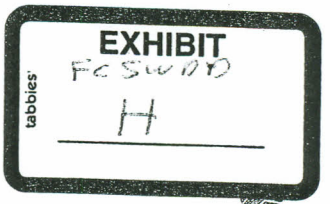
evaluated carbon-14 data for samples collected in September 2009 from the shop well and monitoring wells R-9D, R-12, and R-18 (Siegel 2010). The tritium activity data indicate that the age of the groundwater samples was in excess of 50 years. The oxygen isotope ratios for the groundwater samples are notably different than the oxygen isotope ratios for recent precipitation and surface water in the area, indicating that infiltration of precipitation is not currently a significant source of recharge. The carbon-14 data indicate the ages of the groundwater in the shop well and monitoring well R-12 are in the range of 4,500 to 6,000 years, while the ages of the groundwater in wells R-9D and R-18 are in the range of 17,000 to 22,000 years. Copies of Siegel's reports are provided in Appendices V and Y.

The data evaluated by Siegel generally support a conclusion that the majority of the groundwater below the facility was deposited or recharged well before the Sand Draw Landfill began receiving wastes. Siegel's conclusions are supported by the lack of significant surface water features, relatively low precipitation rates, and relatively high evapotranspiration rates for areas with an established vegetative cover. Although the apparent ages of groundwater below the facility are not indicative of significant recharge in recent time, the noted observations of static water levels indicate that localized, episodic recharge or movement of groundwater has occurred on a limited basis. Existing data is inadequate to correlate the noted observations to specific events, or the nature and extent of hydrogeologic connections between specific wells.

4.8 GROUNDWATER QUALITY

Piper plots of the cation and anion compositions for the January 2010 monitoring event, which included wells R-9D, R-13D, R-18, R-20, R-21, and R-22, are provided in Appendix BB. The intersection of lines extended from the two sample points on the triangles to the central parallelogram gives a point that represents the major ion composition on a percentage basis. These plots visually describe the differences in major ion chemistry of groundwater systems, the associated hydrochemical facies, and data trends.

The summary Piper plot for the six wells indicates that the chemistry of wells R-18 (designated as a background well) and R-9D (designated as a down-gradient well, but may be hydraulically up gradient of an existing portion of the active area) are similar and dominated by calcium cations and bicarbonate anions. The Piper plots of the down-gradient wells R-13D, R-20, R-21, and R-22 indicate hydrochemical facies changes to lower concentrations of calcium cations and higher concentrations of sodium and potassium cations. The Piper plots also indicate hydrochemical facies changes to lower concentrations of bicarbonate anions, and higher concentrations of chloride and fluoride anions. The distinct linearity of the noted hydrochemical facies changes indicates a continuum across an interconnected groundwater



system. If some degree of hydraulic connection exists between the up-gradient and down-gradient wells, the noted hydrochemical facies changes may be due to changes in the mineralogy of the water-bearing zones, or potential migration of landfill contaminants. If no hydraulic connection exists between the up-gradient and down-gradient wells, the noted hydrochemical facies change may be attributable to differences in the mineralogies of the matrices of the water-bearing zones.

Analytical data for naturally occurring geochemical parameters and volatile organic compounds (VOCs) are currently available for six consecutive quarters (July 2009 through November 2010), although reporting and statistical analysis is limited to five consecutive quarters. The following information is provided to generally summarize the available groundwater data and statistical analyses completed to date:

- Statistically significant differences in the concentrations of some naturally-occurring geochemical constituents between up- and down-gradient wells have been identified (Trihydro 2010). With the exception of nitrate-nitrate in R-13D, and calcium in R-22, no statistically significant increasing trends have been identified for constituents that demonstrate statistically significant interwell differences. Due the lack of analytical data prior to the placement of wastes, it is not possible to determine if statistically significant differences and trends in naturally-occurring geochemical parameters are associated with landfill activities, or if the differences are attributable to natural causes (e.g., changes in the mineralogy of the lithologic matrices). The lack of definitive evidence regarding the presence, absence, or extent of hydrogeologic connections between up- and down-gradient wells also qualifies interpretations of the causes of the interwell statistical analyses.
- Several VOCs have been detected in samples from down-gradient wells. In most cases, detections have been reported as estimated values (i.e., qualified data) below the laboratory reporting limits (practical quantitation limits or PQLs), but above method detection limits (MDLs). The only VOC detected above the laboratory reporting limit has been acetone in R-9D, which was detected at 25 µg/L in September 2009, and at 140 µg/L in January 2010. There is no maximum contaminant level (MCLs) for acetone, but the drinking water equivalent level (DWEL) for acetone is 32,800 µg/L (USEPA 2006; WDEQ 2005). The estimated values of VOCs detected below the laboratory reporting limits are less than the associated MCLs.
- No statistically significant differences have been noted between the concentrations of VOCs in up-gradient wells and down-gradient wells.
- No statistically significant increasing trends have been noted in the concentrations of VOCs.

Statistical comparisons of the six consecutive quarters of groundwater data for 19 naturally-occurring geochemical parameters to the class of use standards defined by Chapter 8 of the Water Quality Rules and Regulations (WQRR) were completed to provide a general indication of the potential class of use of the groundwater below the Sand Draw Landfill (Appendix DD). The results of the intrawell compliance tolerance limit analyses for two up-gradient and four down-gradient wells are summarized in Tables 4-4 through 4-7, and summarized as follows:

- Class I Domestic Use
  - Up-gradient water quality exceeded standards for ten parameters
  - Down-gradient water quality exceeded standards for at least six but no more than ten parameters
- Class II Agriculture Use
  - Up-gradient water quality exceeded standards for at least seven but nor more than ten parameters
  - Down-gradient water quality exceeded standards for at least three but no more than eight parameters
- Class III Irrigation Use
  - Up-gradient water quality exceeded standards for four parameters
  - Down-gradient water quality exceeded standards for at least one but no more than six parameters
- Class IV Industrial Use
  - Neither up-gradient nor down-gradient water quality exceeded standards for parameters

The documented variability in static water levels, geologic cross sections, geophysical data, and isotope data indicate that monitoring wells at the Sand Draw Landfill may not penetrate a single, well-defined, laterally continuous aquifer that is capable of yielding significant quantities of groundwater. However, even though existing data may not be sufficient to definitely infer a hydrologic connection between all wells, some of the static water level data, geologic cross sections, geophysical data, and major ion data indicate some degree of hydrologic connection below portions of the facility is possible.