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# K Basins Groundwater Monitoring Task, K Basins Closure Project: Report for January, February, and March 2007

R. E. Peterson

April 2007

Prepared for Fluor Hanford, Inc. and the
U.S. Department of Energy
under Contract DE-AC05-76RL01830

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Pacific Northwest National Laboratory
Richland, Washington 99352

# Summary

This report provides information on groundwater monitoring at the K Basins during January, February, and March 2007. Conditions remained very similar to those reported in the previous quarterly report, with no evidence in monitoring results to suggest groundwater impact from current loss of basin water to the ground. The K Basins monitoring network will be modified during the coming months to take advantage of new wells recently installed near KW Basin as part of a pump-and-treat system for chromium contamination, and new wells recently installed between the KE Basin and the river to augment long-term monitoring capability in that area.

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# 1.0 Introduction

The information contained in this periodic report represents an initial interpretation of monitoring results by a hydrologist from Pacific Northwest National Laboratory's Groundwater Performance Assessment Team. Subsequent new results and/or facility information may warrant changes to these initial interpretations. Groundwater conditions near the K Basins remain very similar to conditions described in the report for the previous quarter (Peterson 2006). Some of the information below is repeated from that earlier report, such that each quarterly report provides a stand alone description of conditions.

The following subsections present a synopsis of current conditions and key issues with regard to groundwater near the K Basins. The level of detail is intended to support general audiences. Technical details are presented in Section 2.0.

## 1.1 Sampling and Analysis Activities

- The quarterly groundwater sampling event occurred as scheduled during January 2007.

- Additional monthly sampling continued at three wells near KE Basin to more closely monitor conditions while sludge removal activities are underway. Some monthly sampling was not conducted because of well access issues and a stoppage of all sampling during March 2007.

- The next regularly scheduled quarterly sampling event will be completed during April 2007 and will include new wells 199-K-141 and 199-K-142, which are located midway between the KE Reactor and the Columbia River. Analytical results are expected by the end of May 2007.

## 1.2 Monitoring for Basin Water Loss

- Groundwater monitoring results do not exhibit evidence to indicate current water loss to the ground from either the KE or KW fuel storage basin. If water loss to the ground is occurring, it is a relatively small volume, when compared to the previous well-documented leakage from KE Basin in 1993, which was readily identifiable in groundwater monitoring results.

- The increase in tritium concentrations that began at two wells near KE Basin in 2003 remain unexplained. The trend reversed itself during 2004 and current concentrations are typical of pre-2003 trends. Although an association with loss of basin water to the ground is possible, there is no conclusive evidence for this.

## 1.3 Groundwater Contamination from Past Basin Leakage and Other Sources

- The tritium plume created by the 1993 leakage from the KE Basin has migrated downgradient more than half the distance to the river. Based on travel time estimates, the leading edge of that plume is likely to be near the shoreline currently. However, tritium has not been detected during recent sampling events at the two aquifer tube sites in the direct path of this plume.

- Sources other than past leakage at the KE Basin (i.e., 1976–1979; 1993) contribute tritium to the currently mapped plume. The most prominent sources near the reactor buildings are the former reactor atmosphere condensate cribs, which were removed in 2004. Some contamination is likely to remain in the vadose zone beneath those waste site excavations.

- Tritium and strontium-90 may remain in the vadose zone beneath the drain fields/injection wells associated with each fuel storage basin. These past-practice waste sites have not yet been remediated. Unusually high water-table conditions (e.g., 1996/97 and 2006) and/or infiltration of moisture from the surface may periodically remobilize radiological contamination remaining beneath these waste sites.

# 2.0 Technical Details and Discussion

The following sections provide technical details regarding groundwater conditions near the KE and KW fuel storage basins, which are located within the respective reactor buildings. These basins are monitored under a groundwater monitoring plan for an operating facility (Peterson 2002). The aquifer near the Columbia River downgradient from the basins is monitored at aquifer tube sites along the river shoreline (Mahood 2007). Because of high tritium concentrations in basin water and tritium's mobility in the environment, that constituent is monitored as a key indicator for detecting basin water loss to the ground. However, tritium in groundwater near the 100-K reactors may come from a variety of past-practice waste sites, as well as from potential basin loss, so additional groundwater constituents are monitored to help differentiate the various sources.

Well locations in the 100-K Area are shown in Figure 1. Additional maps for the 100-K Area are included in the Groundwater Performance Assessment Project's annual report (Peterson and Raidl 2007; http://groundwater.pnl.gov/reports), or contact Bob Peterson (373-9020; robert.peterson@pnl.gov). Note that detailed maps of facilities and aerial photographs are limited to official use only.

## 2.1 Groundwater Conditions Near the KE Basin

Analytical results for the first calendar quarter of 2007 for wells that monitor the flow path beneath the KE Basin are listed in Table 1 and updated tritium concentration trends at selected wells are shown in Figure 2. Tritium concentrations at wells 199-K-27 and 199-K-109A, which are adjacent to and downgradient of the KE Basin, have returned to levels well below the drinking water standard (20,000 pCi/L), following an abrupt rise that started in early 2003. Other shielding water indicators (e.g., technetium-99; gross alpha and gross beta) at these two wells do not show similar trends, so a definitive explanation for the tritium trend remains elusive. Some planned monthly samples were not collected from wells 199-K-109A, 199-K-27, and 199-K-29 this quarter because of a shutdown of sampling during March 2007 and well access issues. Table 1 lists the dates that each well was sampled. The purpose of monthly sampling is to track trends while sludge removal activities are underway, and to more closely monitor conditions following the unexpected rise in concentrations during 2003.

The plume created by leakage from the KE Basin construction joint in 1993 appears to have passed downgradient well 199-K-32A. Tritium concentrations at that well have now returned to levels that existed prior to the arrival of this leakage plume at the well in late 1999. The trends at well 199-K-27, located adjacent to the KE Basin, and at 199-K-32A have been used to estimate a migration rate of 0.12 m/d for the plume (Peterson 2002, pp. 5.11 to 5.13). The peak concentration observed at well 199-K-32A was ~80,000 pCi/L. Assuming a similar migration rate and a reduction in concentration that is proportionate to the reduction between wells 199-K-27 and 199-K-32A, this plume may be currently near the river at concentrations that are below the drinking water standard. However, tritium was not detected at aquifer tube sites situated along the shoreline downgradient from the KE Basin during the last two sampling events at those sites (January 2007 and February 2006).

Tritium concentrations are elevated above the drinking water standard at wells within the groundwater flow path that passes just to the east of the KE Reactor building. The presumed waste site source for this tritium (and co-contaminant carbon-14) is the former KE condensate crib (116-KE-1), which was excavated in March 2004 (see Figure 1 for location map). Tritium trends in the two wells that monitor the flow path downgradient of the crib are shown in Figure 3. Concentrations at well 199-K-30 remain high relative to other locations near KE Reactor, although current concentrations are significantly lower than their historical highs, which ranged up to nearly 2,400,000 pCi/L in the late 1990's. The absence of a long-term gradually decreasing trend at this well suggests some re-supply of tritium to the plume, possibly from the vadose zone beneath the former condensate crib. In early 2001, an increasing trend started at well 199-K-29, which is located ~50 meters north of the northeast corner of the KE Basin. This well is near to, but not in, the presumed groundwater flow path beneath the KE Basin. That trend peaked in early 2002, declined to well below the drinking water standard in 2003, rose again in 2004, and currently reveals a fairly constant level below or at the drinking water standard. The absence of technetium-99 and presence of carbon-14 at well 199-K-29 support the assumption that the former KE condensate crib and underlying soil are the source for the tritium.

## 2.2 Groundwater Conditions Near the KW Basin

Analytical results for the first calendar quarter of 2007 for wells that monitor the flow path beneath the KW Basin are listed in Table 2 and updated tritium concentration trends are shown in Figure 4. For wells adjacent to and immediately downgradient of the KW Basin, recent tritium concentrations remain well below the drinking water standard, with no evidence for water loss from the basin causing an impact on groundwater. (Note: Tritium concentrations in KW Basin shielding water were 1,800,000 pCi/L in June 2006). Starting in mid-2003, results for samples from well 199-K-34 showed a trend toward slightly higher values. However, historical variability appears to be episodic, and recent results from the well remain within the expected range.

To the east of the KW Reactor building, tritium concentrations at well 199-K-106A have declined significantly since a rising trend began with a gradual increase during 2001, followed by two distinct spikes each exceeding 1,000,000 pCi/L. Current concentrations at the well are near the drinking water standard. The well is located ~50 meters northeast of the KW Reactor building and monitors conditions downgradient of the former KW condensate crib (116-KW-1), which was excavated in early 2004. The suspected tritium source is the vadose zone beneath the former crib, which likely contains tritium and carbon-14. The processes responsible for the elevated tritium (and other waste indicators, e.g., nitrate, technetium-99) in groundwater at this well are not fully understood, although a connection to the KW Basin is unlikely.

Because of high tritium concentrations in the KW Basin, loss of KW Basin water to the ground is routinely evaluated as a possible cause when interpreting changes in the characteristics of tritium plumes near the KW Reactor building. However, interpretations to date suggest that unusual circumstances would have to exist if the basin were the source for the tritium observed at well 199-K-106A, and the possibility of that is considered remote.

## 2.3 Other Central 100-K Area News

New wells (199-K-137, 199-K-138, 199-K-139, 199-K-140 and 199-K-158; see Figure 1 for locations) installed in fall 2006 near the KW Reactor are now in use as part of a pump-and-treat system for chromium contamination in groundwater. Three of the new wells located downgradient from KW Reactor, along with existing well 199-K-132, will be used as groundwater extraction wells. Several wells inland of the KW Reactor will be used to inject treated effluent.

Two new long-term monitoring wells (199-K-141 and 199-K-142) were installed between the KE Reactor and the Columbia River and will be sampled for the first time during the quarterly sampling event in April 2007. The purpose for these wells is to enhance long-term monitoring capability in the area near the KE Reactor

# 3.0 References


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Peterson RE and RF Raidl. 2007. "100-KR-4 Operable Unit." In Chapter 2.3 of *Hanford Site Groundwater Monitoring for Fiscal Year 2006*. PNNL-16346, MJ Hartman, LF Morasch, and WD Webber (eds.), Pacific Northwest National Laboratory, Richland, Washington.

**Table 1**. Tritium in Groundwater Near the KE Basin (Jan/Feb/Mar 2007)

(Updated April 23, 2007; new results, changes, and interpretations are printed in blue)

| Well, (Sample Frequency), and Position | Current Quarter, pCi/L (sample date) | Current Concentration Trend | Prior Results, pCi/L (sample date) | Historical Concentration Trend Since 1997 |
|---|---|---|---|---|
| ***Wells Downgradient of KE Basin (Tritium concentration in KE Basin shielding water is ~2,250,000 pCi/L—June 2006)*** | | | | |
| ☑ **199-K-109A** (Q/M) *Adjacent to KE Basin and basin drain field.* | 2,600 (1/18/07) | Concentrations remain well below the DWS, following pulse that started in 2003. Tc-99 not detected. | 4,200 4,100 3,600 (12/20/06) | General decline from high of ~90,000 in mid-1997 (with periodic peaks up to 420,000) until early 2003, when new pulse began. |
| ☑ **199-K-27** (Q/M) *Adjacent to KE Basin.* | 5,300 5,000 (1/12/07) 5,120 (2/23/07) | Concentrations remain well below the DWS, following pulse that started in 2003. Tc-99 not detected. | 11,500 11,000 (12/01/06) | General decline from high of ~40,000 in 1997 to low of several hundred, until early 2003 when new pulse started. |
| **199-K-32A** (Q) *Between KE Reactor and Columbia River.* | 5,700 (1/09/07) | Continued long-term gradual decrease. | 5,800 (10/19/06) | Historically 4,000~80,000; plume created by 1993 KE Basin leak passed in 2001. |
| ***Wells East of KE Basin*** | | | | |
| **199-K-29** (Q/M) *Downgradient of KE Condensate Crib; near KE Basin.* | 16,000 (1/12/07) 19,800 (2/23/07) | Evidence for gradual rise to near DWS in recent months. Source of tritium assumed to be former KE condensate crib, not KE basin. | 13,400 (10/26/06) 13,700 (12/01/06) 14,000 (12/22/06) | Generally constant within range of 8,000~24,000 until summer 2001, when concentrations rose, reaching a high of 98,300 in 2002. |
| **199-K-30** (Q) *Downgradient of KE Condensate Crib.* | 320,000 (1/12/07) | Variable within range 200,000~500,000 during past four years. | 190,000 (10/19/06) | Variable; cyclic within range of ~150,000 to ~2,360,000 since mid-1998. |
| **199-K-111A** (Q/M) *Adjacent to 100-K Burial Ground.* | 9,300 (1/03/07) 10,000 (1/11/07) | Relatively constant during past year at level below the DWS. | 6,900 7,570 (10/16/06) 8,300 (12/20/06) | Tritium undetected until late 1998. Increase started 2000 and peaked at ~100,000 in 2002. Presumed source is 100-K burial ground. |
| ***Wells Upgradient of the KE Basin*** | | | | |
| **199-K-110A** (SA) *Near KE Reactor.* | ND (10/31/06) | Typically not detected. | ND (3/30/06) | Generally not detected (less than several hundred pCi/L). |
| **199-K-36** (A) *Inland from Reactor* | ND (10/19/06) | Essentially constant near the method detection limit. | 392 & 574 (10/10/05) | Change to current level in ~1997. |

☑ Indicates key well for detecting shielding water impact on groundwater. Technetium-99 (Tc-99) is an additional indicator for shielding water.
Abbreviations: (M) = monthly; (Q) = quarterly; (SA) = semiannually; (A) = annually; and (BE) = biennially
Regulatory Standards for Tritium in Groundwater: The drinking water standard (DWS) is 20,000 pCi/L and the DOE derived concentration guide is 2,000,000 pCi/L. The offsite lab (STL-RL) detection limit is ~300 pCi/L.

**Table 2**. Tritium in Groundwater Near the KW Basin (Jan/Feb/Mar 2007)

(Updated April 23, 2007; new results, changes, and interpretations are printed in blue)

| Well, (Sample Frequency), and Position | Current Quarter, pCi/L (sample date) | Current Concentration Trend | Prior Results, pCi/L (sample date) | Historical Concentration Trend Since 1997 |
|---|---|---|---|---|
| ***Wells Downgradient of KW Basin (Tritium concentration in KW Basin shielding water is ~1,800,000 pCi/L—June 2006)*** | | | | |
| ☑ **199-K-34** (Q) *Adjacent to KW Basin.* | 2,900 (1/22/07) | Variable in range 1,000~4,000 since mid-2003, when recent variability started. | 3,500 (10/31/06) | Long-term gradual decrease from ~6,000 to ~1,000. Recent unexplained change in trend started late 2003. |
| ☑ **199-K-107A** (Q) *Adjacent to KW Basin and basin drain field.* | 410 (1/18/07) | Continued long-term decline to well below the DWS; low variability. | 500 (10/12/06) | Long-term gradual decline from ~2,000 down to <1,000. |
| **199-K-139** (Q) *Downgradient of KW Reactor.* | 730 630 (10/31/06) | New well installed as part of pump-and-treat system for chromium. | | |
| **199-K-132** (Q) *Between KW Reactor and the Columbia River.* | 1,200 (1/09/07) | Variable; concentration range similar to 199-K-34. | 2,000 1,500 (10/12/06) | Overall decline from plume that passed 199-K-33 during 1995~1998, with peak values of ~45,000. |
| **199-K-31** (A) *Near river.* | 860 (10/19/06) | Fairly constant, low variability. | 1,350 (10/04/05) | Long-term gradual decline; in path of plume from 200 East (tritium, NO3, Tc-99). |
| ***Wells East of KW Basin*** | | | | |
| **199-K-106A** (Q) *Downgradient of KW Condensate Crib; alongside KW Basin.* | 120,000 (1/18/07) | Returning to lower concentrations, following high values in 2005. Chloride, nitrate, and Tc-99 are also elevated. | 160,000 150,000 (12/20/06) | Variable within range of ~2,500 to ~25,000 (following 1996 plume passage that had peak of 676,000), until recent pulse started in July 2001. |
| ***Wells upgradient of the KW Basin*** | | | | |
| **199-K-108A** (A) *Adjacent to KW Reactor.* | 250 (10/12/06) | Barely detectable. Other contaminants show a return (increase) back to pre-dilution concentrations. | ND (4/12/06) | Gradual decline from ~650 in 1996, until dilution by clean water started in 1999, with tritium undetected. Dilution stopped in 2004. |
| **199-K-35** (BE) *Background for KW Reactor.* | 420 (10/19/06) | Continued gradual decline to background levels. | 949 (10/05/05) | Long-term decline from ~2,600 to <1,000 (regional background for 100-K Area). |

☑ Indicates key well for detecting shielding water loss to the ground. Technetium-99 (Tc-99) is an additional indicator for shielding water.

Abbreviations: (M) = monthly; (Q) = quarterly; (SA) = semiannually; (A) = annually; (BE) = biennially

Regulatory Standards for Tritium in Groundwater: The drinking water standard (DWS) is 20,000 pCi/L and the DOE derived concentration guide is 2,000,000 pCi/L. The offsite lab (STL-RL) detection limit is 300 pCi/L.

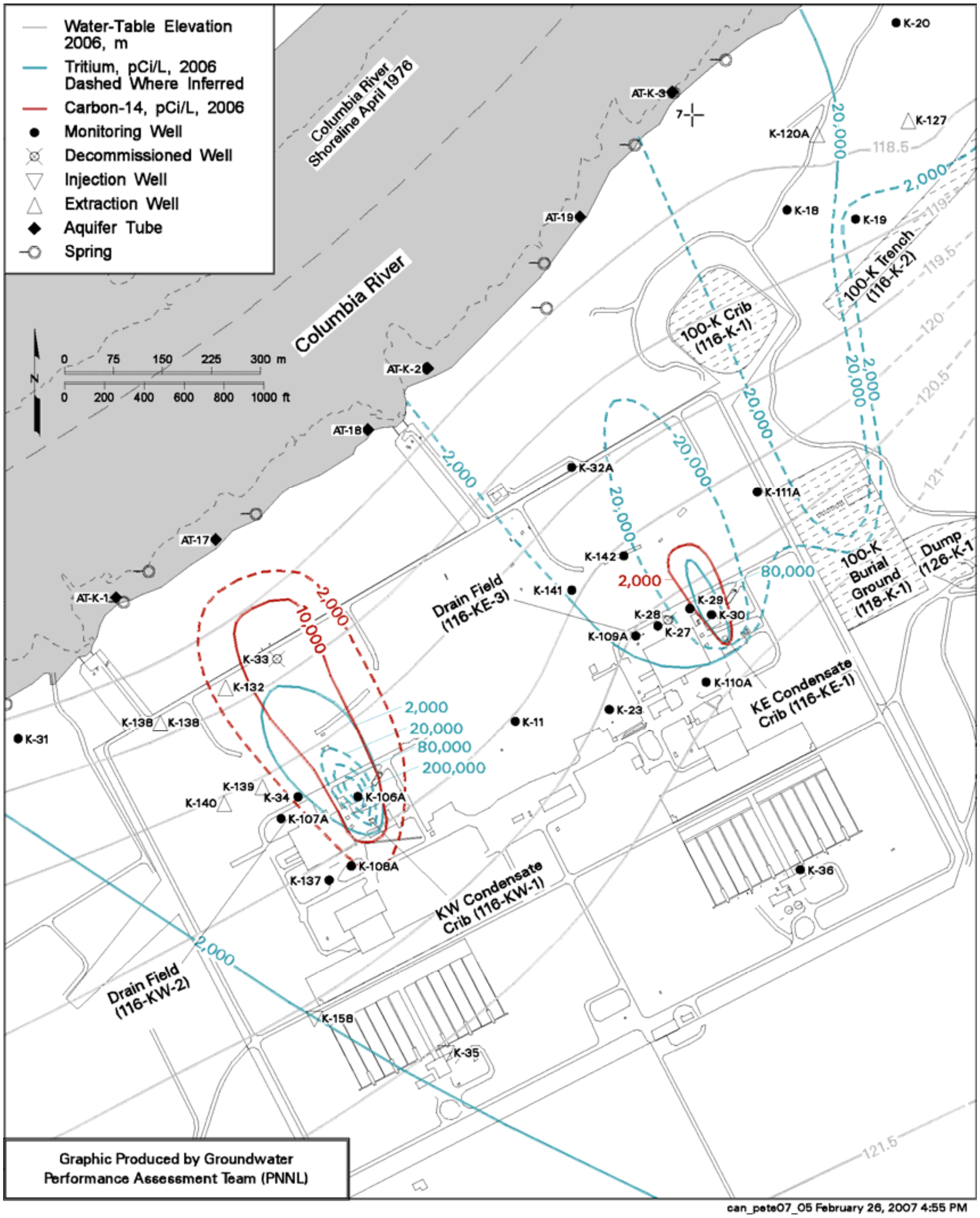


**Figure 1.** Location Map for Wells in the Vicinity of the K Basins, and 2006 Tritium and Carbon-14 Plumes (modified from Peterson and Raidl 2007).

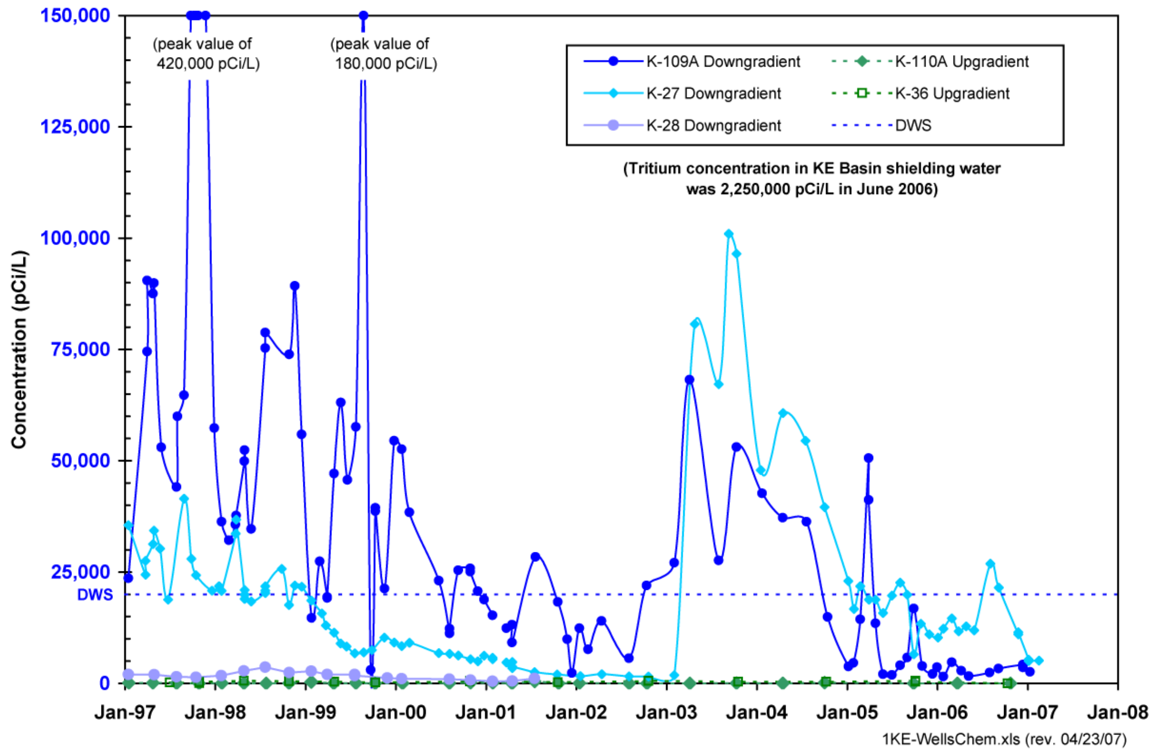


**Figure 2**. Tritium in Groundwater Near the KE Basin

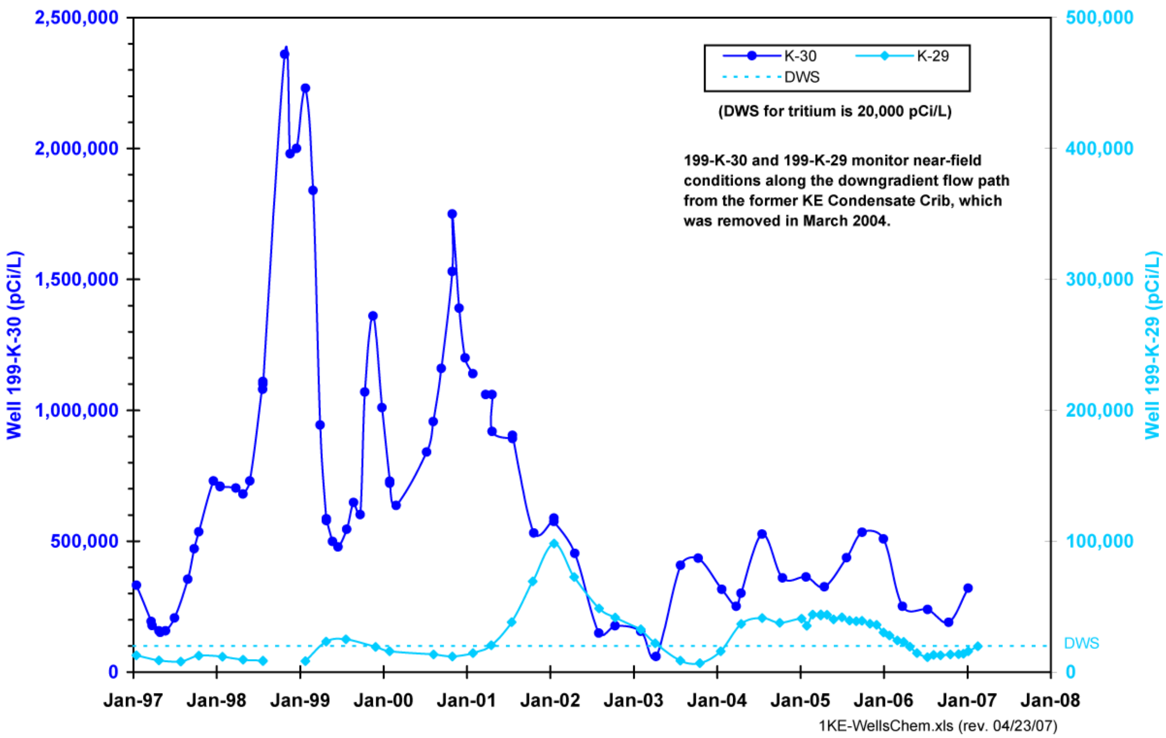


**Figure 3.** Tritium in Groundwater Along East Side of KE Reactor Building

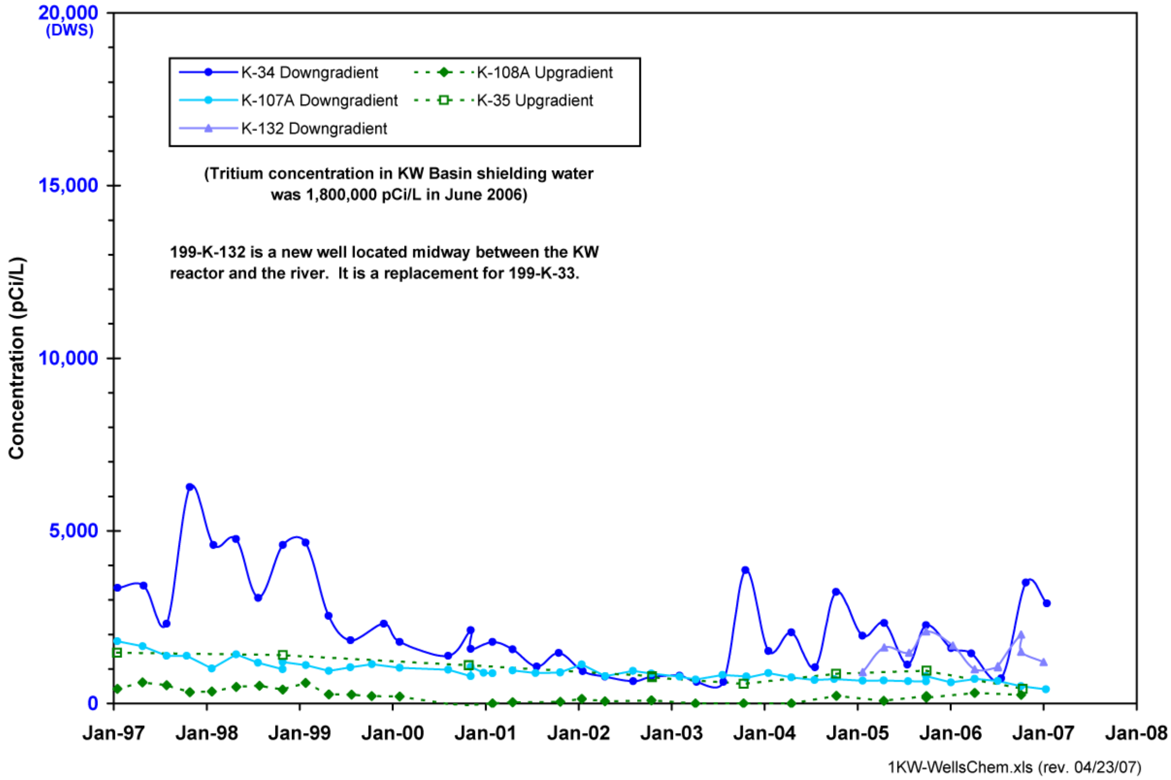


**Figure 4.** Tritium in Groundwater Near the KW Basin

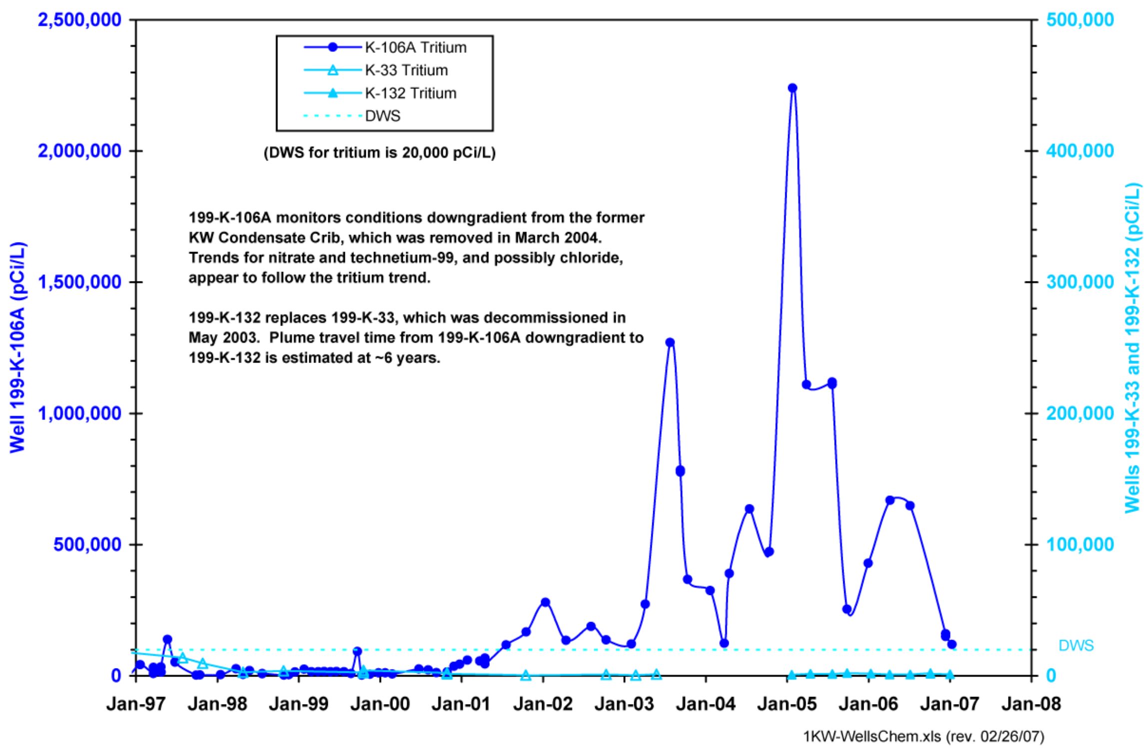


**Figure 5.** Tritium in Groundwater Along East Side of the KW Reactor Building

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