Beryllium (Non-pumping) Extraction/Advection/Dispersion/ChemRxn



Back to Table

luck420_Be_NoPump_Extract_Adv_Dis_Chem_15_60_60_ObsWellDataCHARTS.xls

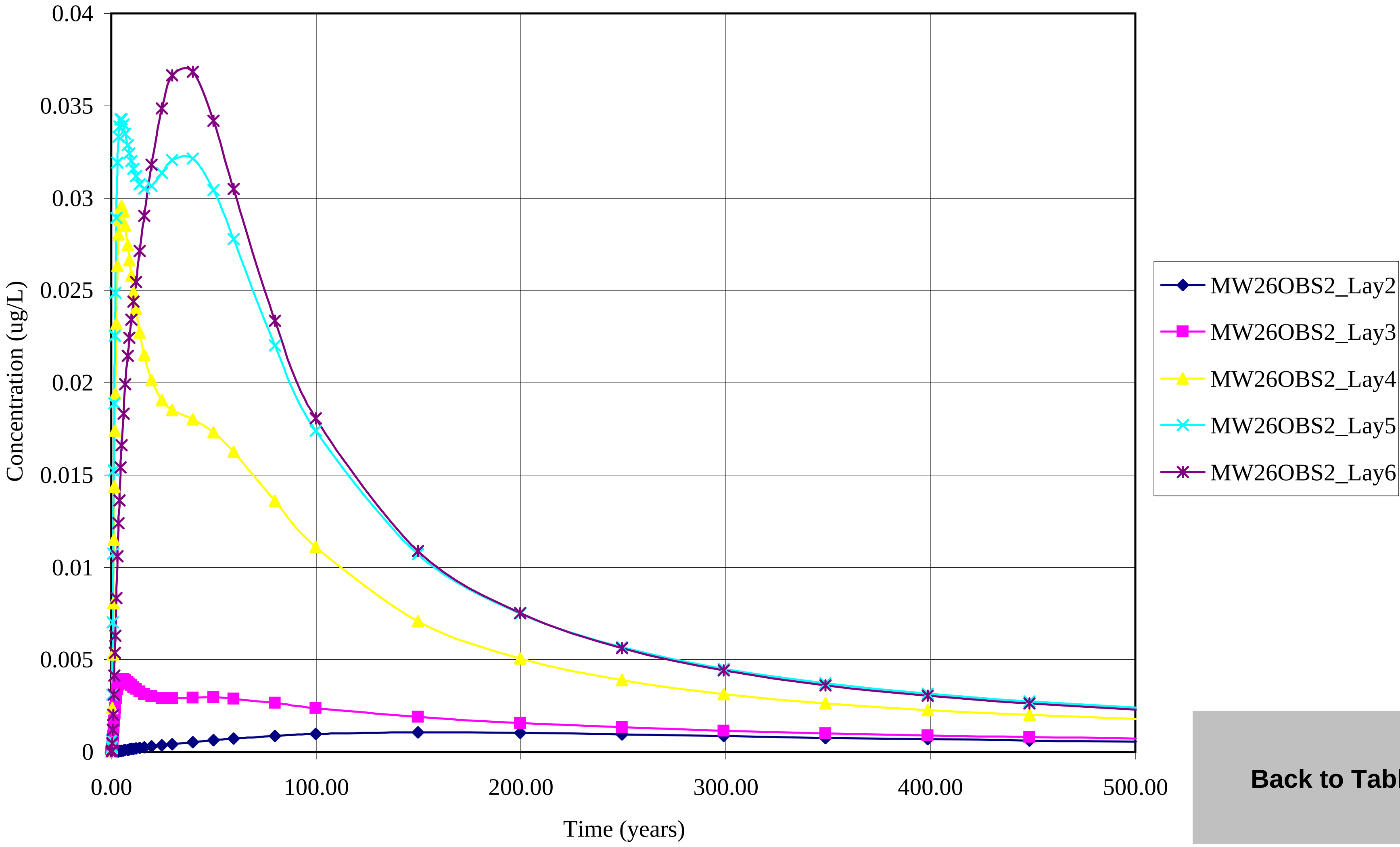
Figure 6A.69. MW26OBS1 Beryllium (Non-pumping) Extraction/Advection/Dispersion/ChemRxn



Back to Table

luck420_Be_NoPump_Extract_Adv_Dis_Chem_15_60_60_ObsWellDataCHARTS.xls

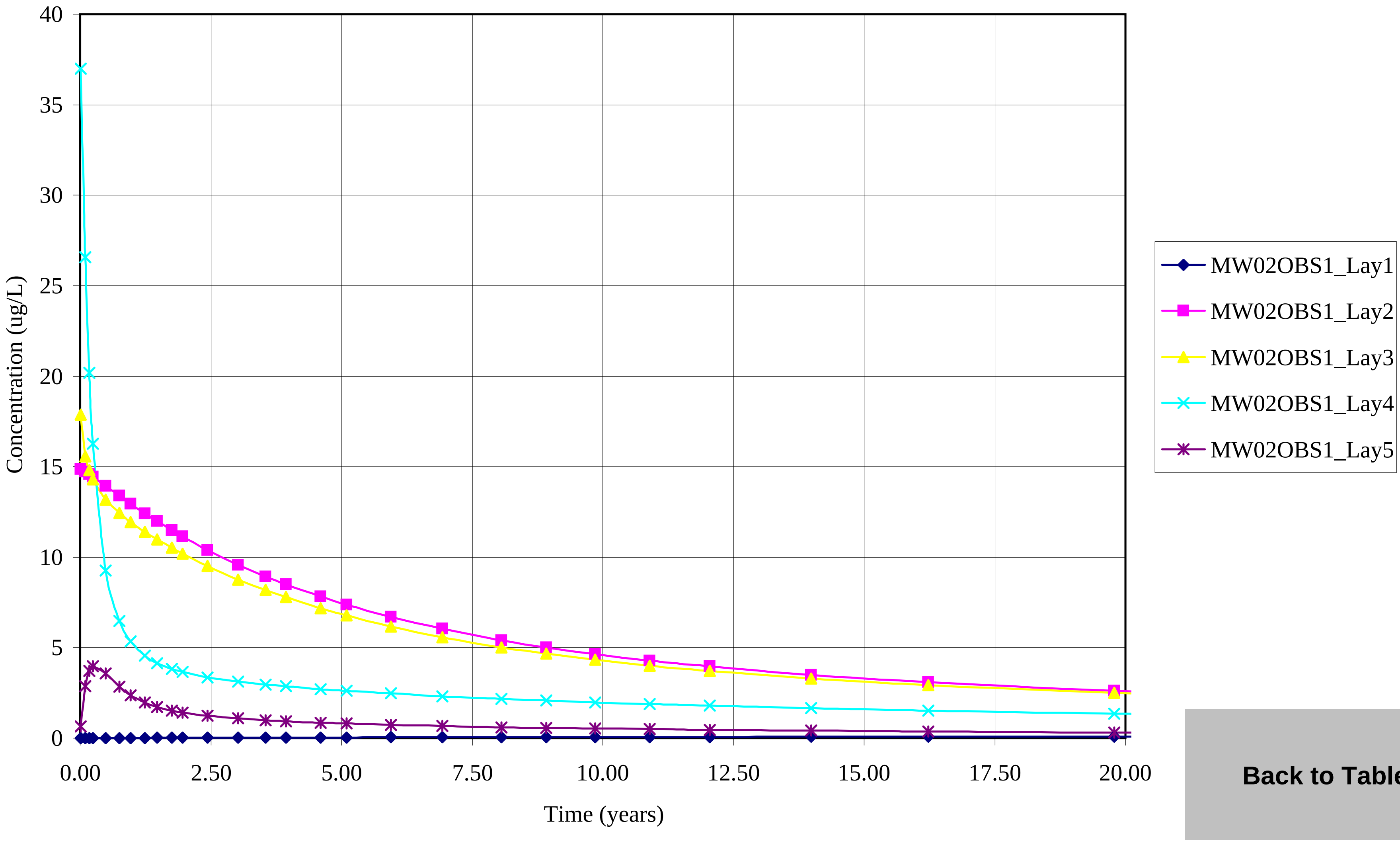
Figure 6A.70. MW26OBS2 Beryllium (Non-pumping) Extraction/Advection/Dispersion/ChemRxn



Back to Table

luck420_Be_NoPump_Extract_Adv_Dis_Chem_15_60_60_ObsWellDataCHARTS.xls

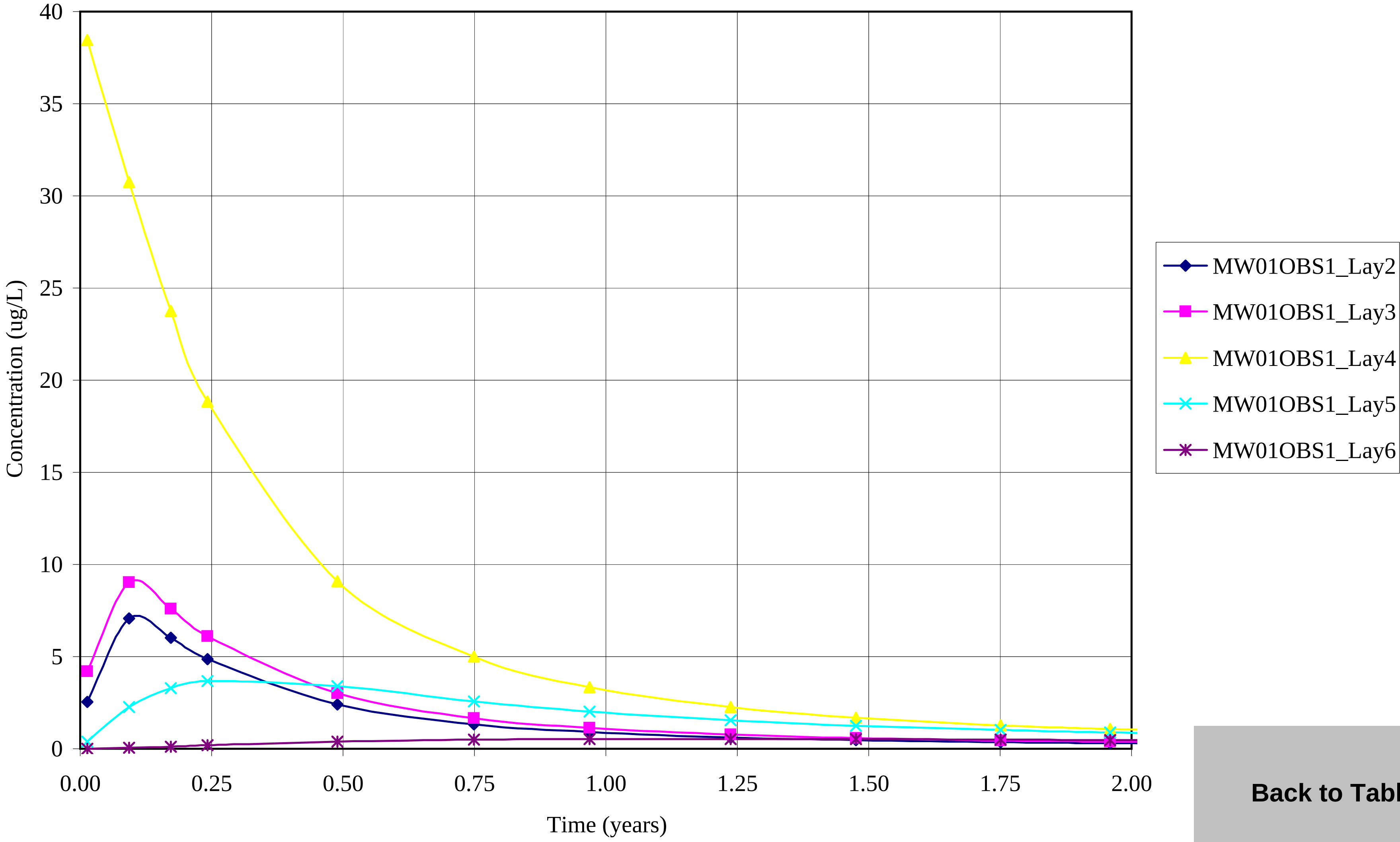
Figure 6A.71. MW02OBS1 Beryllium (Non-pumping) Extraction/Advection/Dispersion/ChemRxn



Back to Table

luck420_Be_NoPump_Extract_Adv_Dis_Chem_15_60_60_ObsWellDataCHARTS.xls

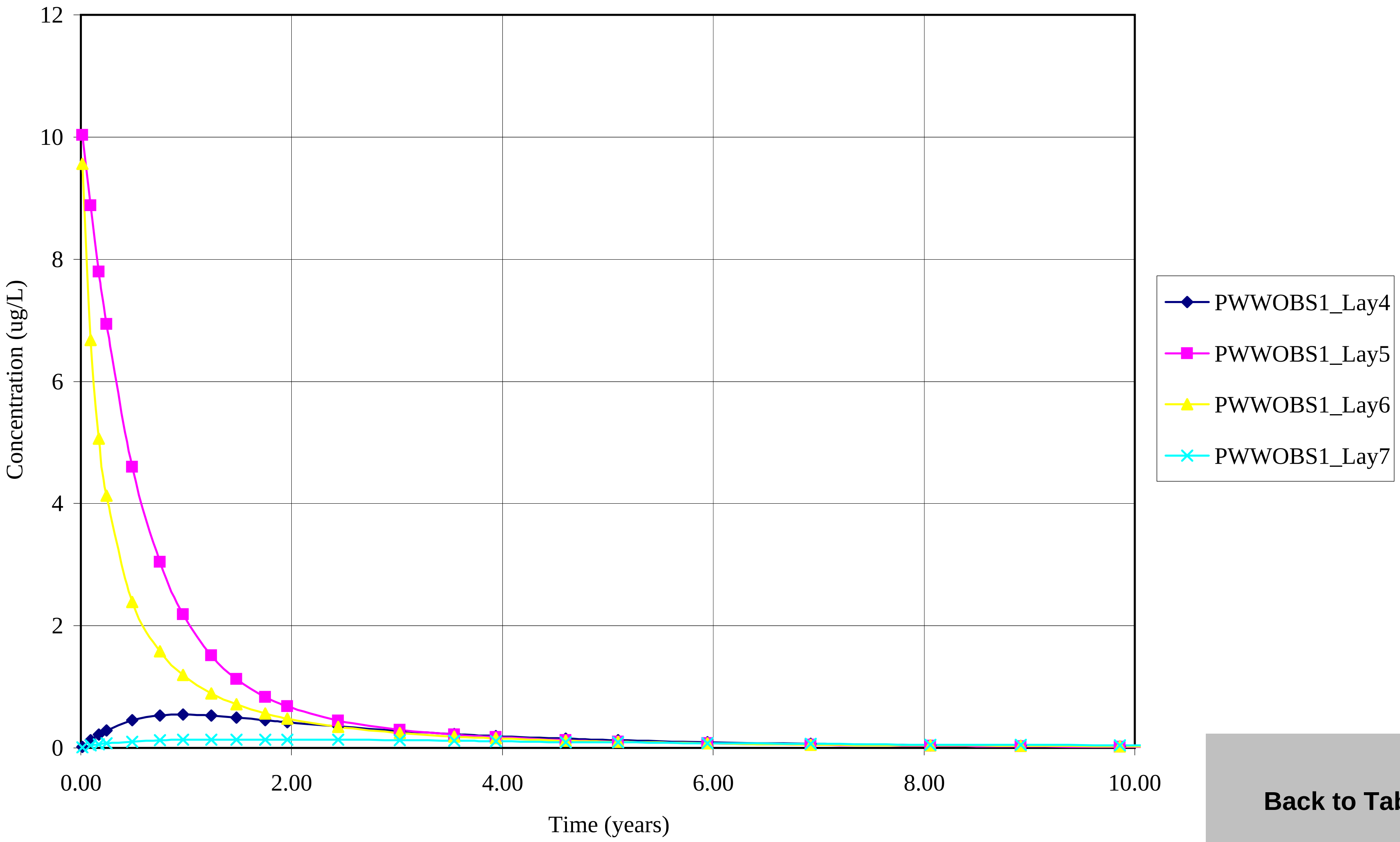
Figure 6A.72. MW01OBS1 Beryllium (Non-pumping) Extraction/Advection/Dispersion/ChemRxn



Back to Table

luck420_Be_NoPump_Extract_Adv_Dis_Chem_15_60_60_ObsWellDataCHARTS.xls

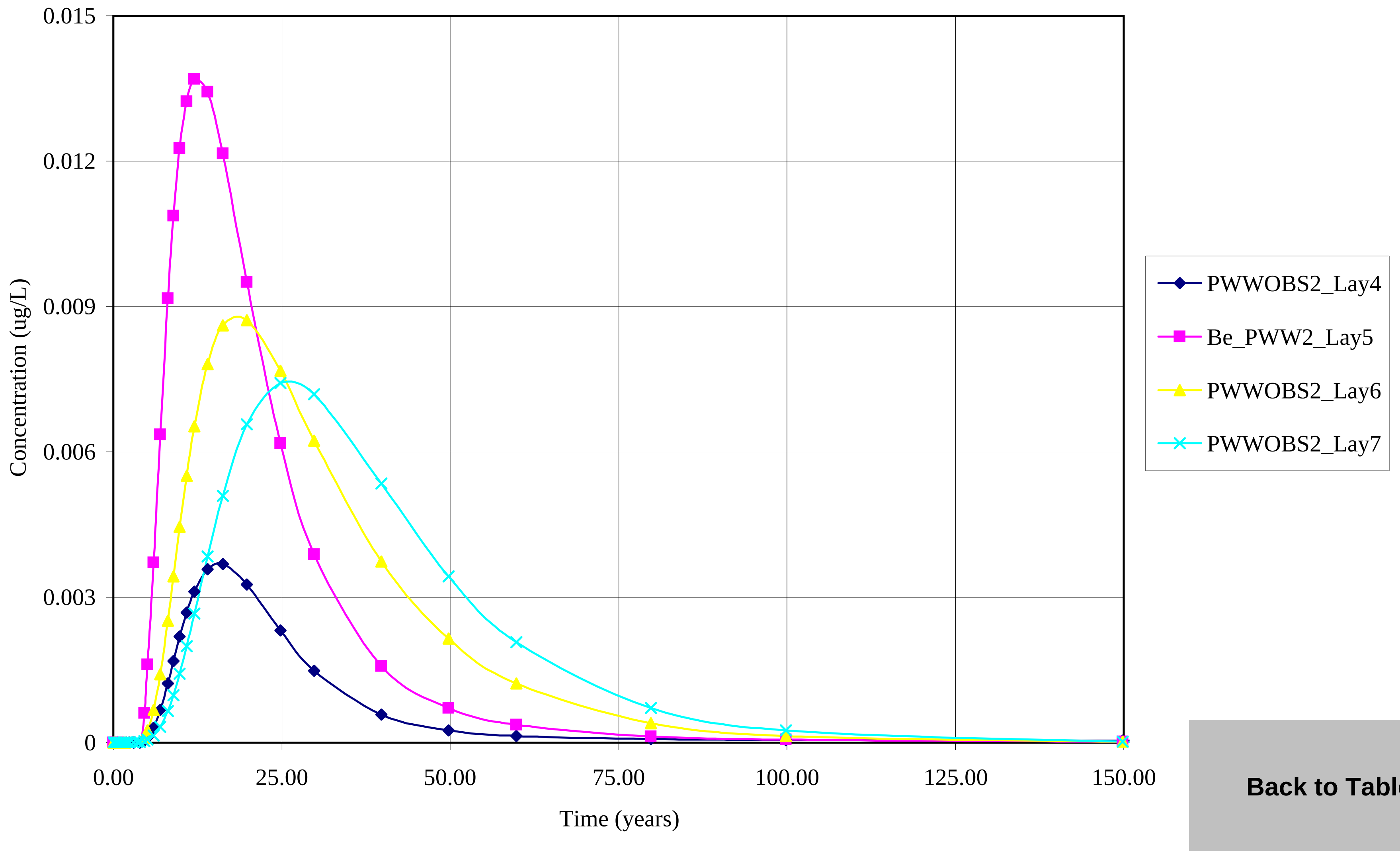
Figure 6A.73. PWWOBS1 Beryllium (Non-pumping) Extraction/Advection/Dispersion/ChemRxn



Back to Table

luck420_Be_NoPump_Extract_Adv_Dis_Chem_15_60_60_ObsWellDataCHARTS.xls

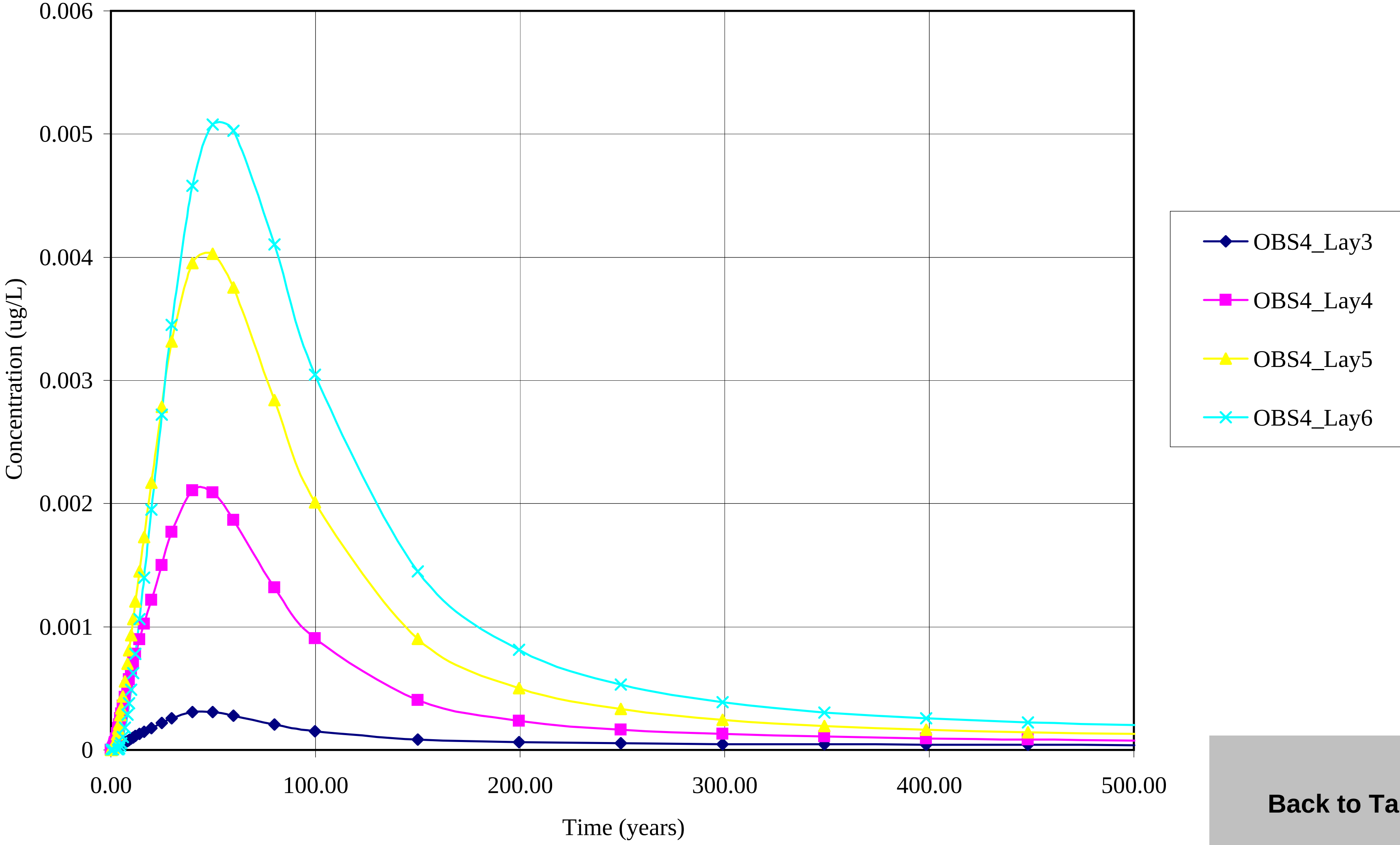
Figure 6A.74. PWWOBS2 Beryllium (Non-pumping) Extraction/Advection/Dispersion/ChemRxn



Back to Table

luck420_Be_NoPump_Extract_Adv_Dis_Chem_15_60_60_ObsWellDataCHARTS.xls

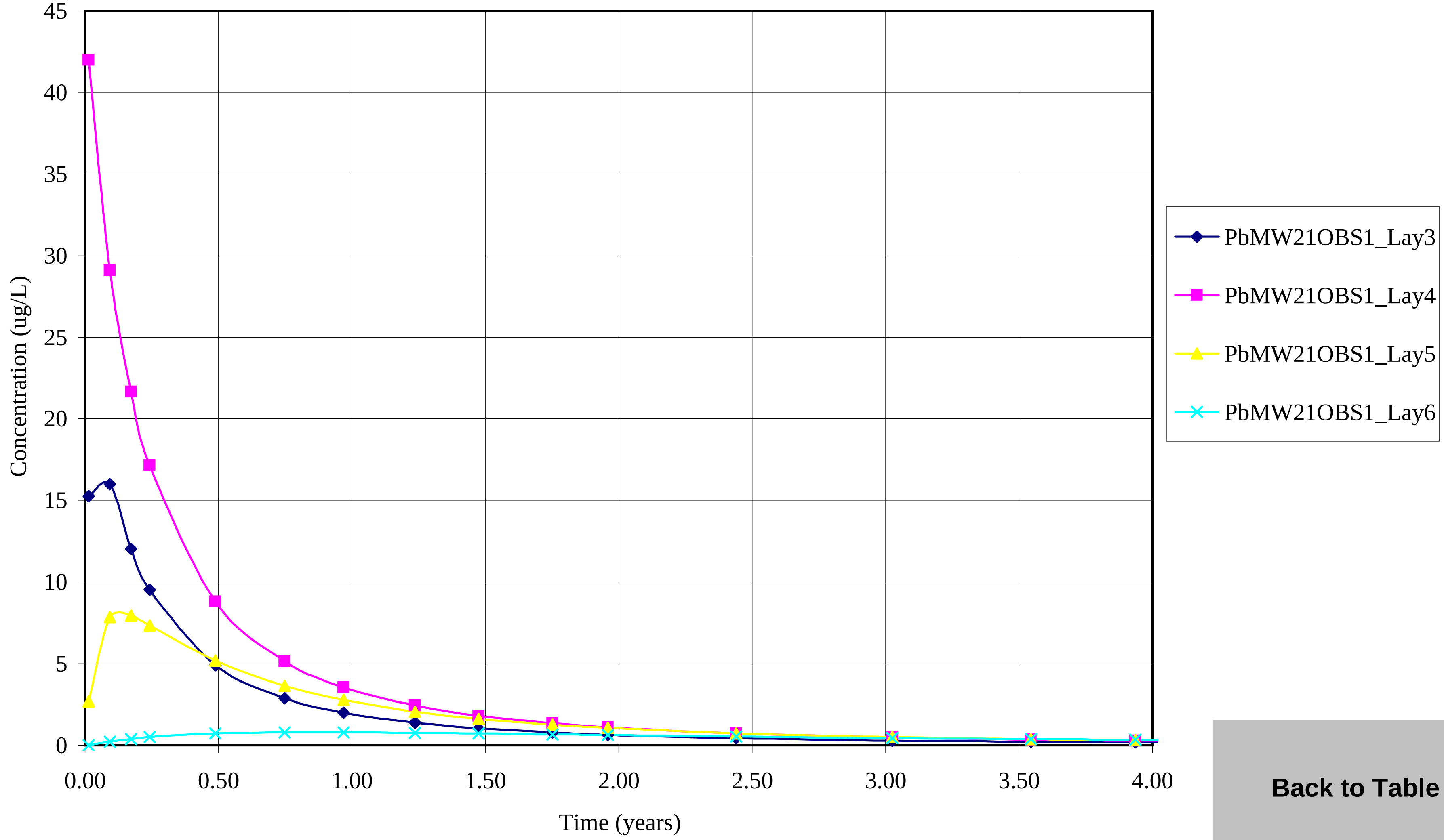
Figure 6A.75. OBS4 Beryllium (Non-pumping) Extraction/Advection/Dispersion/ChemRxn



Back to Table

luck420_Be_NoPump_Extract_Adv_Dis_Chem_15_60_60_ObsWellDataCHARTS.xls

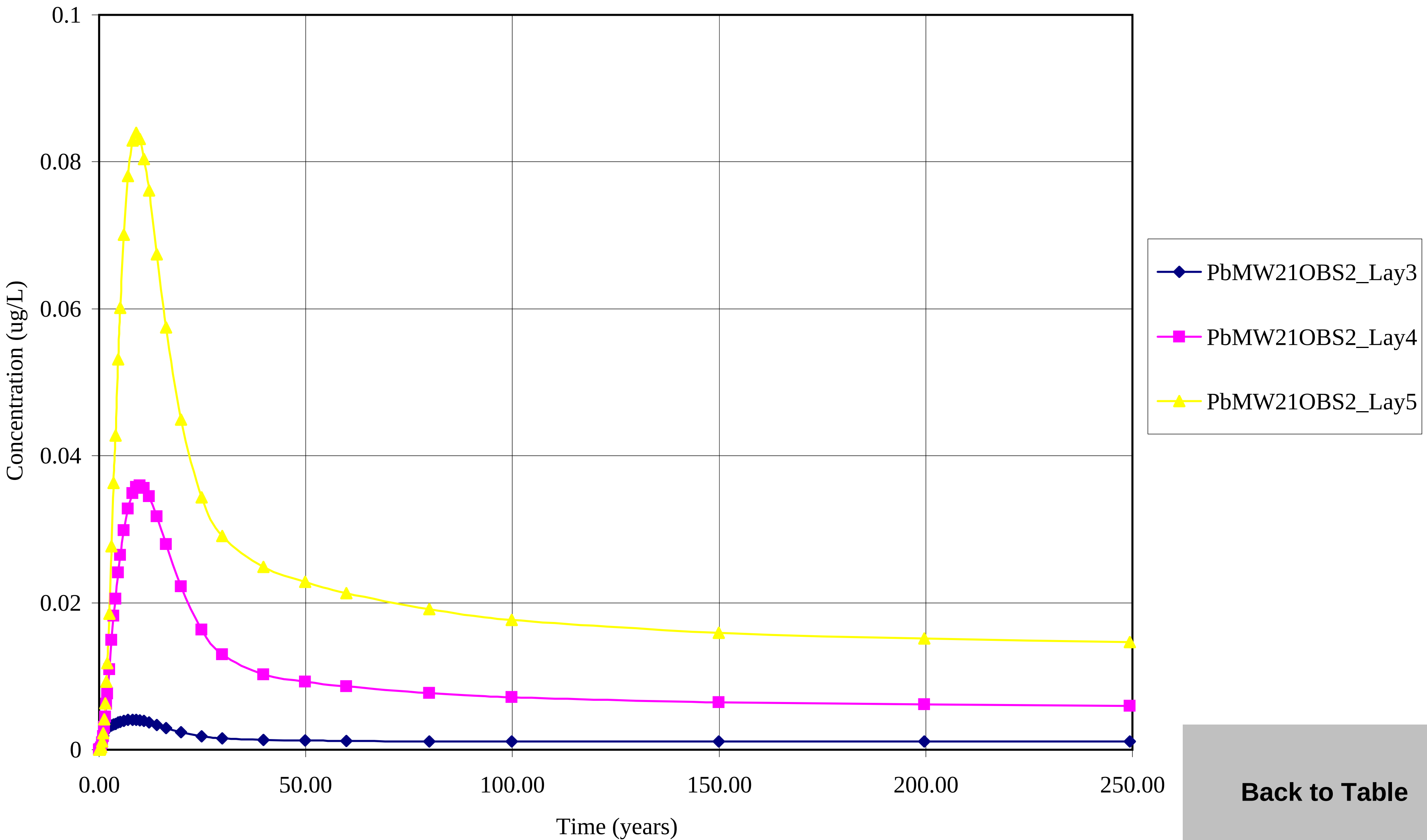
Figure 6A.76. PbMW21OBS1 Lead (Non-pumping) Extraction/Advection/Dispersion/ChemRxn



Back to Table

luck420_Pb_NoPump_Extract_Adv_Dis_Chem_15_60_60_ObsWellDataCHARTS.xls

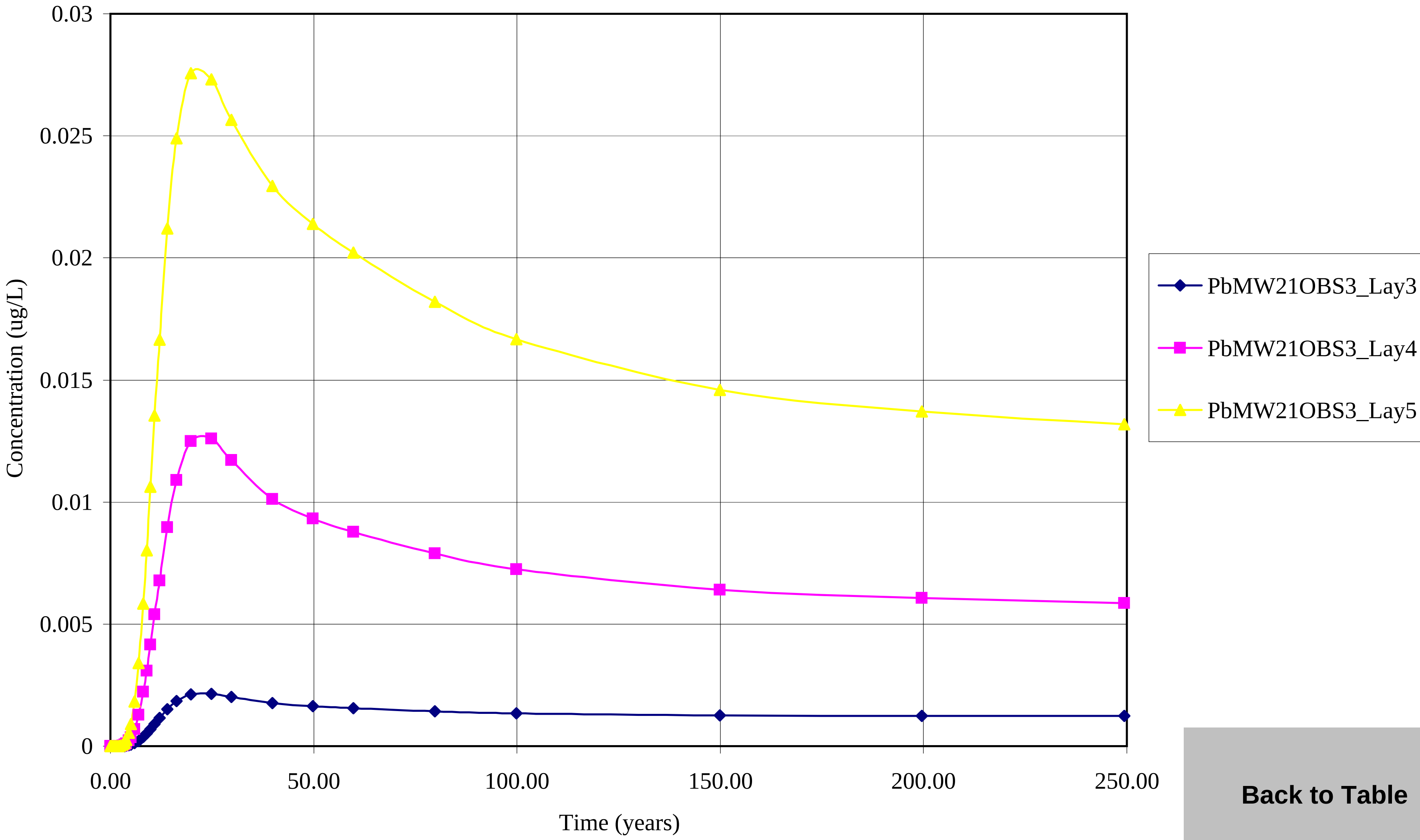
Figure 6A.77. PbMW21OBS2 Lead (Non-pumping) Extraction/Advection/Dispersion/ChemRxn



Back to Table

luck420_Pb_NoPump_Extract_Adv_Dis_Chem_15_60_60_ObsWellDataCHARTS.xls

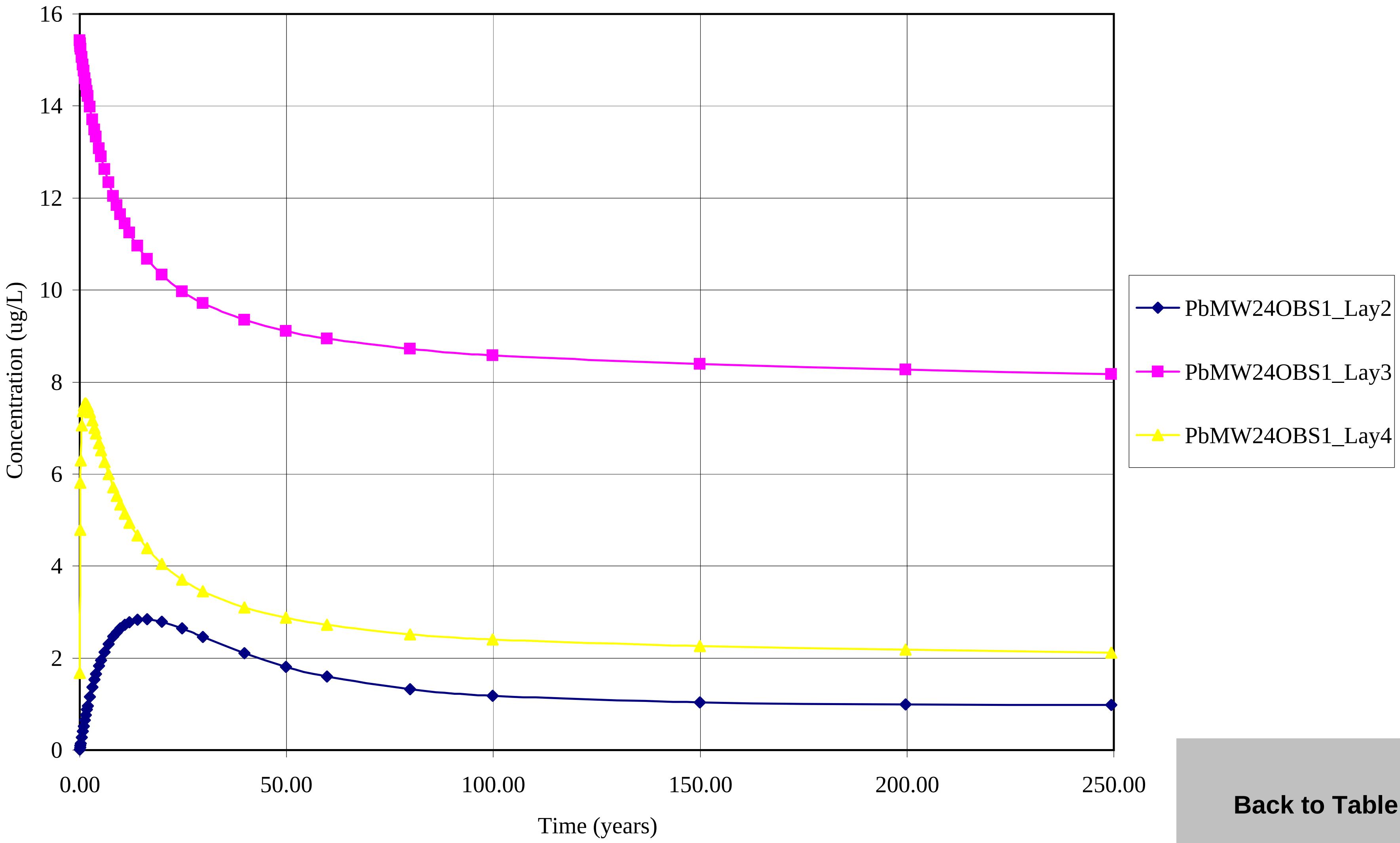
Figure 6A.78. PbMW21OBS3 Lead (Non-pumping) Extraction/Advection/Dispersion/ChemRxn



Back to Table

luck420_Pb_NoPump_Extract_Adv_Dis_Chem_15_60_60_ObsWellDataCHARTS.xls

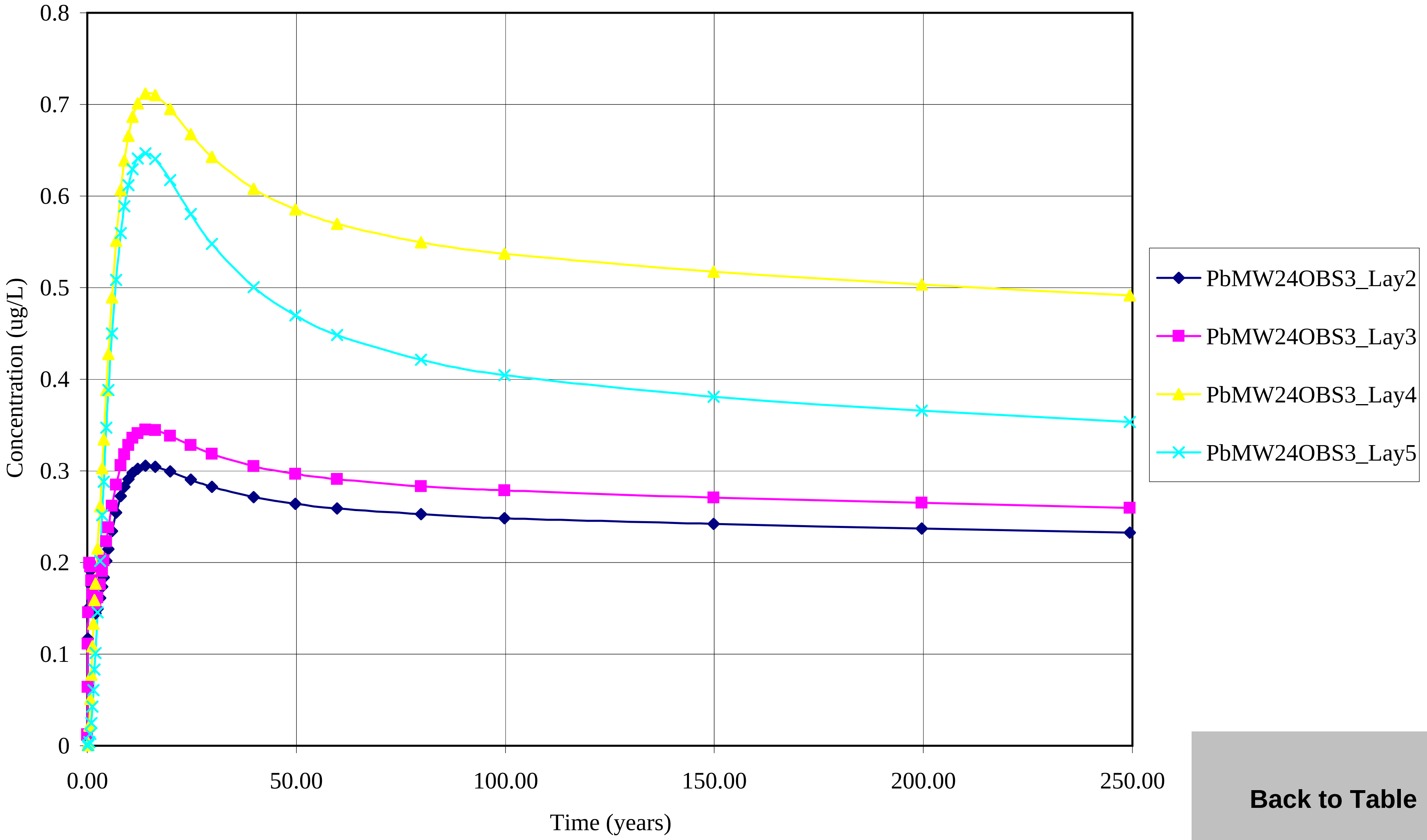
Figure 6A.79. PbMW24OBS1 Lead (Non-pumping) Extraction/Advection/Dispersion/ChemRxn



Back to Table

luck420_Pb_NoPump_Extract_Adv_Dis_Chem_15_60_60_ObsWellDataCHARTS.xls

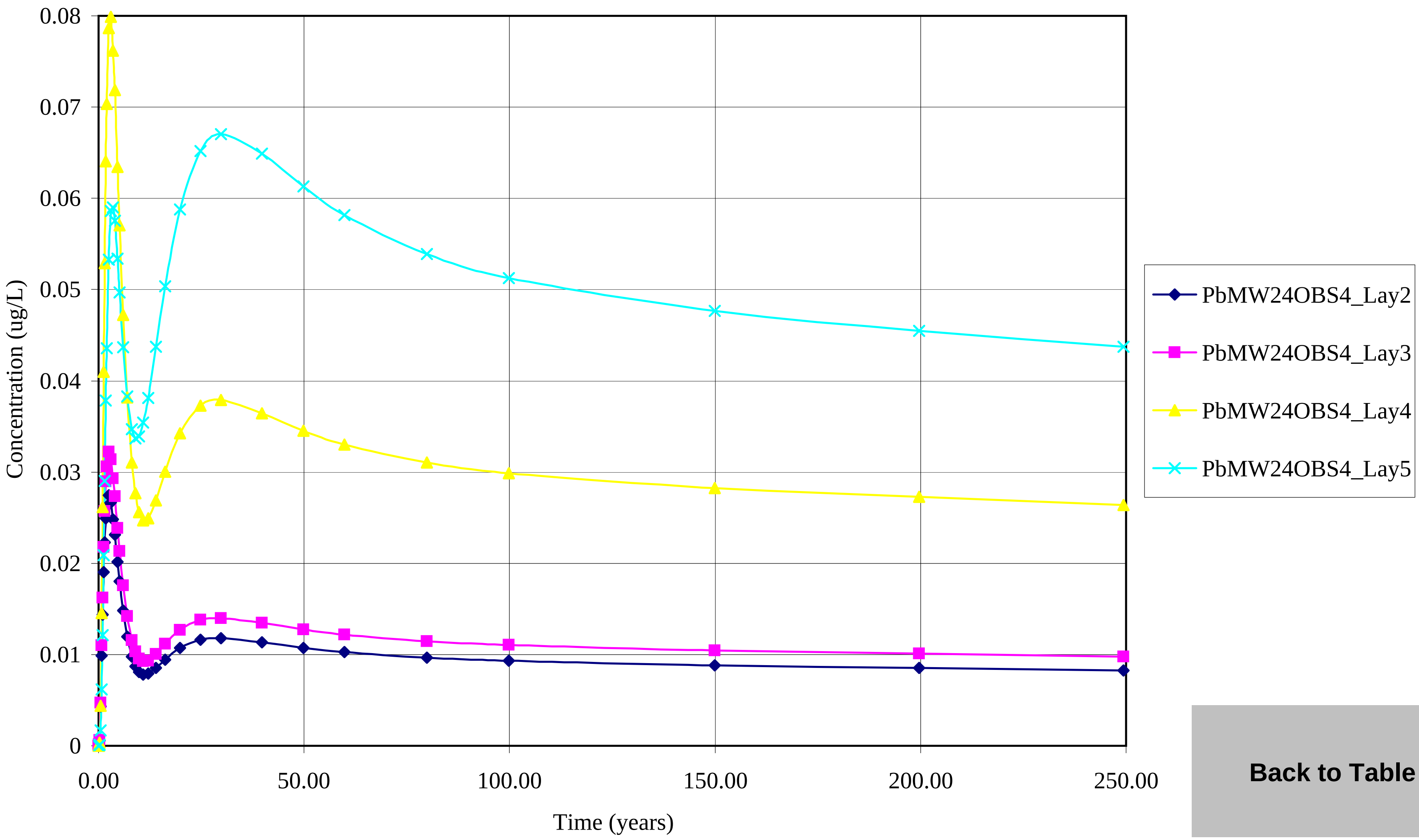
Figure 6A.80. PbMW24OBS3 Lead (Non-pumping) Extraction/Advection/Dispersion/ChemRxn



Back to Table

luck420_Pb_NoPump_Extract_Adv_Dis_Chem_15_60_60_ObsWellDataCHARTS.xls

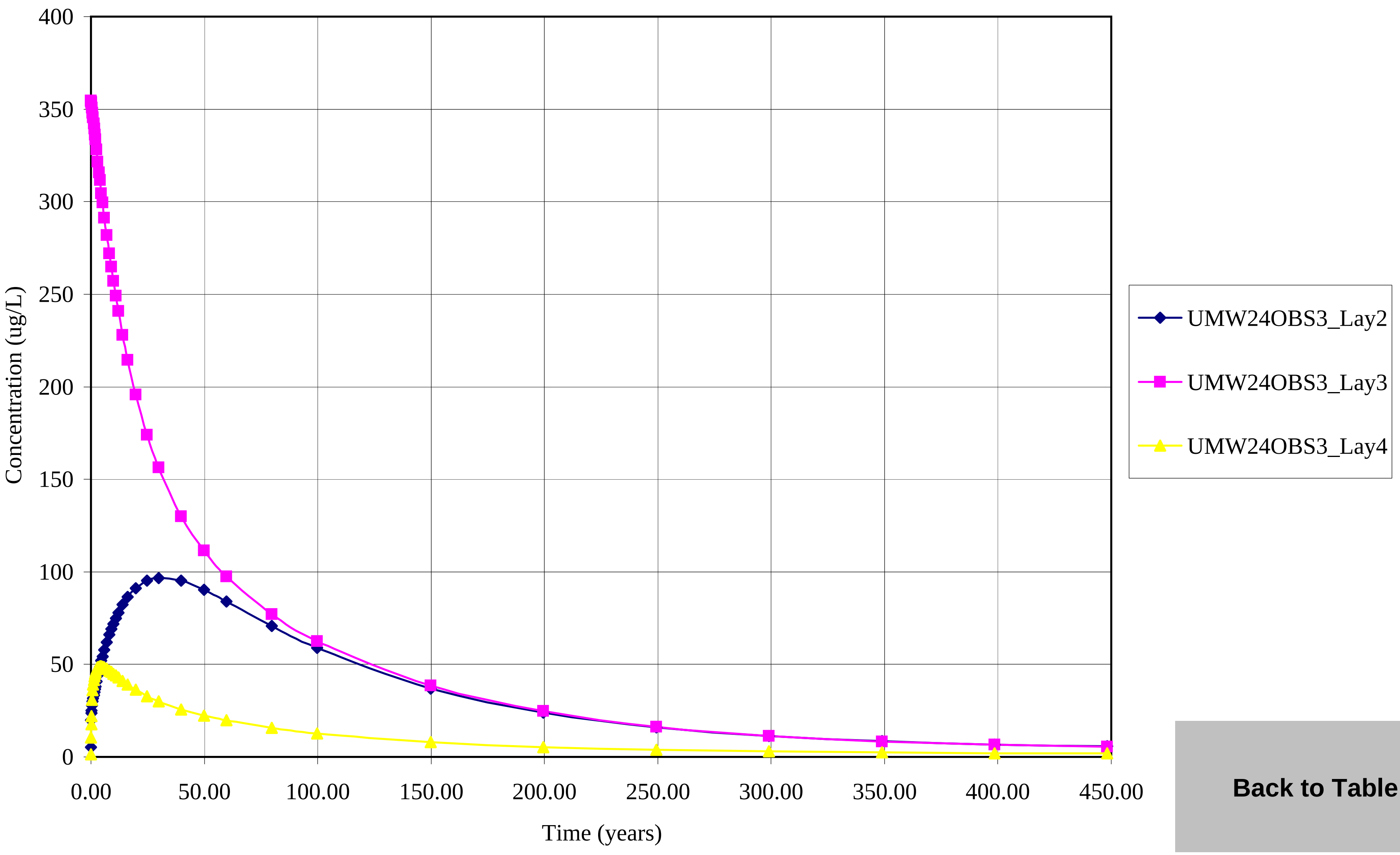
Figure 6A.81. PbMW24OBS4 Lead (Non-pumping) Extraction/Advection/Dispersion/ChemRxn



Back to Table

luck420_Pb_NoPump_Extract_Adv_Dis_Chem_15_60_60_ObsWellDataCHARTS.xls

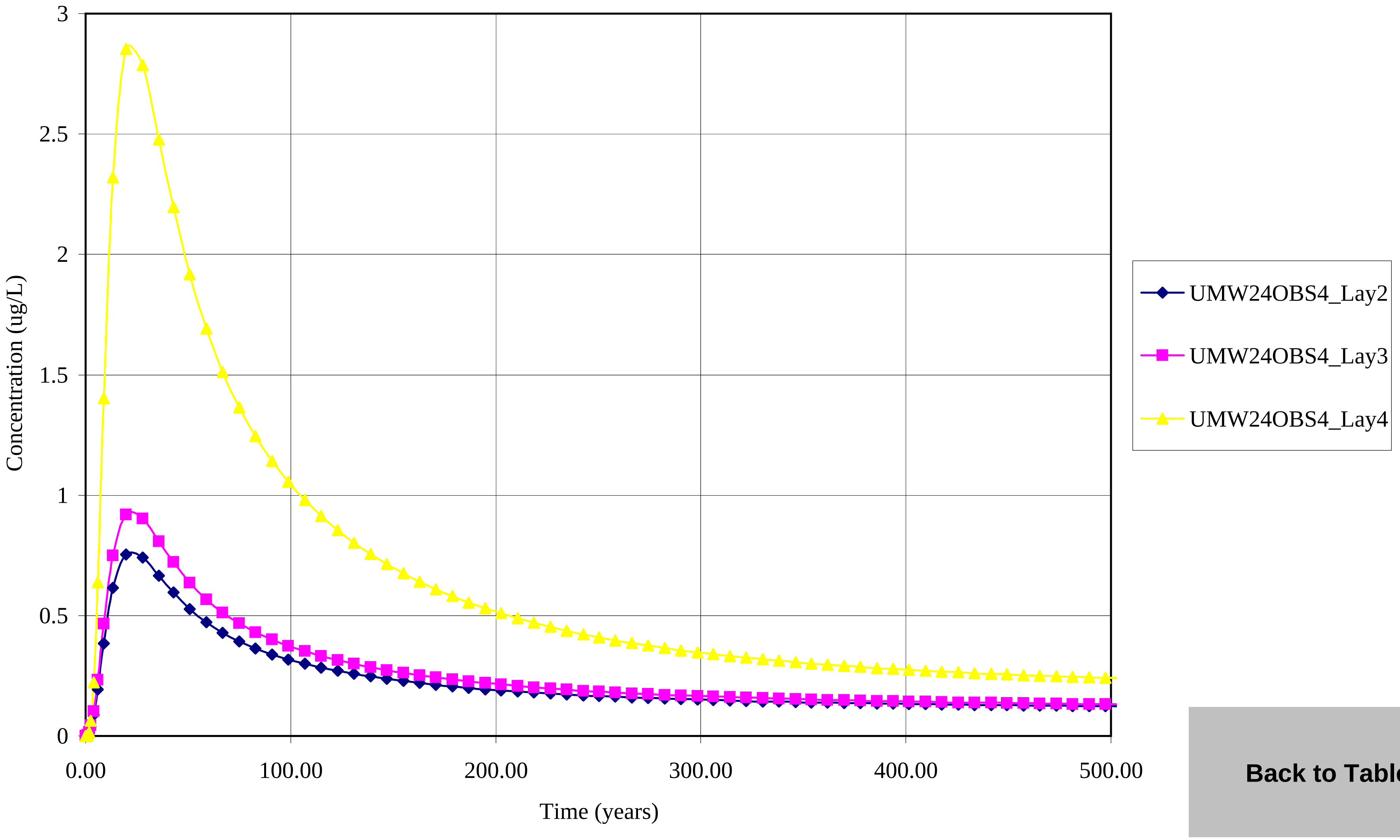
Figure 6A.82. UMW24OBS3 Uranium (Non-pumping) Extraction/Advection/Dispersion/ChemRxn



Back to Table

luck420_U_NoPump_Extract_Adv_Dis_Chem156060CHARTS.xls

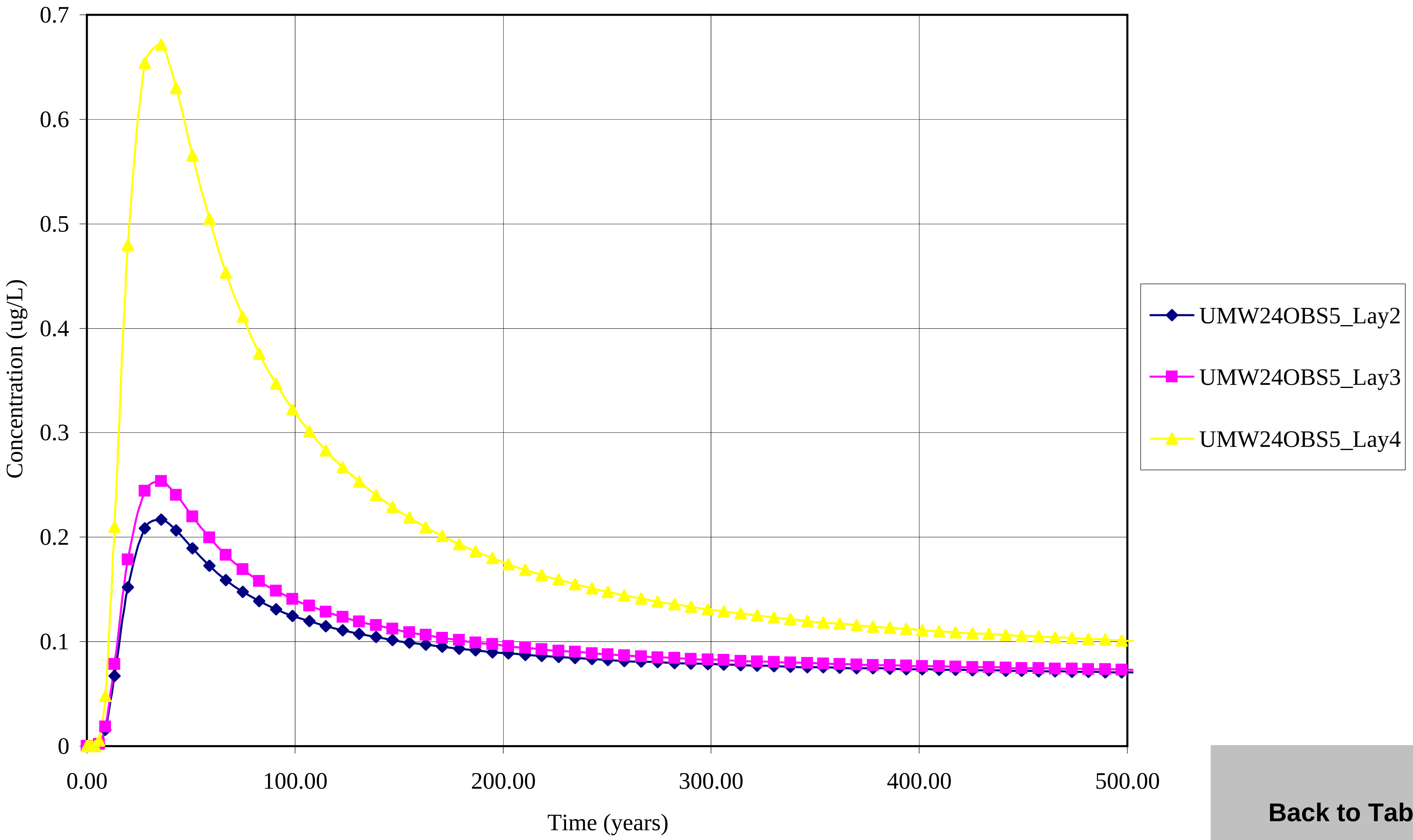
Figure 6A.83. UMW24OBS4 Uranium (Non-pumping) Extraction/Advection/Dispersion/ChemRxn



Back to Table

luck420_U_NoPump_Extract_Adv_Dis_Chem156060CHARTS.xls

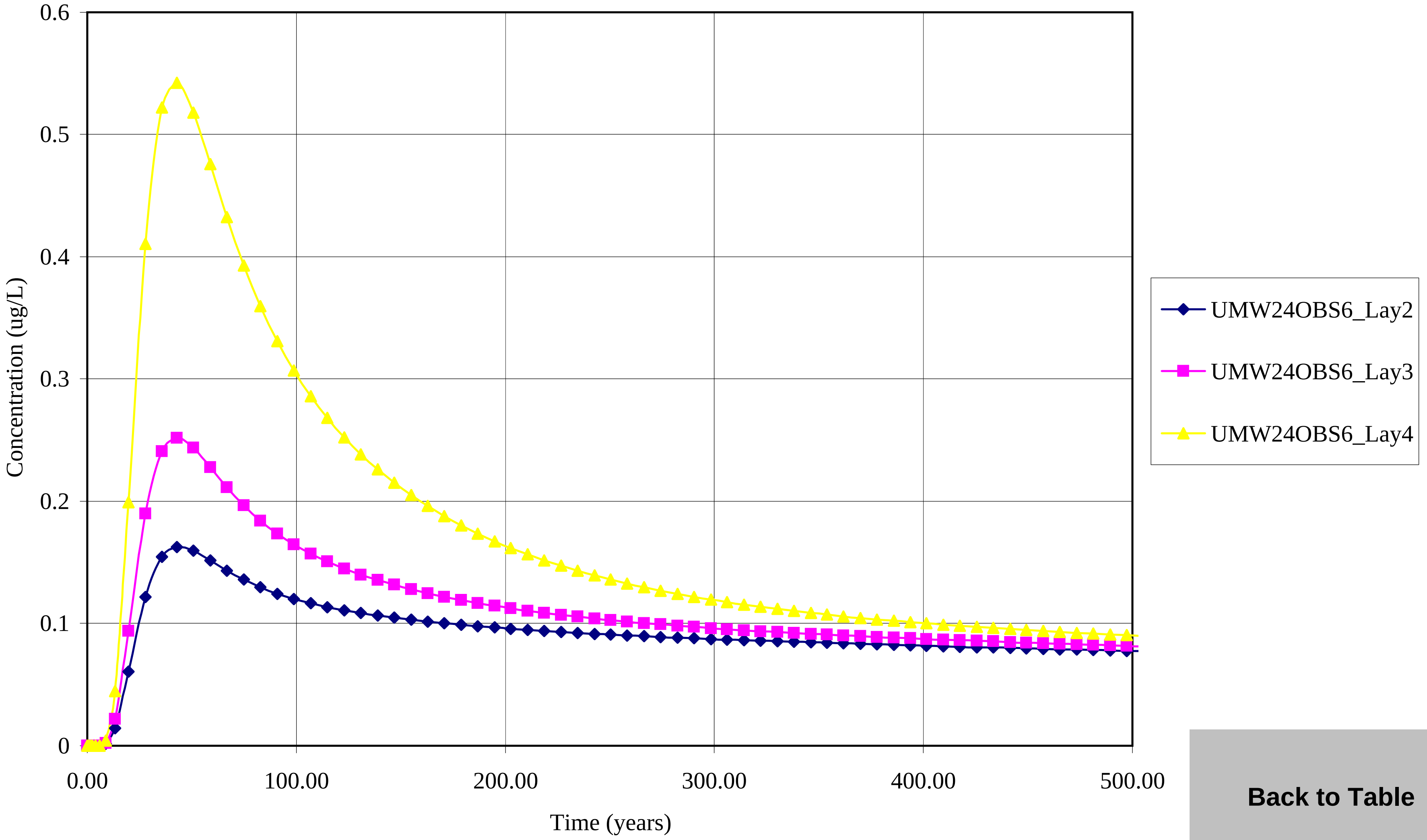
Figure 6A.84. UMW24OBS5 Uranium (Non-pumping) Extraction/Advection/Dispersion/ChemRxn



Back to Table

luck420_U_NoPump_Extract_Adv_Dis_Chem156060CHARTS.xls

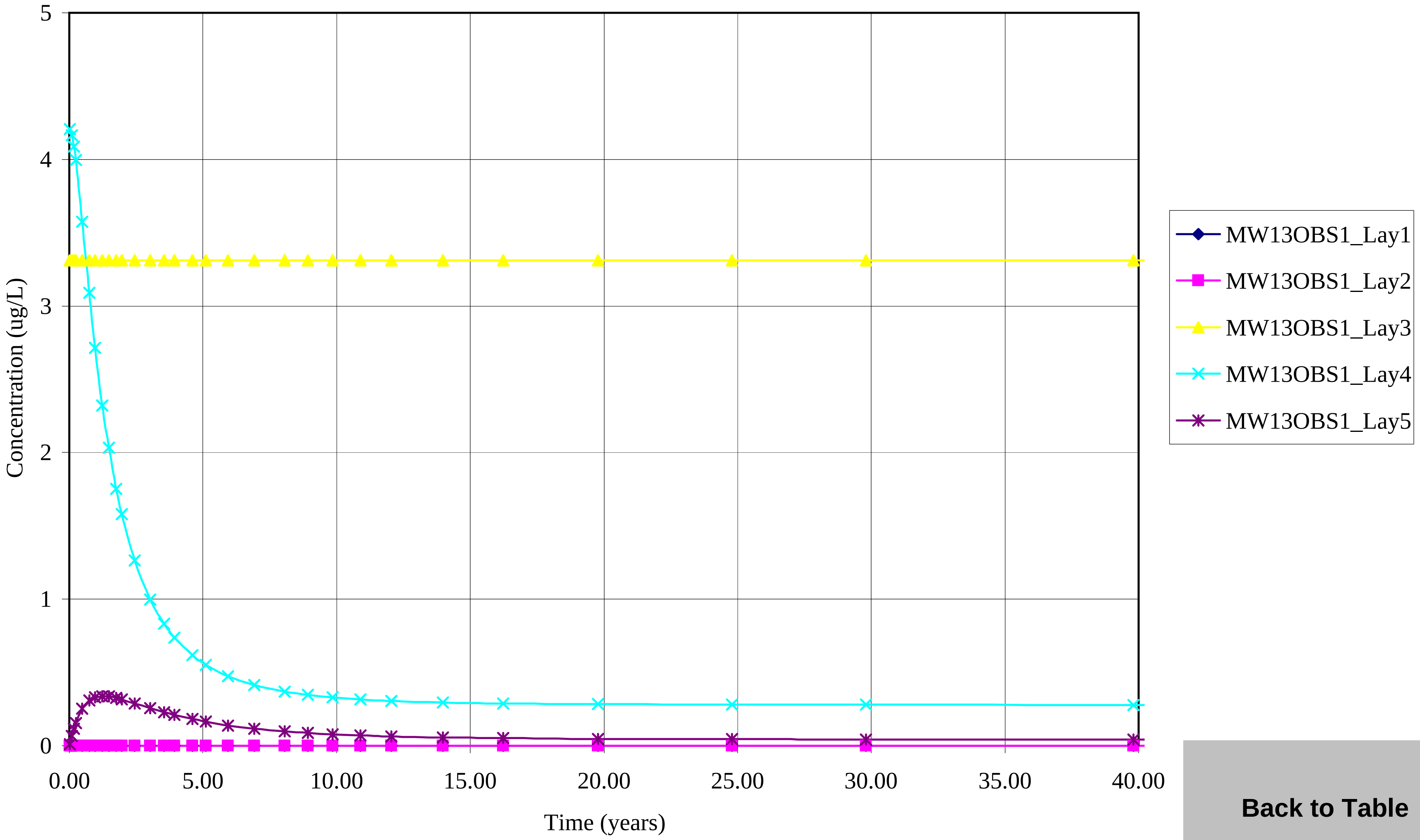
Figure 6A.85. UMW24OBS6 Uranium (Non-pumping) Extraction/Advection/Dispersion/ChemRxn



Back to Table

luck420_U_NoPump_Extract_Adv_Dis_Chem156060CHARTS.xls

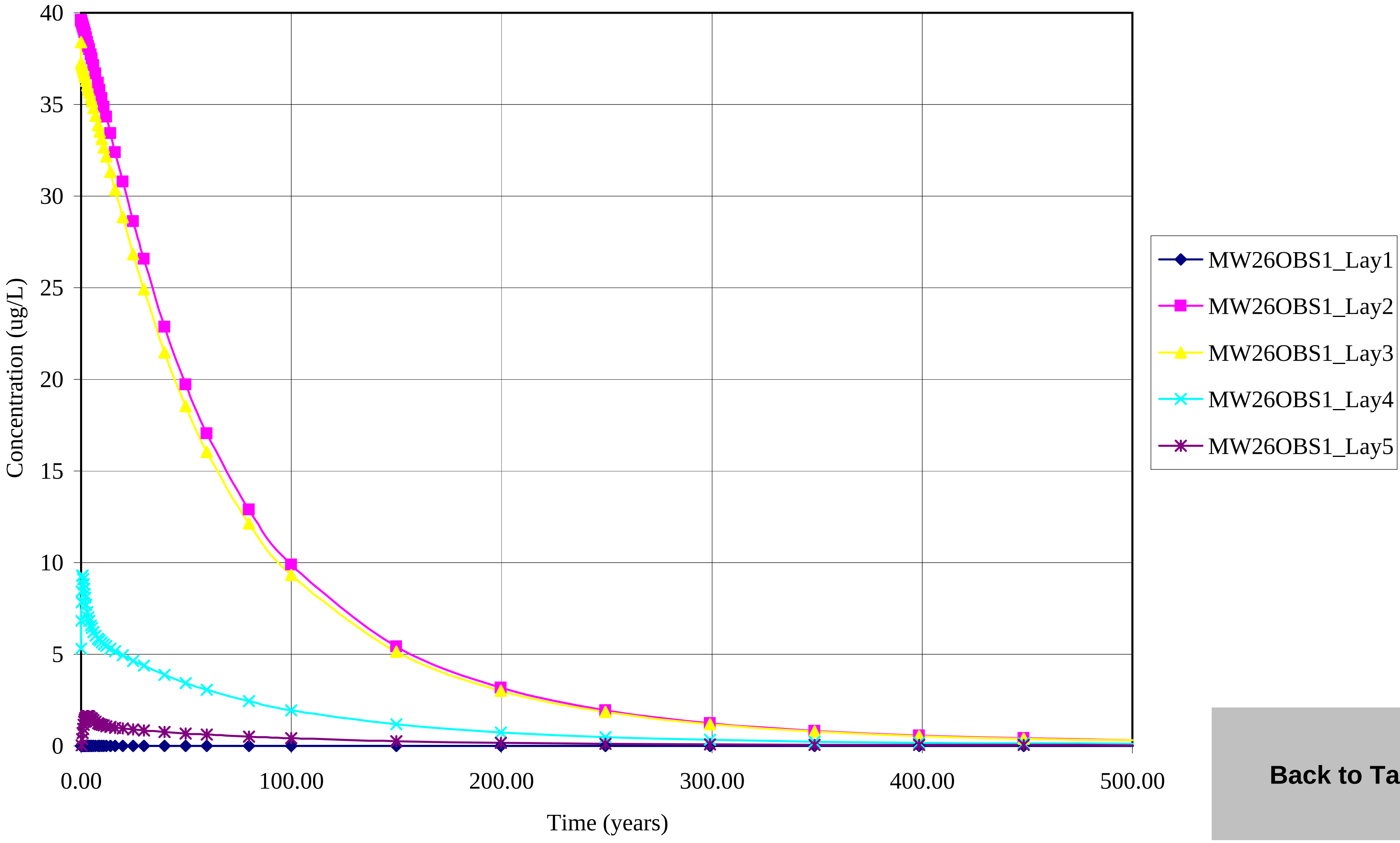
Figure 6A.86. MW13OBS1 Beryllium (Pumping) Advection/Dispersion/ChemRxn



Back to Table

luck420_Be_Pump_Adv_Dis_Chem_15_60_60)ObsWellDataCHARTS.xls

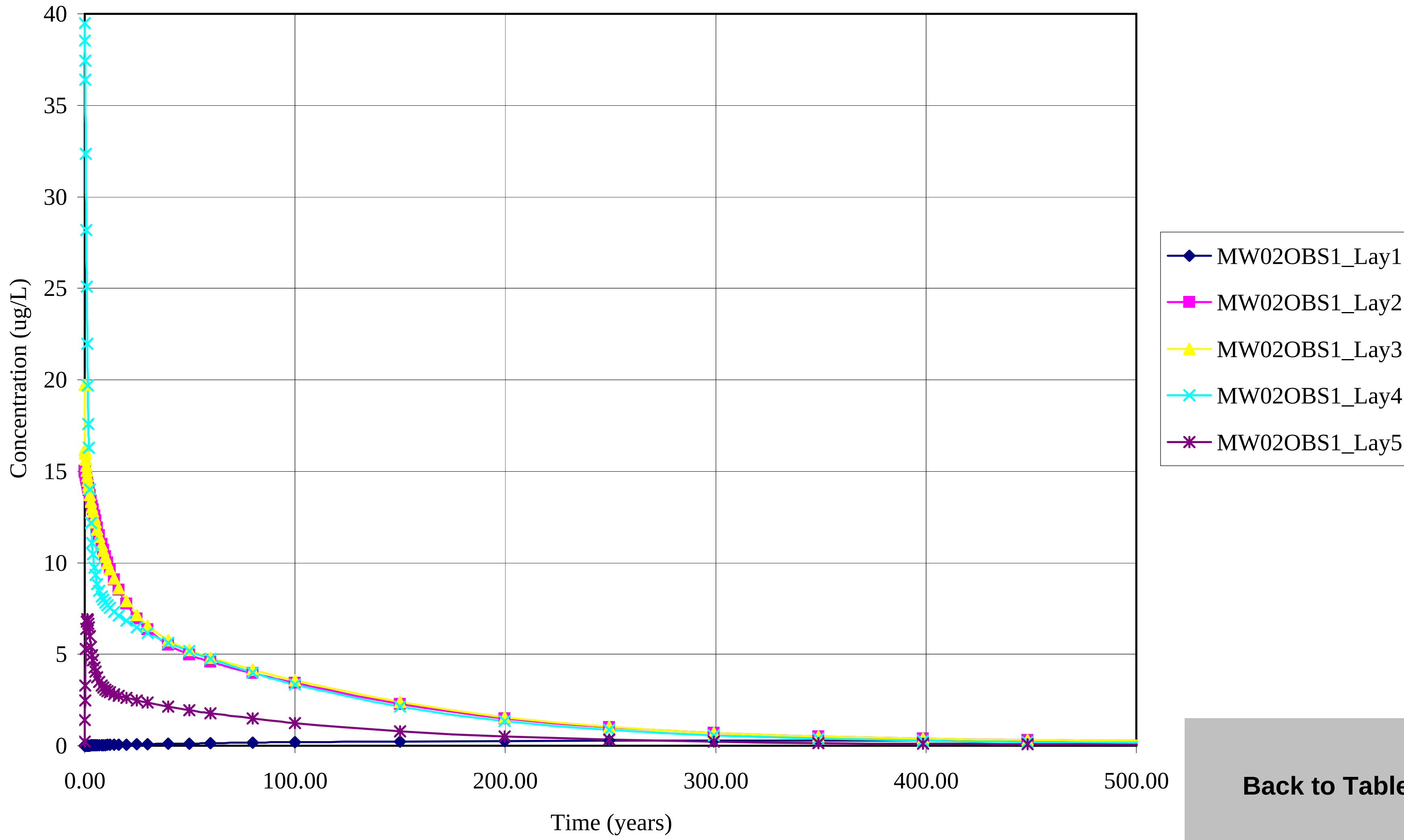
Figure 6A.87. MW26OBS1 Beryllium (Pumping) Advection/Dispersion/ChemRxn



Back to Table

luck420_Be_Pump_Adv_Dis_Chem_15_60_60)ObsWellDataCHARTS.xls

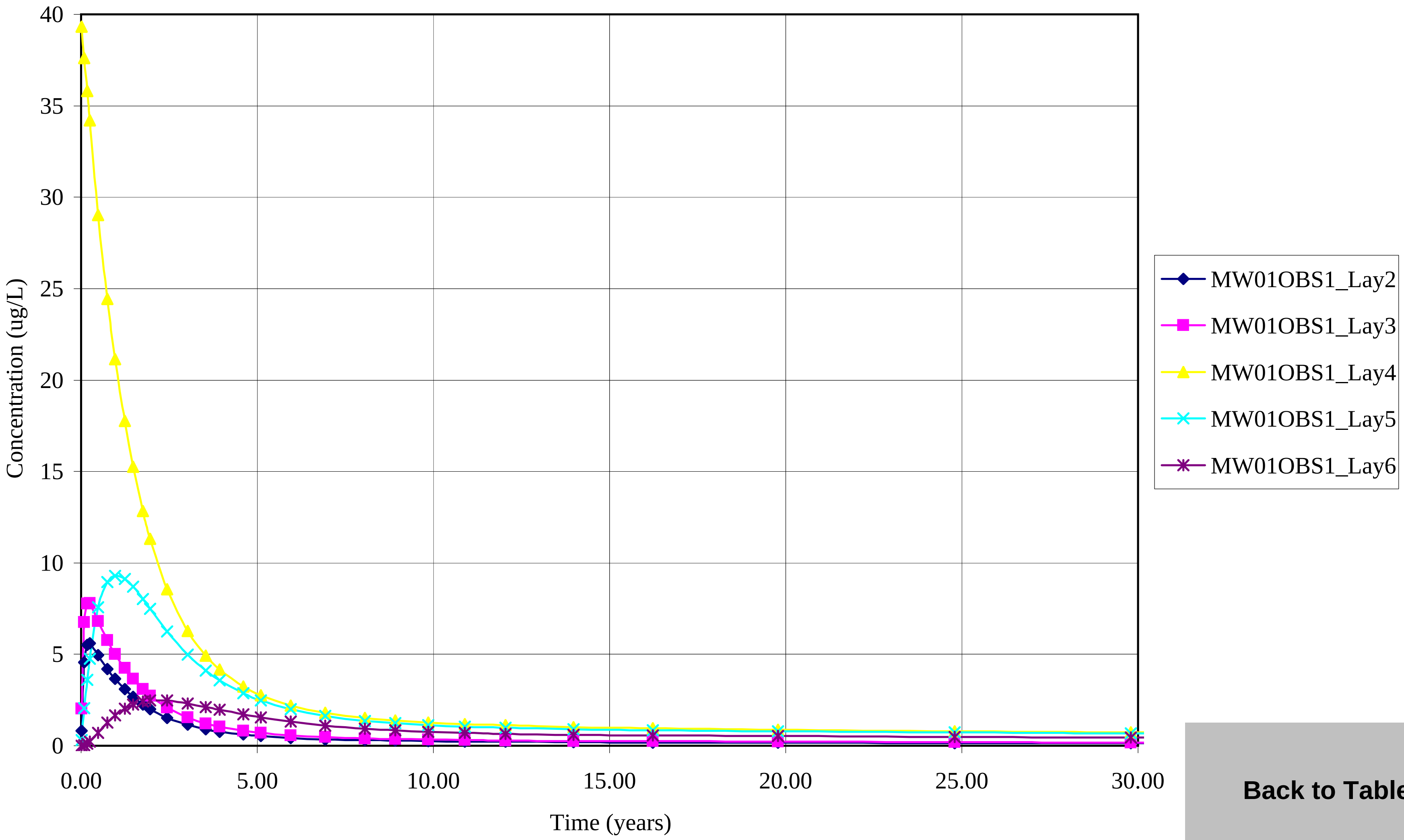
Figure 6A.88. MW02OBS1 Beryllium (Pumping) Advection/Dispersion/ChemRxn



Back to Table

luck420_Be_Pump_Adv_Dis_Chem_15_60_60)ObsWellDataCHARTS.xls

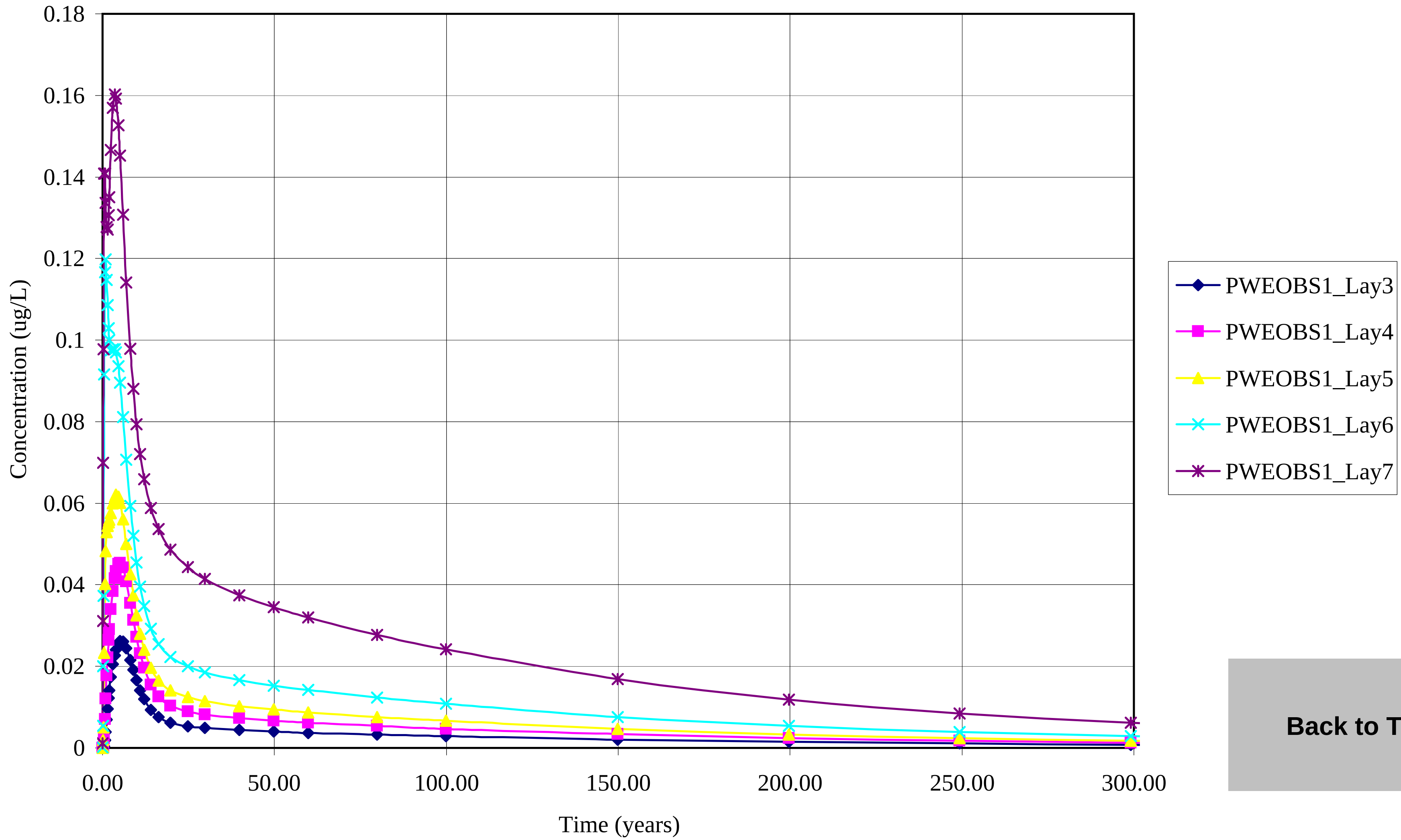
Figure 6A.89. MW01OBS1 Beryllium (Pumping) Advection/Dispersion/ChemRxn



Back to Table

luck420_Be_Pump_Adv_Dis_Chem_15_60_60)ObsWellDataCHARTS.xls

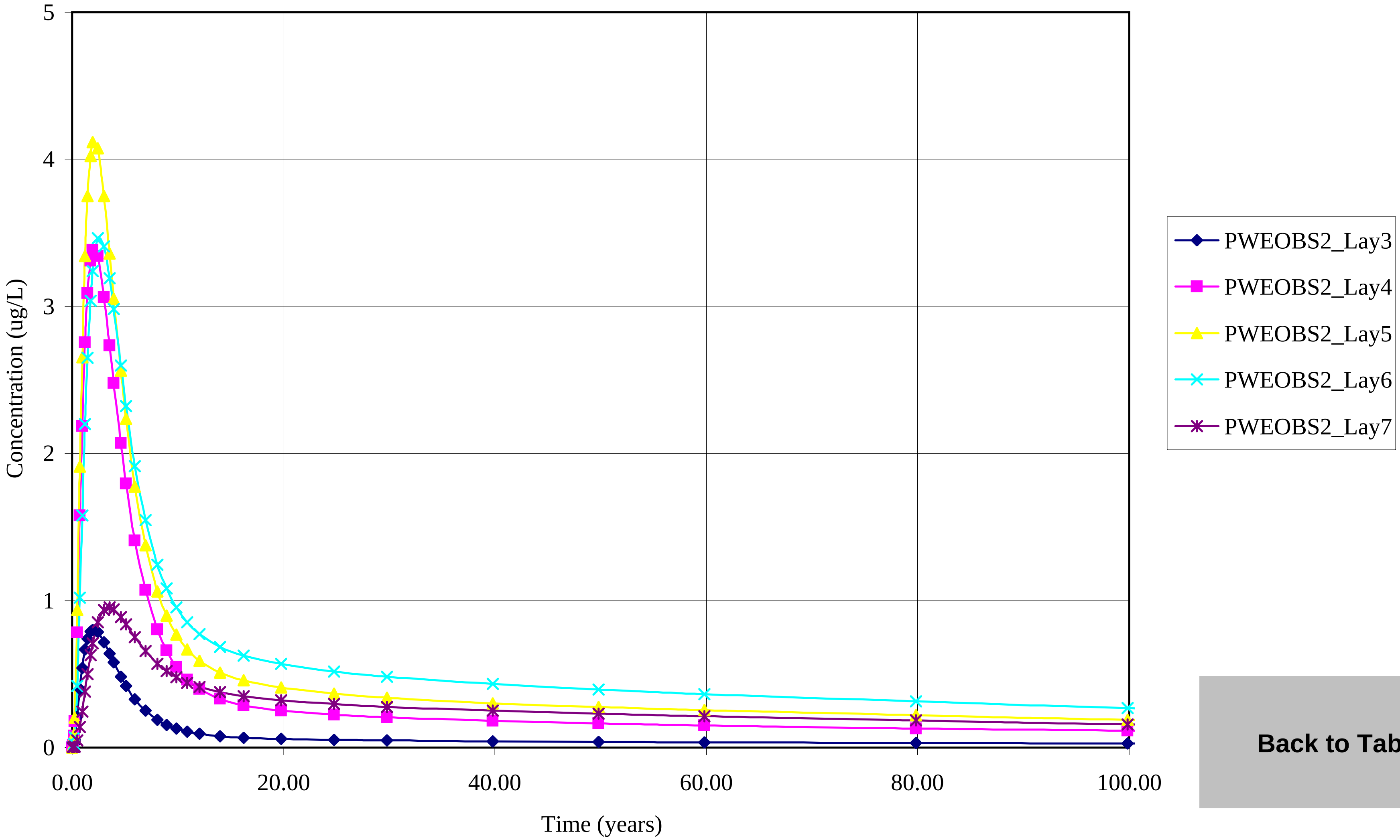
Figure 6A.90. PWEOBS1 Beryllium (Pumping) Advection/Dispersion/ChemRxn



Back to Table

luck420_Be_Pump_Adv_Dis_Chem_15_60_60)ObsWellDataCHARTS.xls

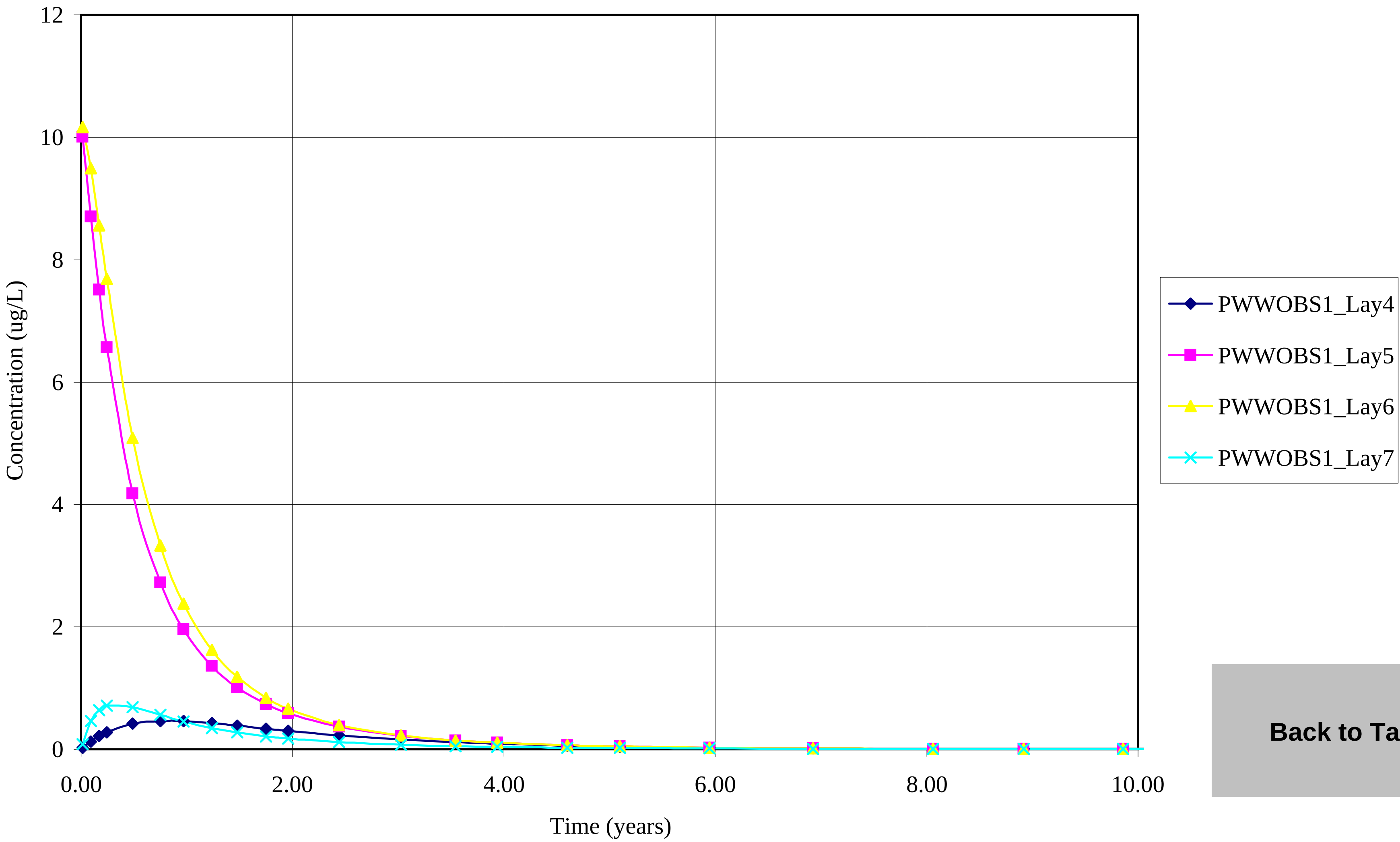
Figure 6A.91. PWEOBS2 Beryllium (Pumping) Advection/Dispersion/ChemRxn



Back to Table

luck420_Be_Pump_Adv_Dis_Chem_15_60_60)ObsWellDataCHARTS.xls

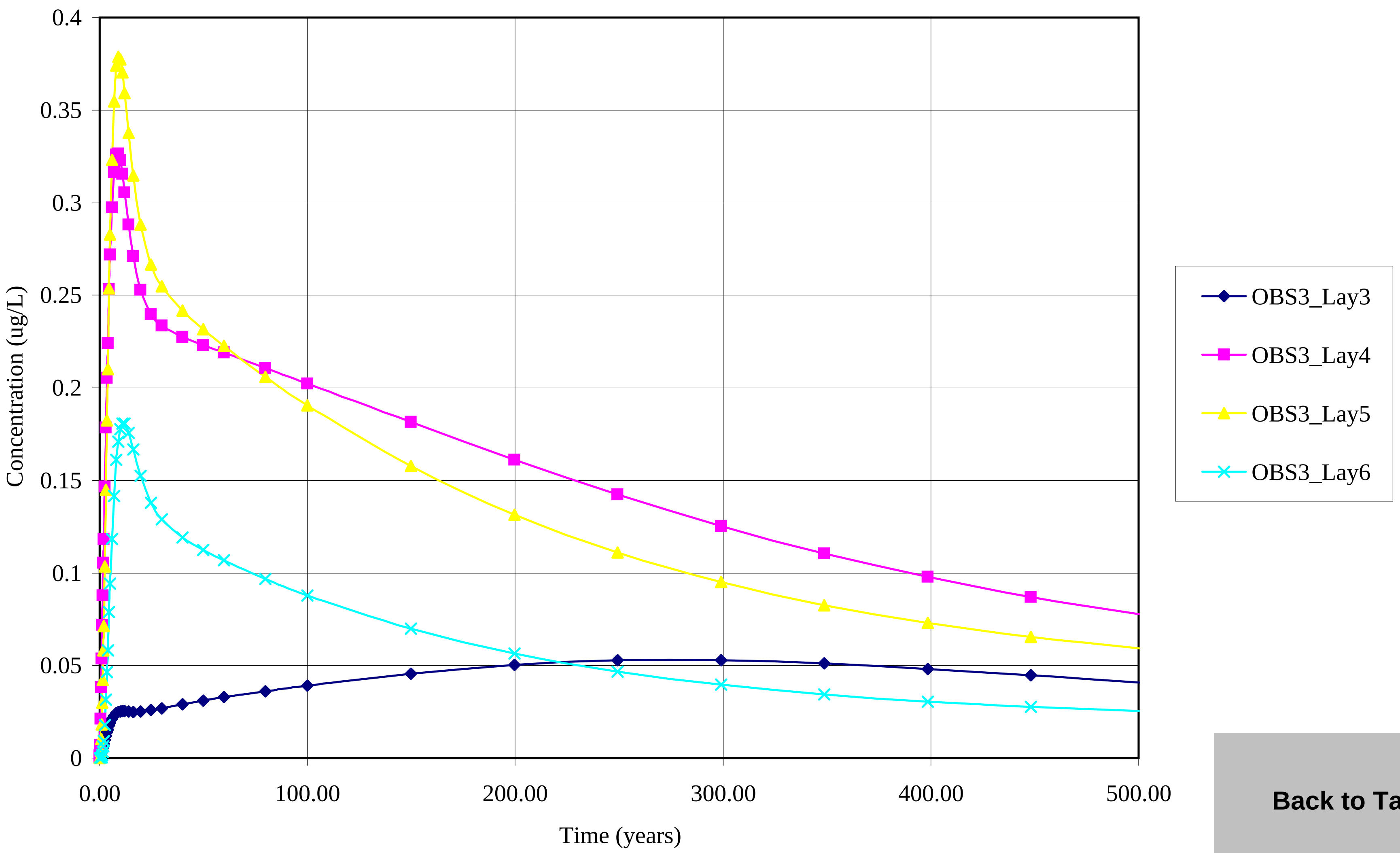
Figure 6A.92. PWWOBS1 Beryllium (Pumping) Advection/Dispersion/ChemRxn



Back to Table

luck420_Be_Pump_Adv_Dis_Chem_15_60_60)ObsWellDataCHARTS.xls

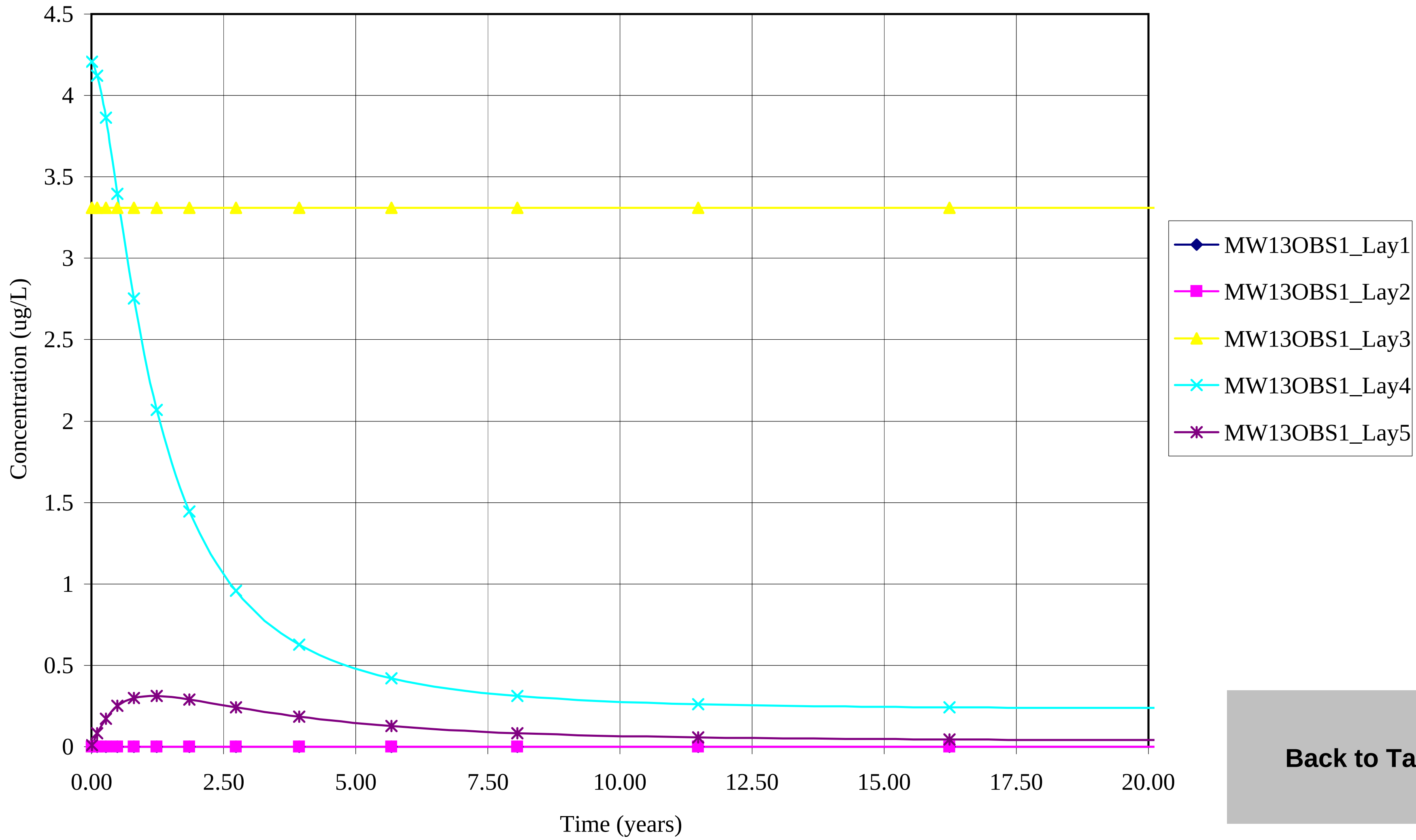
Figure 6A.93. OBS3 Beryllium (Pumping) Advection/Dispersion/ChemRxn



Back to Table

luck420_Be_Pump_Adv_Dis_Chem_15_60_60)ObsWellDataCHARTS.xls

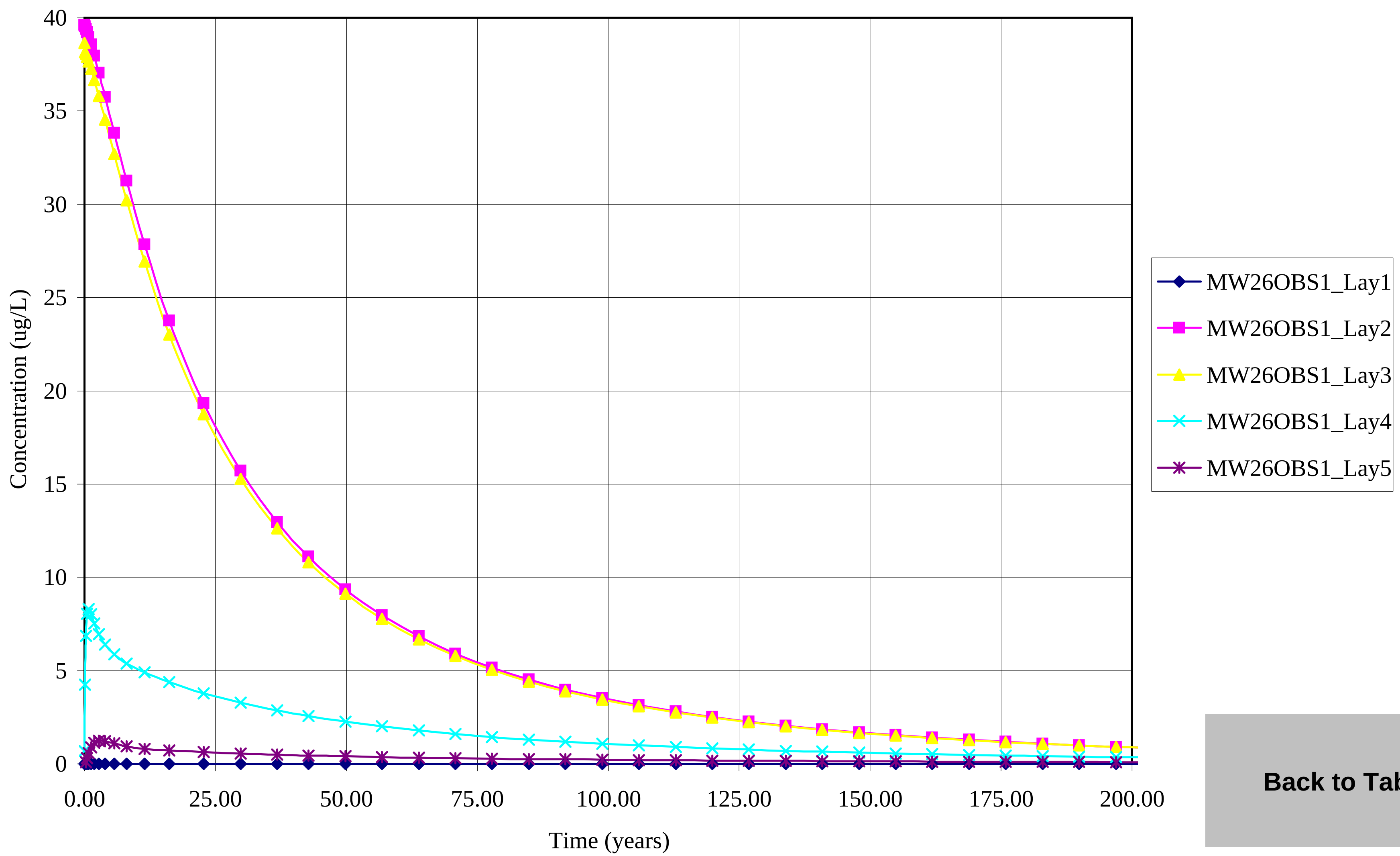
Figure 6A.94. MW13OBS1 Beryllium (Pumping) Extraction/Advection/Dispersion/ChemRxn



Back to Table

luck420_Be_Pump_Extract_Adv_Dis_Chem156060CHARTS.xls

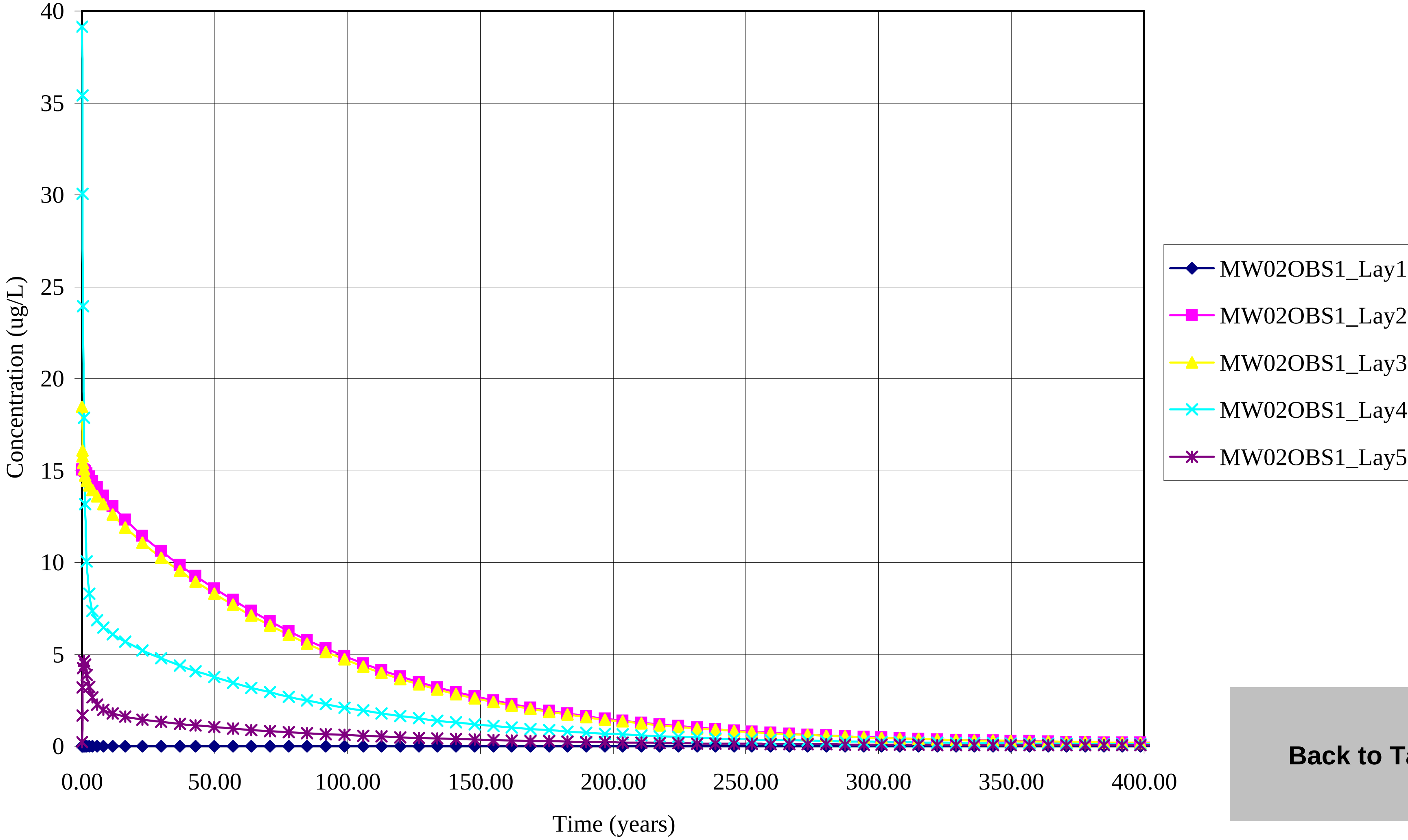
Figure 6A.95. MW26OBS1 Beryllium (Pumping) Extraction/Advection/Dispersion/ChemRxn



Back to Table

luck420_Be_Pump_Extract_Adv_Dis_Chem156060CHARTS.xls

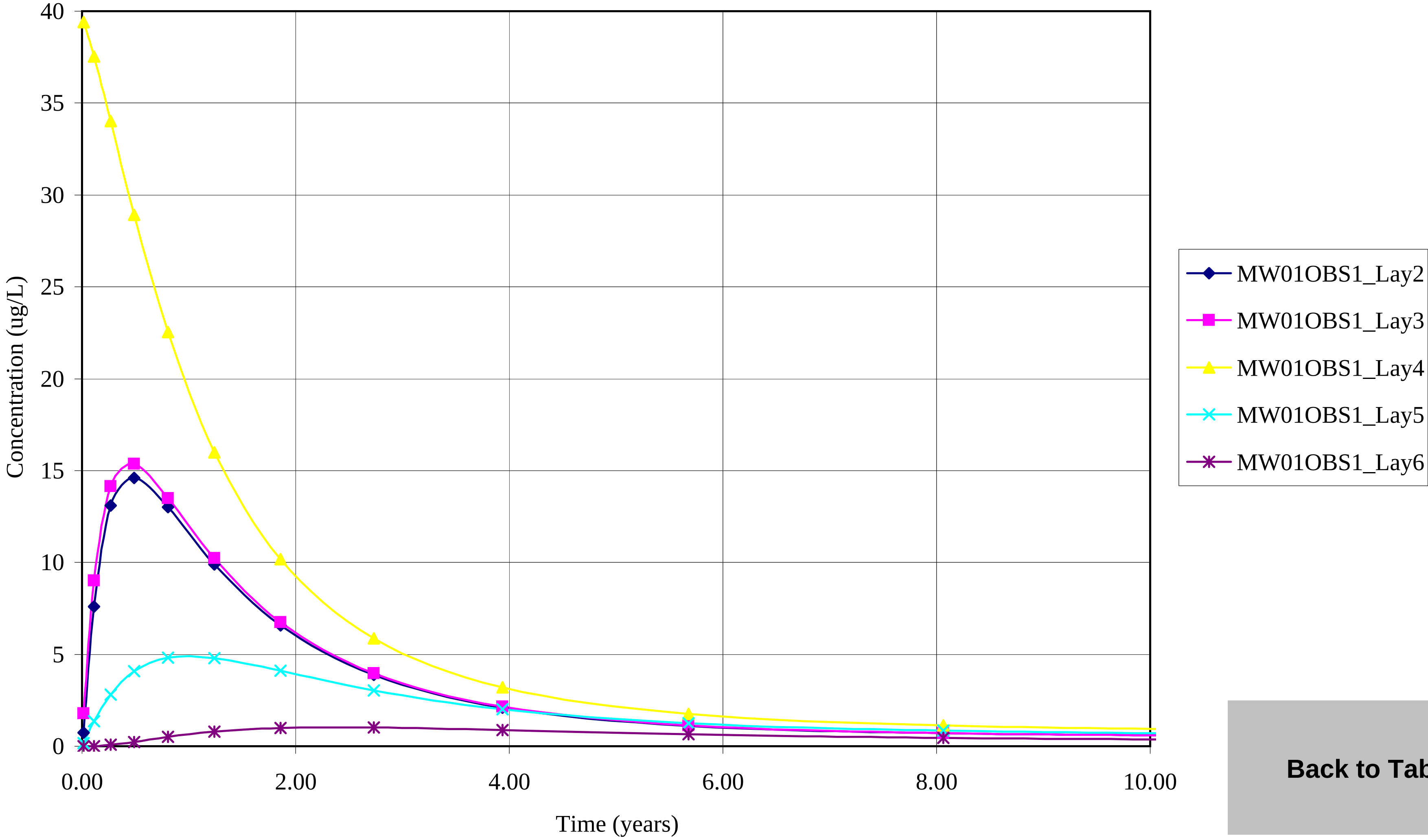
Figure 6A.96. MW02OBS1 Beryllium (Pumping) Extraction/Advection/Dispersion/ChemRxn



Back to Table

luck420_Be_Pump_Extract_Adv_Dis_Chem156060CHARTS.xls

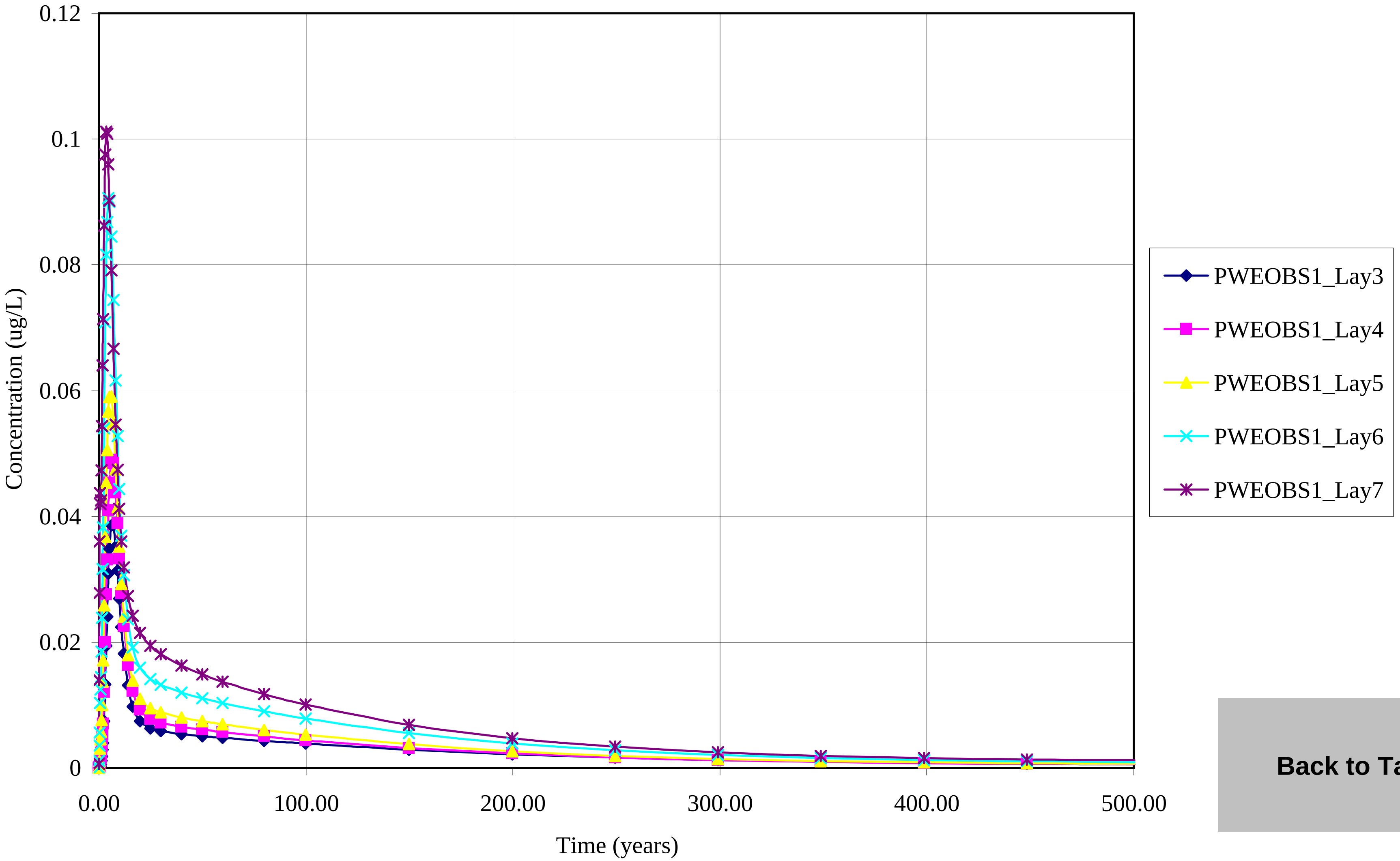
Figure 6A.97. MW01OBS1 Beryllium (Pumping) Extraction/Advection/Dispersion/ChemRxn



Back to Table

luck420_Be_Pump_Extract_Adv_Dis_Chem156060CHARTS.xls

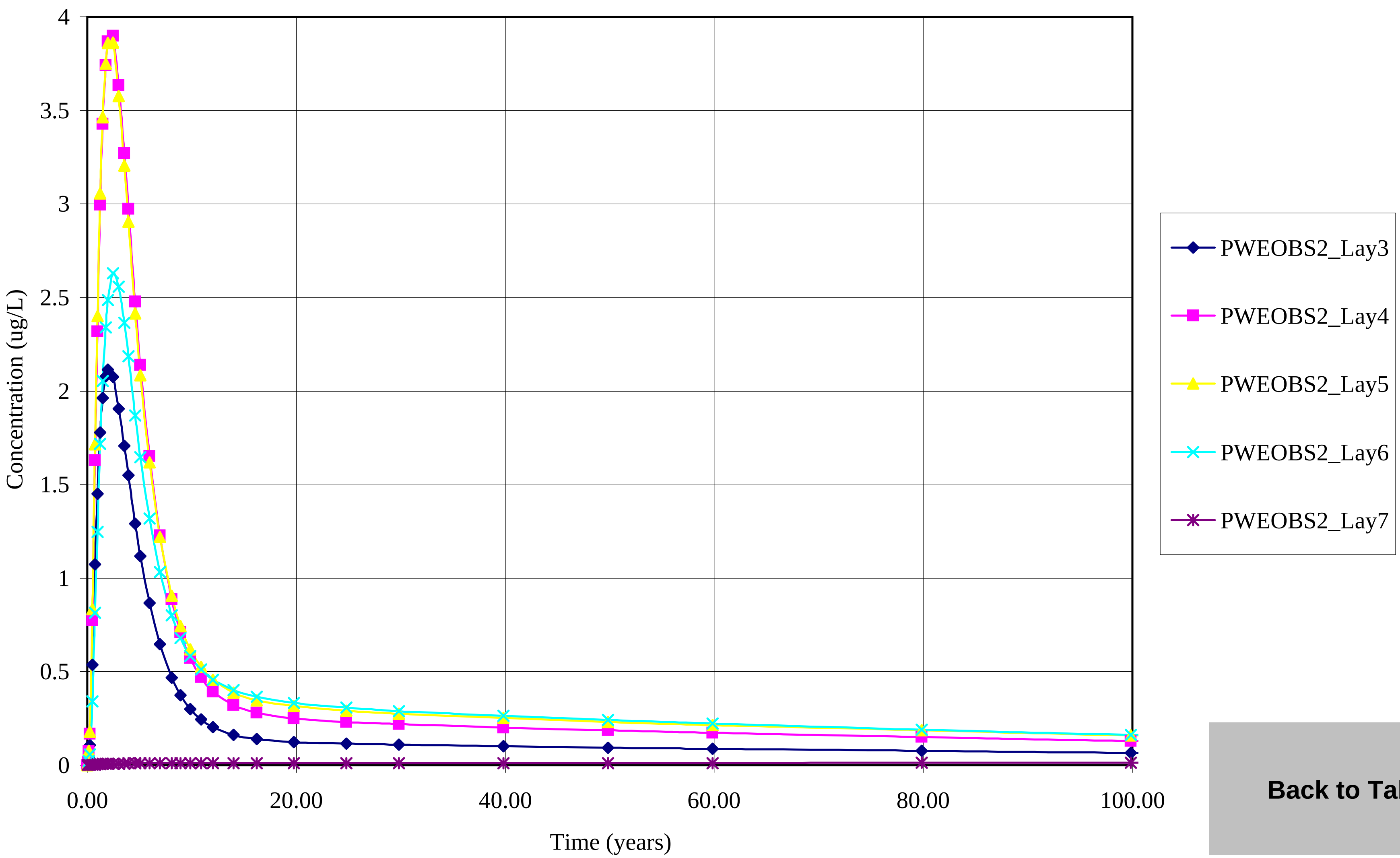
Figure 6A.98. PWEOBS1 Beryllium (Pumping) Extraction/Advection/Dispersion/ChemRxn



Back to Table

luck420_Be_Pump_Extract_Adv_Dis_Chem156060CHARTS.xls

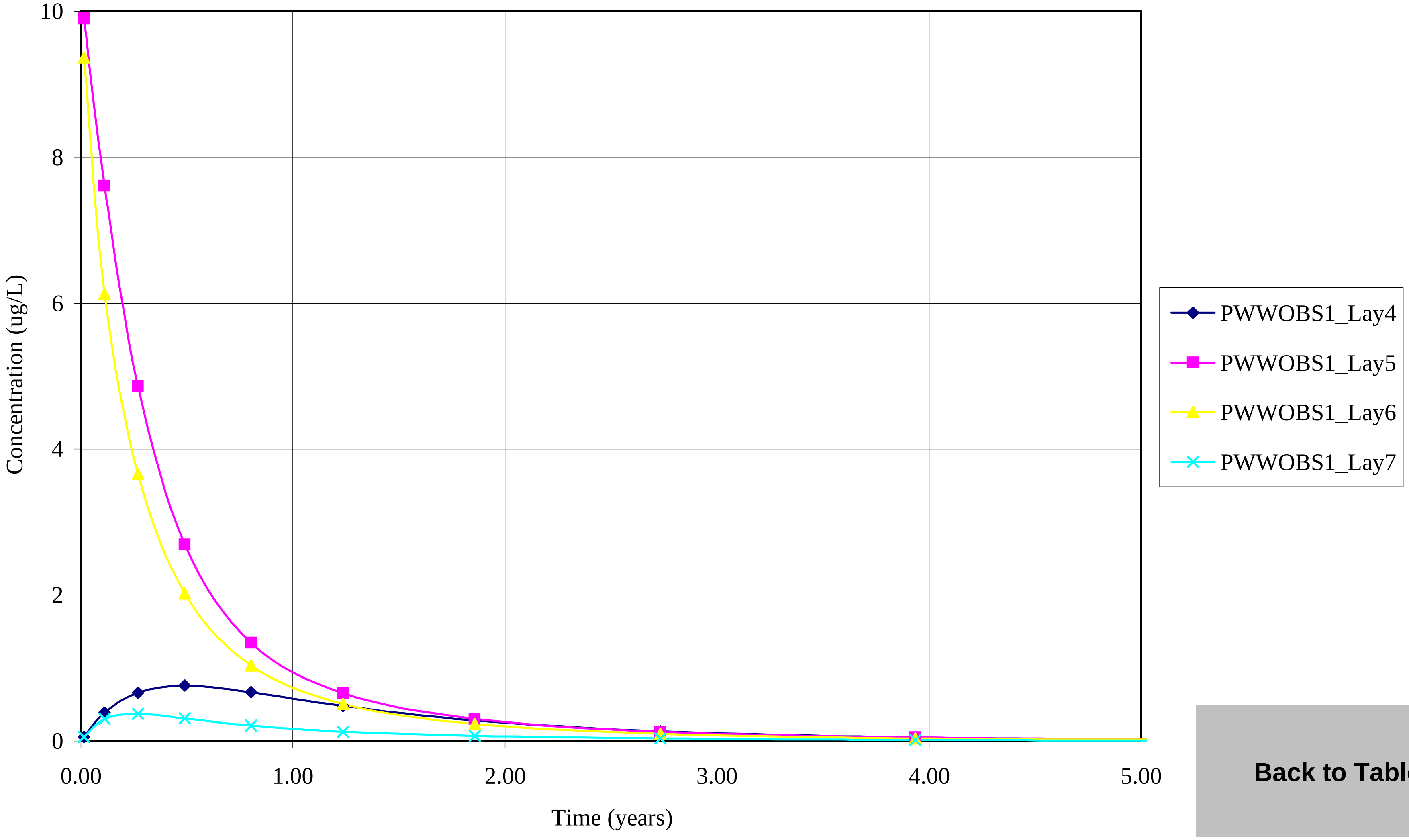
Figure 6A.99. PWEOBS2 Beryllium (Pumping) Extraction/Advection/Dispersion/ChemRxn



Back to Table

luck420_Be_Pump_Extract_Adv_Dis_Chem156060CHARTS.xls

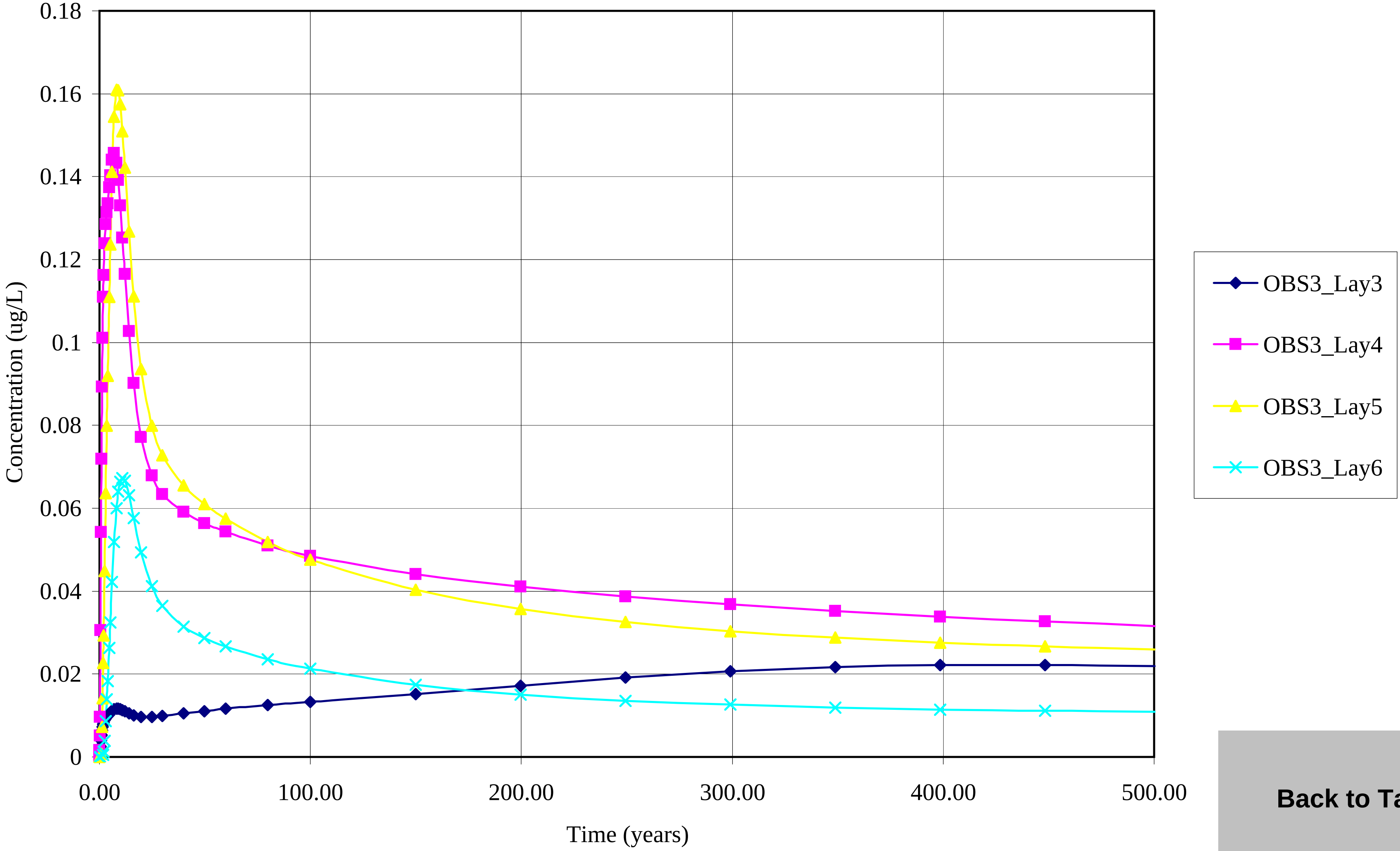
Figure 6A.100. PWWOBS1 Beryllium (Pumping) Extraction/Advection/Dispersion/ChemRxn



Back to Table

luck420_Be_Pump_Extract_Adv_Dis_Chem156060CHARTS.xls

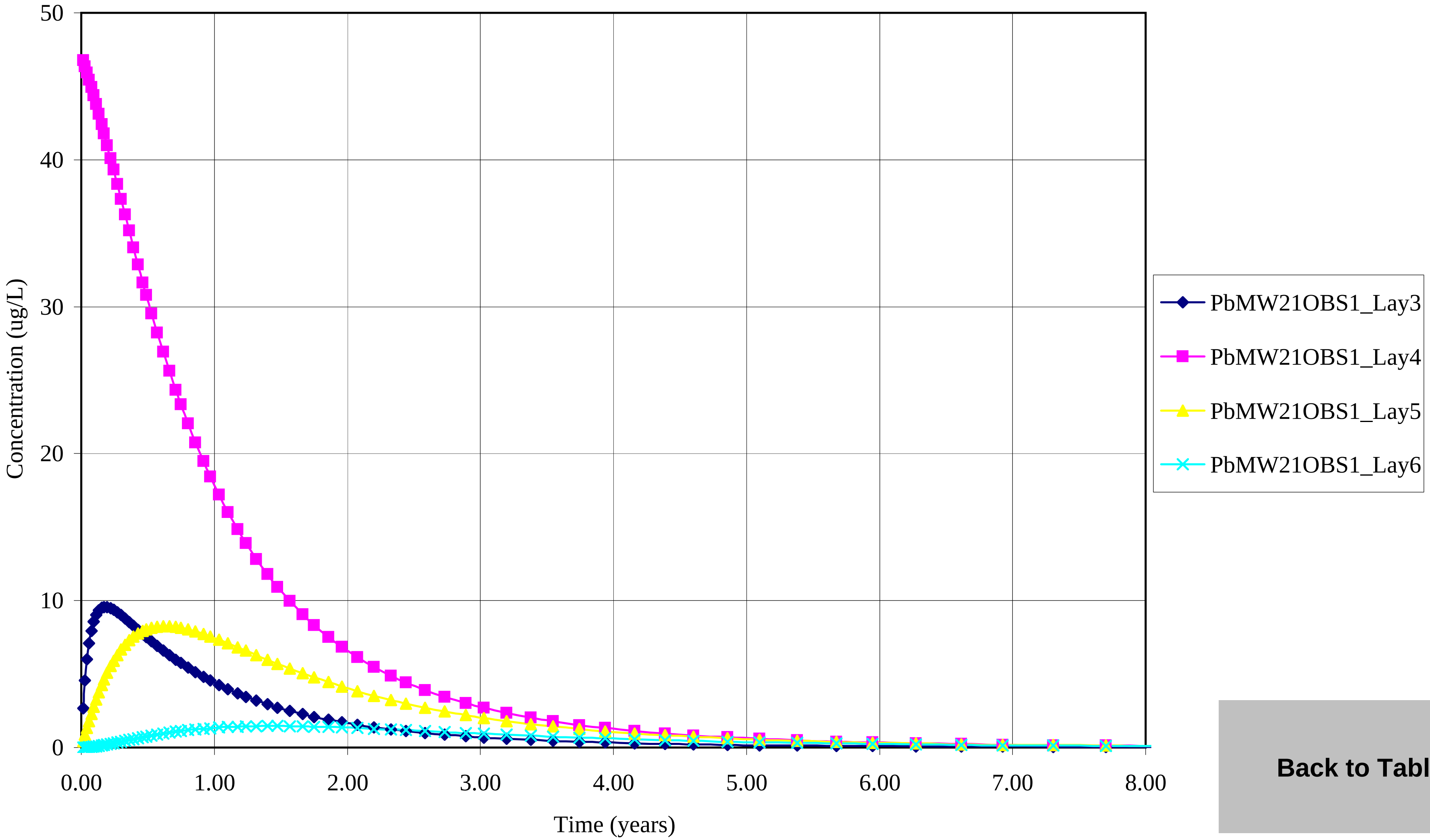
Figure 6A.101. OBS3 Beryllium (Pumping) Extraction/Advection/Dispersion/ChemRxn



Back to Table

luck420_Be_Pump_Extract_Adv_Dis_Chem156060CHARTS.xls

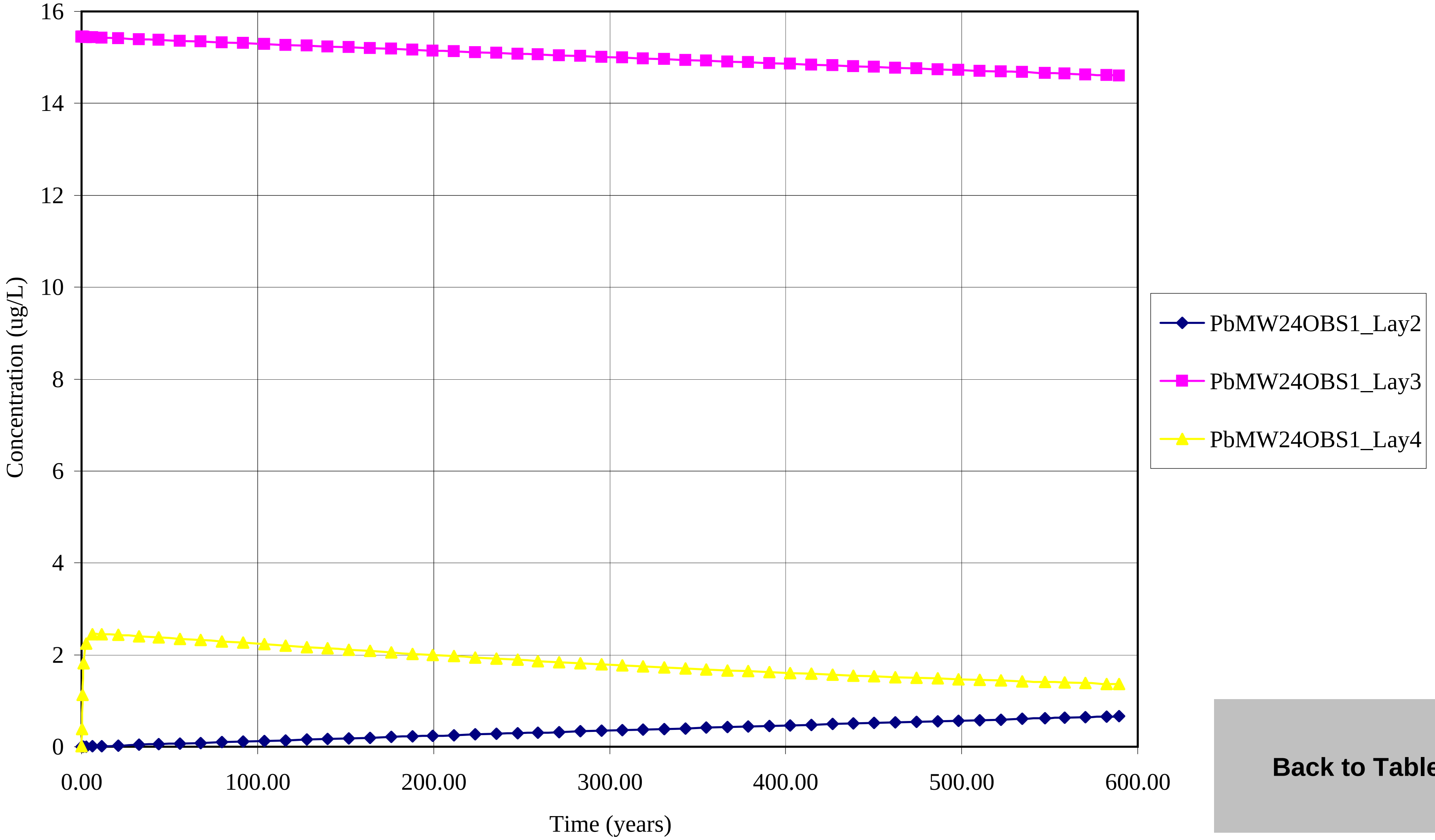
Figure 6A.102. PbMW21OBS1 Lead (Pumping) Advection/Dispersion/ChemRxn



Back to Table

luck420_Pb_Pump_Adv_Dis_Chem_15_60_60CHARTS.xls

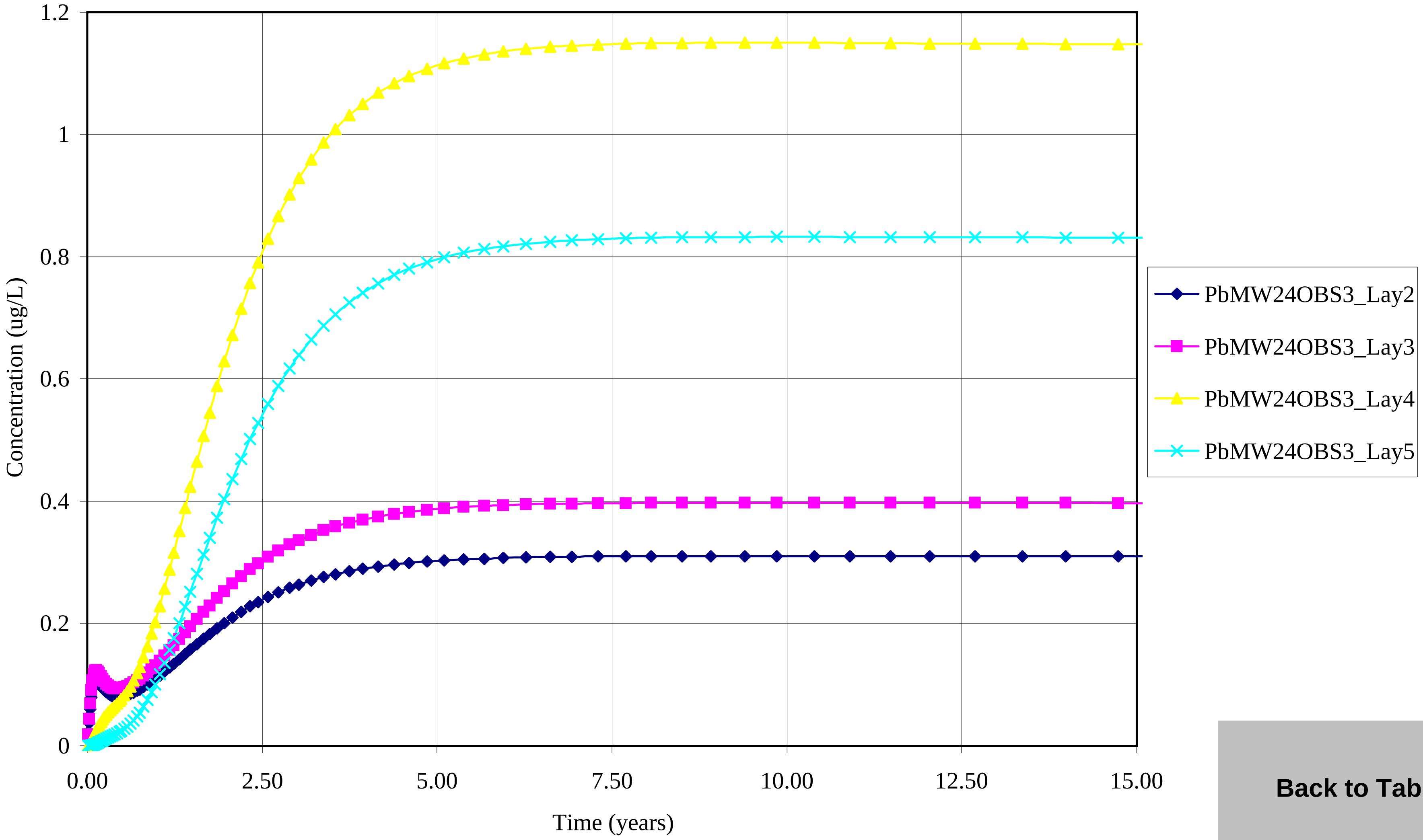
Figure 6A.103. PbMW24OBS1 Lead (Pumping) Advection/Dispersion/ChemRxn



Back to Table

luck420_Pb_Pump_Adv_Dis_Chem_15_60_60CHARTS.xls

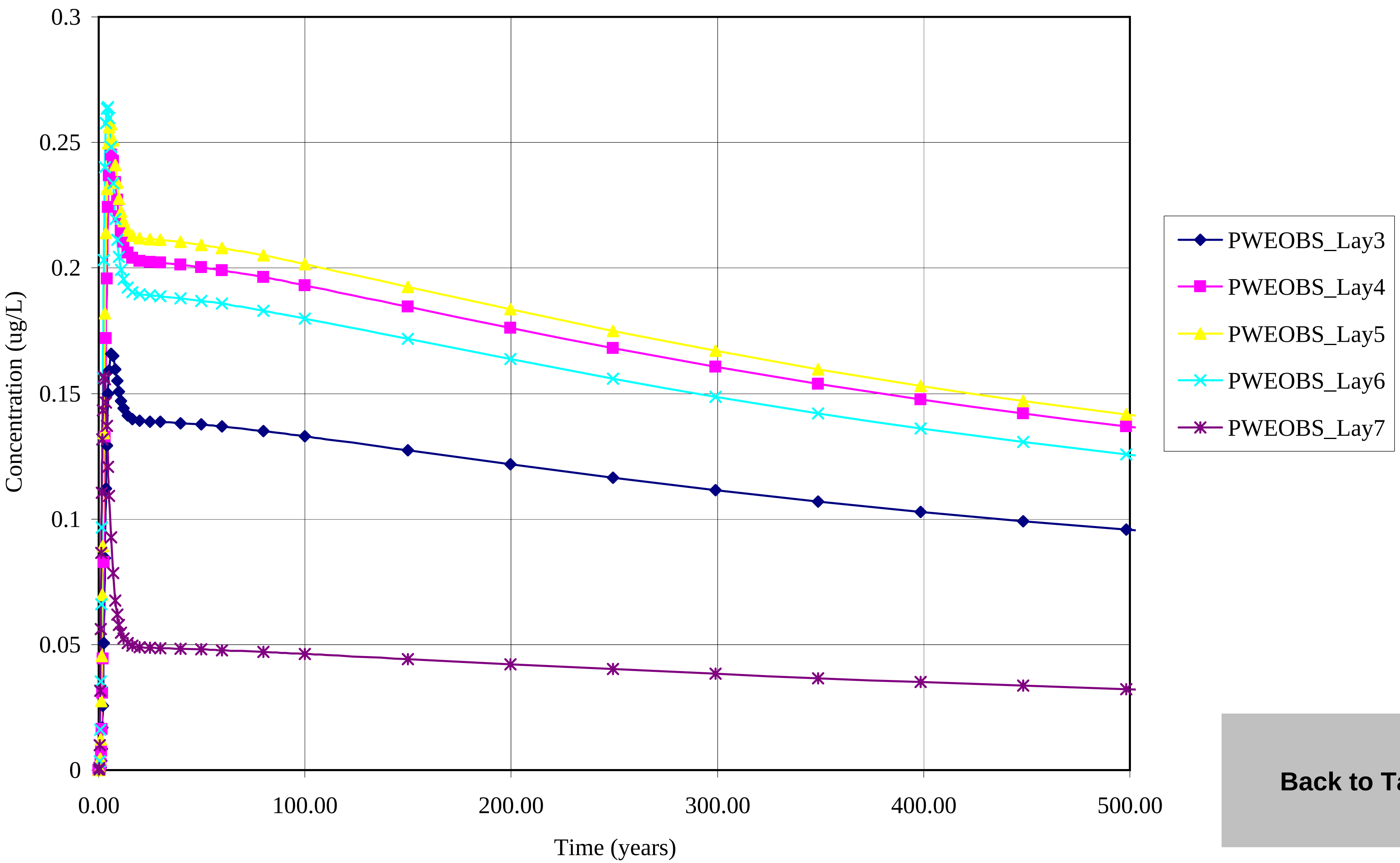
Figure 6A.104. PbMW24OBS3 Lead (Pumping) Advection/Dispersion/ChemRxn



Back to Table

luck420_Pb_Pump_Adv_Dis_Chem_15_60_60CHARTS.xls

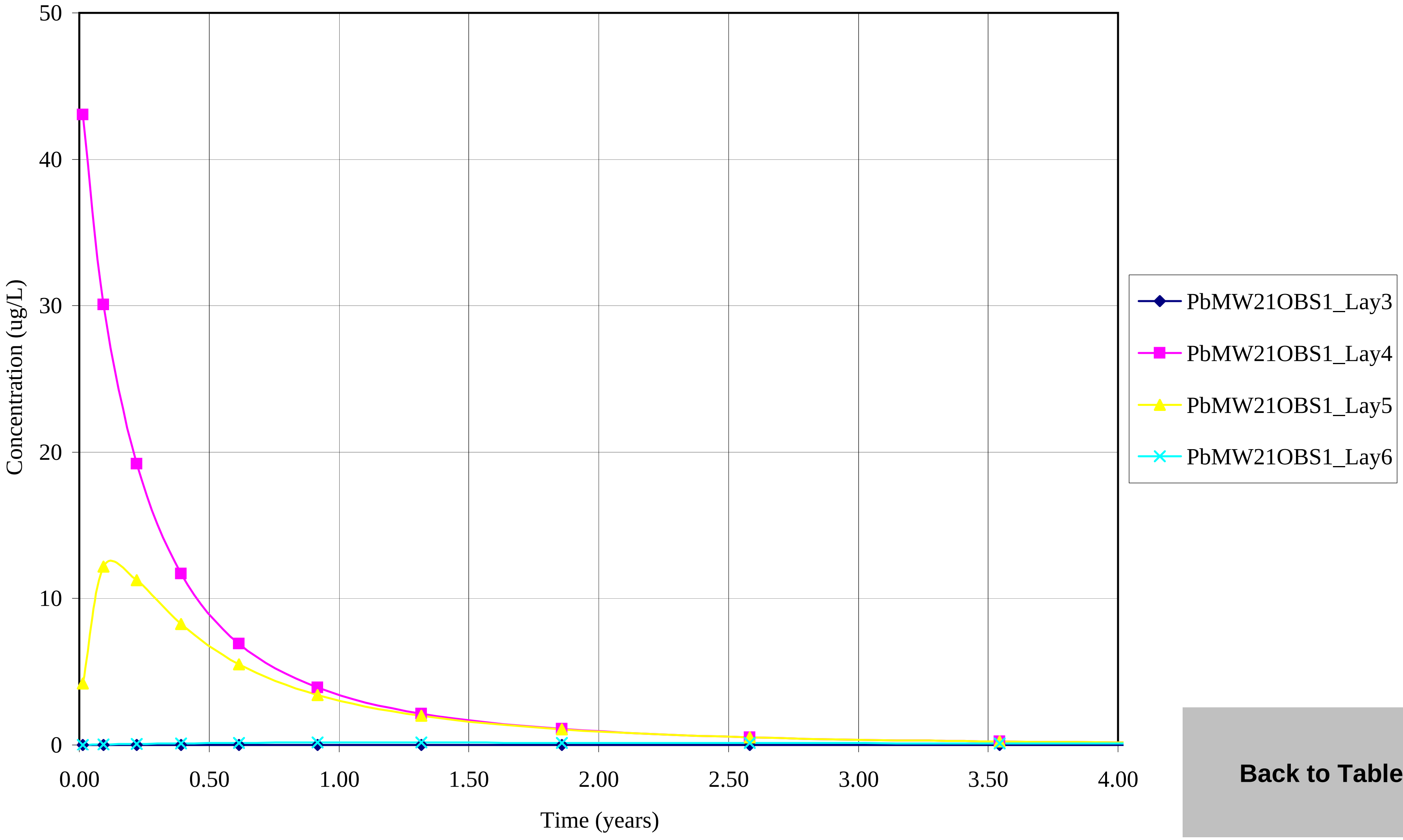
Figure 6A.105. PWEOBS1 Lead (Pumping) Advection/Dispersion/ChemRxn



Back to Table

luck420_Pb_Pump_Adv_Dis_Chem_15_60_60CHARTS.xls

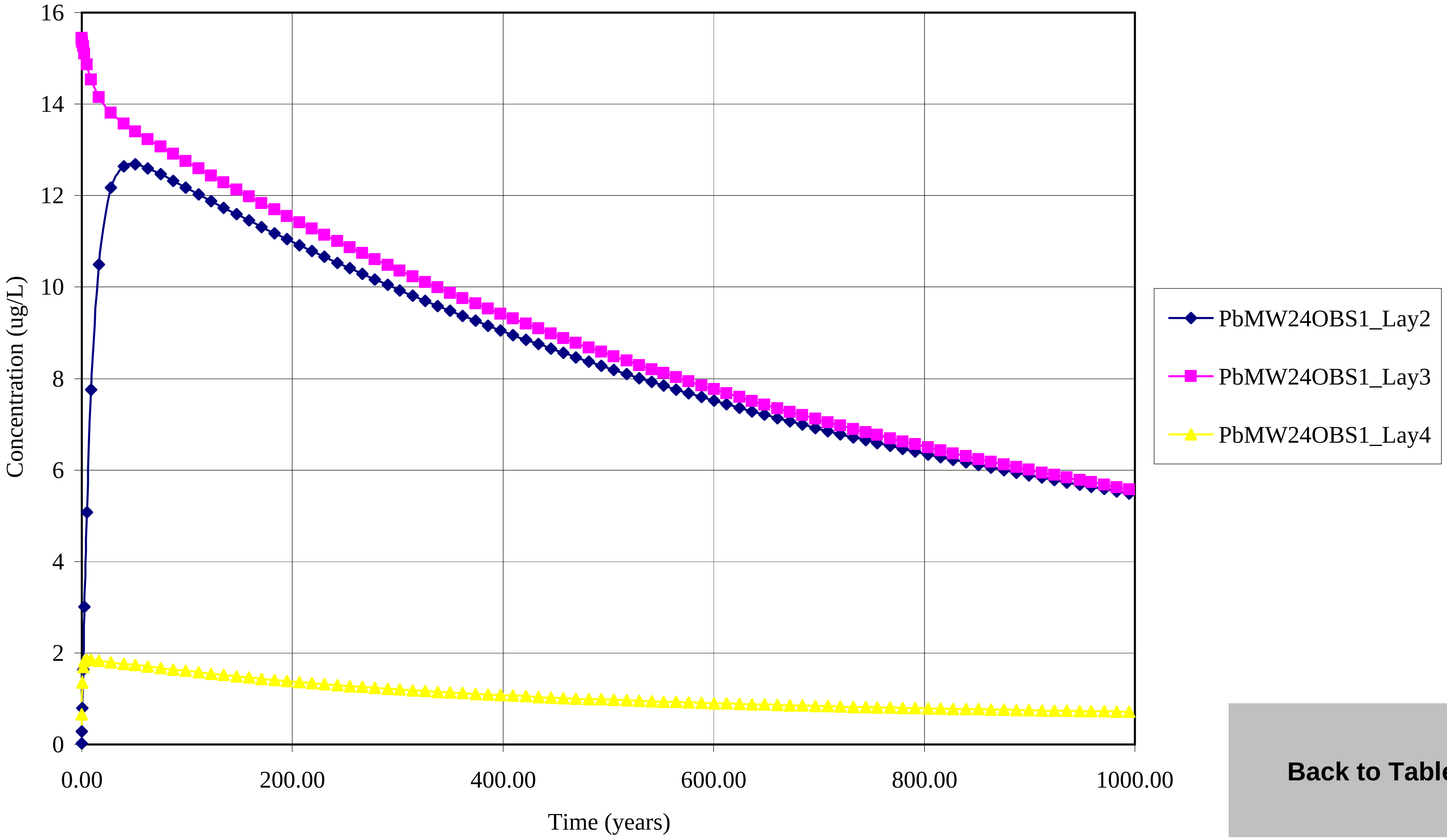
Figure 6A.106. PbMW21OBS1 Lead (Pumping) Extraction/Advection/Dispersion/ChemRxn



Back to Table

luck420_Pb_Pump_Extract_Adv_Dis_Chem156060CHARTS.xls

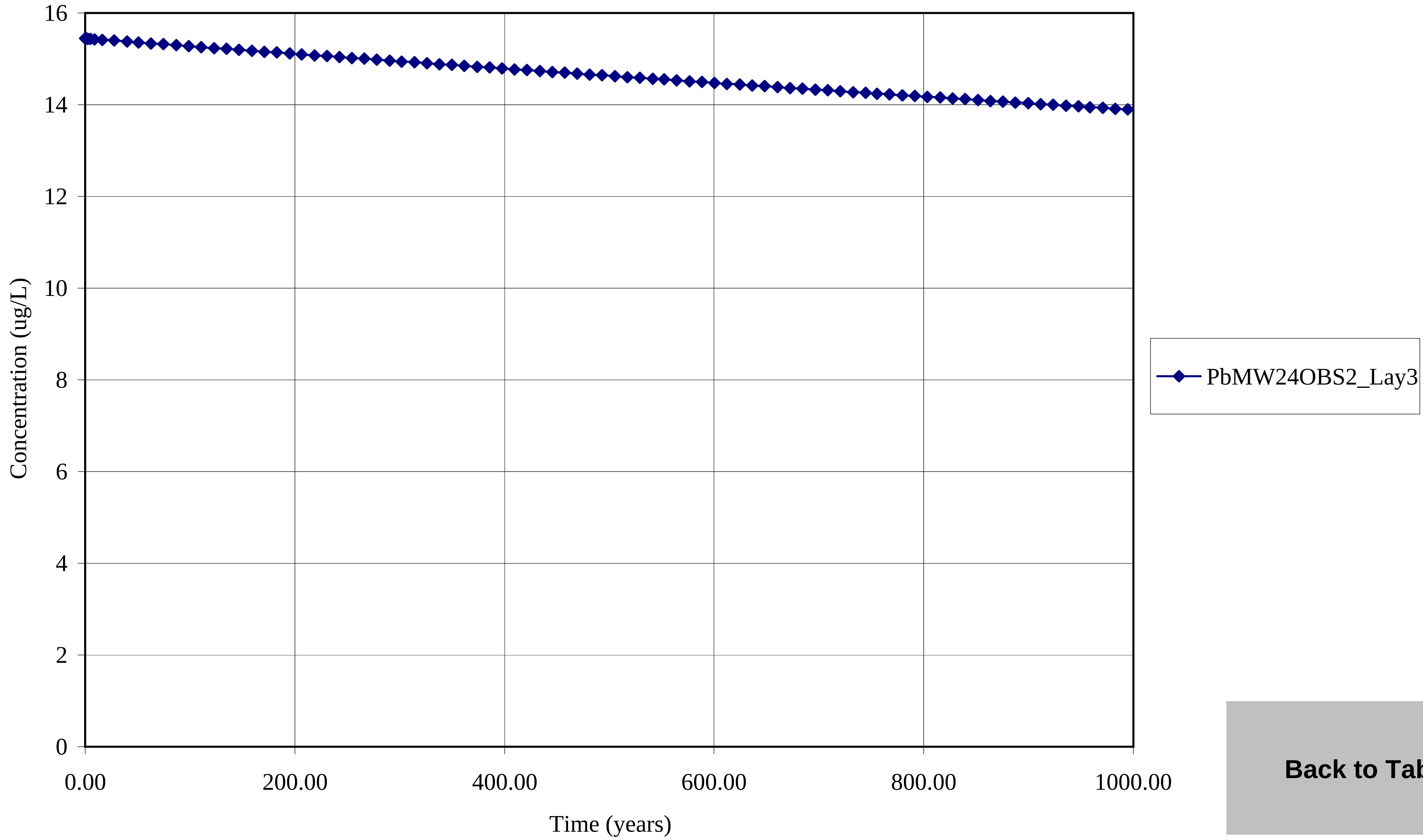
Figure 6A.107. PbMW24OBS1 Lead (Pumping) Extraction/Advection/Dispersion/ChemRxn



Back to Table

luck420_Pb_Pump_Extract_Adv_Dis_Chem156060CHARTS.xls

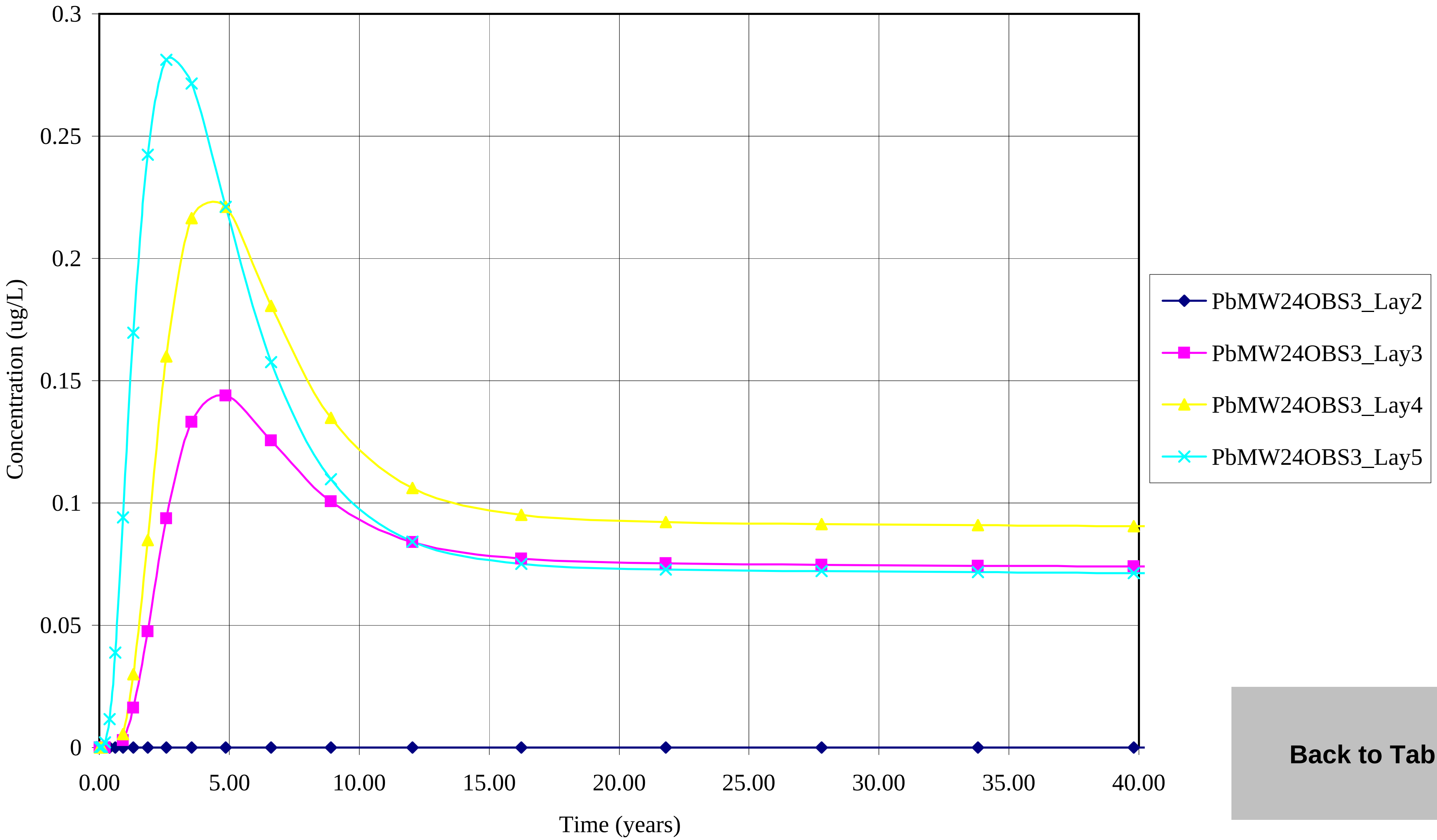
Figure 6A.108. PbMW24OBS2 Lead (Pumping) Extraction/Advection/Dispersion/ChemRxn



Back to Table

luck420_Pb_Pump_Extract_Adv_Dis_Chem156060CHARTS.xls

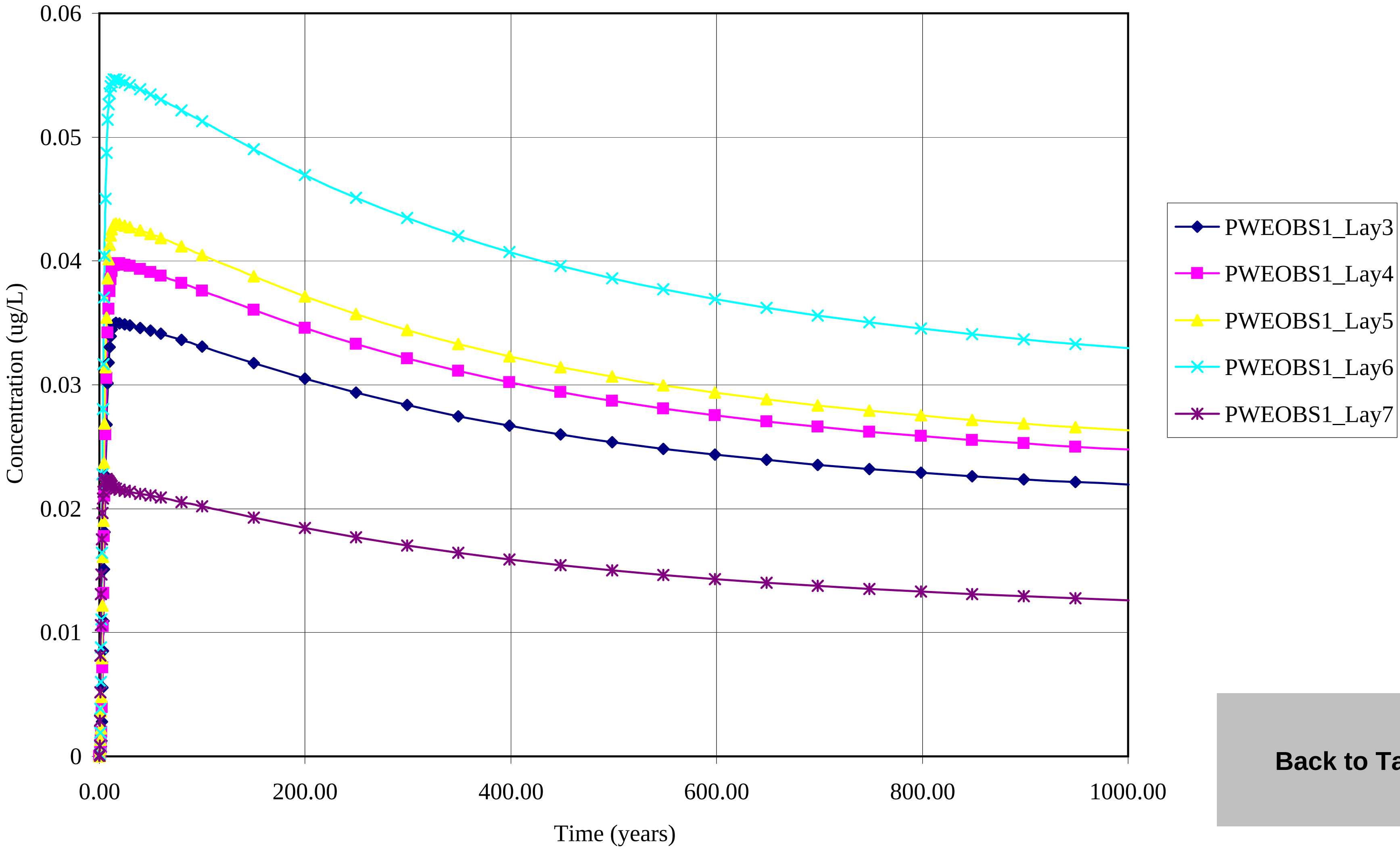
Figure 6A.109. PbMW24OBS3 Lead (Pumping) Extraction/Advection/Dispersion/ChemRxn



Back to Table

luck420_Pb_Pump_Extract_Adv_Dis_Chem156060CHARTS.xls

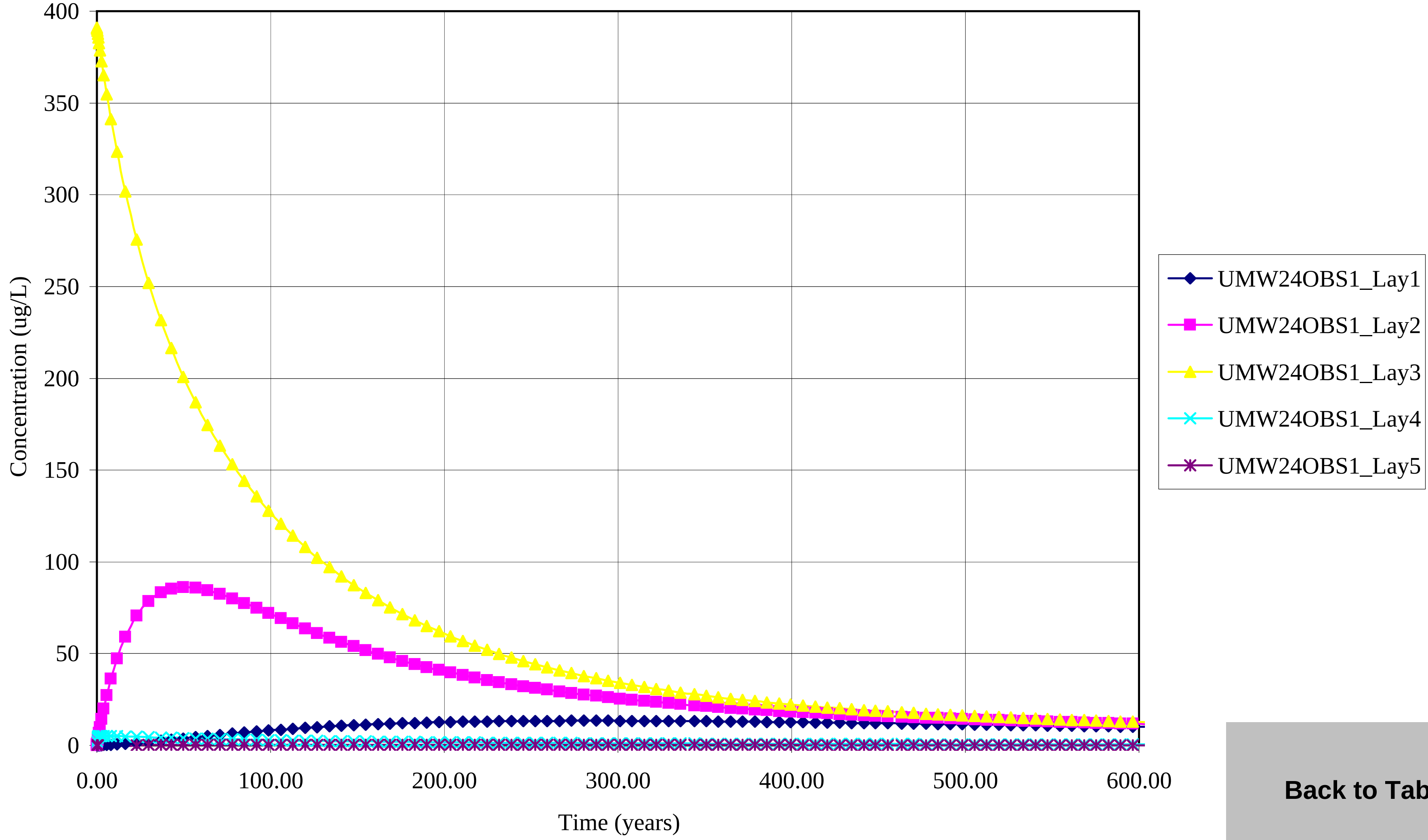
Figure 6A.110. Lead (Pumping) Extraction/Advection/Dispersion/ChemRxn



Back to Table

luck420_Pb_Pump_Extract_Adv_Dis_Chem156060CHARTS.xls

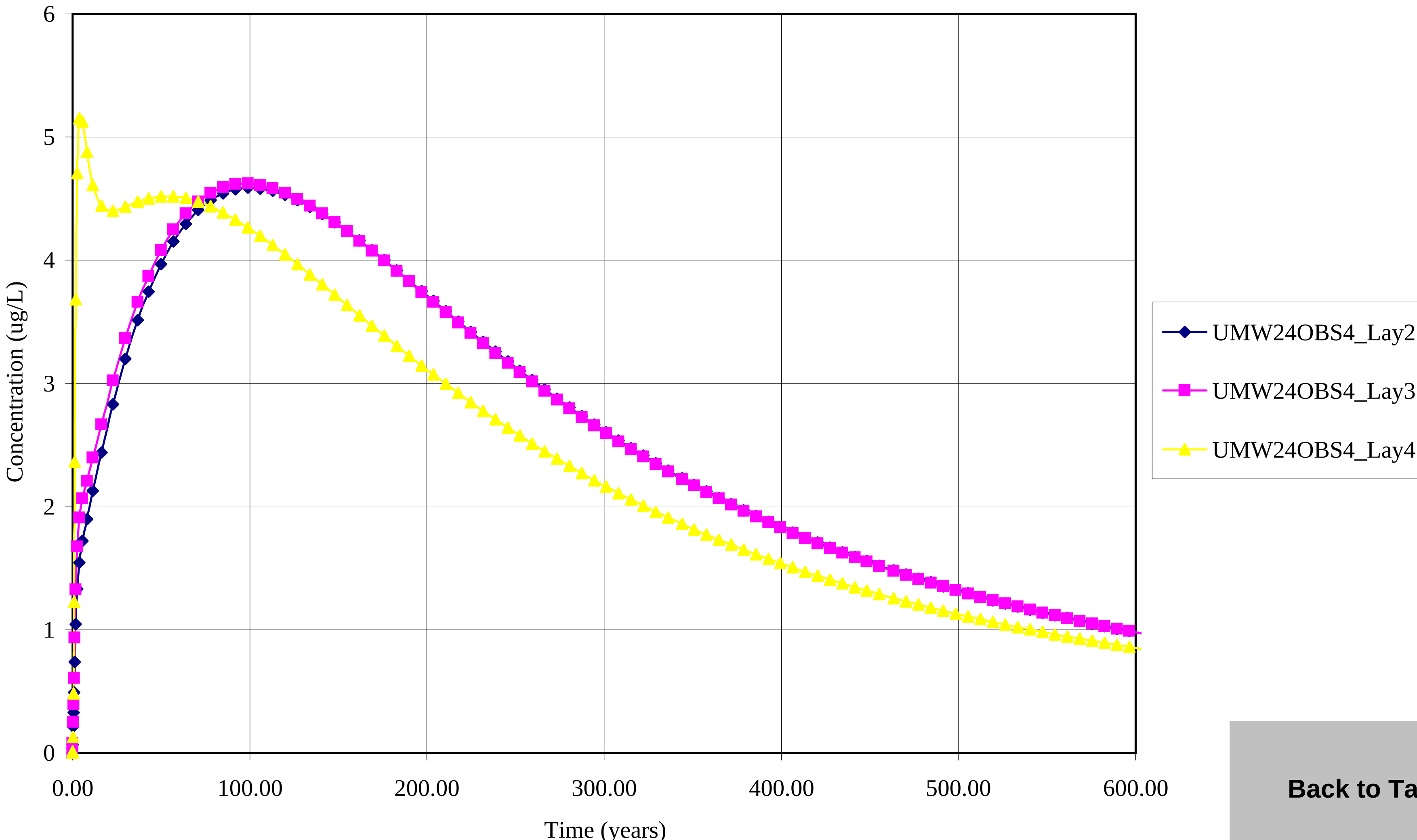
Figure 6A.111. UMW24OBS1 Uranium (Pumping) Advection/Dispersion/ChemRxn



Back to Table

luck420_U_Pump_Adv_Dis_Chem_15_60_60_ObsWellDataCHARTS.xls

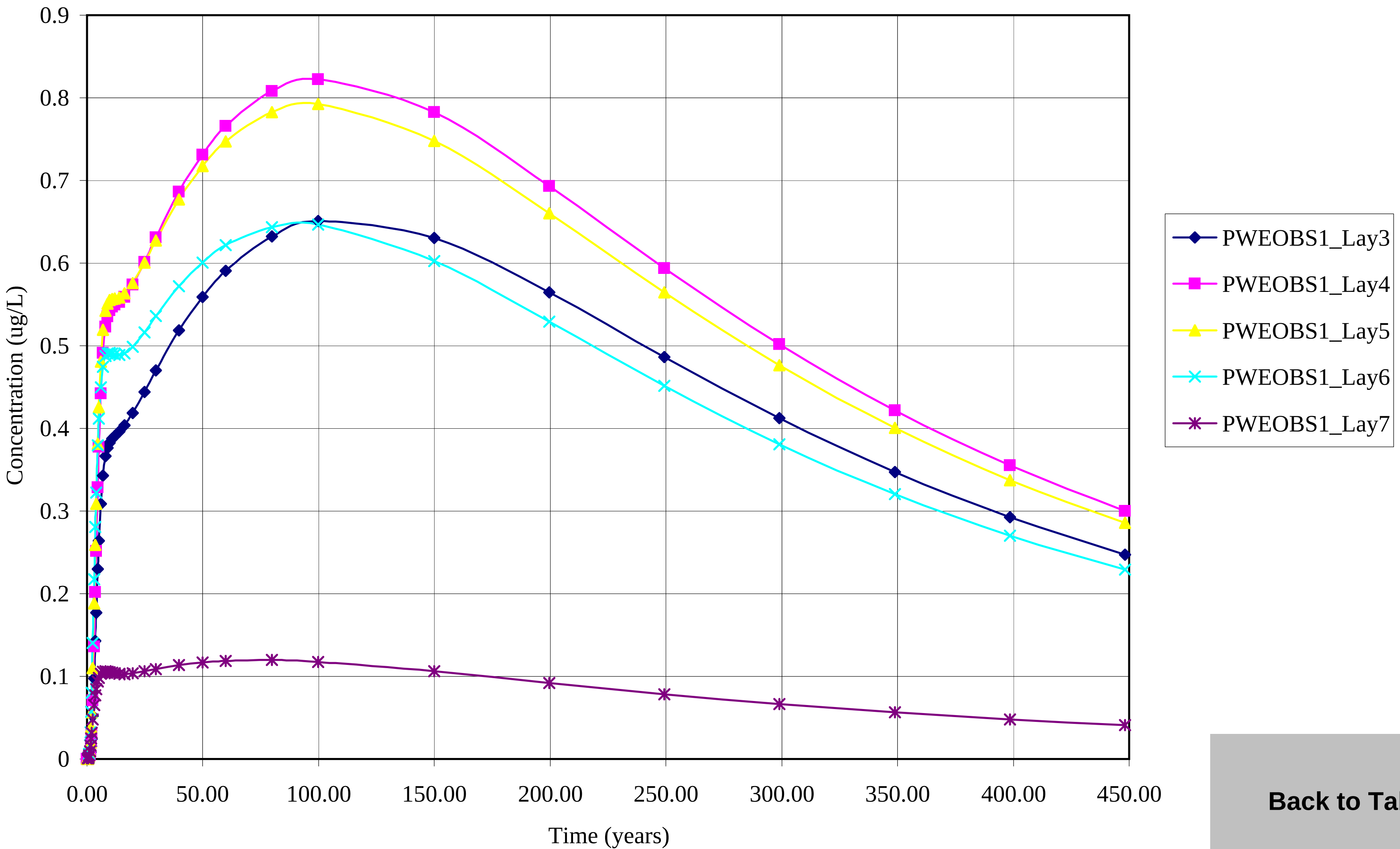
Figure 6A.112. UMW24OBS4 Uranium (Pumping) Advection/Dispersion/ChemRxn



Back to Table

luck420_U_Pump_Adv_Dis_Chem_15_60_60_ObsWellDataCHARTS.xls

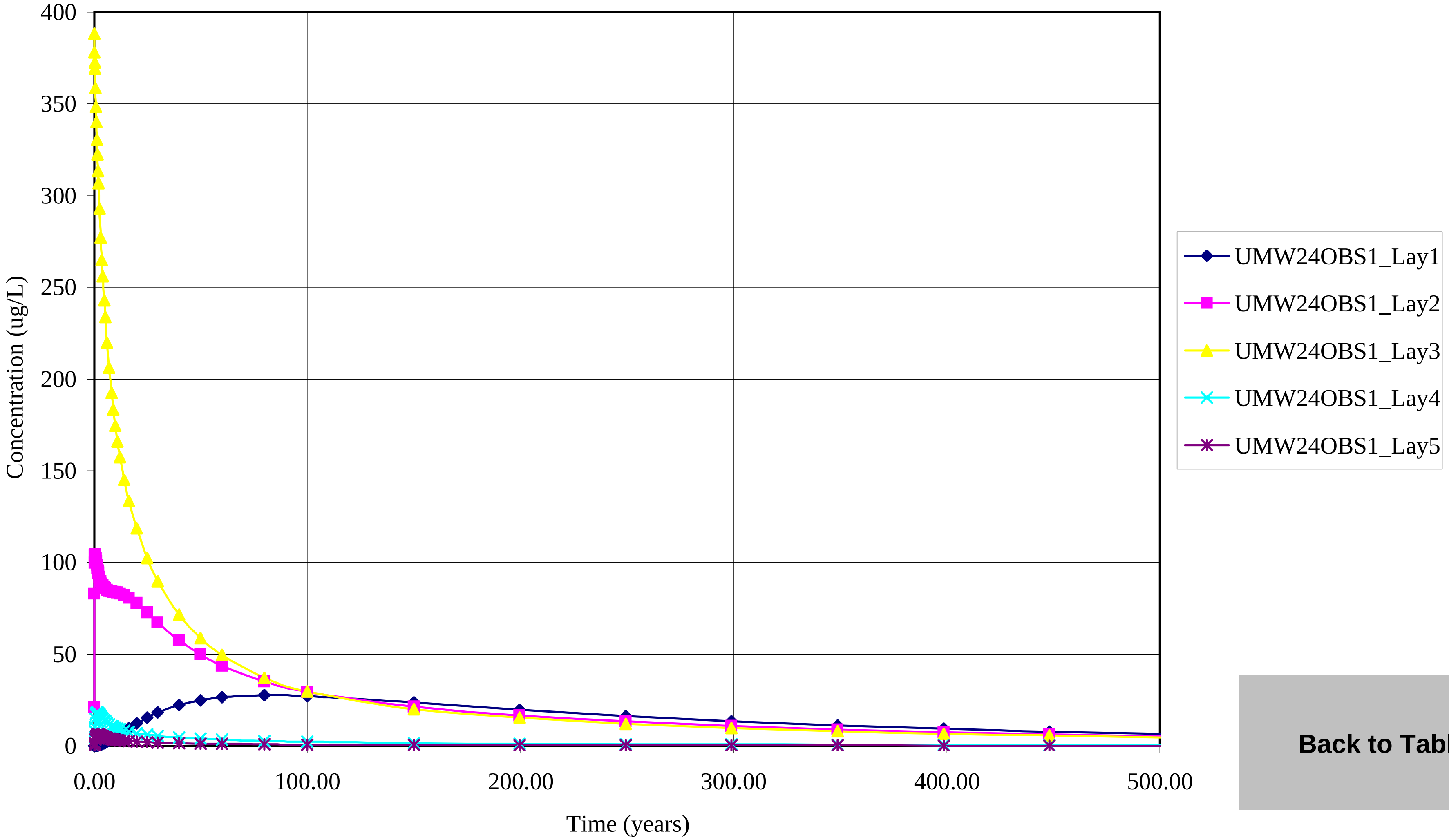
Figure 6A.113. PWEOBS1 Uranium (Pumping) Advection/Dispersion/ChemRxn



Back to Table

luck420_U_Pump_Adv_Dis_Chem_15_60_60_ObsWellDataCHARTS.xls

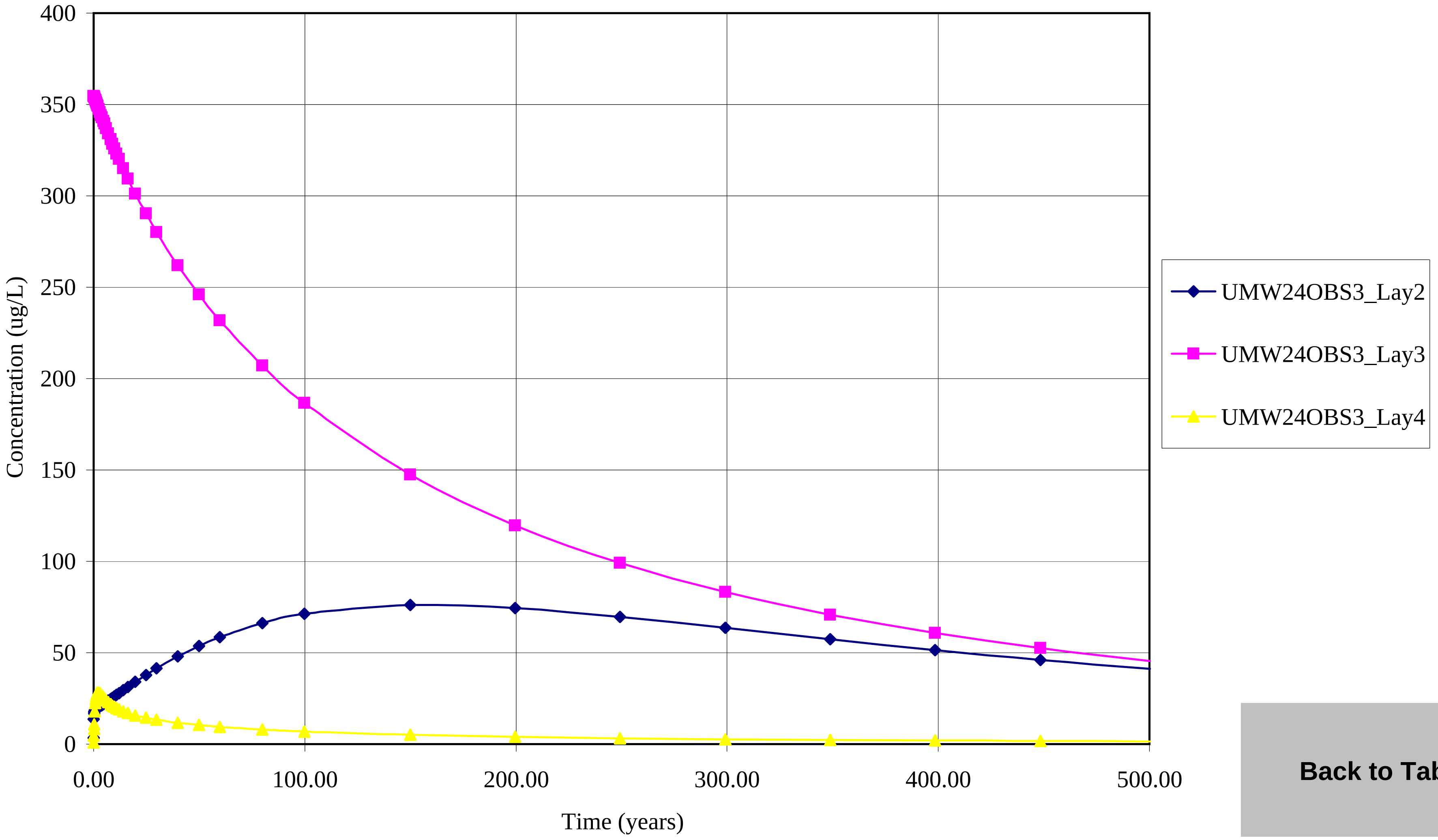
Figure 6A.114. UMW24OBS1 Uranium (Pumping) Extraction/Advection/Dispersion/ChemRxn



Back to Table

luck420_U_Pump_Extract_Adv_Dis_Chem_15_60_60_ObsWellDataCHARTS.xls

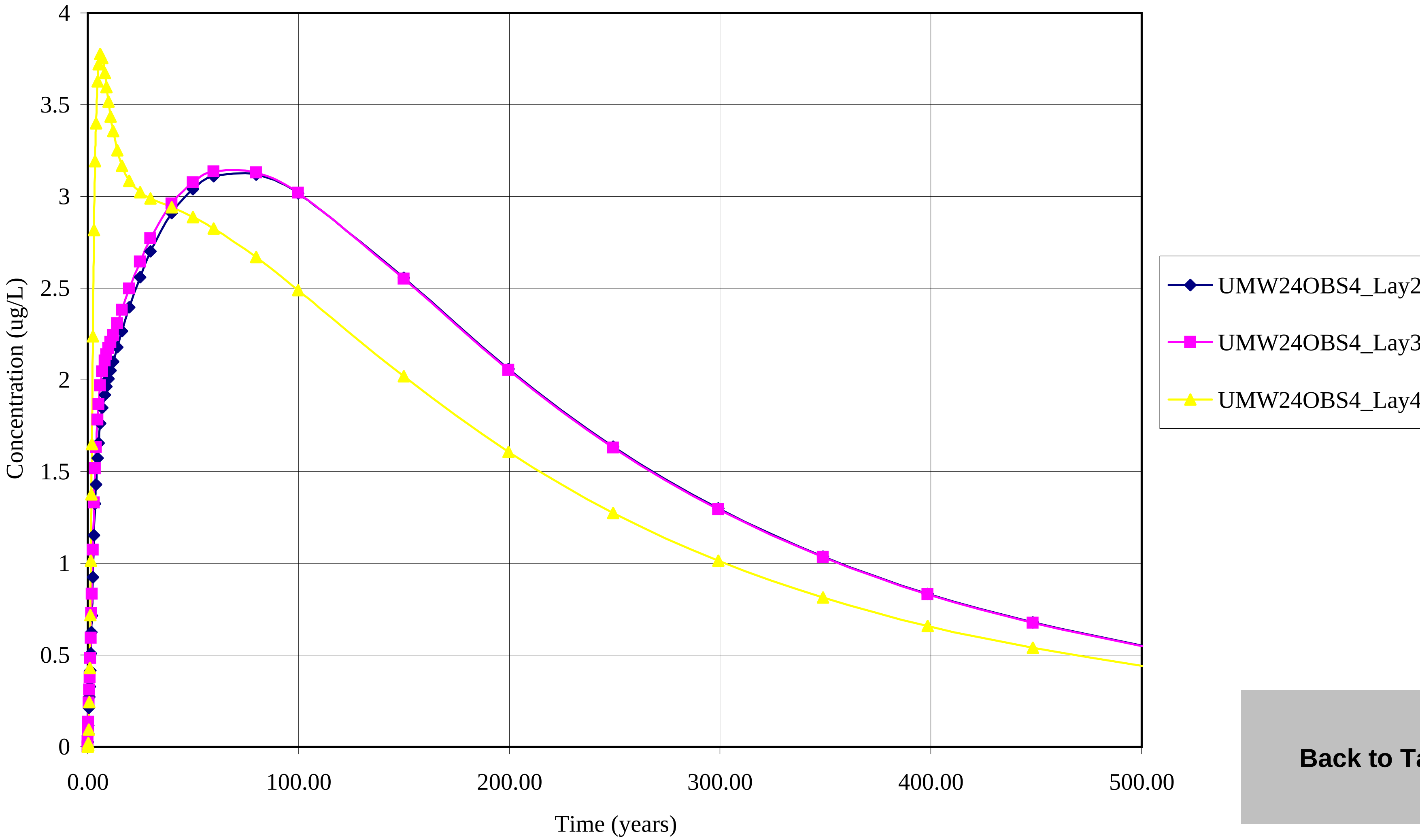
Figure 6A.115. MW24OBS3 Uranium (Pumping) Extraction/Advection/Dispersion/ChemRxn



Back to Table

luck420_U_Pump_Extract_Adv_Dis_Chem_15_60_60_ObsWellDataCHARTS.xls

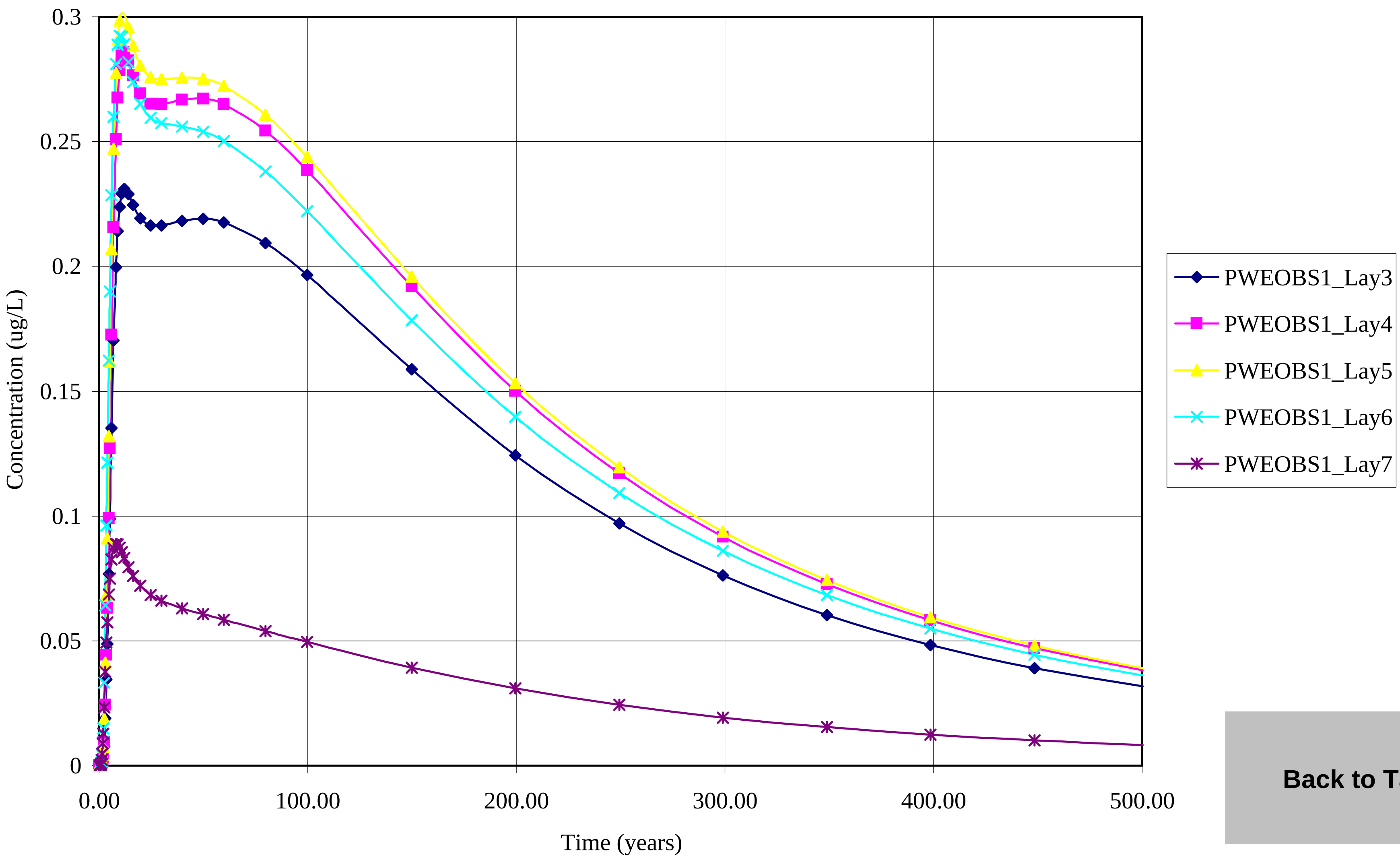
Figure 6A.116. UMW24OBS4 Uranium (Pumping) Extraction/Advection/Dispersion/ChemRxn



Back to Table

luck420_U_Pump_Extract_Adv_Dis_Chem_15_60_60_ObsWellDataCHARTS.xls

Figure 6A.117. PWEOBS1 Uranium (Pumping) Extraction/Advection/Dispersion/ChemRxn



Back to Table

luck420_U_Pump_Extract_Adv_Dis_Chem_15_60_60_ObsWellDataCHARTS.xls

APPENDIX 6B:
Detailed Cost Estimates for
Alternative 2 (Groundwater and Soil Media)
Alternatives 3, 4, 5, and 6 (Soil Media)
Alternatives 7, 8, and 9 (Groundwater Media)

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ATTACHMENTS

6B.1 INTRODUCTION

This appendix provides information regarding the cost estimate for the detailed analysis of alternatives for the Luckey Feasibility Study (FS). These cost estimates are intended to form a basis for comparing alternatives and support remedy selection. The costs used in this analysis are based on existing United States Army Corps of Engineers (USACE) contracts, vendor quotes, estimating reference manuals, and engineering estimates. These cost estimates are expected to provide an accuracy of -30 percent to +50 percent and are prepared using data available from the Lucky Remedial Investigation (RI) Report (USACE 2000a) and this FS Report. The detail used to develop these costs should provide much more certainty (-10 to +15 percent) if the assumptions prove accurate.

The format for the cost estimate is based on guidance from the United States Environmental Protection Agency (EPA) and the USACE, Guide to Developing and Documenting Cost Estimates During a Feasibility Study, July 2000. Section 6B.2 provides general organization of the cost estimates, the Hazardous, Toxic, and Radioactive Waste (HTRW) Work Breakdown Structure (WBS), the project schedules, and estimating methodology. Section 6B.3 summarizes total 2002 costs for each alternative. Section 6B.4 provides the scope of work, detailed assumptions, and basis of estimate for each alternative.

6B.2 GENERAL COST INFORMATION

6B.2.1 Estimate Scope

The Luckey FS developed one alternative for remediating soil and groundwater, three alternatives for remediating contaminated soils, and three alternatives for remediating groundwater. The No Action alternative, Alternative 1, contains no cost. The alternatives included in the detailed cost estimate are listed below:

Soil and Groundwater Media Alternatives

- Alternative 2: Limited Action

Soil Media Alternatives

- Alternative 3: Consolidation and Capping
- Alternative 4: Excavation of Soils and Offsite Disposal ~ Industrial Land Use
- Alternative 5: Excavation of Soils and Offsite Disposal ~ Unrestricted Land Use
- Alternative 6: Excavation of Soils, Treatment, and Offsite Disposal ~ Unrestricted Land Use

Groundwater Media Alternatives

- Alternative 7: Monitored Natural Attenuation ~ Unrestricted Land Use
- Alternative 8: Active Groundwater Treatment ~ Unrestricted Land Use
- Alternative 9: Electrokinetics ~ Unrestricted Land Use

The cost estimates have been organized using the HTRW WBS, February 1996. The cost estimate consists of five hierarchical levels and uses a 2-digit number at each level. The 2-digit numbers for title levels 1, 2, and 3 are taken from the HTRW WBS. Additional detail items are at levels 3 through 5. The WBS elements for the Luckey site alternative cost estimates are described in Section 6B.3.

- Level 1– WBS Level 1 (Account) e.g.,33.01 Luckey Alternative 4
- Level 2– WBS Level 2 (System) e.g., 33.01.08 Solids Collection and Containment
- Level 3– WBS Level 3 (Subsystem) e.g., 33.01.08.01 Contaminated Soil Collection
- Level 4– User Defined (Assembly Category or Other)
- Level 5– User Defined (Assembly Category or Other)

The cost estimates include (1) capital cost, including both direct and indirect cost, (2) annual operation and maintenance (O&M) cost, and (3) net present value of capital and O&M cost. The detailed estimates presenting the non discounted cost for each alternative are included as attachments. The detailed estimates provide the key parameters and assumptions used to develop the cost.

6B.2.2 Schedule

Remediation activities (RA) for the Luckey site are estimated to be complete within 0.5 to 150 years. O&M activities for alternatives where contaminants are left onsite may require up to a 1,000-year period of analysis due to the long life of metal contaminants present at the site. For this reason, the period of analysis when contaminants are left onsite will be based on a maximum 1,000-year project life cycle. The duration for each alternative is calculated using historical productivity factors or based on engineering judgment. The remedial design, remedial action, post RA documentation, and O&M time periods are estimated in Table 6B.1.

6B.2.3 Estimating Methodology

The primary methodology used is a quantity take-off method whereby costs are calculated based on unit cost multiplied by quantity or other input parameters. Unit cost data used in the relationship is primarily drawn from existing USACE contracts, vendor quotes, RS*Means Construction Cost Data Manuals, ECHOS (Environmental Cost Handling Options and Solutions) cost database,* or engineering estimates. The primary source of cost data was from existing USACE contracts or vendor quotes. This should provide an estimate with a high degree of certainty, provided the quantities do not change. For example, Alternative 5 was developed using existing USACE contracts and vendor quotes for over 60% of the total cost.

Solids Collection and Containment WBS elements incorporate a productivity adjustment process as part of the estimating methodology. This process is accomplished through the use of factors, which are applied to equipment performance measures in order to account for degradation in the productivity, performance, or output levels of the equipment resulting from site-specific conditions. Productivity factors exist for three conditions: site, soil, and safety. Site adjustments are made to account for temporary work interruptions and delays resulting from poor weather, unsafe work conditions, and other similar unforeseen events. Soil adjustments are made to account for varying levels of difficulty associated with excavating different types of soil or rubble. A safety adjustment is made to adjust productivity levels due to safety procedures associated with the nature of impacted materials.

6B.2.4 Cost Elements

Federal construction programs have traditionally distinguished between capital and O&M costs. The remedial action alternatives for this FS consist of those activities required to prevent or mitigate the migration of waste into the environment. The remedial action may include activities considered to be O&M in situations where construction alone will not achieve the health and environmental protection criteria.

The remedial action will have a schedule with a defined completion date. The post-closure or O&M phase occurs after the completion of the remedial action and includes those activities necessary to confirm closure of the remedial action or the activities necessary to monitor and maintain controls on releases of hazardous waste into the environment for an indefinite period.

6B.2.4.1 Capital Costs

Capital costs are those expenditures required to implement a remedial action and consist of both direct and indirect costs. Capital costs do not include the costs required to maintain or operate the action throughout its lifetime.

Direct Capital Costs

Direct capital costs include equipment, labor, and material necessary for implementing the remedial action. These typically include costs for:

- land use controls;
- monitoring, sampling, and analysis during remedial action;
- site work;
- surface water and groundwater collection/controls;
- soils collection/containment;
- treatment;
- transportation and disposal; and
- site restoration.

Indirect Capital Costs

Indirect capital costs consist of engineering, supervision, management, administration, financial, and other services necessary to implement a remedial action. These costs are not incurred as part of actual remedial actions but are ancillary to direct or construction costs. Indirect costs typically include:

- general conditions;
- home office overhead and profit;
- remedial design;
- project management;
- construction management; and
- program management cost.

6B.2.4.2 Operations and Maintenance Costs

O&M costs are those post-remedial action costs necessary for monitoring and ensuring hazardous waste will not migrate into the environment. These costs typically include:

- maintaining land use controls and site database;
- monitoring, sampling and analysis after remedial action;
- five-year reviews;
- groundwater treatment system O&M; and
- site management/technical support in support of O&M activities;

6B.3 REMEDIAL ACTION ALTERNATIVE COST SUMMARIES

Tables 6B.3 and 6B.4 provide a cost breakdown of capital cost and O&M cost for each alternative without discounting and with a present value analysis, respectively. The costs have been escalated to July 2002 dollars. The present value analysis is a method to evaluate expenditures, either capital or O&M, which occur over different time periods. Present value calculations allows for cost comparisons of different remedial alternatives on the basis of a single cost figure for each alternative. This single number, referred to as present value, is the amount needed to be set-aside at an initial point in time (base year) to assure that funds will be available in the future as they are needed. This process involves four basic steps; (1) define the period of analysis, (2) calculate the cash outflow for each year, (3) select a discount rate (i.e. interest rate), and (4) calculate present value using standard economic formulas. The Luckey alternatives were evaluated using a 0-1,000 period of analysis and a 7% discount factor. The capital costs have not been discounted due to their relatively short implementation duration. The detailed cost estimates are included at the end of this appendix.

6B.4 BASIS OF COST ESTIMATE

Note: The section numbers listed below (i.e. 33.01 Land Use Controls) are based on the HTRW WBS and therefore are not sequentially numbered.

33.0 HTRW REMEDIAL ACTION (SOILS MEDIA)

33.01 Land Use Controls (Soils)

Provides for the development of a long term management plan and a site information database. The long term management plan would be developed to address administrative or legal measures to reduce or minimize exposure to contaminants left on site in Alternatives 2, 3, and 4. The site information database would be a central repository of information required to assess and monitor contaminants left on site.

33.02 ***Remedial Action Monitoring, Sampling, and Analysis (Soils)***Provides for all work during remedial action associated with air, water, sediment and soil sampling, monitoring, testing and analysis. Includes industrial hygiene/health physics (IH/HP) technicians and associated survey equipment required to monitor personnel and equipment, collection and analysis of samples, and the purchase of an onsite mobile laboratory.

An evaluation of available data indicates Radium-226 may effectively be used as a remedial surrogate for other radiological constituents of concern (COCs) at the Luckey Site. This conclusion is drawn considering that Radium-226 may be field screened using a 2x2, that significantly elevated concentrations of Thorium-230 and Uranium-238 would not remain if Radium-226 were removed above its cleanup level, and considering USACE experience at similar FUSRAP sites.

Periodic sampling of contaminated media would be conducted during Remedial Action activities in Alternatives 3, 4, 5, and 6 to monitor levels of contamination. A duration of 2-3 years is estimated for the completion of actual excavation, loading, consolidation, or treatment activities. Sampling during remedial action activities are performed by IH/HP technicians and analyzed in the onsite laboratory. After all excavation and loading activities have been completed, verification sampling and analysis by an offsite laboratory would be conducted prior to backfill of the site to confirm that cleanup criteria have been met.

33.03 Site Work (Soils)

Provides for the preparation of the site and related improvements. This includes clearing and grubbing a portion of the site, haul road construction, staging and loading areas, truck scales, and security fencing. The total area to be impacted is estimated to be

24 to 27 acres and 5 acres would require light clearing. Haul roads would be required in the undeveloped areas of the site and security fencing would be installed to prohibit access to controlled areas.

33.05 Surface Water Collection/Control (Soils)

Provides for the installation of sedimentation barriers including silt fence and hay bales. Based on the type of excavation, engineering controls will be constructed to prevent surface water from leaving the site without passing through erosion control structures such as a silt fence. Additionally, pumps and above-ground holding tanks will be used to collect and contain contact water that will be removed from excavations. Contact water will be slowly discharged to an existing contaminated low-lying area of the site or used for moisture conditioning soils prior to disposal. Since the majority of the rainfall occurs in the warmer months, most water requiring collection can be used for moisture conditioning soils.

33.08.01 Contaminated Soils Collection/Containment

Provides for excavation of contaminated soils. The total estimated volume of in situ soils to be excavated is 47,000 to 55,000 yds^3. An over-excavation factor of 1.2, a constructability factor of 1.1, and an expansion (swell) factor of 1.2 are applied to the in situ volume to calculate the ex situ volume of 75,000 to 88,000 yds^3. Soils would be excavated and consolidated onsite (Alternative 3), transported directly to an on site staging area (Alternative 4 and 5), or to the soil treatment facility assumed to be located on site (Alternative 6). The contaminated soils from the site would be excavated using an excavator with an adjusted output of 208 yds^3 per eight-hour day and would be loaded directly into 12 yd^3 dump trucks.

In Alternative 3, soils would be transported to the consolidation area (estimated to be approximately 85% of the total volume, 15% would remain in place under the cap). The soils would be spread in six-inch lifts and compacted.

In Alternatives 4, 5, and 6, soils would be transported to a staging area. A front-end loader would be located at the staging area to assist with loading operations. All equipment would be decontaminated prior to leaving the site. The depth of excavation below the existing grade varies from 0 ft. to 20 ft. in some areas. The areas of contamination below the groundwater table is small and minimal dewatering will be required. Any contact water encountered during excavation would be collected and used for conditioning soils.

33.08.05 Capping of Contaminated Soils

This item is applicable to Alternative 3. Provides for capping of contaminated soils. The total volume of in situ soils to be consolidated is 47,000 yds^3. An over-excavation factor of 1.2, a constructability factor of 1.1, and an expansion (swell) factor of 1.2 are applied to the in situ volume to calculate the ex situ volume of 75,000 yds^3. Soils would be excavated and consolidated at a location to be determined onsite. The cap footprint area will cover approximately 4 acres and could be located in one or more areas of the site. For estimating purposes, it was assumed that a 250 ft wide x 650 ft long x 25 ft high storage pile would be constructed with 1:5 side slopes.

A multi-layer cap approximately 13 ft thick would be constructed over the waste materials. A typical cap design for covering radiological contaminated soils was chosen for estimating as follows:

• Clay layer	36 inches
• Geomembrane	80 mils
• Geotextile	170 mils
• Drainage layer	12 inches
• Geotextile	170 mils
• Biointrusion layer	36 inches
• Graded filter layer	12 inches
• Soil cover	24 inches
• Riprap	36 inches

33.13 Physical Treatment (Soils)

Treatment of FUSRAP radioactive soils applies to Alternative 6 only. The treatment facility would be located on site. The soil washing process would include screening, classification of soils, soil washing, and dewatering. The process operation is designed to prevent any spread of contaminants to the environment. Appropriate site improvements would be provided and existing utilities (electrical, plant, air, potable water, sanitary sewer service, etc.) would be extended to the treatment facility. The unit cost for treatment is estimated at \$131/ yd^3, which includes all engineering design, plant facilities, process equipment, utility installations, materials and management to construct and dismantle the plant on the site. The unit cost also includes all costs for startup, testing, sampling, the operation and maintenance of the facility, and the treatment and disposal of all waste water generated.

The total ex situ volume of FUSRAP radioactive soils to be treated is 25,000 yd^3. The beryllium contaminated soils, mixed waste, and hazardous waste will not be considered for treatment. Beryllium impacted soils were excluded from treatment due to availability of disposal at a local facility at a much lower unit rate. Mixed waste and hazardous waste were excluded due to their low volumes and the complexities associated with treating multiple constituents. The term "*mixed waste,*" as used throughout this appendix, is defined as: *RCRA hazardous waste with radioactive residuals that are not NRC regulated*. This includes 1) RCRA hazardous wastes containing radioactive residuals at activities acceptable for disposal at a RCRA permitted disposal facility, and 2) RCRA hazardous waste containing radioactive residuals at activities requiring disposal at a RCRA disposal facility that is both permitted and licensed." The average soil mass reduction resulting from the soil washing process to an average concentration of 5 pCi/g is assumed to be 50% of the throughput (12,500 ex situ yd^3). The plant is assumed to process 20 tons each hour. The processing time for the 25,000 ex situ yd^3 is one year. The process equipment would treat the contaminated soil and would discharge soils into two separate piles, a clean stream of treated soil (12,500 yd^3) and a concentrated waste stream (12,500 yd^3). The clean stream would be used for backfill on site while the concentrated waste stream would be disposed of off site. Any wastewater generated during the soil washing process would be recycled, re-circulated and re-used. The only water requiring actual disposal is the wastewater retained at the end of the treatment process. This water would be transported to a local water treatment facility for treatment and disposal by the vendor.

As part of this alternative, a full-scale treatment demonstration would be conducted on the site soils to determine the effectiveness, implementability, and cost-effectiveness of treatment prior to processing all the contaminated site soils.

33.19 Transportation and Disposal (Soils)

Transportation and commercial disposal during remedial action provides for the shipment and final placement of contaminated soils at a third party commercial facility that charges a fee to accept waste depending on a variety of waste acceptance criteria. This item would be applicable to Alternatives 4, 5, and 6.

In Alternatives 4, 5, and 6, soils to be disposed would be transported to an approved and licensed disposal facility. The soils would be placed in intermodal containers having a 20-ton capacity (approximately 15 yd^3). A truck designed to carry the intermodal containers would transport to a rail transfer facility or directly to the disposal facility. Intermodal containers would be loaded on rail cars and be transported to a disposal facility such as US Ecology in Idaho.

The in-situ density was measured in soil samples collected during the RI. Using these values, the weight of impacted soil can be calculated from the in situ volume estimate. Care was taken in this conversion because the presence of water in the pore spaces can significantly affect the density. The conversion, 1.3 tons/ yd^3, is consistent with experience at other FUSRAP sites.

The Luckey site contains four waste streams that will have different transportation modes or disposal facilities requirements. The waste streams, transportation/disposal volumes, transport mode, transportation unit price, disposal facility, and disposal fee unit price are shown in Table 6B.2.

33.20 Site Restoration (Soils)

Site restoration during remedial action includes backfill, seeding, restoration of roads and fencing disturbed during site remediation.

Backfill and site restoration of the excavation would commence upon verification of the survey unit and would run concurrently with excavation activities. For Alternatives 3, 4, and 5, all of the fill material would be imported from off site and would be placed in 6 in. lifts of loose soils with a dozer. For Alternative 6, the soil treatment process is expected to generate 12,500 ex situ yd^3 of clean fill. The treated fill would be placed in the subsurface to within 1 ft of the final grade. Clean offsite material would be used for the last one foot of cover. The areas would be restored to their existing conditions (seeding, landscaping, asphalt resurfacing, fence replacement, etc.). Backfill would be compacted to obtain the required soil densities.

34.0 HTRW O&M (SOILS MEDIA)

34.01 Land Use Controls (Soils)

Land use controls of the soils applies to Alternative 2, 3, and 4. This item includes maintaining the long term management plan and a site information database. The long term management plan would be revised to address administrative or legal measures to reduce or minimize exposure to contaminants left on site. This would include future coordination with stakeholders. The site information database would be a central repository of information required to assess and monitor contaminants left on site. Land use control measures are conducted over a 1,000-year period of analysis due to the long life of metal contaminants present at the site.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) five-year reviews and report preparation are also included in Alternatives 2, 3, and 4. Five-year reviews are conducted over a 1,000-year period of analysis due to the long life of metal contaminants present at the site.

34.02 Monitoring, Sampling, and Analysis (Soils)

Monitoring, sampling, and analysis of the soils applies to Alternatives 2 and 4, and includes sample collection, shipping samples, and sample analysis to monitor plume migration and support property owner expansions.

34.08 Cap and/or Facility Maintenance (Soils)

Cap and facility maintenance of the soils applies to Alternative 2, 3, and 4. This includes maintenance of structures to restrict access and mitigate migration of contaminants left on site. Under Alternative 2, 3, and 4, limited maintenance would be provided to perform site inspections, prevent erosion and offsite migration, and repair fence lines. Alternative 3 also includes limited maintenance of the cap.

33.0 HTRW REMEDIAL ACTION (GROUNDWATER MEDIA)

33.01A Land Use Controls (Groundwater)

Land use control of groundwater applies to Alternatives 2, 7, 8, and 9. This provides for the development of a long term management plan and a site information database. The long term management plan would be developed to address administrative or legal measures to reduce or minimize exposure to contaminants left on site. The site information database would be a central repository of information required to assess and monitor contaminants left on site.

33.01B West Production Well Interim Options (Groundwater)

Interim options to address impacts to the west production well apply to Alternatives 7, 8, and 9. This provides an allowance to address potential corrective measures for the west production well.

33.02 Monitoring, Sampling, and Analysis (Groundwater)

Monitoring, sampling, and analysis of the groundwater media apply to Alternatives 2, 7, 8, and 9. This includes the installation of 12 monitoring wells for long term monitoring, sample collection, and analysis. It was assumed that wells would be installed to a depth of 20 to 60 ft. Costs are based on the assumptions that the well installations would be permanent and that stainless steel materials would be used to ensure longevity of the wells. Any investigative derived waste (IDW) generated would be disposed with the soil media offsite.

33.13 Treatment – Adsorption (Groundwater)

Ex situ treatment of groundwater applies to Alternative 8 only. The treatment facility would be located on site. The adsorption process includes the installation of 6 extraction wells (4 wells for the beryllium plume and 2 for the Uranium/Lead plume) to a depth of 25 feet. The groundwater would be pumped to a central adsorption treatment system. The approximate estimated flow rate from all wells is 12 gallons per minute (gpm) or 17,280 gallon per day (gpd). The beryllium contaminated groundwater would be treated with activated alumina for a period of 80 years. Uranium contaminated groundwater would be treated with activated carbon for a period of 10 years. Appropriate site improvements would be provided and existing utilities (electrical, potable water, sanitary sewer service, etc.) would be extended to the treatment facility. Treated water would be discharge to a local Publicly Owned Treatment Works (POTW) or to surface water. The site would be monitored for a period of 80 years.

33.14 Treatment – Electrokinetics (Groundwater)

In situ treatment of groundwater applies to Alternative 9 only. The electrical distribution equipment and electrolyte processing facility would be located onsite. The electrokinetic process includes the installation of 1300 electrodes. These electrodes will be charged with current to drive contaminants to the anodes. The anodes will consist of an electrolyte surrounded by a semi-permeable membrane. The electrolyte can be removed and replaced when necessary to clean the system. Appropriate site improvements would be provided and existing utilities would be extended for the treatment process. The contaminated electrolyte would be solidified and disposed at an offsite facility. The process would take 10 years, assuming that the source material has been removed by one of the soil remediation alternatives, after which the groundwater would be free of contaminants above cleanup levels. Monitoring would continue for an additional 30 years.

34.0 HTRW O&M (GROUNDWATER MEDIA)

34.01 Land Use Controls (Groundwater)

Land use controls of the groundwater applies to Alternatives 2, 7, 8, and 9. This item provides for the maintenance of the long term management plan and a site information database. The long term management plan would be revised to address administrative or legal measures to reduce or minimize exposure to contaminants left on site. This would include future coordination with stakeholders. The site information database would be a central repository of information required to assess and monitor contaminants left on site. Land use control measures are conducted over a 150-year period for Alternative 7, a 80-year period for Alternative 8, and a 40-year period for Alternative 9.

CERCLA five-year reviews and report preparation are also included in groundwater Alternative 2 and 7. Five-year reviews are conducted over a 1,000-year period for Alternative 2 and a 150-year period for Alternative 7.

34.02 Monitoring, Sampling, and Analysis (Groundwater)

Monitoring, sampling, and analysis of the groundwater apply to Alternatives 2, 7, 8, and 9. Provides for all work during post construction O&M associated with groundwater and treatment system effluent sampling and analysis. Includes sample collection, shipping samples, and sample analysis by offsite laboratory facilities.

34.13 Treatment System Operation and Maintenance (Groundwater)

Treatment system operation and maintenance applies to Alternatives 8 and 9 only. Provides for all work during post construction O&M. Includes labor to operate and maintain the extraction wells, electrodes, piping, treatment system, instrumentation and controls. The absorptive units and electrolyte would be monitored for contaminant breakthrough or saturation and media would be replaced as necessary. Under Alternative 8, an 80-year period of treatment is required to remediate contaminated groundwater. Under Alternative 9, a 10 year period would be required to remediate groundwater. Groundwater would be monitored for an additional 30 years.

34.14 Treatment System Replacement (Groundwater)

Treatment system replacement applies to Alternative 8 only. It provides for the complete replacement of the treatment system every 30 years and includes replacing the extraction wells, piping, treatment system, instrumentation and controls. Under Alternative 8, an 80-year period of treatment is required to remediate contaminated groundwater.

SUBCONTRACTOR, PRIME CONTRACTOR, AND OWNER MARKUPS

Subcontractor Markups

The following overhead markups have been applied to the Subcontractor's direct cost.

- Professional Labor - A 140% markup was applied to professional labor for fringe benefits, paid vacation, medical insurance, holidays, retirement accounts, etc.
- Craft Labor - A 30% markup was applied to craft labor for fringe benefits, paid vacation, medical insurance, holidays, retirement accounts, etc.
- Equipment and Materials - An 8% markup was applied to all equipment and materials for indirect labor.
- General Conditions - A 6% markup was applied to the direct project cost to account for all general conditions (i.e. Mobilization and Demobilization cost), including temporary facilities and utilities, telephone and communication, permits and licenses, subcontractor submittals, travel and per diem, personal protective equipment, insurance, bonds, and taxes.
- Profit - An 8% profit markup has been applied for the direct cost.

Prime Contractor Markups

The following Overhead Markups have been applied to the Prime Contractor's direct cost.

- General Conditions - A 3% markup was applied to the direct project cost to account for all general conditions (i.e. Mobilization and Demobilization cost), including temporary facilities and utilities, telephone and communication, permits and licenses, subcontractor submittals, travel and per diem, personal protective equipment, insurance, bonds, and taxes.
- Prime Markup on Sub - A 4% markup was applied to all subcontracted work. Indicates the percentage of profit a prime contractor will make on work completed by subcontractors. Prime contractors apply to subs to cover the administrative, management, and financial costs of overseeing and approving subcontractor's work. The prime profit on subcontractors is applied to the total subcontract project cost, including subcontractor's direct costs, overhead, and profit.

Owner Markups

<u>Contingency</u>

Contingencies are shown for both Design Contingencies and Construction Contingencies. EPA Guidance 540-R-00-002, July 2000, was used as a reference in developing design and construction contingencies. A design contingency of 15 to 25% is being applied due to the unknowns associated with the effectiveness of treatment technologies and the required O&M period due to the long half-life of Uranium. A construction contingency of 10 to15% is being applied due to the potential for increases in soil volumes that have been common at other FUSRAP sites. This would also include cost overruns, modifications, and change orders.

<u>Design and Technical Support</u>

Remedial design applies to capital cost and O&M cost and includes services to design the remedial action. Activities that are part of remedial design include pre-design collection and analysis of field data, engineering survey for design, treatability study (e.g., pilot-scale), and the various design components such as design analysis, plans, specifications, cost estimate, and schedule at the preliminary, intermediate, and final design phases including post RA documentation. Remedial Design has been included as a 4 to 12% markup of the total remedial action costs.

<u>Project Management</u>

Project management includes services that are not specific to remedial design, construction management, or technical support of O&M activities. Project management includes planning and reporting, community relations' support during construction or O&M, bid or contract administration, permitting (not already provided by the construction or O&M contractor), and legal services outside of land use controls (e.g., licensing). Project Management has been included as a 5 to 8% markup of the total remedial action costs.

Construction Management

Construction management includes services to manage construction or installation of the remedial action. Activities include reviews of submittals, design modifications, construction observation or oversight, engineering survey for construction, preparation of O&M manual, documentation of quality control/quality assurance, and record drawings. For most of the Luckey site alternatives, this will include a full-time site manager, field engineer, clerical, safety and health officer, and waste management coordinator. It also includes health physics, quality assurance, and engineering during construction. Construction Management has been included as a 10% markup of the total remedial action costs.

Program Management

USACE oversight cost includes Program Management, Project Management, Construction Management, Design Reviews, Quality Assurance, HP Support, Cooperative Agreements with Others, Engineering During Construction, etc. The cost was estimated by LRB to be approximately $1 million per year. Alternatives 3, 4, 5, and 6 include a Program Management cost of $1 million per year for the design, construction, and post-remediation phases of the work. In Alternatives 2, 7, 8, and 9, Program Management cost was included as a 15% markup of the total cost due to the long O&M phases required under these alternatives.

Table 6B.1. Summary of Remedial Alternative Implementation Timelines

Alternatives	Remedial Design (yrs)	Remedial Action (yrs)	Post RA Documentation (yrs)	O & M Period (yrs)
Soil Media Alternatives				
1. No Action	0	0	0	0
2. Limited Action	0.5	0	0	1,000
3. Consolidation and Capping	2	2	1	1,000
4. Excavation and Offsite Disposal ~ Industrial Land Use	1	1.7	1	1,000
5. Excavate and Offsite Disposal ~ Unrestricted Land Use	1	2.9	1	0
6. Excavation, Treatment, and Offsite Disposal ~ Unrestricted Land Use	2	3	1	0
Groundwater Media Alternatives				
7. Monitored Natural Attenuation ~ Unrestricted Land Use	0.5	0	0	150
8. Active Groundwater Treatment ~ Unrestricted Land Use	1	0.5	1	80
9. Electrokinetics ~ Unrestricted Land Use	1	1	1	40

Table 6B.2. Summary of Soil Media Waste Transportation and Disposal Information

Waste Stream	Transport & Disposal Volume	Transport Mode	Transport Unit Price	Disposal Facility	Disposal Fee
Beryllium & FUSRAP Radioactive Waste (Alt 4)	48,200 yd^3 62,700 tons	Intermodal and Rail	$150/ton	US Ecology, Idaho	$72/ton
Mixed Waste (Alt 4)	1,100 yd^3 1,450 tons	Intermodal Only	$152/ton	US Ecology, Idaho	$98/ yd^3
Beryllium Only Soils (Alt 5 & 6)	56,150 yd^3 73,000 tons	Intermodal Only	$15/ton	Envirosource, Ohio	$50/ton
Beryllium & FUSRAP Radioactive Waste (Alt 5)	25,350 yd^3 32,950 tons	Intermodal and Rail	$150/ton	US Ecology, Idaho	$72/ yd^3
Beryllium & FUSRAP Radioactive Waste (Alt 6)	12,675 yd^3 16,500 tons	Intermodal and Rail	$150/ton	US Ecology, Idaho	$72/ yd^3
Mixed Waste (Alt 5 & 6)	3,950 yd^3 5,150 tons	Intermodal and Rail	$150/ton	US Ecology, Idaho	$98/ yd^3
Hazardous Waste (Alt 5 & 6)	2,300 yd^3 3,000 tons	Intermodal Only	$152/ton	RCRA Facility	$160/ yd^3

Table 6B.3. Luckey Site Remedial Alternatives Cost Summary (Non Discounted Cost in Thousands, Fiscal Year 2002 Dollars)

HTRW WBS Number	Activity	Soil Media Alternatives					Groundwater Media Alternatives		
		Alt. 2 Limited Action	Alt. 3 Consolidation & Capping	Alt. 4 Excavation & Disposal ~ Industrial Land Use	Alt. 5 Excavation & Disposal ~ Unrestricted Land Use	Alt. 6 Excavation, Treatment & Disposal ~ Unrestricted Land Use	Alt. 7 Monitored Natural Attenuation ~ Unrestricted Land Use	Alt. 8 Active Ground-water Treatment ~ Unrestricted Land Use	Alt. 9 Electro-kinetics ~ Unrestricted Land Use
33	**HTRW REMEDIAL ACTION**	**292**	**17,246**	**28,853**	**36,480**	**42,779**	**373**	**1,245**	**4,056**
33.01A	Land Use Controls	201	201	201	0	0	201	225	217
33.01B	West Production Well	0	0	0	0	0	75	75	75
33.02	Monitoring, Sampling, & Analysis	91	3,827	3,190	5,203	3,408	97	213	640
33.03	Site Work	0	82	321	430	287	0	0	0
33.05	Surface Water Collection/Control	0	136	132	230	243	0	0	0
33.08	Solids Collection/Containment	0	11,392	2,192	4,225	4,189	0	0	0
33.13	Physical Treatment	0	0	0	0	13,186	0	732	3,124
33.19	Transportation & Disposal	0	0	21,665	24,280	19,412	0	0	0
33.20	Site Restoration	0	1,608	1,152	2,112	2,054	0	0	0
34	**HTRW O&M[1]**	**60,457**	**28,237**	**29,260**	**0**	**0**	**3,667**	**11,720**	**8,055**
34.01	Land Use Controls	17,689	16,416	15,600	0	0	2,834	1,231	551
34.02	Monitoring, Sampling, & Analysis	31,427	0	9,644	0	0	833	1,383	690
34.08	Cap and/or Facility Maintenance	11,341	11,821	4,016	0	0	0	0	0
34.13	Treatment System O&M and Replacement	0	0	0	0	0	0	9,106	6,814
	TOTAL RA AND O&M TOTAL[2]	**60,749**	**45,483**	**58,113**	**36,480**	**42,779**	**4,040**	**12,965**	**12,111**

[1] Costs provided have not been discounted.
[2] Includes project overhead, profit, and owner cost

Table 6B.4. Luckey Site Remedial Alternatives Cost Summary (Discounted Cost in Thousands, Fiscal Year 2002 Dollars)

HTRW WBS Number	Activity	Soil Media Alternatives					Groundwater Media Alternatives		
		Alt. 2 Limited Action	Alt. 3 Consolidation & Capping	Alt. 4 Excavation & Disposal ~ Industrial Land Use	Alt. 5 Excavation & Disposal ~ Unrestricted Land Use	Alt. 6 Excavation, Treatment & Disposal ~ Unrestricted Land Use	Alt. 7 Monitored Natural Attenuation ~ Unrestricted Land Use	Alt. 8 Active Ground-water Treatment ~ Unrestricted Land Use	Alt. 9 Electro-kinetics ~ Unrestricted Land Use
33	**HTRW REMEDIAL ACTION**	**292**	**17,246**	**28,853**	**36,480**	**42,779**	**373**	**1,245**	**4,056**
33.01A	Land Use Controls	201	201	201	0	0	201	225	217
33.01B	West Production Well	0	0	0	0	0	75	75	75
33.02	Monitoring, Sampling, & Analysis	91	3,827	3,190	5,203	3,408	97	213	640
33.03	Site Work	0	82	321	430	287	0	0	0
33.05	Surface Water Collection/Control	0	136	132	230	243	0	0	0
33.08	Solids Collection/Containment	0	11,392	2,192	4,225	4,189	0	0	0
33.13	Physical Treatment	0	0	0	0	13,186	0	732	3,124
33.19	Transportation & Disposal	0	0	21,665	24,280	19,412	0	0	0
33.20	Site Restoration	0	1,608	1,152	2,112	2,054	0	0	0
34	**HTRW O&M[1]**	**854**	**396**	**410**	**0**	**0**	**460**	**2,386**	**5,274**
34.01	Land Use Controls	243	227	215	0	0	259	219	184
34.02	Monitoring, Sampling, & Analysis	449	0	138	0	0	201	396	304
34.08	Cap and/or Facility Maintenance	162	169	57	0	0	0	0	0
34.13	Treatment System O&M and Replacement	0	0	0	0	0	0	1,771	4,786
	TOTAL RA AND O&M TOTAL[2]	**1,146**	**17,642**	**29,263**	**36,480**	**42,779**	**833**	**3,631**	**9,330**

[1] Costs provided have been calculated for present value using a discount factor of 7%.
[2] Includes project overhead, profit, and owner cost

Alternative 2 - Limited Action

Project No. TERC DACW27-97-D-0015

Designed By:

Science Applications International Corporation

Estimated By:

Mike Poligone

Prepared By: Mike Poligone
Preparation Date: 10/10/2002

Effective Date of Pricing: 10/10/2002
Est Construction Time: 0 Days

CostLink CM Report	Page Number

PROJECT DESCRIPTION: ALTERNATIVE 2 - LIMITED ACTION

This alternative involves implementing limited actions for the contaminated soil and groundwater media such as a long-term management plan, land use controls, limited maintenance, and environmental monitoring. (See the Luckey site FS for more details about the Luckey site and this proposed alternative).

PROJECT BREAKDOWN:

The Hazardous, Toxic, Radioactive Waste Work Breakdown Structure (HTRW WBS), February 1996, was used as the basis for organizing the cost estimates for the Luckey site alternatives. The estimate uses a 2 digit number at each level. The 2 digit numbers for the first 3 title levels are taken from the HTRW Remedial Action Work Breakdown Structure. The 2 digit numbers for the remaining title levels are user defined.

LEVEL 1 - WBS Level 1 (Account)- Luckey Alternative 2
LEVEL 2 - WBS Level 2 (System) - Land Use Controls
LEVEL 3 - WBS Level 3 (Subsystem) - Site Database
LEVEL 4 - User Defined (Assembly Category or Other)
LEVEL 5 - User Defined (Assembly or Other)

The Level 2 WBS elements for this estimate are as follows:

33. HTRW REMEDIAL ACTION
 33.01 Land Use Controls

34. HTRW SOILS AND GW O&M
 34.01 Land Use Controls
 34.02 Soil Monitoring, Sampling, and Analysis
 34.02 GW Monitoring, Sampling, and Analysis
 34.08 Facility Maintenance

LUCKEY SITE KEY PARAMETERS:

Total Volume of In Situ Soils = 55,400 cy
Site Area to be Maintained = 24 acres
Total Samples per Year = 20
Total Monitoring Wells = 12

SCHEDULE SUMMARY:

Estimated Project duration: 0.5 yrs.

Engineering Design	0.5 yrs.
Excavation/Disposal of soils/materials	0 yrs.
Post-Remediation Report and As-builts	0 yrs.

Estimated Post-RA Soil and GW sampling: 1,000 yrs.

PRODUCTIVITY:

Not applicable to this alternative.

ESCALATION:

The base year of comparison will be CY2002 and unit cost will be escalated to July 2002. Cost data will be escalated using the Price Escalation Indices (Annual Rates in Percentages) for Budget Authority in the memorandum dated 3 January, 2002 from the Comptroller of the Under Secretary of Defense, Subject: Revised Inflation Guidance, and the Department of the Army, DACS-PCB MEMO 2000-002 of Feb 2002, Subject: Revised Inflation Indices for FY02 President's Budget.

OVERHEAD COSTS

The following overhead markups have been applied to the Subcontractor's direct cost.

Professional Labor - A 140% markup was applied to professional labor for fringe benefits, paid vacation, medical insurance, holidays, retirement accounts, etc.

Craft Labor - A 30% markup was applied to craft labor for fringe benefits, paid vacation, medical insurance, holidays, retirement accounts, etc.

Equipment and Materials - A 8% markup was applied to all equipment and materials for indirect labor.

General Conditions - A 6% markup was applied to the direct project cost to account for all general conditions (i.e. Mobilization and Demobilization cost), including temporary facilities and utilities, telephone and communication, permits and licenses, subcontractor submittals, travel and per diem, personal protective equipment, insurance, bonds, and taxes.

Profit - A 8% profit markup has been applied for the direct cost.

The following Overhead Markups have been applied to the Prime Contractor's direct cost.

General Conditions - A 3% markup was applied to the direct project cost to account for all general conditions (i.e. Mobilization and Demobilization cost), including temporary facilities and utilities, telephone and communication, permits and licenses, subcontractor submittals, travel and per diem, personal protective equipment, insurance, bonds, and taxes.

Prime Markup on Sub - A 4% markup was applied to all subcontracted work. Indicates the percentage of profit a prime contractor will make on work completed by subcontractors. Prime contractors apply to subs to cover the administrative, management, and financial costs of overseeing and approving subcontractor's work. The prime profit on subcontractors is applied to the total subcontract project cost, including subcontractor's direct costs, overhead, and profit.

CONTINGENCY:

Contingencies are shown for both Design Contingencies and Construction Contingencies. EPA Guidance 540-R-00-002, July 2000 was used as a reference in developing design and construction contingencies.

A design contingency of 15% is being applied due to the proven implementation of these technologies. Land use controls, limited maintenance, and environmental monitoring have been successfully implemented at other superfund sites.

A construction contingency of 10% is being applied to account for difficulties associated with implementing land use controls.

DESIGN AND TECHNICAL SUPPORT COSTS:

Remedial design applies to capital cost and O&M cost and includes services to design the remedial action. Activities that are part of remedial design include pre-design collection and analysis of field data, engineering survey for design, treatability study (e.g., pilot-scale), and the various design components such as design analysis, plans, specifications, cost estimate, and schedule at the preliminary, intermediate, and final design phases including post RA documentation. Remedial Design has been included as a 4% markup of the total remedial action costs.

PROJECT MANAGEMENT

Project management includes services that are not specific to remedial design, construction management, or technical support of O&M activities. Project management includes planning and reporting, community relations' support during construction or O&M, bid or contract administration, permitting (not already provided by the construction or O&M contractor), and legal services outside of land use controls (e.g., licensing). Project Management has been included as a 5% markup of the total remedial action costs.

CONSTRUCTION MANAGEMENT

Construction management includes services to manage construction or installation of the remedial action. Activities include review of submittals, design modifications, construction observation or oversight, engineering survey for construction, preparation of O&M manual, documentation of quality control/quality assurance, and record drawings. It also includes HP, QA, and engineering during construction. Construction Management has been included as a 10% markup of the total remedial action costs.

OWNER COST

USACE Program Management cost will be included as a 15% markup of the total cost.

TERC DACW27-97-D-0015 Alternative 2 - Limited Action

	Quantity		Unit Cost	Total Cost	
33 HTRW Remedial Action					
01 Land Use Controls					
0801 Long Term Management Plan and Site Database				111,892	
0802 Land Use Controls				88,750	
SUBTOTAL Land Use Controls	24	ACR	8,360.07	200,642	69%
02 Monitoring,Sampling,Testing, & Analysis					
04 Monitoring Wells	12	EA	7,584.14	91,010	
SUBTOTAL Monitoring,Sampling,Testing, & Analysis	24	ACR	3,792.07	91,010	31%
SUBTOTAL HTRW Remedial Action	24	ACR	12,152.14	291,651	0%
34 HTRW Soils and Groundwater O&M					
01 Land Use Controls					
0801 Long Term Management Plan and Site Database	1,000	YR	12,407.71	12,407,711	
91 Reports	1,000	YR	5,281.19	5,281,186	
SUBTOTAL Land Use Controls	1,000	YR	17,688.90	17,688,897	29%
02 Soil Monitoring/Sampling/Analysis					
08 Sampling Radioactive Media	1,000	YR	6,016.69	6,016,689	
09 Chemical/Rad Lab Analysis	1,000	YR	17,566.27	17,566,271	
SUBTOTAL Soil Monitoring/Sampling/Analysis	1,000	YR	23,582.96	23,582,960	39%
02 GW Monitoring/Sampling/Analysis					
04 Monitoring Wells	1,000	YR	2,080.54	2,080,544	
08 Sampling Media	1,000	YR	3,812.03	3,812,031	
09 Chemical/Rad Lab Analysis	1,000	YR	1,951.12	1,951,125	
SUBTOTAL GW Monitoring/Sampling/Analysis	1,000	YR	7,843.70	7,843,699	13%
08 Facility Maintenance					
01 Site Inspection	1,000	YR	9,226.69	9,226,694	
01 Earthwork	1,000	YR	201.24	201,237	
03 Permanent Features	1,000	YR	871.46	871,462	
04 Revegetation And Planting	1,000	YR	1,041.85	1,041,848	
SUBTOTAL Facility Maintenance	1,000	YR	11,341.24	11,341,242	19%
SUBTOTAL HTRW Soils and Groundwater O&M	1,000	EA	60,456.80	60,456,799	100%
Alternative 2 - Limited Action	**1,000**	**YR**	**60,748.45**	**60,748,450**	

TERC DACW27-97-D-0015 Alternative 2 - Limited Action

33 HTRW Remedial Action

HTRW = Hazardous, Toxic, and Radioactive Waste

01 Land Use Controls

0801 Long Term Management Plan and Site Database

Develop Long Term Management Plan to address administrative or legal measures to reduce or minimize potential exposures to contaminants left on site in soils and groundwater.

Land Use Control Plan per USACE Real Estate Group

a) Text (60 hrs.)
b) Drawings (30 hrs.)
c) GIS/Surveying (159 hrs.)
d) Stakeholder Coordination (189 hrs) - (three, ½ day meetings; (4 Corps personnel w/2 hrs prep.); meeting notes (3); letters (8), memos etc. (4); internal meeting (4 with 3 persons and meeting notes)
e) Internal Technical Review (40 hrs.)
f) Approval Coordination (53 hrs.) (memo package; responses to comments; conf. calls (3)

Total = 531 hrs @ Senior PM Rate $125.81 = 66,805, say $67,000

Site Information Database - Assume 200 hrs to develop a site database. Use Senior Engineer Rate.

		Quantity		Unit Cost	Total Cost
0001011	Long Term Management Plan	1.00	LS	67,000.00	67,000
33220104	Site Database	200.00	HR	105.20	21,041
SUBTOTAL Long Term Management Plan and Site Da		**1**	**LS**		**88,041**

		Quantity		Unit Cost	Total Cost

0802 Land Use Controls

Implement Land Use Controls per USACE Real Estate Group

a) Coordinate with various local, state, and federal agencies to implement controls. Examples of controls requiring coordination are zoning, master plans, ordinances, environmental lists. Under each alternative 5-6 controls will be required. (192 hrs.)
b) Deed notice - Draft and record. (28 hrs.)
c) Acquire real estate interest (REI), e.g., negative easement.
(1) Research and draft real estate interest. (32 hrs.)
(2) Legal descriptions, surveying, parcel drawings. (64 hrs.)
(3) Title work (8 hrs.)
(4) Coordinate within District (8 hrs.)
(5) Coordinate w/owners (2 out of office meetings w/preparation and meeting notes, (3) Corps personnel. (68 hrs.)
(6) Subtotal = 180 hrs.
d) Approval of non-standard REI (memo package; responses to comments; conf. calls (3)); (59 hrs.)
e) SOW for appraisal. (12 hrs)
f) Appraisal of real estate interest. (64 hrs.)
g) Execute and record real estate interest
(1) Update title (5 hrs.)
(2) Update appraisal (10 hrs.)
(3) Closing and recording (12 hrs.)
(4) Subtotal = 27hrs.

Total = 562 hrs. @ Senior PM Rate $125.81 = 70,705, say $71,000

Note: This estimate is based upon no condemnation of a real estate interest. The costs do not include the fair market value of the real estate interest to be acquired.

		Quantity		Unit Cost	Total Cost
0001012	Implement Land Use Controls	1.00	LS	71,000.00	71,000
SUBTOTAL Land Use Controls		**1**	**EA**		**71,000**
SUBTOTAL Land Use Controls		**24**	**ACR**	**6,626.69**	**159,041**

02 Monitoring,Sampling,Testing, & Analysis

04 Monitoring Wells

5 Monitoring Well Installation

Includes installation of 10 monitoring wells at a depth of 20 ft and 2 wells at a depth of 60 ft to monitor the natural attenuation of GW. Assume depth to GW is 8 ft.

		Quantity		Unit Cost	Total Cost
33010101	Standby Time	12.00	HR	427.22	5,127
33010101	Mob/Demob of drilling crew	1.00	LS	3,417.78	3,418
33020303	Organic Vapor Analyzer rental, per Day	4.00	DAY	133.79	535
33170808	Decon. materials for Rig, Augers, Screen (Rental equip.)	4.00	DAY	128.71	515
33220109	Field Geologist	64.00	HR	60.56	3,876
33230121	Well casing, 2" stainless steel (10-50 ft per well)	200.00	LF	31.31	6,261
33230221	Well Screen, 2" stainless steel (10 ft per well)	120.00	LF	26.53	3,184
33230311	Well plug, 2" stainless steel	12.00	EA	83.25	999
33231101	Hollow Stem Auger, 8" Dia Borehole, Depth < 100 ft	332.00	LF	46.15	15,321
33231401	Filter Pack, 2'' Screen	144.00	LF	13.28	1,912
33231504	Surface Pad, Concrete 2'x2'x4"	12.00	EA	151.28	1,815
33231811	Portland Cement Grout	84.00	LF	1.34	112
33232101	Bentonite Seal, 2" Well	12.00	EA	49.11	589

		Quantity		Unit Cost	Total Cost
33232301	5' Guard Post, Cast Iron, Concrete Fill	48.00	EA	74.28	3,565
SUBTOTAL Monitoring Well Installation		**12**	**EA**	**3,935.81**	**47,230**
90 Well Installation Report					
33220109	Field Geologist	24.00	HR	60.56	1,453
33220114	Word Processing	4.00	HR	35.09	140
33220115	Field Draftsmen	8.00	HR	54.37	435
SUBTOTAL Well Installation Report		**1**	**LS**		**2,029**
SUBTOTAL Monitoring Wells		**12**	**EA**	**4,104.87**	**49,258**
SUBTOTAL Monitoring,Sampling,Testing, & Analysis		**24**	**ACR**	**2,052.43**	**49,258**
SUBTOTAL HTRW Remedial Action		**24**	**ACR**	**8,679.12**	**208,299**

34 HTRW Soils and Groundwater O&M

01 Land Use Controls

0801 Long Term Management Plan and Site Database

Maintain O&M plan to address administrative or legal measures to reduce or minimize potential exposure to contaminants left on site.

Long Term Management Plan - Assume 40 hrs/yr for 1,000 yrs = 40,000 hrs to coordinate with stakeholders and make revisions to plan. Use Senior PM Rate.

Site Information Database - Assume 16 hrs/yr for 1,000 yrs = 16,000 hrs to update site database. Use Senior Engineer Rate.

		Quantity		Unit Cost	Total Cost
33220101	Long Term Management Plan	40,000.00	HR	125.81	5,032,358
33220104	Site Database	16,000.00	HR	105.20	1,683,241
SUBTOTAL Long Term Management Plan and Site Da		**1,000**	**YR**	**6,715.60**	**6,715,598**
91 Reports					
15 Five-Year Reviews (Years 0-1,000 = 200 events)					
33220102	Project Manager (60 hours/report x 200 events)	12,000.00	HR	105.39	1,264,738
33220109	Field Geologist (120 hours/report x 200 events)	24,000.00	HR	60.56	1,453,328
33220114	Word Processing (20 hrs/report x 200 events)	4,000.00	HR	35.09	140,343
SUBTOTAL Five-Year Reviews (Years 0-1,000 = 200 eve		**1,000**	**YR**	**2,858.41**	**2,858,410**
SUBTOTAL Reports		**1,000**	**YR**	**2,858.41**	**2,858,410**
SUBTOTAL Land Use Controls		**1,000**	**YR**	**9,574.01**	**9,574,008**

02 Soil Monitoring/Sampling/Analysis

08 Sampling Radioactive Media

Assume 10 soil samples taken per year for 1000 years to support property owner.

Duration is 2 days per year (5 samples per event). Samples will be analyzed for Uranium, Thorium, and Radium, ICPAES metals and GFAA metals.

Equipment pricing base on Vendor Quote (SEC 2/2001;Rates escalated to 2/2002)- Assume weekly rental and that the weekly rental is 33% of the monthly rental.

1. Model 2929 dual channel scaler (1 @ $122/wk =$122/wk)
2. Alpha Survey Instrument, 43-5 or equal (1 @ 70/wk = $70/wk)
3. Ratemeter w/GM pancake, 44-9 or equal (1 @ $65/wk = $65/wk)
4. Micro R Meter, Model 19 or equal (1 @ $45/wk = $45/wk)

Total = $302/month.

10 Soil Sampling (Years 0-1,000)

		Quantity		Unit Cost	Total Cost
33020401	Disposable Materials per Sample (gloves,jars,tape,ice,isop) (10 samples x 1,000 years)	10,000.00	EA	9.96	99,572
33020402	Decon. Materials per Sample (deion. water,soap)(10 samples x 1,000 years)	10,000.00	EA	8.96	89,576
33021498	Radiation Protection Technicians (2 ea x 2 days x 1,000 years)	32,000.00	HR	53.34	1,706,833
Vendor Quote	IH/HP Monitoring Equipment (1 wk/year x 1,000 years)	1,000.00	WK	373.39	373,388
33022028	250 ml, clear, w/septa, wide sample jars (10 x 1,000 years)	10,000.00	EA	72.05	720,503
33022034	Chain of Custody Seals (pkg of 5) (2 packs x 1,000 years)	2,000.00	EA	2.28	4,570
33022046	60 Quart Ice Chest (2 ea x 1,000 years)	2,000.00	EA	76.59	153,188
33022063	Overnite Delivery to Lab (21-50 lb) (2 ea x 1,000 years)	2,000.00	EA	54.43	108,867
SUBTOTAL Soil Sampling (Years 0-1,000)		**1,000**	**YR**	**3,256.50**	**3,256,497**
SUBTOTAL Sampling Radioactive Media		**1,000**	**YR**	**3,256.50**	**3,256,497**

09 Chemical/Rad Lab Analysis

Assume 10 soil samples taken per year for 1000 years to support property owner.

Samples will be analyzed for radionuclides, beryllium, and lead.

10 Soil Analysis (Years 0 - 1,000)

		Quantity		Unit Cost	Total Cost
33022036	Documentation Package for QA, verif,data (1/event)	1,000.00	EA	139.80	139,804
33022250	Radium 226 (10 samples/event x 1000 events)	10,000.00	EA	112.29	1,122,946
ENGR EST	Iso-Thorium (10 samples/event x 1,000 events)	10,000.00	EA	162.28	1,622,754
33022253	Total Uranium (10 samples/event x 1,000 events)	10,000.00	EA	155.78	1,557,844
ENGR EST	Iso-Uranium (10 samples/event x 1,000 events)	10,000.00	EA	162.28	1,622,754
33022288	Gross Alpha/Beta (10 samples/event x 1,000 events)	10,000.00	EA	84.51	845,130
ENGREST	GFAA Metals (10 Samples/event x 1,000 events)	10,000.00	EA	116.84	1,168,383
ENGREST	ICPAES Metals (10 Samples/event x 1,000 events)	10,000.00	EA	142.80	1,428,024
SUBTOTAL Soil Analysis (Years 0 - 1,000)		**1,000**	**YR**	**9,507.64**	**9,507,638**

		Quantity		Unit Cost	Total Cost
SUBTOTAL Chemical/Rad Lab Analysis		**1,000**	**YR**	**9,507.64**	**9,507,638**
SUBTOTAL Soil Monitoring/Sampling/Analysis		**1,000**	**YR**	**12,764.13**	**12,764,134**

02 GW Monitoring/Sampling/Analysis

There will be a network of 12 monitoring wells to monitor the effectiveness of the treatment system. Eight wells will be used to monitor Be contaminant plumes and four wells will be used to monitor U/Lead contaminant plumes for an anticipated 1,000 years.

04 Monitoring Wells

Assume 10 wells to a depth of 20 ft and 2 wells to a depth of 60 ft to monitor Be. They will be replaced every 50 years over 1,000 yr period = 19 events. Use $50,536/well from WBS 33 02 05 for the cost to owner unit cost.

Assume 12 wells will be abandon every 50 years over 1,000 yr period = 20 events. (20 events x 12 wells/event = 240 wells)

Assume 20 sets of reports.

		Quantity		Unit Cost	Total Cost
5 Monitoring Well Replacement					
SEENOTE	Replace 12 wells every 50 years over 1,000 years	19.00	EVT	50,536.00	960,184
SUBTOTAL Monitoring Well Replacement		**1,000**	**YR**	**960.18**	**960,184**
15 Well Abandonment of Old Wells					
015902000150	Hyd. Excavator, 1 C.Y. (2 hrs/well x 240 wells)	480.00	HR	87.08	41,798
33231822	Abandonment of 2" Wells (200 wells @ 20 ft & 40 wells @ 60 ft)	6,400.00	LF	22.87	146,343
SUBTOTAL Well Abandonment of Old Wells		**1,000**	**YR**	**188.14**	**188,140**
90 Well Abandonment Report					
33220109	Field Geologist (24 hr/report x 20 events)	480.00	HR	60.56	29,067
33220114	Word Processing (4 hr/report x 20 events)	80.00	HR	35.09	2,807
33220115	Field Draftsmen (8 hr/report x 20 events)	160.00	HR	54.37	8,700
SUBTOTAL Well Abandonment Report		**1,000**	**YR**	**40.57**	**40,573**
SUBTOTAL Monitoring Wells		**1,000**	**YR**	**1,188.90**	**1,188,898**

08 Sampling Media

Groundwater will be monitored every year for the first 5 years and every five years for years 5-1,000.

		Quantity		Unit Cost	Total Cost

10 Groundwater Sampling (Years 0-5 = 5 events)

Duration is 4 days per year (3 wells/day and 12 wells total). Samples will be taken at each event for a total of 5 events (Years 0,1,2,3,4). Samples will include 4 samples of Uranium and Gross Alpha/Beta each per year; 8 ICPAES metals and GFAA metals each per year; and 12 water quality. The following field measurements will be taken onsite: Dissolved oxygen, Eh, pH, turbidity, temperature, and conductivity. Assume purge water will be returned to the ground upon verification of a clean sample. Approximately 24 samples per event (4 Rad, 8 metals, 12 water quality).

Equipment pricing base on Vendor Quote (SEC 2/2001;Rates escalated to 2/2002)- Assume weekly rental and that the weekly rental is 33% of the monthly rental.

1. Model 2929 dual channel scaler (1 @ $122/wk =$122/wk)
2. Alpha Survey Instrument, 43-5 or equal (1 @ 70/wk = $70/wk)
3. Ratemeter w/GM pancake, 44-9 or equal (1 @ $65/wk = $65/wk)
4. Micro R Meter, Model 19 or equal (1 @ $45/wk = $45/wk)

Total = $302/month.

		Quantity		Unit Cost	Total Cost
33020401	Disposable Materials per Sample (gloves,jars,tape,ice,isop) (24 samples x 5 events)	120.00	EA	9.96	1,195
33020402	Decon. Materials per Sample (deion. water,soap)(24 samples x 5 events)	120.00	EA	8.96	1,075
33020570	Water Quality Indicator (1 wk/ev x 5 events)	5.00	WK	66.90	335
33020573	Water Level Indicator (1 wk/ev x 5 events)	5.00	WK	36.24	181
33021498	Radiation Protection Technicians (4 days x 5 events)	160.00	HR	53.34	8,534
Vendor Quote	IH/HP Monitoring Equipment (1 wk/ev x 5 events)	5.00	WK	373.39	1,867
33022028	250 ml, clear, w/septa, wide sample jars (24 x 5 events)	120.00	EA	72.05	8,646
33022034	Chain of Custody Seals (pkg of 5) (5 packs x 5 events)	25.00	EA	2.28	57
33022046	60 Quart Ice Chest (3 ea x 5 events)	15.00	EA	76.59	1,149
33022063	Overnite Delivery to Lab (21-50 lb) (3 ea x 5 events)	15.00	EA	54.43	817
33190401	55-gal. drum for purging (3/well x 12 wells x 5 events)	180.00	EA	84.38	15,189
33220109	Field Geologist (4 days x 5 events)	160.00	HR	60.56	9,689
33230507	2" Submersible Pump Rental (1 wk/ev x 5 events)	5.00	WK	265.28	1,326
33232407	Disposable Bailer, Poly,1.5" out dia x 36" (24 ea x 5 events)	120.00	EA	11.62	1,394
SUBTOTAL Groundwater Sampling (Years 0-5 = 5 event		**5**	**YR**	**10,290.73**	**51,454**

10 Groundwater Sampling (Years 5-1,000 = 200 events)

Duration is 4 days per year (3 wells/day and 12 wells total). Samples will be taken at each event for a total of 6 events. Samples will include 4 samples of Uranium and Gross Alpha/Beta each per year; 8 ICPAES metals and GFAA metals each per year; and 12 water quality. The following field measurements will be taken onsite: Dissolved oxygen, Eh, pH, turbidity, temperature, and conductivity. Assume purge water will be returned to the ground upon verification of a clean sample. Approximately 24 samples per event (4 Rad, 8 metals, 12 water quality).

Equipment pricing base on Vendor Quote (SEC 2/2001;Rates escalated to 2/2002)- Assume weekly rental and that the weekly rental is 33% of the monthly rental.

1. Model 2929 dual channel scaler (1 @ $122/wk =$122/wk)
2. Alpha Survey Instrument, 43-5 or equal (1 @ 70/wk = $70/wk)
3. Ratemeter w/GM pancake, 44-9 or equal (1 @ $65/wk = $65/wk)
4. Micro R Meter, Model 19 or equal (1 @ $45/wk = $45/wk)

Total = $302/month.

		Quantity		Unit Cost	Total Cost
33020401	Disposable Materials per Sample (gloves,jars,tape,ice,isop) (24 samples x 200 events)	144.00	EA	9.96	1,434
33020402	Decon. Materials per Sample (deion. water,soap)(24 samples x 200 events)	4,800.00	EA	8.96	42,996
33020570	Water Quality Indicator (1 wk/ev x 200 events)	200.00	WK	66.90	13,380
33020573	Water Level Indicator (1 wk/ev x 200 events)	200.00	WK	36.24	7,248
33021498	Radiation Protection Technicians (4 days x 200 events)	6,400.00	HR	53.34	341,367
Vendor Quote	IH/HP Monitoring Equipment (1 wk/ev x 200 events)	200.00	WK	373.39	74,678
33022028	250 ml, clear, w/septa, wide sample jars (24 x 200 events)	4,800.00	EA	72.05	345,841
33022034	Chain of Custody Seals (pkg of 5) (5 packs x 200 events)	1,000.00	EA	2.28	2,285
33022046	60 Quart Ice Chest (3 ea x 200 events)	600.00	EA	76.59	45,956
33022063	Overnite Delivery to Lab (21-50 lb) (3 ea x 200 events)	600.00	EA	54.43	32,660
33190401	55-gal. drum for purging (3/well x 12 wells x 200 events)	7,200.00	EA	84.38	607,559
33220109	Field Geologist (4 days x 200 events)	6,400.00	HR	60.56	387,554
33230507	2" Submersible Pump Rental (1 wk/ev x 200 events)	200.00	WK	265.28	53,056
33232407	Disposable Bailer, Poly,1.5" out dia x 36" (24 ea x 200 events)	4,800.00	EA	11.62	55,771
	SUBTOTAL Groundwater Sampling (Years 5-1,000 = 200 (	**995**	**YR**	**2,021.89**	**2,011,785**

	Quantity		Unit Cost	Total Cost
SUBTOTAL Sampling Media	**1,000**	**YR**	**2,063.24**	**2,063,239**

09 Chemical/Rad Lab Analysis

Groundwater will be monitored every year for the first 5 years and every five years for years 5-1,000.

10 Groundwater Analysis (Years 0-5 = 5 events)

		Quantity		Unit Cost	Total Cost
33022036	Documentation Package for QA, verif,data (1/event)	5.00	EA	139.80	699
33022253	Total Uranium (4 samples/event x 5 events)	20.00	EA	155.78	3,116
ENGR EST	Iso-Uranium (4 samples/event x 5 events)	20.00	EA	162.28	3,246
33022288	Gross Alpha/Beta (4 samples/event x 5 events)	20.00	EA	84.51	1,690
ENGREST	Water Quality (12/event x 5 events)	60.00	EA	149.29	8,958
ENGREST	GFAA Metals (4 Samples/event x 5 events)	20.00	EA	116.84	2,337
ENGREST	ICPAES Metals (8 Samples/event x 5 events)	40.00	EA	142.80	5,712
	SUBTOTAL Groundwater Analysis (Years 0-5 = 5 events)	**5**	**YR**	**5,151.39**	**25,757**

10 Groundwater Analysis (Years 5-1000 = 200 events)

		Quantity		Unit Cost	Total Cost
33022036	Documentation Package for QA, verif,data (1/event)	200.00	EA	139.80	27,961
33022253	Total Uranium (4 samples/event x 200 events)	800.00	EA	155.78	124,628
ENGR EST	Iso-Uranium (4 samples/event x 200 events)	800.00	EA	162.28	129,820
33022288	Gross Alpha/Beta (4 samples/event x 200 events)	800.00	EA	84.51	67,610
ENGREST	Water Quality (12/event x 200 events)	2,400.00	EA	149.29	358,304
ENGREST	GFAA Metals (4 Samples/event x 200 events)	800.00	EA	116.84	93,471
ENGREST	ICPAES Metals (8 Samples/event x 200 events)	1,600.00	EA	142.80	228,484
	SUBTOTAL Groundwater Analysis (Years 5-1000 = 200 e	**995**	**YR**	**1,035.45**	**1,030,277**

	Quantity		Unit Cost	Total Cost
SUBTOTAL Chemical/Rad Lab Analysis	**1,000**	**YR**	**1,056.03**	**1,056,034**

		Quantity		Unit Cost	Total Cost
SUBTOTAL GW Monitoring/Sampling/Analysis		**1,000**	**YR**	**4,308.17**	**4,308,171**
08 Facility Maintenance					
01 Site Inspection					
Assume quarterly site inspection totaling 64 hours for travel, inspection, and report. 1000 year period x 64 hrs = 64,000 hrs.					
33220105	Project Engineer	64,000.00	HR	78.03	4,993,892
SUBTOTAL Site Inspection		**1,000**	**YR**	**4,993.89**	**4,993,892**
01 Earthwork					
03 Backfill					
Assume 10 cy of backfill placed every year over 1000 year period. 1000 events x 10 cy = 10,000 cy.					
17030423	Unclassified Fill, 6" Lifts, Off-Site, Includes Delivery, Spreading, and Compacting	10,000.00	CY	10.89	108,919
SUBTOTAL Backfill		**10,000**	**CY**	**10.89**	**108,919**
SUBTOTAL Earthwork		**1,000**	**YR**	**108.92**	**108,919**
03 Permanent Features					
02 Structures					
Assume 10 lf fence is replaced every year. 10 lf x 1,000 events = 20,000 lf					
028205280800	Fence, Industrial, 6 ft, 6 ga, omit barbed, galv steel	20,000.00	LF	23.58	471,674
SUBTOTAL Structures		**20,000**	**LF**	**23.58**	**471,674**
SUBTOTAL Permanent Features		**1,000**	**YR**	**471.67**	**471,674**
04 Revegetation And Planting					
01 Seeding/Mulch/Fertilizer					
Assume 2 acres will be reseeded every 5 years. (0.4 acr/yr) 2 acres x 200 events = 400 acres					
17040101	General Area Cleanup	400.00	ACR	382.81	153,125
18050101	Area Preparation	400.00	ACR	89.82	35,927
18050401	Hydroseeding, 67% Level & 33% Sloped	400.00	ACR	661.17	264,468
18050408	Fertilizer, Hydro Spread	400.00	ACR	197.59	79,035
18050413	Watering with 3000-gallon Tank Truck	400.00	ACR	78.35	31,339
SUBTOTAL Seeding/Mulch/Fertilizer		**400**	**ACR**	**1,409.74**	**563,894**
SUBTOTAL Revegetation And Planting		**1,000**	**YR**	**563.89**	**563,894**
SUBTOTAL Facility Maintenance		**1,000**	**YR**	**6,138.38**	**6,138,379**
SUBTOTAL HTRW Soils and Groundwater O&M		**1,000**	**EA**	**32,784.69**	**32,784,692**

	Quantity		Unit Cost	Total Cost
SUBTOTAL	***1,000***	***YR***	***32,992.99***	***32,992,991***
General Conditions - PRIME CONTRACTOR AA	3.0%		956.84	956,844
Prime Markup on Subs - PRIME CONTRACTOR AA	4.0%		1,275.79	1,275,792
SUBTOTAL	***1,000***	***YR***	***35,225.63***	***35,225,627***
Contingency	25.0%		8,806.41	8,806,407
Remedial Design	4.0%		1,753.26	1,753,256
Project Management	5.0%		2,279.23	2,279,232
Construction Management	10.0%		4,786.39	4,786,388
Owner Costs	15.0%		7,897.54	7,897,540
Alternative 2 - Limited Action	**1,000**	**YR**	**60,748.45**	**60,748,450**

Alternative 3 - Consolidation and Capping

Project No. TERC DACW27-97-D-0015

Designed By:

Science Application International Corporation

Estimated By:

Mike Poligone

Prepared By: Mike Poligone

Preparation Date: 10/10/2002

Effective Date of Pricing: 10/10/2002

Est Construction Time: 0 Days

CostLink CM Report	Page Number

PROJECT DESCRIPTION: ALTERNATIVE 3 - CONSOLIDATION AND CAPPING

This alternative involves removing contaminated soils above the appropriate cleanup criteria from areas outside the cap footprint and consolidating them to the northeastern corner of the site. A multi-layer cap would be constructed over the consolidated waste pile. Contaminated materials would be left onsite and the need for land use controls and long-term monitoring would be required. (See the Luckey site FS for more details about the Luckey site and this proposed alternative).

PROJECT BREAKDOWN:

The Hazardous, Toxic, Radioactive Waste Work Breakdown Structure (HTRW WBS), February 1996, was used as the basis for organizing the cost estimates for the Luckey site alternatives. The estimate uses a 2 digit number at each level. The 2 digit numbers for the first 3 title levels are taken from the HTRW Remedial Action Work Breakdown Structure. The 2 digit numbers for the remaining title levels are user defined.

LEVEL 1 - WBS Level 1 (Account)- Luckey Alternative 3
LEVEL 2 - WBS Level 2 (System) - Solids Collection and Containment
LEVEL 3 - WBS Level 3 (Subsystem) - Contaminated Soil Collection
LEVEL 4 - User Defined (Assembly Category or Other) - Excavation of Contaminated Soils
LEVEL 5 - User Defined (Assembly or Other)

The Level 2 WBS elements for this estimate are as follows:

33. HTRW REMEDIAL ACTION
33.01 Land Use Controls
33 02 Remedial Action Monitoring, Sampling, and Analysis
33 03 Site Work
33 05 Surface Water Collection/Control
33.08 Solids Collection/Containment
33.19 Disposal (Commercial)
33.20 Site Restoration

34. HTRW Soils O&M
34.01 Land Use Controls
34.08 Cap and Facility Maintenance

LUCKEY SITE SOIL VOLUMES:

Total Soil Volume Estimates of all Waste Streams (Rounded to the nearest 50 cy)
In Situ Most Likely Volume (cy) = 55,400
Including 20% Overexcavation (cy) = 66,500
Including 10% Constructability (cy) = 73,150
Including 20% Swell Factor (cy) = 87,750

Total Soil Volumes Requiring Removal for Consolidation
Percent Soils Requiring Removal = 85%
In Situ Most Likely Volume (cy) = 47,100
Including 20% Overexcavation (cy) = 56,500
Including 10% Constructability (cy) = 62,200
Including 20% Swell Factor (cy) = 74,600

Total Soil Volume Currently within Cap Footprint (in situ cy) = 15% = 10,950

1. The "Total Volume" was calculated with a software package named EarthVision developed by Dynamic Graphics, Incorporated (www.dgi.com) using the Minimum Tension Gridding Algorithm along with engineering judgment to confine and shape the modeled extents.
2. In situ excavation volumes include a 20% increase to account for overexcavation.
3. An additional 10% increase is included to account for constructability.
4. Ex situ excavation volumes include a 20% increase to account for expansion of soil (swell factor).

SCHEDULE SUMMARY:

Estimated Project duration = 5.0 yrs.

Engineering Design = 2.0 yrs*.
Excavation/Disposal of soils/materials = 1.6 yrs.
Install Cap over Soils = 0.4 yrs **
Post-Remediation Report and As-builts = 1.0 yrs.

Estimated Cap Maintenance = 1,000 yrs.

* Assume two year design to account for site suitability analysis and licensing.
** Cap will be installed in parallel with the placement of excavated soils. Assume total cap placement duration of 9.2 months will run an additional 4 months or 0.4 years past excavation activities.

PRODUCTIVITY:

Productivity, as a baseline and as taken from the Unit Price Book (UPB) Database, assumes a non-contaminated working environment with no level of protection productivity reduction factors. Productivity reduction factors have been added to the excavation equipment to more accurately reflect the nature of the excavation at the site. The following factors have been applied:

1. Site Constraint - 70%. This factor is based on engineering judgment and is developed on a site by site basis. It is used to adjust productivity levels due to site layout (i.e. open fields vs. congested area), temporary work interruptions, delays, mobilization, and demobilization. It applies to all excavation and loading equipment. Backfill equipment is excluded. Based on a work schedule availability of 40 weeks/year and a 12 week delay due to weather (4 weeks), unsafe conditions (1 weeks), job sequencing (1 weeks), soil drying (2 weeks), utility shutoff/interruption (0 weeks), and location of as built utilities (0 weeks), post RA surveys (4 weeks) the resulting site constraint for this site is calculated as 40 total weeks/yr - 28 week delay /40 total weeks/year = 70%.

2. Soil adjustment - 75%. This factor is based on engineering judgment based on borings taken from the site and is developed on a site by site basis. It is used to adjust productivity levels due to material handling or the nature of the material to be excavated (i.e. soils and/or asphalt vs. concrete or bedrock; or concentrated area of contamination vs. spotty areas of contamination over large areas). This factor is applied to excavation equipment as required. Backfill equipment is excluded. If not required, factor will be 100%. For the Luckey site, production capacity will be reduced due to spatial areas of contaminants and typical unit price book production rates will be adjusted by 75%. Delays due to wet soils are addressed under the site constraint.

3. Safety factor - 65%. This is the standard factor developed by SAIC, which is used to adjust productivity levels due to safety procedures associated with the radioactive nature of the contaminated materials. It applies to all excavation equipment and excludes all backfill equipment. Derivation of this factor is explained in the backup material for safety factor derivation.

Total productivity adjustment is equal to the site adjustment x soil adjustment x safety adjustment. For this estimate, the total productivity adjustment is 70% x 75% x 65% = 34%

ESCALATION:

The base year of comparison will be CY2002 and unit cost will be escalated to July 2002. Cost data will be escalated using the Price Escalation Indices (Annual Rates in Percentages) for Budget Authority in the memorandum dated 3 January, 2002 from the Comptroller of the Under Secretary of Defense, Subject: Revised Inflation Guidance, and the Department of the Army, DACS-PCB MEMO 2000-002 of Feb 2002, Subject: Revised Inflation Indices for FY02 President's Budget.

OVERHEAD COSTS

The following overhead markups have been applied to the Subcontractor's direct cost.

Professional Labor - A 140% markup was applied to professional labor for fringe benefits, paid vacation, medical insurance, holidays, retirement accounts, etc.

Craft Labor - A 30% markup was applied to craft labor for fringe benefits, paid vacation, medical insurance, holidays, retirement accounts, etc.

Equipment and Materials - A 8% markup was applied to all equipment and materials for indirect labor.

General Conditions - A 6% markup was applied to the direct project cost to account for all general conditions (i.e. Mobilization and Demobilization cost), including temporary facilities and utilities, telephone and communication, permits and licenses, subcontractor submittals, travel and per diem, personal protective equipment, insurance, bonds, and taxes.

Profit - A 8% profit markup has been applied for the direct cost.

The following Overhead Markups have been applied to the Prime Contractor's direct cost.

General Conditions - A 3% markup was applied to the direct project cost to account for all general conditions (i.e. Mobilization and Demobilization cost), including temporary facilities and utilities, telephone and communication, permits and licenses, subcontractor submittals, travel and per diem, personal protective equipment, insurance, bonds, and taxes.

Prime Markup on Sub - A 4% markup was applied to all subcontracted work. Indicates the percentage of profit a prime contractor will make on work completed by subcontractors. Prime contractors apply to subs to cover the administrative, management, and financial costs of overseeing and approving subcontractor's work. The prime profit on subcontractors is applied to the total subcontract project cost, including subcontractor's direct costs, overhead, and profit.

CONTINGENCY:

Contingencies are shown for both Design Contingencies and Construction Contingencies. EPA Guidance 540-R-00-002, July 2000 was used as a reference in developing design and construction contingencies.

A design contingency of 15% is being applied due to the proven implementation of these technologies. Excavation and capping have been successfully implemented at other superfund sites however the design details (cleanup criteria, cover materials and quantities) of the soils to be excavated has not been finalized.

A construction contingency of 10% is being applied due to the potential for increases in soil volumes that have been common at other FUSRAP sites. This would also include cost overruns, modifications, and change orders.

DESIGN AND TECHNICAL SUPPORT COSTS:

Remedial design applies to capital cost and O&M cost and includes services to design the remedial action. Activities that are part of remedial design include pre-design collection and analysis of field data, engineering survey for design, treatability study (e.g., pilot-scale), and the various design components such as design analysis, plans, specifications, cost estimate, and schedule at the preliminary, intermediate, and final design phases including post RA documentation. Remedial Design has been included as a 4% markup of the total remedial action costs.

PROJECT MANAGEMENT

Project management includes services that are not specific to remedial design, construction management, or technical support of O&M activities. Project management includes planning and reporting, community relations' support during construction or O&M, bid or contract administration, permitting (not already provided by the construction or O&M contractor), and legal services outside of land use controls (e.g., licensing). Project Management has been included as a 5% markup of the total remedial action costs.

CONSTRUCTION MANAGEMENT

Construction management includes services to manage construction or installation of the remedial action. Activities include review of submittals, design modifications, construction observation or oversight, engineering survey for construction, preparation of O&M manual, documentation of quality control/quality assurance, and record drawings. For the Luckey site, this will include a full-time site manager, field engineer, clerical, safety and health officer, and waste management coordinator. It also includes HP, QA, and engineering during construction. Construction Management has been included as a 10% markup of the total remedial action costs.

OWNER COST

USACE oversight cost includes Program Management, Project Management, Construction Management, Design Reviews, Quality Assurance, HP Support, Cooperative Agreements with Others, Engineering During Construction, etc. The cost was estimated by LRB to be approximately $1 million per year. The estimated schedule for design, construction, and port RA closeout is 5 years for a total owner cost of $5 million.

	Quantity		Unit Cost	Total Cost	
TERC DACW27-97-D-0015 Alternative 3 - Consolidation and Capping					
33 HTRW Remedial Action					
01 Land Use Controls					
0801 Long Term Management Plan and Site Database				111,892	
0802 Land Use Controls				88,750	
SUBTOTAL Land Use Controls	73,150	CY	2.74	200,642	1%
02 Monitoring,Sampling,Testing, & Analysis					
02 Beryllium & Rad Monitoring	73,150	CY	23.33	1,706,742	
10 Waste Analysis	73,150	CY	18.00	1,316,602	
13 On-Site Laboratory Facilities	73,150	CY	10.99	803,856	
SUBTOTAL Monitoring,Sampling,Testing, & Analysis	73,150	CY	52.32	3,827,201	22%
03 Site Work					
02 Clearing and Grubbing	5	ACR	1,396.94	6,985	
04 Roads/Parking/Curbs/Walks	4,000	SY	11.10	44,414	
05 Fencing	4,350	LF	6.94	30,187	
SUBTOTAL Site Work	73,150	CY	1.12	81,585	0%
05 Surface Water Collect & Control					
01 Sediment Barriers	4,350	LF	7.26	31,595	
02 Contact Water Control and Collection				104,564	
SUBTOTAL Surface Water Collect & Control	73,150	CY	1.86	136,159	1%
08 Solids Collection/Containment					
01 Contaminated Soil Excavation	73,150	CY	44.39	3,247,147	
05 Capping of Contaminated Waste Pile	162,500	SF	50.12	8,145,066	
SUBTOTAL Solids Collection/Containment	73,150	CY	155.74	11,392,213	66%
20 Site Restoration					
01 Earthwork	62,200	CY	19.67	1,223,531	
03 Permanent Features	73,150	CY	4.56	333,855	
04 Revegetation And Planting	73,150	CY	0.70	50,920	
SUBTOTAL Site Restoration	73,150	CY	21.99	1,608,306	9%
SUBTOTAL HTRW Remedial Action	73,150	CY	235.76	17,246,105	38%
34 HTRW Soils O&M					
01 Land Use Controls					
0801 Long Term Management Plan and Site Database	1,000	YR	12,128.51	12,128,507	
91 Reports	1,000	YR	4,287.43	4,287,433	

	Quantity		Unit Cost	Total Cost	
SUBTOTAL Land Use Controls	1,000	YR	16,415.94	16,415,939	58%
08 Monitor Facility and Maintenance					
04 Cap Maintenance	1,000	YR	8,439.35	8,439,347	
01 Site Inspection	1,000	YR	3,382.15	3,382,152	
SUBTOTAL Monitor Facility and Maintenance	1,000	YR	11,821.50	11,821,499	42%
SUBTOTAL HTRW Soils O&M	1,000	YR	28,237.44	28,237,438	62%
Alternative 3 - Consolidation and Capping	**73,150**	**CY**	**621.78**	**45,483,543**	

		Quantity		Unit Cost	Total Cost

TERC DACW27-97-D-0015 Alternative 3 - Consolidation and Capping

33 HTRW Remedial Action

HTRW = Hazardous, Toxic, and Radioactive Waste

01 Land Use Controls

0801 Long Term Management Plan and Site Database

Develop Long Term Management Plan to address administrative or legal measures to reduce or minimize potential exposures to contaminants left on site.

Land Use Control Plan per USACE Real Estate Group

a) Text (60 hrs.)
b) Drawings (30 hrs.)
c) GIS/Surveying (159 hrs.)
d) Stakeholder Coordination (189 hrs) - (three, ½ day meetings; (4 Corps personnel w/2 hrs prep.); meeting notes (3); letters (8), memos etc. (4); internal meeting (4 with 3 persons and meeting notes)
e) Internal Technical Review (40 hrs.)
f) Approval Coordination (53 hrs.) (memo package; responses to comments; conf. calls (3)

Total = 531 hrs @ Senior PM Rate $125.81 = 66,805, say $67,000

Site Information Database - Assume 200 hrs to develop a site database. Use Senior Engineer Rate

		Quantity		Unit Cost	Total Cost
00010027	Long Term Management Plan	1.00	LS	67,000.00	67,000
33220104	Site Database	200.00	HR	105.20	21,041
SUBTOTAL Long Term Management Plan and Site Da		**1**	**EA**		**88,041**

		Quantity		Unit Cost	Total Cost

0802 Land Use Controls

Implement Land Use Controls per USACE Real Estate Group

a) Coordinate with various local, state, and federal agencies to implement controls. Examples of controls requiring coordination are zoning, master plans, ordinances, environmental lists. Under each alternative 5-6 controls will be required. (192 hrs.)
b) Deed notice - Draft and record. (28 hrs.)
c) Acquire real estate interest (REI), e.g., negative easement.
(1) Research and draft real estate interest. (32 hrs.)
(2) Legal descriptions, surveying, parcel drawings. (64 hrs.)
(3) Title work (8 hrs.)
(4) Coordinate within District (8 hrs.)
(5) Coordinate w/owners (2 out of office meetings w/preparation and meeting notes, (3) Corps personnel. (68 hrs.)
(6) Subtotal = 180 hrs.
d) Approval of non-standard REI (memo package; responses to comments; conf. calls (3)); (59 hrs.)
e) SOW for appraisal. (12 hrs)
f) Appraisal of real estate interest. (64 hrs.)
g) Execute and record real estate interest
(1) Update title (5 hrs.)
(2) Update appraisal (10 hrs.)
(3) Closing and recording (12 hrs.)
(4) Subtotal = 27hrs.

Total = 562 hrs. @ Senior PM Rate $125.81 = 70,705, say $71,000

Note: This estimate is based upon no condemnation of a real estate interest. The costs do not include the fair market value of the real estate interest to be acquired.

		Quantity		Unit Cost	Total Cost
00010033	Implement Land Use Controls	1.00	LS	71,000.00	71,000
SUBTOTAL Land Use Controls		**1**	**EA**		**71,000**
SUBTOTAL Land Use Controls		**73,150**	**CY**	**2.17**	**159,041**

02 Monitoring,Sampling,Testing, & Analysis

02 Beryllium & Rad Monitoring

This WBS covers IH/HP technicians for the following areas: 2 at the excavation site to survey personnel, survey additional areas requiring excavation, and obtaining post RA samples; 2 at the consolidation area to survey personnel and transport vehicles; and 2 at the onsite lab to analyze samples/swipes and calibrate equipment. The IH/HP technicians and equipment would be required for the duration of excavation activities of 18 working months or 3,168 hours each. Total hours is 15,840. (See WBS 331 08 for duration calculation)

Equipment pricing base on Vendor Quote (SEC 2/2001;Rates escalated to 2/2002)- The Beryllium and Radiological monitoring equipment includes the following:

1. Model 2929 dual channel scaler (2 @ $365/mo =$730/mo)
2. Alpha Survey Instrument, 43-5 or equal (3 @ 210/mo = $630/mo)
3. Ratemeter w/GM pancake, 44-9 or equal (2 @ $195/mo = $390/mo)
4. Alarming Frisker w/ GM pancake, 44-9 or equal (5 @ $133/mo = $665/mo)
5. Micro R Meter, Model 19 or equal (2 @ $133/mo = $266/mo)
6. Personal Air Sampling pumps (3 @ $83/mo = $249/mo)
7. Personal air sampling pump charger (2 @ $52/mo = $104/mo)
8. High Volume air samplers (8 @ $130/mo = $1,040/mo)

Total = $4,074/month. Use $4,500/mo direct cost to account for other miscellaneous equipment or supplies.

		Quantity		Unit Cost	Total Cost
33021498	IH/HP Technicians	15,840.00	HR	53.34	844,882
Vendor Quote	IH/HP Monitoring Equipment	18.00	MO	5,563.73	100,147

		Quantity		Unit Cost	Total Cost
SUBTOTAL Beryllium & Rad Monitoring		**73,150**	**CY**	**12.92**	**945,029**
10 Waste Analysis					
04 Analytical Urine/Feces					
33022307	Bioassays (2/yr x 2 yrs x 20 people)	80.00	EA	168.77	13,501
SUBTOTAL Analytical Urine/Feces		**80**	**EA**	**168.77**	**13,501**
02 Rad/BE/RCRA Offsite Analysis					
09 Chemical/Rad Lab Soils Analysis					

Includes MARSSIM Samples (Reference Cost-Monitoring.xls, R Tucker and USACE comment by Hallem to increase by 50%)

330 for class 1 areas and 225 for class 2 areas.
Total 555 samples. Assume 20% of areas need to be resampled for a total of 670 samples.
Samples will be analyzed for radionuclides, beryllium, and lead.

Assume 5% of rad/Be sampled will also have TCLP Test = 34 samples

		Quantity		Unit Cost	Total Cost
33022036	Documentation Package for QA, verif,data	20.00	EA	139.80	2,796
33022250	Radium 226	670.00	EA	112.29	75,237
ENGR EST	Iso-Thorium	670.00	EA	162.28	108,725
33022253	Total Uranium	670.00	EA	155.78	104,376
ENGR EST	Iso-Uranium	670.00	EA	162.28	108,725
33022288	Gross Alpha/Beta	670.00	EA	84.51	56,624
ENGREST	ICPAES Metals	670.00	EA	142.80	95,678
ENGREST	GFAA Metals	670.00	EA	116.84	78,282
33021705	Targeted TCLP (Metals, Volatiles, SemiVolatiles), Soil Analysis	34.00	EA	816.01	27,744
SUBTOTAL Chemical/Rad Lab Soils Analysis		**670**	**EA**	**982.37**	**658,185**
09 Chemical/Rad Lab Air Analysis					

The high volume air samplers and personal samples will be analyzed on-site. It is assumed that 5% of the samples will be sent offsite for QA verification.

Excavation duration = 2,393 hours or 60 weeks.

High volume air samples = 5% off-site x 8 samplers x 60 weeks x 5 days/week = 120 off-site air samples

Personal air samplers = 5% off-site x 3 samplers x 60 weeks x 5 days/week = 45 off-site air samples

Samples will be analyzed for radionuclides, beryllium, and lead.

		Quantity		Unit Cost	Total Cost
33020217	Gamma Spec	165.00	EA	120.08	19,814
33022288	Gross Alpha/Beta	165.00	EA	84.51	13,945
ENGREST	ICPAES Metals	165.00	EA	142.80	23,562
SUBTOTAL Chemical/Rad Lab Air Analysis		**193**	**EA**	**297.00**	**57,321**
SUBTOTAL Rad/BE/RCRA Offsite Analysis		**863**	**EA**	**829.09**	**715,506**
SUBTOTAL Waste Analysis		**73,150**	**CY**	**9.97**	**729,008**

		Quantity		Unit Cost	Total Cost
13 On-Site Laboratory Facilities					
02 Rental/Ownership/Operation					
Assume $10,000/month for direct cost. Includes mobilization, monthly rental, lab equipment and furnishings, utilities, and demobilization. Personnel included in WBS 331 02 02.					
ENGREST	On-site Mobile Laboratory Rental (Engineering Estimate)	36.00	MO	12,363.84	445,098
SUBTOTAL Rental/Ownership/Operation		**18**	**MO**	**24,727.68**	**445,098**
SUBTOTAL On-Site Laboratory Facilities		**73,150**	**CY**	**6.08**	**445,098**
SUBTOTAL Monitoring,Sampling,Testing, & Analysis		**73,150**	**CY**	**28.97**	**2,119,135**
03 Site Work					
02 Clearing and Grubbing					
Assume 5 acres of the site requires clearing prior to excavation.					
17010110	Wet Clearing - Light - w/o Grub D5LGP	5.00	ACR	773.49	3,867
SUBTOTAL Clearing and Grubbing		**5**	**ACR**	**773.49**	**3,867**
04 Roads/Parking/Curbs/Walks					
01 Aggregate Surfacing					
Assume 3,000 lf of haul roads required at 12 inch thick and 12 ft wide at base. Include 6 oz geotextile. Area = 4,000 sy. Add 50% to cost for small area.					
027202000300	Haul Road - Crushed 3/4 in stone base, 12 in.	4,000.00	SY	4.34	17,365
027202006000	Geotextile, 6 oz/sy	4,000.00	SY	1.81	7,227
SUBTOTAL Aggregate Surfacing		**4,000**	**SY**	**6.15**	**24,592**
SUBTOTAL Roads/Parking/Curbs/Walks		**4,000**	**SY**	**6.15**	**24,592**
05 Fencing					
Assume installation of snow fence to prohibit access to contaminated areas. Area to be disturbed is 27 acres. Perimeter = 4,350 lf.					
028205237001	Snow Fence on Stl Post, 10' OC, 4' high	4,350.00	LF	3.84	16,715
SUBTOTAL Fencing		**4,350**	**LF**	**3.84**	**16,715**
SUBTOTAL Site Work		**73,150**	**CY**	**0.62**	**45,174**
05 Surface Water Collect & Control					
01 Sediment Barriers					
Assume installation of silt fence and hay bales around perimeter of contaminated areas. Area to be disturbed is 27 acres. Perimeter = 4,350 lf.					

		Quantity		Unit Cost	Total Cost
023705501100	Silt Fences, Polypropylene, 3' High, Adverse Conditions	4,350.00	LF	0.96	4,162
023705501250	Hay Bales, staked	4,350.00	LF	3.06	13,332
SUBTOTAL Sediment Barriers		**4,350**	**LF**	**4.02**	**17,494**

02 Contact Water Control and Collection

The average annual rainfall is 32.3 inches and 16.2 inches occurs during the warmer months of May thru September. 5.7 inches occurs during December through February when it is assumed there are no operations. The monthly range is from 1.6 inches (Feb) to 3.8 inches (Jun). Given the low monthly rainfall events, most rainfall will naturally percolate into the underlying soils.

It will be assumed that any water requiring collection will be slowly discharged to an existing contaminated low-lying area of the site or used for moisture conditioning. Since the majority of the rainfall occurs in the warmer months, most water requiring collection can be used for moisture conditioning soils.

The average monthly accumulation during the 9 working months is 2.96 inches. Say 3 inches for calculating the required storage capacity.

Assume maximum of 30,000 sf open excavation area.
Assume 20% infiltration.

Volume = 30,000 sf x 0.25 inches rain x 0.80 = 6,000 cf
Volume = 6,000 cf x 7.48 gal/cf = 44,880 gallons

Use 2 ea, 21,000 gallon wastewater storage tanks for the duration of excavation activities.

Duration = 14 months x 2 tanks = 28 months

Assume pumps will be required an average of 3 days/month for 14 months = 42 days.

		Quantity		Unit Cost	Total Cost
17031003	3" Diameter Contractor's Trash Pump, 150 GPM	42.00	DAYS	63.32	2,659
19040407	21,000 Gallon, Steel Closed Stationary Aboveground Wastewater Holding Tank, Rental	28.00	MO	1,758.26	49,231
33109649	Pump, Cast-iron Close Coupling, 2 HP, 50 GPM	2.00	EA	1,691.70	3,383
33231306	High Sump Level Switch for Avoiding Overflow	4.00	EA	472.46	1,890
33260550	2" Polyethylene, flexible piping, SDR15, 125 psi	1,000.00	LF	1.34	1,340
SUBTOTAL Contact Water Control and Collection		**1**	**LS**		**58,504**
SUBTOTAL Surface Water Collect & Control		**73,150**	**CY**	**1.04**	**75,998**

08 Solids Collection/Containment

		Quantity		Unit Cost	Total Cost

01 Contaminated Soil Excavation

Total Excavation Volume w/ 20% overexcavation and 10% constructability (in situ cy) = 62,200

Total Excavation Volume w/ 20% expansion (ex situ cy) = 74,600 (also referred to as the Transportation Volume)

One excavation crew will be assumed for calculating excavation durations. The crew will consist of 1 excavator, 1 operator, 1 oiler, and 2 laborers. Expected output per crew per day is 208 cy per crew, based on an adjusted hourly output of 26 cy/hr (See RS Means 2002 for 1 cy excavator productivity Ref 02315 400 0200). Equipment output has been decreased 66% to allow for site, safety and soil factors described in the project notes. The excavator productivity will determine productivity for the crew.

The transportation crew will transport soils to the staging area. The crew will consist of 2 dump trucks and drivers. Total daily output is the same as excavator or 208 cy/day.

Excavators will remove in situ soils and load trucks for transport of materials to the temporary staging area. The laborers will be used for equipment spotters, dust control, decon, maintaining erosion and sediment installation, etc.

02 Excavation of Contaminated Soils

The crew will excavate 62,200 cy of soils at 26 cy/hr for a total of 2,393 hours.

Assume surveyors are required for 40 events at 4 hours each.

Total Excavation Duration = 300 days = 14 months

011077001200	Survey Areas to be Excavated and As-builts (2 people)	20.00	DAY	803.65	16,073
015902000150	Hyd. Excavator, 1 C.Y.	2,394.00	HR	87.08	208,466
CLAB	Common Building Laborers (2 ea)	4,788.00	HR	34.90	167,098
EQMD	Equipment Operators, Medium Equipment	2,394.00	HR	46.43	111,161
EQOL	Equipment Operators, Oilers	2,394.00	HR	39.66	94,950
SUBTOTAL Excavation of Contaminated Soils		**62,200**	**CY**	**9.61**	**597,747**

04 Transport to Consolidation Area

The crews productivity will be limited by the excavators productivity. Therefore, the total crew hours will be the same at 2,394 hours based on a productivity of 26 cy/hour.

Total Transportation Duration = 300 days = 14 months (Same as Excavation)

015902005300	Dump Truck, 16 Ton (2 each)	4,788.00	HR	72.74	348,262
TRHV	Truck Drivers, Heavy (2 each)	4,788.00	HR	37.21	178,142
SUBTOTAL Transport to Consolidation Area		**74,600**	**CY**	**7.06**	**526,405**

99 Place and Compact

Total Duration to Place and Compact = 300 days = 14 months.

17030422	Unclassified Fill, 6" Lifts, Off-Site, Includes Spreading and Compacting	74,600.00	CY	9.03	673,805
SUBTOTAL Place and Compact		**74,600**	**CY**	**9.03**	**673,805**
SUBTOTAL Contaminated Soil Excavation		**73,150**	**CY**	**24.58**	**1,797,957**

		Quantity		Unit Cost	Total Cost

05 Capping of Contaminated Waste Pile

The contaminated soils will be capped in the northeastern corner of the site. The waste footprint area is approximated to be 250 ft by 650 ft and located 100 ft minimum from the northern and eastern property boundary line.

Capping Assumptions and Key Parameters:

The cap footprint area = 250 ft x 650 ft = 162,500 sf (10-60% was added for side slopes and runout)
The cap components consist of the following: (10% was added to natural cap material volumes for incidental placement thicker than required)

Riprap (d = 3 ft, l = 650 ft, w = 250 ft, runout factor = 1.6, excess waste = 1.1, duration = 64 days)
Soil Cover (d = 2 ft, l = 650 ft, w = 250 ft, runout factor = 1.5, excess waste = 1.1, duration = 20 days)
Graded Filter Layer (d = 1 ft, l = 650 ft, w = 250 ft, runout = 1.4, excess waste = 1.1, duration = 9 days)
Biointrusion Layer (d = 3 ft, l = 650 ft, w = 250 ft, runout = 1.25, excess waste = 1.1, duration = 50 days)
Geotextile (d = 130 mil, l = 650 ft, w = 250 ft, runout = 1.25, excess waste = 1.1, duration = 2 days)
Drainage Layer (d = 1 ft, l = 650 ft, w = 250 ft, runout = 1.2, excess waste = 1.1, duration = 8 days)
Geotextile (d = 130 mil, l = 650 ft, w = 250 ft, runout = 1.2, excess waste = 1.1, duration = 2 days)
Geomembrane (d = 80 mil, l = 650 ft, w = 250 ft, runout = 1.2, excess waste = 1.1, duration = 21 days)
Low Permeable Clay (d = 3 ft, l = 650 ft, w = 250 ft, runout = 1.1, excess waste = 1.1, duration = 22 days)
Anchor Trench (l = 650 ft, w = 250 ft, duration = 4 days)
Herbicide (l = 750, w = 350, duration = 2 days)
Land (d= 850, w= 450)

		Quantity		Unit Cost	Total Cost
17030423	Unclassified Fill, 6" Lifts, Off-Site, Includes Delivery, Spreading, and Compacting	19,861.00	CY	10.89	216,323
17030426	Sand, 6 in lifts, off-site	9,269.00	CY	24.81	229,978
17030430	Gravel, 6" Lifts	7,944.00	CY	13.67	108,616
18050202	Biointrusion Layer	24,826.00	CY	28.12	698,021
18050203	Rock Cover, Riprap, Medium (10 to 200 lb pieces)	31,778.00	CY	28.60	908,751
33080503	Liner Anchor Trench, 3' x 1.5	1,920.00	LF	0.99	1,900
33080504	Herbicide Application	6.00	ACR	367.29	2,204
33080507	Clay 10E-7, 6' lifts, off-site	21,847.00	CY	25.75	562,640
33080534	12 oz/sy Geotextile/Drainage (130 mil)	223,438.00	SF	2.38	531,341
33080534	12 oz/sy Geotextile/Drainage (130 mil)	214,500.00	SF	2.38	510,086
33080573	80 mil High Density Poly	214,500.00	SF	3.30	708,233
ENGREST	Temporary Pile Tarp and Ballast	1.00	LS	12,982.03	12,982
ENGREST	Purchase Undeveloped Land	9.00	ACR	3,000.00	27,000
SUBTOTAL Capping of Contaminated Waste Pile		**162,500**	**SF**	**27.80**	**4,518,074**
SUBTOTAL Solids Collection/Containment		**73,150**	**CY**	**86.34**	**6,316,031**

20 Site Restoration

01 Earthwork

03 Backfill

		Quantity		Unit Cost	Total Cost
17030423	Unclassified Fill, 6" Lifts, Off-Site, Includes Delivery, Spreading, and Compacting	62,200.00	CY	10.89	677,473
SUBTOTAL Backfill		**62,200**	**CY**	**10.89**	**677,473**
SUBTOTAL Earthwork		**62,200**	**CY**	**10.89**	**677,473**

03 Permanent Features

		Quantity		Unit Cost	Total Cost
01 Roads					
	Assume 40,000 sf (2000 lf at 20 ft wide) of road way/parking lot repair. Assume 10 in gravel base and 2.5 in asphalt, 6.75 ft ditch, and 1 culvert. The majority of the impacted areas are currently in vegetated areas.				
17030103	Rough Grading	11,111.00	SY	1.20	13,369
17030108	Fine Grading, 130G, 2 Passes	5,556.00	SY	0.23	1,266
17030202	Ditch Excavation, Normal Soil, Haul Spoil 1 mile	2,500.00	CY	3.44	8,604
18010102	Gravel, Delivered and Dumped	1,543.00	CY	29.50	45,512
18010310	Prime Coat	4,444.00	SY	0.48	2,152
18010312	Asphalt Wearing Course, 1 Pass (Inc 5% Waste)	605.00	TON	75.34	45,583
19030402	34' Complete, 24" Corrugated Metal Pipe, Culvert w/Headwall	1.00	EA	7,053.84	7,054
SUBTOTAL Roads		**4,444**	**SY**	**27.80**	**123,539**
02 Structures					
	Assume capped area w/100 ft buffer will be enclosed (450 ft x 850 ft) Perimeter= 2600 lf				
028205280800	Fence, Industrial, 6 ft, 6 ga, omit barbed, galv steel	2,600.00	LF	23.58	61,318
SUBTOTAL Structures		**2,600**	**LF**	**23.58**	**61,318**
SUBTOTAL Permanent Features		**73,150**	**CY**	**2.53**	**184,857**
04 Revegetation And Planting					
	Approximately 24 acres of the site will be disturbed less the cap area of 6 acres that will be covered with riprap. Assumes area of excavation plus 10% of additional area adjacent to excavation. 24 - 6 acres x 1.1 = 20 acres.				
01 Seeding/Mulch/Fertilizer					
17040101	General Area Cleanup	20.00	ACR	382.81	7,656
18050101	Area Preparation	20.00	ACR	89.82	1,796
18050401	Hydroseeding, 67% Level & 33% Sloped	20.00	ACR	661.17	13,223
18050408	Fertilizer, Hydro Spread	20.00	ACR	197.59	3,952
18050413	Watering with 3000-gallon Tank Truck	20.00	ACR	78.35	1,567
SUBTOTAL Seeding/Mulch/Fertilizer		**20**	**ACR**	**1,409.74**	**28,195**
SUBTOTAL Revegetation And Planting		**73,150**	**CY**	**0.39**	**28,195**
SUBTOTAL Site Restoration		**73,150**	**CY**	**12.17**	**890,525**
SUBTOTAL HTRW Remedial Action		**73,150**	**CY**	**131.32**	**9,605,904**

34 HTRW Soils O&M

01 Land Use Controls

		Quantity		Unit Cost	Total Cost
0801 Long Term Management Plan and Site Database					
Maintain O&M plan to address administrative or legal measures to reduce or minimize potential for exposure to contaminants left on site. Maintain Cap for 1,000 year duration due to long half life of radioactive constituents. Assume the following:					
Long Term Management Plan - Assume 40 hrs/yr for 1,000 yrs = 40,000 hrs to coordinate with stakeholders and make revisions to plan. Use Senior PM Rate.					
Site Information Database - Assume 16 hrs/yr for 1,000 yrs = 16,000 hrs to update site database. Use Senior Engineer Rate.					
33220101	Long Term Management Plan	40,000.00	HR	125.81	5,032,358
33220104	Site Database	16,000.00	HR	105.20	1,683,241
SUBTOTAL Long Term Management Plan and Site Da		**1,000**	**YR**	**6,715.60**	**6,715,598**
91 Reports					
99 Five Year Reviews (Years 0-1,000 = 200 events)					
33220102	Project Manager (60 hours/report x 200 events)	12,000.00	HR	105.39	1,264,738
33220109	Field Geologist (80 hours/report x 200 events)	16,000.00	HR	60.56	968,885
33220114	Word Processing (20 hrs/report x 200 events)	4,000.00	HR	35.09	140,343
SUBTOTAL Five Year Reviews (Years 0-1,000 = 200 eve		**1,000**	**YR**	**2,373.97**	**2,373,967**
SUBTOTAL Reports		**1,000**	**YR**	**2,373.97**	**2,373,967**
SUBTOTAL Land Use Controls		**1,000**	**YR**	**9,089.57**	**9,089,565**
08 Monitor Facility and Maintenance					
Monitor site for 1,000 year duration due to long half life of radioactive constituents.					
04 Cap Maintenance					
Assume $5,000/yr for limited fenceline monitoring, mowing grass, and weed control, and misc maintenance.					
ENGREST	Site Maintenance	1,000.00	YR	5,000.00	5,000,000
SUBTOTAL Cap Maintenance		**1,000**	**YR**	**5,000.00**	**5,000,000**
01 Site Inspection					
Assume annual site inspection totaling 24 hours for travel ,inspection, and report. 1000 year period x 24 hrs = 24,000 hrs.					
33220105	Project Engineer	24,000.00	HR	78.03	1,872,710
SUBTOTAL Site Inspection		**1,000**	**YR**	**1,872.71**	**1,872,710**
SUBTOTAL Monitor Facility and Maintenance		**1,000**	**YR**	**6,872.71**	**6,872,710**
SUBTOTAL HTRW Soils O&M		**1,000**	**YR**	**15,962.28**	**15,962,275**

	Quantity		Unit Cost	Total Cost
SUBTOTAL	***73,150***	***CY***	***349.53***	***25,568,179***
General Conditions - PRIME CONTRACTOR AA	3.0%		8.32	608,903
Prime Markup on Subs - PRIME CONTRACTOR AA	4.0%		11.10	811,871
SUBTOTAL	***73,150***	***CY***	***368.95***	***26,988,953***
Contingency	25.0%		92.24	6,747,238
Remedial Design	4.0%		18.34	1,341,422
Project Management	5.0%		23.84	1,743,849
Construction Management	10.0%		50.06	3,662,082
Owner Costs	12.4%		68.35	5,000,000
Alternative 3 - Consolidation and Capping	**73,150**	**CY**	**621.78**	**45,483,543**

Alternative 4 - Excavation and Offsite Disposal - Industrial Land Use

Project No. TERC DACW27-97-D-0015

Designed By:

Science Applications International Corporation

Estimated By:

Mike Poligone

Prepared By: Mike Poligone
Preparation Date: 10/10/2002

Effective Date of Pricing: 10/10/2002
Est Construction Time: 0 Days

CostLink CM Report	Page Number

PROJECT DESCRIPTION: ALTERNATIVE 4 - EXCAVATION AND OFFSITE DISPOSAL - INDUSTRIAL USE

This alternative involves removing contaminated soils above the industrial land use cleanup criteria from the site and disposing at commercial disposal facilities. Contaminated materials would be excavated and staged onsite for transport by intermodal to a rail transfer facility (applicable for long haul shipments) or truck to the disposal facility (applicable for regional facilities). Contaminated materials would be transported to their designated disposal locations. A breakdown of waste streams and disposal facilities is shown below. (See the Luckey site FS for more details about the Luckey site and this proposed alternative).

PROJECT BREAKDOWN:

The Hazardous, Toxic, Radioactive Waste Work Breakdown Structure (HTRW WBS), February 1996, was used as the basis for organizing the cost estimates for the Luckey site alternatives. The estimate uses a 2 digit number at each level. The 2 digit numbers for the first 3 title levels are taken from the HTRW Remedial Action Work Breakdown Structure. The 2 digit numbers for the remaining title levels are user defined.

LEVEL 1 - WBS Level 1 (Account)- Luckey Alternative 4
LEVEL 2 - WBS Level 2 (System) - Solids Collection and Containment
LEVEL 3 - WBS Level 3 (Subsystem) - Contaminated Soil Collection
LEVEL 4 - User Defined (Assembly Category or Other) - Excavation of Contaminated Soils
LEVEL 5 - User Defined (Assembly or Other)

The Level 2 WBS elements for this estimate are as follows:

33. HTRW REMEDIAL ACTION
33.01 Land Use Controls
33 02 Remedial Action Monitoring, Sampling, and Analysis
33 03 Site Work
33 05 Surface Water Collection/Control
33.08 Solids Collection/Containment
33.19 Disposal (Commercial)
33.20 Site Restoration

34. HTRW Soils O&M
34.01 Land Use Controls
34.02 Soil Monitoring/Sampling/Analysis
34.08 Monitoring and Facility Maintenance

LUCKEY SITE SOIL VOLUMES:

Soil Volume Estimates Grouped By Waste Stream (Rounded to the nearest 50 cy)

Be and LLW Mixed Soils
In Situ Most Likely Volume (cy) = 30,400
Including 20% Overexcavation (cy) = 36,500
Including 10% Constructability (cy) = 40,150
Including 20% Swell Factor (cy) = 48,200
Total Disposal Volume (cy) = 48,200

Mixed Waste Soils (LLW, Lead, and Be)
In Situ Most Likely Volume (cy) = 700
Including 20% Overexcavation (cy) = 800

Including 10% Constructability (cy) = 900
Including 20% Swell Factor (cy) = 1,100
Total Disposal Volume (cy) = 1,100

Total of All Soils
In Situ Most Likely Volume (cy) = 31,100
Including 20% Overexcavation (cy) = 37,300
Including 10% Constructability (cy) = 41,050
Including 20% Swell Factor (cy) = 49,250
Total Disposal Volume (cy) = 49,250

Soil Volume Estimates Grouped By Disposal Facility (Rounded to the nearest 50 cy)

US Ecology of Idaho (Low Level Waste/Rads Alone and with Be Soils)
In Situ Most Likely Volume (cy) = 30,400
Including 20% Overexcavation (cy) = 36,500
Including 10% Constructability (cy) = 40,150
Including 20% Swell Factor (cy) = 48,200
Total Disposal Volume (cy) = 48,200

US Ecology of Idaho (Mixed Waste/Rads With Lead or Be Soils)
In Situ Most Likely Volume (cy) = 700
Including 20% Overexcavation (cy) = 800
Including 10% Constructability (cy) = 900
Including 20% Swell Factor (cy) = 1,100
Total Disposal Volume (cy) = 1,100

Total of All Soils
In Situ Most Likely Volume (cy) = 31,100
Including 20% Overexcavation (cy) = 37,300
Including 10% Constructability (cy) = 41,050
Including 20% Swell Factor (cy) = 49,250
Total Disposal Volume (cy) = 49,250

1. The "Total Volume" was calculated with a software package named EarthVision developed by Dynamic Graphics, Incorporated (www.dgi.com) using the Minimum Tension Gridding Algorithm along with engineering judgment to confine and shape the modeled extents.
2. In situ excavation volumes include a 20% increase to account for overexcavation.
3. An additional 10% increase is included to account for constructability.
4. Ex situ excavation volumes include a 20% increase to account for expansion of soil (swell factor).

SCHEDULE SUMMARY:

The schedule is based on working 8 hours/day, 22 days/month, and 9 months/year.

Estimated Project duration:	3.7 yrs.
Engineering Design	1.0 yrs.
Excavation/Disposal of soils/materials	1.7 yrs.
Post-Remediation Report and As-builts	1.0 yrs.

PRODUCTIVITY:

Productivity, as a baseline and as taken from the Unit Price Book (UPB) Database, assumes a non-contaminated working environment with no level of protection productivity reduction factors. Productivity reduction factors have been added to the excavation equipment to more accurately reflect the nature of the excavation at the site. The following factors have been applied:

1. Site Constraint - 70%. This factor is based on engineering judgment and is developed on a site by site basis. It is used to adjust productivity levels due to site layout (i.e. open fields vs. congested area), temporary work interruptions, delays, mobilization, and demobilization. It applies to all excavation and loading equipment. Backfill equipment is excluded. Based on a work schedule availability of 40 weeks/year and a 12 week delay due to weather (4 weeks), unsafe conditions (1 weeks), job sequencing (1 weeks), soil drying (2 weeks), utility shutoff/interruption (0 weeks), and location of as built utilities (0 weeks), post RA surveys (4 weeks) the resulting site constraint for this site is calculated as 40 total weeks/yr - 28 week delay /40 total weeks/year = 70%.

2. Soil adjustment - 75%. This factor is based on engineering judgment based on borings taken from the site and is developed on a site by site basis. It is used to adjust productivity levels due to material handling or the nature of the material to be excavated (i.e. soils and/or asphalt vs. concrete or bedrock; or concentrated area of contamination vs. spotty areas of contamination over large areas). This factor is applied to excavation equipment as required. Backfill equipment is excluded. If not required, factor will be 100%. For the Luckey site, production capacity will be reduced due to spatial areas of contaminants and typical unit price book production rates
will be adjusted by 75%. Delays due to wet soils are addressed under the site constraint.

3. Safety factor - 65%. This is the standard factor developed by SAIC, which is used to adjust productivity levels due to safety procedures associated with the radioactive nature of the contaminated materials. It applies to all excavation equipment and excludes all backfill equipment. Derivation of this factor is explained in the backup material for safety factor derivation.

Total productivity adjustment is equal to the site adjustment x soil adjustment x safety adjustment. For this estimate, the total productivity adjustment is 70% x 75% x 65% = 34%

ESCALATION:

The base year of comparison will be CY2002 and unit cost will be escalated to July 2002. Cost data will be escalated using the Price Escalation Indices (Annual Rates in Percentages) for Budget Authority in the memorandum dated 3 January, 2002 from the Comptroller of the Under Secretary of Defense, Subject: Revised Inflation Guidance, and the Department of the Army, DACS-PCB MEMO 2000-002 of Feb 2002, Subject: Revised Inflation Indices for FY02 President's Budget.

OVERHEAD COSTS

The following overhead markups have been applied to the Subcontractor's direct cost. (note: no markups have been applied to the transportation and disposal unit cost. The transportation unit cost is a vendor quote and includes all markups and the disposal unit cost are based on the existing USACE contract).

Professional Labor - A 140% markup was applied to professional labor for fringe benefits, paid vacation, medical insurance, holidays, retirement accounts, etc.

Craft Labor - A 30% markup was applied to craft labor for fringe benefits, paid vacation, medical insurance, holidays, retirement accounts, etc.

Equipment and Materials - A 8% markup was applied to all equipment and materials for indirect labor.

General Conditions - A 6% markup was applied to the direct project cost to account for all general conditions (i.e. Mobilization and Demobilization cost), including temporary facilities and utilities, telephone and communication, permits and licenses, subcontractor submittals, travel and per diem, personal protective equipment, insurance, bonds, and taxes.

Profit - A 8% profit markup has been applied for the direct cost.

The following Overhead Markups have been applied to the Prime Contractor's direct cost.

General Conditions - A 3% markup was applied to the direct project cost to account for all general conditions (i.e. Mobilization and Demobilization cost), including temporary facilities and utilities, telephone and communication, permits and licenses, subcontractor submittals, travel and per diem, personal protective equipment, insurance, bonds, and taxes.

Prime Markup on Sub - A 4% markup was applied to all subcontracted work. Indicates the percentage of profit a prime contractor will make on work completed by subcontractors. Prime contractors apply to subs to cover the administrative, management, and financial costs of overseeing and approving subcontractor's work. The prime profit on subcontractors is applied to the total subcontract project cost, including subcontractor's direct costs, overhead, and profit.

CONTINGENCY:

Contingencies are shown for both Design Contingencies and Construction Contingencies. EPA Guidance 540-R-00-002, July 2000 was used as a reference in developing design and construction contingencies.

A design contingency of 15% is being applied due to the proven implementation of these technologies. Excavation and offsite disposal technologies have been successfully implemented at other superfund sites however the design details (cleanup criteria, disposal facilities, overexcavation required) of the soils to be excavated has not been finalized.

A construction contingency of 10% is being applied due to the potential for increases in soil volumes that have been common at other FUSRAP sites. This would also include cost overruns, modifications, and change orders.

DESIGN AND TECHNICAL SUPPORT COSTS:

Remedial design applies to capital cost and O&M cost and includes services to design the remedial action. Activities that are part of remedial design include pre-design collection and analysis of field data, engineering survey for design, treatability study (e.g., pilot-scale), and the various design components such as design analysis, plans, specifications, cost estimate, and schedule at the preliminary, intermediate, and final design phases including post RA documentation. Remedial Design has been included as a 4% markup of the total remedial action costs.

PROJECT MANAGEMENT

Project management includes services that are not specific to remedial design, construction management, or technical support of O&M activities. Project management includes planning and reporting, community relations support during construction or O&M, bid or contract administration, permitting (not already provided by the construction or O&M contractor), and legal services outside of land use controls (e.g., licensing). Project Management has been included as a 5% markup of the total remedial action costs.

CONSTRUCTION MANAGEMENT

Construction management includes services to manage construction or installation of the remedial action. Activities include review of submittals, design modifications, construction observation or oversight, engineering survey for construction, preparation of O&M manual, documentation of quality control/quality assurance, and record drawings. For the Luckey site, this will include a full-time site manager, field engineer, clerical, safety and health officer, and waste management coordinator. It also includes HP, QA, and engineering during construction. Construction Management has been included as a 10% markup of the total remedial action costs.

OWNER COST

USACE oversight cost includes Program Management, Project Management, Construction Management, Design Reviews, Quality Assurance, HP Support, Cooperative Agreements with Others, Engineering During Construction, etc. The cost was estimated by LRB to be approximately $1 million per year. The estimated schedule for design, construction, and port RA closeout is 3.7 years for a total owner cost of $3.7 million.

	Quantity		Unit Cost	Total Cost	
TERC DACW27-97-D-0015 Alternative 4 - Excavation and Offsite Disposal - Industrial Land Use					
33 HTRW Remedial Action					
01 Land Use Controls					
0801 Long Term Management Plan and Site Database	41,050	CY	2.73	111,892	
0802 Land Use Controls	41,050	CY	2.16	88,750	
SUBTOTAL Land Use Controls	41,050	CY	4.89	200,642	1%
02 Monitoring,Sampling,Testing, & Analysis					
02 Beryllium & Rad Monitoring	41,050	CY	37.76	1,549,876	
10 Waste Analysis	41,050	CY	27.07	1,111,254	
13 On-Site Laboratory Facilities	41,050	CY	12.89	529,313	
SUBTOTAL Monitoring,Sampling,Testing, & Analysis	41,050	CY	77.72	3,190,443	11%
03 Site Work					
02 Clearing and Grubbing	5	ACR	1,327.51	6,638	
04 Roads/Parking/Curbs/Walks	41,050	CY	7.05	289,221	
05 Fencing	3,750	LF	6.59	24,730	
SUBTOTAL Site Work	41,050	CY	7.81	320,588	1%
05 Surface Water Collect & Control					
01 Sediment Barriers	3,750	LF	6.90	25,884	
02 Contact Water Control and Collection				105,707	
SUBTOTAL Surface Water Collect & Control	41,050	CY	3.21	131,590	0%
08 Solids Collection/Containment					
01 Contaminated Soil Excavation	41,050	CY	30.81	1,264,672	
02 Load Trucks at Staging Area	49,250	CY	18.82	927,020	
SUBTOTAL Solids Collection/Containment	41,050	CY	53.39	2,191,692	8%
19 Transportation and Disposal					
01 Transportation to Disposal Facility	49,250	CY	324.16	15,964,697	
02 LLW Disposal Costs	49,250	CY	115.73	5,699,820	
SUBTOTAL Transportation and Disposal	49,250	CY	439.89	21,664,518	75%
20 Site Restoration					
01 Earthwork	49,250	CY	18.69	920,642	
03 Permanent Features	49,250	CY	3.72	183,365	
04 Revegetation And Planting	20	ACR	2,419.47	48,389	
SUBTOTAL Site Restoration	49,250	CY	23.40	1,152,396	4%
SUBTOTAL HTRW Remedial Action	41,050	CY	702.85	28,851,869	50%

	Quantity		Unit Cost	Total Cost	
34 HTRW Soils O&M					
01 Land Use Controls					
0801 Long Term Management Plan and Site Database	1,000	YR	11,525.70	11,525,697	
91 Reports	1,000	YR	4,074.34	4,074,339	
SUBTOTAL Land Use Controls	1,000	YR	15,600.04	15,600,037	53%
02 Soil Monitoring/Sampling/Analysis					
08 Sampling Soils	1,000	YR	4,948.16	4,948,157	
09 Chemical/Rad Lab Analysis	1,000	YR	4,696.04	4,696,041	
SUBTOTAL Soil Monitoring/Sampling/Analysis	1,000	YR	9,644.20	9,644,199	33%
08 Monitor Facility and Maintenance					
01 Sediment and Erosion Control	1,000	YR	801.99	801,990	
01 Site Inspection	1,000	YR	3,214.05	3,214,052	
SUBTOTAL Monitor Facility and Maintenance	1,000	YR	4,016.04	4,016,042	14%
SUBTOTAL HTRW Soils O&M	1,000	YR	29,260.28	29,260,278	50%
Alternative 4 - Excavation and Offsite Disposal - I	**41,050**	**CY**	**1,415.64**	**58,112,146**	

		Quantity		Unit Cost	Total Cost

TERC DACW27-97-D-0015 Alternative 4 - Excavation and Offsite Disposal - Industrial Land Use

33 HTRW Remedial Action

01 Land Use Controls

0801 Long Term Management Plan and Site Database

Develop Long Term Management Plan to address administrative or legal measures to reduce or minimize potential exposures to contaminants left on site.

Land Use Control Plan per USACE Real Estate Group

a) Text (60 hrs.)
b) Drawings (30 hrs.)
c) GIS/Surveying (159 hrs.)
d) Stakeholder Coordination (189 hrs) - (three, ½ day meetings; (4 Corps personnel w/2 hrs prep.); meeting notes (3); letters (8), memos etc. (4); internal meeting (4 with 3 persons and meeting notes)
e) Internal Technical Review (40 hrs.)
f) Approval Coordination (53 hrs.) (memo package; responses to comments; conf. calls (3)

Total = 531 hrs @ Senior PM Rate $125.81 = 66,805, say $67,000

Site Information Database - Assume 200 hrs to develop a site database. Use Senior Engineer Rate

		Quantity		Unit Cost	Total Cost
00010023	Long Term Management Plan	1.00	LS	67,000.00	67,000
33220104	Site Database	200.00	HR	105.20	21,041
SUBTOTAL Long Term Management Plan and Site Da		**41,050**	**CY**	**2.14**	**88,041**

0802 Land Use Controls

Implement Land Use Controls per USACE Real Estate Group

a) Coordinate with various local, state, and federal agencies to implement controls. Examples of controls requiring coordination are zoning, master plans, ordinances, environmental lists. Under each alternative 5-6 controls will be required. (192 hrs.)
b) Deed notice - Draft and record. (28 hrs.)
c) Acquire real estate interest (REI), e.g., negative easement.
(1) Research and draft real estate interest. (32 hrs.)
(2) Legal descriptions, surveying, parcel drawings. (64 hrs.)
(3) Title work (8 hrs.)
(4) Coordinate within District (8 hrs.)
(5) Coordinate w/owners (2 out of office meetings w/preparation and meeting notes, (3) Corps personnel. (68 hrs.)
(6) Subtotal = 180 hrs.
d) Approval of non-standard REI (memo package; responses to comments; conf. calls (3)); (59 hrs.)
e) SOW for appraisal. (12 hrs)
f) Appraisal of real estate interest. (64 hrs.)
g) Execute and record real estate interest
(1) Update title (5 hrs.)
(2) Update appraisal (10 hrs.)
(3) Closing and recording (12 hrs.)
(4) Subtotal = 27hrs.

Total = 562 hrs. @ Senior PM Rate $125.81 = 70,705, say $71,000

Note: This estimate is based upon no condemnation of a real estate interest. The costs do not include the fair market value of the real estate interest to be acquired.

00010025	Implement Land Use Controls	1.00	LS	71,000.00	71,000

		Quantity		Unit Cost	Total Cost
SUBTOTAL Land Use Controls		**41,050**	**CY**	**1.73**	**71,000**
SUBTOTAL Land Use Controls		**41,050**	**CY**	**3.87**	**159,041**

02 Monitoring,Sampling,Testing, & Analysis

02 Beryllium & Rad Monitoring

This WBS covers IH/HP technicians for the following areas: 2 at the excavation site to survey personnel, survey additional areas requiring excavation, and obtaining post RA samples; 2 at the loading site to survey personnel and transport vehicles; and 2 at the onsite lab to analyze samples/swipes and calibrate equipment. The IH/HP technicians and equipment would be required for the duration of field activities of 2,561 hours each spanning approximately 1.7 years. Total hours is 15,366. (See WBS 331 08 for duration calculation)

Equipment pricing base on Vendor Quote (SEC 2/2001;Rates escalated to 2/2002)- The Beryllium and Radiological monitoring equipment includes the following:

1. Model 2929 dual channel scaler (2 @ $365/mo =$730/mo)
2. Alpha Survey Instrument, 43-5 or equal (3 @ 210/mo = $630/mo)
3. Ratemeter w/GM pancake, 44-9 or equal (2 @ $195/mo = $390/mo)
4. Alarming Frisker w/ GM pancake, 44-9 or equal (5 @ $133/mo = $665/mo)
5. Micro R Meter, Model 19 or equal (2 @ $133/mo = $266/mo)
6. Personal Air Sampling pumps (3 @ $83/mo = $249/mo)
7. Personal air sampling pump charger (2 @ $52/mo = $104/mo)
8. High Volume air samplers (8 @ $130/mo = $1,040/mo)

Total = $4,074/month. Use $4,500/mo direct cost to account for other miscellaneous equipment or supplies.

33021498	IH/HP Technicians	15,366.00	HR	53.34	819,600
Vendor Quote	IH/HP Monitoring Equipment	15.00	MO	5,563.73	83,456
SUBTOTAL Beryllium & Rad Monitoring		**41,050**	**CY**	**22.00**	**903,056**

10 Waste Analysis

01 Rad Analytical Urine/Feces

33022307	Bioassays (2/yr x 2 yrs x 20 people)	80.00	EA	168.77	13,501
SUBTOTAL Rad Analytical Urine/Feces		**80**	**EA**	**168.77**	**13,501**

02 Rad/BE/RCRA Offsite Analysis

09 Chemical/Rad Lab Soils Analysis

Includes MARSSIM Samples (Reference Cost-Monitoring.xls, R Tucker and USACE comment by Hallem to increase by 50%). Assume total samples collected are 75% of the samples required for the unrestricted use cleanup alternative.

248 for class 1 areas and 169 for class 2 areas.
Total 417 samples. Assume 20% of areas need to be resampled for a total of 584 samples.
Samples will be analyzed for radionuclides, beryllium, and lead.

Assume 5% of rad/Be sampled will also have TCLP Test = 29 samples

33022036	Documentation Package for QA, verif,data	15.00	EA	139.80	2,097
33022250	Radium 226	584.00	EA	112.29	65,580
ENGR EST	Iso-Thorium	584.00	EA	162.28	94,769
33022253	Total Uranium	584.00	EA	155.78	90,978
ENGR EST	Iso-Uranium	584.00	EA	162.28	94,769
33022288	Gross Alpha/Beta	584.00	EA	84.51	49,356

		Quantity		Unit Cost	Total Cost
ENGREST	GFAA Metals	584.00	EA	116.84	68,234
ENGREST	ICPAES Metals	584.00	EA	142.80	83,397
33021705	Targeted TCLP (Metals, Volatiles, SemiVolatiles), Soil Analysis	29.00	EA	816.01	23,664
	SUBTOTAL Chemical/Rad Lab Soils Analysis	**584**	**EA**	**980.90**	**572,843**

09 Chemical/Rad Lab Air Analysis

The high volume air samplers and personal samples will be analyzed on-site. It is assumed that 5% of the samples will be sent offsite for QA verification.

Duration = 2,561 hours or 64 weeks.

High volume air samples = 5% off-site x 8 samplers x 64 weeks x 5 days/week = 128 off-site air samples

Personal air samplers = 5% off-site x 3 samplers x 64 weeks x 5 days/week = 48 off-site air samples

Samples will be analyzed for radionuclides, beryllium, and lead.

		Quantity		Unit Cost	Total Cost
33020217	Gamma Spec	176.00	EA	120.08	21,135
33022288	Gross Alpha/Beta	176.00	EA	84.51	14,874
ENGREST	ICPAES Metals	176.00	EA	142.80	25,133
	SUBTOTAL Chemical/Rad Lab Air Analysis	**176**	**EA**	**347.40**	**61,142**
	SUBTOTAL Rad/BE/RCRA Offsite Analysis	**760**	**EA**	**834.19**	**633,985**
	SUBTOTAL Waste Analysis	**41,050**	**CY**	**15.77**	**647,486**

13 On-Site Laboratory Facilities

02 Rental/Ownership/Operation

This engineering estimate is based on installing a mobile lab similar to the St. Louis FUSRAP Lab. The estimated startup costs are approximately $187,000 and includes an alpha and gamma spec unit. For the Luckey site assume $225,000 to include the additional Beryllium and Lead analytical equipment.

The estimated O&M costs for the St. Louis lab is $6,000/month. For the Luckey site assume $7,000 to include the additional Beryllium and Lead O&M cost.

Includes mobilization, monthly rental, lab equipment and furnishings, utilities, and demobilization. Personnel included in WBS 331 02 02.

		Quantity		Unit Cost	Total Cost
ENGREST	On-site Mobile Laboratory Startup Cost	1.00	LS	225,000.00	225,000
ENGREST	On-site Mobile Laboratory Rental (Engineering Estimate)	15.00	MO	7,000.00	105,000
	SUBTOTAL Rental/Ownership/Operation	**15**	**MO**	**22,000.00**	**330,000**
	SUBTOTAL On-Site Laboratory Facilities	**41,050**	**CY**	**8.04**	**330,000**
	SUBTOTAL Monitoring,Sampling,Testing, & Analysis	**41,050**	**CY**	**45.81**	**1,880,542**

03 Site Work

02 Clearing and Grubbing

Assume 5 acres of the site requires clearing prior to excavation.

		Quantity		Unit Cost	Total Cost
17010110	Wet Clearing - Light - w/o Grub D5LGP	5.00	ACR	773.49	3,867
SUBTOTAL Clearing and Grubbing		**5**	**ACR**	**773.49**	**3,867**

04 Roads/Parking/Curbs/Walks

01 Aggregate Surfacing

Assume 2,000 lf of haul roads required at 12 inch thick and 12 ft wide at base. Include 6 oz geotextile. Area = 2,700 sy.

Add 50% to cost for small area.

		Quantity		Unit Cost	Total Cost
027202000300	Haul Road - Crushed 3/4 in stone base, 12 in.	2,700.00	SY	4.34	11,721
027202006000	Geotextile, 6 oz/sy	2,700.00	SY	1.81	4,878
SUBTOTAL Aggregate Surfacing		**2,000**	**SY**	**8.30**	**16,600**

02 Staging and Loading Area

Cost assembly based on the RACER parametric cost modeling program. The decontamination facility model was used and modified for a staging and loading area. The heavy equipment rating option was used to calculate quantities for the concrete slab.

The total concrete slab area calculated for soils staging (5,000 cy), soils loading, and truck staging (2 ea) was 11,000 sf. This does not include truck turn-around area.

		Quantity		Unit Cost	Total Cost
17030109	Pad Subgrade Preparation	980.00	CY	5.85	5,733
17030257	Cat 215, 1.0 CY, Soil, Shallow, Trenching	3.47	CY	1.62	6
17030501	Compact Subgrade, 2 Lifts	980.00	CY	0.61	598
17030510	Dry Roll Gravel, Steel Roller	1,468.00	SY	1.05	1,541
18010102	Gravel, Delivered & Dumped	407.00	CY	27.67	11,262
18010103	Gravel (90%) & Sand Base (10%), with Calcium Chloride 3/4 - 1 Lb/CY	407.00	CY	28.07	11,424
18010201	Concrete Curb, 6" x 6"	859.00	LF	2.68	2,302
18010203	26" x 26", 5' Deep Area Drain with Grate	1.00	EA	3,370.74	3,371
18020321	6" Structural Slab on Grade	11,000.00	SF	6.40	70,400
19020313	5' x 5' x 5' Reinforced Concrete Sump	1.00	EA	4,048.88	4,049
19020604	12" x 12" CIP Concrete In-Ground Trench Drain with Metal Grate	39.00	LF	118.12	4,607
33080532	8 oz/sy Erosion Control/Drainage Filter Fabric (80 Mil)	1,468.00	SY	1.54	2,261
SUBTOTAL Staging and Loading Area		**11,000**	**SF**	**10.69**	**117,553**

03 Truck Scales

		Quantity		Unit Cost	Total Cost
33010462	Truck Scale Rental	15.00	MO	3,000.00	45,000
SUBTOTAL Truck Scales		**1**	**EA**		**45,000**
SUBTOTAL Roads/Parking/Curbs/Walks		**41,050**	**CY**	**4.36**	**179,153**

05 Fencing

Assume installation of snow fence to prohibit access to contaminated areas. Area to be disturbed is 20 acres. Perimeter = 3,750 lf. Assume 75% of the area impacted under the unrestricted use cleanup alternative.

		Quantity		Unit Cost	Total Cost
028205237001	Snow Fence on Stl Post, 10' OC, 4' high	3,750.00	LF	3.84	14,409

		Quantity		Unit Cost	Total Cost
SUBTOTAL Fencing		**3,750**	**LF**	**3.84**	**14,409**
SUBTOTAL Site Work		**41,050**	**CY**	**4.81**	**197,429**

05 Surface Water Collect & Control

01 Sediment Barriers

Assume installation of silt fence and hay bales around perimeter of contaminated areas. Area to be disturbed is 20 acres. Perimeter = 3,750 lf. Assume 75% of the area impacted under the unrestricted use cleanup alternative.

		Quantity		Unit Cost	Total Cost
023705501100	Silt Fences, Polypropylene, 3' High, Adverse Conditions	3,750.00	LF	0.96	3,588
023705501250	Hay Bales, staked	3,750.00	LF	3.06	11,493
SUBTOTAL Sediment Barriers		**3,750**	**LF**	**4.02**	**15,081**

02 Contact Water Control and Collection

The average annual rainfall is 32.3 inches and 16.2 inches occurs during the warmer months of May thru September. 5.7 inches occurs during December through February when it is assumed there are no operations. The monthly range is from 1.6 inches (Feb) to 3.8 inches (Jun). Given the low monthly rainfall events, most rainfall will naturally percolate into the underlying soils.

It will be assumed that any water requiring collection will be slowly discharged to an existing contaminated low-lying area of the site or used for moisture conditioning. Since the majority of the rainfall occurs in the warmer months, most water requiring collection can be used for moisture conditioning soils.

The average monthly accumulation during the 9 working months is 2.96 inches. Say 3 inches for calculating the required storage capacity.

Assume maximum of 30,000 sf open excavation area.
Assume 20% infiltration.

Volume = 30,000 sf x 0.25 inches rain x 0.80 = 6,000 cf
Volume = 6,000 cf x 7.48 gal/cf = 44,880 gallons

Use 2 ea, 21,000 gallon wastewater storage tanks for the duration of excavation activities.

Duration = 15 months x 2 tanks = 30 months

Assume pumps will be required an average of 3 days/month for 15 months = 45 days.

		Quantity		Unit Cost	Total Cost
17031003	3" Diameter Contractor's Trash Pump, 150 GPM	45.00	DAYS	63.32	2,849
19040407	21,000 Gallon, Steel Closed Stationary Aboveground Wastewater Holding Tank, Rental	30.00	MO	1,758.26	52,748
33109649	Pump, Cast-iron Close Coupling, 2 HP, 50 GPM	2.00	EA	1,691.70	3,383
33231306	High Sump Level Switch for Avoiding Overflow	4.00	EA	472.46	1,890
33260550	2" Polyethylene, flexible piping, SDR15, 125 psi	1,000.00	LF	1.34	1,340
SUBTOTAL Contact Water Control and Collection		**1**	**LS**		**62,210**
SUBTOTAL Surface Water Collect & Control		**41,050**	**CY**	**1.88**	**77,292**

08 Solids Collection/Containment

		Quantity		Unit Cost	Total Cost

01 Contaminated Soil Excavation

Total Excavation Volume w/ 20% overexcavation and 10% constructability (in situ cy) = 41,050

Total Excavation Volume w/ 20% expansion (ex situ cy) = 49,250 (also referred to as the Transportation Volume)

One excavation crew will be assumed for calculating excavation durations. The crew will consist of 1 excavator, 1 operator, 1 oiler, and 2 laborers. Expected output per crew per day is 208 cy per crew, based on an adjusted hourly output of 26 cy/hr (See RS Means 2002 for 1 cy excavator productivity Ref 02315 400 0200). Equipment output has been decreased 66% to allow for site, safety and soil factors described in the project notes. The excavator productivity will determine productivity for the crew.

The transportation crew will transport soils to the staging area. The crew will consist of 2 dump trucks and drivers. Total daily output is the same as excavator or 208 cy/day.

Excavators will remove in situ soils and load trucks for transport of materials to the temporary staging area. The laborers will be used for equipment spotters, dust control, decon, maintaining erosion and sediment installation, etc.

02 Excavation of Contaminated Soils

The crew will excavate 41,050 cy of soils at 26 cy/hr for a total of 1,579 hours.

Assume surveyors are required for 15 events at 4 hours each.

		Quantity		Unit Cost	Total Cost
011077001200	Survey Areas to be Excavated and As-builts (2 people)	7.50	DAY	803.65	6,027
015902000150	Hyd. Excavator, 1 C.Y.	1,579.00	HR	87.08	137,497
CLAB	Common Building Laborers (2 ea)	3,158.00	HR	34.90	110,212
EQMD	Equipment Operators, Medium Equipment	1,579.00	HR	46.43	73,318
EQOL	Equipment Operators, Oilers	1,579.00	HR	39.66	62,626
SUBTOTAL Excavation of Contaminated Soils		**41,050**	**CY**	**9.49**	**389,680**

04 Transport to Staging Area

The crews productivity will be limited by the excavators productivity. Therefore, the total crew hours will be the same at 1,579 hours based on a productivity of 26 cy/hour.

		Quantity		Unit Cost	Total Cost
015902005300	Dump Truck, 16 Ton (2 each)	3,158.00	HR	72.74	229,702
TRHV	Truck Drivers, Heavy (2 each)	3,158.00	HR	37.21	117,497
SUBTOTAL Transport to Staging Area		**49,250**	**CY**	**7.05**	**347,198**
SUBTOTAL Contaminated Soil Excavation		**41,050**	**CY**	**17.95**	**736,878**

		Quantity		Unit Cost	Total Cost

02 Load Trucks at Staging Area

This WBS is for loading contaminated materials at the staging area for transport to the disposal destination. Ten intermodals per day are assumed available. Each holds 20 tons for a total shipment of 200 tons/day. Based on shipment of 200 tons/day, 22 days/mos. for 9 mos./yr, the duration for excavation and loading containers with 49,250 cy or 64,025 tons of ex situ soils would be 321 days or 1.7 years. Assumes 1.3 ton/cy conversion factor.

The loading crew will consist of three laborers and one front end loader w/operator. The laborers will protect trucks from becoming contaminated, lining trucks, spotting for loader, taping liners closed, and light decontamination. Additionally, they will uncover/cover stockpile with tarp and ballast.

Loading output is equivalent to 10 intermodal containers per day for a total daily shipping 200 tons/day (25 tons/hr).

Loading 64,025 tons of soils at a rate of 25 tons/hr results in a total duration of 2,561 hours.

		Quantity		Unit Cost	Total Cost
015902004710	F.E. Loader, W.M., 2.5 C.Y.	2,561.00	HR	57.24	146,603
CLAB	Common Building Laborers (3 ea)	7,683.00	HR	34.90	268,131
ENGR EST	Staging Pile Tarp and Ballast	1.00	LS	6,491.02	6,491
EQMD	Equipment Operators, Medium Equipment	2,561.00	HR	46.43	118,915
SUBTOTAL Load Trucks at Staging Area		**49,250**	**CY**	**10.97**	**540,140**
SUBTOTAL Solids Collection/Containment		**41,050**	**CY**	**31.11**	**1,277,018**

19 Transportation and Disposal

01 Transportation to Disposal Facility

US Ecology of Idaho (Low Level Waste/Rads Alone and with Be Soils)
Total to be Transported = 48,200 cy or 62,700 tons
Unit Price = $150.15/ton
Based on quote given by MHF Transportation and includes hauling from the site to an intermodal loading facility in Toledo and transporting via rail to Envirocare. US Ecology is approximately 15% further in road distance, so 10% will be added to the Envirocare quote. Unit rate based on each rail car holding 6 intermodals and each intermodal holding 20 tons each. Assume each intermodal will have average 6 week turnaround time rental (time it arrives on site to time it is returned to site). Based on loading 10 intermodals per day, 300 intermodal containers will be required. The total number of intermodals trips is 3,135 (62,700 tons/ 20 tons/intermodal). Unit Rate to US Ecology = $2,730/container x 1.1 = $3,003/container. Assume 20 ton capacity is used. $3,003/20 ton = $150.15/ton

US Ecology of Idaho (Mixed Waste/Rads With Lead or Be Soils)
Total to be Transported = 1,100 cy or 1,450 tons
Unit Price = $150.15/ton
Assume same rate as LLW to US Ecology. Based on loading 10 intermodals per day, 73 intermodal containers will be required. The total number of intermodals required is 73 (1,450 tons/20 tons/intermodal). Unit Rate to US Ecology = $2,730/container x 1.1 = $3,003/container. Assume 20 ton capacity is used. $3,003/20 ton = $150.15/ton

US Ecology of Idaho (LLW with Be)

Assume demurrage allowance charge on 10% of containers for 1 hour @ $65/hour.

3,135 containers x 10% x 1 hour = 314 hours.

		Quantity		Unit Cost	Total Cost
VENDOR	Mob & Demob of Containers	300.00	EA	1,000.00	300,000
VENDOR	Transport to US Ecology	62,700.00	TON	150.15	9,414,405
VENDOR	Demurrage	316.00	HRS	65.00	20,540

		Quantity		Unit Cost	Total Cost
SUBTOTAL US Ecology of Idaho (LLW with Be)		**48,200**	**CY**	**201.97**	**9,734,945**

US Ecology of Idaho (Mixed Waste)

Assume use of LLW containers. No separate mob/demob included.

Assume demurrage allowance charge on 10% of containers for 1 hour @ $65/hour.
73 containers x 10% x 1 hour = 8 hours.

		Quantity		Unit Cost	Total Cost
VENDOR	Transport to US Ecology	1,450.00	TON	150.15	217,718
VENDOR	Demurrage	8.00	HRS	65.00	520
SUBTOTAL US Ecology of Idaho (Mixed Waste)		**1,100**	**CY**	**198.40**	**218,238**
SUBTOTAL Transportation to Disposal Facility		**49,250**	**CY**	**202.10**	**9,953,183**

02 LLW Disposal Costs

US Ecology of Idaho (Low Level Waste/Rads Alone and with Be Soils)
Total to be Transported = 48,200 cy
Unit Price = $71.50/cy (Based on USACE DACW41-99-D-9007 Intermodal Soil Rate)

US Ecology of Idaho (Mixed Waste/Rads With Lead or Be Soils)
Total to be Transported = 1,100 cy
Unit Price = $97.50/cy (Based on USACE DACW41-99-D-9007 Intermodal Soil Rate with state hazardous waste surcharge)

US Ecology of Idaho (LLW with Be)

		Quantity		Unit Cost	Total Cost
USACE	Disposal of LLW and LLW/BE at US Ecology, ID	48,200.00	CY	71.50	3,446,300
SUBTOTAL US Ecology of Idaho (LLW with Be)		**48,200**	**CY**	**71.50**	**3,446,300**

US Ecology of Idaho (Mixed Waste)

		Quantity		Unit Cost	Total Cost
USACE	Disposal of Mixed Waste Soils at US Ecology, ID	1,100.00	CY	97.50	107,250
SUBTOTAL US Ecology of Idaho (Mixed Waste)		**1,100**	**CY**	**97.50**	**107,250**
SUBTOTAL LLW Disposal Costs		**49,250**	**CY**	**72.15**	**3,553,550**
SUBTOTAL Transportation and Disposal		**49,250**	**CY**	**274.25**	**13,506,733**

20 Site Restoration

01 Earthwork

03 Backfill

		Quantity		Unit Cost	Total Cost
17030423	Unclassified Fill, 6" Lifts, Off-Site, Includes Delivery, Spreading, and Compacting	49,250.00	CY	10.89	536,424
SUBTOTAL Backfill		**49,250**	**CY**	**10.89**	**536,424**
SUBTOTAL Earthwork		**49,250**	**CY**	**10.89**	**536,424**

03 Permanent Features

		Quantity		Unit Cost	Total Cost
01 Roads					
	Assume 75% of the area impacted under the unrestricted use cleanup alternative.				
	Assume 30,000 sf (1,500 lf at 20 ft wide) of road way/parking lot repair. Assume 10 in gravel base and 2.5 in asphalt, 6.75 ft ditch, and 1 culvert. The majority of the impacted areas are currently in vegetated areas.				
17030103	Rough Grading	8,333.00	SY	1.20	10,026
17030108	Fine Grading, 130G, 2 Passes	4,167.00	SY	0.23	949
17030202	Ditch Excavation, Normal Soil, Haul Spoil 1 mile	1,875.00	CY	3.44	6,453
18010102	Gravel, Delivered and Dumped	1,158.00	CY	29.50	34,156
18010310	Prime Coat	3,333.00	SY	0.48	1,614
18010312	Asphalt Wearing Course, 1 Pass (Inc 5% Waste)	454.00	TON	75.34	34,206
19030402	34' Complete, 24" Corrugated Metal Pipe, Culvert w/Headwall	1.00	EA	7,053.84	7,054
SUBTOTAL Roads		**30,000**	**SF**	**3.15**	**94,458**
02 Structures					
	Assume 75% of the area impacted under the unrestricted use cleanup alternative.				
	Assume approximately 525 lf of fence needs to be replaced.				
028205280800	Fence, Industrial, 6 ft, 6 ga, omit barbed, galv steel	525.00	LF	23.58	12,381
SUBTOTAL Structures		**525**	**LF**	**23.58**	**12,381**
SUBTOTAL Permanent Features		**49,250**	**CY**	**2.17**	**106,840**
04 Revegetation And Planting					
	Assume 75% of the area impacted under the unrestricted use cleanup alternative.				
	Approximately 18 acres of the site will be disturbed. Assumes area of excavation plus 10% of additional area adjacent to excavation. Total = 20 acres.				
01 Seeding/Mulch/Fertilizer					
17040101	General Area Cleanup	20.00	ACR	382.81	7,656
18050101	Area Preparation	20.00	ACR	89.82	1,796
18050401	Hydroseeding, 67% Level & 33% Sloped	20.00	ACR	661.17	13,223
18050408	Fertilizer, Hydro Spread	20.00	ACR	197.59	3,952
18050413	Watering with 3000-gallon Tank Truck	20.00	ACR	78.35	1,567
SUBTOTAL Seeding/Mulch/Fertilizer		**20**	**ACR**	**1,409.74**	**28,195**
SUBTOTAL Revegetation And Planting		**20**	**ACR**	**1,409.74**	**28,195**
SUBTOTAL Site Restoration		**49,250**	**CY**	**13.63**	**671,458**
SUBTOTAL HTRW Remedial Action		**41,050**	**CY**	**432.87**	**17,769,513**

34 HTRW Soils O&M

01 Land Use Controls

		Quantity		Unit Cost	Total Cost

0801 Long Term Management Plan and Site Database

Maintain O&M plan to address administrative or legal measures to reduce or minimize potential for exposure to contaminants left on site.

Long Term Management Plan - Assume 40 hrs/yr for 1,000 yrs = 40,000 hrs to coordinate with stakeholders and make revisions to plan. Use Senior PM Rate.

Site Information Database - Assume 16 hrs/yr for 1,000 yrs = 16,000 hrs to update site database. Use Senior Engineer Rate.

		Quantity		Unit Cost	Total Cost
33220101	Long Term Management Plan	40,000.00	HR	125.81	5,032,358
33220104	Site Database	16,000.00	HR	105.20	1,683,241
SUBTOTAL Long Term Management Plan and Site Da		**1,000**	**YR**	**6,715.60**	**6,715,598**

91 Reports

99 Five Year Reviews (Years 0-1,000 = 200 events)

		Quantity		Unit Cost	Total Cost
33220102	Project Manager (60 hours/report x 200 events)	12,000.00	HR	105.39	1,264,738
33220109	Field Geologist (80 hours/report x 200 events)	16,000.00	HR	60.56	968,885
33220114	Word Processing (20 hrs/report x 200 events)	4,000.00	HR	35.09	140,343
SUBTOTAL Five Year Reviews (Years 0-1,000 = 200 eve		**1,000**	**YR**	**2,373.97**	**2,373,967**
SUBTOTAL Reports		**1,000**	**YR**	**2,373.97**	**2,373,967**
SUBTOTAL Land Use Controls		**1,000**	**YR**	**9,089.57**	**9,089,565**

02 Soil Monitoring/Sampling/Analysis

08 Sampling Soils

Assume 10 soil samples taken per year for 1000 years to monitor contaminants and support property owner.

Duration is 2 days per year (5 samples per event). Samples will be analyzed for ICPAES metals and GFAA metals.

10 Soil Sampling (Years 0-1,000)

		Quantity		Unit Cost	Total Cost
33020401	Disposable Materials per Sample (gloves,jars,tape,ice,isop) (10 samples x 1,000 years)	10,000.00	EA	9.96	99,572
33020402	Decon. Materials per Sample (deion. water,soap)(10 samples x 1,000 years)	10,000.00	EA	8.96	89,576
33021498	Sampling Technicians (2 ea x 2 days x 1,000 years)	32,000.00	HR	53.34	1,706,833
33022028	250 ml, clear, w/septa, wide sample jars (10 x 1,000 years)	10,000.00	EA	72.05	720,503
33022034	Chain of Custody Seals (pkg of 5) (2 packs x 1,000 years)	2,000.00	EA	2.28	4,570
33022046	60 Quart Ice Chest (2 ea x 1,000 years)	2,000.00	EA	76.59	153,188
33022063	Overnite Delivery to Lab (21-50 lb) (2 ea x 1,000 years)	2,000.00	EA	54.43	108,867
SUBTOTAL Soil Sampling (Years 0-1,000)		**1,000**	**YR**	**2,883.11**	**2,883,109**
SUBTOTAL Sampling Soils		**1,000**	**YR**	**2,883.11**	**2,883,109**

		Quantity		Unit Cost	Total Cost
09 Chemical/Rad Lab Analysis					
Assume 10 soil samples taken per year for 1000 years to monitor contaminants.					
Samples will be analyzed for beryllium and lead.					
10 Soil Analysis (Years 0 - 1,000)					
33022036	Documentation Package for QA, verif,data (1/event)	1,000.00	EA	139.80	139,804
ENGREST	ICPAES Metals (10 Samples/event x 1,000 events)	10,000.00	EA	142.80	1,428,024
ENGREST	GFAA Metals (10 Samples/event x 1,000 events)	10,000.00	EA	116.84	1,168,383
SUBTOTAL Soil Analysis (Years 0 - 1,000)		**1,000**	**YR**	**2,736.21**	**2,736,210**
SUBTOTAL Chemical/Rad Lab Analysis		**1,000**	**YR**	**2,736.21**	**2,736,210**
SUBTOTAL Soil Monitoring/Sampling/Analysis		**1,000**	**YR**	**5,619.32**	**5,619,319**
08 Monitor Facility and Maintenance					
Monotor site for 1,000 year duration due to CERCLA requirements since contaminants remain on site above the unrestricted release criteria.					
01 Sediment and Erosion Control					
Assume an average annual cost of $500/year to maintain vegetation and prevent erosion and sediment runoff.					
ENGR EST	Sediment and Erosion Control	1,000.00	YR	500.00	500,000
SUBTOTAL Sediment and Erosion Control		**1,000**	**YR**	**500.00**	**500,000**
01 Site Inspection					
Assume annual site inspection totaling 24 hours for travel ,inspection, and report. 1000 year period x 24 hrs = 24,000 hrs.					
33220105	Project Engineer	24,000.00	HR	78.03	1,872,710
SUBTOTAL Site Inspection		**1,000**	**YR**	**1,872.71**	**1,872,710**
SUBTOTAL Monitor Facility and Maintenance		**1,000**	**YR**	**2,372.71**	**2,372,710**
SUBTOTAL HTRW Soils O&M		**1,000**	**YR**	**17,081.59**	**17,081,594**
SUBTOTAL		***41,050***	***CY***	***848.99***	***34,851,107***
General Conditions - PRIME CONTRACTOR AA		3.0%		14.77	606,131
Prime Markup on Subs - PRIME CONTRACTOR AA		4.0%		19.69	808,174
SUBTOTAL		***41,050***	***CY***	***883.44***	***36,265,412***
Contingency		25.0%		220.86	9,066,353
Remedial Design		4.0%		43.98	1,805,245
Project Management		5.0%		57.17	2,346,818

	Quantity	Unit Cost	Total Cost
Construction Management	10.0%	120.06	4,928,319
Owner Costs	6.8%	90.13	3,700,000
Alternative 4 - Excavation and Offsite Disposal - Ind	**41,050 CY**	**1,415.64**	**58,112,146**

Alternative 5 - Excavation and Offsite Disposal-Unrestricted Land Use

Project No. TERC DACW27-97-D-0015

Designed By:

Science Applications International Corporation

Estimated By:

Mike Poligone

Prepared By: Mike Poligone

Preparation Date: 10/10/2002

Effective Date of Pricing: 10/10/2002

Est Construction Time: 0 Days

CostLink CM Report	**Page Number**

PROJECT DESCRIPTION: ALTERNATIVE 5 - EXCAVATION AND OFFSITE DISPOSAL - UNRESTRICTED LAND USE

This alternative involves removing contaminated soils above the subsistence farmer cleanup criteria from the site and disposing at commercial disposal

shipments) or truck to the disposal facility (applicable for regional facilities). Contaminated materials would be transported to their designated disposal locations. A breakdown of waste streams and disposal facilities is shown below. (See the Luckey site FS for more details about the Luckey site and this

PROJECT BREAKDOWN:

The Hazardous, Toxic, Radioactive Waste Work Breakdown Structure (HTRW WBS), February 1996, was used as the basis for organizing the cost

from the HTRW Remedial Action Work Breakdown Structure. The 2 digit numbers for the remaining title levels are user defined.

LEVEL 1 - WBS Level 1 (Account)- Luckey Alternative 5

LEVEL 3 - WBS Level 3 (Subsystem) - Contaminated Soil Collection
LEVEL 4 - User Defined (Assembly Category or Other) - Excavation of Contaminated Soils

The Level 2 WBS elements for this estimate are as follows:

33. HTRW REMEDIAL ACTION

33 03 Site Work
33 05 Surface Water Collection/Control

33.19 Disposal (Commercial)
33.20 Site Restoration

LUCKEY SITE SOIL VOLUMES:

Soil Volume Estimates Grouped By Waste Stream (Rounded to the nearest 50 cy)

In Situ Most Likely Volume (cy) = 35,450
Including 20% Overexcavation (cy) = 42,500

Including 20% Swell Factor (cy) = 56,150
Total Disposal Volume (cy) = 56,150

In Situ Most Likely Volume (cy) = 7,200
Including 20% Overexcavation (cy) = 8,650

Including 20% Swell Factor (cy) = 11,450
Total Disposal Volume (cy) = 11,450

In Situ Most Likely Volume (cy) = 8,800
Including 20% Overexcavation (cy) = 10,550

Including 20% Swell Factor (cy) = 13,950
Total Disposal Volume (cy) = 13,950

In Situ Most Likely Volume (cy) = 150
Including 20% Overexcavation (cy) = 150

Including 20% Swell Factor (cy) = 200
Total Disposal Volume (cy) = 200

In Situ Most Likely Volume (cy) = 1,450
Including 20% Overexcavation (cy) = 1,750

Including 20% Swell Factor (cy) = 2,300
Total Disposal Volume (cy) = 2,300

Mixed Waste Soils (LLW, Lead, and Be)
In Situ Most Likely Volume (cy) = 2,350
Including 20% Overexcavation (cy) = 2,850
Including 10% Constructability (cy) = 3,100
Including 20% Swell Factor (cy) = 3,750
Total Disposal Volume (cy) = 3,750

Total of All Soils
In Situ Most Likely Volume (cy) = 55,400
Including 20% Overexcavation (cy) = 66,500
Including 10% Constructability (cy) = 73,150
Including 20% Swell Factor (cy) = 87,750
Total Disposal Volume (cy) = 87,750

Soil Volume Estimates Grouped By Disposal Facility (Rounded to the nearest 50 cy)

Envirosource, Ohio (Be Soils)
In Situ Most Likely Volume (cy) = 35,450
Including 20% Overexcavation (cy) = 42,500
Including 10% Constructability (cy) = 46,800
Including 20% Swell Factor (cy) = 56,150
Total Disposal Volume (cy) = 56,150

US Ecology of Idaho (Low Level Waste/Rads Alone and with Be Soils)
In Situ Most Likely Volume (cy) = 16,000
Including 20% Overexcavation (cy) = 19,200
Including 10% Constructability (cy) = 21,150
Including 20% Swell Factor (cy) = 25,350
Total Disposal Volume (cy) = 25,350

US Ecology of Idaho (Mixed Waste/Rads With Lead or Be Soils)
In Situ Most Likely Volume (cy) = 2,500
Including 20% Overexcavation (cy) = 3,000
Including 10% Constructability (cy) = 3,300
Including 20% Swell Factor (cy) = 3,950
Total Disposal Volume (cy) = 3,950

Waste Management (Lead Alone or With Be Soils)
In Situ Most Likely Volume (cy) = 1,450
Including 20% Overexcavation (cy) = 1,750
Including 10% Constructability (cy) = 1,900
Including 20% Swell Factor (cy) = 2,300
Total Disposal Volume (cy) = 2,300

Total of All Soils
In Situ Most Likely Volume (cy) = 55,400
Including 20% Overexcavation (cy) = 66,500
Including 10% Constructability (cy) = 75,150
Including 20% Swell Factor (cy) = 87,750
Total Disposal Volume (cy) = 87,750

1. The "Total Volume" was calculated with a software package named EarthVision developed by Dynamic Graphics, Incorporated (www.dgi.com) using the Minimum Tension Gridding Algorithm along with engineering judgment to confine and shape the modeled extents.
2. In situ excavation volumes include a 20% increase to account for overexcavation.
3. An additional 10% increase is included to account for constructability.
4. Ex situ excavation volumes include a 20% increase to account for expansion of soil (swell factor).

SCHEDULE SUMMARY:

The schedule is based on working 8 hours/day, 22 days/month, and 9 months/year.

Estimated Project duration: 4.9 yrs.

Engineering Design 1.0 yrs.
Excavation/Disposal of soils/materials 2.9 yrs.
Post-Remediation Report and As-builts 1.0 yrs.

Productivity, as a baseline and as taken from the Unit Price Book (UPB) Database, assumes a non-contaminated working environment with no level of protection productivity reduction factors. Productivity reduction

been applied:

1. Site Constraint - 70%. This factor is based on engineering judgment and is developed on a site by site basis. It is used to adjust productivity levels

excavation and loading equipment. Backfill equipment is excluded. Based on a work schedule availability of 40 weeks/year and a 12 week delay due to weather (4 weeks), unsafe conditions (1 weeks), job sequencing (1 weeks), soil drying (2 weeks), utility shutoff/interruption (0 weeks), and location of

total weeks/year = 70%.

2. Soil adjustment - 75%. This factor is based on engineering judgment based on borings taken from the site and is developed on a site by site basis.

bedrock; or concentrated area of contamination vs. spotty areas of contamination over large areas). This factor is applied to excavation equipment as required. Backfill equipment is excluded. If not required, factor will be 100%. For the Luckey site, production capacity will be reduced due to spatial

will be adjusted by 75%. Delays due to wet soils are addressed under the site constraint.

3. Safety factor - 65%. This is the standard factor developed by SAIC, which is used to adjust productivity levels due to safety procedures associated

factor is explained in the backup material for safety factor derivation.

Total productivity adjustment is equal to the site adjustment x soil adjustment x safety adjustment. For this estimate, the total productivity adjustment

ESCALATION:

(Annual Rates in Percentages) for Budget Authority in the memorandum dated 3 January, 2002 from the Comptroller of the Under Secretary of Defense, Subject: Revised Inflation Guidance, and the Department of the Army, DACS-PCB MEMO 2000-002 of Feb 2002, Subject: Revised Inflation Indices for

OVERHEAD COSTS

The following overhead markups have been applied to the Subcontractor's direct cost. (note: no markups have been applied to the transportation and

contract).

Professional Labor - A 140% markup was applied to professional labor for fringe benefits, paid vacation, medical insurance, holidays, retirement

Craft Labor - A 30% markup was applied to craft labor for fringe benefits, paid vacation, medical insurance, holidays, retirement accounts, etc.

Equipment and Materials - A 8% markup was applied to all equipment and materials for indirect labor.

including temporary facilities and utilities, telephone and communication, permits and licenses, subcontractor submittals, travel and per diem, personal protective equipment, insurance, bonds, and taxes.

The following Overhead Markups have been applied to the Prime Contractor's direct cost.

General Conditions - A 3% markup was applied to the direct project cost to account for all general conditions (i.e. Mobilization and Demobilization cost),

protective equipment, insurance, bonds, and taxes.

Prime Markup on Sub - A 4% markup was applied to all subcontracted work. Indicates the percentage of profit a prime contractor will make on work

subcontractor's work. The prime profit on subcontractors is applied to the total subcontract project cost, including subcontractor's direct costs, overhead, and profit.

Contingencies are shown for both Design Contingencies and Construction Contingencies. EPA Guidance 540-R-00-002, July 2000 was used as a reference in developing design and construction contingencies.

A design contingency of 15% is being applied due to the proven implementation of these technologies. Excavation and offsite disposal technologies have been successfully implemented at other superfund sites however the design details (cleanup criteria, disposal facilities, overexcavation required) of the soils to be excavated has not been finalized.

A construction contingency of 10% is being applied due to the potential for increases in soil volumes that have been common at other FUSRAP sites. This would also include cost overruns, modifications, and change orders.

DESIGN AND TECHNICAL SUPPORT COSTS:

Remedial design applies to capital cost and O&M cost and includes services to design the remedial action. Activities that are part of remedial design include pre-design collection and analysis of field data, engineering survey for design, treatability study (e.g., pilot-scale), and the various design components such as design analysis, plans, specifications, cost estimate, and schedule at the preliminary, intermediate, and final design phases including post RA documentation. Remedial Design has been included as a 4% markup of the total remedial action costs.

PROJECT MANAGEMENT

Project management includes services that are not specific to remedial design, construction management, or technical support of O&M activities. Project management includes planning and reporting, community relations support during construction or O&M, bid or contract administration, permitting (not already provided by the construction or O&M contractor), and legal services outside of land use controls (e.g., licensing). Project Management has been included as a 5% markup of the total remedial action costs.

CONSTRUCTION MANAGEMENT

Construction management includes services to manage construction or installation of the remedial action. Activities include review of submittals, design modifications, construction observation or oversight, engineering survey for construction, preparation of O&M manual, documentation of quality control/quality assurance, and record drawings. For the Luckey site, this will include a full-time site manager, field engineer, clerical, safety and health officer, and waste management coordinator. It also includes HP, QA, and engineering during construction. Construction Management has been included as a 10% markup of the total remedial action costs.

OWNER COST

USACE oversight cost includes Program Management, Project Management, Construction Management, Design Reviews, Quality Assurance, HP Support, Cooperative Agreements with Others, Engineering During Construction, etc. The cost was estimated by LRB to be approximately $1 million per year. The estimated schedule for design, construction, and port RA closeout is 5 years for a total owner cost of $5 million.

TERC DACW27-97-D-0015 Alternative 5 - Excavation and Offsite Disposal-Unrestricted Land Use

	Quantity		Unit Cost	Total Cost	
33 HTRW Remedial Action					
02 Monitoring,Sampling,Testing, & Analysis					
02 Beryllium & Rad Monitoring	73,150	CY	42.30	3,093,945	
10 Waste Analysis	73,150	CY	18.98	1,388,686	
13 On-Site Laboratory Facilities	73,150	CY	9.85	720,745	
SUBTOTAL Monitoring,Sampling,Testing, & Analysis	73,150	CY	71.13	5,203,375	14%
03 Site Work					
02 Clearing and Grubbing	5	ACR	1,440.86	7,204	
04 Roads/Parking/Curbs/Walks	73,150	CY	5.35	391,477	
05 Fencing	4,350	LF	7.16	31,136	
SUBTOTAL Site Work	73,150	CY	5.88	429,817	1%
05 Surface Water Collect & Control					
01 Sediment Barriers	4,350	LF	7.49	32,588	
02 Contact Water Control and Collection				197,307	
SUBTOTAL Surface Water Collect & Control	73,150	CY	3.14	229,896	1%
08 Solids Collection/Containment					
01 Contaminated Soil Excavation	73,150	CY	33.37	2,441,219	
02 Load Trucks at Staging Area	87,750	CY	20.33	1,784,043	
SUBTOTAL Solids Collection/Containment	73,150	CY	57.76	4,225,263	12%
19 Transportation and Disposal					
01 Transportation to Disposal Facility	87,750	CY	151.15	13,263,728	
02 LLW Disposal Costs	87,750	CY	125.54	11,015,989	
SUBTOTAL Transportation and Disposal	87,750	CY	276.69	24,279,717	67%
20 Site Restoration					
01 Earthwork	87,750	CY	20.29	1,780,385	
03 Permanent Features	87,750	CY	2.97	260,880	
04 Revegetation And Planting	27	ACR	2,626.05	70,903	
SUBTOTAL Site Restoration	73,150	CY	28.87	2,112,168	6%
SUBTOTAL HTRW Remedial Action	73,150	CY	498.70	36,480,234	100%
Alternative 5 - Excavation and Offsite Disposal-Unrestricte	**73,150**	**CY**	**498.70**	**36,480,234**	

		Quantity		Unit Cost	Total Cost

TERC DACW27-97-D-0015 Alternative 5 - Excavation and Offsite Disposal-Unrestricted Land Use

33 HTRW Remedial Action

02 Monitoring,Sampling,Testing, & Analysis

02 Beryllium & Rad Monitoring

This WBS covers IH/HP technicians for the following areas: 2 at the excavation site to survey personnel, survey additional areas requiring excavation, and obtaining post RA samples; 2 at the loading site to survey personnel and transport vehicles; and 2 at the onsite lab to analyze samples/swipes and calibrate equipment. The IH/HP technicians and equipment would be required for the duration of field activities of 4,564 hours each spanning approximately 2.9 years. Total hours is 27,384. (See WBS 331 08 for duration calculation)

Equipment pricing base on Vendor Quote (SEC 2/2001;Rates escalated to 2/2002)- The Beryllium and Radiological monitoring equipment includes the following:

1. Model 2929 dual channel scaler (2 @ $365/mo =$730/mo)
2. Alpha Survey Instrument, 43-5 or equal (3 @ 210/mo = $630/mo)
3. Ratemeter w/GM pancake, 44-9 or equal (2 @ $195/mo = $390/mo)
4. Alarming Frisker w/ GM pancake, 44-9 or equal (5 @ $133/mo = $665/mo)
5. Micro R Meter, Model 19 or equal (2 @ $133/mo = $266/mo)
6. Personal Air Sampling pumps (3 @ $83/mo = $249/mo)
7. Personal air sampling pump charger (2 @ $52/mo = $104/mo)
8. High Volume air samplers (8 @ $130/mo = $1,040/mo)

Total = $4,074/month. Use $4,500/mo direct cost to account for other miscellaneous equipment or supplies.

		Quantity		Unit Cost	Total Cost
33021498	IH/HP Technicians	27,384.00	HR	53.34	1,460,622
Vendor Quote	IH/HP Monitoring Equipment	36.00	MO	5,563.73	200,294
SUBTOTAL Beryllium & Rad Monitoring		**73,150**	**CY**	**22.71**	**1,660,916**

10 Waste Analysis

01 Rad Analytical Urine/Feces

		Quantity		Unit Cost	Total Cost
33022307	Bioassays (2/yr x 3 yrs x 20 people)	120.00	EA	168.77	20,252
SUBTOTAL Rad Analytical Urine/Feces		**120**	**EA**	**168.77**	**20,252**

02 Rad/BE/RCRA Offsite Analysis

09 Chemical/Rad Lab Soils Analysis

Includes MARSSIM Samples (Reference Cost-Monitoring.xls, R Tucker and USACE comment by Hallem to increase by 50%)

330 for class 1 areas and 225 for class 2 areas.
Total 555 samples. Assume 20% of areas need to be resampled for a total of 670 samples.
Samples will be analyzed for radionuclides, beryllium, and lead.

Assume 5% of rad/Be sampled will also have TCLP Test = 34 samples

		Quantity		Unit Cost	Total Cost
33022036	Documentation Package for QA, verif,data	20.00	EA	139.80	2,796
33022250	Radium 226	670.00	EA	112.29	75,237
ENGR EST	Iso-Thorium	670.00	EA	162.28	108,725
33022253	Total Uranium	670.00	EA	155.78	104,376
ENGR EST	Iso-Uranium	670.00	EA	162.28	108,725
33022288	Gross Alpha/Beta	670.00	EA	84.51	56,624
ENGREST	GFAA Metals	670.00	EA	116.84	78,282
ENGREST	ICPAES Metals	670.00	EA	142.80	95,678
33021705	Targeted TCLP (Metals, Volatiles, SemiVolatiles), Soil Analysis	34.00	EA	816.01	27,744
SUBTOTAL Chemical/Rad Lab Soils Analysis		**670**	**EA**	**982.37**	**658,185**

		Quantity		Unit Cost	Total Cost
	09 Chemical/Rad Lab Air Analysis				

The high volume air samplers and personal samples will be analyzed on-site. It is assumed that 5% of the samples will be sent offsite for QA verification.

Excavation duration = 2,814 hours or 70 weeks.

High volume air samples = 5% off-site x 8 samplers x 70 weeks x 5 days/week = 140 off-site air samples

Personal air samplers = 5% off-site x 3 samplers x 70 weeks x 5 days/week = 53 off-site air samples

Samples will be analyzed for radionuclides, beryllium, and lead.

		Quantity		Unit Cost	Total Cost
33020217	Gamma Spec	193.00	EA	120.08	23,176
33022288	Gross Alpha/Beta	193.00	EA	84.51	16,311
ENGREST	ICPAES Metals	193.00	EA	142.80	27,561
	SUBTOTAL Chemical/Rad Lab Air Analysis	**193**	**EA**	**347.40**	**67,048**
	SUBTOTAL Rad/BE/RCRA Offsite Analysis	**863**	**EA**	**840.36**	**725,233**
	SUBTOTAL Waste Analysis	**73,150**	**CY**	**10.19**	**745,485**

13 On-Site Laboratory Facilities

02 Rental/Ownership/Operation

This engineering estimate is based on installing a mobile lab similar to the St. Louis FUSRAP Lab. The estimated startup costs are approximately $187,000 and includes an alpha and gamma spec unit. For the Luckey site assume $225,000 to include the additional Beryllium and Lead analytical equipment.

The estimated O&M costs for the St. Louis lab is $6,000/month. For the Luckey site assume $7,000 to include the additional Beryllium and Lead O&M cost.

Includes mobilization, monthly rental, lab equipment and furnishings, utilities, and demobilization. Personnel included in WBS 331 02 02.

		Quantity		Unit Cost	Total Cost
ENGREST	On-site Mobile Laboratory Startup Cost	1.00	LS	225,000.00	225,000
ENGREST	On-site Mobile Laboratory Rental (Engineering Estimate)	27.00	MO	7,000.00	189,000
	SUBTOTAL Rental/Ownership/Operation	**27**	**MO**	**15,333.33**	**414,000**
	SUBTOTAL On-Site Laboratory Facilities	**73,150**	**CY**	**5.66**	**414,000**
	SUBTOTAL Monitoring,Sampling,Testing, & Analysis	**73,150**	**CY**	**38.56**	**2,820,402**

03 Site Work

02 Clearing and Grubbing

Assume 5 acres of the site requires clearing prior to excavation.

		Quantity		Unit Cost	Total Cost
17010110	Wet Clearing - Light - w/o Grub D5LGP	5.00	ACR	773.49	3,867
	SUBTOTAL Clearing and Grubbing	**5**	**ACR**	**773.49**	**3,867**

04 Roads/Parking/Curbs/Walks

01 Aggregate Surfacing

Assume 3,000 lf of haul roads required at 12 inch thick and 12 ft wide at base. Include 6 oz geotextile. Area = 4,000 sy.

Add 50% to cost for small area.

		Quantity		Unit Cost	Total Cost
027202000300&8	Haul Road - Crushed 3/4 in stone base, 12 in.	4,000.00	SY	4.34	17,365

		Quantity		Unit Cost	Total Cost
027202006000&8	Geotextile, 6 oz/sy	4,000.00	SY	1.81	7,227
SUBTOTAL Aggregate Surfacing		**4,000**	**SY**	**6.15**	**24,592**

02 Staging and Loading Area

Cost assembly based on the RACER parametric cost modeling program. The decontamination facility model was used and modified for a staging and loading area. The heavy equipment rating option was used to calculate quantities for the concrete slab.

The total concrete slab area calculated for soils staging (5,000 cy), soils loading, and truck staging (2 ea) was 11,000 sf. This does not include truck turn-around area.

		Quantity		Unit Cost	Total Cost
17030109	Pad Subgrade Preparation	980.00	CY	5.85	5,733
17030257	Cat 215, 1.0 CY, Soil, Shallow, Trenching	3.47	CY	1.62	6
17030501	Compact Subgrade, 2 Lifts	980.00	CY	0.61	598
17030510	Dry Roll Gravel, Steel Roller	1,468.00	SY	1.05	1,541
18010102	Gravel, Delivered & Dumped	407.00	CY	27.67	11,262
18010103	Gravel (90%) & Sand Base (10%), with Calcium Chloride 3/4 - 1 Lb/CY	407.00	CY	28.07	11,424
18010201	Concrete Curb, 6" x 6"	859.00	LF	2.68	2,302
18010203	26" x 26", 5' Deep Area Drain with Grate	1.00	EA	3,370.74	3,371
18020321	6" Structural Slab on Grade	11,000.00	SF	6.40	70,400
19020313	5' x 5' x 5' Reinforced Concrete Sump	1.00	EA	4,048.88	4,049
19020604	12" x 12" CIP Concrete In-Ground Trench Drain with Metal Grate	39.00	LF	118.12	4,607
33080532	8 oz/sy Erosion Control/Drainage Filter Fabric (80 Mil)	1,468.00	SY	1.54	2,261
SUBTOTAL Staging and Loading Area		**11,000**	**SF**	**10.69**	**117,553**

03 Truck Scales

		Quantity		Unit Cost	Total Cost
33010462	Truck Scale Rental	27.00	MO	3,000.00	81,000
SUBTOTAL Truck Scales		**1**	**EA**		**81,000**
SUBTOTAL Roads/Parking/Curbs/Walks		**73,150**	**CY**	**3.05**	**223,145**

05 Fencing

Assume installation of snow fence to prohibit access to contaminated areas. Area to be disturbed is 27 acres. Perimeter = 4,350 lf.

		Quantity		Unit Cost	Total Cost
028205237001	Snow Fence on Stl Post, 10' OC, 4' high	4,350.00	LF	3.84	16,715
SUBTOTAL Fencing		**4,350**	**LF**	**3.84**	**16,715**
SUBTOTAL Site Work		**73,150**	**CY**	**3.33**	**243,727**

05 Surface Water Collect & Control

01 Sediment Barriers

Assume installation of silt fence and hay bales around perimeter of contaminated areas. Area to be disturbed is 27 acres. Perimeter = 4,350 lf.

		Quantity		Unit Cost	Total Cost
023705501100	Silt Fences, Polypropylene, 3' High, Adverse Conditions	4,350.00	LF	0.96	4,162
023705501250	Hay Bales, staked	4,350.00	LF	3.06	13,332
SUBTOTAL Sediment Barriers		**4,350**	**LF**	**4.02**	**17,494**

		Quantity		Unit Cost	Total Cost

02 Contact Water Control and Collection

The average annual rainfall is 32.3 inches and 16.2 inches occurs during the warmer months of May thru September. 5.7 inches occurs during December through February when it is assumed there are no operations. The monthly range is from 1.6 inches (Feb) to 3.8 inches (Jun). Given the low monthly rainfall events, most rainfall will naturally percolate into the underlying soils.

It will be assumed that any water requiring collection will be slowly discharged to an existing contaminated low-lying area of the site or used for moisture conditioning. Since the majority of the rainfall occurs in the warmer months, most water requiring collection can be used for moisture conditioning soils.

The average monthly accumulation during the 9 working months is 2.96 inches. Say 3 inches for calculating the required storage capacity.

Assume maximum of 30,000 sf open excavation area.
Assume 20% infiltration.

Volume = 30,000 sf x 0.25 inches rain x 0.80 = 6,000 cf
Volume = 6,000 cf x 7.48 gal/cf = 44,880 gallons

Use 2 ea, 21,000 gallon wastewater storage tanks for the duration of excavation activities.

Duration = 27 months x 2 tanks = 54 months

Assume pumps will be required an average of 3 days/month for 27 months = 81 days.

		Quantity		Unit Cost	Total Cost
17031003	3" Diameter Contractor's Trash Pump, 150 GPM	81.00	DAYS	63.32	5,129
19040407	21,000 Gallon, Steel Closed Stationary Aboveground Wastewater Holding Tank, Rental	54.00	MO	1,758.26	94,946
33109649	Pump, Cast-iron Close Coupling, 2 HP, 50 GPM	2.00	EA	1,691.70	3,383
33231306	High Sump Level Switch for Avoiding Overflow	4.00	EA	472.46	1,890
33260550	2" Polyethylene, flexible piping, SDR15, 125 psi	1,000.00	LF	1.34	1,340
SUBTOTAL Contact Water Control and Collection		**1**	**LS**		**106,688**
SUBTOTAL Surface Water Collect & Control		**73,150**	**CY**	**1.70**	**124,183**

08 Solids Collection/Containment

01 Contaminated Soil Excavation

Total Excavation Volume w/ 20% overexcavation and 10% constructability (in situ cy) = 73,150

Total Excavation Volume w/ 20% expansion (ex situ cy) = 87,750 (also referred to as the Transportation Volume)

One excavation crew will be assumed for calculating excavation durations. The crew will consist of 1 excavator, 1 operator, 1 oiler, and 2 laborers. Expected output per crew per day is 208 cy per crew, based on an adjusted hourly output of 26 cy/hr (See RS Means 2002 for 1 cy excavator productivity Ref 02315 400 0200). Equipment output has been decreased 66% to allow for site, safety and soil factors described in the project notes. The excavator productivity will determine productivity for the crew.

The transportation crew will transport soils to the staging area. The crew will consist of 2 dump trucks and drivers. Total daily output is the same as excavator or 208 cy/day.

Excavators will remove in situ soils and load trucks for transport of materials to the temporary staging area. The laborers will be used for equipment spotters, dust control, decon, maintaining erosion and sediment installation, etc.

02 Excavation of Contaminated Soils

The crew will excavate 73,150 cy of soils at 26 cy/hr for a total of 2,814 hours.

Assume surveyors are required for 20 events at 4 hours each.

		Quantity		Unit Cost	Total Cost
011077001200	Survey Areas to be Excavated and As-builts (2 people)	10.00	DAY	803.65	8,036
015902000150	Hyd. Excavator, 1 C.Y.	2,814.00	HR	87.08	245,039
CLAB	Common Building Laborers (2 ea)	5,628.00	HR	34.90	196,413
EQMD	Equipment Operators, Medium Equipment	2,814.00	HR	46.43	130,663
EQOL	Equipment Operators, Oilers	2,814.00	HR	39.66	111,608

		Quantity		Unit Cost	Total Cost
	SUBTOTAL Excavation of Contaminated Soils	**73,150**	**CY**	**9.46**	**691,759**
	04 Transport to Staging Area				

The crews productivity will be limited by the excavators productivity. Therefore, the total crew hours will be the same at 2,814 hours based on a productivity of 26 cy/hour.

		Quantity		Unit Cost	Total Cost
015902005300	Dump Truck, 16 Ton (2 each)	5,628.00	HR	72.74	409,361
TRHV	Truck Drivers, Heavy (2 each)	5,628.00	HR	37.21	209,395
	SUBTOTAL Transport to Staging Area	**87,750**	**CY**	**7.05**	**618,756**
	SUBTOTAL Contaminated Soil Excavation	**73,150**	**CY**	**17.92**	**1,310,515**

02 Load Trucks at Staging Area

This WBS is for loading contaminated materials at the staging area for transport to the disposal destination. Ten intermodals per day are assumed available. Each holds 20 tons for a total shipment of 200 tons/day. Based on shipment of 200 tons/day, 22 days/mos. for 9 mos./yr, the duration for excavation and loading containers with 87,750 cy or 114,100 tons of ex situ soils would be 571 days or 2.9 years. Assumes 1.3 ton/cy conversion factor.

The loading crew will consist of three laborers and one front end loader w/operator. The laborers will protect trucks from becoming contaminated, lining trucks, spotting for loader, taping liners closed, and light decontamination. Additionally, they will uncover/cover stockpile with tarp and ballast.

Loading output is equivalent to 10 intermodal containers per day for a total daily shipping 200 tons/day (25 tons/hr).

Loading 114,100 tons of soils at a rate of 25 tons/hr results in a total duration of 4,564 hours.

		Quantity		Unit Cost	Total Cost
015902004710	F.E. Loader, W.M., 2.5 C.Y.	4,565.00	HR	57.24	261,322
CLAB	Common Building Laborers (3 ea)	13,695.00	HR	34.90	477,945
ENGR EST	Staging Pile Tarp and Ballast	1.00	LS	6,491.02	6,491
EQMD	Equipment Operators, Medium Equipment	4,565.00	HR	46.43	211,967
	SUBTOTAL Load Trucks at Staging Area	**87,750**	**CY**	**10.91**	**957,724**
	SUBTOTAL Solids Collection/Containment	**73,150**	**CY**	**31.01**	**2,268,239**

19 Transportation and Disposal

		Quantity		Unit Cost	Total Cost

01 Transportation to Disposal Facility

Envirosource, Ohio (Be Soils)
Total to be Transported = 56,150 cy or 73,000 tons
Unit Price = $15/ton
Based on Envirosource quote - An additional $5/ton was added to the $10/ton vendor quote to account for liners and other regulatory requirements. Assume each intermodal will have average 1 day turnaround time (time it arrives on site to time it is returned to site). Based on loading 10 intermodals per day, 10 intermodal containers will be required. The total number of intermodal trips is 3,650 (73,000 tons/ 20 tons/intermodal).

US Ecology of Idaho (Low Level Waste/Rads Alone and with Be Soils)
Total to be Transported = 25,350 cy or 32,950 tons
Unit Price = $150.15/ton
Based on quote given by MHF Transportation and includes hauling from the site to an intermodal loading facility in Toledo and transporting via rail to Envirocare. US Ecology is approximately 15% further in road distance, so 10% will be added to the Envirocare quote. Unit rate based on each rail car holding 6 intermodals and each intermodal holding 20 tons each. Assume each intermodal will have average 6 week turnaround time rental (time it arrives on site to time it is returned to site). Based on loading 10 intermodals per day, 300 intermodal containers will be required. The total number of intermodals trips is 1,648 (32,950 tons/ 20 tons/intermodal).
Unit Rate to US Ecology = $2,730/container x 1.1 = $3,003/container. Assume 20 ton capacity is used. $3,003/20 ton = $150.15/ton

US Ecology of Idaho (Mixed Waste/Rads With Lead or Be Soils)
Total to be Transported = 3,950 cy or 5,150 tons
Unit Price = $150.15/ton
Assume same rate as LLW to US Ecology. Based on loading 10 intermodals per day, 258 intermodal containers will be required. The total number of intermodals required is 258 (5,150 tons/20 tons/intermodal). Unit Rate to US Ecology = $2,730/container x 1.1 = $3,003/container. Assume 20 ton capacity is used. $3,003/20 ton = $150.15/ton

Waste Management (Lead Alone or With Be Soils)
Total to be Transported = 2,300 cy or 3,000 tons
Unit Rate = $152/ton
Based on ECHOS 33190206 Transport Bulk Solid Hazardous Waste, Maximum 18 Ton. Unit Rate is 1.52/MI/Ton. Assume 100 MI one-way.
Unit Rate = $1.52 x 100 MI = $152/ton. Assume each intermodal will have average 1.5 day turnaround time (time it arrives on site to time it is returned to site). Based on loading 10 intermodals per day, 15 intermodal containers will be required. The total number of intermodal trips is 150 (3,000 tons/ 20 tons/intermodal).

Envirosource, Ohio (Be)

Assume demurrage allowance charge on 10% of containers for 1 hour @ $65/hour.

3,650 containers x 10% x 1 hour = 365 hours.

		Quantity		Unit Cost	Total Cost
VENDOR	Transport Be Soils to Envirosource, OH (20 mile)	73,000.00	TON	15.00	1,095,000
VENDOR	Mob & Demob of Containers	10.00	EA	1,000.00	10,000
VENDOR	Demurrage	365.00	HRS	65.00	23,725
SUBTOTAL Envirosource, Ohio (Be)		**56,150**	**CY**	**20.10**	**1,128,725**

US Ecology of Idaho (LLW with Be)

Assume demurrage allowance charge on 10% of containers for 1 hour @ $65/hour.

1,648 containers x 10% x 1 hour = 164 hours.

		Quantity		Unit Cost	Total Cost
VENDOR	Demurrage	164.00	HRS	65.00	10,660
VENDOR	Mob & Demob of Containers	300.00	EA	1,000.00	300,000
VENDOR	Transport to US Ecology	32,950.00	TON	150.15	4,947,443
SUBTOTAL US Ecology of Idaho (LLW with Be)		**25,350**	**CY**	**207.42**	**5,258,103**

US Ecology of Idaho (Mixed Waste)

Assume use of LLW containers. No separate mob/demob included.

Assume demurrage allowance charge on 10% of containers for 1 hour @ $65/hour.
258 containers x 10% x 1 hour = 26 hours.

		Quantity		Unit Cost	
VENDOR	Demurrage	26.00	HRS		
VENDOR	Transport to US Ecology	5,150.00	TON	150.15	773,273
SUBTOTAL US Ecology of Idaho (Mixed Waste)		**3,950**	**CY**	**196.19**	**774,963**

Waste Management (RCRA)

Assume demurrage allowance charge on 10% of containers for 1 hour @ $65/hour.

150 containers x 10% x 1 hour = 15 hours.

VENDOR	Transport Soils WM Facility (100 mile one-way)	3,000.00	TON	152.00	456,000
VENDOR	Demurrage	15.00	HRS	65.00	975
SUBTOTAL Waste Management (RCRA)		**2,300**	**CY**	**198.68**	**456,975**
SUBTOTAL Transportation to Disposal Facility		**87,750**	**CY**	**86.82**	**7,618,765**

02 LLW Disposal Costs

Envirosource, Ohio (Be Soils)
Total to be Disposed = 73,000 tons
Unit Price = $50/ton (Based on Envirosource quote)

US Ecology of Idaho (Low Level Waste/Rads Alone and with Be Soils)
Total to be Transported = 25,350 cy
Unit Price = $71.50/cy (Based on USACE DACW41-99-D-9007 Intermodal Soil Rate)

US Ecology of Idaho (Mixed Waste/Rads With Lead or Be Soils)
Total to be Transported = 3,950 cy
Unit Price = $97.50/cy (Based on USACE DACW41-99-D-9007 Intermodal Soil Rate with state hazardous waste surcharge)

Waste Management (Lead Alone or With Be Soils)
Total to be Transported = 3,000 tons
Unit Rate = $160/ton (Based on ECHOS 33197263 Landfill Hazardous Waste by Ton).

Envirosource, Ohio (Be)

VENDOR	Disposal of Be Soils at Envirosource, OH	73,000.00	TON	50.00	3,650,000
SUBTOTAL Envirosource, Ohio (Be)		**56,150**	**CY**	**65.00**	**3,650,000**

US Ecology of Idaho (LLW with Be)

USACE DACW41	Disposal of LLW and LLW/BE at US Ecology, ID	25,350.00	CY	71.50	1,812,525
SUBTOTAL US Ecology of Idaho (LLW with Be)		**25,350**	**CY**	**71.50**	**1,812,525**

US Ecology of Idaho (Mixed Waste)

USACE DACW41	Disposal of Mixed Waste Soils at US Ecology, ID	3,950.00	CY	97.50	385,125
SUBTOTAL US Ecology of Idaho (Mixed Waste)		**3,950**	**CY**	**97.50**	**385,125**

Waste Management (RCRA)

USACE DACW41	Disposal of RCRA Waste at RCRA Facility	3,000.00	TON	160.00	480,000
SUBTOTAL Waste Management (RCRA)		**2,300**	**CY**	**208.70**	**480,000**
SUBTOTAL LLW Disposal Costs		**87,750**	**CY**	**72.11**	**6,327,650**
SUBTOTAL Transportation and Disposal		**87,750**	**CY**	**158.93**	**13,946,415**

20 Site Restoration

01 Earthwork

		Quantity		Unit Cost	Total Cost
03 Backfill					
17030423	Unclassified Fill, 6" Lifts, Off-Site, Includes Delivery, Spreading, and Compacting	87,750.00	CY	10.89	955,760
SUBTOTAL Backfill		**87,750**	**CY**	**10.89**	**955,760**
SUBTOTAL Earthwork		**87,750**	**CY**	**10.89**	**955,760**
03 Permanent Features					
01 Roads					
Assume 40,000 sf (2000 lf at 20 ft wide) of road way/parking lot repair. Assume 10 in gravel base and 2.5 in asphalt, 6.75 ft ditch, and 1 culvert. The majority of the impacted areas are currently in vegetated areas.					
17030103	Rough Grading	11,111.00	SY	1.20	13,369
17030108	Fine Grading, 130G, 2 Passes	5,556.00	SY	0.23	1,266
17030202	Ditch Excavation, Normal Soil, Haul Spoil 1 mile	2,500.00	CY	3.44	8,604
18010102	Gravel, Delivered and Dumped	1,543.00	CY	29.50	45,512
18010310	Prime Coat	4,444.00	SY	0.48	2,152
18010312	Asphalt Wearing Course, 1 Pass (Inc 5% Waste)	605.00	TON	75.34	45,583
19030402	34' Complete, 24" Corrugated Metal Pipe, Culvert w/Headwall	1.00	EA	7,053.84	7,054
SUBTOTAL Roads		**4,444**	**SY**	**27.80**	**123,539**
02 Structures					
Assume approximately 700 lf of fence needs to be replaced.					
028205280800	Fence, Industrial, 6 ft, 6 ga, omit barbed, galv steel	700.00	LF	23.58	16,509
SUBTOTAL Structures		**700**	**LF**	**23.58**	**16,509**
SUBTOTAL Permanent Features		**87,750**	**CY**	**1.60**	**140,048**
04 Revegetation And Planting					
Approximately 24 acres of the site will be disturbed. Assumes area of excavation plus 10% of additional area adjacent to excavation. Total = 27 acres.					
01 Seeding/Mulch/Fertilizer					
17040101	General Area Cleanup	27.00	ACR	382.81	10,336
18050101	Area Preparation	27.00	ACR	89.82	2,425
18050401	Hydroseeding, 67% Level & 33% Sloped	27.00	ACR	661.17	17,852
18050408	Fertilizer, Hydro Spread	27.00	ACR	197.59	5,335
18050413	Watering with 3000-gallon Tank Truck	27.00	ACR	78.35	2,115
SUBTOTAL Seeding/Mulch/Fertilizer		**27**	**ACR**	**1,409.74**	**38,063**
SUBTOTAL Revegetation And Planting		**27**	**ACR**	**1,409.74**	**38,063**
SUBTOTAL Site Restoration		**73,150**	**CY**	**15.50**	**1,133,871**
SUBTOTAL HTRW Remedial Action		**73,150**	**CY**	**280.75**	**20,536,837**
SUBTOTAL		***73,150***	***CY***	***280.75***	***20,536,837***

	Quantity		Total Cost
General Conditions - PRIME CONTRACTOR AA	3.0%		178,984
Prime Markup on Subs - PRIME CONTRACTOR AA	4.0%	3.26	238,645
SUBTOTAL	***73,150 CY***	***286.46***	***20,954,466***
Contingency	25.0%	71.61	5,238,616
Remedial Design	4.0%	14.32	1,047,723
Project Management	5.0%	18.62	1,362,040
Construction Management	10.0%	39.10	2,860,285
Owner Costs	15.9%	68.59	5,017,104
Alternative 5 - Excavation and Offsite Disposal-Unrestricted Lan	**73,150 CY**	**498.70**	**36,480,234**

Alt. 6 - Excavation, Treatment, & Offsite Disposal-Unrestricted Land Use

Project No. TERC DACW27-97-D-0015

Designed By:

Science Applications International Corporation

Estimated By:

Mike Poligone

Prepared By: Mike Poligone

Preparation Date: 10/10/2002

Effective Date of Pricing: 10/10/2002

Est Construction Time: 0 Days

CostLink CM Report	Page Number

PROJECT DESCRIPTION: ALTERNATIVE 6 -EXCAVATION, TREATMENT, AND OFFSITE DISPOSAL

This alternative involves excavating contaminated soils above the appropriate cleanup criteria and treating the radioactive and radioactive/BE mixed soils using soil washing technologies. Radioactive and radioactive/BE mixed contaminated soils would be excavated and staged onsite for application of the soil washing process. The soil washing process would result in a clean stream to be used as backfill onsite and a concentrated contaminated stream that would be disposed at an offsite commercial disposal facility. The contaminated stream from the soil washing process would be transported in intermodal containers to rail transfer facility and loaded into rail cars for transport to their designated disposal locations. Beryllium soils, mixed waste, and hazardous waste will be excavated and disposed at an offsite commercial disposal facility. (See the Luckey site FS for more details about the Luckey site and this proposed alternative).

PROJECT BREAKDOWN:

The Hazardous, Toxic, Radioactive Waste Work Breakdown Structure (HTRW WBS), February 1996, was used as the basis for organizing the cost estimates for the Luckey site alternatives. The estimate uses a 2 digit number at each level. The 2 digit numbers for the first 3 title levels are taken from the HTRW Remedial Action Work Breakdown Structure. The 2 digit numbers for the remaining title levels are user defined.

LEVEL 1 - WBS Level 1 (Account)- Luckey Alternative 6
LEVEL 2 - WBS Level 2 (System) - Solids Collection and Containment
LEVEL 3 - WBS Level 3 (Subsystem) - Contaminated Soil Collection
LEVEL 4 - User Defined (Assembly Category or Other) - Excavation of Contaminated Soils
LEVEL 5 - User Defined (Assembly or Other)

The Level 2 WBS elements for this estimate are as follows:

33. HTRW REMEDIAL ACTION
33 02 Monitoring, Sampling, and Analysis
33 03 Site Work
33 05 Surface Water Collection/Control
33.08 Solids Collection/Containment
33.13 Physical Treatment
33.19 Disposal (Commercial)
33.20 Site Restoration

LUCKEY SITE SOIL VOLUMES:

Soil Volume Estimates Grouped By Waste Stream (Rounded to the nearest 50 cy)

Be Soils
In Situ Most Likely Volume (cy) = 35,450
Including 20% Overexcavation (cy) = 42,500
Including 10% Constructability (cy) = 46,800
Including 20% Swell Factor (cy) = 56,150
Total Disposal Volume (cy) = 56,150

LLW Soils
In Situ Most Likely Volume (cy) = 7,200
Including 20% Overexcavation (cy) = 8,650
Including 10% Constructability (cy) = 9,550
Including 20% Swell Factor (cy) = 11,450
Total Disposal Volume (cy) = 11,450

Be and LLW Mixed Soils
In Situ Most Likely Volume (cy) = 8,800
Including 20% Overexcavation (cy) = 10,550
Including 10% Constructability (cy) = 11,600
Including 20% Swell Factor (cy) = 13,950
Total Disposal Volume (cy) = 13,950

Mixed Waste Soils (LLW with Lead)
In Situ Most Likely Volume (cy) = 150
Including 20% Overexcavation (cy) = 150
Including 10% Constructability (cy) = 150
Including 20% Swell Factor (cy) = 200
Total Disposal Volume (cy) = 200

Hazardous Waste Soils (Lead Alone or with Be)

In Situ Most Likely Volume (cy) = 1,450
Including 20% Overexcavation (cy) = 1,750
Including 10% Constructability (cy) = 1,900
Including 20% Swell Factor (cy) = 2,300
Total Disposal Volume (cy) = 2,300

Mixed Waste Soils (LLW, Lead, and Be)
In Situ Most Likely Volume (cy) = 2,350
Including 20% Overexcavation (cy) = 2,850
Including 10% Constructability (cy) = 3,100
Including 20% Swell Factor (cy) = 3,750
Total Disposal Volume (cy) = 3,750

Total of All Soils
In Situ Most Likely Volume (cy) = 55,400
Including 20% Overexcavation (cy) = 66,500
Including 10% Constructability (cy) = 73,150
Including 20% Swell Factor (cy) = 87,750
Total Disposal Volume (cy) = 87,750

Soil Volume Estimates Grouped By Treatment and Disposal Facility (Rounded to the nearest 50 cy)

Envirosource, Ohio (Be Soils)
In Situ Most Likely Volume (cy) = 35,450
Including 20% Overexcavation (cy) = 42,500
Including 10% Constructability (cy) = 46,800
Including 20% Swell Factor (cy) = 56,150
Total Disposal Volume (cy) = 56,150

US Ecology of Idaho (Low Level Waste/Rads Alone and with Be Soils)
In Situ Most Likely Volume (cy) = 16,000
Including 20% Overexcavation (cy) = 19,200
Including 10% Constructability (cy) = 21,150
Including 20% Swell Factor (cy) = 25,350

Soil Mass Reduction due to Treatment = 50% (5)
Treated Clean Soil for Backfill (ex situ cy) = 12,675
Total Disposal Volume (ex situ cy) = 12,675

US Ecology of Idaho (Mixed Waste/Rads With Lead or Be Soils)
In Situ Most Likely Volume (cy) = 2,500
Including 20% Overexcavation (cy) = 3,000
Including 10% Constructability (cy) = 3,300
Including 20% Swell Factor (cy) = 3,950
Total Disposal Volume (cy) = 3,950

Waste Management (Lead Alone or With Be Soils)
In Situ Most Likely Volume (cy) = 1,450
Including 20% Overexcavation (cy) = 1,750
Including 10% Constructability (cy) = 1,900
Including 20% Swell Factor (cy) = 2,300
Total Disposal Volume (cy) = 2,300

1. The "Total Volume" was calculated with a software package named EarthVision developed by Dynamic Graphics, Incorporated (www.dgi.com) using the Minimum Tension Gridding Algorithm along with engineering judgment to confine and shape the modeled extents.
2. In situ excavation volumes include a 20% increase to account for overexcavation.
3. An additional 10% increase is included to account for constructability.
4. Ex situ excavation volumes include a 20% increase to account for expansion of soil (swell factor).
5. Based on the Maywood Site, NJ treatibility studies. (Maywood Site Feasibility Study October 1999)

SCHEDULE SUMMARY:

Estimated RA Project duration = 5.0 years.

Engineering Design = 2.0 yrs. (1)
Excavation/Disposal of soils/materials = 2.5 yrs.
Treatment = 1.0 yrs (0.5 yr lag from excavation)
Post-Remediation Report and As-builts = 1.0 yrs.

1. Engineering design will consist of:

(a) 6 months technical evaluation and RFP/Bid
(b) 12 months characterization, bench scale, pilot scale, report, and award of a treatment contractor.
(c) 6 months for startup to reach full operations

PRODUCTIVITY:

Productivity, as a baseline and as taken from the Unit Price Book (UPB) Database, assumes a non-contaminated working environment with no level of protection productivity reduction factors. Productivity reduction factors have been added to the excavation equipment to more accurately reflect the nature of the excavation at the site. The following factors have been applied:

1. Site Constraint - 70%. This factor is based on engineering judgment and is developed on a site by site basis. It is used to adjust productivity levels due to site layout (i.e. open fields vs. congested area), temporary work interruptions, delays, mobilization, and demobilization. It applies to all excavation and loading equipment. Backfill equipment is excluded. Based on a work schedule availability of 40 weeks/year and a 12 week delay due to weather (4 weeks), unsafe conditions (1 weeks), job sequencing (1 weeks), soil drying (2 weeks), utility shutoff/interruption (0 weeks), and location of as built utilities (0 weeks), post RA surveys (4 weeks) the resulting site constraint for this site is calculated as 40 total weeks/yr - 28 week delay /40 total weeks/year = 70%.

2. Soil adjustment - 75%. This factor is based on engineering judgment based on borings taken from the site and is developed on a site by site basis. It is used to adjust productivity levels due to material handling or the nature of the material to be excavated (i.e. soils and/or asphalt vs. concrete or bedrock; or concentrated area of contamination vs. spotty areas of contamination over large areas). This factor is applied to excavation equipment as required. Backfill equipment is excluded. If not required, factor will be 100%. For the Luckey site, production capacity will be reduced due to spatial areas of contaminants and typical unit price book production rates will be adjusted by 75%. Delays due to wet soils are addressed under the site constraint.

3. Safety factor - 65%. This is the standard factor developed by SAIC, which is used to adjust productivity levels due to safety procedures associated with the radioactive nature of the contaminated materials. It applies to all excavation equipment and excludes all backfill equipment. Derivation of this factor is explained in the backup material for safety factor derivation.

Total productivity adjustment is equal to the site adjustment x soil adjustment x safety adjustment. For this estimate, the total productivity adjustment is 70% x 75% x 65% = 34%

ESCALATION:

The base year of comparison will be CY2002 and unit cost will be escalated to July 2002. Cost data will be escalated using the Price Escalation Indices (Annual Rates in Percentages) for Budget Authority in the memorandum dated 3 January, 2002 from the Comptroller of the Under Secretary of Defense, Subject: Revised Inflation Guidance, and the Department of the Army, DACS-PCB MEMO 2000-002 of Feb 2002, Subject: Revised Inflation Indices for FY02 President's Budget.

OVERHEAD COSTS

The following overhead markups have been applied to the Subcontractor's direct cost. (note: no markups have been applied to the transportation and disposal unit cost. The transportation unit cost is a vendor quote and includes all markups and the disposal unit cost are based on the existing USACE contract).

Professional Labor - A 140% markup was applied to professional labor for fringe benefits, paid vacation, medical insurance, holidays, retirement accounts, etc.

Craft Labor - A 30% markup was applied to craft labor for fringe benefits, paid vacation, medical insurance, holidays, retirement accounts, etc.

Equipment and Materials - A 8% markup was applied to all equipment and materials for indirect labor.

General Conditions - A 6% markup was applied to the direct project cost to account for all general conditions (i.e. Mobilization and Demobilization cost), including temporary facilities and utilities, telephone and communication, permits and licenses, subcontractor submittals, travel and per diem, personal protective equipment, insurance, bonds, and taxes.

Profit - A 8% profit markup has been applied for the direct cost.

The following Overhead Markups have been applied to the Prime Contractor's direct cost.

General Conditions - A 3% markup was applied to the direct project cost to account for all general conditions (i.e. Mobilization and Demobilization cost), including temporary facilities and utilities, telephone and communication, permits and licenses, subcontractor submittals, travel and per diem, personal protective equipment, insurance, bonds, and taxes.

Prime Markup on Sub - A 4% markup was applied to all subcontracted work. Indicates the percentage of profit a prime contractor will make on work completed by subcontractors. Prime contractors apply to subs to cover the administrative, management, and financial costs of overseeing and approving subcontractor's work. The prime profit on subcontractors is applied to the total subcontract project cost, including subcontractor's direct costs, overhead, and profit.

CONTINGENCY:

Contingencies are shown for both Design Contingencies and Construction Contingencies. EPA Guidance 540-R-00-002, July 2000 was used as a reference in developing design and construction contingencies.

A design contingency of 20% is being applied due to the proven implementation of the excavation technology, however soil washing has not been successfully implemented for the large-scale treatment of clay soils contaminated with radioactive and beryllium contaminants. Therefore, the contingency has been increased to account for the additional uncertainties.

A construction contingency of 15% is being applied due to the potential for increases in soil volumes that have been common at other FUSRAP sites. This would also include cost overruns, modifications, and change orders.

DESIGN AND TECHNICAL SUPPORT COSTS:

Remedial design applies to capital cost and O&M cost and includes services to design the remedial action. Activities that are part of remedial design include pre-design collection and analysis of field data, engineering survey for design, treatability study (e.g., pilot-scale), and the various design components such as design analysis, plans, specifications, cost estimate, and schedule at the preliminary, intermediate, and final design phases including post RA documentation. Remedial Design has been included as a 4% markup of the total remedial action costs.

PROJECT MANAGEMENT

Project management includes services that are not specific to remedial design, construction management, or technical support of O&M activities. Project management includes planning and reporting, community relations support during construction or O&M, bid or contract administration, permitting (not already provided by the construction or O&M contractor), and legal services outside of land use controls (e.g., licensing). Project Management has been included as a 5% markup of the total remedial action costs.

CONSTRUCTION MANAGEMENT

Construction management includes services to manage construction or installation of the remedial action. Activities include review of submittals, design modifications, construction observation or oversight, engineering survey for construction, preparation of O&M manual, documentation of quality control/quality assurance, and record drawings. For the Luckey site, this will include a full-time site manager, field engineer, clerical, safety and health officer, and waste management coordinator. It also includes HP, QA, and engineering during construction. Construction Management has been included as a 10% markup of the total remedial action costs.

OWNER COST

USACE oversight cost includes Program Management, Project Management, Construction Management, Design Reviews, Quality Assurance, HP Support, Cooperative Agreements with Others, Engineering During Construction, etc. The cost was estimated by LRB to be approximately $1 million per year. The estimated schedule for design, construction, and port RA closeout is 5 years for a total owner cost of $5 million.

	Quantity		Unit Cost	Total Cost	
TERC DACW27-97-D-0015 Alt. 6 - Excavation, Treatment, & Offsite Disposal-Unrestricted Land Use					
33 HTRW Remedial Action					
02 Monitoring,Sampling,Testing, & Analysis					
02 Beryllium & Rad Monitoring	73,150	CY	16.15	1,181,299	
10 Waste Analysis	73,150	CY	0.54	39,815	
02 Rad/BE/RCRA Offsite Analysis	863	EA	1,652.15	1,425,803	
13 On-Site Laboratory Facilities	73,150	CY	10.40	760,674	
SUBTOTAL Monitoring,Sampling,Testing, & Analysis	73,150	CY	46.58	3,407,591	8%
03 Site Work					
02 Clearing and Grubbing	5	ACR	1,520.68	7,603	
04 Roads/Parking/Curbs/Walks	4,000	SY	61.73	246,901	
05 Fencing	4,350	LF	7.55	32,861	
SUBTOTAL Site Work	73,150	CY	3.93	287,365	1%
05 Surface Water Collect & Control					
01 Sediment Barriers	4,350	LF	7.91	34,394	
02 Contact Water Control and Collection				208,238	
SUBTOTAL Surface Water Collect & Control	73,150	CY	3.32	242,632	1%
08 Solids Collection/Containment					
01 Contaminated Soil Excavation	73,150	CY	35.22	2,576,462	
02 Load Trucks at Staging Area	75,075	CY	21.47	1,612,091	
SUBTOTAL Solids Collection/Containment	73,150	CY	57.26	4,188,553	10%
13 Physical Treatment					
09 Soil Washing	25,350	CY	520.16	13,186,127	
SUBTOTAL Physical Treatment	25,350	CY	520.16	13,186,127	31%
19 Transportation and Disposal					
01 Transportation to Disposal Facility	75,075	CY	125.88	9,450,604	
02 LLW Disposal Costs	75,075	CY	132.68	9,961,128	
SUBTOTAL Transportation and Disposal	73,150	CY	265.37	19,411,731	45%
20 Site Restoration					
01 Earthwork	75,075	CY	22.70	1,704,328	
03 Permanent Features	73,150	CY	3.76	275,332	
04 Revegetation And Planting	27	ACR	2,771.53	74,831	
SUBTOTAL Site Restoration	73,150	CY	28.09	2,054,492	5%
SUBTOTAL HTRW Remedial Action	73,150	CY	584.81	42,778,492	100%

	Quantity		Unit Cost	Total Cost
Alt. 6 - Excavation, Treatment, & Offsite Disposal-Unrestricte	**73,150**	**CY**	**584.81**	**42,778,492**

		Quantity		Unit Cost	Total Cost

TERC DACW27-97-D-0015 Alt. 6 - Excavation, Treatment, & Offsite Disposal-Unrestricted Land Use

33 HTRW Remedial Action

HTRW = Hazardous, Toxic, and Radioactive Waste

02 Monitoring,Sampling,Testing, & Analysis

02 Beryllium & Rad Monitoring

This WBS covers IH/HP technicians for the following areas: 2 at the excavation site to survey personnel, survey additional areas requiring excavation, and obtaining post RA samples; 2 at the treatment/loading site to survey personnel, transport vehicles, and sample treated soils; and 2 at the onsite lab to analyze samples/swipes and calibrate equipment. This WBS also includes all necessary monitoring equipment. The IH/HP technicians and equipment for excavation activities would be 2,814 hours spanning 16 months for excavation activities and 3,904 hours to load and an additional 792 hrs to treat for a total 4,696 hours spanning 27 months or 3 years for treatment/loading and the onsite lab activities. Treatment activities would lag excavation activities by 4.5 months. (See WBS 331 08 for duration calculation)

2 @ 2,814 hrs. = 3,694 hrs.
4 @ 4,696 hrs. = 16,200 hrs.
Total = 7,510 hours

Equipment pricing base on Vendor Quote (SEC 2/2001;Rates escalated to 2/2002)- The Beryllium and Radiological monitoring equipment includes the following:

1. Model 2929 dual channel scaler (2 @ $365/mo =$730/mo)
2. Alpha Survey Instrument, 43-5 or equal (3 @ 210/mo = $630/mo)
3. Ratemeter w/GM pancake, 44-9 or equal (2 @ $195/mo = $390/mo)
4. Alarming Frisker w/ GM pancake, 44-9 or equal (5 @ $133/mo = $665/mo)
5. Micro R Meter, Model 19 or equal (2 @ $133/mo = $266/mo)
6. Personal Air Sampling pumps (3 @ $83/mo = $249/mo)
7. Personal air sampling pump charger (2 @ $52/mo = $104/mo)
8. High Volume air samplers (8 @ $130/mo = $1,040/mo)

Total = $4,074/month. Use $4,500/mo direct cost to account for other miscellaneous equipment or supplies.

		Quantity		Unit Cost	Total Cost
33021498	IH/HP Technicians	7,510.00	HR	53.34	400,572
Vendor Quote	Beryllium & Rad Monitoring Equipment	36.00	MO	5,563.73	200,294
SUBTOTAL Beryllium & Rad Monitoring		**73,150**	**CY**	**8.21**	**600,867**

10 Waste Analysis

01 Rad Analytical Urine/Feces

		Quantity		Unit Cost	Total Cost
33022307	Bioassays (2/yr x 3 yrs x 20 people)	120.00	EA	168.77	20,252
SUBTOTAL Rad Analytical Urine/Feces		**120**	**EA**	**168.77**	**20,252**
SUBTOTAL Waste Analysis		**73,150**	**CY**	**0.28**	**20,252**

02 Rad/BE/RCRA Offsite Analysis

09 Chemical/Rad Lab Soils Analysis

Includes MARSSIM Samples (Reference Cost-Monitoring.xls, R Tucker and USACE comment by Hallem to increase by 50%)

330 for class 1 areas and 225 for class 2 areas.
Total 555 samples. Assume 20% of areas need to be resampled for a total of 670 samples.
Samples will be analyzed for radionuclides, beryllium, and lead.

Assume 5% of rad/Be sampled will also have TCLP Test = 34 samples

		Quantity		Unit Cost	Total Cost
33021705	Targeted TCLP (Metals, Volatiles, SemiVolatiles), Soil Analysis	34.00	EA	816.01	27,744
33022036	Documentation Package for QA, verif,data	20.00	EA	139.80	2,796
33022250	Radium 226	670.00	EA	112.29	75,237
33022253	Total Uranium	670.00	EA	155.78	104,376

		Quantity		Unit Cost	Total Cost
33022288	Gross Alpha/Beta	670.00	EA	84.51	56,624
ENGR EST	Iso-Uranium	670.00	EA	162.28	108,725
ENGR EST	Iso-Thorium	670.00	EA	162.28	108,725
ENGREST	ICPAES Metals	670.00	EA	142.80	95,678
ENGREST	GFAA Metals	670.00	EA	116.84	78,282
SUBTOTAL Chemical/Rad Lab Soils Analysis		**670**	**EA**	**982.37**	**658,185**

09 Chemical/Rad Lab Air Analysis

The high volume air samplers and personal samples will be analyzed on-site. It is assumed that 5% of the samples will be sent offsite for QA verification.

Excavation duration = 2,814 hours or 70 weeks.

High volume air samples = 5% off-site x 8 samplers x 70 weeks x 5 days/week = 140 off-site air samples

Personal air samplers = 5% off-site x 3 samplers x 70 weeks x 5 days/week = 53 off-site air samples

Samples will be analyzed for radionuclides, beryllium, and lead.

		Quantity		Unit Cost	Total Cost
33020217	Gamma Spec	193.00	EA	120.08	23,176
33022288	Gross Alpha/Beta	193.00	EA	84.51	16,311
ENGREST	ICPAES Metals	193.00	EA	142.80	27,561
SUBTOTAL Chemical/Rad Lab Air Analysis		**193**	**EA**	**347.40**	**67,048**
SUBTOTAL Rad/BE/RCRA Offsite Analysis		**863**	**EA**	**840.36**	**725,233**

13 On-Site Laboratory Facilities

02 Rental/Ownership/Operation

This engineering estimate is based on installing a mobile lab similar to the St. Louis FUSRAP Lab. The estimated startup costs are approximately $187,000 and includes an alpha and gamma spec unit. For the Luckey site assume $225,000 to include the additional Beryllium and Lead analytical equipment.

The estimated O&M costs for the St. Louis lab is $6,000/month. For the Luckey site assume $7,000 to include the additional Beryllium and Lead O&M cost.

Includes mobilization, monthly rental, lab equipment and furnishings, utilities, and demobilization. Personnel included in WBS 331 02 02.

		Quantity		Unit Cost	Total Cost
ENGREST	On-site Mobile Laboratory Rental (Engineering Estimate)	27.00	MO	7,000.00	189,000
ENGREST	On-site Mobile Laboratory Startup Cost	1.00	LS	225,000.00	225,000
SUBTOTAL Rental/Ownership/Operation		**27**	**MO**	**15,333.33**	**414,000**
SUBTOTAL On-Site Laboratory Facilities		**73,150**	**CY**	**5.66**	**414,000**
SUBTOTAL Monitoring,Sampling,Testing, & Analysis		**73,150**	**CY**	**24.06**	**1,760,352**

03 Site Work

02 Clearing and Grubbing

Assume 5 acres of the site requires clearing prior to excavation.

		Quantity		Unit Cost	Total Cost
17010110	Wet Clearing - Light - w/o Grub D5LGP	5.00	ACR	773.49	3,867
SUBTOTAL Clearing and Grubbing		**5**	**ACR**	**773.49**	**3,867**

04 Roads/Parking/Curbs/Walks

		Quantity		Unit Cost	Total Cost
01 Aggregate Surfacing					

Assume 3,000 lf of haul roads required at 12 inch thick and 12 ft wide at base. Include 6 oz geotextile. Area = 4,000 sy.

Add 50% to cost for small area.

		Quantity		Unit Cost	Total Cost
027202000300&8	Haul Road - Crushed 3/4 in stone base, 12 in.	4,000.00	SY	4.34	17,365
027202006000&8	Geotextile, 6 oz/sy	4,000.00	SY	1.81	7,227
SUBTOTAL Aggregate Surfacing		**4,000**	**SY**	**6.15**	**24,592**

02 Staging and Loading Area

Cost assembly based on the RACER parametric cost modeling program. The decontamination facility model was used and modified for a staging and loading area. The heavy equipment rating option was used to calculate quantities for the concrete slab.

The total concrete slab area calculated for soils staging (5,000 cy), soils loading, and truck staging (2 ea) was 11,000 sf. This does not include truck turn-around area.

		Quantity		Unit Cost	Total Cost
17030109	Pad Subgrade Preparation	980.00	CY	5.85	5,733
17030257	Cat 215, 1.0 CY, Soil, Shallow, Trenching	3.47	CY	1.62	6
17030501	Compact Subgrade, 2 Lifts	980.00	CY	0.61	598
17030510	Dry Roll Gravel, Steel Roller	1,468.00	SY	1.05	1,541
18010102	Gravel, Delivered & Dumped	407.00	CY	27.67	11,262
18010103	Gravel (90%) & Sand Base (10%), with Calcium Chloride 3/4 - 1 Lb/CY	407.00	CY	28.07	11,424
18010201	Concrete Curb, 6" x 6"	859.00	LF	2.68	2,302
18010203	26" x 26", 5' Deep Area Drain with Grate	1.00	EA	3,370.74	3,371
18020321	6" Structural Slab on Grade	11,000.00	SF	6.40	70,400
19020313	5' x 5' x 5' Reinforced Concrete Sump	1.00	EA	4,048.88	4,049
19020604	12" x 12" CIP Concrete In-Ground Trench Drain with Metal Grate	39.00	LF	118.12	4,607
33080532	8 oz/sy Erosion Control/Drainage Filter Fabric (80 Mil)	1,468.00	SY	1.54	2,261
SUBTOTAL Staging and Loading Area		**11,000**	**SF**	**10.69**	**117,553**
03 Truck Scales					
33010462	Truck Scale Rental	27.00	MO	3,000.00	81,000
SUBTOTAL Truck Scales		**1**	**EA**		**81,000**
SUBTOTAL Roads/Parking/Curbs/Walks		**4,000**	**SY**	**55.79**	**223,145**

05 Fencing

Assume installation of snow fence to prohibit access to contaminated areas. Area to be disturbed is 27 acres. Perimeter = 4,350 lf.

		Quantity		Unit Cost	Total Cost
028205237001	Snow Fence on Stl Post, 10' OC, 4' high	4,350.00	LF	3.84	16,715
SUBTOTAL Fencing		**4,350**	**LF**	**3.84**	**16,715**
SUBTOTAL Site Work		**73,150**	**CY**	**3.33**	**243,727**

05 Surface Water Collect & Control

01 Sediment Barriers

Assume installation of silt fence and hay bales around perimeter of contaminated areas. Area to be disturbed is 27 acres. Perimeter = 4,350 lf.

		Quantity		Unit Cost	Total Cost
023705501100	Silt Fences, Polypropylene, 3' High, Adverse Conditions	4,350.00	LF	0.96	4,162
023705501250	Hay Bales, staked	4,350.00	LF	3.06	13,332
SUBTOTAL Sediment Barriers		**4,350**	**LF**	**4.02**	**17,494**

02 Contact Water Control and Collection

The average annual rainfall is 32.3 inches and 16.2 inches occurs during the warmer months of May thru September. 5.7 inches occurs during December through February when it is assumed there are no operations. The monthly range is from 1.6 inches (Feb) to 3.8 inches (Jun). Given the low monthly rainfall events, most rainfall will naturally percolate into the underlying soils.

It will be assumed that any water requiring collection will be slowly discharged to an existing contaminated low-lying area of the site or used for moisture conditioning. Since the majority of the rainfall occurs in the warmer months, most water requiring collection can be used for moisture conditioning soils.

The average monthly accumulation during the 9 working months is 2.96 inches. Say 3 inches for calculating the required storage capacity.

Assume maximum of 30,000 sf open excavation area.
Assume 20% infiltration.

Volume = 30,000 sf x 0.25 inches rain x 0.80 = 6,000 cf
Volume = 6,000 cf x 7.48 gal/cf = 44,880 gallons

Use 2 ea, 21,000 gallon wastewater storage tanks for the duration of excavation activities.

Duration = 27 months x 2 tanks = 54 months

Assume pumps will be required an average of 3 days/month for 27 months = 81 days.

17031003	3" Diameter Contractor's Trash Pump, 150 GPM	81.00	DAYS	63.32	5,129
19040407	21,000 Gallon, Steel Closed Stationary Aboveground Wastewater Holding Tank, Rental	54.00	MO	1,758.26	94,946
33109649	Pump, Cast-iron Close Coupling, 2 HP, 50 GPM	2.00	EA	1,691.70	3,383
33231306	High Sump Level Switch for Avoiding Overflow	4.00	EA	472.46	1,890
33260550	2" Polyethylene, flexible piping, SDR15, 125 psi	1,000.00	LF	1.34	1,340
SUBTOTAL Contact Water Control and Collection		**1**	**LS**		**106,688**
SUBTOTAL Surface Water Collect & Control		**73,150**	**CY**	**1.70**	**124,183**

08 Solids Collection/Containment

01 Contaminated Soil Excavation

02 Excavation of Contaminated Soils

Total Excavation Volume w/ 20% overexcavation and 10% constructability (in situ cy) = 73,150

One excavation crew will be assumed for calculating excavation durations. The crew will consist of 1 excavator, 1 operator, 1 oiler, and 2 laborers. Expected output per crew per day is 208 cy per crew, based on an adjusted hourly output of 26 cy/hr (See RS Means 2002 for 1 cy excavator productivity Ref 02315 400 0200). Equipment output has been decreased 66% to allow for site, safety and soil factors described in the project notes. The excavator productivity will determine productivity for the crew.

The transportation crew will transport soils to the staging area. The crew will consist of 2 dump trucks and drivers. Total daily output is the same as excavator or 208 cy/day.

Excavators will remove in situ soils and load trucks for transport of materials to the temporary staging area. The laborers will be used for equipment spotters, dust control, decon, maintaining erosion and sediment installation, etc.

The crew will excavate 73,150 cy of soils at 26 cy/hr for a total of 2,814 hours.

Assume surveyors are required for 20 events at 4 hours each.

011077001200	Survey Areas to be Excavated and As-builts (2 people)	10.00	DAY	803.65	8,036
015902000150	Hyd. Excavator, 1 C.Y.	2,814.00	HR	87.08	245,039
CLAB	Common Building Laborers (2 ea)	5,628.00	HR	34.90	196,413
EQMD	Equipment Operators, Medium Equipment	2,814.00	HR	46.43	130,663

		Quantity		Unit Cost	Total Cost
EQOL	Equipment Operators, Oilers	2,814.00	HR	39.66	111,608
	SUBTOTAL Excavation of Contaminated Soils	**73,150**	**CY**	**9.46**	**691,759**

04 Transport to Staging Area

Total Volume w/ 20% expansion to be transported to the staging area = 87,750 ex situ cy.

The crews productivity will be limited by the excavators productivity. Therefore, the total crew hours will be the same at 2,814 hours based on a productivity of 26 cy/hour.

		Quantity		Unit Cost	Total Cost
015902005300	Dump Truck, 16 Ton (2 each)	5,628.00	HR	72.74	409,361
TRHV	Truck Drivers, Heavy (2 each)	5,628.00	HR	37.21	209,395
	SUBTOTAL Transport to Staging Area	**87,750**	**CY**	**7.05**	**618,756**
	SUBTOTAL Contaminated Soil Excavation	**73,150**	**CY**	**17.92**	**1,310,515**

02 Load Trucks at Staging Area

Total Volume to be Loaded = 75,075 ex situ cy or 97,600 tons (Assumes 1.3 ton/cy conversion factor).

This WBS is for loading contaminated materials at the staging area for transport to the disposal destination. Ten intermodals per day are assumed available. Each holds 20 tons for a total shipment of 200 tons/day. Approximately 12,675 cy will be treated and placed back on site. Based on shipment of 200 tons/day, 22 days/mos. for 9 mos./yr, the duration for excavation and loading containers with 75,075 cy or 97,600 tons of ex situ soils would be 488 days or 2.5 years.

The loading crew will consist of three laborers and one front end loader w/operator. The laborers will protect trucks from becoming contaminated, lining trucks, spotting for loader, taping liners closed, and light decontamination. Additionally, they will uncover/cover stockpile with tarp and ballast.

Loading 97,600 tons of soils at a rate of 25 tons/hr results in a total duration of 3,904 hours.

		Quantity		Unit Cost	Total Cost
015902004710	F.E. Loader, W.M., 2.5 C.Y.	3,904.00	HR	57.24	223,483
CLAB	Common Building Laborers (3 ea)	11,712.00	HR	34.90	408,740
ENGR EST	Staging Pile Tarp and Ballast	1.00	LS	6,491.02	6,491
EQMD	Equipment Operators, Medium Equipment	3,904.00	HR	46.43	181,275
	SUBTOTAL Load Trucks at Staging Area	**75,075**	**CY**	**10.92**	**819,988**
	SUBTOTAL Solids Collection/Containment	**73,150**	**CY**	**29.13**	**2,130,503**

13 Physical Treatment

Assume $2,000,000 is allotted for soil characterization, design and construction of treatment unit, and demonstration of soil washing treatment technologies. (Based on verbal quote from Maywood Site PM)

Total volume to be treated is 25,350 ex situ cy
Total weight to be treated is (25,350 cy x 1.3 ton/cy) = 33,000 tons
Soil Mass Reduction due to Treatment = 50%
Treated Clean Soil for Backfill = 12,675 ex situ cy
Total Disposal Volume = 12,675 ex situ cy

A processing rate of 20 tons/hr is assumed.
Treatment duration of 32,955 tons = 1,648 hours or 206 days

Transportation and disposal costs of the concentrated waste stream produced are included in WBS 33.19. Water used for the soil washing process is expected to be minimal and will be used to condition soils or discharged to a POTW upon completion of the treatment.

09 Soil Washing

		Quantity		Unit Cost	Total Cost
33130911	Soil Washing, Treat 55,000-59,999 Tons of Soils inc. Residual Water.	33,000.00	TON	144.63	4,772,902
	Added 10% to material cost for costs associated with chemical additives.				
33130915	Mobilize/Demolilize Soil Washing System (Assume 1000 mi RT)	1,000.00	MI	3.06	3,064
33130916	Assemble/Disassemble Soil Washing System	1.00	EA	63,279.62	63,280

		Quantity		Unit Cost	Total Cost
33130918	Decontaminate Soil Washing System	1.00	EA	324.21	324
ENGR EST	Soil Characterization, Equipment Design and Construction, and Treatment Demonstration	1.00	LS	2,000,000.00	2,000,000
SUBTOTAL Soil Washing		**25,350**	**CY**	**269.81**	**6,839,569**
SUBTOTAL Physical Treatment		**25,350**	**CY**	**269.81**	**6,839,569**

19 Transportation and Disposal

01 Transportation to Disposal Facility

This WBS is for transporting contaminated materials to a selected disposal facility. Approximately 12,675 cy will be treated and placed back on site. Total Volume to be Transported = 75,075 ex situ cy or 97,600 tons (Assumes 1.3 ton/cy conversion factor).

Envirosource, Ohio (Be Soils)
Total to be Transported = 56,150 cy or 73,000 tons
Unit Price = $15/ton
Based on Envirosource quote - An additional $5/ton was added to the $10/ton vendor quote to account for liners and other regulatory requirements. Assume each intermodal will have average 1 day turnaround time (time it arrives on site to time it is returned to site). Based on loading 10 intermodals per day, 10 intermodal containers will be required. The total number of intermodal trips is 3,650 (73,000 tons/ 20 tons/intermodal).

US Ecology of Idaho (Low Level Waste/Rads Alone and with Be Soils)
Total to be Transported = 12,675 cy or 16,500 tons
Unit Price = $150.15/ton
Based on quote given by MHF Transportation and includes hauling from the site to an intermodal loading facility in Toledo and transporting via rail to Envirocare. US Ecology is approximately 15% further in road distance, so 10% will be added to the Envirocare quote. Unit rate based on each rail car holding 6 intermodals and each intermodal holding 20 tons each. Assume each intermodal will have average 6 week turnaround time rental (time it arrives on site to time it is returned to site). Based on loading 10 intermodals per day, 300 intermodal containers will be required. The total number of intermodals trips is 825 (16,500 tons/ 20 tons/intermodal). Unit Rate to US Ecology = $2,730/container x 1.1 = $3,003/container. Assume 20 ton capacity is used. $3,003/20 ton = $150.15/ton

US Ecology of Idaho (Mixed Waste/Rads With Lead or Be Soils)
Total to be Transported = 3,950 cy or 5,150 tons
Unit Price = $150.15/ton
Assume same rate as LLW to US Ecology. Based on loading 10 intermodals per day, 258 intermodal containers will be required. The total number of intermodals required is 258 (5,150 tons/20 tons/intermodal). Unit Rate to US Ecology = $2,730/container x 1.1 = $3,003/container. Assume 20 ton capacity is used. $3,003/20 ton = $150.15/ton

Waste Management (Lead Alone or With Be Soils)
Total to be Transported = 2,300 cy or 3,000 tons
Unit Rate = $152/ton
Based on ECHOS 33190206 Transport Bulk Solid Hazardous Waste, Maximum 18 Ton. Unit Rate is 1.52/MI/Ton. Assume 100 MI one-way.
Unit Rate = $1.52 x 100 MI = $152/ton. Assume each intermodal will have average 1.5 day turnaround time (time it arrives on site to time it is returned to site). Based on loading 10 intermodals per day, 15 intermodal containers will be required. The total number of intermodal trips is 150 (3,000 tons/ 20 tons/intermodal).

Envirosource, Ohio (Be)

Assume demurrage allowance charge on 10% of containers for 1 hour @ $65/hour.

3,650 containers x 10% x 1 hour = 365 hours.

		Quantity		Unit Cost	Total Cost
VENDOR	Mob & Demob of Containers	10.00	EA	1,000.00	10,000
VENDOR	Transport Be Soils to Envirosource, OH (20 mile)	73,000.00	TON	15.00	1,095,000
VENDOR	Demurrage	365.00	HRS	65.00	23,725
SUBTOTAL Envirosource, Ohio (Be)		**56,150**	**CY**	**20.10**	**1,128,725**

US Ecology of Idaho (LLW with Be)

Assume demurrage allowance charge on 10% of containers for 1 hour @ $65/hour.

825 containers x 10% x 1 hour = 83 hours.

		Quantity		Unit Cost	Total Cost
VENDOR	Transport to US Ecology	16,500.00	TON	150.15	2,477,475
VENDOR	Demurrage	83.00	HRS	65.00	5,395
VENDOR	Mob & Demob of Containers	300.00	EA	1,000.00	300,000
SUBTOTAL US Ecology of Idaho (LLW with Be)		**12,675**	**CY**	**219.56**	**2,782,870**

US Ecology of Idaho (Mixed Waste)

Assume use of LLW containers. No separate mob/demob included.

Assume demurrage allowance charge on 10% of containers for 1 hour @ $65/hour.
258 containers x 10% x 1 hour = 26 hours.

VENDOR	Demurrage	26.00	HRS	65.00	1,690
VENDOR	Transport to US Ecology	5,150.00	TON	150.15	773,273
SUBTOTAL US Ecology of Idaho (Mixed Waste)		**3,950**	**CY**	**196.19**	**774,963**

Waste Management (RCRA)

Assume demurrage allowance charge on 10% of containers for 1 hour @ $65/hour.

150 containers x 10% x 1 hour = 15 hours.

VENDOR	Transport Soils WM Facility (100 mile one-way)	3,000.00	TON	152.00	456,000
VENDOR	Demurrage	15.00	HRS	65.00	975
SUBTOTAL Waste Management (RCRA)		**2,300**	**CY**	**198.68**	**456,975**
SUBTOTAL Transportation to Disposal Facility		**75,075**	**CY**	**68.51**	**5,143,533**

02 LLW Disposal Costs

Envirosource, Ohio (Be Soils)
Total to be Disposed = 73,000 tons
Unit Price = $50/ton (Based on Envirosource quote)

US Ecology of Idaho (Low Level Waste/Rads Alone and with Be Soils)
Total to be Transported = 25,350 cy
Unit Price = $71.50/cy (Based on USACE DACW41-99-D-9007 Intermodal Soil Rate)

US Ecology of Idaho (Mixed Waste/Rads With Lead or Be Soils)
Total to be Transported = 3,950 cy
Unit Price = $97.50/cy (Based on USACE DACW41-99-D-9007 Intermodal Soil Rate with state hazardous waste surcharge)

Waste Management (Lead Alone or With Be Soils)
Total to be Transported = 3,000 tons
Unit Rate = $160/ton (Based on ECHOS 33197263 Landfill Hazardous Waste by Ton).

Envirosource, Ohio (Be)

VENDOR	Disposal of Be Soils at Envirosource, OH	73,000.00	TON	50.00	3,650,000
SUBTOTAL Envirosource, Ohio (Be)		**56,150**	**CY**	**65.00**	**3,650,000**

US Ecology of Idaho (LLW with Be)

USACE DACW41	Disposal of LLW and LLW/BE at US Ecology, ID	12,675.00	CY	71.50	906,263
SUBTOTAL US Ecology of Idaho (LLW with Be)		**12,675**	**CY**	**71.50**	**906,263**

US Ecology of Idaho (Mixed Waste)

USACE DACW41	Disposal of Mixed Waste Soils at US Ecology, ID	3,950.00	CY	97.50	385,125
SUBTOTAL US Ecology of Idaho (Mixed Waste)		**3,950**	**CY**	**97.50**	**385,125**

		Quantity		Unit Cost	Total Cost
Waste Management (RCRA)					
USACE DACW41	Disposal of RCRA Waste at RCRA Facility	3,000.00	TON	160.00	480,000
SUBTOTAL Waste Management (RCRA)		**2,300**	**CY**	**208.70**	**480,000**
SUBTOTAL LLW Disposal Costs		**75,075**	**CY**	**72.21**	**5,421,388**
SUBTOTAL Transportation and Disposal		**73,150**	**CY**	**144.43**	**10,564,920**
20 Site Restoration					
01 Earthwork					
03 Backfill					
Includes 75,075 cy off site backfill and 12,675 cy from treatment system.					
17030423	Unclassified Fill, 6" Lifts, Off-Site, Includes Delivery, Spreading, and Compacting	75,075.00	CY	10.89	817,706
17030423R	Unclassified Fill, 6" Lifts, On-Site Spreading, and Compacting	12,675.00	CY	3.88	49,199
SUBTOTAL Backfill		**75,075**	**CY**	**11.55**	**866,905**
SUBTOTAL Earthwork		**75,075**	**CY**	**11.55**	**866,905**
03 Permanent Features					
01 Roads					
Assume 40,000 sf (2000 lf at 20 ft wide) of road way/parking lot repair. Assume 10 in gravel base and 2.5 in asphalt, 6.75 ft ditch, and 1 culvert. The majority of the impacted areas are currently in vegetated areas.					
17030103	Rough Grading	11,111.00	SY	1.20	13,369
17030108	Fine Grading, 130G, 2 Passes	5,556.00	SY	0.23	1,266
17030202	Ditch Excavation, Normal Soil, Haul Spoil 1 mile	2,500.00	CY	3.44	8,604
18010102	Gravel, Delivered and Dumped	1,543.00	CY	29.50	45,512
18010310	Prime Coat	4,444.00	SY	0.48	2,152
18010312	Asphalt Wearing Course, 1 Pass (Inc 5% Waste)	605.00	TON	75.34	45,583
19030402	34' Complete, 24" Corrugated Metal Pipe, Culvert w/Headwall	1.00	EA	7,053.84	7,054
SUBTOTAL Roads		**4,444**	**SY**	**27.80**	**123,539**
02 Structures					
Assume approximately 700 lf of fence needs to be replaced.					
028205280800	Fence, Industrial, 6 ft, 6 ga, omit barbed, galv steel	700.00	LF	23.58	16,509
SUBTOTAL Structures		**700**	**LF**	**23.58**	**16,509**
SUBTOTAL Permanent Features		**73,150**	**CY**	**1.91**	**140,048**
04 Revegetation And Planting					
Approximately 24 acres of the site will be disturbed. Assumes area of excavation plus 10% of additional area adjacent to excavation. Total = 27 acres.					
01 Seeding/Mulch/Fertilizer					
17040101	General Area Cleanup	27.00	ACR	382.81	10,336
18050101	Area Preparation	27.00	ACR	89.82	2,425

		Quantity		Unit Cost	Total Cost
18050401	Hydroseeding, 67% Level & 33% Sloped	27.00	ACR	661.17	17,852
18050408	Fertilizer, Hydro Spread	27.00	ACR	197.59	5,335
18050413	Watering with 3000-gallon Tank Truck	27.00	ACR	78.35	2,115
	SUBTOTAL Seeding/Mulch/Fertilizer	**27**	**ACR**	**1,409.74**	**38,063**
	SUBTOTAL Revegetation And Planting	**27**	**ACR**	**1,409.74**	**38,063**
	SUBTOTAL Site Restoration	**73,150**	**CY**	**14.29**	**1,045,015**
	SUBTOTAL HTRW Remedial Action	**73,150**	**CY**	**310.43**	**22,708,270**
	SUBTOTAL	***73,150***	***CY***	***310.43***	***22,708,270***
	General Conditions - PRIME CONTRACTOR AA	3.0%		3.89	284,830
	Prime Markup on Subs - PRIME CONTRACTOR AA	4.0%		5.19	379,773
	SUBTOTAL	***73,150***	***CY***	***319.52***	***23,372,872***
	Contingency	35.0%		110.88	8,111,012
	Remedial Design	4.0%		17.11	1,251,413
	Project Management	5.0%		22.24	1,626,837
	Construction Management	10.0%		46.70	3,416,358
	Owner Costs	13.3%		68.35	5,000,000
	Alt. 6 - Excavation, Treatment, & Offsite Disposal-Unrestricte	**73,150**	**CY**	**584.81**	**42,778,492**

Alternative 7 - Monitored Natural Attenuation

Project No. TERC DACW27-97-D-0015

Designed By:

Science Applications International Corporation

Estimated By:

Mike Poligone

Prepared By: Mike Poligone

Preparation Date: 5/8/2003

Effective Date of Pricing: 07/10/2002

Est Construction Time: 0 Days

CostLink Report	Page Number

PROJECT DESCRIPTION: ALTERNATIVE 7 MONITORED NATURAL ATTENUATION

This alternative involves monitored natural attenuation of the groundwater media and includes interim options to address impacts to the west production well, land use controls, limited maintenance, and environmental monitoring. (See the Luckey site FS for more details about the Luckey site and this proposed alternative).

PROJECT BREAKDOWN:

The Hazardous, Toxic, Radioactive Waste Work Breakdown Structure (HTRW WBS), February 1996, was used as the basis for organizing the cost estimates for the Luckey site alternatives. The estimate uses a 2 digit number at each level. The 2 digit numbers for the first 3 title levels are taken from the HTRW Remedial Action Work Breakdown Structure. The 2 digit numbers for the remaining title levels are user defined.

LEVEL 1 - WBS Level 1 (Account)- Luckey Alternative 7
LEVEL 2 - WBS Level 2 (System) - Land Use Controls
LEVEL 3 - WBS Level 3 (Subsystem) - Long Term Management Plan
LEVEL 4 - User Defined (Assembly Category or Other)
LEVEL 5 - User Defined (Assembly or Other)

The Level 2 WBS elements for this estimate are as follows:

33. HTRW REMEDIAL ACTION
33.01A West Production Well Interim Actions
33.01B Land Use Controls
33 02   Monitoring, Sampling, Tecting, and Analysis

34. HTRW O&M
34.01 Land Use Controls
34.02 GW Monitoring, Sampling, and Analysis

LUCKEY SITE KEY PARAMETERS:

Total Volume of In Situ Soils = 55,400 cy
Site Area = 24 acres
Total Monitoring Wells = 12

SCHEDULE SUMMARY:

Estimated Project duration: 0.5 yrs.

Engineering Design 0.5 yrs.
Excavation/Disposal of soils/materials 0 yrs.
Post-Remediation Report and As-builts 0 yrs.

Estimated Post-RA GW sampling:
Be Sampling = 150 yrs.
Uranium/Lead = 30 yrs.

PRODUCTIVITY:

Not applicable to this alternative.

ESCALATION:

The base year of comparison will be CY2002 and unit cost will be escalated to July 2002. Cost data will be escalated using the Price Escalation Indices (Annual Rates in Percentages) for Budget Authority in the memorandum dated 3 January, 2002 from the Comptroller of the Under Secretary of Defense, Subject: Revised Inflation Guidance, and the Department of the Army, DACS-PCB MEMO 2000-002 of Feb 2002, Subject: Revised Inflation Indices for FY02 President's Budget.

OVERHEAD COSTS

The following overhead markups have been applied to the Subcontractor's direct cost.

Professional Labor - A 140% markup was applied to professional labor for fringe benefits, paid vacation, medical insurance, holidays, retirement accounts, etc.

Craft Labor - A 30% markup was applied to craft labor for fringe benefits, paid vacation, medical insurance, holidays, retirement accounts, etc.

Equipment and Materials - A 8% markup was applied to all equipment and materials for indirect labor.

General Conditions - A 6% markup was applied to the direct project cost to account for all general conditions (i.e. Mobilization and Demobilization cost), including temporary facilities and utilities, telephone and communication, permits and licenses, subcontractor submittals, travel and per diem, personal protective equipment, insurance, bonds, and taxes.

Profit - A 8% profit markup has been applied for the direct cost.

The following Overhead Markups have been applied to the Prime Contractor's direct cost.

General Conditions - A 3% markup was applied to the direct project cost to account for all general conditions (i.e. Mobilization and Demobilization cost), including temporary facilities and utilities, telephone and communication, permits and licenses, subcontractor submittals, travel and per diem, personal protective equipment, insurance, bonds, and taxes.

Prime Markup on Sub - A 4% markup was applied to all subcontracted work. Indicates the percentage of profit a prime contractor will make on work completed by subcontractors. Prime contractors apply to subs to cover the administrative, management, and financial costs of overseeing and approving subcontractor's work. The prime profit on subcontractors is applied to the total subcontract project cost, including subcontractor's direct costs, overhead, and profit.

CONTINGENCY:

Contingencies are shown for both Design Contingencies and Construction Contingencies. EPA Guidance 540-R-00-002, July 2000 was used as a reference in developing design and construction contingencies.

A design contingency of 15% is being applied due to the proven implementation of these technologies. Land use controls, limited maintenance, and environmental monitoring have been successfully implemented at other superfund sites.

A construction contingency of 10% is being applied to account for difficulties associated with implementing land use controls.

DESIGN AND TECHNICAL SUPPORT COSTS:

Remedial design applies to capital cost and O&M cost and includes services to design the remedial action. Activities that are part of remedial design include pre-design collection and analysis of field data, engineering survey for design, treatability study (e.g., pilot-scale), and the various design components such as design analysis, plans, specifications, cost estimate, and schedule at the preliminary, intermediate, and final design phases including post RA documentation. Remedial Design has been included as a 8% markup of the total remedial action costs.

PROJECT MANAGEMENT

Project management includes services that are not specific to remedial design, construction management, or technical support of O&M activities. Project management includes planning and reporting, community relations' support during construction or O&M, bid or contract administration, permitting (not already provided by the construction or O&M contractor), and legal services outside of land use controls (e.g., licensing). Project Management has been included as a 8% markup of the total remedial action costs.

CONSTRUCTION MANAGEMENT

Construction management includes services to manage construction or installation of the remedial action. Activities include review of submittals, design modifications, construction observation or oversight, engineering survey for construction, preparation of O&M manual, documentation of quality control/quality assurance, and record drawings. Construction Management has been included as a 10% markup of the total remedial action costs.

OWNER COST

USACE Program Management cost will be included as a 15% markup of the total cost.

	Quantity		Unit Cost	Total Cost	
TERC DACW27-97-D-0015 Alternative 7 - Monitored Natural Attenuation					
33 HTRW Remedial Action					
01A West Production Well Interim Actions				$75,000	20%
01B Land Use Controls					
0801 Long Term Management Plan and Site Database				$111,892	
0802 Land Use Controls				$88,750	
SUBTOTAL Land Use Controls	24	ACR	$8,360.07	$200,642	54%
02 Monitoring,Sampling,Testing, & Analysis					
04 Monitoring Wells	12	EA	$8,100.86	$97,210	
SUBTOTAL Monitoring,Sampling,Testing, & Analysis	24	ACR	$4,050.43	$97,210	26%
SUBTOTAL HTRW Remedial Action	24	ACR	$15,535.50	$372,852	9%
34 HTRW GROUNDWATER O&M					
01 Land Use Controls					
0801 Long Term Management Plan and Site Database	150	YR	$13,253.07	$1,987,961	
15 Five-Year Reviews (Years 0-150 = 30 events)	150	YR	$5,641.00	$846,150	
SUBTOTAL Land Use Controls	150	YR	$18,894.07	$2,834,111	77%
02 GW Monitoring/Sampling/Analysis					
04 Monitoring Wells	150	YR	$1,270.19	$190,529	
08 Sampling Media	150	YR	$3,036.37	$455,455	
09 Chemical/Rad Lab Analysis	150	YR	$1,245.01	$186,751	
SUBTOTAL GW Monitoring/Sampling/Analysis	150	YR	$5,551.57	$832,736	23%
SUBTOTAL HTRW GROUNDWATER O&M	150	EA	$24,445.65	$3,666,847	91%
Alternative 7 - Monitored Natural Attenuation	**150**	**YR**	**$26,931.33**	**$4,039,699**	

		Quantity		Unit Cost	Total Cost

TERC DACW27-97-D-0015 Alternative 7 - Monitored Natural Attenuation

33 HTRW Remedial Action

HTRW = Hazardous, Toxic, and Radioactive Waste

01A West Production Well Interim Actions

Includes interim options to address impacts to the west production well.
Assume $75K.

		Quantity		Unit Cost	Total Cost
ENGR EST 009	West Production Well Interim Actions	1.00	LS	$75,000.00	$75,000
SUBTOTAL West Production Well Interim Actions		**1**	**LS**		**$75,000**

01B Land Use Controls

0801 Long Term Management Plan and Site Database

Develop Long Term Management Plan to address administrative or legal measures to reduce or minimize potential exposures to contaminants left on site in groundwater.

Long Term Management Plan - Includes $67,000 per Don Erwin to research controls, coordinate with stakeholders, and develop plan.

Site Information Database - Assume 200 hrs to develop a site database. Use Senior Engineer Rate.

		Quantity		Unit Cost	Total Cost
33220104	Site Database	200.00	HR	$105.20	$21,041
D. Erwin	Long Term Management Plan	1.00	LS	$67,000.00	$67,000
SUBTOTAL Long Term Management Plan and Site Da		**1**	**LS**		**$88,041**

0802 Land Use Controls

Implement Land Use Controls - Includes $71,000 per Don Erwin to implement land use controls.

		Quantity		Unit Cost	Total Cost
D. Erwin	Implement Land Use Controls	1.00	LS	$71,000.00	$71,000
SUBTOTAL Land Use Controls		**1**	**EA**		**$71,000**
SUBTOTAL Land Use Controls		**24**	**ACR**	**$6,626.69**	**$159,041**

02 Monitoring,Sampling,Testing, & Analysis

04 Monitoring Wells

5 Monitoring Well Replacement

Includes installation of 10 monitoring wells at a depth of 20 ft and 2 wells at a depth of 60 ft to monitor the GW. Assume depth to GW is 8 ft.

		Quantity		Unit Cost	Total Cost
33010101	Standby Time	12.00	HR	$427.22	$5,127
33010101	Mob/Demob of drilling crew	1.00	LS	$3,417.78	$3,418
33020303	Organic Vapor Analyzer rental, per Day	4.00	DAY	$133.79	$535
33170808	Decon. materials for Rig, Augers, Screen (Rental equip.)	4.00	DAY	$128.71	$515
33220109	Field Geologist	64.00	HR	$60.56	$3,876

		Quantity		Unit Cost	Total Cost
33230121	Well casing, 2" stainless steel (10-50 ft per well)	200.00	LF	$31.31	$6,261
33230221	Well Screen, 2" stainless steel (10 ft per well)	120.00	LF	$26.53	$3,184
33230311	Well plug, 2" stainless steel	12.00	EA	$83.25	$999
33231101	Hollow Stem Auger, 8" Dia Borehole, Depth < 100 ft	332.00	LF	$46.15	$15,321
33231401	Filter Pack, 2" Screen	144.00	LF	$13.28	$1,912
33231504	Surface Pad, Concrete 2'x2'x4"	12.00	EA	$151.28	$1,815
33231811	Portland Cement Grout	84.00	LF	$1.34	$112
33232101	Bentonite Seal, 2" Well	12.00	EA	$49.11	$589
33232301	5' Guard Post, Cast Iron, Concrete Fill	48.00	EA	$74.28	$3,565
SUBTOTAL Monitoring Well Replacement		**12**	**EA**	**$3,935.81**	**$47,230**
90 Well Installation Report					
33220109	Field Geologist	24.00	HR	$60.56	$1,453
33220114	Word Processing	4.00	HR	$35.09	$140
33220115	Field Draftsmen	8.00	HR	$54.37	$435
SUBTOTAL Well Installation Report		**1**	**LS**		**$2,029**
SUBTOTAL Monitoring Wells		**12**	**EA**	**$4,104.87**	**$49,258**
SUBTOTAL Monitoring,Sampling,Testing, & Analysis		**24**	**ACR**	**$2,052.43**	**$49,258**
SUBTOTAL HTRW Remedial Action		**24**	**ACR**	**$11,804.12**	**$283,299**

34 HTRW GROUNDWATER O&M

01 Land Use Controls

0801 Long Term Management Plan and Site Database

Maintain O&M plan to address administrative or legal measures to reduce or minimize potential exposure to contaminants left on site. Assume the following:

Long Term Management Plan - Assume 40 hrs/yr for 150 yrs = 6,000 hrs to coordinate with stakeholders and make revisions to plan. Use Senior PM Rate.

Site Information Database - Assume 16 hrs/yr for 150 yrs = 2,400 hrs to update site database. Use Senior Engineer Rate.

		Quantity		Unit Cost	Total Cost
33220101	Long Term Management Plan	6,000.00	HR	$125.81	$754,854
33220104	Site Database	2,400.00	HR	$105.20	$252,486
SUBTOTAL Long Term Management Plan and Site Da		**150**	**YR**	**$6,715.60**	**$1,007,340**
15 Five-Year Reviews (Years 0-150 = 30 events)					
33220102	Project Manager (60 hours/report x 30 events)	1,800.00	HR	$105.39	$189,711
33220109	Field Geologist (120 hours/report x 30 events)	3,600.00	HR	$60.56	$217,999
33220114	Word Processing (20 hrs/report x 30 events)	600.00	HR	$35.09	$21,051
SUBTOTAL Five-Year Reviews (Years 0-150 = 30 eve		**150**	**YR**	**$2,858.41**	**$428,761**
SUBTOTAL Land Use Controls		**150**	**YR**	**$9,574.01**	**$1,436,101**

		Quantity		Unit Cost	Total Cost

02 GW Monitoring/Sampling/Analysis

There will be a network of 12 monitoring wells to monitor the effectiveness of the treatment system. Eight wells will be used to monitor Be contaminant plumes for an anticipated 150 years of treatment. Four wells will be used to monitor U/Lead contaminant plumes for an anticipated 30 years of treatment. Monitoring periods are based on the transport model.

04 Monitoring Wells

Assume 4 wells to a depth of 20 ft to monitor U/Lead.

Assume 6 wells to a depth of 20 ft and 2 wells to a depth of 60 ft to monitor Be. They will be replaced every 50 years over 150 yr period = 2 events. Use $4,500/well average based on WBS 33 02 05 for the cost to owner unit cost. $36,000 cost to owner per event.

Assume wells will be abandon every 50 years. Four wells will be abandon at the end of the 30-year monitoring period. Eight Be wells will be abandon every 50 years over a 150 yr period = 3 events. Total wells = (4 wells x 1 event) + (8 wells x 3 events) = 28 wells to a depth of 20 ft.

Assume 3 sets of reports.

		Quantity		Unit Cost	Total Cost
5 Monitoring Well Replacement					
SEENOTE	Replace 8 wells every 50 years over 150 years	2.00	EVT	$36,000.00	$72,000
SUBTOTAL Monitoring Well Replacement		**150**	**YR**	**$480.00**	**$72,000**
15 Well Abandonment of Old Wells					
015902000150	Hyd. Excavator, 1 C.Y. (2 hrs/well x 28 wells)	56.00	HR	$87.08	$4,876
33231822	Well Abandonment of 2" wells (22 wells @ 20 ft & 6 wells @ 60 ft)	800.00	LF	$22.87	$18,293
SUBTOTAL Well Abandonment of Old Wells		**150**	**YR**	**$154.46**	**$23,169**
90 Well Abandonment Report					
33220109	Field Geologist (24 hr/report x 3 events)	72.00	HR	$60.56	$4,360
33220114	Word Processing (4 hr/report x 3 events)	12.00	HR	$35.09	$421
33220115	Field Draftsmen (8 hr/report x 3 events)	24.00	HR	$54.37	$1,305
SUBTOTAL Well Abandonment Report		**150**	**YR**	**$40.57**	**$6,086**
SUBTOTAL Monitoring Wells		**150**	**YR**	**$675.03**	**$101,255**

08 Sampling Media

Groundwater will be monitored every year for the first 5 years and every five years for years 5-150. Beryllium will be monitored for a 150 year period. U/Lead constituents will be monitored for a 30 year period.

10 Groundwater Sampling (Years 0-5 = 5 events)

Duration is 4 days per year (3 wells/day and 12 wells total). Samples will be taken at each event for a total of 5 events (Years 0,1,2,3,4). Samples will include 4 samples of Uranium and Gross Alpha/Beta each per year; 8 ICPAES metals and GFAA metals each per year; and 12 water quality. The following field measurements will be taken onsite: Dissolved oxygen, Eh, pH, turbidity, temperature, and conductivity. Assume purge water will be returned to the ground upon verification of a clean sample. Approximately 24 samples per event (4 Rad, 8 metals, 12 water quality).

		Quantity		Unit Cost	Total Cost
33020401	Disposable Materials per Sample (gloves,jars,tape,ice,isop) (24 samples x 5 events)	120.00	EA	$9.96	$1,195
33020402	Decon. Materials per Sample (deion. water,soap)(24 samples x 5 events)	120.00	EA	$8.96	$1,075
33020570	Water Quality Indicator (1 wk/ev x 5 events)	5.00	WK	$66.90	$335
33020573	Water Level Indicator (1 wk/ev x 5 events)	5.00	WK	$36.24	$181
33021498	Radiation Protection Technicians (4 days x 5 events)	160.00	HR	$53.34	$8,534
33022028	250 ml, clear, w/septa, wide sample jars (24 x 5 events)	120.00	EA	$72.05	$8,646
33022034	Chain of Custody Seals (pkg of 5) (5 packs x 5 events)	25.00	EA	$2.28	$57
33022046	60 Quart Ice Chest (3 ea x 5 events)	15.00	EA	$76.59	$1,149
33022063	Overnite Delivery to Lab (21-50 lb) (3 ea x 5 events)	15.00	EA	$54.43	$817
33190401	55-gal. drum for purging (3/well x 12 wells x 5 events)	180.00	EA	$84.38	$15,189
33220109	Field Geologist (4 days x 5 events)	160.00	HR	$60.56	$9,689
33230507	2" Submersible Pump Rental (1 wk/ev x 5 events)	5.00	WK	$265.28	$1,326
33232407	Disposable Bailer, Poly,1.5" out dia x 36" (24 ea x 5 events)	120.00	EA	$11.62	$1,394
	SUBTOTAL Groundwater Sampling (Years 0-5 = 5 eve	**5**	**YR**	**$9,917.34**	**$49,587**

10 Groundwater Sampling (Years 5-30 = 6 events)

Duration is 4 days per year (3 wells/day and 12 wells total). Samples will be taken at each event for a total of 6 events. Samples will include 4 samples of Uranium and Gross Alpha/Beta each per year; 8 ICPAES metals and GFAA metals each per year; and 12 water quality. The following field measurements will be taken onsite: Dissolved oxygen, Eh, pH, turbidity, temperature, and conductivity. Assume purge water will be returned to the ground upon verification of a clean sample. Approximately 24 samples per event (4 Rad, 8 metals, 12 water quality).

		Quantity		Unit Cost	Total Cost
33020401	Disposable Materials per Sample (gloves,jars,tape,ice,isop) (24 samples x 6 events)	144.00	EA	$9.96	$1,434
33020402	Decon. Materials per Sample (deion. water,soap)(24 samples x 6 events)	144.00	EA	$8.96	$1,290
33020570	Water Quality Indicator (1 wk/ev x 6 events)	6.00	WK	$66.90	$401
33020573	Water Level Indicator (1 wk/ev x 6 events)	6.00	WK	$36.24	$217
33021498	Radiation Protection Technicians (4 days x 6 events)	192.00	HR	$53.34	$10,241
33022028	250 ml, clear, w/septa, wide sample jars (24 x 6 events)	144.00	EA	$72.05	$10,375
33022034	Chain of Custody Seals (pkg of 5) (5 packs x 6 events)	30.00	EA	$2.28	$69
33022046	60 Quart Ice Chest (3 ea x 6 events)	18.00	EA	$76.59	$1,379
33022063	Overnite Delivery to Lab (21-50 lb) (3 ea x 6 events)	18.00	EA	$54.43	$980
33190401	55-gal. drum for purging (3/well x 12 wells x 6 events)	216.00	EA	$84.38	$18,227
33220109	Field Geologist (4 days x 6 events)	192.00	HR	$60.56	$11,627
33230507	2" Submersible Pump Rental (1 wk/ev x 6 events)	6.00	WK	$265.28	$1,592
33232407	Disposable Bailer, Poly,1.5" out dia x 36" (24 ea x 6 events)	144.00	EA	$11.62	$1,673
	SUBTOTAL Groundwater Sampling (Years 5-30 = 6 ev	**25**	**YR**	**$2,380.16**	**$59,504**

		Quantity		Unit Cost	Total Cost
10 Groundwater Sampling (Years 35-150 = 24 events)					

Duration is 3 days per year (3 wells/day and 8 wells total). Samples will be taken at each event for a total of 24 events. Samples will include 8 ICPAES metals each per year; and 12 water quality. The following field measurements will be taken onsite: Dissolved oxygen, Eh, pH, turbidity, temperature, and conductivity. Assume purge water will be returned to the ground upon verification of a clean sample. Approximately 24 samples per event (8metals, 12 water quality).

		Quantity		Unit Cost	Total Cost
33020401	Disposable Materials per Sample (gloves,jars,tape,ice,isop) (8 samples x 24 events)	192.00	EA	$9.96	$1,912
33020402	Decon. Materials per Sample (deion. water,soap)(8 samples x 24 events)	192.00	EA	$8.96	$1,720
33020570	Water Quality Indicator (1 wk/ev x 24 events)	24.00	WK	$66.90	$1,606
33020573	Water Level Indicator (1 wk/ev x 24 events)	24.00	WK	$36.24	$870
33021498	Radiation Protection Technicians (3 days x 24 events)	576.00	HR	$53.34	$30,723
33022028	250 ml, clear, w/septa, wide sample jars (8 x 24 events)	192.00	EA	$72.05	$13,834
33022034	Chain of Custody Seals (pkg of 5) (2 packs x 24 events)	48.00	EA	$2.28	$110
33022046	60 Quart Ice Chest (1 ea x 24 events)	24.00	EA	$76.59	$1,838
33022063	Overnite Delivery to Lab (21-50 lb) (1 ea x 24 events)	24.00	EA	$54.43	$1,306
33190401	55-gal. drum for purging (3/well x 4 wells x 24 events)	288.00	EA	$84.38	$24,302
33220109	Field Geologist (3 days x 24 events)	576.00	HR	$60.56	$34,880
33230507	2" Submersible Pump Rental (1 wk/ev x 24 events)	24.00	EA	$265.28	$6,367
33232407	Disposable Bailer, Poly,1.5" out dia x 36" (8 ea x 24 events)	192.00	EA	$11.62	$2,231
SUBTOTAL Groundwater Sampling (Years 35-150 = 24		**115**	**YR**	**$1,058.24**	**$121,698**
SUBTOTAL Sampling Media		**150**	**YR**	**$1,538.59**	**$230,788**

09 Chemical/Rad Lab Analysis

Groundwater will be monitored every year for the first 5 years and every five years for years 5-150. Beryllium will be monitored for a 150 year period. U/Lead constituents will be monitored for a 30 year period.

10 Groundwater Analysis (Years 0-5 = 5 events)

		Quantity		Unit Cost	Total Cost
33022036	Documentation Package for QA, verif,data (1/event)	5.00	EA	$139.80	$699
33022253	Total Uranium (4 samples/event x 5 events)	20.00	EA	$155.78	$3,116
33022288	Gross Alpha/Beta (4 samples/event x 5 events)	20.00	EA	$84.51	$1,690
ENGREST	ICPAES Metals (8 Samples/event x 5 events)	40.00	EA	$142.80	$5,712
ENGREST	Water Quality (12/event x 5 events)	60.00	EA	$149.29	$8,958
ENGREST	GFAA Metals (4 Samples/event x 5 events)	20.00	EA	$116.84	$2,337
SUBTOTAL Groundwater Analysis (Years 0-5 = 5 even		**5**	**YR**	**$4,502.29**	**$22,511**

10 Groundwater Analysis (Years 5-30 = 6 events)

		Quantity		Unit Cost	Total Cost
33022036	Documentation Package for QA, verif,data (1/event)	6.00	EA	$139.80	$839
33022253	Total Uranium (4 samples/event x 6 events)	24.00	EA	$155.78	$3,739
33022288	Gross Alpha/Beta (4 samples/event x 6 events)	24.00	EA	$84.51	$2,028
ENGREST	Water Quality (12/event x 6 events)	72.00	EA	$149.29	$10,749

		Quantity		Unit Cost	Total Cost
ENGREST	GFAA Metals (4 Samples/event x 6 events)	24.00	EA	$116.84	$2,804
ENGREST	ICPAES Metals (8 Samples/event x 6 events)	48.00	EA	$142.80	$6,855
	SUBTOTAL Groundwater Analysis (Years 5-30 = 6 eve	**25**	**YR**	**$1,080.55**	**$27,014**
	02 Groundwater Analysis (Years 35-150 = 24 events)				
33022036	Documentation Package for QA, verif,data (1/event)	24.00	EA	$139.80	$3,355
ENGREST	Water Quality (4 samples/event x 24 events)	96.00	EA	$149.29	$14,332
ENGREST	ICPAES Metals (8 Samples/event x 24 events)	192.00	EA	$142.80	$27,418
	SUBTOTAL Groundwater Analysis (Years 35-150 = 24 (	**115**	**YR**	**$392.22**	**$45,105**
	SUBTOTAL Chemical/Rad Lab Analysis	**150**	**YR**	**$630.87**	**$94,631**
	SUBTOTAL GW Monitoring/Sampling/Analysis	**150**	**YR**	**$2,844.50**	**$426,674**
	SUBTOTAL HTRW GROUNDWATER O&M	**150**	**EA**	**$12,418.50**	**$1,862,776**
SUBTOTAL		***150***	***YR***	***$14,307.16***	***$2,146,074***
General Conditions - PRIME CONTRACTOR AA		3.0%		$372.21	$55,832
Prime Markup on Subs - PRIME CONTRACTOR AA		4.0%		$496.29	$74,443
SUBTOTAL		***150***	***YR***	***$15,175.66***	***$2,276,350***
Contingency		25.0%		$3,668.92	$550,337
Remedial Design		8.0%		$1,360.56	$204,084
Project Management		8.0%		$1,469.40	$220,410
Construction Management		10.0%		$1,983.69	$297,554
Owner Costs		15.0%		$3,273.09	$490,964
Alternative 7 - Monitored Natural Attenuation		**150**	**YR**	**$26,931.33**	**$4,039,699**

Alternative 8 - Active Groundwater Treatment

Project No. TERC DACW27-97-D-0015

Designed By:

Science Applications International Corporation

Estimated By:

Mike Poligone

Prepared By: Mike Poligone

Preparation Date: 5/5/2003

Effective Date of Pricing: 07/10/2002

Est Construction Time: 0 Days

CostLink Report	Page Number
Project Notes	1
Level 3 Owner Cost Summary	4
Estimate Detail	6

PROJECT DESCRIPTION:

Alternative 8 - Active Groundwater Treatment

This alternative involves removing contaminated groundwater above the appropriate cleanup criteria from the site and treating on site using adsorptive technologies and includes interim options to address impacts to the west production well. Impacted groundwater would be extracted by a network of 6 extraction wells (4 wells for the Be plume and 2 for the Lead/Uranium plume) and pumped to a central treatment system. The Be contaminated groundwater would be treated with an activated alumina for a period of 80 years. The Uranium contaminated groundwater would be treated with an activated carbon for a period of 10 years. Treated water would be discharged to the site surface water discharge. The site would be monitored for a period of 80 years. This alternative would be applicable if monitored natural attenuation (MNA) is unsuccessful. This alternative would begin after 5 years of MNA. (See the Luckey site FS for more details about the Luckey site and this proposed alternative).

PROJECT BREAKDOWN:

The Hazardous, Toxic, Radioactive Waste Work Breakdown Structure (HTRW WBS), February 1996, was used as the basis for organizing the cost estimates for the Luckey site alternatives. The estimate uses a 2 digit number at each level. The 2 digit numbers for the first 3 title levels are taken from the HTRW Remedial Action Work Breakdown Structure. The 2 digit numbers for the remaining title levels are user defined.

LEVEL 1 - WBS Level 1 (Account)- Luckey Alternative 8
LEVEL 2 - WBS Level 2 (System) - Treatment
LEVEL 3 - WBS Level 3 (Subsystem) - Carbon Adsorption Unit
LEVEL 4 - User Defined (Assembly Category or Other)
LEVEL 5 - User Defined (Assembly or Other)

The Level 2 WBS elements for this estimate are as follows:

33. HTRW REMEDIAL ACTION
33.01A West Production Well Interim Actions
33.01B Land Use Controls
33 02 Monitoring, Sampling, and Analysis
33.13 Treatment - Adsorption

34. HTRW O&M
34.01 Land Use Controls
34.02 GW Monitoring, Sampling, and Analysis
33.13A Treatment System O&M
33.13B Treatment System Replacement

LUCKEY SITE GROUNDWATER PARAMETERS

Extraction Wells = 6 ea
Depth of Wells = 25 ft
Depth to GW = 8 ft
Formation = unconsolidated
Pumping Rate = 2-3 GPM/well (use 2.5 gpm) for the Be wells
Pumping Rate = 1 GPM/well for the U/Lead wells
Average Pumping Rate = 2 GPM/well
Total Pumping Rate = 12 GPM for all wells

Treatment Unit (Be) = Duel Bed Alumina Adsorption, Single Pass with Instrumentation and Controls
Treatment Unit (U/Lead) = Duel Bed Carbon Adsorption, Single Pass with Instrumentation and Controls
Equipment Enclosure = 8 ft x 15 ft

Cost assembly based on RACER. RACER is a parametric cost modeling system used for estimating costs. Technology costs are based on generic engineering solutions for environmental projects, technologies, and processes. The generic engineering solutions were derived from historical project information, industry data, government laboratories, construction management agencies, vendors, contractors, and engineering analysis. The RACER cost database is a duplicate of the 2000 ECHOS (Environmental Cost Handling Options and Solutions) cost database. Costs have been updated to the 2002 ECHOS (Environmental Cost Handling Options and Solutions) cost database.

SCHEDULE SUMMARY:

The schedule is based on continuous 24 hr/day treatment.

Engineering Design = 1.0 years
Installation = 2 months
Startup = 6 weeks
Be Treatment = 80 years
U/Lead Treatment = 10 years
Monitoring = 80 years

ESCALATION:

The base year of comparison will be CY2002 and unit cost will be escalated to July 2002. Cost data will be escalated using the Price Escalation Indices (Annual Rates in Percentages) for Budget Authority in the memorandum dated 3 January, 2002 from the Comptroller of the Under Secretary of Defense, Subject: Revised Inflation Guidance, and the Department of the Army, DACS-PCB MEMO 2000-002 of Feb 2002, Subject: Revised Inflation Indices for FY02 President's Budget.

OVERHEAD COSTS

The following overhead markups have been applied to the Subcontractor's direct cost.

Professional Labor - A 140% markup was applied to professional labor for fringe benefits, paid vacation, medical insurance, holidays, retirement accounts, etc.

Craft Labor - A 30% markup was applied to craft labor for fringe benefits, paid vacation, medical insurance, holidays, retirement accounts, etc.

Equipment and Materials - A 8% markup was applied to all equipment and materials for indirect labor.

General Conditions - A 6% markup was applied to the direct project cost to account for all general conditions (i.e. Mobilization and Demobilization cost), including temporary facilities and utilities, telephone and communication, permits and licenses, subcontractor submittals, travel and per diem, personal protective equipment, insurance, bonds, and taxes.

Profit - A 8% profit markup has been applied for the direct cost.

The following Overhead Markups have been applied to the Prime Contractor's direct cost.

General Conditions - A 3% markup was applied to the direct project cost to account for all general conditions (i.e. Mobilization and Demobilization cost), including temporary facilities and utilities, telephone and communication, permits and licenses, subcontractor submittals, travel and per diem, personal protective equipment, insurance, bonds, and taxes.

Prime Markup on Sub - A 4% markup was applied to all subcontracted work. Indicates the percentage of profit a prime contractor will make on work completed by subcontractors. Prime contractors apply to subs to cover the administrative, management, and financial costs of overseeing and approving subcontractor's work. The prime profit on subcontractors is applied to the total subcontract project cost, including subcontractor's direct costs, overhead, and profit.

CONTINGENCY:

Contingencies are shown for both Design Contingencies and Construction Contingencies. EPA Guidance 540-R-00-002, July 2000 was used as a reference in developing design and construction contingencies.

A design contingency of 25% is being applied due to the unknowns associated with the effectiveness of treatment technologies and the required O&M period due to the long half life of Uranium.

A construction contingency of 15% is being applied due to the potential for increases in soil volumes that have been common at other FUSRAP sites. This would also include cost overruns, modifications, and change orders.

DESIGN AND TECHNICAL SUPPORT COSTS:

Remedial design applies to capital cost and O&M cost and includes services to design the remedial action. Activities that are part of remedial design include pre-design collection and analysis of field data, engineering survey for design, treatability study (e.g., pilot-scale), and the various design components such as design analysis, plans, specifications, cost estimate, and schedule at the preliminary, intermediate, and final design phases including post RA documentation. Remedial Design has been included as a 12% markup of the total remedial action costs.

PROJECT MANAGEMENT

Project management includes services that are not specific to remedial design, construction management, or technical support of O&M activities. Project management includes planning and reporting, community relations support during construction or O&M, bid or contract administration, permitting (not already provided by the construction or O&M contractor), and legal services outside of land use controls (e.g., licensing). Project Management has been included as a 8% markup of the total remedial action costs.

CONSTRUCTION MANAGEMENT

Construction management includes services to manage construction or installation of the remedial action. Activities include review of submittals, design modifications, construction observation or oversight, engineering survey for construction, preparation of O&M manual, documentation of quality control/quality assurance, and record drawings. Construction Management has been included as a 10% markup of the total remedial action costs.

OWNER COST

USACE Program Management cost will be included as a 15% markup of the total cost.

	Quantity		Unit Cost	Total Cost	
TERC DACW27-97-D-0015 Alternative 8 - Active Groundwater Treatment					
33 HTRW Remedial Action					
01A West Production Well Interim Actions				$75,000	6%
01B Land Use Controls					
0801 Long Term Management Plan and Site Database				$125,319	
0802 Land Use Controls				$99,400	
SUBTOTAL Land Use Controls	24	ACR	$9,363.28	$224,719	18%
02 Monitoring,Sampling,Testing, & Analysis					
04 Monitoring Wells	12	EA	$9,409.00	$112,908	
02 Beryllium & Rad Monitoring				$100,241	
SUBTOTAL Monitoring,Sampling,Testing, & Analysis	24	ACR	$8,881.21	$213,149	17%
13 Treatment - Adsorption					
01 Overhead Electrical Distribution				$59,888	
02 Building Enclosure				$21,422	
03 Groundwater Extraction Wells	6	EA	$21,520.84	$129,125	
04 Trenching/Piping	2,300	LF	$21.49	$49,431	
05 Carbon Adsorption Unit - Uranium				$121,663	
06 Alumina Adsorption Unit - Be				$121,663	
07 Instrumentation				$148,784	
08 Startup				$61,759	
09 Discharge to Site	17,300	GPD	$1.04	$17,999	
SUBTOTAL Treatment - Adsorption	17,300	GPD	$42.30	$731,734	59%
SUBTOTAL HTRW Remedial Action	17,300	GPD	$71.94	$1,244,602	10%
34 HTRW Groundwater O&M					
01 Land Use Controls					
0801 Long Term Management Plan and Site Database	80	YR	$15,393.20	$1,231,456	
SUBTOTAL Land Use Controls	80	YR	$15,393.20	$1,231,456	11%
02 GW Monitoring/Sampling/Analysis					
04 Monitoring Wells	80	YR	$2,510.92	$200,873	
08 Sampling Media	80	YR	$8,507.85	$680,628	
09 Chemical/Rad Lab Analysis	80	YR	$6,265.64	$501,251	
SUBTOTAL GW Monitoring/Sampling/Analysis	80	YR	$17,284.41	$1,382,753	12%
13A Treatment System O&M					
01 Annual O&M Misc. (Be and Uranium)	80	YR	$16,749.92	$1,339,994	
01 Beryllium Treatment System	80	YR	$84,609.76	$6,768,781	

	Quantity		Unit Cost	Total Cost	
02 Uranium Treatment System	10	YR	$29,031.25	$290,312	
SUBTOTAL Treatment System O&M	80	YR	$104,988.59	$8,399,087	72%
13B Treatment System Replacement					
01 Building Enclosure	80	YR	$535.55	$42,844	
02 Groundwater Extraction Wells	80	YR	$2,152.91	$172,233	
03 Trenching/Piping	80	YR	$824.75	$65,980	
06 Alumina Adsorption Unit - Be	80	YR	$3,041.57	$243,326	
05 Instrumentation	80	YR	$743.92	$59,514	
06 Startup	80	YR	$1,543.98	$123,519	
SUBTOTAL Treatment System Replacement	80	YR	$8,842.69	$707,415	6%
SUBTOTAL HTRW Groundwater O&M	80	YR	$146,508.89	$11,720,711	90%
Alternative 8 - Active Groundwater Treatment	**17,300**	**GPD**	**$749.44**	**$12,965,313**	

		Quantity		Unit Cost	Total Cost

TERC DACW27-97-D-0015 Alternative 8 - Active Groundwater Treatment

33 HTRW Remedial Action

HTRW = Hazardous, Toxic, and Radioactive Waste

01A West Production Well Interim Actions

Includes interim options to address impacts to the west production well.
Assume $75K.

		Quantity		Unit Cost	Total Cost
ENGR EST 009	West Production Well Interim Actions	1.00	LS	$75,000.00	$75,000
SUBTOTAL West Production Well Interim Actions		**1**	**LS**		**$75,000**

01B Land Use Controls

0801 Long Term Management Plan and Site Database

Develop Long Term Management Plan to address administrative or legal measures to reduce or minimize potential exposures to contaminants left on site in groundwater.

Long Term Management Plan - Includes $67,000 per Don Erwin to research controls, coordinate with stakeholders, and develop plan.

Site Information Database - Assume 200 hrs to develop a site database. Use Senior Engineer Rate.

		Quantity		Unit Cost	Total Cost
33220104	Site Database	200.00	HR	$105.20	$21,041
D. Erwin	Long Term Management Plan	1.00	LS	$67,000.00	$67,000
SUBTOTAL Long Term Management Plan and Site Da		**1**	**LS**		**$88,041**

0802 Land Use Controls

Implement Land Use Controls - Includes $71,000 per Don Erwin to implement land use controls.

		Quantity		Unit Cost	Total Cost
D. Erwin	Implement Land Use Controls	1.00	LS	$71,000.00	$71,000
SUBTOTAL Land Use Controls		**1**	**EA**		**$71,000**
SUBTOTAL Land Use Controls		**24**	**ACR**	**$6,626.69**	**$159,041**

02 Monitoring,Sampling,Testing, & Analysis

04 Monitoring Wells

5 Monitoring Well Replacement

Includes installation of 10 monitoring wells at a depth of 20 ft and 2 wells at a depth of 60 ft to monitor the GW. Assume depth to GW is 8 ft.

		Quantity		Unit Cost	Total Cost
33010101	Mob/Demob of drilling crew	1.00	LS	$3,417.78	$3,418
33010101	Standby Time	12.00	HR	$427.22	$5,127
33020303	Organic Vapor Analyzer rental, per Day	4.00	DAY	$133.79	$535
33170808	Decon. materials for Rig, Augers, Screen (Rental equip.)	4.00	DAY	$128.71	$515
33220109	Field Geologist	64.00	HR	$60.56	$3,876
33230121	Well casing, 2" stainless steel (10-50 ft per well)	200.00	LF	$31.31	$6,261
33230221	Well Screen, 2" stainless steel (10 ft per well)	120.00	LF	$26.53	$3,184

		Quantity		Unit Cost	Total Cost
33230311	Well plug, 2" stainless steel	12.00	EA	$83.25	$999
33231101	Hollow Stem Auger, 8" Dia Borehole, Depth < 100 ft	332.00	LF	$46.15	$15,321
33231401	Filter Pack, 2" Screen	144.00	LF	$13.28	$1,912
33231504	Surface Pad, Concrete 2'x2'x4"	12.00	EA	$151.28	$1,815
33231811	Portland Cement Grout	84.00	LF	$1.34	$112
33232101	Bentonite Seal, 2" Well	12.00	EA	$49.11	$589
33232301	5' Guard Post, Cast Iron, Concrete Fill	48.00	EA	$74.28	$3,565
SUBTOTAL Monitoring Well Replacement		**12**	**EA**	**$3,935.81**	**$47,230**

90 Well Installation Report

33220109	Field Geologist	24.00	HR	$60.56	$1,453
33220114	Word Processing	4.00	HR	$35.09	$140
33220115	Field Draftsmen	8.00	HR	$54.37	$435
SUBTOTAL Well Installation Report		**1**	**LS**		**$2,029**
SUBTOTAL Monitoring Wells		**12**	**EA**	**$4,104.87**	**$49,258**

02 Beryllium & Rad Monitoring

This WBS covers 2 IH/HP technicians to survey personnel and equipment during installation of the treatment system. The IH/HP technicians and equipment would be required for the duration of installation activities of 2 working months or 352 hours each. Total hours is 704.

Equipment pricing base on Vendor Quote (SEC 2/2001;Rates escalated to 2/2002)- The Beryllium and Radiological monitoring equipment includes the following:

1. Model 2929 dual channel scaler (1 @ $365/mo =$365/mo)
2. Alpha Survey Instrument, 43-5 or equal (2 @ 210/mo = $420/mo)
3. Ratemeter w/GM pancake, 44-9 or equal (2 @ $195/mo = $390/mo)
4. Alarming Frisker w/ GM pancake, 44-9 or equal (2 @ $133/mo = $266/mo)
5. Micro R Meter, Model 19 or equal (2 @ $133/mo = $266/mo)
6. Personal Air Sampling pumps (2 @ $83/mo = $166/mo)
7. Personal air sampling pump charger (2 @ $52/mo = $104/mo)
8. High Volume air samplers (3 @ $130/mo = $390/mo)

Total = $2,367/month. Use $2,500/mo direct cost to account for other miscellaneous equipment or supplies.

33021498	IH/HP Technicians	704.00	HR	$53.34	$37,550
Vendor Quote	IH/HP Monitoring Equipment	2.00	MO	$3,090.96	$6,182
SUBTOTAL Beryllium & Rad Monitoring		**1**	**LS**		**$43,732**
SUBTOTAL Monitoring,Sampling,Testing, & Analysis		**24**	**ACR**	**$3,874.61**	**$92,991**

13 Treatment - Adsorption

01 Overhead Electrical Distribution

20020101	Pole-mounted Transformer, 15 KV - 480/277 3 Phase	1.00	EA	$13,062.43	$13,062
20020103	Pole-mounted Capacitors, 6 KW	2.00	EA	$909.73	$1,819
20020310	1/C #2 Aluminum, Bare Wire	3,180.00	LF	$0.90	$2,851
20020421	Straight-line Structure, 15 KV Pole Top	4.00	EA	$544.53	$2,178
20020431	Terminal Structure, 15 KV Pole Top	2.00	EA	$2,961.27	$5,923
20020506	3/C #2 Underground, 600V Direct Burial Wire	23.00	LF	$7.41	$170

		Quantity		Unit Cost	Total Cost
20039901	Steel Conduit, 1" Rigid	23.00	LF	$5.37	$123
SUBTOTAL Overhead Electrical Distribution		**1**	**EA**		**$26,127**
02 Building Enclosure					
ENGR EST	Portable Building Enclosure, 10' x 15', insulated w/ exhaust.	1.00	EA	$10,000.00	$10,000
SUBTOTAL Building Enclosure		**1**	**EA**		**$10,000**
03 Groundwater Extraction Wells					

Includes installation of 6 extraction wells to a depth of 25. Four wells will be installed to pump contaminants from the Beryllium plume and 2 wells to pump water from the Uranium plumes. The depth to groundwater is 8 ft. The formation is unconsolidated. The Be/Lead flow rates are 2-3 gpm (use 2.5 gpm) and the Uranium is 1 gpm. Assume 2 gpm average over all wells.

		Quantity		Unit Cost	Total Cost
33010101	Mob/Demob of drilling crew	1.00	LS	$3,417.78	$3,418
33020303	Organic Vapor Analyzer rental, per Day	14.00	DAY	$133.79	$1,873
33109660	5000 Gallon Single Wall Steel Above Ground Tank	1.00	EA	$7,429.24	$7,429
33170808	Decon. materials for Rig, Augers, Screen (Rental equip.)	11.00	DAY	$128.71	$1,416
33220109	Field Geologist	35.00	HR	$60.56	$2,119
33230103	Well Casing, 6" PVC	48.00	LF	$21.23	$1,019
33230157	2" Pitless Adapter	6.00	EA	$252.87	$1,517
33230203	Well Screen, 6" PVC, Sch 40	96.00	LF	$38.31	$3,678
33230303	Well plug, 6" PVC	6.00	EA	$116.56	$699
33230521	4" Submersible Pump, 0.3-7 GPM, Head < 40, 1/3 Hp, w/controls	6.00	EA	$2,305.61	$13,834
33231103	Hollow Stem Auger, 11" Dia Borehole, Depth < 100 ft	144.00	LF	$48.80	$7,028
33231186	Well Development Equipment	6.00	WK	$284.31	$1,706
33231403	Filter Pack, 6" Screen	96.00	LF	$33.95	$3,259
33231813	Portland Cement Grout, 6" well	4.00	LF	$11.35	$45
33232103	Bentonite Seal, 6" Well	6.00	EA	$196.41	$1,178
33232205	Restricted Area, Well Protection	6.00	EA	$1,018.98	$6,114
SUBTOTAL Groundwater Extraction Wells		**6**	**EA**	**$9,388.91**	**$56,333**
04 Trenching/Piping					
17030257	Cat 225, 1.0 CY Trenching	1,023.00	CY	$1.51	$1,543
17030415	Backfill with Excavated Material	1,176.00	CY	$4.64	$5,460
17030513	Backfill, Spread and Compact	128.00	CY	$0.52	$66
17030418	Stone Backfill, Delivered and Dumped	128.00	CY	$31.98	$4,094
33260428	2" PVC Schedule 80 Piping	2,300.00	LF	$4.52	$10,403
SUBTOTAL Trenching/Piping		**2,300**	**LF**	**$9.38**	**$21,565**
05 Carbon Adsorption Unit - Uranium					
18020322	Structural Slab on Grade, 8"	15.00	SF	$8.51	$128
33132029	Duel Bed - 2-4' Diameter, 65 GPM Series, 130 GPM Parallel, 2000 lb ea	1.00	EA	$51,332.76	$51,333
33290117	Transfer Pump with Motor, Valves, Piping, 15 GPM, 1/2 Hp	1.00	EA	$1,617.51	$1,618
SUBTOTAL Carbon Adsorption Unit - Uranium		**1**	**EA**		**$53,078**

		Quantity		Unit Cost	Total Cost
06 Alumina Adsorption Unit - Be					
18020322	Structural Slab on Grade, 8"	15.00	SF	$8.51	$128
33132029	Duel Bed - 2-4' Diameter, 65 GPM Series, 130 GPM Parallel, 2000 lb ea	1.00	EA	$51,332.76	$51,333
33290117	Transfer Pump with Motor, Valves, Piping, 15 GPM, 1/2 Hp	1.00	EA	$1,617.51	$1,618
SUBTOTAL Alumina Adsorption Unit - Be		**1**	**EA**		**$53,078**
07 Instrumentation					
ENGR EST	Instrumentation/Controls	1.00	LS	$64,910.16	$64,910
SUBTOTAL Instrumentation		**1**	**LS**		**$64,910**
08 Startup					
33240104	Startup Cost	1.00	LS	$26,943.78	$26,944
SUBTOTAL Startup		**1**	**EA**		**$26,944**
09 Discharge to Site					
17030259	Cat 225, 1.5 CY Trenching	223.00	CY	$1.13	$253
17030401	950, 3.00 CY, Backfill with Excavated Material	223.00	CY	$1.43	$319
17031001	Wellpoint for Trench, Install & Remove < 500', 1 month.	5.00	LFHD	$76.81	$384
18050402	Seeding, Vegetative Cover	1.00	ACRE	$4,527.55	$4,528
19010202	PVC Piping, 1", Class 1	500.00	LF	$4.74	$2,370
SUBTOTAL Discharge to Site		**17,300**	**GPD**	**$0.45**	**$7,853**
SUBTOTAL Treatment - Adsorption		**17,300**	**GPD**	**$18.49**	**$319,888**
SUBTOTAL HTRW Remedial Action		**17,300**	**GPD**	**$37.39**	**$646,919**

34 HTRW Groundwater O&M

01 Land Use Controls

0801 Long Term Management Plan and Site Database

Maintain O&M plan to address administrative or legal measures to reduce or minimize potential exposure to contaminants left on site. Assume the following:

Long Term Management Plan - Assume 40 hrs/yr for 80 yrs = 3,200 hrs to coordinate with stakeholders and make revisions to plan. Use Senior PM Rate.

Site Information Database - Assume 16 hrs/yr for 80 yrs = 1,280 hrs to update site database. Use Senior Engineer Rate.

		Quantity		Unit Cost	Total Cost
33220101	Long Term Management Plan	3,200.00	HR	$125.81	$402,589
33220104	Site Database	1,280.00	HR	$105.20	$134,659
SUBTOTAL Long Term Management Plan and Site Da		**80**	**YR**	**$6,715.60**	**$537,248**
SUBTOTAL Land Use Controls		**80**	**YR**	**$6,715.60**	**$537,248**

		Quantity		Unit Cost	Total Cost

02 GW Monitoring/Sampling/Analysis

There will be a network of 12 monitoring wells to monitor the effectiveness of the treatment system. Eight wells will be used to monitor Be contaminant plumes for an anticipated 80 years of treatment. Four wells will be used to monitor U/Lead contaminant plumes for an anticipated 10 years of treatment. Monitoring periods are based on the transport model.

04 Monitoring Wells

Assume 4 wells to a depth of 20 ft to monitor U/Lead will be monitored over a 10 yr period.

Assume 8 wells to a depth of 20 ft to monitor Be will be replaced every 50 years over 80 yr period = 1 events. Use $4,500/well average based on WBS 33 02 05 for the cost to owner unit cost. $36,000 cost to owner per event.

Assume wells will be abandon every 50 years. Four wells will be abandon at year 30 = 1 events. Eight wells will be abandon every 50 years over a 80 yr period = 2 events. Total wells = (4 wells x 1 event) + (8 wells x 2 events) = 20 wells to a depth of 20 ft.

Assume 2 sets of reports.

		Quantity		Unit Cost	Total Cost
5 Monitoring Well Replacement					
SEENOTE	Replace 8 wells every 50 years over 80 years	2.00	EVT	$36,000.00	$72,000
SUBTOTAL Monitoring Well Replacement		**80**	**YR**	**$900.00**	**$72,000**
15 Well Abandonment of Old Wells					
015902000150	Hyd. Excavator, 1 C.Y. (2 hrs/well x 20 wells)	40.00	HR	$87.08	$3,483
33231822	Well Abandonment of 2" wells (16 wells @ 20 ft & 4 wells @ 60 ft)	560.00	LF	$22.87	$12,805
SUBTOTAL Well Abandonment of Old Wells		**80**	**YR**	**$203.60**	**$16,288**
90 Well Abandonment Report					
33220109	Field Geologist (24 hr/report x 2 events)	48.00	HR	$60.56	$2,907
33220114	Word Processing (4 hr/report x 2 events)	8.00	HR	$35.09	$281
33220115	Field Draftsmen (8 hr/report x 2 events)	16.00	HR	$54.37	$870
SUBTOTAL Well Abandonment Report		**80**	**YR**	**$50.72**	**$4,057**
SUBTOTAL Monitoring Wells		**80**	**YR**	**$1,154.32**	**$92,345**

08 Sampling Media

Groundwater will be monitored every year for the first 5 years and every five years for years 5-80. Beryllium will be monitored for a 80 year period. U/Lead constituents will be monitored for a 10 year period.

10 Groundwater Sampling (Years 0-5 = 5 events)

Duration is 4 days per year (3 wells/day and 12 wells total). Samples will be taken at each event for a total of 5 events (Years 0,1,2,3,4). Samples will include 4 samples of Uranium and Gross Alpha/Beta each per year; 8 ICPAES metals and GFAA metals each per year; and 12 water quality. The following field measurements will be taken onsite: Dissolved oxygen, Eh, pH, turbidity, temperature, and conductivity. Assume purge water will be returned to the ground upon verification of a clean sample. Approximately 24 samples per event (4 Rad, 8 metals, 12 water quality).

		Quantity		Unit Cost	Total Cost
33020401	Disposable Materials per Sample (gloves,jars,tape,ice,isop) (24 samples x 5 events)	120.00	EA	$9.96	$1,195
33020402	Decon. Materials per Sample (deion. water,soap)(24 samples x 5 events)	120.00	EA	$8.96	$1,075
33020570	Water Quality Indicator (1 wk/ev x 5 events)	5.00	WK	$66.90	$335
33020573	Water Level Indicator (1 wk/ev x 5 events)	5.00	WK	$36.24	$181
33021498	Radiation Protection Technicians (4 days x 5 events)	160.00	HR	$53.34	$8,534
33022028	250 ml, clear, w/septa, wide sample jars (24 x 5 events)	120.00	EA	$72.05	$8,646
33022034	Chain of Custody Seals (pkg of 5) (5 packs x 5 events)	25.00	EA	$2.28	$57
33022046	60 Quart Ice Chest (3 ea x 5 events)	15.00	EA	$76.59	$1,149
33022063	Overnite Delivery to Lab (21-50 lb) (3 ea x 5 events)	15.00	EA	$54.43	$817
33190401	55-gal. drum for purging (3/well x 12 wells x 5 events)	180.00	EA	$84.38	$15,189
33220109	Field Geologist (4 days x 5 events)	160.00	HR	$60.56	$9,689
33230507	2" Submersible Pump Rental (1 wk/ev x 5 events)	5.00	WK	$265.28	$1,326
33232407	Disposable Bailer, Poly,1.5" out dia x 36" (24 ea x 5 events)	120.00	EA	$11.62	$1,394
SUBTOTAL	**Groundwater Sampling (Years 0-5 = 5 eve**	**5**	**YR**	**$9,917.34**	**$49,587**

10 Groundwater Sampling (Years 5-10 = 2 events)

Duration is 4 days per year (3 wells/day and 12 wells total). Samples will be taken at each event for a total of 2 events. Samples will include 4 samples of Uranium and Gross Alpha/Beta each per year; 8 ICPAES metals and GFAA metals each per year; and 12 water quality. The following field measurements will be taken onsite: Dissolved oxygen, Eh, pH, turbidity, temperature, and conductivity. Assume purge water will be returned to the ground upon verification of a clean sample. Approximately 24 samples per event (4 Rad, 8 metals, 12 water quality).

		Quantity		Unit Cost	Total Cost
33020401	Disposable Materials per Sample (gloves,jars,tape,ice,isop) (24 samples x 2 events)	48.00	EA	$9.96	$478
33020402	Decon. Materials per Sample (deion. water,soap)(24 samples x 2 events)	48.00	EA	$8.96	$430
33020570	Water Quality Indicator (1 wk/ev x 2 events)	2.00	WK	$66.90	$134
33020573	Water Level Indicator (1 wk/ev x 2 events)	2.00	WK	$36.24	$72
33021498	Radiation Protection Technicians (4 days x 2 events)	64.00	HR	$53.34	$3,414
33022028	250 ml, clear, w/septa, wide sample jars (24 x 2 events)	48.00	EA	$72.05	$3,458
33022034	Chain of Custody Seals (pkg of 5) (5 packs x 2 events)	10.00	EA	$2.28	$23
33022046	60 Quart Ice Chest (3 ea x 2 events)	6.00	EA	$76.59	$460
33022063	Overnite Delivery to Lab (21-50 lb) (3 ea x 2 events)	6.00	EA	$54.43	$327
33190401	55-gal. drum for purging (3/well x 12 wells x 2 events)	72.00	EA	$84.38	$6,076
33220109	Field Geologist (4 days x 2 events)	64.00	HR	$60.56	$3,876
33230507	2" Submersible Pump Rental (1 wk/ev x 2 events)	2.00	WK	$265.28	$531
33232407	Disposable Bailer, Poly,1.5" out dia x 36" (24 ea x 2 events)	48.00	EA	$11.62	$558
SUBTOTAL	**Groundwater Sampling (Years 5-10 = 2 ev**	**5**	**YR**	**$3,966.94**	**$19,835**

		Quantity		Unit Cost	Total Cost
	10 Groundwater Sampling (Years 15-80 = 14 events)				

Duration is 3 days per year (3 wells/day and 8 wells total). Samples will be taken at each event for a total of 14 events. Samples will include 8 samples ICPAES metals, and 8 water quality. The following field measurements will be taken onsite: Dissolved oxygen, Eh, pH, turbidity, temperature, and conductivity. Assume purge water will be returned to the ground upon verification of a clean sample. Approximately 16 samples per event (8 Be, 8 water quality).

		Quantity		Unit Cost	Total Cost
33020401	Disposable Materials per Sample (gloves,jars,tape,ice,isop) (16 samples x 14 events)	224.00	EA	$9.96	$2,230
33020402	Decon. Materials per Sample (deion. water,soap)(16 samples x 14 events)	224.00	EA	$8.96	$2,007
33020570	Water Quality Indicator (1 wk/ev x 14 events)	14.00	WK	$66.90	$937
33020573	Water Level Indicator (1 wk/ev x 14 events)	14.00	WK	$36.24	$507
33021498	Radiation Protection Technicians (3 days x 14 events)	336.00	HR	$53.34	$17,922
33022028	250 ml, clear, w/septa, wide sample jars (16 x 14 events)	224.00	EA	$72.05	$16,139
33022034	Chain of Custody Seals (pkg of 5) (4 packs x 14 events)	64.00	EA	$2.28	$146
33022046	60 Quart Ice Chest (2 ea x 14 events)	28.00	EA	$76.59	$2,145
33022063	Overnite Delivery to Lab (21-50 lb) (2 ea x 14 events)	28.00	EA	$54.43	$1,524
33190401	55-gal. drum for purging (3/well x 4 wells x 14 events)	168.00	EA	$84.38	$14,176
33220109	Field Geologist (3 days x 14 events)	336.00	HR	$60.56	$20,347
33230507	2" Submersible Pump Rental (1 wk/ev x 14 events)	14.00	EA	$265.28	$3,714
33232407	Disposable Bailer, Poly,1.5" out dia x 36" (12 ea x 14 events)	224.00	EA	$11.62	$2,603
	SUBTOTAL Groundwater Sampling (Years 15-80 = 14 e	**65**	**YR**	**$1,298.41**	**$84,396**
	10 Treatment System Effluent Sampling (Years 0-10)				

Treatment system effluent samples will be taken quarterly to monitor the effectiveness of the system and filter media replacement. Samples will be obtained and analyzed for Uranium and Gross Alpha/Beta (1 sample), ICPAES metals and GFAA metals (1 sample), and water quality (1 sample). 3 samples per event.

Total samples = 3 samples/event x 4 events/year x 10 years = 120 samples taken on 40 events

		Quantity		Unit Cost	Total Cost
33020401	Disposable Materials per Sample (gloves,jars,tape,ice,isop) (3 samples x 40 events)	120.00	EA	$9.96	$1,195
33020402	Decon. Materials per Sample (deion. water,soap)(3 samples x 40 events)	120.00	EA	$8.96	$1,075
33020570	Water Quality Indicator (8 wks)	8.00	WK	$66.90	$535
33020573	Water Level Indicator (8 wks)	8.00	WK	$36.24	$290
33021498	Radiation Protection Technicians (1 days x 40 events)	320.00	HR	$53.34	$17,068
33022028	250 ml, clear, w/septa, wide sample jars (3 x 40 events)	120.00	EA	$72.05	$8,646
33022034	Chain of Custody Seals (pkg of 5) (1 packs x 40 events)	40.00	EA	$2.28	$91
33022046	60 Quart Ice Chest (1 ea x 40 events)	40.00	EA	$76.59	$3,064
33022063	Overnite Delivery to Lab (21-50 lb) (1 ea x 40 events)	40.00	EA	$54.43	$2,177
	SUBTOTAL Treatment System Effluent Sampling (Yea	**5**	**YR**	**$6,828.35**	**$34,142**

		Quantity		Unit Cost	Total Cost
10 Treatment System Effluent Sampling (Years 10-80)					
	Treatment system effluent samples will be taken quarterly to monitor the effectiveness of the system and filter media replacement. Samples will be obtained and analyzed for ICPAES metals (1 sample), and water quality (1 sample). 2 samples per event. Total samples = 2 samples/event x 4 events/year x 70 years = 560 samples taken on 280 events				
33020401	Disposable Materials per Sample (gloves,jars,tape,ice,isop) (2 samples x 280 events)	560.00	EA	$9.96	$5,576
33020402	Decon. Materials per Sample (deion. water,soap)(2 samples x 280 events)	560.00	EA	$8.96	$5,016
33020570	Water Quality Indicator (56 wks)	56.00	WK	$66.90	$3,746
33020573	Water Level Indicator (56 wks)	56.00	WK	$36.24	$2,029
33021498	Radiation Protection Technicians (1 days x280 events)	280.00	HR	$53.34	$14,935
33022028	250 ml, clear, w/septa, wide sample jars (2 x 280 events)	560.00	EA	$72.05	$40,348
33022034	Chain of Custody Seals (pkg of 5) (1 packs x280 events)	280.00	EA	$2.28	$640
33022046	60 Quart Ice Chest (1 ea x 280 events)	280.00	EA	$76.59	$21,446
33022063	Overnite Delivery to Lab (21-50 lb) (1 ea x 280 events)	280.00	EA	$54.43	$15,241
SUBTOTAL Treatment System Effluent Sampling (Yea		**70**	**YR**	**$1,556.84**	**$108,979**
SUBTOTAL Sampling Media		**80**	**YR**	**$3,711.73**	**$296,938**
09 Chemical/Rad Lab Analysis					
	Groundwater will be monitored every year for the first 5 years and every five years for years 5-80. Beryllium will be monitored for a 80 year period. U/Lead constituents will be monitored for a 10 year period.				
10 Groundwater Analysis (Years 0-5 = 5 events)					
33022036	Documentation Package for QA, verif,data (1/event)	5.00	EA	$139.80	$699
33022253	Total Uranium (4 samples/event x 5 events)	20.00	EA	$155.78	$3,116
33022288	Gross Alpha/Beta (4 samples/event x 5 events)	20.00	EA	$84.51	$1,690
ENGREST	GFAA Metals (4 Samples/event x 5 events)	20.00	EA	$116.84	$2,337
ENGREST	ICPAES Metals (8 Samples/event x 5 events)	40.00	EA	$142.80	$5,712
ENGREST	Water Quality (12/event x 5 events)	60.00	EA	$149.29	$8,958
SUBTOTAL Groundwater Analysis (Years 0-5 = 5 even		**5**	**YR**	**$4,502.29**	**$22,511**
10 Groundwater Analysis (Years 5-10 = 2 events)					
33022036	Documentation Package for QA, verif,data (1/event)	2.00	EA	$139.80	$280
33022253	Total Uranium (4 samples/event x 2 events)	8.00	EA	$155.78	$1,246
33022288	Gross Alpha/Beta (4 samples/event x 2 events)	8.00	EA	$84.51	$676
ENGREST	Water Quality (12/event x 2 events)	24.00	EA	$149.29	$3,583
ENGREST	ICPAES Metals (8 Samples/event x 2 events)	16.00	EA	$142.80	$2,285
ENGREST	GFAA Metals (4 Samples/event x 2 events)	8.00	EA	$116.84	$935
SUBTOTAL Groundwater Analysis (Years 5-10 = 2 eve		**5**	**YR**	**$1,800.91**	**$9,005**
02 Groundwater Analysis (Years 15-80 = 14 events)					

		Quantity		Unit Cost	Total Cost
33022036	Documentation Package for QA, verif,data (1/event)	14.00	EA	$139.80	$1,957
ENGREST	ICPAES Metals (8 Samples/event x 14 events)	112.00	EA	$142.80	$15,994
ENGREST	Water Quality (8 samples/event x 14 events)	112.00	EA	$149.29	$16,721
SUBTOTAL Groundwater Analysis (Years 15-80 = 14 e		**65**	**YR**	**$533.41**	**$34,672**

10 Treatment System Effluent Analysis (Years 0-10)

Treatment system effluent samples will be taken quarterly to monitor the effectiveness of the system and filter media replacement. Samples will be obtained and analyzed for Uranium and Gross Alpha/Beta (1 sample), ICPAES metals and GFAA metals (1 sample), and water quality (1 sample).

Total samples = 4 events/year x 10 years = 40 events

		Quantity		Unit Cost	Total Cost
33022036	Documentation Package for QA, verif,data (1/event)	40.00	EA	$139.80	$5,592
33022253	Total Uranium (1 samples/event x 40 events)	40.00	EA	$155.78	$6,231
33022288	Gross Alpha/Beta (1 samples/event x 40 events)	40.00	EA	$84.51	$3,381
ENGREST	GFAA Metals (1 Samples/event x 40 events)	40.00	EA	$116.84	$4,674
ENGREST	ICPAES Metals (1 Samples/event x 40 events)	40.00	EA	$142.80	$5,712
ENGREST	Water Quality (1/event x 40 events)	40.00	EA	$149.29	$5,972
SUBTOTAL Treatment System Effluent Analysis (Year		**10**	**YR**	**$3,156.14**	**$31,561**

02 Treatment System Effluent Analysis (Years 10-80)

Treatment system effluent samples will be taken quarterly to monitor the effectiveness of the system and filter media replacement. Samples will be obtained and analyzed for ICPAES metals (1 sample), and water quality (1 sample).

Total samples = 4 events/year x 70 years = 280 events

		Quantity		Unit Cost	Total Cost
33022036	Documentation Package for QA, verif,data (1/event)	280.00	EA	$139.80	$39,145
ENGREST	Water Quality (1 samples/event x 280 events)	280.00	EA	$149.29	$41,802
ENGREST	ICPAES Metals (1 Samples/event x 280 events)	280.00	EA	$142.80	$39,985
SUBTOTAL Treatment System Effluent Analysis (Year		**70**	**YR**	**$1,727.60**	**$120,932**
SUBTOTAL Chemical/Rad Lab Analysis		**80**	**YR**	**$2,733.51**	**$218,681**
SUBTOTAL GW Monitoring/Sampling/Analysis		**80**	**YR**	**$7,599.56**	**$607,965**

13A Treatment System O&M

01 Annual O&M Misc. (Be and Uranium)

		Quantity		Unit Cost	Total Cost
33220106	Senior Staff Engineer (10 hrs/yr)	80.00	YR	$1,052.03	$84,162
33220106	Staff Engineer (16 hr/yr)	80.00	YR	$994.82	$79,586
33220112	Field Technician (32 hr/yr)	80.00	YR	$1,354.86	$108,389
33420101	Electrical (2,105 KWH/yr)- Freeze Protection	80.00	YR	$163.96	$13,117
99020110	Annual Maintenance Materials and Labor	80.00	YR	$3,741.83	$299,346
SUBTOTAL Annual O&M Misc. (Be and Uranium)		**80**	**YR**	**$7,307.50**	**$584,600**

01 Beryllium Treatment System

02 Annual O&M Extraction Wells (Beryllium)

		Quantity		Unit Cost	Total Cost
33220106	Staff Engineer (Be Wells)(20 hr/yr)	80.00	YR	$1,243.53	$99,482

		Quantity		Unit Cost	Total Cost
33220112	Field Technician (Be Wells) (105 hr/yr)	80.00	YR	$4,445.62	$355,650
33420101	Electrical (Be Wells) 825 KWH/yr)- Freeze Protection	80.00	YR	$64.26	$5,141
	SUBTOTAL Annual O&M Extraction Wells (Beryllium)	**80**	**YR**	**$5,753.41**	**$460,273**
	04 Annual Discharge to POTW (Beryllium)				
33197102	Wastewater Disposal Fee (Be)(5,526 KGAL)	80.00	YR	$11,621.67	$929,734
33220106	Staff Engineer (Be) (30 hr/yr)	80.00	YR	$1,865.29	$149,223
33220112	Field Technician (Be) (150 hr/yr)	80.00	YR	$6,350.89	$508,071
33420101	Electrical (Be) 1,100 KWH/yr	80.00	YR	$85.68	$6,855
	SUBTOTAL Annual Discharge to POTW (Beryllium)	**80**	**YR**	**$19,923.54**	**$1,593,883**
	06 Annual O&M Alumina Adsorption (Beryllium)				
33132052	Coal-based General Purpose, 8 x 30 Sieve, 900 Iodine, (4,156 lb/yr)	80.00	YR	$5,071.61	$405,729
33220106	Staff Engineer (17 hr/yr)	80.00	YR	$1,057.00	$84,560
33220112	Field Technician (85 hr/yr)	80.00	YR	$3,598.84	$287,907
33420101	Electrical (1367 KWH/yr)	80.00	YR	$106.48	$8,518
ENGR EST	Removal, Transport, and Disposal of Spent Carbon (4,156 lb/yr)	80.00	YR	$1,500.00	$120,000
	SUBTOTAL Annual O&M Alumina Adsorption (Beryll	**80**	**YR**	**$11,333.93**	**$906,714**
SUBTOTAL Beryllium Treatment System		**80**	**YR**	**$37,010.88**	**$2,960,870**
02 Uranium Treatment System					
	03 Annual O&M Extraction Wells (Uranium)				
33220106	Staff Engineer (U Wells) (10 hr/yr)	10.00	YR	$621.76	$6,218
33220112	Field Technician (50 hr/yr)	10.00	YR	$2,116.96	$21,170
33420101	Electrical (U wells) (414 KWH/yr)	10.00	YR	$32.25	$322
	SUBTOTAL Annual O&M Extraction Wells (Uranium)	**10**	**YR**	**$2,770.98**	**$27,710**
	05 Annual Discharge to POTW (Uranium)				
33197102	Wastewater Disposal Fee (Uranium)(1,051 KGAL)	10.00	YR	$2,210.35	$22,103
33220106	Staff Engineer (Be) (30 hr/yr)	10.00	YR	$621.76	$6,218
33220112	Field Technician (Be) (150 hr/yr)	10.00	YR	$2,116.96	$21,170
33420101	Electrical (Be) 1,100 KWH/yr	10.00	YR	$42.06	$421
	SUBTOTAL Annual Discharge to POTW (Uranium)	**10**	**YR**	**$4,991.14**	**$49,911**
	07 Annual O&M Carbon Adsorption (Uranium)				
33132052	Coal-based General Purpose, 8 x 30 Sieve, 900 Iodine, (832 lb/yr)	10.00	YR	$1,015.30	$10,153
33132066	Removal, Transport, and Disposal of Spent Carbon (832 lb/yr)	10.00	YR	$1,500.00	$15,000
33220106	Staff Engineer (9 hr/yr)	10.00	YR	$559.59	$5,596
33220112	Field Technician (45 hr/yr)	10.00	YR	$1,905.27	$19,053
33420101	Electrical (274 KWH/yr)	10.00	YR	$21.34	$213
	SUBTOTAL Annual O&M Carbon Adsorption (Uranium)	**10**	**YR**	**$5,001.50**	**$50,015**
SUBTOTAL Uranium Treatment System		**10**	**YR**	**$12,763.61**	**$127,636**

		Quantity		Unit Cost	Total Cost
SUBTOTAL Treatment System O&M		**80**	**YR**	**$45,913.83**	**$3,673,106**

13B Treatment System Replacement

Assume entire Be Treatment system is replaced every 30 years for a total 5 replacements.

01 Building Enclosure

		Quantity		Unit Cost	Total Cost
33132377	Portable Building Enclosure, 8' x 15', insulated w/ exhaust.	2.00	EA	$10,000.00	$20,000
SUBTOTAL Building Enclosure		**80**	**YR**	**$250.00**	**$20,000**

02 Groundwater Extraction Wells

Includes installation of 2 extraction wells to a depth of 25 for the Uranium plumes and 4 wells for the Be plume. The depth to groundwater is 8 ft. The formation is unconsolidated. The Uranium is 1 gpm per well.

Assume Be wells will be replaced every 30 years over 80 yr period = 2 events. Reference WBS 33 13 03 for the cost to owner unit cost. Total cost for 6 wells is $60,277. Four wells would be $40,200.

		Quantity		Unit Cost	Total Cost
Task00247	Replace Be Extraction Wells	2.00	EA	$40,200.00	$80,400
SUBTOTAL Groundwater Extraction Wells		**80**	**YR**	**$1,005.00**	**$80,400**

03 Trenching/Piping

Assume Be well piping will be replaced every 30 years over 80 yr period = 2 events. Reference WBS 33 13 02 for the cost to owner unit cost. Total cost for piping to 6 wells is $23,075. Four wells would be $15,400.

		Quantity		Unit Cost	Total Cost
Task00247	Replace Be Well Piping (5 events)	2.00	EA	$15,400.00	$30,800
SUBTOTAL Trenching/Piping		**80**	**YR**	**$385.00**	**$30,800**

06 Alumina Adsorption Unit - Be

		Quantity		Unit Cost	Total Cost
18020322	Structural Slab on Grade, 8" (2 replacements x 15 sf ea)	30.00	SF	$8.51	$255
33132029	Duel Bed - 2-4' Diameter, 65 GPM Series, 130 GPM Parallel, 2000 lb ea	2.00	EA	$51,332.76	$102,666
33290117	Transfer Pump with Motor, Valves, Piping, 15 GPM, 1/2 Hp	2.00	EA	$1,617.51	$3,235
SUBTOTAL Alumina Adsorption Unit - Be		**80**	**YR**	**$1,326.95**	**$106,156**

05 Instrumentation

		Quantity		Unit Cost	Total Cost
ENGR EST	Instrumentation/Controls (2 replacements)	2.00	LS	$12,982.03	$25,964
SUBTOTAL Instrumentation		**80**	**YR**	**$324.55**	**$25,964**

06 Startup

		Quantity		Unit Cost	Total Cost
33240104	Startup Cost	2.00	LS	$26,943.78	$53,888
SUBTOTAL Startup		**80**	**YR**	**$673.59**	**$53,888**
SUBTOTAL Treatment System Replacement		**80**	**YR**	**$3,965.09**	**$317,207**
SUBTOTAL HTRW Groundwater O&M		**80**	**YR**	**$64,194.08**	**$5,135,526**

	Quantity		Unit Cost	Total Cost
SUBTOTAL	***17,300***	***GPD***	***$334.25***	***$5,782,446***
General Conditions - PRIME CONTRACTOR AA	3.0%		$9.05	$156,637
Prime Markup on Subs - PRIME CONTRACTOR AA	4.0%		$12.07	$208,850
SUBTOTAL	***17,300***	***GPD***	***$355.37***	***$6,147,933***
Contingency	40.0%		$140.41	$2,429,173
Remedial Design	12.0%		$57.42	$993,286
Project Management	8.0%		$42.87	$741,654
Construction Management	10.0%		$57.87	$1,001,233
Owner Costs	15.0%		$95.49	$1,652,034
Alternative 8 - Active Groundwater Treatment	**17,300**	**GPD**	**$749.44**	**$12,965,313**

Alternative 9 - Electrokinetics Groundwater Treatment

Project No. TERC DACW27-97-D-0015

Designed By:

Science Applications International Corporation

Estimated By:

Mike Poligone

Prepared By: Mike Poligone

Preparation Date: 5/8/2003

Effective Date of Pricing: 11/25/2002

Est Construction Time: 0 Days

CostLink Report	Page Number

PROJECT DESCRIPTION: ALTERNATIVE 9 - ELECTROKINETICS GROUNDWATER TREATMENT

This alternative involves treating groundwater contaminated above the appropriate cleanup criteria in place using Electrokinetics technologies and includes interim options to address impacts to the west production well. Impacted groundwater would be treated with a network of electrodes placed on a 10 ft grid. The Be would be treated over a period of 0-5 years followed by the treatment of Uranium for years 5-10. Contaminated electrolyte from the anodes would be solidified and disposed at a licensed facility. The site would be monitored for a period of 40 years. (See the Luckey site FS for more details about the Luckey site and this proposed alternative).

PROJECT BREAKDOWN:

The Hazardous, Toxic, Radioactive Waste Work Breakdown Structure (HTRW WBS), February 1996, was used as the basis for organizing the cost estimates for the Luckey site alternatives. The estimate uses a 2 digit number at each level. The 2 digit numbers for the first 3 title levels are taken from the HTRW Remedial Action Work Breakdown Structure. The 2 digit numbers for the remaining title levels are user defined.

LEVEL 1 - WBS Level 1 (Account)- Luckey Alternative 9
LEVEL 2 - WBS Level 2 (System) - Electrokinetics Groundwater Treatment
LEVEL 3 - WBS Level 3 (Subsystem) - System Installation
LEVEL 4 - User Defined (Assembly Category or Other)
LEVEL 5 - User Defined (Assembly or Other)

The Level 2 WBS elements for this estimate are as follows:

33. HTRW REMEDIAL ACTION
- 33.01A West Production Well Interim Actions
- 33.01B Land Use Controls
- 33 02 Monitoring, Sampling, and Analysis
- 33.13 Treatment - Electrokinetics Groundwater Treatment

34. HTRW O&M
- 34.01 Land Use Controls
- 34.02 GW Monitoring, Sampling, and Analysis
- 34.13 Treatment System O&M
- 34.19 Transportion and Disposal

LUCKEY SITE GROUNDWATER PARAMETERS

Treatment Volumes
Uranium Contaminated Zone - 62m x 60m x 3m = 11,160 m3 or 15,000 cy
Beryllium Contaminated Zone - (1) 90m x 31m x 3m = 8,370 m3 or 11,000 cy
(2) 46m x 30m x 3m = 4,140 m3 or 6,000 cy

Site to be treated in two 'batches' - (A) Both Be sites @ 5 years, (B) U site @ 5 years (10 years total)

Target Be concentration: Reduce from 80 ug/l to 4 ug/l (95%)
Target U concentration: Reduce from 100 ug/l to 30 ug/l (70%)
Electrodes Required = 650 ea
Electrode Depth = 20 ft
Electrode spacing: 3 m
Electrical charge required to reach target: 50,000 Ah/m3
Conductivity of soil: 2000 umho/cm
Cost of Electricity: $0.05/kWh

SCHEDULE SUMMARY:

The schedule is based on continuous 24 hr/day treatment.
Treatibility Study and Design = 1.0 year
System Installation = 1.0 year
Beryllium Treatment = 5 years
Uranium Treatment = 5 years (performed after Be treatment)
Monitoring = 15 to 40 years (15 years for shallow wells and 40 years for deep bedrock wells)

ESCALATION:

The base year of comparison will be CY2002 and unit cost will be escalated to July 2002. Cost data will be escalated using the Price Escalation Indices (Annual Rates in Percentages) for Budget Authority in the memorandum dated 3 January, 2002 from the Comptroller of the Under Secretary of Defense, Subject: Revised Inflation Guidance, and the Department of the Army, DACS-PCB MEMO 2000-002 of Feb 2002, Subject: Revised Inflation Indices for FY02 President's Budget.

OVERHEAD COSTS

The following overhead markups have been applied to the Subcontractor's direct cost. Overhead markups have been included in the Vendor quotes.

Professional Labor - A 140% markup was applied to professional labor for fringe benefits, paid vacation, medical insurance, holidays, retirement accounts, etc.

Craft Labor - A 30% markup was applied to craft labor for fringe benefits, paid vacation, medical insurance, holidays, retirement accounts, etc.

Equipment and Materials - A 8% markup was applied to all equipment and materials for indirect labor.

General Conditions - A 6% markup was applied to the direct project cost to account for all general conditions (i.e. Mobilization and Demobilization cost), including temporary facilities and utilities, telephone and communication, permits and licenses, subcontractor submittals, travel and per diem, personal protective equipment, insurance, bonds, and taxes.

Profit - A 8% profit markup has been applied for the direct cost.

The following Overhead Markups have been applied to the Prime Contractor's direct cost.

General Conditions - A 3% markup was applied to the direct project cost to account for all general conditions (i.e. Mobilization and Demobilization cost), including temporary facilities and utilities, telephone and communication, permits and licenses, subcontractor submittals, travel and per diem, personal protective equipment, insurance, bonds, and taxes.

Prime Markup on Sub - A 4% markup was applied to all subcontracted work. Indicates the percentage of profit a prime contractor will make on work completed by subcontractors. Prime contractors apply to subs to cover the administrative, management, and financial costs of overseeing and approving subcontractor's work. The prime profit on subcontractors is applied to the total subcontract project cost, including subcontractor's direct costs, overhead, and profit.

CONTINGENCY:

Contingencies are shown for both Design Contingencies and Construction Contingencies. EPA Guidance 540-R-00-002, July 2000 was used as a reference in developing design and construction contingencies.

A design contingency of 20% is being applied due to the unknowns associated with the effectiveness of treatment technologies and the required O&M period due to the long half life of Uranium.

A construction contingency of 15% is being applied due to the potential for increases in soil volumes that have been common at other FUSRAP sites. This would also include cost overruns, modifications, and change orders.

DESIGN AND TECHNICAL SUPPORT COSTS:

Remedial design applies to capital cost and O&M cost and includes services to design the remedial action. Activities that are part of remedial design include pre-design collection and analysis of field data, engineering survey for design, treatability study (e.g., pilot-scale), and the various design components such as design analysis, plans, specifications, cost estimate, and schedule at the preliminary, intermediate, and final design phases including post RA documentation. Remedial Design has been included as a 4% markup of the total remedial action costs.

PROJECT MANAGEMENT

Project management includes services that are not specific to remedial design, construction management, or technical support of O&M activities. Project management includes planning and reporting, community relations support during construction or O&M, bid or contract administration, permitting (not already provided by the construction or O&M contractor), and legal services outside of land use controls (e.g., licensing). Project Management has been included as a 4% markup of the total remedial action costs.

CONSTRUCTION MANAGEMENT

Construction management includes services to manage construction or installation of the remedial action. Activities include review of submittals, design modifications, construction observation or oversight, engineering survey for construction, preparation of O&M manual, documentation of quality control/quality assurance, and record drawings. Construction Management has been included as a 4% markup of the total remedial action costs.

OWNER COST

USACE Program Management cost will be included as a 15% markup of the total cost.

	Quantity		Unit Cost	Total Cost	
TERC DACW27-97-D-0015 Alternative 9 - Electrokinetics Groundwater Treatment					
33 HTRW Remedial Action					
01A West Production Well Interim Actions				$75,000	2%
01B Land Use Controls					
0801 Long Term Management Plan and Site Database				$120,843	
0802 Land Use Controls				$95,850	
SUBTOTAL Land Use Controls	24	ACR	$9,028.88	$216,693	5%
02 Monitoring,Sampling,Testing, & Analysis					
04 Monitoring Wells	12	EA	$8,427.89	$101,135	
02 Beryllium & Rad Monitoring	32,000	CY	$16.84	$538,732	
SUBTOTAL Monitoring,Sampling,Testing, & Analysis	24	ACR	$26,661.11	$639,867	16%
13 Treatment - Electrokinetics System					
System Installation	32,000	CY	$97.61	$3,123,661	
SUBTOTAL Treatment - Electrokinetics System	32,000	CY	$97.61	$3,123,661	77%
SUBTOTAL HTRW Remedial Action	32,000	CY	$126.73	$4,055,220	33%
34 HTRW Groundwater O&M					
01 Land Use Controls					
0801 Long Tern Management Plan and Site Database	40	YR	$13,788.10	$551,524	
SUBTOTAL Land Use Controls	40	YR	$13,788.10	$551,524	7%
02 GW Monitoring/Sampling/Analysis					
04 Monitoring Wells	40	YR	$691.11	$27,644	
08 Sampling Media	40	YR	$9,328.03	$373,121	
09 Chemical/Rad Lab Analysis	40	YR	$7,219.88	$288,795	
SUBTOTAL GW Monitoring/Sampling/Analysis	40	YR	$17,239.01	$689,560	9%
13A Treatment System O&M	10	YR	$674,816.18	$6,748,162	84%
19 Transportation and Disposal	23	CY	$2,878.24	$66,200	1%
SUBTOTAL HTRW Groundwater O&M	40	YR	$201,386.15	$8,055,446	67%
Alternative 9 - Electrokinetics Groundwater Treatme	**32,000**	**CY**	**$378.46**	**$12,110,666**	

		Quantity		Unit Cost	Total Cost

TERC DACW27-97-D-0015 Alternative 9 - Electrokinetics Groundwater Treatment

33 HTRW Remedial Action

HTRW = Hazardous, Toxic, and Radioactive Waste

01A West Production Well Interim Actions

Includes interim options to address impacts to the west production well.
Assume $75K.

		Quantity		Unit Cost	Total Cost
ENGR EST 009	West Production Well Interim Actions	1.00	LS	$75,000.00	$75,000
SUBTOTAL West Production Well Interim Actions		**1**	**LS**		**$75,000**

01B Land Use Controls

0801 Long Term Management Plan and Site Database

Develop Long Term Management Plan to address administrative or legal measures to reduce or minimize potential exposures to contaminants left on site in groundwater.

Land Use Control Plan per USACE Real Estate Group

a) Text (60 hrs.)
b) Drawings (30 hrs.)
c) GIS/Surveying (159 hrs.)
d) Stakeholder Coordination (189 hrs) - (three, ½ day meetings; (4 Corps personnel w/2 hrs prep.); meeting notes (3); letters (8), memos etc. (4); internal meeting (4 with 3 persons and meeting notes)
e) Internal Technical Review (40 hrs.)
f) Approval Coordination (53 hrs.) (memo package; responses to comments; conf. calls (3)

Total = 531 hrs @ Senior PM Rate $125.81 = 66,805, say $67,000

Site Information Database - Assume 200 hrs to develop a site database. Use Senior Engineer Rate.

		Quantity		Unit Cost	Total Cost
00010018	Long Term Management Plan	1.00	LS	$67,000.00	$67,000
33220104	Site Database	200.00	HR	$105.20	$21,041
SUBTOTAL Long Term Management Plan and Site Da		**1**	**LS**		**$88,041**

		Quantity		Unit Cost	Total Cost

0802 Land Use Controls

Implement Land Use Controls per USACE Real Estate Group

a) Coordinate with various local, state, and federal agencies to implement controls. Examples of controls requiring coordination are zoning, master plans, ordinances, environmental lists. Under each alternative 5-6 controls will be required. (192 hrs.)
b) Deed notice - Draft and record. (28 hrs.)
c) Acquire real estate interest (REI), e.g., negative easement.
(1) Research and draft real estate interest. (32 hrs.)
(2) Legal descriptions, surveying, parcel drawings. (64 hrs.)
(3) Title work (8 hrs.)
(4) Coordinate within District (8 hrs.)
(5) Coordinate w/owners (2 out of office meetings w/preparation and meeting notes, (3) Corps personnel. (68 hrs.)
(6) Subtotal = 180 hrs.
d) Approval of non-standard REI (memo package; responses to comments; conf. calls (3)); (59 hrs.)
e) SOW for appraisal. (12 hrs)
f) Appraisal of real estate interest. (64 hrs.)
g) Execute and record real estate interest
(1) Update title (5 hrs.)
(2) Update appraisal (10 hrs.)
(3) Closing and recording (12 hrs.)
(4) Subtotal = 27hrs.

Total = 562 hrs. @ Senior PM Rate $125.81 = 70,705, say $71,000

Note: This estimate is based upon no condemnation of a real estate interest. The costs do not include the fair market value of the real estate interest to be acquired.

		Quantity		Unit Cost	Total Cost
00010019	Implement Land Use Controls	1.00	LS	$71,000.00	$71,000
SUBTOTAL Land Use Controls		**1**	**EA**		**$71,000**
SUBTOTAL Land Use Controls		**24**	**ACR**	**$6,626.69**	**$159,041**

02 Monitoring,Sampling,Testing, & Analysis

04 Monitoring Wells

5 Monitoring Well Replacement

Includes installation of 10 monitoring wells at a depth of 20 ft and 2 wells at a depth of 60 ft to monitor the GW. Assume depth to GW is 8 ft.

		Quantity		Unit Cost	Total Cost
33010101	Mob/Demob of drilling crew	1.00	LS	$3,417.78	$3,418
33010101	Standby Time	12.00	HR	$427.22	$5,127
33020303	Organic Vapor Analyzer rental, per Day	4.00	DAY	$133.79	$535
33170808	Decon. materials for Rig, Augers, Screen (Rental equip.)	4.00	DAY	$128.71	$515
33220109	Field Geologist	64.00	HR	$60.56	$3,876
33230121	Well casing, 2" stainless steel (10-50 ft per well)	200.00	LF	$31.31	$6,261
33230221	Well Screen, 2" stainless steel (10 ft per well)	120.00	LF	$26.53	$3,184
33230311	Well plug, 2" stainless steel	12.00	EA	$83.25	$999
33231101	Hollow Stem Auger, 8" Dia Borehole, Depth < 100 ft	332.00	LF	$46.15	$15,321
33231401	Filter Pack, 2" Screen	144.00	LF	$13.28	$1,912
33231504	Surface Pad, Concrete 2'x2'x4"	12.00	EA	$151.28	$1,815

		Quantity		Unit Cost	Total Cost
33231811	Portland Cement Grout	84.00	LF	$1.34	$112
33232101	Bentonite Seal, 2" Well	12.00	EA	$49.11	$589
33232301	5' Guard Post, Cast Iron, Concrete Fill	48.00	EA	$74.28	$3,565
	SUBTOTAL Monitoring Well Replacement	**12**	**EA**	**$3,935.81**	**$47,230**
	90 Well Installation Report				
33220109	Field Geologist	24.00	HR	$60.56	$1,453
33220114	Word Processing	4.00	HR	$35.09	$140
33220115	Field Draftsmen	8.00	HR	$54.37	$435
	SUBTOTAL Well Installation Report	**1**	**LS**		**$2,029**
	SUBTOTAL Monitoring Wells	**12**	**EA**	**$4,104.87**	**$49,258**

02 Beryllium & Rad Monitoring

This WBS covers 2 IH/HP technicians to survey personnel and equipment during installation of the treatment system. The IH/HP technicians and equipment would be required for the duration of installation activities of 12 working months or 2,112 hours each. Total hours are 4,224.

Equipment pricing base on Vendor Quote (SEC 2/2001;Rates escalated to 2/2002)- The Beryllium and Radiological monitoring equipment includes the following:

1. Model 2929 dual channel scaler (1 @ $365/mo =$365/mo)
2. Alpha Survey Instrument, 43-5 or equal (2 @ 210/mo = $420/mo)
3. Ratemeter w/GM pancake, 44-9 or equal (2 @ $195/mo = $390/mo)
4. Alarming Frisker w/ GM pancake, 44-9 or equal (2 @ $133/mo = $266/mo)
5. Micro R Meter, Model 19 or equal (2 @ $133/mo = $266/mo)
6. Personal Air Sampling pumps (2 @ $83/mo = $166/mo)
7. Personal air sampling pump charger (2 @ $52/mo = $104/mo)
8. High Volume air samplers (3 @ $130/mo = $390/mo)

Total = $2,367/month. Use $2,500/mo direct cost to account for other miscellaneous equipment or supplies.

		Quantity		Unit Cost	Total Cost
33021498	IH/HP Technicians	4,224.00	HR	$53.34	$225,302
Vendor Quote	IH/HP Monitoring Equipment	12.00	MO	$3,090.96	$37,092
	SUBTOTAL Beryllium & Rad Monitoring	**32,000**	**CY**	**$8.20**	**$262,393**
	SUBTOTAL Monitoring,Sampling,Testing, & Analysis	**24**	**ACR**	**$12,985.49**	**$311,652**
	13 Treatment - Electrokinetics System				
	System Installation				
VENDOR	Mob/Demob, Piping, Controls, Shelter, etc.	1.00	LS	$200,000.00	$200,000
Engr Est	Treatment Demonstration	1.00	LS	$200,000.00	$200,000
VENDOR	Purchase Electrodes	650.00	EA	$1,298.20	$843,832
VENDOR	Install Electrodes (650 electrodes x 20 ft deep)	13,000.00	LF	$25.00	$325,000
	SUBTOTAL System Installation	**32,000**	**CY**	**$49.03**	**$1,568,832**
	SUBTOTAL Treatment - Electrokinetics System	**32,000**	**CY**	**$49.03**	**$1,568,832**
	SUBTOTAL HTRW Remedial Action	**32,000**	**CY**	**$66.08**	**$2,114,524**

		Quantity		Unit Cost	Total Cost

34 HTRW Groundwater O&M

01 Land Use Controls

0801 Long Tern Management Plan and Site Database

Maintain O&M plan to address administrative or legal measures to reduce or minimize potential exposure to contaminants left on site. Assume the following:

Long Tern Management Plan - Assume 40 hrs/yr for 40 yrs = 1,600 hrs to coordinate with stakeholders and make revisions to plan. Use Senior PM Rate.

Site Information Database - Assume 16 hrs/yr for 40 yrs = 640 hrs to update site database. Use Senior Engineer Rate.

		Quantity		Unit Cost	Total Cost
33220101	Long Tern Management Plan	1,600.00	HR	$125.81	$201,294
33220104	Site Database	640.00	HR	$105.20	$67,330
SUBTOTAL Long Tern Management Plan and Site Da		**40**	**YR**	**$6,715.60**	**$268,624**
SUBTOTAL Land Use Controls		**40**	**YR**	**$6,715.60**	**$268,624**

02 GW Monitoring/Sampling/Analysis

Groundwater will be monitored for a period of 40 years for Be (Years 0-40) and 10 years for Uranium (Years 5-15).

04 Monitoring Wells

Assume 10 shallow wells (20 ft deep) will be abandon at year 15 and 2 deep wells (60 ft deep) at year 40. Assume 1 well closure report.

		Quantity		Unit Cost	Total Cost
15 Well Abandonment of Old Wells (Year 15)					
015902000150	Hyd. Excavator, 1 C.Y. (2 hrs/well x 10 wells)	20.00	HR	$87.08	$1,742
33231822	Well Abandonment of 2" wells (10 wells @ 20 ft)	200.00	LF	$22.87	$4,573
SUBTOTAL Well Abandonment of Old Wells (Year 15)		**15**	**YR**	**$420.99**	**$6,315**
90 Well Abandonment Report (Year 15)					
33220109	Field Geologist (24 hr/report)	24.00	HR	$60.56	$1,453
33220114	Word Processing (4 hr/report)	4.00	HR	$35.09	$140
33220115	Field Draftsmen (8 hr/report)	8.00	HR	$54.37	$435
SUBTOTAL Well Abandonment Report (Year 15)		**15**	**YR**	**$135.24**	**$2,029**
16 Well Abandonment of Old Wells (Year 40)					
015902000150	Hyd. Excavator, 1 C.Y. (2 hrs/well x 2 wells)	4.00	HR	$87.08	$348
33231822	Well Abandonment of 2" wells (2 wells @ 60 ft)	120.00	LF	$22.87	$2,744
SUBTOTAL Well Abandonment of Old Wells (Year 40)		**40**	**YR**	**$77.31**	**$3,092**
90 Well Abandonment Report (Year 40)					
33220109	Field Geologist (24 hr/report)	24.00	HR	$60.56	$1,453
33220114	Word Processing (4 hr/report)	4.00	HR	$35.09	$140
33220115	Field Draftsmen (8 hr/report)	8.00	HR	$54.37	$435
SUBTOTAL Well Abandonment Report (Year 40)		**40**	**YR**	**$50.72**	**$2,029**

		Quantity		Unit Cost	Total Cost
SUBTOTAL Monitoring Wells		**40**	**YR**	**$336.61**	**$13,464**

08 Sampling Media

Groundwater will be treated for Beryllium for years 0-5 and monitored in the shallow wells for years 0-10 and in deep wells for years 0-40. Radioactive constituents will be treated for years 5-10 and monitored for years 5-15.

01 Groundwater Sampling (Years 0- 5 = 5 events)

Duration is 4 days per year (3 wells/day and 12 wells total). Samples will be taken at each event for a total of 5 events. Samples will include 12 samples of ICPAES metals and GFAA metals each per year; and 12 water quality. The following field measurements will be taken onsite: Dissolved oxygen, Eh, pH, turbidity, temperature, and conductivity. Assume purge water will be returned to the ground upon verification of a clean sample. Approximately 24 samples total.

		Quantity		Unit Cost	Total Cost
33020401	Disposable Materials per Sample (gloves,jars,tape,ice,isop) (24 samples x 5 events)	120.00	EA	$9.96	$1,195
33020402	Decon. Materials per Sample (deion. water,soap)(24 samples x 5 events)	120.00	EA	$8.96	$1,075
33020570	Water Quality Indicator (1 wk/ev x 5 events)	5.00	WK	$66.90	$335
33020573	Water Level Indicator (1 wk/ev x 5 events)	5.00	WK	$36.24	$181
33021498	Radiation Protection Technicians (4 days x 5 events)	160.00	HR	$53.34	$8,534
33022028	250 ml, clear, w/septa, wide sample jars (12 x 5 events)	60.00	EA	$72.05	$4,323
33022034	Chain of Custody Seals (pkg of 5) (6 packs x 5 events)	30.00	EA	$2.28	$69
33022046	60 Quart Ice Chest (2 ea x 5 events)	10.00	EA	$76.59	$766
33022063	Overnite Delivery to Lab (21-50 lb) (2 ea x 5 events)	10.00	EA	$54.43	$544
33190401	55-gal. drum for purging (3/well x 12 wells x 5 events)	180.00	EA	$84.38	$15,189
33220109	Field Geologist (4 days x 5 events)	160.00	HR	$60.56	$9,689
33230507	2" Submersible Pump Rental (1 wk/ev x 5 events)	5.00	EA	$265.28	$1,326
33232407	Disposable Bailer, Poly,1.5" out dia x 36" (24 ea x 5 events)	120.00	EA	$11.62	$1,394
SUBTOTAL Groundwater Sampling (Years 0- 5 = 5 eve		**5**	**YR**	**$8,923.99**	**$44,620**

02 Groundwater Sampling (Years 5-10 = 5 events)

Duration is 4 days per year (3 wells/day and 12 wells total). Samples will be taken at each event for a total of 5 events Samples will include 12 samples of Uranium, Thorium, and Radium each per year; 12 ICPAES metals and GFAA metals each per year; and 12 water quality. The following field measurements will be taken onsite: Dissolved oxygen, Eh, pH, turbidity, temperature, and conductivity. Assume purge water will be returned to the ground upon verification of a clean sample. Approximately 36 samples total for 11 events.

		Quantity		Unit Cost	Total Cost
33020401	Disposable Materials per Sample (gloves,jars,tape,ice,isop) (36 samples x 5 events)	180.00	EA	$9.96	$1,792
33020402	Decon. Materials per Sample (deion. water,soap)(36 samples x 5 events)	180.00	EA	$8.96	$1,612
33020570	Water Quality Indicator (1 wk/ev x 5 events)	5.00	WK	$66.90	$335
33020573	Water Level Indicator (1 wk/ev x 5 events)	5.00	WK	$36.24	$181
33021498	Radiation Protection Technicians (4 days x 5 events)	160.00	HR	$53.34	$8,534

		Quantity		Unit Cost	Total Cost
33022028	250 ml, clear, w/septa, wide sample jars (12 x 5 events)	60.00	EA	$72.05	$4,323
33022034	Chain of Custody Seals (pkg of 5) (8 packs x 5 events)	40.00	EA	$2.28	$91
33022046	60 Quart Ice Chest (3 ea x 5 events)	15.00	EA	$76.59	$1,149
33022063	Overnite Delivery to Lab (21-50 lb) (3 ea x 5 events)	15.00	EA	$54.43	$817
33190401	55-gal. drum for purging (3/well x 12 wells x 5 events)	180.00	EA	$84.38	$15,189
33220109	Field Geologist (4 days x 5 events)	160.00	HR	$60.56	$9,689
33230507	2" Submersible Pump Rental (1 wk/ev x 5 events)	5.00	EA	$265.28	$1,326
33232407	Disposable Bailer, Poly,1.5" out dia x 36" (24 ea x 5 events)	120.00	EA	$11.62	$1,394
SUBTOTAL Groundwater Sampling (Years 5-10 = 5 ev		**5**	**YR**	**$9,286.57**	**$46,433**

03 Groundwater Sampling (Years 10-15 = 5 events)

Duration is 4 days per event (3 wells/day for a total of 12 wells). Samples will be taken each event for 5 events. Samples will include 12 samples of Uranium, Thorium, and Radium each and 2 samples from the deep bedrock wells for ICPAEC and GFAA metals per year. The following field measurements will be taken onsite: Dissolved oxygen, Eh, pH, turbidity, temperature, and conductivity. Assume purge water will be returned to the ground upon verification of a clean sample. Approximately 14 samples total for 5 events.

		Quantity		Unit Cost	Total Cost
33020401	Disposable Materials per Sample (gloves,jars,tape,ice,isop) (14 samples x 5 events)	70.00	EA	$9.96	$697
33020402	Decon. Materials per Sample (deion. water,soap)(14 samples x 5 events)	70.00	EA	$8.96	$627
33020570	Water Quality Indicator (1 wk/ev x 5 events)	5.00	WK	$66.90	$335
33020573	Water Level Indicator (1 wk/ev x 5 events)	5.00	WK	$36.24	$181
33021498	Radiation Protection Technicians (4 days x 5 events)	160.00	HR	$53.34	$8,534
33022028	250 ml, clear, w/septa, wide sample jars (14 x 5 events)	70.00	EA	$72.05	$5,044
33022034	Chain of Custody Seals (pkg of 5) (3 packs x 5 events)	15.00	EA	$2.28	$34
33022046	60 Quart Ice Chest (1 ea x 5 events)	5.00	EA	$76.59	$383
33022063	Overnite Delivery to Lab (21-50 lb) (1 ea x 5 events)	5.00	EA	$54.43	$272
33190401	55-gal. drum for purging (3/well x 12 wells x 5 events)	180.00	EA	$84.38	$15,189
33220109	Field Geologist (4 days x 5 events)	160.00	HR	$60.56	$9,689
33230507	2" Submersible Pump Rental (1 wk/ev x 5 events)	5.00	EA	$265.28	$1,326
33232407	Disposable Bailer, Poly,1.5" out dia x 36" (14 ea x 5 events)	70.00	EA	$11.62	$813
SUBTOTAL Groundwater Sampling (Years 10-15 = 5 e		**5**	**YR**	**$8,624.88**	**$43,124**

04 Groundwater Sampling (Years 16-40 = 25 events)

Duration is 1 day per event (2 wells/day for a total of 2 wells). Samples will be taken each event for 25 events. Samples will include 2 from the deep bedrock wells for ICPAEC and GFAA metals per year. The following field measurements will be taken onsite: Dissolved oxygen, Eh, pH, turbidity, temperature, and conductivity. Assume purge water will be returned to the ground upon verification of a clean sample. Approximately 2 samples total for 25 events.

		Quantity		Unit Cost	Total Cost
33020401	Disposable Materials per Sample (gloves,jars,tape,ice,isop) (2 samples x 25 events)	25.00	EA	$9.96	$249

		Quantity		Unit Cost	Total Cost
33020402	Decon. Materials per Sample (deion. water,soap)(2 samples x 25 events)	50.00	EA	$8.96	$448
33020570	Water Quality Indicator (1 wk/ev x 25 events)	25.00	WK	$66.90	$1,673
33020573	Water Level Indicator (1 wk/ev x 25 events)	25.00	WK	$36.24	$906
33021498	Technicians (1 day x 25 events)	200.00	HR	$53.34	$10,668
33022028	250 ml, clear, w/septa, wide sample jars (2 x 25 events)	50.00	EA	$72.05	$3,603
33022034	Chain of Custody Seals (pkg of 5) (1 packs x 25 events)	25.00	EA	$2.28	$57
33022046	60 Quart Ice Chest (1 ea x 25 events)	25.00	EA	$76.59	$1,915
33022063	Overnite Delivery to Lab (21-50 lb) (1 ea x 25 events)	25.00	EA	$54.43	$1,361
33190401	55-gal. drum for purging (3/well x 2 wells x 25 events)	150.00	EA	$84.38	$12,657
33220109	Field Geologist (1 day x 25 events)	200.00	HR	$60.56	$12,111
33230507	2" Submersible Pump Rental (1 wk/ev x 5 events)	5.00	EA	$265.28	$1,326
33232407	Disposable Bailer, Poly,1.5" out dia x 36" (2 ea x 25 events)	50.00	EA	$11.62	$581
	SUBTOTAL Groundwater Sampling (Years 16-40 = 25 e	**25**	**YR**	**$1,902.17**	**$47,554**
	SUBTOTAL Sampling Media	**40**	**YR**	**$4,543.29**	**$181,731**

09 Chemical/Rad Lab Analysis

Groundwater will be treated for Beryllium for years 0-5 and monitored in the shallow wells for years 0-10 and in deep wells for years 0-40. Radioactive constituents will be treated for years 5-10 and monitored for years 5-15.

01 Groundwater Analysis (Years 0-5 = 5 events)

		Quantity		Unit Cost	Total Cost
33022036	Documentation Package for QA, verif,data (1/event)	5.00	EA	$139.80	$699
ENGREST	ICPAES Metals (12Samples/event x 5 events)	60.00	EA	$142.80	$8,568
ENGREST	Water Quality (12/event x 5 events)	60.00	EA	$149.29	$8,958
	SUBTOTAL Groundwater Analysis (Years 0-5 = 5 even	**5**	**YR**	**$3,644.95**	**$18,225**

02 Groundwater Analysis (Years 5-10 = 5 events)

		Quantity		Unit Cost	Total Cost
33022036	Documentation Package for QA, verif,data (1/event)	5.00	EA	$139.80	$699
33022250	Radium 226 (12 samples/event x 5 events)	60.00	EA	$112.29	$6,738
33022252	Thorium 232 (12 samples/event x 5 events)	60.00	EA	$155.78	$9,347
33022253	Total Uranium (12 samples/event x 5 events)	60.00	EA	$155.78	$9,347
33022288	Gross Alpha/Beta (12 samples/event x 5 events)	60.00	EA	$84.51	$5,071
ENGREST	GFAA Metals (12 Samples/event x 5 events)	60.00	EA	$116.84	$7,010
ENGREST	ICPAES Metals (12 Samples/event x 5 events)	60.00	EA	$142.80	$8,568
ENGREST	Water Quality (12/event x 5 events)	60.00	EA	$149.29	$8,958
	SUBTOTAL Groundwater Analysis (Years 5-10 = 5 eve	**5**	**YR**	**$11,147.53**	**$55,738**

03 Groundwater Analysis (Years 10-15 = 5 events)

		Quantity		Unit Cost	Total Cost
33022036	Documentation Package for QA, verif,data (1/event)	5.00	EA	$139.80	$699
33022250	Radium 226 (12 samples/event x 5 events)	60.00	EA	$112.29	$6,738
33022252	Thorium 232 (12 samples/event x 5 events)	60.00	EA	$155.78	$9,347
33022253	Total Uranium (12 samples/event x 5 events)	60.00	EA	$155.78	$9,347
33022288	Gross Alpha/Beta (12 samples/event x 5 events)	60.00	EA	$84.51	$5,071

		Quantity		Unit Cost	Total Cost
ENGREST	ICPAES Metals (2 Samples/event x 5 events)	10.00	EA	$142.80	$1,428
ENGREST	Water Quality (12 samples/event x 5 events)	60.00	EA	$149.29	$8,958
ENGREST	GFAA Metals (2 Samples/event x 5 events)	10.00	EA	$116.84	$1,168
SUBTOTAL Groundwater Analysis (Years 10-15 = 5 ev		**5**	**YR**	**$8,551.12**	**$42,756**
04 Groundwater Analysis (Years 16-40 = 25 events)					
33022036	Documentation Package for QA, verif,data (1/event)	25.00	EA	$139.80	$3,495
ENGREST	Water Quality (2 samples/event x 25 events)	50.00	EA	$149.29	$7,465
ENGREST	GFAA Metals (2 Samples/event x 25 events)	50.00	EA	$116.84	$5,842
ENGREST	ICPAES Metals (2 Samples/event x 25 events)	50.00	EA	$142.80	$7,140
SUBTOTAL Groundwater Analysis (Years 16-40 = 25 e		**25**	**YR**	**$957.67**	**$23,942**
SUBTOTAL Chemical/Rad Lab Analysis		**40**	**YR**	**$3,516.49**	**$140,660**
SUBTOTAL GW Monitoring/Sampling/Analysis		**40**	**YR**	**$8,396.39**	**$335,856**
13A Treatment System O&M					
VENDOR	Re-Install Electrodes - Year 5 (650 ea x 20 ft)	13,000.00	LF	$25.00	$325,000
VENDOR	BE Treatment Electricity (Year 0-5)	5.00	YR	$480,000.00	$2,400,000
VENDOR	U Treatment Electricity (Year 5-10)	5.00	YR	$120,000.00	$600,000
33420101	Electrical (2,105 KWH/yr)- Freeze Protection	10.00	YR	$194.73	$1,947
99020110	Annual Maintenance Materials and Labor	10.00	YR	$5,000.00	$50,000
33220106	Staff Engineer (10 yr @ 40 hr/yr)	400.00	HR	$62.18	$24,871
33220106	Senior Staff Engineer (10 yr @ 20 hrs/yr)	200.00	HR	$105.20	$21,041
33220112	Field Technician (10 years @ 200 hr/yr)	2,000.00	HR	$42.34	$84,679
SUBTOTAL Treatment System O&M		**10**	**YR**	**$350,753.69**	**$3,507,537**
19 Transportation and Disposal					

Assume 3,000 gallons of contaminated electrolyte is generated during the treatment process (15 cy)
Electrolyte will be solidified and assume 50% increase in volume (23 cy)
Assume cost to solidify, transport, and dispose = $1.500/cy. (This is higher than would be typically expected due to small volume)

		Quantity		Unit Cost	Total Cost
ENGR EST	Treatment, Transport, and Disposal of 23 cy Electyolyte	23.00	CY	$1,500.00	$34,500
SUBTOTAL Transportation and Disposal		**23**	**CY**	**$1,500.00**	**$34,500**
SUBTOTAL HTRW Groundwater O&M		**40**	**YR**	**$103,662.91**	**$4,146,516**
SUBTOTAL		***32,000***	***CY***	***$195.66***	***$6,261,041***
General Conditions - PRIME CONTRACTOR AA		3.0%		$1.79	$57,406
Prime Markup on Subs - PRIME CONTRACTOR AA		4.0%		$2.39	$76,542
SUBTOTAL		***32,000***	***CY***	***$199.84***	***$6,394,989***

	Quantity	Unit Cost	Total Cost
Contingency	35.0%	$69.12	$2,211,996
Remedial Design	6.0%	$15.59	$498,918
Project Management	6.0%	$16.53	$528,853
Construction Management	10.0%	$29.20	$934,306
Owner Costs	15.0%	$48.18	$1,541,605
Alternative 9 - Electrokinetics Groundwater Treatment	**32,000 CY**	**$378.46**	**$12,110,666**