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U.S. Environmental Protection Agency

Third Five-Year Review Report for Silver Bow Creek/Butte Area Superfund Site

Volume 4: Warm Springs Ponds Active and Inactive Operable Units

June 2011

Final

REMEDIAL ACTION CONTRACT
FOR REMEDIAL, ENFORCEMENT OVERSIGHT, AND NON-TIME-CRITICAL REMOVAL ACTIVITIES AT SITES OF RELEASE OR THREATENED RELEASE OF HAZARDOUS SUBSTANCES
IN EPA REGION 8

U. S. EPA CONTRACT NO. EP-W-05-049

FINAL

Third Five-Year Review for the Silver Bow Creek/Butte Area NPL Site Butte, Montana

Volume 4: Warm Springs Ponds Active and Inactive Operable Units

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June 2011

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Acronyms

#/m^2	organisms per square meter
ACMC	Anaconda Copper Mining Company
AOC	Administrative Order on Consent
ARAR	Applicable or Relevant and Appropriate Requirement
ARCO	Atlantic Richfield Company
AVS	acid volatile sulfide
BMI	benthic macroinvertebrates
BPS	Butte Priority Soils
CDM	CDM Federal Programs Corporation
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Act Information System
CFR	Clark Fork River
cfs	cubic feet per second
CGWA	Controlled Groundwater Area
COC	contaminant of concern
CTEC	Citizens Technical Environmental Committee
DEQ	Montana Department of Environmental Quality
DNRC	Montana Department of Natural Resources and Conservation
dwt	dry weight
EPA	U.S. Environmental Protection Agency
EqP	equilibrium partitioning
ESD	explanation of significant differences
EWC	East Wet Closure
FWP	Montana Department of Fish, Wildlife, and Parks
FWS	United States Fish and Wildlife Service
IC	institutional control
kg	kilogram
LOAEL	lowest observable adverse effect level
mgd	million gallons per day
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MCE	maximum credible earthquake
MCL	maximum contaminant level
NCP	National Contingency Plan
NOAEL	no observable adverse effect level
NPL	National Priorities List
O&M	operations and maintenance
OU	Operable Unit
PMF	probable maximum flood
RAO	remedial action objectives
ROD	record of decision

RPM	Remedial Project Manager
SEM	simultaneously extracted metals
Site	Silver Bow Creek/Butte Area Superfund Site
SST	Stream Side Tailings
s.u.	standard units
TRV	toxicity reference value
TSS	total suspended solids
UAO	unilateral administrative order
USGS	U.S. Geological Survey
μg/g	micrograms per gram (dry weight)
μg/L	micrograms per liter
WSP	Warm Springs Ponds
WWC	West Wet Closure

Section 1
Introduction

The U.S. Environmental Protection Agency (EPA) Region 8 has conducted a five-year review of the response actions implemented at the Silver Bow Creek/Butte Area Superfund site (Site), Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Information System (CERCLIS) ID: MTD980502777 in Silver Bow County and Deer Lodge County, Montana. This review covers activities conducted from January 2005 through December 2009. This volume of the report focuses on the Warm Springs Ponds (WSP) Operable Unit (OU) 04 – Active Area and WSPOU 12 – Inactive Area; separate volumes have been prepared for the other Silver Bow Creek/Butte Area Site OUs. This is the third five-year review for the Site and this is the third five-year review for the WSPOUs. The purpose of this volume of the five-year review report is to determine whether the selected interim remedies in place at the WSPOUs are protective of human health and the environment. The methods, findings, and conclusions of the reviews are documented in the report. In addition, the five-year review report identifies deficiencies found during the review, if any, and identifies recommendations to address them. The WSPOUs are two of seven OUs comprising the Site.

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Section 2
Site Chronology

Table 2-1 presents important site events and relevant dates for the WSPOUs. The identified events are selective, not comprehensive.

Table 2-1
Chronology of Site Events

Event	Operable Unit	Date
Placer gold discovered in Silver Bow Creek	All	1864
Large scale underground mining in Butte	03, 08	1875 - 1955
Open pit mining at Berkeley Pit	03	1955 - 1982
Major smelting period in Butte	03, 08	1879 - 1900
Anaconda Copper Mining Company (ACMC) merges with the Atlantic Richfield Company (ARCO) with full assumption of liability	All	1977
Discovery of mining-related contamination along Silver Bow Creek between Butte and Warm Springs, Montana	01	September 1, 1979
Hazard Ranking System package completed	All	December 1, 1982
Silver Bow Creek Site proposed to the National Priorities List (NPL)	All	December 30, 1982
Silver Bow Creek Site (original portion) listed as Final on the NPL	All	September 8, 1983
Silver Bow Creek Site (original portion) Phase 1 Remedial Investigation Final Report	All	January 1987
Administrative Order on Consent (AOC) for Mill-Willow Bypass Removal Action	04, 12	June 1990
Interim record of decision (ROD) for WSP Active Area OU	04	September 28, 1990
Explanation of Significant Differences (ESD) for WSP Active Area OU	04	June 24, 1991
Unilateral Administrative Order (UAO) for WSP Active Area OU	04	September 25, 1991
Interim ROD for WSP Inactive Area OU	12	June 30, 1992
Remedial Action start OU 04	04	June 30, 1992
UAO for WSP Inactive Area OU	12	June 17, 1993
Remedial Action start OU 12	12	May 18, 1994
Initial five-year review for Silver Bow Creek/Butte Area Site with emphasis on WSPOUs	04, 12	March 23, 2000
Second five-year review for Silver Bow Creek/Butte Area Site with emphasis on WSPOUs	01, 03, 04, 07, 12	September 2005
Third five-year review for Silver Bow Creek/Butte Area Site	04, 12, 01, 03, 07, 08	September 2010

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Section 3
Background

3.1 Location and Setting

The WSPOUs are located in southwestern Montana, at the lower end of Silver Bow Creek, approximately 27 miles downstream of Butte, Montana (Figure 3-1). The complex covers approximately 2,600 acres and is bordered by the Mill-Willow Bypass (stream diversion around the WSP) to the west, the Clark Fork River to the north, hills to the east, and marsh lands and incoming streams to the south.

The pond system is a series of three sediment settling ponds that were constructed over a span of about 60 years. Pond 1 was constructed around 1911, Pond 2 around 1916, and Pond 3 during the late 1950s. They were constructed by the Anaconda Copper Mining Company (ACMC) in an effort to prevent tailings and other sediments from entering the Clark Fork River, which begins approximately a half mile below Pond 1.

Pond 1 was never involved in the active treatment of water from Silver Bow Creek by the addition of lime, and it no longer plays a role in settling sediments. This inactive area, and the area below Pond 1, is essentially isolated from the active treatment portion of the pond system. The relatively small volume of water contained within this inactive area is present because of seepage from the ponds above.

Ponds 2 and 3 have been retained as settling ponds. Tailings and other sediments from Silver Bow Creek physically settle to the bottom as the velocity of the incoming water decreases. The addition of lime near the inlet to Pond 3, a practice that began some 20 years ago, also makes it possible to actively treat the dissolved metals, or cause them to precipitate out of solution and settle to the bottom. Historically, lime has been added only during the late fall, winter, and early spring. This practice still continues to be implemented.

Willow Creek and Mill Creek, which historically joined with Silver Bow Creek in the area above the present pond system, were diverted away from Silver Bow Creek and around the pond system in the late 1960s.

3.2 Physical Characteristics

3.2.1 Surface Hydrology

The WSP include the primary hydrologic features within the OUs. Three creeks from the south and the west flow through the OUs. Silver Bow Creek, the longest of the three creeks, flows from the south and enters Pond 3 near the southern end of the OU. Mill and Willow creeks from the west and south flow into the Mill-Willow Bypass, which routes the comparatively less contaminated water in these two creeks around the ponds and to the Clark Fork River.

Water flowing out of Pond 3 goes primarily into Pond 2, with a smaller volume being used to maintain several wildlife ponds located between ponds 2 and 3. The effluent from Pond 2 flows into the Mill-Willow Bypass, as a regulated point-source discharge, and then down the bypass to the Clark Fork River. The average flows in the three creeks are 73 cubic feet per second (cfs) for Silver Bow Creek and 27 cfs for combined Mill and Willow creeks.

The average flow of 100 cfs in the lower portion of the Mill-Willow Bypass is joined by the average flow of approximately 47 cfs in Warm Springs Creek at the northern end of the OU to form the Clark Fork River. Warm Springs Creek is also slightly impacted from milling and smelting activities in the Anaconda area to the west.

3.2.2 Groundwater Hydrology

The shallow groundwater system in the WSPOUs is complex, owing to the heterogeneity of the near surface geology in the area. The site is in a groundwater discharge area for the upper Deer Lodge valley, typified by shallow groundwater tables and swamps. The presence of the pond system affects shallow groundwater elevations and groundwater movement within the site.

Shallow aquifers occur along present-day stream channels, but do not extend laterally throughout the site. Deeper aquifers are associated with tertiary-age valley fill and thick deposits of glaciofluvial material. The aquifers exhibit moderate to low permeabilities and are probably connected on a regional scale, although fine-grained interbeds tend to confine the deeper aquifers locally.

The uppermost aquifer at the site is a 10- to 15-foot-thick sand and gravel unit approximately 10 feet below ground surface. This sand and gravel aquifer appears to be present throughout most of the site. Groundwater movement through the site is generally south to north, although a significant component of groundwater enters from the Opportunity Ponds area to the southwest.

3.3 Land and Resource Use

The WSP are located at the downstream end of the Silver Bow Creek Site and cover an area of approximately 2,500 acres. These ponds consist of three treatment ponds (two of which are actively used for water treatment) and two wildlife ponds. Together the treatment ponds and wildlife ponds offer habitat for migrating waterfowl and breeding areas for dozens of songbirds and osprey. The area is designated as a wildlife management area that is administered by the Montana Department of Fish, Wildlife, and Parks (FWP). Property within the WSPOUs is owned exclusively by ARCO.

A portion of the ponds was designated by the State as a wildlife management area. Currently, the FWP operates the wildlife management area under a 2005 lease with ARCO. The lease allows recreational use of the area, but restricts swimming and limits fishing to catch-and-release only.

No domestic wells are within the WSPOUs; however, several wells are located east of the pond system within a mile of the OU. These wells are completed in bedrock aquifers that do not appear to be affected by the pond system. The town of Warm Springs derives its water from supply wells constructed in unconsolidated tertiary deposits from depths of approximately 200 feet. These wells appear to be supplied with water derived from groundwater resources west of and hydraulically isolated from the WSP.

3.4 Contamination and Regulatory History Summary

Active Area OU

From the beginning of ore processing (concentrating/smelting) activities in Butte in 1880 until about 1911, mine and mill tailings from the Butte and Anaconda areas were carried down Silver Bow Creek to the Clark Fork River, at least as far as the Milltown Reservoir (built in 1907), approximately 145 river miles, and probably farther. ACMC made the first attempt to control the amount of sediment carried into the Clark Fork River from Silver Bow Creek in 1911 by building a 20-foot-high tailings dam on Silver Bow Creek near the town of Warm Springs; this created Pond 1.

In 1916, another 18-foot-high dam was built at Warm Springs by ACMC upstream from the first dam, creating Pond 2. The dam was subsequently raised five feet to a total height of 23 feet during 1967-1969. Ponds 1 and 2 trapped and settled out sediment from Silver Bow Creek. The primary source of the sediments was mine waste from the Butte area; however, there is evidence that the Anaconda Smelter operations also contributed to the contaminated sediments residing in the pond system. Overflow discharge from the adjacent Anaconda and Opportunity Ponds at the Anaconda Smelter, routed into Silver Bow Creek above the WSP, contributed additional sediments.

A third, and much larger, 28-foot high dam was built upstream of Pond 2 by ACMC between 1954 and 1959, primarily for sediment control. The structure created Pond 3. The height of the dam was increased by five feet during 1967-1969 to a maximum height of 33 feet.

As a result of the activities described above, over 19 million cubic yards of contaminated sediments accumulated in the WSP, and a substantial volume of contaminated soils and tailings was present in areas surrounding the WSP, including the Mill-Willow Bypass and the area downstream (north) of Pond 1.

In 1967, Pond 3 was converted into a treatment facility to treat mill losses, precipitation plant spent solution from Butte operations, and overflow from the Opportunity Ponds. Treatment consisted of introducing a lime/water suspension from the Anaconda Smelter into Silver Bow Creek above Pond 3. The addition of the lime suspension raised the pH of the creek water to facilitate precipitation of heavy metals in the WSP.

Wildlife ponds were constructed about 1967 by FWP in association with ACMC to enhance waterfowl habitat in the southern Deer Lodge valley. Two large cells and several smaller sub-cells and islands were constructed. Water within the Wildlife Ponds is obtained from siphon structures in Pond 3.

ARCO (now Atlantic Richfield) merged with ACMC in 1977. ARCO became the responsible party for cleanup of the environmental problems in Butte and Silver Bow Creek when the area was listed on the CERCLA National Priorities List (NPL) in 1982.

In early prioritization efforts, EPA identified dam stability and safety issues for the pond structures. Accordingly, the ponds area was designated for early action under Superfund.

In July 1990, EPA issued an action memorandum and ordered ARCO to clean the Mill-Willow Bypass area. This work was completed and is an integral part of the two remedial actions (Active Area and Inactive Area) for the WSP. The Mill-Willow Bypass removal action involved the following work:

- Removal of 436,000 cubic yards of tailings and contaminated soils from the bypass and disposal in a dry portion of Pond 3
- Reinforcing and armoring the Pond 2 and Pond 3 berms (an additional 1 million cubic yards of uncontaminated fill dirt was excavated from the bypass for this purpose)
- Construction of improved inlet and outlet structures and a divider dike between Silver Bow Creek and Willow and Mill creeks

Active Area OU

The initial record of decision (ROD) for the WSPOU was released by EPA on September 28, 1990 (EPA 1990b). In June of 1991, EPA released an ESD that modified certain elements of the initial WSP ROD (EPA 1991a). Most significantly, the ESD identified the inactive area of Pond 1 and the area beneath Pond 1 as a separate action that would be addressed under a separate ROD. The ESD divided the WSP into two separate OUs: 1) the WSP Active Area OU and 2) the WSP Inactive Area OU. The Active Area OU would address Pond 2 and Pond 3, and the Mill-Willow Bypass and berms, inlet and outlet structures, treatment improvement features, and monitoring systems. The Inactive Area would address the inactive areas (Pond 1 and the area downstream of Pond 1).

In September 1991, EPA issued a Unilateral Administrative Order (UAO) directing implementation of the Active Area ROD (EPA 1991b).

Currently, the WSP treatment system is operated by Atlantic Richfield. Pond 1 is not used in the treatment process at the site, because the pond is largely filled with sediment. Lime is added to Silver Bow Creek above Pond 3, primarily during the winter months, to raise the pH of the influent to facilitate metals precipitation.

Inactive Area OU

EPA issued the Inactive Area ROD in June 1992. In July 1993, EPA issued a UAO to ARCO to conduct this remedial action. Remedial action was implemented from 1993 to 1995.

Before remedial action, the Inactive Area OU contained an estimated 3.4 million cubic yards of contaminated sediments, tailings, and soils. Approximately 475,000 cubic yards of these materials were within the area downstream of Pond 1. These source materials consisted of over-bank deposits that settled out along Silver Bow Creek before the construction of Pond 1. Approximately 2.9 million cubic yards of contaminated sediments, tailings, and soils were contained within Pond 1.

Previous Five-Year Reviews

In 1997, ARCO issued the preformance review report (ARCO 1997) for the WSPOUs. The report presented data collected during construction of the remedial action improvements and an evaluation of the system's performance since completion of the improvements in 1995. An addendum to the report was issued in 1998 (ARCO 1998). The addendum presented additional operational data gathered in the interim and the results of additional investigations completed to understand the system's dynamics. In 2000, after the system had been operating for approximately 5 years, EPA issued its initial five-year review report for the Site. In 2005, a second five-year report was issued by EPA. Because the initial report issued by ARCO (the 1998 addendum) presented data through 1997, the 2005 report addressed the period from January 1, 1998, through December 31, 2004.

This report is the third five-year review report for these OUs and addresses the period from January 1, 2005, through December 31, 2009.

3.5 Basis for Taking Action

The basis for taking action is well-summarized in the 1991 Administrative Order for remedial design/remedial action as follows:

> *Surface water moving into and out of the Warm Springs Ponds area presents a pathway of migration for the contaminants, and currently the Ponds do not accept and treat 100 year flood flows of contaminated surface water entering the Warm Springs Ponds area. Point source discharges of contaminated surface water into Mill and Willow Creeks and the nearby Clark Fork River from Ponds 2 and 3 are of particular concern. Large areas of surface contamination, located within the Ponds and outside of the Ponds and in the Mill-Willow Bypass, and composed of contaminated soils and tailings, may subject humans and wildlife to risks from exposure. In particular, copper and zinc in soils and tailings may cause acute fish kills in and around the Warm Springs Ponds area. The Ponds also present the possibility of a catastrophic release of contaminated material, if the berms surrounding the Ponds give way due to a flood or an earthquake.*

The overall remedial action objectives (RAOs) established for the WSP Active OU are listed below.

- Prevent releases of pond bottom sediments due to earthquakes or floods. The Montana Department of Natural Resources and Conservation (DNRC) dam safety requirements have been identified as the applicable standard. The standard requires protecting the ponds to fractions of a probable maximum flood (PMF) and to the maximum credible earthquake (MCE).

- Meet Montana Water Quality Act ambient water quality standards for arsenic, cadmium, lead, mercury, copper, iron, and zinc at a compliance point just above the defined starting point of the Clark Fork River, and comply with discharge standards for the Pond 2 discharge after implementation of the WSP response actions and the upstream cleanup actions.

- Prevent ingestion of water above concentrations deemed safe by the Montana Public Water Supply Act for arsenic, cadmium, lead, mercury, and silver and above established reference doses for copper, iron, lead, zinc, and cadmium. Also, prevent ingestion of water containing arsenic concentrations that would cause risk greater than one chance in 10,000.

- Inhibit the migration of tailings from the Mill-Willow Bypass to the Clark Fork River to reduce the potential for future exceedances of ambient water quality standards in the Clark Fork River.

- Inhibit the migration of tailings from the upper reaches of Silver Bow, Mill and Willow creeks to the Clark Fork River to reduce the potential for re-contamination of the Mill-Willow Bypass and future exceedances of ambient water quality standards in the Clark Fork River.

- Reduce the potential for direct human contact, inhalation, and ingestion of exposed tailings and contaminated soils and tailings posing excess cancer risks above one chance in 10,000.

- Reduce the levels of arsenic, cadmium, and other contaminant concentrations in the groundwater of the Pond 1 area to achieve compliance with ground water performance standards.

Section 4
Remedial Actions

Summaries of the remedial actions selected, their implementation, and operations and maintenance (O&M) activities for the WSP Active and Inactive OUs as described in the *Record of Decision Silver Bow Creek/Butte Area* report for WSP Active Area OU 04 from September 1990 and the *Record of Decision Silver Bow Creek/Butte Area* report for WSP Inactive Area OU 12 from June 1992 are presented below (EPA 1990b, 1992b).

4.1 Remedy Selection

4.1.1 Active Area OU (OU 04)

Major components of the selected interim remedy for the WSP Active Area OU are listed below.

- Allow the ponds to remain in place; Ponds 2 and 3 will continue to function as treatment ponds until upstream sources of contamination are cleaned up and standards can be met without treatment.
- Raise and strengthen all pond berms according to specified criteria to protect against dam failure in the event of major earthquakes or floods, and increase the storage capacity of Pond 3 to receive and treat flows up to the 100-year flood.
- Construct new inlet and hydraulic structures to prevent debris from plugging the Pond 3 inlet and to safely route flows in excess of the 100-year flood around the ponds.
- Comprehensively upgrade the treatment capability of Ponds 2 and 3 to fully treat all flows up to 3,300 cfs (100-year peak discharge) and construct spillways for routing excess flood water into the bypass channel.
- Remove remaining tailings and contaminated soils from the Mill-Willow Bypass, consolidate them over existing dry tailings and contaminated soils within the Pond 1 and Pond 3 berms, and provide adequate cover material which will be revegetated.
- Reconstruct the Mill-Willow Bypass channel and armor the north-south berms of all ponds to safely route flows up to 70,000 cfs (one-half of the previously estimated PMF).
- Flood (wet-close) all dry portions of Pond 2.
- Establish surface and groundwater quality monitoring systems and perform all activities necessary to ensure compliance with all applicable or relevant and appropriate requirements (ARARs).

- Implement institutional controls (ICs) to prevent future residential development, swimming, and consumption of fish by humans.
- Defer, for not more than one year after the effective date of the ROD, decisions concerning the remediation of contaminated soils, tailings, and groundwater in the area below Pond 1, pending evaluation of various wet- and dry-closure alternatives and public review.

4.1.2 Inactive Area OU (OU 12)

Components of the interim remedy associated with Pond 1 and the area downstream of Pond 1 (the inactive area), including the Pond 1 berms, the old Silver Bow Creek channel, and the lowermost portion of the Mill-Willow bypass, were removed from the 1990 ROD for the WSP. The explanation of significant differences (ESD) called for a separate and thorough evaluation of remedial alternatives and ROD for the inactive area.

The WSP Inactive Area interim remedy may be summarized as follows.

- Remove all tailings and contaminated soils from the adjacent portion of the bypass channel and from the area below Pond 1 not planned for wet-closure. Consolidate the wastes over existing dry tailings within the western portion of Pond 1.
- Modify, or enlarge if necessary, the adjacent portion of the bypass channel to safely route flood flows up to 70,000 cfs, which is one-half the previously estimated PMF for the combined flows of Silver Bow Creek, Willow Creek, and Mill Creek. Soils and gravels that have copper concentrations below 500 milligrams per kilogram (mg/kg) and meet geotechnical requirements will be used for raising and strengthening the existing berms and constructing new berms.
- Raise, strengthen, and armor with soil cement the north-south aspect of the Pond 1 berm. In accordance with specified state safety standards for high hazard dams and for the protection of human health and the environment, the reconstructed berm must withstand the estimated MCE for this area. In addition, the reinforced berm must be constructed to withstand flood flows up to 70,000 cfs in the enlarged bypass channel.
- Stabilize the east-west aspect of the Pond 1 berm. The reconstructed berm must withstand an MCE for this area, thus protecting against the movement of contained pond bottom sediments or tailings into the uncontaminated or wet-closed areas below Pond 1 in accordance with specified state dam safety standards and for the protection of human health and the environment.
- Extend and armor the north-south aspect of the Pond 1 berm approximately 2,400 feet in a north-northeasterly direction. This extended berm will be constructed to provide MCE protection and the ability to withstand one-half the estimated PMF (70,000 cfs) in the adjacent bypass channel.

- Relocate the downstream portion of the bypass channel and convert the present channel into a groundwater interception trench. The relatively straight reach of the bypass channel, from the apex of the existing Pond 1 berm to the historic Silver Bow Creek channel, will be relocated north of the extended berm. The entire reach of the bypass channel that is adjacent to the inactive area will be reconstructed, reclaimed, and restored to a more natural, meandering condition. Other excavated areas will be reclaimed and restored to their natural condition.

- Deepen the converted groundwater interception trench and install pumps to allow for a pump-back system. Pump intercepted water that fails to meet specified standards back to the active area for treatment. Place monitoring wells and surface water quality monitoring stations at strategic locations.

- Construct wet-closure berms to enclose the submerged and partially submerged tailings and contaminated soils. Within the eastern portion of Pond 1 and along the historic Silver Bow Creek channel below Pond 1, these smaller berms will create a series of cells, which when flooded will vary in depth from a minimum of 1 foot to a maximum of 6 feet.

- Chemically fix (immobilize) the tailings and contaminated soils, now enclosed by smaller berms, by incorporating lime and lime slurry onto or into them.

- Flood the wet-closure cells with water adjusted to a pH greater than 8.5 standard units (s.u.) and maintain proper water surface elevations in the wet-closure cells.

- Cover the dry tailings and contaminated soils within the western portion of Pond 1 with 2 inches of limestone, 12 inches of fill, and 6 inches of a suitable soil cap. This dry-closed area will be contoured to control runoff and seeded with native vegetation.

- Construct a runoff interception system along the east side of the inactive area. This system will prevent floods originating in the eastern hills from entering the wet-closure cells. It will be designed to intercept one-half the PMF, which is estimated to be 8,500 cfs at its peak. A collection system or other engineered solution will be constructed to prevent excessive sediments from entering the Clark Fork River immediately below.

- Install toe drains along the armored berms and construct a collection manifold for both the active and inactive areas. The water collected will be pumped to the active area for treatment if it exceeds final point discharge standards specified in Attachment 5 to the WSP Active Area UAO.

- Implement long-term ecological monitoring. By means of an unbiased set of measurements, this monitoring effort will concentrate on the effects of biological systems living in contact with metals in the water and substrate of ponds and wetlands environments. The results will validate or invalidate the decision to chemically fix, wet-close, and contain in place the exposed and submerged tailings and contaminated soils.

- Implement ICs to prevent residential development, swimming, domestic well construction, and disruption of dry-closure caps.

4.2 Remedy Implementation

Response actions were conducted by Atlantic Richfield under extensive EPA enforcement and oversight from July 1990 through September 1995. Beginning with the Mill-Willow Bypass expedited response action in 1990 and 1991, and continuing through remedial action construction for both the active and inactive areas in 1992 through 1995, EPA has determined that Atlantic Richfield has met all remedial action construction requirements that were set forth in the two RODs (EPA 1990b, 1992b) and three administrative orders (Mill-Willow Bypass Removal Action - 1990, Active Area Remedial Action – 1991, and Inactive Area Remedial Action - 1993).

4.3 System O&M

4.3.1 System Operations

The primary processes involved in the WSP system are two-fold:

- Hydrated lime is added to the influent stream (Silver Bow Creek) as necessary to raise the pH to the target level of 9.2 s.u. to 9.5 s.u. as shown on Figure 4-1. This is the first step toward maximizing the chemical and physical changes that cause dissolved metals to become solids and begin settling out (precipitation).

- The WSP are both a treatment and settling facility. The addition of large volumes of lime at the inlet initiates the alkaline precipitation processes. But, adequate retention time (approximately 21 days) and a final “polishing action” (principally in Pond 2 by algae) are also needed to reduce metal concentrations to acceptable levels prior to discharge back into the natural stream system below.

The opportunities for controlling these processes generally involve two operations or activities. First, the quantity of lime added to the influent stream can be adjusted. When lime is added to Silver Bow Creek, mixing is facilitated by installed baffles at the inlet channel and by the meandering stream channel that flows into Pond 3.

Second, hydraulic controls can be altered so that the water surface elevations (and subsequent volumes) of Ponds 3 and 2 are raised or lowered. Water flows can also be routed differently between or around the ponds and wet closures. The hydraulic controls are applied to create an environment that promotes maximum sedimentation of suspended particles in Pond 3. The wet closures and Pond 2 provide additional sedimentation and treatment polishing. During periods of increased suspended particle loads, the sedimentation process can be prolonged by using the hydraulic controls to increase pond volumes and retention times.

Lime Addition

As previously discussed, when necessary, hydrated lime is added to the influent stream (SS-1), as shown in Figure 4-1, with the objective of maintaining the target pH of 9.2 to 9.5 s.u. as measured at SS-2 (downstream of the inlet structure and lime feeder). During the report period, the average lime dosage rate was 26.2 milligrams per liter (mg/L) when lime was being added. The target pH value has remained the same throughout this 5-year period.

During high flow/high turbidity influent conditions, the lime dosage rate is increased to ensure sufficient lime addition to maximize treatment of metals and subsequent settling of metal oxides and hydroxides.

Lime addition is not necessary during those times of the year when photosynthesis naturally raises the pH of the pond system (typically summer and early fall).

Hydraulic Controls

Flows from Silver Bow Creek enter the WSP system at the inlet structure where the pH is adjusted by lime addition. Flow passes through Pond 3 and Pond 2 with a portion diverted through the Wildlife Ponds and Pond 2 wet closures. The Wildlife Ponds and wet closures discharge back into Pond 2 where all flows are combined prior to discharge from the outlet structure. Flows from Mill and Willow Creeks are diverted into the Mill-Willow Bypass above the inlet structure. Other system flows include the effluent from the Inactive Area Pumpback Station, which pumps water from the Groundwater Interception Trench back to Pond 2. In addition, a small flow is maintained from Pond 2 into Pond 1 of the Inactive Area, which is subsequently returned to Pond 2 as part of the pumpback discharge. A general flow schematic for the Active Area is provided in Figure 4-2.

Flows entering the system vary greatly. Figure 4-3 illustrates the daily flow rates measured at SS-1 and SS-5. Monthly average flow measurements are presented in Figure 4-4. Average influent flows (at Station SS-1) during the report period were 32.3 million gallons per day (mgd), while average effluent flows (at Station SS-5) were 25.8 mgd. These flows are roughly two-thirds the average annual flows anticipated at SS-1 of 47 mgd as indicated in the O&M plan (ARCO 1995). Monthly average flows at SS-1 ranged from 9.6 mgd to 125.5 mgd and monthly average flows measured at SS-5 ranged from 6.5 mgd to 125.5 mgd. Increased flow periods each spring/early summer correspond to seasonal runoff. Increased flows are also observed after isolated precipitation events.

Low discharge rates at SS-1 and SS-5 occur primarily during summer and fall months when influent flows are lower in order to increase the residence time (and sedimentation time) in the ponds.

Although flow patterns can be changed within the pond system, the main control on flow detention is the fluctuation of Pond 3 elevation. Pond 2 elevations have remained relatively constant as shown in Figure 4-5, ranging from about 4,835 to 4,836 feet.

Pond 3 elevations vary depending on seasonal flows and ranged from about 4,868 feet to 4,871 feet (target elevation is 4,870 feet, which minimizes sediment re-suspension from previously flooded areas).

Pond 3 levels vary based on climatic conditions (Figure 4-6). In years when there is high snowpack, Pond 3 levels are kept low through the winter and spring to accommodate high inflow runoff events. During drier years, levels in Pond 3 are maintained at somewhat higher levels in order to maintain flow through the system and maintain habitat for aquatic life during the summer.

4.3.2 System Maintenance Events

The following provides a brief summary of some of the more significant O&M activities that have taken place during the report period from January 1, 2005, through December 31, 2009. The events listed involved the Active Area of the WSP system and may have directly or indirectly affected pond water quality.

- June 5, 2005: Power outage at SS-5 lead to unrepresentative sample collection. Sample collection system re-designed and replaced to avoid future problems.
- November 2006: Riprap maintenance was performed along the Pond 1 embankments.
- 2006: As a result of the dam safety and hydraulic operations inspection, a number of piezometers were identified as having been damaged during construction. Damaged piezometers were repaired and new piezometers were added and are now part of the monitoring program.
- February to March 2007: Embankment stabilization was performed on the Pond 3 Mill-Willow divider dike from the emergency spillway to the south approximately 1,600 feet.
- August 2007: the East Wildlife Pond dike between the East Wildlife Pond and the Pond 2 inlet channel were repaired. The repairs were due to a muskrat hole which was burrowed from the toe to the center of the crest of the dike.
- November 2008: Nine survey monuments were installed on the Pond 2 north dam to monitor potential movement in an area where potential sloughing was identified during an annual voluntary inspection. Subsequent consultation with construction engineers and monitoring verified there has been no movement.
- 2009: Underwater inspection and repairs made to SS-5 spillway and adjacent structures.
- March 2009: Banks of the Pond 2 inlet causeway upstream from the SS-4 weir were re-sloped. The 2008 dam inspection had indicated sloughing of slopes.

Section 5
Progress Since Last Review

This section discusses the performance of the remedies at the WSPOUs since they are complete and functioning.

5.1 Evaluation of Warm Springs Ponds OUs

No major new actions have been conducted at the WSPOUs during the 2005 to 2009 time period; hence, the progress consists of O&M of the WSP treatment system. This section will present the performance of the WSPOUs with respect to performance standards during this last review period. Table 5-1 lists the issues and recommended follow-up actions from the previous five-year review report and summarizes the outcome.

5.2 Previous Statement on Protectiveness

From the second five-year review in 2005, the following statements were made regarding the protectiveness of the selected interim remedy for the WSP Active and Inactive OUs:

> *The remedy for the WSP Active Area and Inactive Area OUs is currently functioning as designed. The Ponds serve to capture, treat, and retain contaminants from upstream sources in other OUs, and greatly reduce contaminant loading to the Clark Fork River. Discharge from the Active Area treatment system is generally in compliance for most constituents. Arsenic exceedances occur seasonally as a result of changing geochemical conditions in the pond bottom sediments within the treatment ponds (Ponds 2 and 3) and copper and zinc exceedances occur infrequently as a result of seasonal high flows into the Pond system. Surface water discharge from the WSP treatment system typically exceeds human health standards for arsenic during the late summer and fall of the year. However, aquatic life standards for arsenic are never exceeded and institutional controls are in place to protect against human exposure. During this evaluation period, the frequency of exceedances of copper and zinc were reduced from the initial five-year review period. Continued long-term operations and maintenance, coupled with annual dam safety inspections, required water quality and biological monitoring, will ensure that maximum protectiveness and effectiveness are maintained within the recognized limitations of alkaline precipitation technology and the physical size of the WSP system.*
>
> *The WSP effectively remove or reduce acutely toxic concentrations of metals that enter the treatment system from Silver Bow Creek. Whereas Silver Bow Creek above the ponds supports absolutely no fish population and is severely impaired in respect to invertebrate and periphyton (algal) community structure, the aquatic environment immediately below the WSP supports healthy populations of trout, good biological integrity for periphyton, and biological integrity for invertebrates. The pond system has become a safety net for the Clark Fork River. EPA deems the remedy to be*

protective in terms of substantially reducing – quite possibly eliminating – the threat of acute lethality to fish.

In light of the current and long-standing status of severe contamination in Silver Bow Creek above the ponds, and in light of the gradual degradation of water quality that occurs in the upper Clark Fork River, beginning within a few miles downstream of the WSP and continuing for about 40 miles, any attempt to eliminate occasional chronic threats that persist immediately below the ponds through modification of the WSP system would produce virtually no change in protectiveness for the river in the Deer Lodge valley. However, as the Clark Fork River water quality is improved, this issue will need to be re-examined, as will standards.

While a high degree of protectiveness has been achieved, an even higher degree of protectiveness is achievable. But, such a higher degree of protectiveness for the river can be attained only after all remaining operable units along this continuum of stream environments have been cleaned up and are functioning as a whole.

Table 5-1
Actions Taken Since the Last Five-Year Review

Issues from Previous Review	Recommendations and Follow-Up Actions	Party Responsible	Milestone Date	Action Taken and Outcome	Status
Continued seasonal exceedances of arsenic concentration in effluent.	EPA may initiate additional wildlife studies to determine whether bioaccumulation of arsenic in birds requires mitigation.	EPA	January 31, 2009	EPA decided not to implement this recommendation. Atlantic Richfield continued to independently study (i.e., without EPA oversight) the arsenic loading issues at the WSPs. The Streamside Tailings OU is still undergoing remedial actions and construction is scheduled to be complete by 2012.	Considered and not implemented
Increasing trend in benthic macroinvertebrate tissue metal concentrations.	Continued periodic monitoring of trends in tissue metal concentrations should be performed to determine if risks are significant to fish or wildlife inhabiting the WSP.	Atlantic Richfield	February 1, 2010	Benthic macroinvertebrate monitoring continued (McGuire 2009). Increased abundance observed in the latest surveys (2009) is considered an indication of reduced toxicity at the WSP. While performance standards and biomonitoring indicate an acceptable level of protectiveness, it is premature to make a definitive statement about remedial effectiveness of the entire Silver Bow Creek system.	Complete
Meeting arsenic standards for surface water will require an additional treatment step (beyond lime addition and settling), because the ponds are operating at their maximum efficiency and capacity. The cost-benefit of additional treatment to meet lower arsenic standards could be examined, keeping in mind that the upstream Streamside Tailings and Butte Priority Soils OUs remedial actions will decrease influent loading, improving treatment performance, and that significant additional arsenic loads are discharged by the Mill-Willow Bypass.	EPA may conduct arsenic mass loading studies (seasonal) to determine the significance of the arsenic load from the WSP as compared to other sources of arsenic loading in the basin. This may provide a better understanding of arsenic loading from numerous sources in the upper reaches of the system.	EPA	January 31, 2009	EPA decided not to implement this recommendation. Atlantic Richfield continued to independently study (i.e., without EPA oversight) the arsenic loading issues at the WSPs. The Streamside Tailings OU is still undergoing remedial actions and construction is scheduled to be complete by 2012.	Complete

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Section 6
Five-Year Review Evaluation

The WSPOUs five-year review team was lead by Roger Hoogerheide, an EPA Remedial Project Manager (RPM), and included EPA and State of Montana project managers of the OUs covered in the review, and technical staff from EPA's contractor CDM with expertise in areas of civil and environmental engineering, and community involvement.

The review was initiated in October 2009 and included the following components:

- Community involvement
- Local interviews
- Document review
- Data review
- Institutional controls review
- Site Inspection

The schedule for review extended through September 2010.

6.1 Community Involvement and Notification

Display ads were placed in the local papers (the Montana Standard and the Butte Weekly). The first ad announced the start of the five-year review process and ran in the Butte Weekly and the Montana Standard on September 30, 2009.

The agencies participated in three public meetings hosted by the Citizens Technical Environmental Committee (CTEC) regarding the five-year review process. The meetings were held on November 17, 2009, February 24, 2010, and March 3, 2010.

These advertisements and details of the public meetings are summarized in the community involvement and interviews memorandum included in Appendix A of Volume 1 of this five-year review report.

EPA released a draft of the five-year review report for public review and comment from December 12, 2010 through January 31, 2011. A public meeting was held on January 11, 2011. Comments received on the WSPOUs are included in Appendix B.

6.2 Local Interviews

Interviews were conducted from January through March 2010 with several groups of people which included members of the general public, site neighbors, members of special interest groups such as the Citizen Action Group and Technical Action Committees, representatives of local government, and oversight personnel with direct knowledge of the project. Advertisements were placed in newspapers and postcards were mailed to many citizens in the area. The final list of interviewees included 94 individuals. Considering the interview questions were fairly broad in nature and were not specific to any particular OU, the responses have been summarized separately in the community involvement and interviews memorandum (Volume 1, Appendix A).

6.3 Document Review

In preparing this five-year review, the following documents were reviewed:

- Atlantic Richfield Company, WSP, Five-Year Review Report, March 31, 2010.
- Atlantic Richfield Company, WSP, Five-Year Independent Site Inspection Report, May 2007.
- Clark Fork River Biomonitoring Macroinvertebrate Community Assessments, 2006.
- Clark Fork River Biomonitoring Macroinvertebrate Community Assessments, 2008.
- EPA Comprehensive Five-Year Review Guidance, 2001.
- EPA ROD for WSP Active Area OU, 1990.
- ESD for WSP Active Area OU, 1991.
- EPA ROD for WSP Inactive Area OU, 1992.

ARARs were reviewed to determine if changes since the signing of RODs or ESDs could impact the protectiveness of the remedy of the site. The results of the review are discussed in Section 7.0, under Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and RAOs Used at the Time of the Remedy Selection Still Valid?

6.4 Data Review

This section was developed using data provided by Pioneer Technical Services, Inc., a contractor to Atlantic Richfield. The following sections provide a summary and evaluation of the WSP Active and Inactive OU data collected during this report period. A summary of the data was also compiled in the *Silver Bow Creek/Butte Area NPL Site Warm Springs Ponds Operable Units, Upper Clark Fork River Basin, Montana, Five-Year Review Report* by Atlantic Richfield. The report was completed in March 2010.

6.4.1 Active Area Performance Evaluation

Performance standards for the WSP Active Area are described in the ROD and the Active Area UAO. Most of the regulatory standards at the WSP are applied to effluent composite samples taken at SS-5 which is located as shown in Figure 4-1. The standards contain daily maximum and monthly average limitations for the total recoverable concentrations of nine trace elements (arsenic, cadmium, copper, iron, lead, mercury, selenium, silver, and zinc), total suspended solids (TSS), and pH. Table 6-1 provides a summary of the final discharge standards for Pond 2 discharge.

Table 6-1
Final Standards for Pond 2 Discharge (Station SS-5)

Final Discharge Standards		
Constituent	**Daily Maximum (mg/L)**	**Monthly Average (mg/L)**
Total Recoverable Arsenic	0.02	0.02
Total Recoverable Cadmium	**0.0062**	**0.0016**
Total Recoverable Copper	**0.026**	**0.017**
Total Recoverable Iron	1.5	1.0
Total Recoverable Lead	**0.137**	**0.0053**
Total Mercury	0.0002	0.0002
Total Recoverable Selenium	0.26	0.035
Total Recoverable Silver	**0.0082**	0.00012
Total Recoverable Zinc	**0.16**	**0.15**
TSS	45.0	30.0
pH	6.5 to 9.5 s.u.	----

Note: The bold values are hardness-dependant standards. The concentration shown represents the standard calculated at a hardness of 150 mg/L as $CaCO_3$.

As required in the UAO, several of the constituents (cadmium, copper, lead, silver, and zinc) have standards that are hardness-based. This means that the maximum allowable concentration varies with each sample depending on the amount of hardness measured in the sample. Therefore, the standards for these metals, as shown on the figures, have been adjusted for each measurement based on the hardness in that sample (or set of samples, for the monthly average standards).

Additional standards have been established for SS-3B for special instances when circumstances dictate discharge directly from Pond 3, via SS-3B. The SS-3B discharge was not used during this report period.

Prior to 1998, both total recoverable and dissolved samples were analyzed to better understand removal mechanisms in the system. After the first quarter of 1998, dissolved metals analyses were discontinued because the Active Area performance standards (outlined in the UAO) for surface water discharge are based on total recoverable concentrations.

During the report period, influent quality at the WSP has been impacted by upstream remedial construction on the Streamside Tailings (SST) OU. The SSTOU work, conducted by the State of Montana, has been ongoing. According to the SSTOU Consent Decree, the WSP are not responsible for the unintentional and temporary exceedances associated with upset influent conditions caused by SSTOU construction.

Remedial construction at the Subarea 3 (Durant Canyon) and Subarea 4 (Upper Deer Lodge Valley) has not yet been completed. The anticipated completion of remedial construction is scheduled for 2011 and 2012, respectively.

The numbers of exceedances observed during the report period using final daily maximum standards are presented in Table 6-2. The numbers of exceedances observed during the report period using final monthly average standards are presented in Table 6-3.

Table 6-2
Daily Maximum Standard Exceedance Summary

Final Discharge Standards – Report Period			
Constituent	**Number of Measurements**	**Number of Exceedances**	**Percentage of Exceedances**
Total Recoverable Arsenic	517	296	57
Total Recoverable Cadmium	517	0	0
Total Recoverable Copper	521	0	0
Total Recoverable Iron	521	0	0
Total Recoverable Lead	517	0	0
Total Mercury	521	0	0
Total Recoverable Selenium	114	0	0
Total Recoverable Silver	114	0	0
Total Recoverable Zinc	521	0	0
TSS	521	0	0
pH	521	117	22

Table 6-3
Monthly Average Standard Exceedance Summary

Final Discharge Standards – Report Period			
Constituent	**Number of Measurements**	**Number of Exceedances**	**Percentage of Exceedances**
Total Recoverable Arsenic	60	34	57
Total Recoverable Cadmium	60	0	0
Total Recoverable Copper	60	0	0
Total Recoverable Iron	60	0	0
Total Recoverable Lead	60	0	0
Total Mercury	60	0	0
Total Recoverable Selenium	57	0	0
Total Recoverable Silver	57	See Note 1	
Total Recoverable Zinc	60	0	0
TSS	60	0	0

Note 1: The detection limit for silver is greater than the monthly average standard of 0.00012 mg/L.

Arsenic. Comparison of influent (SS-1) and effluent (SS-5) daily maximum and monthly average total recoverable arsenic concentrations are presented for the report period illustrated on Figure 6-1 and 6-2, respectively. From these figures, the effect of seasonal fluctuations on the compliance of arsenic with final daily standards can be observed.

Monthly averages verify that the spring and early summer months are generally accompanied by increases in total recoverable arsenic concentrations at SS-1, while concentrations of arsenic at SS-5 are generally highest during the summer and early fall. As shown in Table 6-2, the frequency of exceedances of the daily maximum arsenic standard is approximately 57 percent. This is an increase over the frequency of approximately 44 percent from the previous five-year report. However, the magnitude of the exceedances (i.e., the maximum and average effluent concentration) was still in the same scale as previous years. The frequency of exceedances of the average monthly arsenic standard was also approximately 57 percent.

To provide an additional perspective, annual influent and effluent arsenic loads were examined to quantify the amount of arsenic removed each year. The annual loads were calculated using the available daily concentration and flow data (as shown in Figure 6-3 and 6-4) to calculate a loading rate. This loading rate was then applied to the number of days between sampling events (typically 3 to 4 days) to obtain a mass load for the 3- or 4-day time period. These loads were then totaled for each calendar year. In addition, results from the previous five-year review mass loading calculations were kept for a historical comparison purposes. Figure 6-5 provides a summary of the approximate net arsenic loads in the WSP.

Based on the summary of net arsenic loads presented in Table 6-4, the mass load of arsenic entering (SS-1) the WSP has not varied too significantly from typical values since 1998. The fluctuations in influent load are mostly attributed to the varying flow rates each year, as shown in Figure 6-5. However, the mass load of arsenic leaving (SS-5) the WSP appears to have an increasing trend. As a result, the net load removed has been reduced significantly, most notably in 2008 and 2009 where the net loads are negative, indicating a net release of arsenic from the WSP system. This is different from previous years where, despite the exceedances of arsenic concentrations at SS-5, the WSP system served as an overall sink for arsenic. The trend indicates that the WSP are possibly becoming a net source of arsenic. Consistent with previous years, the net release of arsenic is most prevalent during the summer and early fall months when water temperature and aquatic vegetation are both reaching their peak. The net release of arsenic in recent years also coincides with reduced influent concentrations of copper (see below). Atlantic Richfield continues to study these issues related to arsenic, as described in later sections.

Table 6-4
Summary of Approximate Net Arsenic Loads in the Warm Springs Ponds

Annual Averages					Two-year Averages		
Year	**SS-1 (kg)**	**SS-5 (kg)**	**Net Load Removed (kg)**	**Percent Removed**	**Two-year Period**	**Net Load Removed (kg)**	**Percent Removed**
1998	1,485	920	565	38.0	**--**	--	--
1999	1,286	625	661	51.4	**1998-1999**	1,226	44.2
2000	572	321	251	44.0	**1999-2000**	913	49.1
2001	541	298	244	45.0	**2000-2001**	495	44.5
2002	589	287	302	51.3	**2001-2002**	546	48.3
2003	2,148	1,010	1,138	53.0	**2002-2003**	1,441	52.6
2004	612	601	11	1.8	**2003-2004**	1,149	41.6
2005	673	590	83	12.3	**2004-2005**	94	7.3
2006	847	839	8	0.9	**2005-2006**	91	6.0
2007	635	601	33	5.2	**2006-2007**	41	2.8
2008	1,051	1,199	-149	-14.1	**2007-2008**	-115	-6.8
2009	1,079	1,285	-206	-19.1	**2008-2009**	-355	-16.7

Notes:

The arsenic loads were calculated using daily concentration and flow data to obtain a daily loading rate (kilogram [kg]/day).
The flow data for SS-1 was obtained from U.S. Geological Survey (USGS) Station 12323600.
The number of days between daily samples was calculated (usually 3 or 4 days) and multiplied by the daily loading rate.
This gave an approximate load for the period between samples. These loads were then totaled for each year.
The total number of days in the calculation was checked to make sure it was 365 days (or 366 for leap year).
If concentration data were absent, the concentration from the previous sample date was used.
If flow data were absent, the average of the two measurements immediately before and after the missing date was used.

Although the discharge from the WSP exceeds the performance standard at times, human health is protected as the arsenic standard is set to protect human health through drinking water and no humans are consuming the WSP effluent or utilizing the upper Clark Fork River as a potable water source. To minimize exposure and ensure protection of human health, swimming in the WSP is forbidden; signs posted at the site inform the public of this ban. There are no existing water rights on the upper Clark Fork River for use as potable water, and, since it is a closed basin under Montana Department of Natural Resources and Conservation rules, no new surface water rights can be granted. Human health is further protected by the WSP Controlled Groundwater Area (CGWA), which prevents the use of the aquifer as a drinking water source.

To better understand the arsenic cycling at the site and mechanisms controlling arsenic, Atlantic Richfield began a study on this subject in 2007. The ongoing study has indicated that there are several complex processes controlling water quality in the ponds, including photosynthesis, groundwater recharge, respiration (decomposition) of detrital organics, adsorption/desorption, and an organo-phosphate-arsenate association. Based on the findings of the study, Atlantic Richfield is implementing a pilot test to increase water mixing and cooling within Pond 2, Pond 3, and the West Wet Closure (WWC). An over-abundance of organic compounds is present in the WSP, and this is a common factor in all of the identified arsenic release mechanisms. The objective of the pilot test is to enhance aerobic oxidation of these compounds and to cool the water, resulting in less anaerobic decomposition. The results should provide foundational data for the evaluation of future management scenarios.

In addition, several third-party studies (see Section 6.4.12) were conducted to evaluate the diel effects on arsenic concentrations from three locations. These include the mouth of the Mill-Willow Bypass above its confluence with Silver Bow Creek, the outlet from Pond 2 to lower Silver Bow Creek (i.e., SS-5), and lower Silver Bow Creek below the Mill-Willow Bypass and WSP. The researchers concluded as waters from Mill-Willow Bypass and Silver Bow Creek warmed during the day, arsenic was released by desorption from streambed sediments to the water column. As the temperature cooled at night, the arsenic was removed from the water column by adsorption to sediments. In contrast to results from Mill-Willow Bypass and Silver Bow Creek, diel cycles were either very weak or not observed in water discharging from the WSP.

Cadmium. Comparison of influent (SS-1) and effluent (SS-5) daily maximum and monthly average total recoverable cadmium concentrations are presented for the report period illustrated on Figure 6-6 and 6-7, respectively. Concentrations are in compliance with the final standards; there were no exceedances of the daily maximum or monthly average cadmium standards during the reporting period.

Copper. Comparison of influent (SS-1) and effluent (SS-5) daily maximum and monthly average total recoverable copper concentrations are presented for the report period illustrated on Figure 6-8 and 6-9, respectively. Average compliance with copper discharge standards has improved since the 2005 five-year review report. To provide an additional perspective, Figure 6-10 shows influent (SS-1) and effluent (SS-5) mass loading of copper and net load removal efficiency. On average, the annual removal efficiency has ranged between 91.8 to 95.9 percent. Concentrations are in compliance with the final standards; there were no exceedances of the daily maximum or monthly average copper standards during the reporting period.

Iron. Comparison of influent (SS-1) and effluent (SS-5) daily maximum and monthly average total recoverable iron concentrations are presented for the report period illustrated on Figure 6-11 and 6-12, respectively. Concentrations are in compliance with the final standards; there were no exceedances of the daily maximum or monthly average iron standards during the reporting period.

Lead. Comparison of influent (SS-1) and effluent (SS-5) daily maximum and monthly average total recoverable lead concentrations are presented for the report period illustrated on Figure 6-13 and 6-14, respectively. Concentrations are in compliance with the final standards; there were no exceedances of the daily maximum or monthly average lead standards during the reporting period.

Mercury. Comparison of influent (SS-1) and effluent (SS-5) daily maximum and monthly average total mercury concentrations are presented for the report period illustrated on Figure 6-15 and 6-16, respectively. Concentrations are in compliance with the final standards; there were no exceedances of the daily maximum or monthly average mercury standards during the reporting period.

Selenium. Comparison of influent (SS-1) and effluent (SS-5) daily maximum and monthly average total recoverable selenium concentrations are presented for the report period illustrated on Figure 6-17 and 6-18, respectively. Concentrations are in compliance with the final standards; there were no exceedances of the daily maximum or monthly average selenium standards during the reporting period. Selenium is rarely detected in either influent or effluent from the WSP.

Silver. Comparison of influent (SS-1) and effluent (SS-5) daily maximum total recoverable silver concentrations are presented for the report period illustrated on Figure 6-19. Daily maximum concentrations are in compliance with the final standards. The detection limit for silver is greater than the monthly average standard of 0.00012 mg/L. Silver is rarely detected in either influent or effluent from the WSP.

Zinc. Comparison of influent (SS-1) and effluent (SS-5) daily maximum and monthly average total recoverable zinc concentrations are presented for the report period illustrated on Figure 6-20 and 6-21, respectively. Concentrations are in compliance with the final standards; there were no exceedances of the daily maximum zinc standards during the reporting period.

Total Suspended Solids (TSS). Comparison of influent (SS-1) and effluent (SS-5) daily maximum and monthly average TSS concentrations are presented for the report period illustrated on Figure 6-22 and 6-23, respectively. Concentrations of TSS observed in SS-5 samples have always been less than the final daily standard. The figure illustrates that even though TSS concentrations at SS-5 (effluent) vary, high concentrations observed at SS-1 (influent) are decreased significantly through the system. A majority of the samples at SS-5 are at or below the detection limit for TSS.

pH. Measurements of influent (SS-1) and effluent (SS-5) pH are presented for the report period illustrated on Figure 6-24. The final daily standard for pH requires SS-5 values to be between 6.5 and 9.5 s.u. The pH standard was exceeded approximately 22 percent of the time (Table 6-2), which is greater than the previous five-year period where pH was exceeded 12 percent of the time. The exceedances occur consistently in the summer months, and are due to increased biological activity in the system. During this time of year, lime is not being added to the system because natural biological activity raises the pH to the target level (and sometimes above). The high pH is not due to “overliming”. This is a naturally occurring phenomenon and is not attributable to the operation of the WSP.

6.4.2 Pond 2 Wet Closures

A fraction of the discharge from Pond 3 is diverted from the Pond 3 discharge channel into the Pond 2 wet closures. Water flows through the wet closures (East Wet Closure [EWC]and WWC) and subsequently discharges into Pond 2.

The base flow from the east and west outlets of Pond 3 is routed into the Pond 2 wet closures to maintain inundation of the tailings deposits. A weir structure in the Pond 2 inlet channel allows adjustment of the quantity of flow entering each wet closure with excess flow bypassing the cells directly into Pond 2. The pool level for each wet closure is held at a constant level to ensure that the tailings within the cells remain covered.

The wet closures also provide wetland and wildlife habitat. Construction of islands and nest boxes within certain ponds has increased suitable habitat for waterfowl nesting.

Throughout the report period, the wet closures remained inundated, thereby achieving the RAOs and this performance standard for wet closure cells. The west closure outlets were sampled quarterly during the report period. The performance of each cell was evaluated based on the water quality in the Pond 3 discharge water quality (SS-3E) and the west closure outlet water quality. Note that SS-3E represents only a fraction of the discharge from Pond 3 to the wet closures because the other portion comes from SS-3W, which is not sampled.

Data showing the concentrations from SS-3E, the EWC and WWC are shown in Figures 6-25 through 6-29. Results from this reporting period were generally consistent with results from the previous reporting period. Copper and zinc concentrations were generally consistent, with a noticeable decrease in concentrations at EWC and WWC compared with SS-3E. Iron concentrations were more inconsistent, with some increases in iron concentrations measured at the wet closures. Sulfate concentrations were inconsistent with a general increase in sulfate concentration through the wet closures. Seasonal increases in arsenic concentrations were measured in the west closure ponds. During the summer and fall, effluent arsenic concentration from the wet closures were generally greater than influent concentrations, with higher concentrations consistently measured from the WWC.

In general, it appears that the wet closures are functioning as intended, and are providing some additional contaminant removal and polishing, with the exception of arsenic and sulfate. The arsenic data show that the wet closure ponds are subject to the same arsenic mobilization geochemistry as the main ponds.

6.4.3 Mill-Willow Bypass and Lower Silver Bow Creek

6.4.3.1 Channel Stability

The Mill-Willow Bypass is the primary floodway adjacent to the WSP. In addition to flows from Mill Creek and Willow Creek, it was designed and constructed to divert excessive flows in Silver Bow Creek around the WSP System.

Since the original revegetation effort and supplemental planting of 5,880 containerized (10 cubic inch) sandbar willows (*Salix exigua*) and 12 mature willow transplants to assist the development of the riparian community and stabilize approximately 200 feet of streambank in the upper reach of the Mill-Willow Bypass, vegetative development in the Mill-Willow Bypass has been excellent, as observed during the site inspection (see photos in Appendix A). There are no indications of actively eroding banks or floodplain erosion. As a result, Atlantic Richfield is currently evaluating if willow density or height needs to be reduced to safely pass the 0.5 PMF as required by the ROD (EPA 1990b).

6.4.3.2 Soil-Cement Toe Drains

Dike side slopes adjacent to the Mill-Willow Bypass were faced with soil-cement to protect them from erosion. Perforated pipe drains were installed behind the soil-cement to relieve seepage pressures that could build behind the relatively impervious soil-cement. Outfall pipes convey the seepage flow through the soil-cement to the Mill-Willow Bypass side of the dikes. These outfalls, or toe drains, are illustrated on Figure 6-30. Toe drains along the Pond 2 dike (165 through 193) discharge into a collection pipeline called the Soil-Cement Toe Drain Manifold. The Toe Drain Manifold collects the seepage and conveys the water to the Groundwater Interception Trench.

Minor seepage from around the manifolded toe drain laterals has been observed during routine inspections. This seepage has always been clear and there is no evidence of piping or related dam instability. The seeps are checked periodically to ensure that there is no increase in flow rate or evidence of piping. There have been no observations of a direct discharge to surface water; the seepage rates are so low that water typically collects in low spots at or near the toe of the Pond 2 dike where it presumably infiltrates or evaporates.

Some toe drains, per the original design, are not manifolded. Several of the unmanifolded toe drains are selected for water quality sampling on an annual basis. During the report period, samples were collected in October of each year. The toe drains selected as being representative of the overall outfall water quality are numbers 67, 84, 87, 90, 91, 99, 104, 152, 157, 160, and 161. Toe Drain number 67 was not sampled in 2008 or 2009 because it no longer produces any flow. Attempts have been made to "snake" this toe drain but that did not produce any results. Average flows and concentrations of selected constituents are presented in Table 6-5. Values of pH have consistently been near neutral with sampling averages ranging from 7.3 to 7.9 s.u. Of the trace elements analyzed, concentrations of cadmium and copper are all low or nondetectable. Arsenic concentrations in toe drain samples have averaged 0.065 mg/L (Table 6-5). The discharge from these toe drains is also monitored for clarity to assure there is no indication of piping from the embankment. To aid in this monitoring, the outlet areas from these toe drains were graded during this report period to allow water to freely drain from the outlet area, aiding in the observation of water clarity.

Table 6-5
Soil Cement Toe Drain Water Quality Summary by Year

Constituent	Units	Sample Data					Overall Average
		2005	2006	2007	2008	2009	
Flow	gallons per minute	53.64	71.3	58.19	42.06	33.02	51.64
pH	s.u.	7.9	7.6	7.3	7.8	7.7	7.7
Arsenic	mg/L	0.067	0.064	0.06	0.067	0.066	0.065
Cadmium	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Copper	mg/L	0.003	0.002	0.002	0.002	0.001	0.002
Iron	mg/L	0.176	0.589	0.205	0.151	0.138	0.252
Manganese	mg/L	0.669	0.595	0.603	0.615	0.585	0.613
Zinc	mg/L	0.007	0.002	0.015	0.014	0.014	0.010
Hardness	mg/L (as $CaCO_3$)	281	273	240	229	205	246

Notes:

1. Values are arithmetic averages of toe drains 67, 84, 87, 90, 91, 99, 104, 152, 157, 160, and 161. Toe Drain 67 was not sampled in 2008 or 2009 because that toe drain stopped flowing in 2008.
2. The average flow is the sum of the flow rates for each toe drain.
3. Metals averages are reported as dissolved.
4. Samples were collected in October of each year.
5. Averages were calculated using the detection limit for non-detect data.
6. Toe drains 152, 157, 160, and 161 were submerged in 2009 and flow rates were not collected at these locations.

The soil-cement toe drains are successfully draining water from the soil-cement dikes, maintaining the piezometric surface at levels that are safe and ensure dam stability, as designed. The manifolds are collecting and routing water to the Groundwater Interception Trench where intended. Overall, the toe drains are functioning as designed.

6.4.3.3 Water Quality Trends

Monthly water quality samples are collected in the Mill-Willow Bypass at three stations, MWB-1 (farthest upstream station), MWB-2 (just above the SS-5 discharge point), and MWB-3 (immediately below the SS-5 discharge) as shown in Figure 4-1. Flow data are not collected at these stations (although United States Geological Survey [USGS] station 12323750 Silver Bow Creek at Warm Springs is located in the vicinity of MWB-3); therefore, it was not possible to do a loading analysis on the Mill-Willow Bypass. Water quality samples collected at MWB-1 should be representative of local conditions in the Mill and Willow Creek watersheds while water quality samples from MWB-2 and MWB-3 would reflect the influences of the Mill-Willow Bypass channel and WSP effluent, respectively.

The water quality data were examined to determine the possible effects that the WSP system may be having on the Mill-Willow Bypass, either through direct discharge or through groundwater inflow. Specifically, arsenic, copper, and zinc data were examined. Similar to Silver Bow Creek and the WSP system, trace elements that are not regularly observed in any appreciable concentration in the Mill-Willow Bypass include cadmium, lead, mercury, selenium, and silver; therefore, are not presented.

Arsenic concentrations within the Mill-Willow Bypass are graphed in Figure 6-31. Arsenic shows a similar seasonal oscillation observed in the WSP monitoring data. However, arsenic concentrations in the Mill-Willow Bypass peak during late spring and early summer, while arsenic concentrations in the WSP system peak in late summer and fall. The peak concentrations occur at MWB-1 and persist downstream, indicating mobilization of an arsenic source upstream of the OU (the Anaconda Smelter site). These peak concentrations are similar to those observed during the previous five-year review. Total recoverable arsenic concentrations at MWB-1 and MWB-2 are similar to those measured at MWB-3 indicating either no significant seepage from the WSP, or that arsenic concentrations in water seeping from the WSP are similar in concentration to that of the Mill-Willow Bypass.

Copper and zinc concentration data are shown in Figure 6-32 and 6-33, respectively. Copper and zinc show similar trends in total recoverable concentrations through the Mill-Willow Bypass. Inspection of these figures shows that elevated concentrations of copper and zinc at MWB-3 (as compared to MWB-1 and MWB-2) occurred on very few occasions during the report period. The Pond 2 effluent generally has a minimal effect on the total recoverable concentrations of copper and zinc in the Mill-Willow Bypass.

6.4.4 Inactive Area Performance Evaluation

The Inactive Area is not directly involved in the treatment of Silver Bow Creek entering the WSP. Although some additional treatment of surface water occurs in the wet-closures of the Inactive Area, it is a relatively small volume and the additional treatment benefits only the wet closure cells. The principal functions of constructed features within the Inactive Area are to prevent migration of contaminated groundwater. The constructed features include raised, reinforced, and armored berms; toe ditches; manifolded toe drains; the groundwater interception trench and pump-back system; and wet and dry closure cells. Figure 6-34 illustrates the inactive sampling locations along Pond 1 (i.e., upgradient monitoring wells, downgradient monitoring wells, and the surface water monitoring locations).

The 1993 UAO specifies that the performance standards for groundwater are defined as the maximum contaminant level (MCL) and non-zero MCL goals for contaminants of concern (COCs), as promulgated by the Federal Safe Drinking Water Act and the

Montana Public Water Supplies Act. The performance standards for the contaminants of concern in groundwater at the WSP are as follows:

- Arsenic 0.050 mg/L
- Cadmium 0.010 mg/L
- Chromium 0.050 mg/L
- Lead 0.050 mg/L
- Mercury 0.002 mg/L
- Nitrate 10.0 mg/L

Both the time and point of compliance for these performance standards are influenced by the temporary groundwater interception and pump-back system. During the time that the pump-back system is operational, intercepted water is pumped from the interception trench to the east side of Pond 2 via a 32-inch pipe that is 7,600 feet long. When the pump-back system is operational, the point of compliance for groundwater is the north, or downgradient, side of the interception trench. Piezometers P-02, P-04, P-06, and P-08 are the measurement points of compliance when the pump-back system is operational as shown in Figure 6-34.

When it is demonstrated that all groundwater performance standards have been consistently met at all monitoring wells, both upgradient and downgradient of the interception trench, for a period of at least 24 consecutive months, EPA may determine that the pump-back system is no longer needed. If such an action is carried out and it is determined following analysis of the data that migration of groundwater is adversely affecting the lower Mill-Willow Bypass or the Clark Fork River, then EPA will require that operation of the pump-back system be resumed.

If the pump-back system is deemed by EPA to be no longer needed, the points of compliance for groundwater will shift to the south, or upgradient, side of the interception trench. Piezometers P-01, P-03, P-05, P-07, and P-09 are the measurement points of compliance when the pump-back system is not operational as shown in Figure 6-34.

6.4.5 Interception Trench

The interception trench receives groundwater flow from the upper sand and gravel aquifer beneath Pond 1 and surface water flow from Pond 1 and the lower wet closures, the manifolded toe drains, and the Pond 1 and the Pond 2 toe ditches. The eastern-most part of the interception trench is excavated deeper to form a sump for the pump-back system inlet. The interception trench and the Pond 1 and Pond 2 toe ditches were designed to prevent offsite migration of groundwater that may have constituent concentrations exceeding performance standards.

Groundwater Quality

The Inactive Area UAO specifically identifies the groundwater standards that must be met by groundwater that flows off site toward the Mill-Willow Bypass, and eventually enters the Clark Fork River. While the groundwater interception trench and pump-back system are operating, the standards must be met immediately north (downgradient) of the interception trench. For a 24-month period before shutting down the interception trench and pump-back system, and thereafter, these standards must be met immediately south (upgradient) of the interception trench. A series of piezometers were installed upgradient and downgradient of the interception trench to evaluate compliance with these standards. These piezometers are shown on Figure 6-34.

The UAO also requires that a groundwater gradient toward the groundwater interception trench be maintained to assure all affected groundwater that potentially exceeded performance standards is collected and routed via the pump-back system to Pond 2 for treatment. Groundwater level monitoring conducted from 2005 through 2009 has consistently shown a gradient toward the groundwater interception trench for all piezometers, with the exception of P-14, on the southwest corner of the Pond 1 dry closure.

Semi-annual monitoring was conducted in each of the piezometers in accordance with the O&M Plan (ARCO 1995). To ensure that groundwater exceeding performance standards was not escaping the WSP system, groundwater quality in P-14 was also measured semi-annually over the evaluation period and is reported herein.

The pump-back system was operated nearly continuously throughout the evaluation period. Therefore, piezometers on the downgradient (north) side of the interception trench (P-02, P-04, P-06, and P-08) and piezometer P-14 (since there is not a documented gradient from this piezometer to the interception trench), represent the points of compliance for the entire evaluation period. All individual measurements from all downgradient piezometers, and for piezometer P-14, during this period were below the groundwater performance standards. Individual sample results from the downgradient piezometers and for piezometer P-14 over the evaluation period are shown on Figures 6-35 through 6-40 and 6-41 through 6-46, respectively.

All measurements for all constituents in the upgradient piezometers (P-01, P-03, P-05, P-07, and P-09), located south of interception trench, complied with the performance standards during the period with the exception of arsenic in P-03 and nitrate in P-07. The arsenic concentration in piezometer P-03 exceeded the performance standard for arsenic (0.050 mg/L) in 2005 and 2006, with concentrations ranging from 0.052 to 0.0724 mg/L. Nitrate exceeded the performance standard for nitrate (10 mg/L) during the June sampling event at 16.4 mg/L. Individual sample results from the upgradient piezometers over the evaluation period are shown on Figures 6-47 through 6-52. The performance standards have been met for the past 36 consecutive months (last six monitoring events); regardless, Atlantic Richfield will continue to operate the pump-back system.

6.4.6 Manifold Toe Drains and Toe Ditches

For the approximate length of the north-south Pond 2 dike, flows from the toe drains between Stations 165 and 193 are collected in the Toe Drain Manifold as shown in Figure 6-30. The Pond 2 Toe Ditch is located at the toe of the western portion of the dam separating Pond 2 and Pond 1. The purpose of this ditch is to intercept seepage originating in Pond 2, thereby controlling the groundwater table throughout the western dry-closure area of Pond 1 dry closure. The toe drain manifold collects the drainage from toe drains along Pond 2 and from the Pond 2 Toe Ditch and the combined system discharges to the upper end of the groundwater interception trench.

Water quality samples are taken quarterly at the manifold outlet to the interception trench (IA-3) in accordance with the O&M plan (ARCO 1995). In general, total recoverable concentrations of cadmium, copper, lead, mercury, and zinc are all low or undetectable, as they were during the 1992-2005 period (ARCO 1997, Atlantic Richfield Company 2005). Arsenic concentrations in the manifold samples have averaged 0.035 mg/L, which is comparable to the concentration measured from 1992 through 2005 (ARCO 1997, Atlantic Richfield 2005) and are below or comparable to seasonal concentrations observed in the Mill-Willow Bypass (see Figure 6-31).

Concentrations of iron are notably higher in the toe drain manifold samples than are observed from the individual, unmanifolded toe drain samples. (It should be noted that total recoverable iron was measured in the manifolded toe drain samples while dissolved iron was measured in the individual, unmanifolded samples.) Dissolved iron concentrations in unmanifolded toe drains average 0.248 mg/L while total recoverable concentrations measured at the manifold discharge average 2.43 mg/L. These concentrations are slightly different but show the same trend as that reported in the 1997 and 2005 report (ARCO 1997, Atlantic Richfield 2005). From this comparison and visual observation of the Pond 2 Toe Ditch (orange precipitation layer in the bottom of the ditch), it is evident that the toe ditch is collecting iron rich seepage and groundwater flows.

6.4.7 Pond 1 Wet Closures

At the time of remediation, Pond 1, the original settling pond in the WSP System, was no longer functional as a settling pond. The relatively small volume of water contained within and flowing through the Inactive Area was due to seepage from the upgradient ponds, precipitation, and local runoff. Flows are now managed by means of the pump-back system which intercepts and returns all Pond 1 outflows to Pond 2 for treatment before discharge to the Mill-Willow Bypass.

System Description

The Pond 1 Wet Closure inundates approximately 141 acres. A small diversion of flow from Pond 2 into Pond 1 maintains the wet closure. The wet closures below Pond 1 consist of three cells that inundate previously exposed tailings.

A structure between the Pond 2 outlet and the Pond 1 inlet transfers flows, typically less than 4 mgd, from Pond 2 into the wet closure area of Pond 1. In addition, inlet and outlet facilities provide flow from the Pond 1 Wet Closure to the lower wet closures. These lower wet closures are referred to as the north, middle, and south cells as shown in Figure 6-34. The lower wet closures were initially filled by flows from Pond 1 from October through November 1995. Flow from the Pond 1 Wet Closure moves consecutively through the south cell, middle cell, and then to the north cell, before discharging to the interception trench and is returned to Pond 2 via the pump-back system.

Pond 1 and the lower wet closures also provide a significant enhancement to wetland/wildlife habitat with minimal risk to the wildlife. Willow stands within and around certain ponds also provide refuge for deer, waterfowl, and songbirds. Nest boxes and islands within certain ponds also continue to provide habitat suitable for waterfowl nesting.

Cell Performance

The Pond 1 Wet Closure has remained inundated during the report period, achieving the RAOs for the wet closure areas. Water quality samples are collected quarterly at the north cell outlet (IA-2). Concentrations of hardness, sulfate, and total recoverable iron in samples from IA-2 suggest a groundwater influence on the wet closure flows, although it is possible that these higher concentrations are due at least in part to evapoconcentration. Higher concentrations of these constituents are generally observed to be associated with groundwater as opposed to surface waters. As identified in Table 6-6, average yearly concentrations of hardness and sulfate are greater than average concentrations observed at either SS-3E or SS-5 during the same period. Total recoverable iron concentrations are less than concentrations observed at either SS-3E or SS-5 during the same period.

As reported previously, several trace metals appeared to have undergone an initial period of elevated concentration immediately following filling of the wet closures. These elevated total recoverable and dissolved concentrations were very short lived. Most recently, from 2005 through 2009, trace metals measured at IA-2 have stabilized and are relatively low when compared to Active Area concentrations. Figures 6-53 and 6-54 show relative concentrations of copper and zinc, respectively, compared to average quarterly concentrations at the Pond 3 (SS-3E) and Pond 2 (SS-5) discharges.

Table 6-6
Average Yearly Concentration of Hardness, Sulfate, and Total Recoverable Iron from IA-2

Yearly Average Analyte	2005	2006	2007	2008	2009
Hardness	348	336	303	293	267
Sulfate	340	230	204	212	201
Total Recoverable Iron	0.084	0.095	0.300	0.115	0.148

Average Yearly Concentration of Hardness, Sulfate, and Total Recoverable Iron from SS-3E

Yearly Average Analyte	2005	2006	2007	2008	2009
Hardness	207	210	235	221	186
Sulfate	128	108	131	118	91
Total Recoverable Iron	0.164	0.207	0.282	0.482	0.309

Average Yearly Concentration of Hardness, Sulfate, and Total Recoverable Iron from SS-5

Yearly Average Analyte	2005	2006	2007	2008	2009
Hardness	225	210	237	229	192
Sulfate	155	122	143	136	106
Total Recoverable Iron	0.205	0.164	0.185	0.221	0.195

All concentrations in mg/L

Arsenic concentrations through Pond 1 and the lower wet closures do not display the same trends as the trace metals as shown in Figure 6-55. Instead, total recoverable concentrations of arsenic appear to be following the same pattern of seasonal fluctuation that is observed in Pond 3 and Pond 2 of the Active Area. It should be noted that arsenic concentrations in IA-2 are significantly higher than concentrations measured in the Active Area (i.e., SS-3E and SS-5). The peak arsenic concentration in September 2009 of 0.133 mg/L is approaching the chronic aquatic life standard for arsenic of 0.150 mg/L.

Figures 6-53 through 6-55 illustrate relative concentrations of copper, zinc, and arsenic measured at the north cell discharge. The total recoverable concentrations of other trace elements currently measured at IA-2 are generally near or less than corresponding total recoverable concentrations measured at SS-5.

6.4.8 Pumpback System

The pump-back system for the Inactive Area is designed to: 1) maintain the necessary water level elevation in the interception trench to achieve hydraulic capture of groundwater; and 2) to return flows collected from the interception trench, Pond 1 toe ditch, Pond 2 toe ditch, the soil-cement toe drain manifold, and the Inactive Area wet closures (Pond 1, south, middle, and north cells) to Pond 2 for treatment before release to the Mill-Willow Bypass. The pump-back system consists of two major elements, the pump station facilities and the pump-back pipeline as shown in Figure 6-34.

The pump-back pipeline discharges to Pond 2 (IA-1) have been sampled quarterly for water quality in accordance with the O&M plan. The water quality measured at IA-1 typically reflects the combination of flows that enter the groundwater interception trench. The quality of these flows has been previously discussed in this section, and in summary, these constituents are generally at levels similar to Pond 2 concentrations. In addition, concentrations of hardness, sulfate, and iron are typically higher than those observed in Active Area surface waters, illustrating continued groundwater influence on the Inactive Area flows.

Pumpback flows have been monitored consistently since May 1, 2008, after the installation of a new flowmeter. The average flow in the pump-back system from May 1, 2008, to November 19, 2009, was 6.6 cfs. The instantaneous maximum (based on 15-minute interval data) pump-back flow in that same period was 15.5 cfs. Typically, pump-back flows are significantly lower than flows through the Active Area system (average influent and effluent flow during the report period was 49.9 and 40.0 cfs, respectively). However, during low flow times of the year, the pump-back flows can account for a significant fraction of the discharge from Pond 2 (flows from SS-5 have averaged 16.1 cfs during August each year since 2005, with a low monthly average of 10.1 cfs during August 2007). Note that if the water was not returned to Pond 2 via the pump-back system, the water would discharge as groundwater to Mill-Willow Bypass or Lower Silver Bow Creek, and, therefore, instream flows should not be affected if the pump-back system is shut down. It does not appear that the pump-back flows have a detrimental effect on the water quality in Pond 2 (as observed at the Pond 2 discharge, SS-5). Total recoverable trace metal concentrations do not have an obvious effect on SS-5 concentrations when compared to SS-3E concentrations. This is illustrated on Figures 6-56 and 6-57 with total recoverable copper and zinc concentrations.

6.4.9 Dry Closures

All of the dry closure cells occur on sites that are essentially flat with little or no topographic diversity. Cell 1 is a small area (7 acres) located in the southern part of the WSP, Cell 2 is somewhat larger (19 acres) and located approximately 0.5 miles north of Cell 1, and Cell 3 is located at the north end of the WSP area and covers approximately 140 acres as shown in Figure 6-30.

In general, the vegetation on the dry closure areas is well established. Dominance by the major perennial grass species has continued. The dry closure areas are monitored as part of the annual voluntary dam safety inspections, in accordance with Earthwork Inspection and Maintenance Procedure IMP-3 (ARCO 1995). During the annual inspections for this reporting period, no reportable items (i.e., items in need of repair or items observed to be potential areas of concern) were documented. Periodic weed controls continue on the dry closures as needed to maintain vegetation success.

Overall, dry closure covers are intact and vegetation success assures stability of the covers. The dry closures are meeting the RAOs through reducing the potential for human exposure to exposed tailings and other surface contamination.

6.4.10 Biomonitoring Evaluations

This section summarizes the results of biomonitoring investigations conducted at the WSP during the 2005 through 2009 period. Two separate biomonitoring investigations of the WSP were completed: one investigation was completed within the ponds themselves; and the other in surrounding areas, including Silver Bow Creek and the Mill-Willow Bypass channel. The majority of the following text was summarized or taken directly from Atlantic Richfield's Five-Year Review report (Atlantic Richfield 2010).

6.4.10.1 Warm Springs Ponds Biomonitoring Investigations

This section summarizes the results from two biomonitoring investigations (2006 and 2009) at the WSP. The scope and methods used during this extensive sampling and analysis effort over this period of time were based upon the final 1995 Biomonitoring Work Plan for the WSP (Work Plan), and subsequent amendments to the Work Plan. The Biomonitoring Work Plan was developed cooperatively by the EPA, the U.S. Fish and Wildlife Service (FWS), and Atlantic Richfield, as a direct result of the RODs for the Active and Inactive OUs of WSP. Since certain aspects of the remedial actions will leave metals-contaminated mine wastes on site, the EPA has determined that long-term monitoring of biological communities was necessary.

The objectives of the long-term biomonitoring program, as provided by the EPA in the Final Draft Biomonitoring Plan, Warm Springs Ponds Operable Unit (EPA 1994) included:

- Monitor diversity and abundance in selected biological communities.
- Directly measure the potential toxicity of the submerged sediments using standard toxicity tests.
- Directly measure metals concentrations in water and sediments.
- Directly measure metals concentrations in selected plant and animal tissues to evaluate exposure and metals bioavailability.

A multi-year sampling program was originally established because potential effects may manifest themselves over an extended period of time, and to discriminate between normal year-to-year variations in assessing meaningful long-term trends. The WSP biomonitoring results can be used to provide an extensive database to support future decisions regarding the effectiveness of the WSP remedy. The number of sampling sites and types of samples collected since 1998 have been reduced over time, while still providing the necessary data for continued monitoring of metals bioavailability within the WSP system.

The compilation and comparisons (both within a given year and among all years) of these annual data sets will characterize and evaluate the status of the WSP System biological communities. In certain areas, where expected equilibrium (mature) conditions have been achieved, few, if any, changes among the measured parameters are expected over the long term, other than those associated with natural biological variability.

The original biomonitoring study measurement endpoints selected at the WSP included:

- Metal concentrations in water and sediments
- Toxicity of sediments.
- Tissue metal concentrations of key receptors (benthic macroinvertebrates [BMI], pelagic macroinvertebrates, aquatic macrophytes, bottom fish, forage fish, and waterfowl).
- BMI and zooplankton abundance and diversity.
- Macrophyte abundance and diversity.
- Waterfowl abundance and diversity.

With the exception of fish tissue, waterfowl liver samples, and vegetation surveys, all field collections required within a given area were collected from common sampling locations as specified in the 1995 work plan. Waterfowl monitoring, which had been performed in the past at the WSP by the FWP, were not conducted in 2007 and 2008 but were started up again in 2009. More recently, important fall shorebird and waterfowl migration information and data have been developed and reported by Swant (Swant 2009).

Sampling locations were marked in 1995 with floating buoys or permanent stakes so that these locations could be resampled in subsequent years. In addition, global positioning system readings were taken at each marker and at the ends of each vegetative survey transect to ensure location consistency with future sampling events. Sites were re-marked as needed depending on the condition of the buoy, which was evaluated during each sampling event.

Methods. For the 2006 and 2009 biomonitoring events, sampling was completed at four sites, including: Pond 3 wetlands head (P3-WH), Pond 2 west wet closure (P2-WWC), Pond 2 northwest (P2-NW), and Pond 1 middle wet closure (P1-MWC). Sampling locations are summarized in Table 6-7.

In 2006 and 2009, sampling focused on metals and physical/chemical parameters of sediments, sediment toxicity using the amphipod *Hyalella azteca*, BMI density and diversity, and metals concentrations in select BMI.

Results and Discussion. Results of individual sampling events are reported in the respective biomonitoring reports. The information presented below attempts to briefly summarize the overall trends and comparisons of 5 years worth of data collected in the WSP system.

Sediments. The sediment metal concentrations are typically elevated in the WSP system because historical tailings piles are buried under the Ponds and the treatment system is designed to sequester metals/metalloids within the WSP system. Sediment metal concentrations in 2006 were typically lower or similar to those measured in previous biomonitoring events 2003 or 2000 (P2-NW was not sampled in 2003). Metal concentrations reported in 2009 were higher than concentrations measured in 2006 at all sites except P1-MWC. At this site, metals concentrations were similar to previous years (1999-2006). For example, the copper concentrations in 2009 at P3-WH (5,543 mg/kg) and P2-WWC (5,280 mg/kg) were among the highest observed since sampling started in 1995. In comparison, copper concentrations at P2-NW were similar to average concentrations measured historically (2,340 mg/kg), while concentrations measured at P1-MWC were among the lowest observed at this site (3,880 mg/kg). Historically, sediment metals concentrations have been highest at P1-MWC and lowest at P2-NW which occurred in 2006 but not in 2009. Spatial variability within the individual sites may be represented by the differences seen in sediment metal concentrations among the different sampling years. Small-scale variations (reductions) in sediment porosity and permeability can locally enhance chemical anoxia, and metal concentrations. This can be seen by the sediment arsenic, copper, and zinc data that had duplicate measurements collected at P3-WH. Variability was higher for arsenic and copper sediment data in 2003 and 2009 compared to other years. This variability was not seen with zinc.

Table 6-7
Warm Springs Ponds Biomonitoring Sampling Locations

Site Designation	Location	Site Description	Events Sampled
P3-WH	Wetlands at head of Pond 3	Upstream portion of active treatment area; receives direct input from Silver bow Creek (post liming); this area was flooded in 1993.	1995 – 1998, 1999, 2000, 2003, 2006, 2009
P3-N	North end of Pond 3	Near outlet in northwest corner of Pond 3; water discharges from here into Pond 2; Pond 3 was initially flooded during the late 1950s (circa 1956-1959)	1995 - 1998
P2-WWC	West wet closure area, Pond 2	Wet closure cell to the south of and separated from the active area of Pond 2; this area was flooded in 1995.	1995 – 1998, 1999, 2000, 2003, 2006, 2009
P2EWC	East wet closure area, Pond 2	Wet closure cell to the south (east) of and separated from the active area of pond 2; this area was flooded in 1995.	1995 - 1998
P2-S	Southern end of Pond 2	Inlet portion of active treatment areas (receives water from Pond 3); this area was flooded in 1993.	1995 - 1998
P2-NW	Northwestern part of Pond 2	Near outlet of Pond 2 (and, therefore, of the active WSP treatment area as a whole); Pond 2 was initially flooded in 1916.	1995 – 1998, 1999, 2000, 2006, 2009
P1-WA	Wetlands adjacent to Pond 1	Flooded areas adjacent to the Pond 1 – Center; this area has been flooded for many years. No longer part of the active treatment system.	1995 - 1998
P1-C	Central part of Pond 1	Pond 1 has been flooded since approximately 1911 and is no longer part of the active treatment system.	1995 - 1998
P1-MWC	Middle wet closure area, north of Pond 1	Wet closure cell north of Pond 1 – wet closure area; flooded with water in late 1995. Not part of the active treatment system.	1995 – 1998, 1999, 2000, 2003, 2006, 2009
P1-WAN	Wetlands adjacent to middle Pond 1 wet closure area	Wetland area adjacent to the wet closure cell north of Pond 1; flooded with water in late 1995. Not part of the active treatment system.	1995 - 1998

Sediment data were evaluated based on chemical concentrations and metals "bioavailability" was also assessed and used to interpret the results of the sediment toxicity studies with the freshwater amphipod *Hyalella azteca,* which is a widespread WSP System resident species. Metal bioavailability was assessed using the EPA's equilibrium partitioning (EqP) approach (EPA 1996). For this approach, simultaneously extracted metals (SEM) concentrations in sediment were compared to the available sulfide concentrations in the sediments (termed acid volatile sulfide [AVS]).Based on this metal partitioning theory, and in cases where AVS concentration exceeds SEM concentration, metals (cadmium, copper, lead, and zinc) would not be available to cause toxicity to the organism since they would be bound to the sulfide. In general, SEM concentrations exceeded AVS levels at P3-WH and P1-MWC; whereas, AVS historically exceeded SEM concentrations at P2-WWC and P2-NW. This has been the general trend observed since 1995, but there have been differences in some years. In 2006 and 2009, AVS concentrations at P1-MWC exceeded SEM concentrations. Part of the EqP evaluation process involves porewater metals concentrations (porewater metals concentrations are compared to ambient water quality criteria), and is considered more consistently predictive of sediment toxicity compared to exclusive SEM-AVS evaluations.

The sediment toxicity in 2006 was low at all sampled sites, with less than 20 percent mortality observed to *Hyalella azteca*. In 2009, the sediments exhibited greater toxicity in all sites except P2-NW. The mortality rates at the other sites ranged from 40 to 54 percent. There were high metal concentrations detected in sediments in 2009 at sites P3-WH and P2-WWC which may be a reason for the increased toxicity in 2009. When comparing the sediment toxicity over time, only the result at P3-WH stood out as being different from past results. Until 2009, toxicity had only been observed at this site in 1995 and 1996. Even though there was measured toxicity to *Hyalella azteca* under laboratory exposure conditions, this species is widely and abundantly distributed throughout the WSP system indicating either natural conditions are not as toxic as predicted, or that the *Hyalella azteca* have adapted to the conditions at the WSP.

BMI Tissue Residues. Since 1999, metal residues have only been monitored in BMI tissues because metal concentrations in BMI were greater than concentrations measured in other biota (i.e., corixids, aquatic macrophytes, suckers [bottom fish], coot livers [young of the year], and amphipods [measured only in 1998]). In 2006, the BMI metal residues were mainly lower than concentrations measured in previous sampling events (2006 or 2003). Copper and zinc BMI residues for 2009 were similar to those measured in 2006 active areas. Arsenic residues were typically 50 percent higher at all sites. Arsenic residues at P2-NW in 2009 were 18.1 mg/kg (dry weight [dwt]) and were higher at other sites (37 mg/kg at P3-WH, 87.8 mg/kg at P2-WWC, and 126 mg/kg at P1-MWC). Historically, the BMI metal residues have been highest at P1-MWC and lowest at P2-NW (the sampling location proximate to the Pond 2 outfall). This is a similar trend as observed with sediment concentrations. Trends did vary depending on the site and the metal. Arsenic concentrations increased in 2009, and copper and zinc residues in BMI in the active areas appear to be similar or decreasing when compared to measurements since 2003. It is important to note that BMI metal residues were lower at the outfall (P2-NW) compared to the site next to the inlet (P3-WH), indicating metals concentrations are decreasing through the treatment ponds.

BMI Community Analysis. The BMI diversity has been mostly consistent in almost all sites since 1999. The number of species observed in 2009 was lower than in 2006 (quantitative samples) but were within the range of values measured since that time. The highest diversity has been measured at P3-WH and the lowest at P2-WWC or P2-

NW, which is similar to past measurements. Diversity measured at P1-MWC has been among the highest since 1998 and was the highest in 2009 with 28 different species observed (qualitative samples). This demonstrates the complexity of the WSP System as metals concentrations have been higher at this site historically. There have been a total of 98 different (i.e., cumulative) genera collected since 1995 indicating the diversity of the invertebrate population within the WSP System. Eight new taxa were collected in 2006 and seven new taxa were collected in 2009 showing that BMI diversity at the ponds is still increasing.

The BMI densities for P3-WH and P2-WWC have been higher with densities ranged from 3,400 to 14,000 and 2,100 to 12,700 organisms per square meter (#/m^2) since 1996, respectively. In 2006, densities were higher at P2-WWC (12,700 #/m^2) and in 2009 were higher at P3-WH (5,800 #/m^2).

At P1-MWC, lower densities have been measured in 2006 and 2009. Amphipods (both *Hyalella azteca* and a slightly larger species, *Gammarus lacustris*) typically represent 50 to 70 percent of the total densities in the active areas (especially P3-WH and P2-WWC). Amphipod densities at the active areas average over several thousand organisms per square meter, and cover a significant amount of the macrophytes in the water, indicating high productivity of the Ponds. Amphipods (especially *Hyalella azteca*) are among the more sensitive test organisms to metals (e.g., EPA 2007). Their presence with other more sensitive test species (i.e., zooplankton species *Daphnia pulex* and *Ceriodaphnia lacustris* collected at P2-NW discharge in 2009 and previously in plankton tows) demonstrate the productive yet dynamic system that exists within the WSP System since metals sensitive species are abundant.

Avian Community. A highly abundant and diverse assemblage of avian species has been seen on or near the WSP, fueled in part by the invertebrate populations and plant communities. Wildlife utilization has increased at the WSP because of these factors as well as abundance of cover, nesting sites, and other man-made amenities (Swant 2009).

In the Fall Shorebird and Waterfowl Migration at Warm Springs Wildlife Management Area report (Swant 2009) it was reported that during the 2009 fall period, on a daily basis, there were 5,000 to 7,000 individuals birds seen using the Warm Springs Wildlife Management Area. A variety of swans, geese, ducks, grebes, shorebirds and the American coot constitute the majority of species in this important fall staging area. Most of this activity has been occurring in the WSP sections of the Wildlife Management Area. Pond shallows and mudflats were specifically identified as important feeding areas for birds in this system.

Habitat within the WSP appears to be highly suitable for a diverse assemblage of wildlife species. The WSP provides highly abundant invertebrate populations for food, a diverse macrophyte community for food, cover, and nesting, and a number of other amenities that continue to increase wildlife utilization and success.

Summary. The results of the chemical and biological monitoring at the WSP demonstrate that complex interactions are affecting metals fluctuations and organism distributions within the OU. Past sampling results have shown that locations bearing maximum water or sediment metal concentrations were not necessarily areas that had elevated metal residues or decreased invertebrate communities. An example of this is seen at P3-WH where the BMI density and diversity is typically higher but the sediment from this site was determined to be toxic under laboratory testing conditions. Metal bioavailability was also higher at this site than at other sites.

The most abundant BMI species seen at P3-WH was the *Hyalella azteca* which is an epibenthic invertebrate species. It lives on the surface of the sediment and submerged vegetation in the water column. Because of their epi-benthic nature, they may not be exposed to the higher metals concentrations associated with the sediments. This may explain why they are one of the more abundant and widely distributed species in the WSP System. Hence, while sediment from this site may exhibit greater toxicity and show more elevated levels of metals, the BMI community at almost all sites indicates a relatively healthy and productive system, especially since these organisms that are known to be sensitive to metals, reside there in large numbers (i.e., *Hyalella azteca* and *Daphnia pulex*).

An evaluation of the functionality of the ponds was also conducted and it was shown that lower metals concentrations were observed at the outfall (P2-NW) compared to the site near the inlet (P3-WH). This was observed for BMI metal residues as well as for sediment metals. This is a good indication that the metals are being sequestered (into the sediments) as water from Silver Bow Creek moves through the active areas of the ponds and are precipitated. Whole body arsenic values did increase in 2009 compared to 2006, but these values are considered low compared to values thought to be of dietary concern.

6.4.10.2 Mill-Willow Bypass/Silver Bow Creek Biomonitoring Investigations

During the report period, biomonitoring investigations were conducted in the vicinity of the WSP and Mill-Will Bypass during 2006, 2007, and 2008. Biomonitoring investigations in the vicinity have been completed by Atlantic Richfield since 1995, and BMI has been assessed by McGuire since 1986.

McGuire BMI Assessments

BMI assessments were completed in 2006, 2007, and 2008 by McGuire (McGuire 2007, 2009). Two sample stations, 02.5 (Silver Bow Creek at Opportunity) and 04.5 (Silver Bow Creek below Warm Springs Ponds), were evaluated for BMI integrity, and provide information regarding the WSP impact on Silver Bow Creek conditions. A third nearby station, 05 (Mill-Willow Bypass) was also evaluated. These stations have been evaluated for BMI communities since 1993 (1986 for Mill-Will Bypass), providing information on pre- and post-remedial activity conditions. The most recent analyses included various population diversity measures and assessments of pollution-sensitive BMIs. McGuire utilized the different community analyses to develop a biological integrity score, as well as to distinguish whether community impacts were caused by metals, organics, or neither.

Based on August 2008 data, the biointegrity indices for 02.5 and 04.5 were 52 and 74, respectively. The score of 52 suggests that Silver Bow Creek at Opportunity is moderately impaired, while the score of 74 indicates only slight impairment at Silver Bow Creek below WSP (McGuire 2009). The metals and organics indices indicated that Silver Bow Creek at Opportunity is slightly impaired by metals contamination, and moderately impaired by organics, while Silver Bow Creek below WSP was not impaired by either. This suggests that the WSP improves the water quality in Silver Bow Creek with relation to metals and organic contamination. The overall biointegrity index for station 04.5 suggested slight impairment; McGuire indicated this was likely because of higher temperatures or elevated pH associated with the WSP outflow. The biointegrity index for the Mill-Willow Bypass was 94, indicating a non-impaired system.

Before remedial activities in the vicinity of the WSP (approximately the 1990s), biointegrity scores for stations 04.5 and 05 were frequently rated as severely impaired (scores in the 50s and 60s), and were strongly influenced by metals and organic contaminants. Biointegrity scores have shown substantial improvement since that time, and indicate that metals and organic-related contamination have had limited impact on the BMI communities.

Overall, the biointegrity indices have increased since remedial activity began, although for several years (approximately 2003 through 2007), biointegrity indices had declined in Silver Bow Creek. In 2008, the indices either stabilized or increased, suggesting an improvement in habitat. McGuire suggested the decline was partly due to a period of extended drought in the Clark Fork River basin. Lower flow rates cause declines in BMI populations because of increased water temperature, nutrient retention, plant growth, and altered water chemistry (McGuire 2009). Flow rates and total flow increased in 2008 when compared to the previous years' flows, providing a probable reason for increased biointegrity scores. During the period of decline, slight metals and organic pollution was also indicated in station 04.5. This slight metals and organic pollution was likely related to intermittent events of pond discharge with elevated ammonia, arsenic, or alkaline pH (McGuire 2009). The combination of slight impairment and drought conditions likely led to the decline in biointegrity indices.

Dodge et al. BMI Studies

In addition to the BMI studies completed by McGuire, Dodge et al. (2008) completed yearly BMI investigations at two nearby stations on Silver Bow Creek: Silver Bow Creek at Opportunity and Silver Bow Creek at Warm Springs. Historic sampling had been completed at the locations since 1985. Tissue metals concentrations were analyzed for the caddisfly *Hydropsyche* species, a common BMI species within the upper Clark Fork River basin. Tissue concentrations in the Silver Bow Creek at Opportunity were highest, with lower concentrations present at the Silver Bow Creek at Warm Springs; 2008 data is presented in Table 6-8. Statistical data, including means and medians, are presented in Table 6-9. The 2008 data can be compared against the mean and median to show how the current concentrations compare to historical data. At Silver Bow Creek at Opportunity, the concentrations of all metals were greater than the mean and median for *Hydropsyche cockerelli*, while only the concentrations of chromium, iron, and lead exceeded the mean and median values for the *Hydropsyche spp.* as a whole. This indicates that during 2008, the *hydropsychid* had a greater accumulation of metals than an average season during the past 20+ years. At Silver Bow Creek at Warm Springs, 2008 metals concentrations for *Hydropsyche cockerelli*, exceeded the mean and median for chromium and lead only.

Table 6-8
Biological Data for the Upper Clark Fork Basin, Montana, August 2008

Taxon	No. of Comp. Samples	Concentration (µg/g)								
		As	Cd	Cr	Cu	Fe	Pb	Mn	Ni	Zn
12323600--Silver Bow Creek at Opportunity										
Hydropsyche cockerelli	2	16.5	6.9	4.1	506	4,180	66.2	1,170	3.0	1,010
Hydropsyche spp.	1	13.0	4.7	3.0	333	3,250	237	1,060	2.4	809
12323750--Silver Bow Creek at Warm Springs										
Hydropsyche cockerelli	3	8.5	0.4	1.4	26.6	656	3.5	930	0.6	162

Table taken from Dodge et al., 2009. [Analyses are for the whole-body tissue of aquatic insects. Composite samples were made by combining similar-sized insects of the same species into a sample of sufficient mass for analysis. Concentrations for bioaccumulation samples composed of two or more composite samples are the means of all analyses. Abbreviations: µg/g, micrograms per gram of dry sample weight; spp., species]. Arsenic – As; Cadmium – Cd; Chromium – Cr; Copper – Cu; Iron – Fe; Lead – Pb; Manganese – Mn; Nickel - Ni; Zinc - Zn

Table 6-9
Statistical Summary of Long-Term Biological Data for the Upper Clark Fork Basin, Montana, August 1986 through August 2008

Constituent	Number of composite samples	Maximum	Minimum	Mean	Median
12323600--Silver Bow Creek at Opportunity Period of record for biological data: 1992, 1994–95, 1997–2008					
Hydropsyche cockerelli					
Arsenic	10	20.4	9.5	13.5	12.7
Cadmium	16	9.7	3.1	5.7	5.4
Chromium	16	8.0	1.0	3.0	2.6
Copper	16	1,090	269	440	410
Iron	16	4,950	689	1,970	1,890
Lead	16	68.3	19.0	36.5	39.0
Manganese	16	3,030	180	1,030	975
Nickel	16	3.6	0.7	2.2	2.1
Zinc	16	1,590	619	913	868
Hydropsyche spp.					
Arsenic	8	23.1	10.7	15.7	15.1
Cadmium	13	11.0	4.2	6.6	5.7
Chromium	13	4.7	0.6	2.3	2.8
Copper	13	930	312	547	469
Iron	13	3,250	1,050	2,050	2,110
Lead	13	237	21.8	55.0	40.4
Manganese	13	1,340	712	1,090	1,060
Nickel	13	2.7	0.7	2.2	2.4
Zinc	13	1,290	784	1,020	1,080
12323750--Silver Bow Creek at Warm Springs Period of record for biological data: 1992–2008					
Hydropsyche cockerelli					
Arsenic	11	23.6	7.9	13.5	13.3
Cadmium	37	2.1	0.2	0.6	0.5
Chromium	37	4.3	0.4	1.1	0.8
Copper	37	97.0	16.7	37.4	29.9
Iron	37	1,590	351	785	761
Lead	37	5.7	0.3	3.0	2.9
Manganese	37	3,890	491	1,320	1,110
Nickel	37	1.8	0.3	0.9	0.8
Zinc	37	276	115	174	167

Table taken from Dodge et al., 2009. [Concentrations are in micrograms per gram dry weight (µg/g). Number of composite samples represents the total of all individual composite samples collected for every year that the constituent was analyzed. Values for a single sample are arbitrarily listed in the “Mean” column. Because Hydropsyche insects were not sorted to the species level during 1986–89, Hydropsyche species statistics for stations sampled during those years are based on the results of all Hydropsyche species combined. At some sites, statistics of Hydropsyche morosa group are based on the combined results of two or more species. Insects collected during 1986–98 were depurated before analysis; depuration was discontinued in 1999. Arsenic was not analyzed until 2003; therefore, the number of samples may be small or zero for some taxa. Values are reported using U.S. Geological Survey rounding standards. Abbreviation: spp., one or more similar species. Symbols: <, less than minimum reporting level; --, indicates either too few samples (less than three) or insufficient data to compute statistic, or element not analyzed]

The results for arsenic were also compared against the dietary toxicity reference values (TRVs) developed for rainbow trout in the Clark Fork River Basin (EPA 1999; Tillquist et al. 1999; Hansen et al. 2004; and Hockett et al. 2003; as reported in Atlantic Richfield 2010.) These values are included in Table 6-10, as reported in Atlantic Richfield 2010. Values are indicated for a no observable adverse effect level (NOAEL) and a lowest observable adverse effect level (LOAEL). All of the 2008 arsenic results indicate that *hydropsychid* arsenic tissue concentrations do not pose a threat to rainbow trout.

Table 6-10
Arsenic Dietary Toxic Reference Values

Study	Oral TRV (mg/kg diet, dwt)	
	NOAEL	LOAEL
Clark Fork River RA (EPA 1999)	63	137
Tillquist & Vertucci 1999	40	44
Hansen, et al. (2004)	-	27.6*
Hockett, et al. (2003)	38.8	52.2

*included variable, multiple metal dietary exposures: LOAEL-like endpoint.

6.4.11 Additional Surface Water Investigation

In July 2007, Atlantic Richfield collected a suite of surface water samples (designated the AS-series) from 24 locations within and adjacent to ponds 1 and 2. The goal was to acquire a mechanistic understanding of the processes affecting cyclical arsenic concentrations within the WSP system. Based on the initial data set, 10 locations were strategically selected for monitoring on a regular basis (samples collected once every three weeks).

Discussions of results from this study have identified several potential major processes that affect surface water quality in the Ponds, and the corresponding arsenic levels. These include:

- Photosynthesis – responsible for elevated seasonal pH cycling, dissolved oxygen enrichment, biomass production;
- Groundwater recharge and cyclical dilution event – the peak of the arsenic cycle temporally coincides with the annual dilution event at all AS-series stations, suggesting an unidentified mechanism;
- Respiration of detrital organics – drives redox downward, reductive dissolution of mineral oxides, potential release of adsorbed arsenic;
- Adsorption/desorption – strong control on cyclical arsenic concentrations; and
- Strong evidence of organo-phosphate-arsenate association – dissolved organic ligands may enhance phosphate and arsenate solubility.

In the short-term, Atlantic Richfield plans to install eight SolarBees™ at nested locations within the WSP system as a pilot test in 2010. These systems circulate the local water column and greatly enhance its aeration. The results should provide foundational data for future management scenarios. Additional details of this investigation are presented in the *Silver Bow Creek/Butte Area NPL Site Warms Springs Ponds Operable Units 5-Year Review Report* by Atlantic Richfield from March 2010 (Atlantic Richfield 2010).

6.4.12 Third-Party Geochemistry Evaluations

During the report period, a series of third-party studies have been conducted to evaluate surface water geochemistry and metals transport in the vicinity of WSP. These publications mainly provide additional insight into the complex nature of the arsenic issues at the WSP. The reports are summarized for informational purposes only. These published and unpublished reports include:

- Gammons, C. and T. Grant, 2005. *Hydrogeochemistry of arsenic below Warm Springs Ponds*, Preliminary results of the diel investigation of July 22-23, 2004, Prepared for EPA and BP-Atlantic Richfield Company, April 20, 2005.

- Grant, T. M., 2006. *Hydrogeochemistry of Arsenic and Trace Metals in Lower Silver Bow Creek Below Warm Springs Ponds, Montana*. Master of Science Thesis, Montana Tech of the University of Montana, Butte, Montana, May 2006; 78 pp.

- Gammons, C. H., T. M. Grant, D.A. Nimick, S.R. Parker, and M.D. DeGrandpre, 2007. *Diel changes in water chemistry in an arsenic-rich stream and treatment-pond system*, Science of the Total Environment, v. 384, p. 433-451.

- Gammons, C., 2007. *Groundwater-surface water interactions along the Mill-Willow Bypass: A summary of results of the August 2007 Montana Tech*. Field Hydrogeology Class, prepared October 22, 2007.

6.4.12.1 Diel Cycling of Metals – 2004 Investigation

In July 2004, Dr. Gammons and students at Montana Tech collected detailed surface water monitoring data to evaluate diel cycling of metals in the vicinity of WSP.

Water samples were collected from three locations over a 24-hour period beginning on July 22, 2004. The three locations include the mouth of the Mill-Willow Bypass, above its confluence with Silver Bow Creek; the outlet from Pond 2 to lower Silver Bow Creek; and lower Silver Bow Creek, below the Mill-Willow Bypass and WSP. No samples were collected from within the WSP. Field measurements of temperature, pH, specific conductance, and dissolved oxygen were recorded during sampling, and water samples were analyzed for general water quality parameters (i.e., anions and cations), stable hydrogen and oxygen isotopic ratios, and total and dissolved metals/metalloids, including arsenic.

An interpretation of these results indicated that temperature-controlled, arsenic sorption-desorption cycling occurs in Mill-Willow Bypass and Silver Bow Creek. As water temperature warmed during the day, arsenic was released by desorption from streambed sediments to the water column, and as the temperature cooled at night, the arsenic was removed from the water column by adsorption to sediments. The author recommended that the time of day be considered when conducting future arsenic monitoring in Mill-Willow Bypass and Silver Bow Creek.

Additional details of this investigation are presented in the S*ilver Bow Creek/Butte Area NPL Site Warms Springs Ponds Operable Units 5-Year Review Report* by Atlantic Richfield from March 2010 and *Hydrogeochemistry of arsenic below Warm Springs Ponds, Preliminary results of the diel investigation of July 22-23, 2004,* by Gammons, C. and T. Grant from April 2005.

6.4.12.2 Diel Cycling of Metals – 2004 and 2005 Investigation

A similar sampling effort to the 2004 diel cycling of metals investigation was conducted in July 2004 and August 2005. Both sampling efforts collected water samples every 4 hours over a 24 hour period. Water samples were analyzed for general water chemistry parameters, stable hydrogen and oxygen isotopic rations, and total and dissolved metals/metalloids.

Results from the investigation indicated that arsenic, copper, manganese, and zinc were the trace constituents observed to have diel variability within Mill-Willow Bypass and Silver Bow Creek. The manganese and arsenic diel trends were most evident, especially in 2004, and copper and zinc trends less so. Manganese and zinc concentrations were typically highest during early morning and dropped throughout the day. Arsenic and copper concentrations show the opposite trend, with maximum concentrations during late afternoon and decreasing overnight.

A number of geochemical mechanisms for diel cycling of metals/metalloids were discussed, but no single mechanism was identified that clearly explain the diel trends observed in Mill-Willow Bypass and lower Silver Bow Creek.

Additional details of this investigation are presented in the S*ilver Bow Creek/Butte Area NPL Site Warms Springs Ponds Operable Units 5-Year Review Report* by Atlantic Richfield from March 2010 and in *Hydrogeochemistry of Arsenic and Trace Metals in Lower Silver Bow Creek Below Warm Springs Ponds, Montana* by Grant, T. M from May 2006.

6.4.12.3 Diel Cycling of Metals – 2004 & 2005 Investigation Follow-Up

Data collected during the July 2004 and August 2005 field investigations conducted by Grant (2006) were used along with additional data collected from the Mill-Willow Bypass adjacent to WSP to further evaluate mechanisms for diel cycling of metals/metalloids, including arsenic, in the vicinity of WSP. The additional data were collected during the 2005 monitoring event and included: (1) water quality data collected at a second location within the Mill-Willow Bypass, near the Silver Bow

Creek inlet to WSP; and (2) flow and water quality data collected at toe drains along the Pond 2 and Pond 3 embankments adjacent to Mill-Willow Bypass.

Results of sampling conducted during two separate, 24-hour events, described previously, indicate diel cycling of arsenic, along with pH, dissolved oxygen, temperature, and certain trace metals/metalloids, at both of the locations monitored in Mill-Willow Bypass and also in lower Silver Bow Creek. The diel pH, arsenic, copper, manganese, and zinc were consistent with the descriptions presented earlier.

In contrast to results from Mill-Willow Bypass and Silver Bow Creek, diel cycles were either very weak or not observed in water discharging from the WSP.

The investigators concluded that sorption and desorption of arsenic in response to diel cycles in pH and temperature caused primarily by day-time photosynthetic activity, was considered the most likely mechanism for arsenic cycling in Mill-Willow Bypass and Silver Bow Creek. Based on the results described above, the investigators reinforced the importance of accounting for diel cycling when monitoring surface water quality in Mill Willow Bypass, Silver Bow Creek, and similar stream systems that transport metals.

Additional details of this investigation are presented in the S*ilver Bow Creek/Butte Area NPL Site Warms Springs Ponds Operable Units 5-Year Review Report* by Atlantic Richfield from March 2010 and *Diel changes in water chemistry in an arsenic-rich stream and treatment-pond system,* by Gammons, C. H., T. M. Grant, D.A. Nimick, S.R. Parker, and M.D. DeGrandpre from 2007.

6.4.12.4 Groundwater/Surface Interaction along Mill-Willow Bypass – 2007 Investigation

In August 2007, Dr. Gammons and students from Montana Tech conducted field investigations to evaluate groundwater-surface water interactions along the Mill-Willow Bypass adjacent to WSP. A secondary objective was to further evaluate fate and transport of trace metals and metalloids, including arsenic, in the vicinity of the Mill-Willow Bypass. Sampling of Mill-Willow Bypass, ponds on the Mill-Willow Bypass floodplain, and toe drains along the Pond 2 and Pond 3 embankments adjacent to Mill-Willow Bypass was conducted August 6-7, 2007. Shallow piezometers were also installed across the Mill-Willow Bypass floodplain to allow for collection of shallow groundwater, and shallow groundwater samples were collected from six piezometers on August 7, 2007.

Data collected to evaluate flow and water quality at the toe drains indicate that less than 10 percent of the observed increases in Mill-Willow Bypass arsenic load could be attributed to discharge from the unmanifolded toe drains. The increases in Mill-Willow Bypass flow and arsenic load were attributed to other sources of water to this reach of Mill-Willow Bypass, such as groundwater inflow.

Additional details of this investigation are presented in the *Silver Bow Creek/Butte Area NPL Site Warms Springs Ponds Operable Units 5-Year Review Report* by Atlantic Richfield from March 2010 and *Groundwater-surface water interactions along the Mill-Willow Bypass: A summary of results of the August 2007 Montana Tech Field Investigation*, by Gammons, C. from October 2007.

6.5 Review of Institutional Controls

6.5.1 Institutional Controls and Instruments

The initial ROD for the WSP OU was released by EPA on September 28, 1990. In June 1991, EPA released an ESD that divided the original OU into the WSP Active Area OU and the WSP Inactive Area OU, and reiterated the goals of the ICs program by stating that ICs would prevent future residential development, swimming, and consumption of fish by humans. For each of the new OUs, EPA prepared UAOs.

Project documentation states that for each OU Atlantic Richfield will prepare an ICs compliance demonstration report to document implementation of the ICs program. Those reports are required to contain copies of deed notices, leases, enacted zoning provisions, water well bans, evidence of sign posting, and any other required activities. With respect to site access easements, the UAOs state that Atlantic Richfield will provide agreements to allow EPA, Montana Department of Environmental Quality (DEQ), and their respective authorized representatives access at all times to enter and move freely in order to conduct business related to the work under the UAOs.

The CDs and administrative orders reference the ICs identified in the ROD and ESD. The ESD provided clarification regarding ICs by stating that the following specific ICs will be initiated in cooperation with local governments at the site.

1. Renewal of the lease agreement between Atlantic Richfield and FWP for continuation of use of major portions of the area as a wildlife refuge.

2. Implementation of a conservation easement with restrictive covenants by Atlantic Richfield for the Site, to ensure that future development will not include residential use, and will not cause disruption of disposal areas or waste ponds.

3. Implementation of a permit development system, in cooperation with Anaconda-Deer Lodge County and Atlantic Richfield, which will prevent residential development at the Site. The permit system includes the development of a master plan, which will designate the ponds as a wildlife refuge.

4. Implementation of a water well ban in the area. The well ban shall prohibit water wells within the waste ponds at the Site permanently, and shall temporarily prohibit water wells within the Site in areas outside of the waste ponds, until ARARs are achieved for the groundwater at the Site.

5. Implementation of a ban on swimming in the ponds at the Site, to be accomplished through the posting of appropriate signs at the Site.

The FWP maintains a catch and release policy at the WSP as its preferred approach to managing the sports fishery most effectively.

6.5.2 Implementation

The ESD and UAOs indicated that Atlantic Richfield was to prepare ICs compliance demonstration reports to document implementation of the WSP ICs program. For the Active and Inactive OUs, Atlantic Richfield released ICs compliance reports on January 23, 1992, and November 5, 1993, respectively.

In addition to the information obtained from those reports, interviews were conducted with the following individuals to determine which ICs or other protocol have been implemented and are being effective in protecting the remedy:

- Scott Brown. EPA RPM. December 21, 2009.
- Daryl Reed. DEQ. December 22, 2009.
- Dave Dziak. FWP. December 31, 2009.

The implementation of ICs for the WSP is discussed below and a summary is provided in Table 6-11.

Table 6-11
Implementation and Effectiveness of Institutional Controls at the Warm Springs Ponds Operable Units

	Institutional Control and Instrument (as identified in the controlling documents)	Instrument Implementation and Use	Effectiveness of the Institutional Control in Supporting the Remedy
Controlling Document	UAOs (1991, 1993),		
Responsible Entity	Atlantic Richfield		
Access	Written land access agreements for all land parcels within the OU for the purpose of monitoring components of the remedy.	All land parcels are owned by Atlantic Richfield. The controlling documents implement this IC. EPA and the DEQ continue to have access to this OU. No access issues have occurred (Brown 2009, Reed 2009).	This IC is implemented and effective.
Land and Water Use Restrictions	Renewal of the lease agreement between Atlantic Richfield and FWP for continuation of use of a portion of the ponds as a wildlife management area.	FWP is operating under a lease with Atlantic Richfield. The lease allows for recreation uses of the area but restricts swimming and limits fishing to catch-and-release only.	This IC is considered effectively implemented by the FWP.
	Implementation of measures to ensure that future development does not include residential use and will not cause disruption of disposal areas or waste ponds.	This IC has been implemented through the County Master Plan and development permit system. Additionally, the WSPs lie within the 100-year floodplain of Silver Bow Creek. As such, building and other restrictions on land-use are controlled by floodway-related ARARs.	This IC is implemented and effective.
	Implementation of a water well ban to prohibit water wells within the waste ponds permanently, and temporarily prohibit water wells in areas outside of the waste ponds, until such time as ARARs are achieved for the groundwater at the Site.	Restricting well drilling has been enacted through the DNRC's delineation of a CGWA, through property access controls (Atlantic Richfield owns all lands), and through the county's development permit system. The latter requires a permit for installing wells anywhere in the county and thus is an effective way to oversee well drilling and protect private citizens from possibly accessing contaminated groundwater. No groundwater-related issues have occurred (Brown 2009, Reed 2009).	This IC is effectively implemented using several instruments.
Informational Devices	Implementation of a ban on swimming through the posting of appropriate signs.	Signs banning swimming are posted at the ponds by the FWP and enforced by oversight; swimming has not been a problem at the site (Dziak 2009).	This IC is implemented and effective.

6.5.2.1 Access

Property within the WSPOUs is owned exclusively by Atlantic Richfield and, as such, the controlling documents allow EPA, DEQ, and their respective representatives to enter the OU at all times and move freely in order to conduct CERCLA-related work. The site project managers have stated that site access by agency personnel and their representatives has not been a problem since the UAOs were issued (Brown 2009, Reed 2009).

6.5.2.2 Land and Water Use Restrictions

Restrictions on land and water use at the WSP include:

- renewing a lease to continue using portions of the WSP as wildfire management area and to limit certain types of use;
- restricting residential and other uses that may disturb disposal or waste areas (this includes implementing appropriate zoning under the county master plan and development permit system);
- implementing a water well ban; and,
- implementing a ban on swimming and placing signage.

Wildlife Management Area

A portion of the ponds was designated by the county as a wildlife management area. Currently, FWP is operating the wildlife management area under a 2005 lease with Atlantic Richfield. A new 10-year lease is being negotiated between Atlantic Richfield and FWP and is anticipated to be in place in early 2010 (Dziak 2009). The lease allows for recreational uses of the area but restricts swimming and limits fishing to catch-and-release only. To date, the lease agreement has operated without major issues (Reed 2009).

Restrictions on Residential Use and Other Uses that May Disturb Remedy

It was originally envisioned that restrictions on future development would be accomplished through a conservation easement with restrictive covenants, but that approach proved difficult to implement. Instead, the implementation of land use restrictions has involved Atlantic Richfield working with Anaconda-Deer Lodge County to use other instruments that prevent the WSP from being used for residential habitation or in other ways that could disturb the remedy.

The comprehensive land-use master plan for Anaconda-Deer Lodge County was approved by the Board of County Commissioners in December 1990 (EPA 1993). The plan designates the WSPOUs (Active and Inactive Areas) as suitable for recreational uses and open space, and not residential development. Additionally, Anaconda-Deer Lodge County adopted regulations under its development permit system (which it currently uses to control activities on land within the NPL sites in the county) stating that residential development and other land uses that would be inconsistent with recreational use and open space are prohibited. Currently, use of the publically accessible portion of the ponds is controlled by FWP through an agreement with Atlantic Richfield. Access to the other areas of the pond system is strictly enforced by Atlantic Richfield with fencing and periodic reconnaissance.

Water Well Ban

During the 1993 legislative session, the Montana statute governing designation and modification of CGWAs was amended to provide that such areas may be established to prohibit groundwater development where groundwater quality is impaired. Atlantic Richfield submitted a petition to the DNRC for designation of the WSP Active and Inactive Area OUs as a CGWA pursuant to Section 85-2-506(2)(f), Montana Code Annotated. The petition included a request that the DNRC issue an order establishing a permanent water well ban for potable water supply within these OUs. The DNRC approved the petition and established a CGWA at the WSP effective May 25, 1995, (DNRC 2003) based on contamination of the shallow aquifer. The DNRC stated that:

- it will not accept any applications for a Permit for Beneficial Water Use to divert water from 0-40 feet in depth; and
- wells deeper than 40 feet must be constructed to include a grouted conductor casing maintained to a depth of 40 feet and must be terminated and sealed in a minimum 6-foot thick clay aquitard.

The DNRC also stated that this was not a permanent CGWA and that if the EPA rescinded or modified the WSPOUs, the current requirements for a well ban could be modified or deleted. As such, the CGWA could be modified, suspended, or revoked.

In addition to the DNRC well restrictions, a permit is required under the county's development permit system to construct a water well within the county. This effectively protects the public through a process of water testing if wells are drilled near the ponds.

Swimming Ban

The IC called for the implementation of a ban on swimming in the ponds, to be accomplished through the posting of appropriate signs. This provision has been implemented through the posting of notices on the bulletin boards and entrances maintained and managed by FWP.

6.6 Site Inspection

6.6.1 Dam Safety

In accordance with the RAO for the site, the WSP must prevent the release of bound sediments due to earthquakes or floods. In addition DNRC dam safety standards require protecting the ponds to fractions of a probable maximum flood and to the maximum credible earthquake. Based on results from the annual routine inspection and maintenance activities, and the independent five-year site inspection, no critical items have been identified that would negatively impact protectiveness to human health and the environment. A brief summary of the findings are presented below:

Annual Dam Safety Inspections
In addition to the routine inspection and maintenance activities identified in the O&M plan (ARCO 1995), Atlantic Richfield conducts voluntary annual dam safety inspections to evaluate the condition of earthwork and hydraulic facilities. The results of these inspections are documented in an annual inspection report, and any findings are brought to the attention of the site manager and operator to be addressed.

During one of the voluntary annual inspections, an inspector noticed an area on the Pond 2 embankment that appeared to have an irregular surface. A member of the original design team was contacted to evaluate the situation; this engineer concluded that the irregular surface was likely a remnant of a construction road across the embankment and not an indication of any movement. To verify this, the engineer recommended installing a series of monuments for periodic visual monitoring and annual survey monitoring. These monuments were installed during the report period and have been monitored since. There has been no indication of movement in this area.

Five-Year Independent Site Inspection
In addition to the annual inspection, once every 5 years an inspection by a qualified third-party engineer is completed in accordance with the O&M plan and Montana Dam Safety Regulations. One five-year third-party inspection was conducted during the period covered by this report. This inspection was conducted in 2006 by Todd Lorenzen, P.E., of Pioneer Technical Services, Inc (Atlantic Richfield 2007). This inspection found no critical conditions or maintenance items requiring immediate attention. The inspection did document a number of erosional and other miscellaneous features that required attention; these items were subsequently addressed.

The inspection recommended further inspection of the SS-5 spillway and associated structures because of some spalling concrete. Subsequently, a specialized inspection/repair contractor was brought to the site to complete an inspection and repairs to the SS-5 spillway and associated structures. This work was completed in 2009. The next third-party dam safety inspection is scheduled for 2011.

Also, the Emergency Action Plan for the WSP is updated annually. This plan was updated in accordance with the requirements of the Montana Dam Safety Regulations to reflect changes in the system and responsible personnel in the event of an emergency. Copies of the updated plan are provided to the EPA, the DNRC, and DEQ, as well as local emergency response personnel. A table top exercise to test the emergency action plan was conducted with DNRC, EPA, DEQ, and local emergency response personnel on March 10, 2009.

Section 7
Technical Assessment

A technical assessment of the remedies for WSP OU04 and OU12 undergoing a full statutory review is performed as part of the five-year review process. This technical assessment, focusing on answers to three unique questions, is presented in this section of the five-year review.

7.1 Question A: Is The Remedy Functioning As Intended By The Decision Documents?

Remedial Action Performance

No. While the ambient water quality standards for cadmium, lead, mercury, copper, iron, and zinc have been in compliance with discharge standards for the Pond 2 discharge, arsenic continues to exceed standards on a seasonal basis, mainly during the summer and fall months. Atlantic Richfield is continuing to study and better understand the arsenic cycling at the site. Initial findings from the study indicate that there are several complex processes controlling water quality in the ponds, including photosynthesis, groundwater recharge, respiration of detrital organics, adsorption/desorption, and an organo-phosphate-arsenate association.

As indicated in the previous five-year review, it is possible that the WSP are operating at their maximum potential given the inherent limitations of alkaline precipitation and settling technology and the physical limitation of the size of the ponds.

Revegetation efforts have proven to be successful at both the dry closures and along the Mill-Willow Bypass. The removal of tailings in combination with the re-construction of the Mill-Willow Bypass has prevented erosion of tailings from the Mill-Willow Bypass into the Clark Fork River. In general, the revegetation effort prevents exposure of COCs associated with tailings to human and ecological receptors via direct contact, ingestion, or inhalation.

The Inactive Area at the northern boundary of the site continues to achieve RAOs, except the ambient water quality standard for arsenic. Offsite migration of groundwater exceeding performance standards is prevented. The wet closures remain inundated and biologically active. The wet closures are functioning as intended to prevent mobilization or direct exposure to COCs in the wet closures, and, therefore, protecting human health and the environment.

System Operations/O&M

To prevent releases of pond bottom sediments due to earthquakes or floods, a routine site inspection is conducted to evaluate the condition of earthwork and hydraulic facilities. In summary, the dam safety inspections have confirmed that the WSP facilities comply with the State of Montana Dam Safety Regulations.

Opportunities for Optimization

As suggested in the previous five-year review, concentrations of silver and selenium continue to be well below performance standards. These parameters could be dropped from the analytical list.

Early Indicators of Potential Issues

There are no early indicators of additional potential issues; however, arsenic exceedances and releases from the WSP remain issues, as discussed throughout this report and in previous reports. Arsenic mass loading data indicates that net load removal has been decreasing steadily each year, particularly during the summer and fall months. In recent years, the WSP have become a net source of arsenic instead of a net sink of arsenic (i.e., more arsenic is released than is retained – see Figure 6-5). This trend should continue to be monitored; however, as long as arsenic concentrations do not increase to the point where they are approaching the chronic aquatic life standard (0.150 mg/L), the remedy should still remain protective of human health and the environment.

Implementation of Institutional Controls and Other Measures

Based on the information obtained from a review of the site documentation in the administrative record and from interviews with key individuals, the ICs identified in the controlling documents have been implemented for the WSPOUs and continue to be effective in protecting the remedy (Table 6-11). The county's master plan and development permit system, the DNRC's CGWA, and the fact that all land parcels within the boundary of the WSPOUs are owned and controlled by Atlantic Richfield or the FWP collectively, continue to effectively prevent the use of contaminated groundwater, swimming in the ponds, or another use that could compromise the remedy.

7.2 Question B: Are The Exposure Assumptions, Toxicity Data, Cleanup Levels, and RAOs Used At The Time of Remedy Selection Still Valid?

Changes in Standards and TBCs

No. An ARAR review was conducted for the WSP Active and Inactive OUs as a part of this five-year review. In accordance with the preamble to the National Contingency Plan, ARARs are frozen at the time of the ROD unless "a new or modified requirement calls into question the protectiveness of the selected remedy" (55 FR 8757 [March 8, 1990]). The findings of the ARARs review were submitted in the ARARs Review Technical Memorandum (see Appendix B of Volume 1). Although the National Contingency Plan (NCP) requires analysis of the ARARs for the interim RODs, an interim ROD, by definition, does not set forth the final selected remedy. Therefore, the final ARARs for the WSP Active and Inactive OUs will be set forth in the final RODs.

Since completion of the previous five-year review for the Site, both the state and federal aquatic and human health standards have changed for several constituents of concern. The most significant change to the ARARs for the WSPs Active and Inactive OUs was the lowering of the State of Montana standard for arsenic. This change was incorporated in the State of Montana water quality standards (Circular DEQ-7, published in 2008). The standard was lowered to an arsenic concentration to 10 micrograms per liter (µg/L), consistent with the federal MCL. An additional change to water quality standards included the lowering of the criterion maximum concentration (acute exposure) for copper to 2.337 µg/L and the criterion continuous concentration (chronic exposure) to 1.45 µg/L (data based on hardness of 84.6 mg/L as $CaCO_3$).

The federal Safe Drinking Water Act MCLs and the State of Montana human health standards for groundwater for cadmium, chromium, and lead have been lowered relative to the groundwater performance standards established for the WSP Inactive Area OU. The changes in these standards were noted in the previous five-year review; however, the performance standards for these constituents have not been changed to match the new MCLs. However, because the WSP groundwater is not used for drinking water, and because there are ICs in place to prevent its use, the protectiveness of the remedy would not be affected.

At this time, it is recommended and documented in Section 9 that forward planning for the final ROD be begun, in consultation with DEQ, and in conjunction with continued progress in upstream remedy implementation. It is recommended that the appropriate surface water and groundwater standards be considered now or when issuing the final ROD, as appropriate.

Several other ARARs were either modified or repealed, although they are not anticipated to cause significant impacts to remedy protectiveness. Repealed standards included requirements for permitted facilities (ARM 17.54.702), odor control (ARM 16.8.1427), hazardous waste facilities (ARM 17.54.702 and ARM 17.54.701-703), contouring (ARM 17.24.514), livestock grazing (ARM 17.24.719), composition of vegetation (ARM 17.24.728), and measurement for trees and shrubs (ARM 17.24.733).

Surface Water

Arsenic
The current daily maximum and monthly average performance standard for arsenic in surface water discharge from the WSP is 0.020 mg/L. This performance standard is lower than the state and federal acute and chronic aquatic life standards, but exceeds the state human health standard for surface water of 10 µg/L (MCL). Water quality in the discharge from the WSP does not exceed current federal and state aquatic life standards and, therefore, must be considered protective of aquatic life to downstream ecological receptors. Arsenic in discharged surface water from the ponds does exceed the current federal and state human health standards. However, the water in the upper Clark Fork River is not used directly as a drinking water source. Additionally,

existing institutional controls prohibit swimming in the WSP and the upper Clark Fork River. Thus, although the interim remedy does not meet the ARARs, there is not a pathway for human exposure to arsenic at levels in surface water that would reasonably present a human health risk so the interim remedy continues to be protective of human health.

Copper
From 1998 through 2004, the existing daily maximum (0.026 mg/L) and monthly average (0.017 mg/L) performance standards for copper, were exceeded in 2 percent and 10 percent of the samples analyzed for Pond 2 discharge (SS-5), respectively. However, from 2005 through 2009, the performance standards for copper were not exceeded. Lowering of the standard may result in increased numbers of exceedances, but if met, would provide a higher level of protection to downstream aquatic receptors. It is believed that operation of the WSP cannot be measurably improved because the WSPs are performing at their maximum ability.

Groundwater

Since implementation of the remedy at the WSPOUs, the federal Safe Drinking Water Act MCLs and the State of Montana human health standards for groundwater for arsenic, cadmium, chromium, and lead have been lowered, relative to the groundwater performance standards established for the WSP. (Currently, groundwater in the area of the WSP is not used as a drinking water source and, therefore, lowering of the groundwater performance standards to be consistent with state and/or federal drinking water standards would not affect the protectiveness of the remedy with regard to human health). In consultation with DEQ, EPA should consider revising the existing groundwater standards to meet the current federal and state MCLs at the both WSPOUs.

Changes in Exposure Pathways
No changes in site conditions that affect exposure pathways were identified as part of this five-year review.

The WSPOUs are suitable and controlled for recreational uses and open space, and occupational use (e.g., FWP employees) and not residential development. Physical or land use changes have not altered potential exposure pathways for workers or recreational visitors. An IC protects recreational users by banning swimming in the ponds; this provision has been implemented through the posting of notices on the bulletin boards and entrances maintained and managed by FWP.

Changes in Toxicity and Other Contaminant Characteristics
Minor changes in toxicity values for human health (i.e., oral cancer slope factor for arsenic) would not alter the conclusions of the human health risk assessment or result in a change to the protectiveness of the remedy. The human health-based standard for arsenic in surface water and groundwater under the State of Montana water quality standards (Circular DEQ-7, published in 2008) was lowered since the ROD.

This lowering of the arsenic standard brings the state human health-based standards in line with the federal MCL for arsenic.

Expected Progress Towards Meeting RAOs

In large part, RAOs at the WSP have been met and conditions have improved dramatically over pre-remedial conditions. In general, the WSP are supporting a healthy, diverse, and abundant aquatic, terrestrial, and avian wildlife population. There is uncertainty as to whether the arsenic performance standard can be met. Currently, the remedial action is protective of human health and the environment.

7.3 Question C: Has Any Other Information Come To Light That Could Call Into Question The Protectiveness Of The Remedy?

No. There is no other information that has come to light that would call into question the protectiveness of the remedy. The remedy is functioning as intended and is effectively removing contaminants from Silver Bow Creek that would have otherwise discharged directly into the Upper Clark Fork River. The site will continue to be monitored and evaluated for any changes in this regard.

Currently, the WSP construction and operations are governed by the selected remedy in the interim RODs. The interim RODs were put in place with the intention of selecting a final site remedy once upstream conditions warranted such an effort.

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Section 8
Issues

Based on information collected during preparation of this five-year review report, the following issues were identified and summarized in Table 8-1.

Table 8-1
WSP OUs Issues Summary

Issue No.	Issue	Affects Current Protectiveness (Y/N)	Affects Future Protectiveness (Y/N)
1	Arsenic standard seasonally exceeded in effluent.	Yes	Yes
2	New exposure pathways for wildlife/aquatic life may now be present. These have not yet been evaluated	Unknown	Yes
3	A final ROD has not been issued. Final construction of the upstream SSTOU will soon make it possible for a final decision for this OU	No	No

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Section 9
Recommendations and Follow-Up Actions

Table 9-1 presents recommendations and follow-up actions for the WSPOUs.

Table 9-1
Recommendations and Follow-Up Actions

Issue	Recommendation and Follow-Up Action	Party Responsible	Oversight Agency	Milestone Date
1	Complete arsenic treatment optimization studies, and then determine if meeting RAOs is feasible.	Atlantic Richfield	EPA	December 31, 2014
2	Evaluate contaminant pathways.	EPA/Atlantic Richfield	EPA	December 31, 2014
3	Begin forward planning for the final ROD (including data collection efforts, updated risk assessments, and feasibility studies).	EPA/DEQ	EPA/DEQ	December 31, 2014

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Section 10
Protectiveness Statement

The remedy at WSPOUs 04 and 12 is not protective because the arsenic standard is not met in the Pond discharge. In order to ensure protectiveness, full remedy implementation must progress at other OUs upstream. Further, it is unknown if additional human or wildlife exposures are occurring within these OUs.

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Section 11
Next Review

The next five-year review for the WSPOUs is required by September 30, 2015, five years from the date of this review.

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Section 12
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Figures

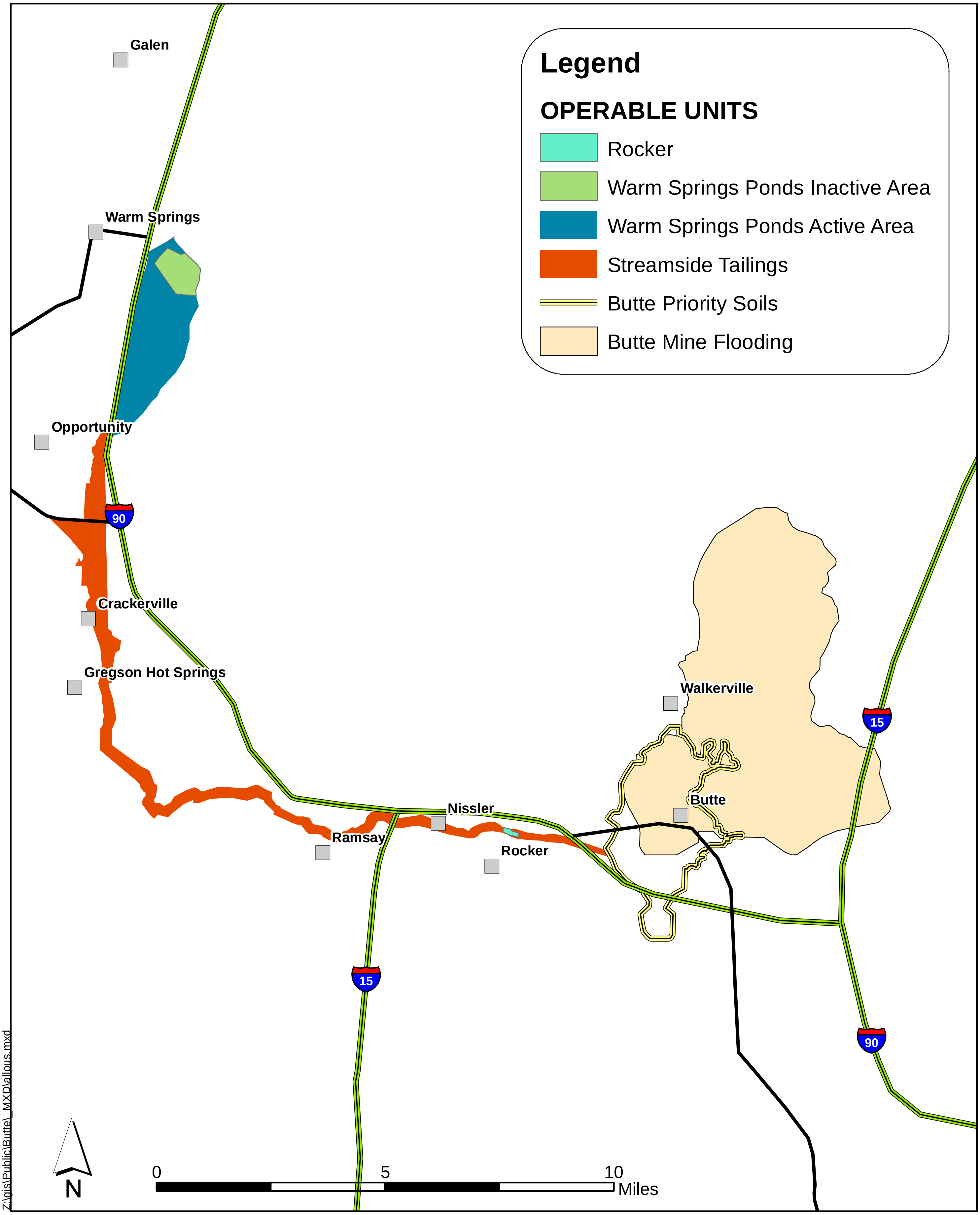


Figure 3-1 Operable Units in the Silver Bow Creek/Butte Area Site

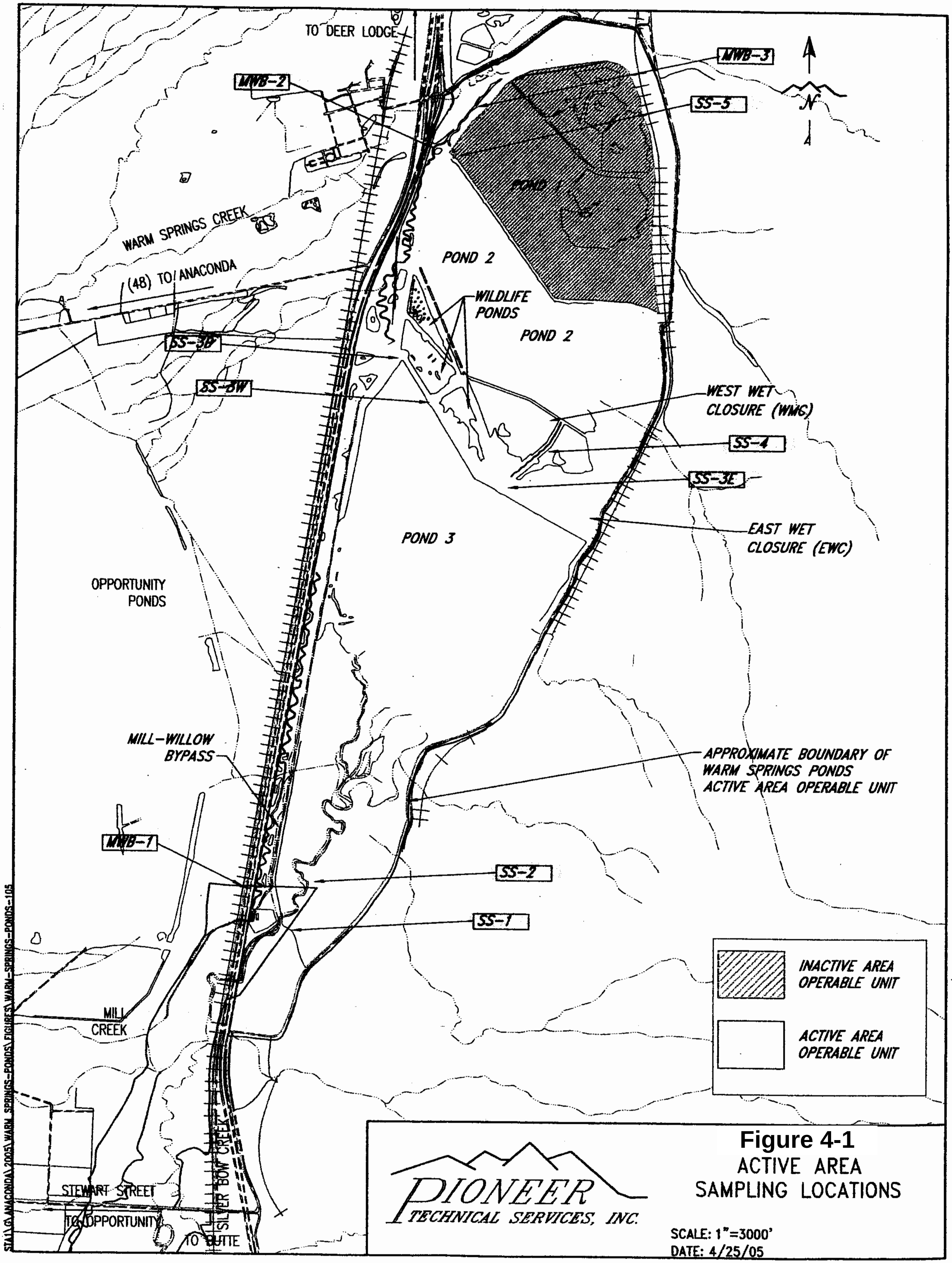
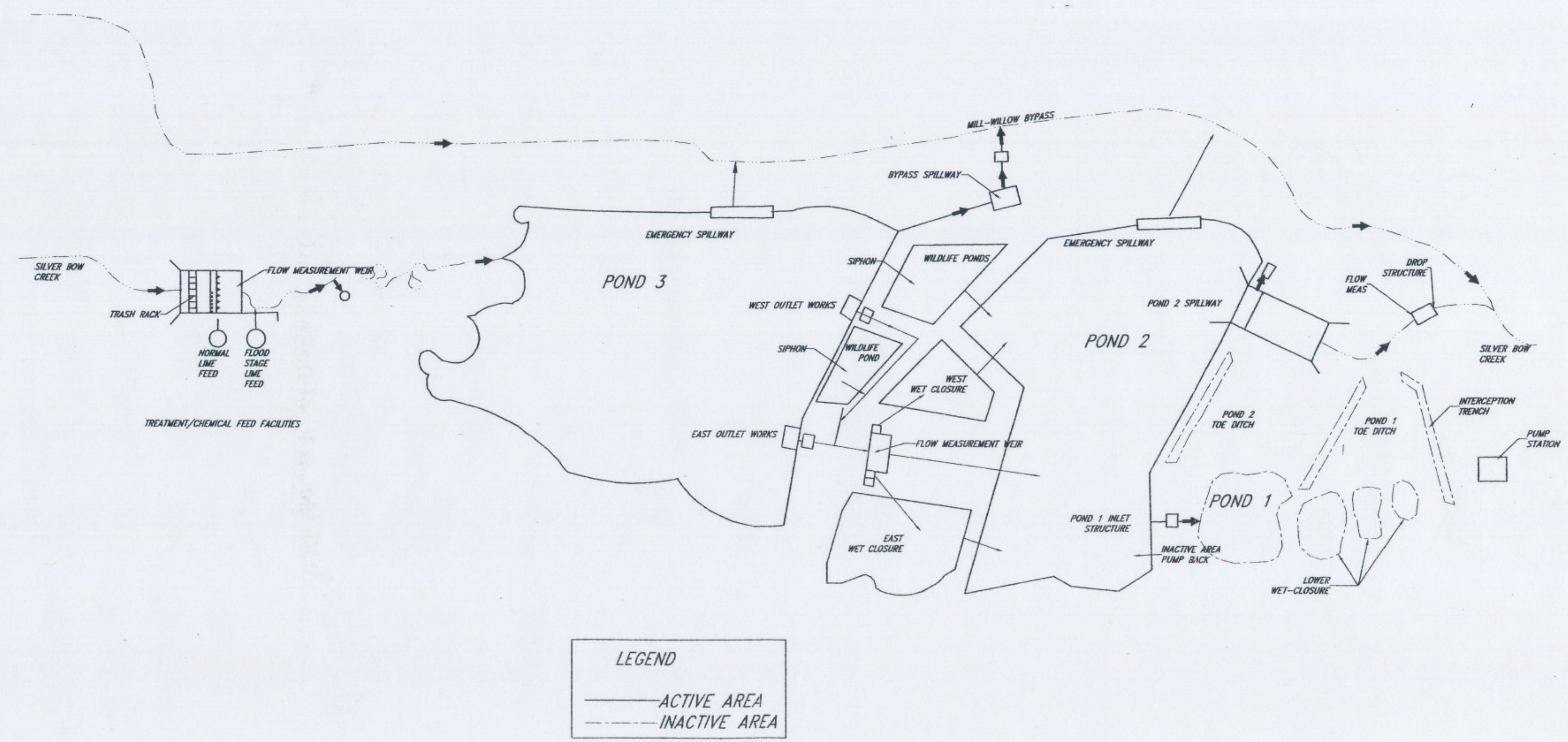


Figure 4-1
ACTIVE AREA SAMPLING LOCATIONS



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PIONEER TECHNICAL SERVICES, INC.

Figure 4-2
ACTIVE AREA SCHEMATIC GENERAL FLOW

SCALE: N.T.S.
DATE: 4/25/05

Figure 4-3
Influent (SS-1) and Effluent (SS-5) Daily Flow Rates for the Warm Springs Ponds
Silver Bow Creek/Butte Area Superfund Site, Five-Year Review, 2010

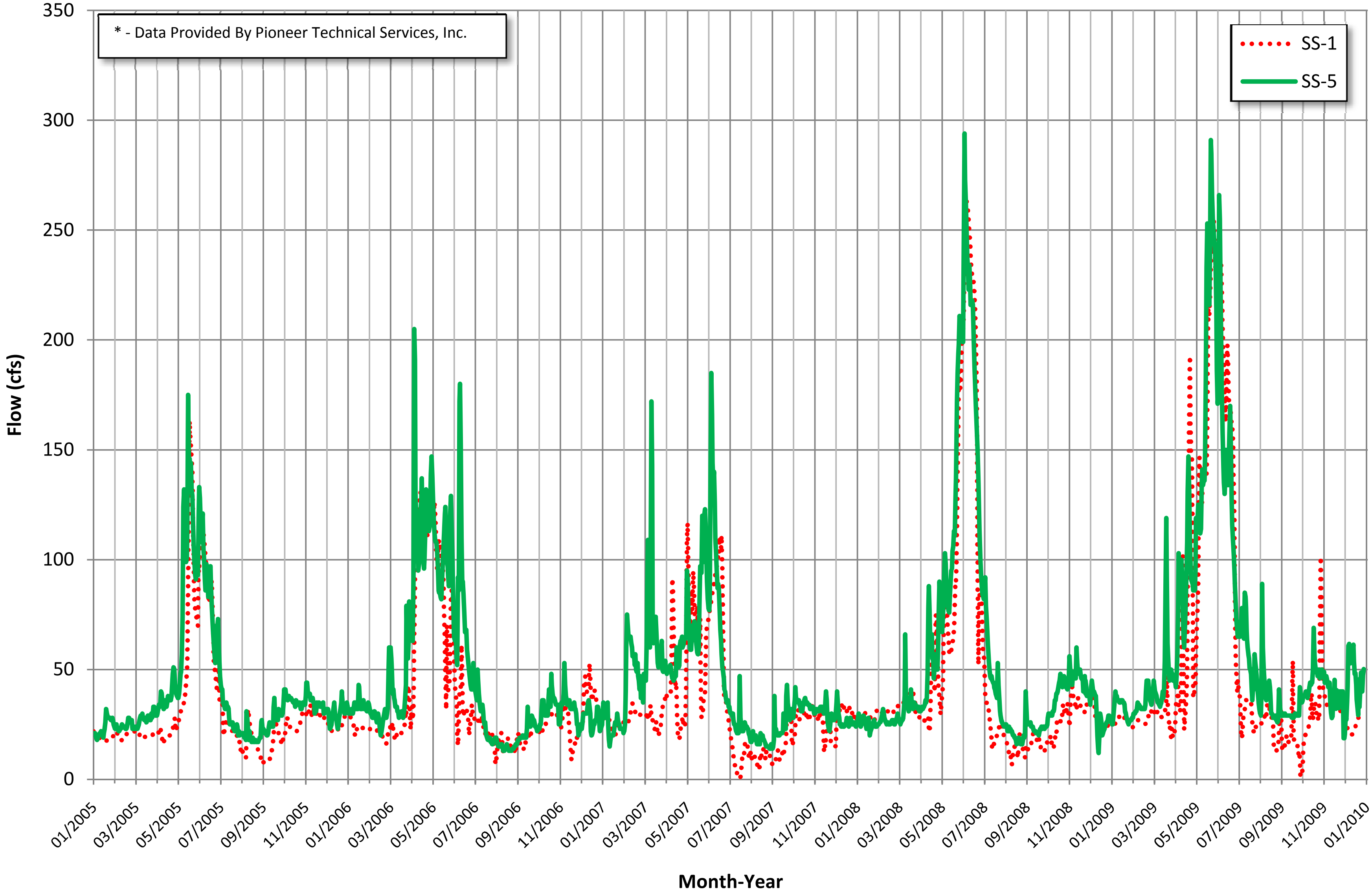

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Figure 4-4

Influent (SS-1) and Effluent (SS-5) Monthly Average Flow Rates for the Warm Springs Ponds

Silver Bow Creek/Butte Area Superfund Site, Five-Year Review, 2010

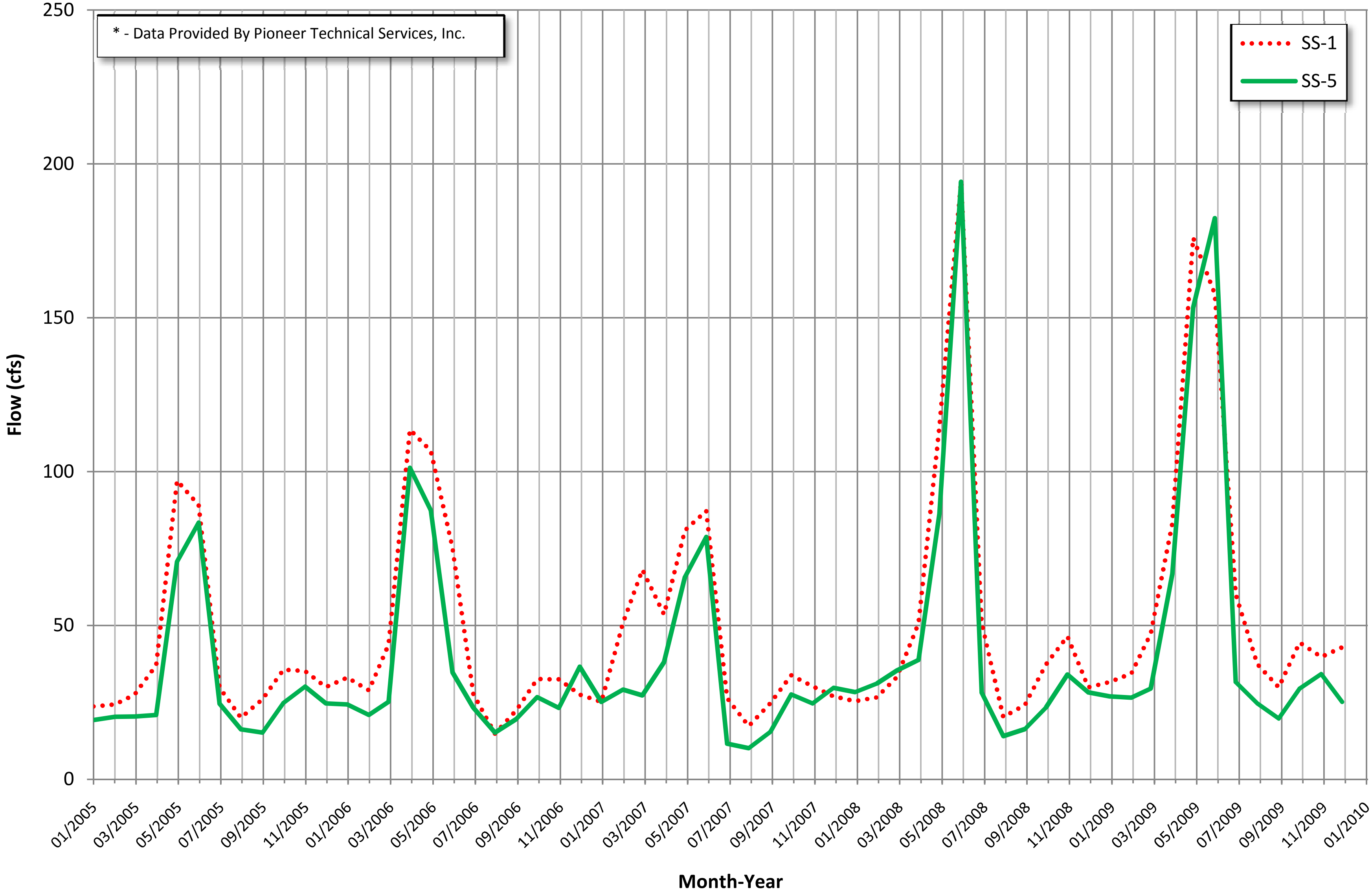

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Figure 4-5
Pond 2 Water Surface Elevation at the Warm Springs Ponds
Silver Bow Creek/Butte Area Superfund Site, Five-Year Review, 2010

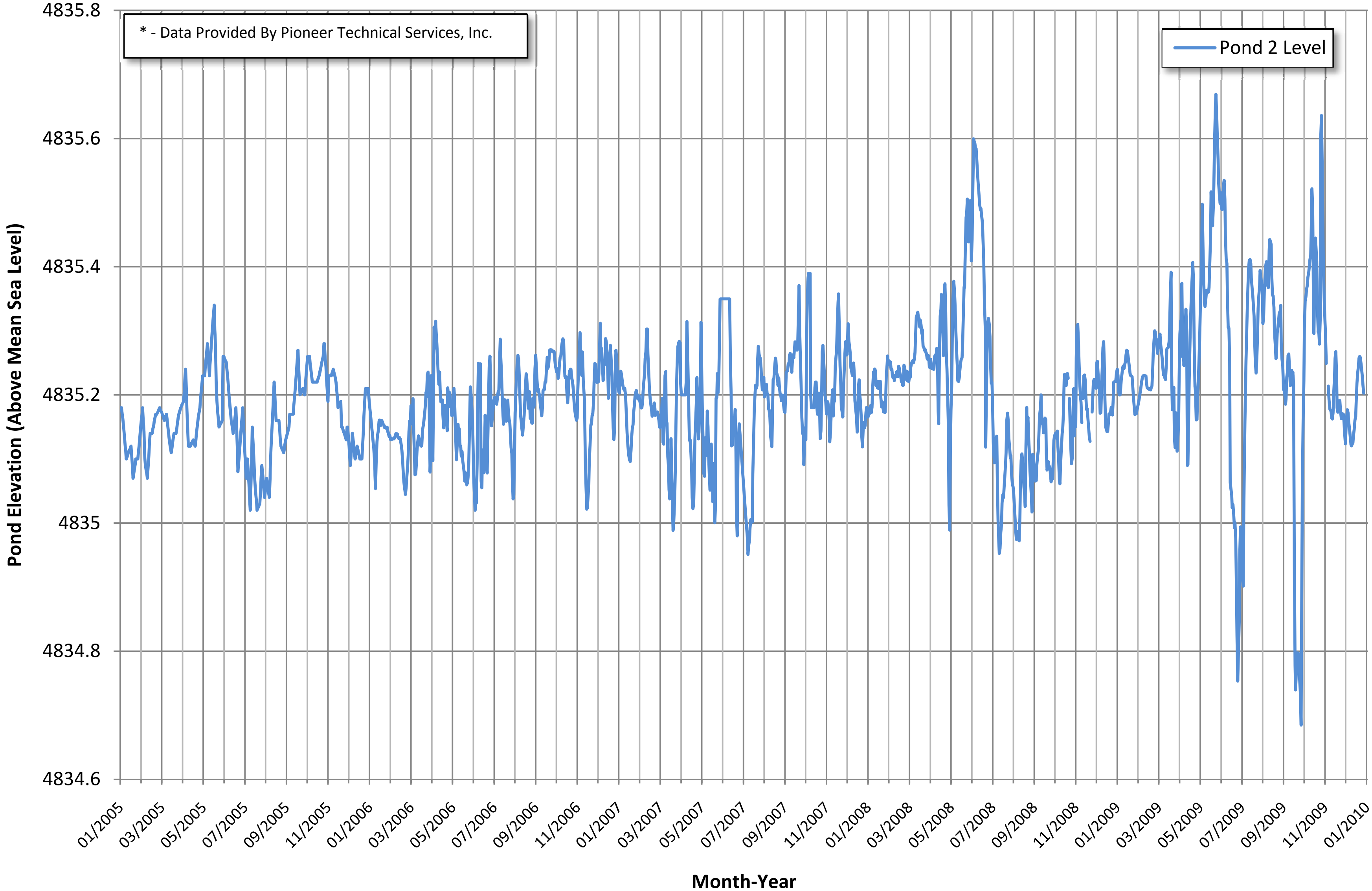

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Figure 4-6

Pond 3 Water Surface Elevation at the Warm Springs Ponds

Silver Bow Creek/Butte Area Superfund Site, Five-Year Review, 2010

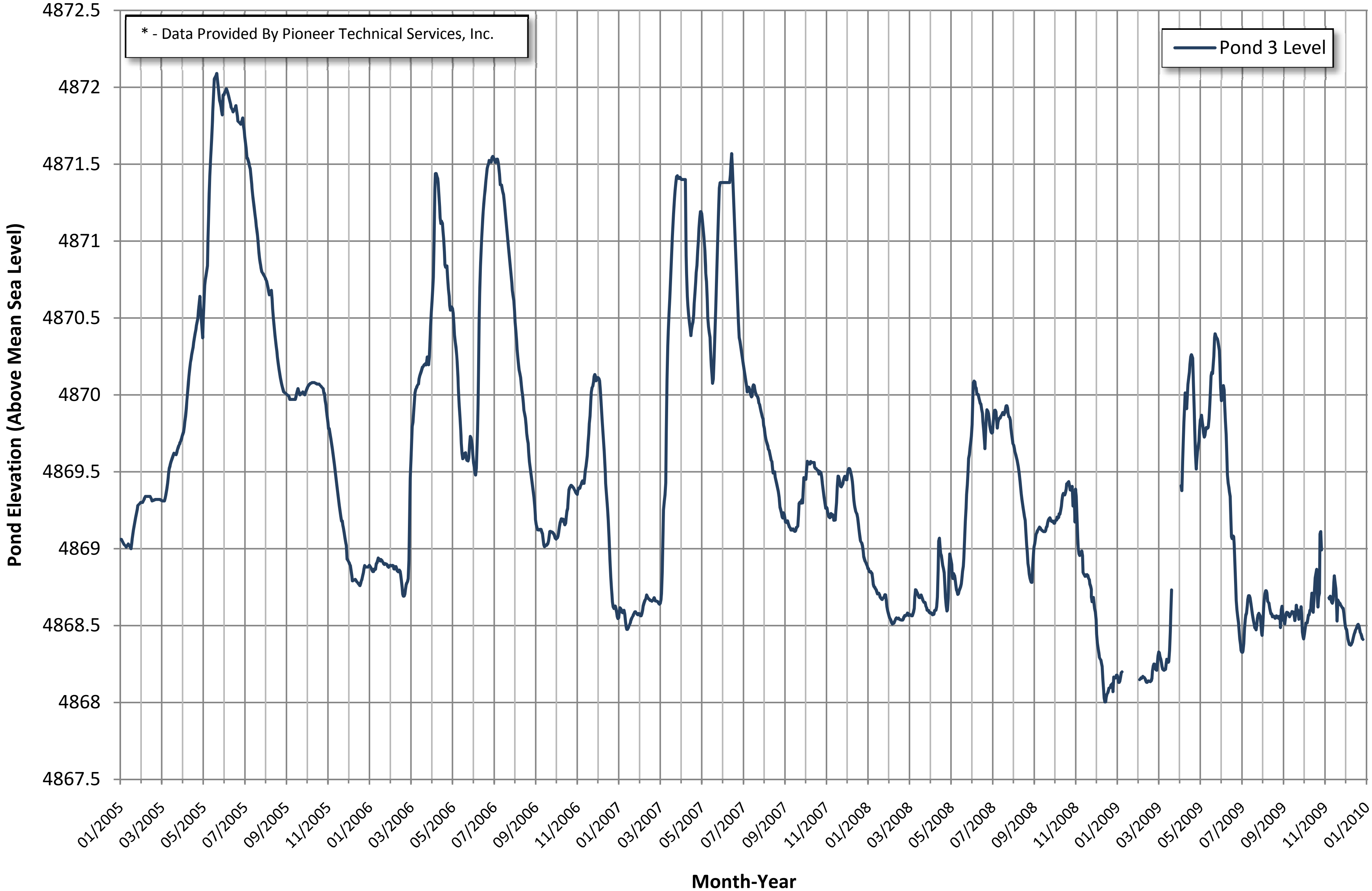

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Figure 6-1
Comparison of Influent (SS-1) and Effluent (SS-5) Total Recoverable Arsenic Concentrations with Final Daily Maximum Standard
Silver Bow Creek/Butte Area Superfund Site, Five-Year Review, 2010

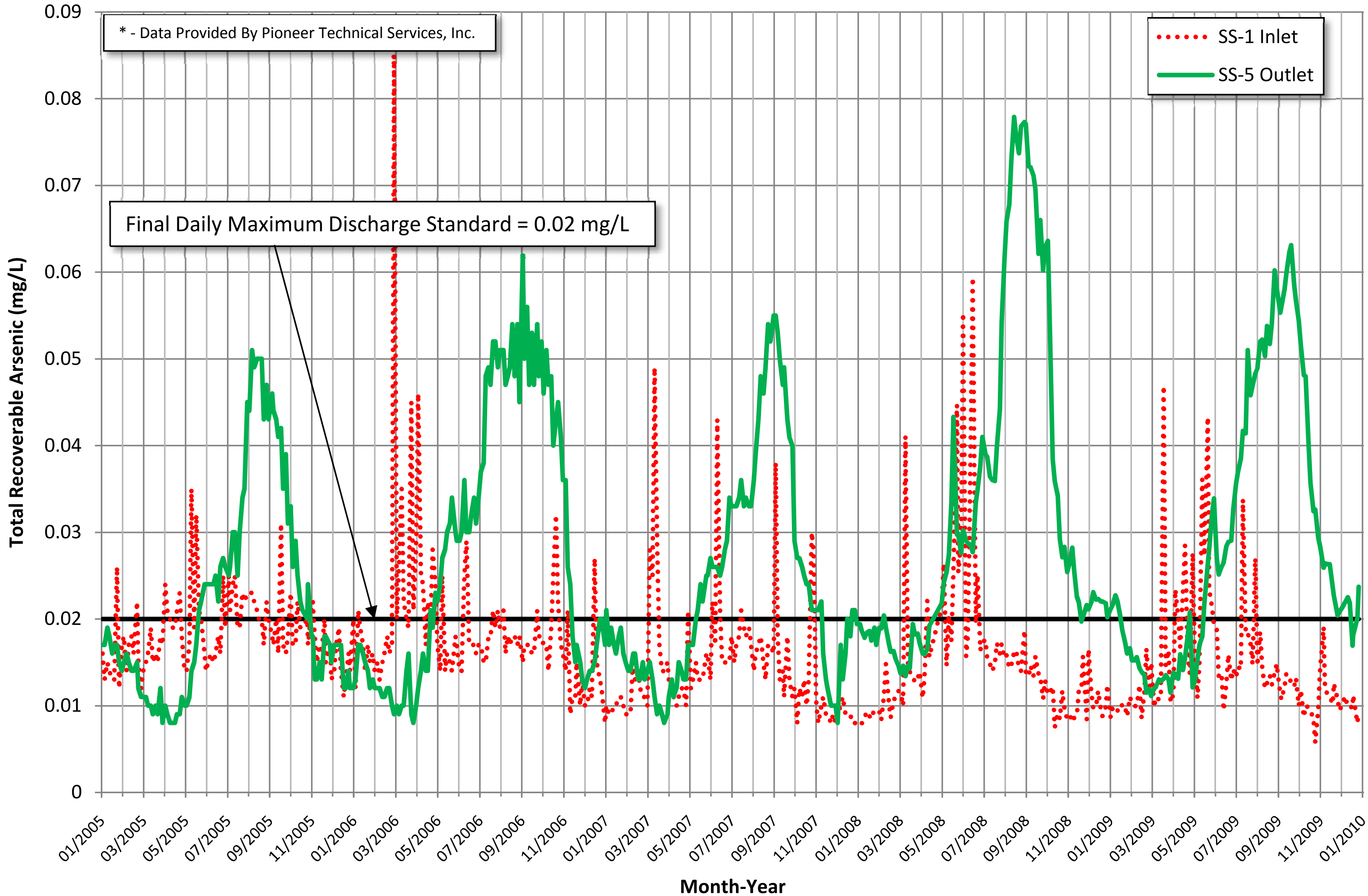

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Figure 6-2
Comparison of Influent (SS-1) and Effluent (SS-5) Total Recoverable Arsenic Concentrations with Final Monthly Average Standard
Silver Bow Creek/Butte Area Superfund Site, Five-Year Review, 2010

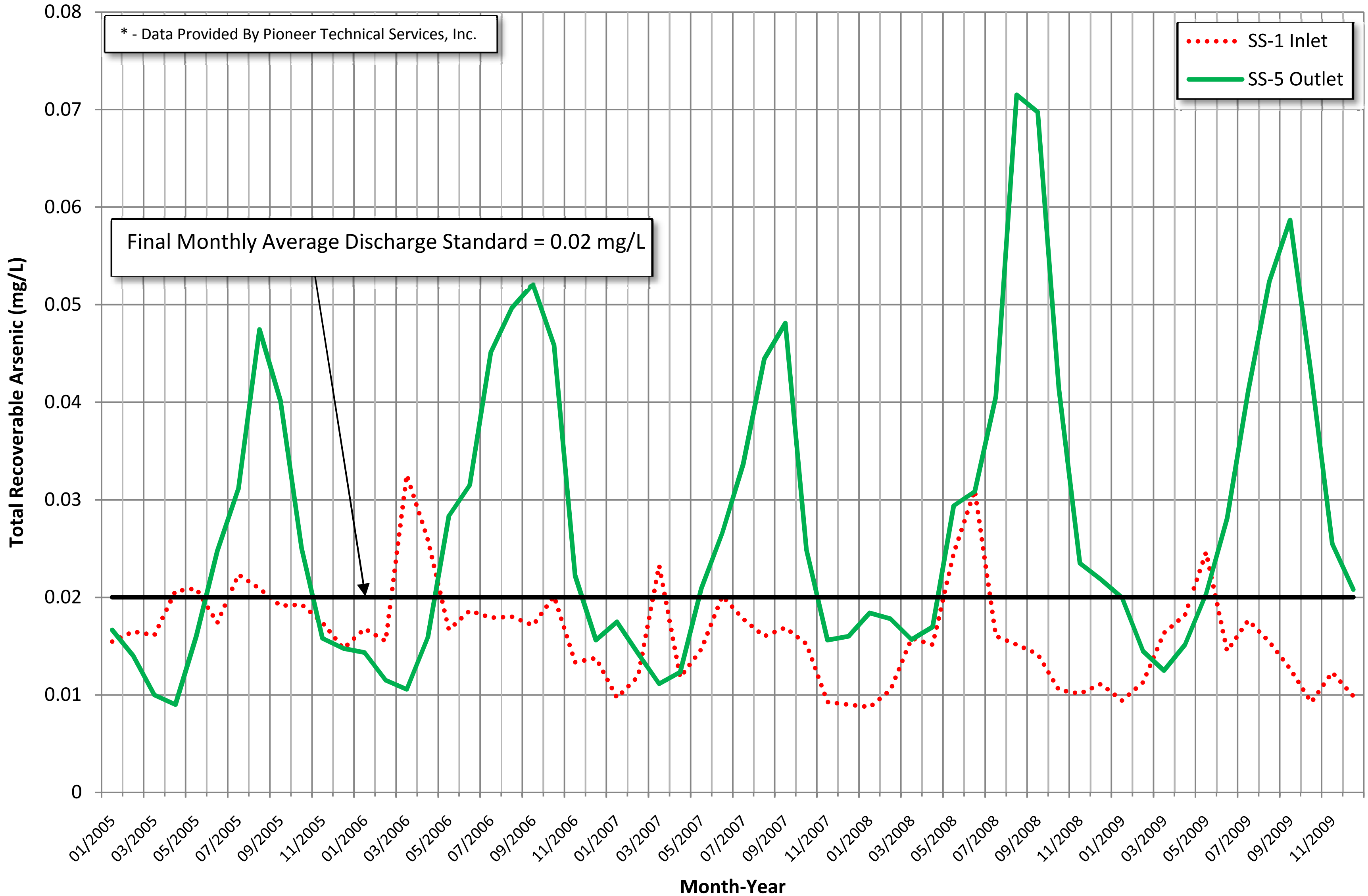

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Figure 6-3
Comparison of Influent (SS-1) Total Recoverable Arsenic and Flow Rate
Silver Bow Creek/Butte Area Superfund Site, Five-Year Review, 2010

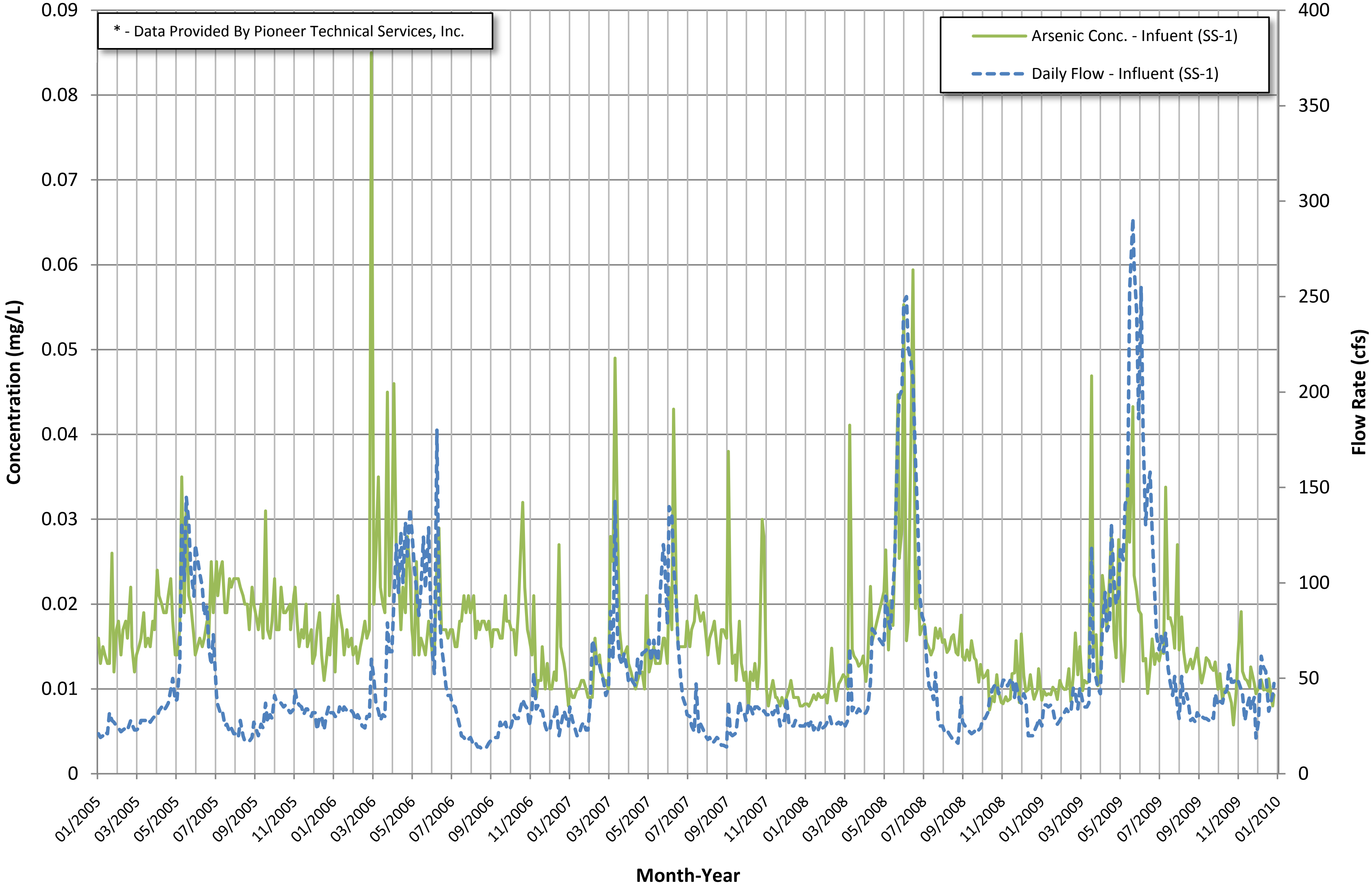

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Figure 6-4

Comparison of Effluent (SS-5) Total Recoverable Arsenic and Flow Rate

Silver Bow Creek/Butte Area Superfund Site, Five-Year Review, 2010

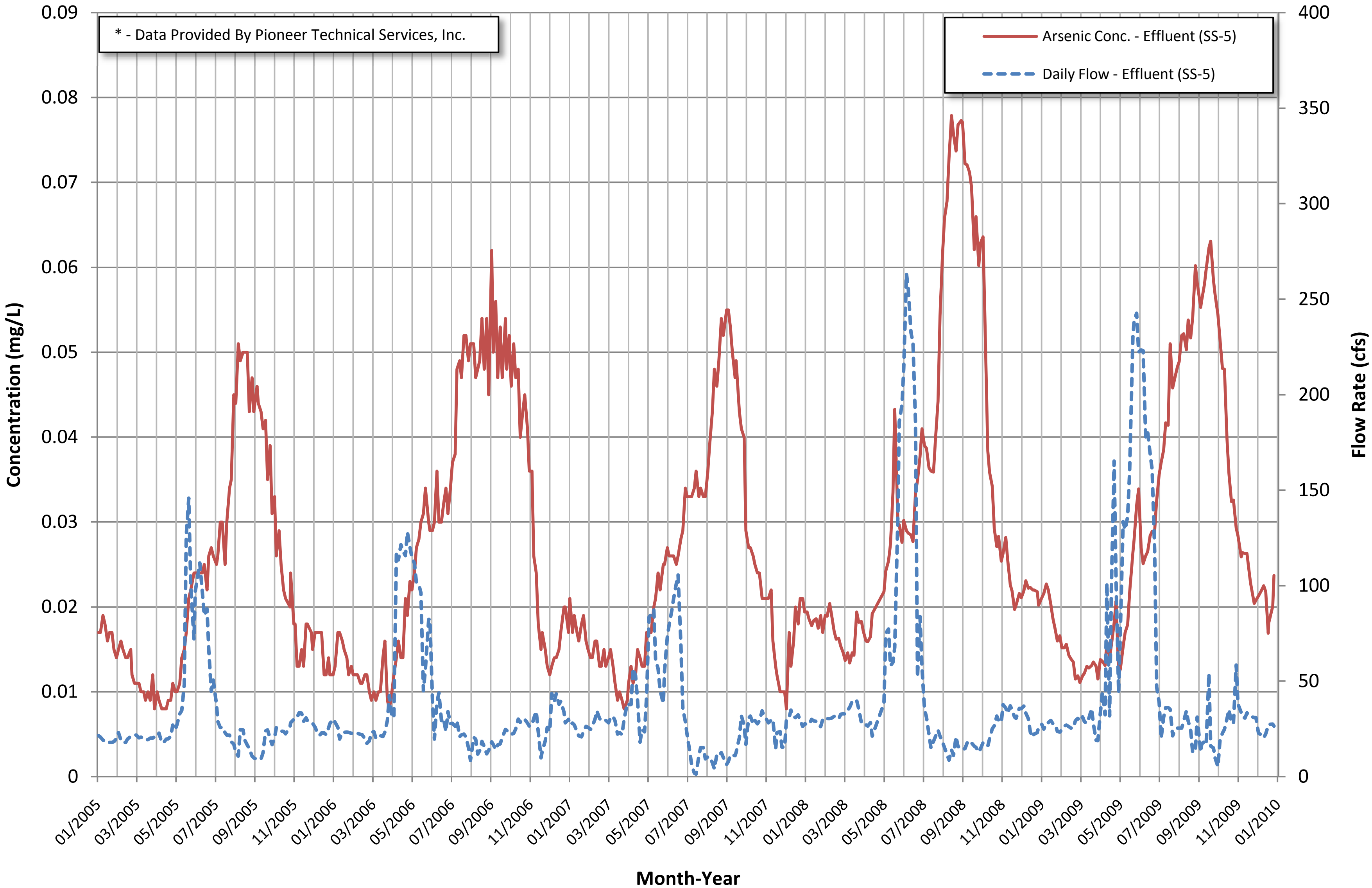

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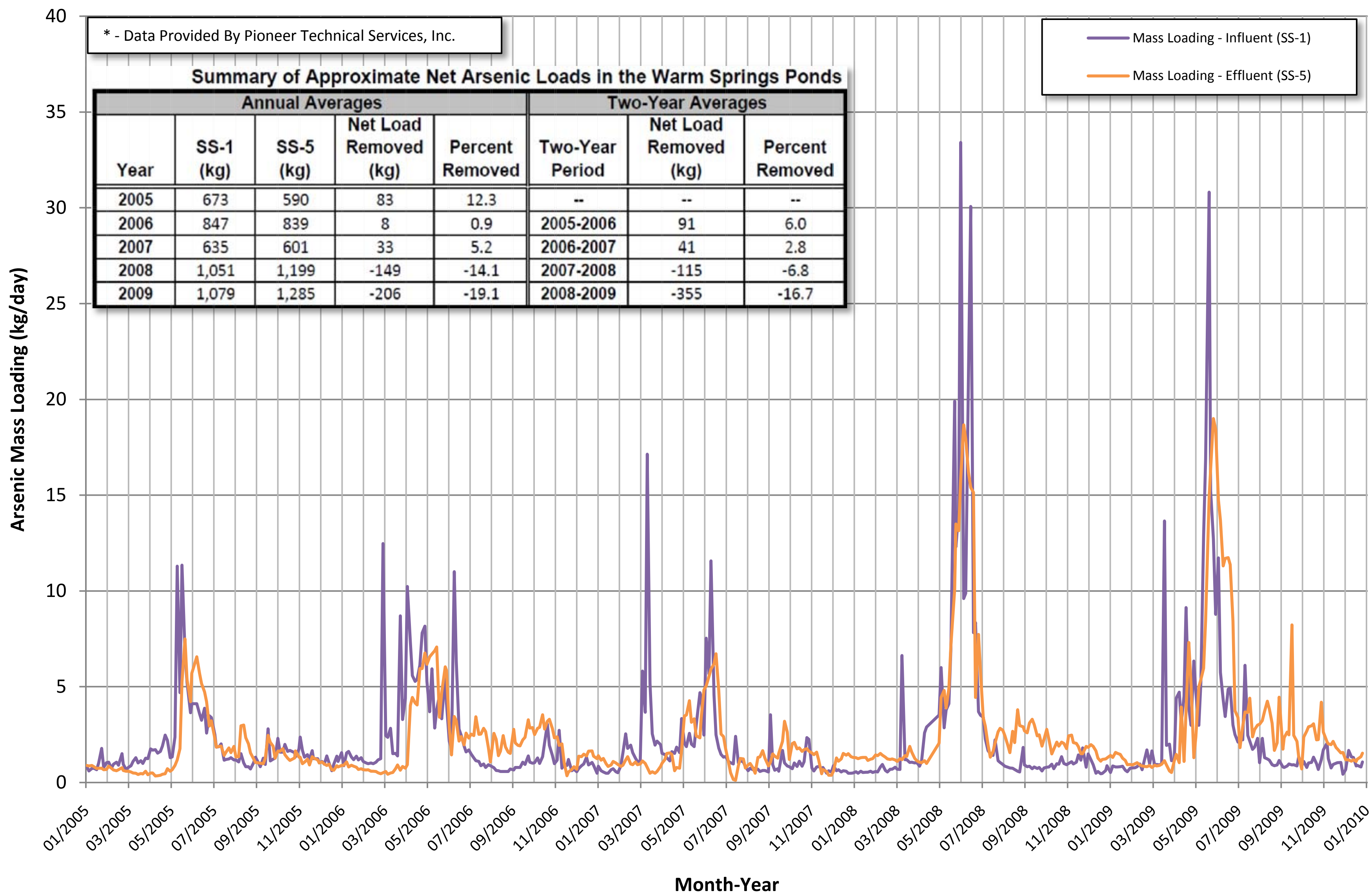
Figure 6-5
Comparison of Influent (SS-1) and Effluent (SS-5) Arsenic Mass Loading
Silver Bow Creek/Butte Area Superfund Site, Five-Year Review, 2010



Summary of Approximate Net Arsenic Loads in the Warm Springs Ponds

Annual Averages					Two-Year Averages		
Year	SS-1 (kg)	SS-5 (kg)	Net Load Removed (kg)	Percent Removed	Two-Year Period	Net Load Removed (kg)	Percent Removed
2005	673	590	83	12.3	--	--	--
2006	847	839	8	0.9	2005-2006	91	6.0
2007	635	601	33	5.2	2006-2007	41	2.8
2008	1,051	1,199	-149	-14.1	2007-2008	-115	-6.8
2009	1,079	1,285	-206	-19.1	2008-2009	-355	-16.7

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Figure 6-6
Comparison of Influent (SS-1) and Effluent (SS-5) Total Recoverable Cadmium Concentrations with Final Daily Maximum Standard
Silver Bow Creek/Butte Area Superfund Site, Five-Year Review, 2010

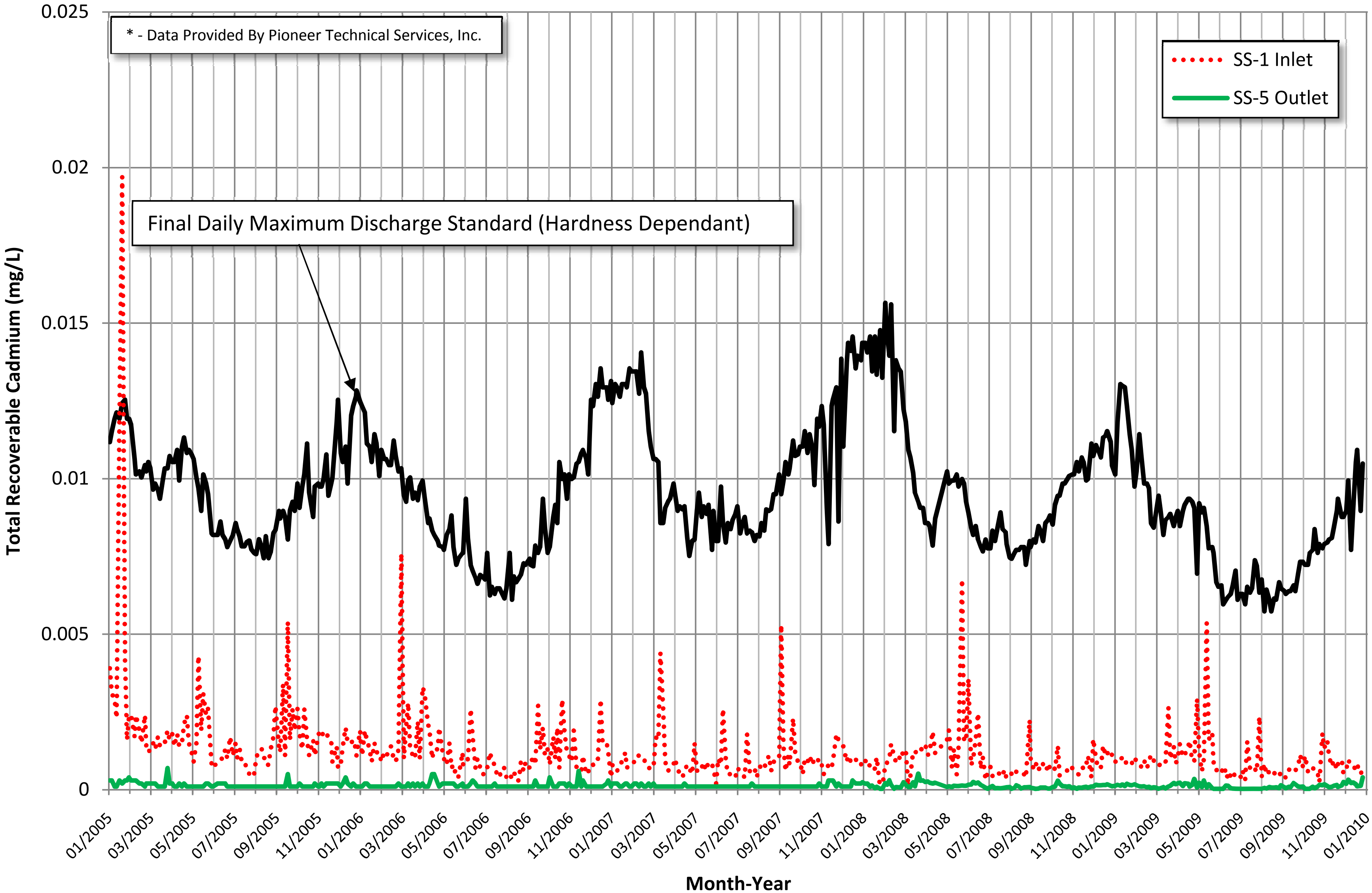

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Figure 6-7
Comparison of Influent (SS-1) and Effluent (SS-5) Total Recoverable Cadmium Concentrations with Final Monthly Average Standard
Silver Bow Creek/Butte Area Superfund Site, Five-Year Review, 2010

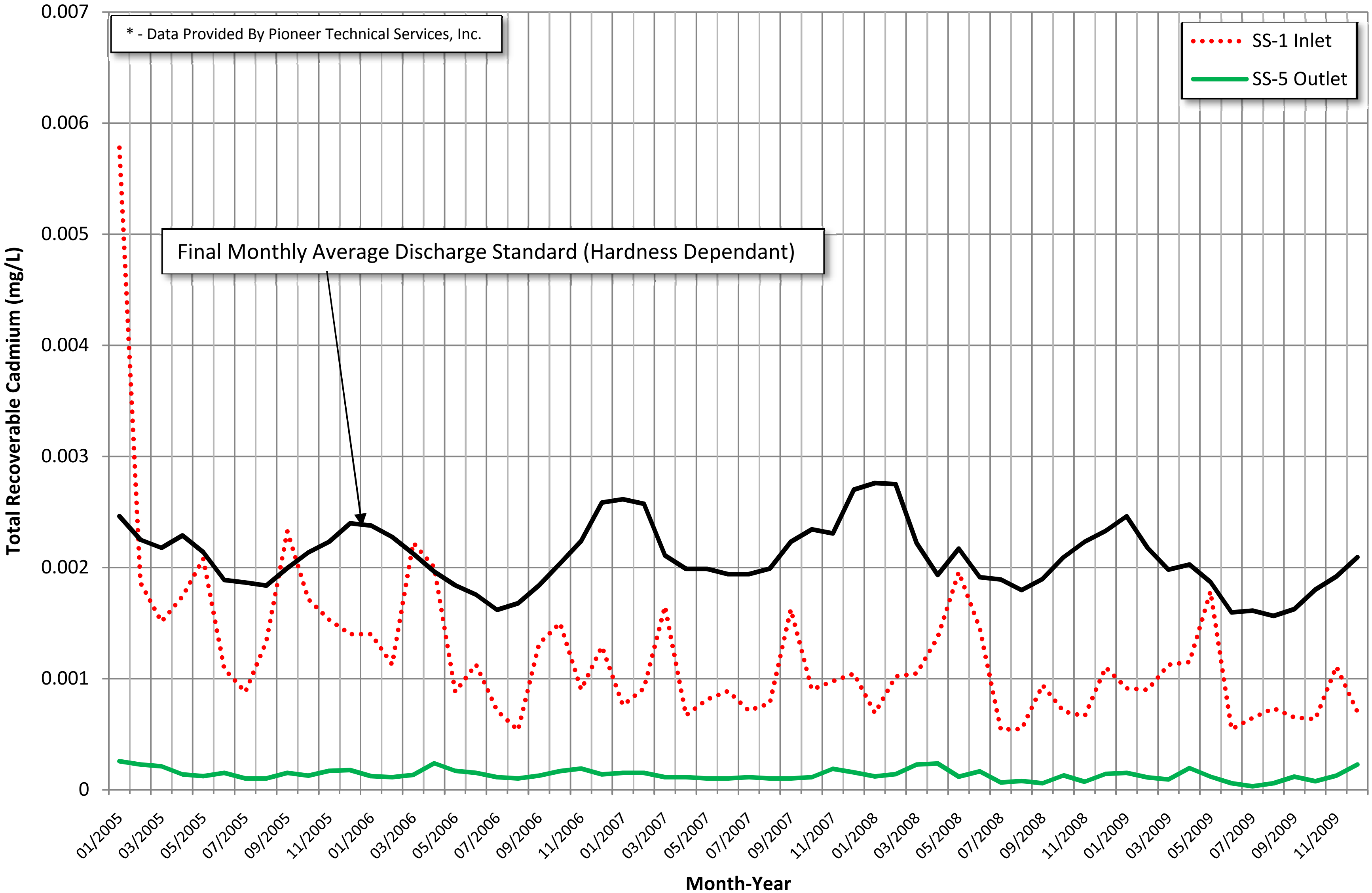

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Figure 6-8
Comparison of Influent (SS-1) and Effluent (SS-5) Total Recoverable Copper Concentrations with Final Daily Maximum Standard
Silver Bow Creek/Butte Area Superfund Site, Five-Year Review, 2010

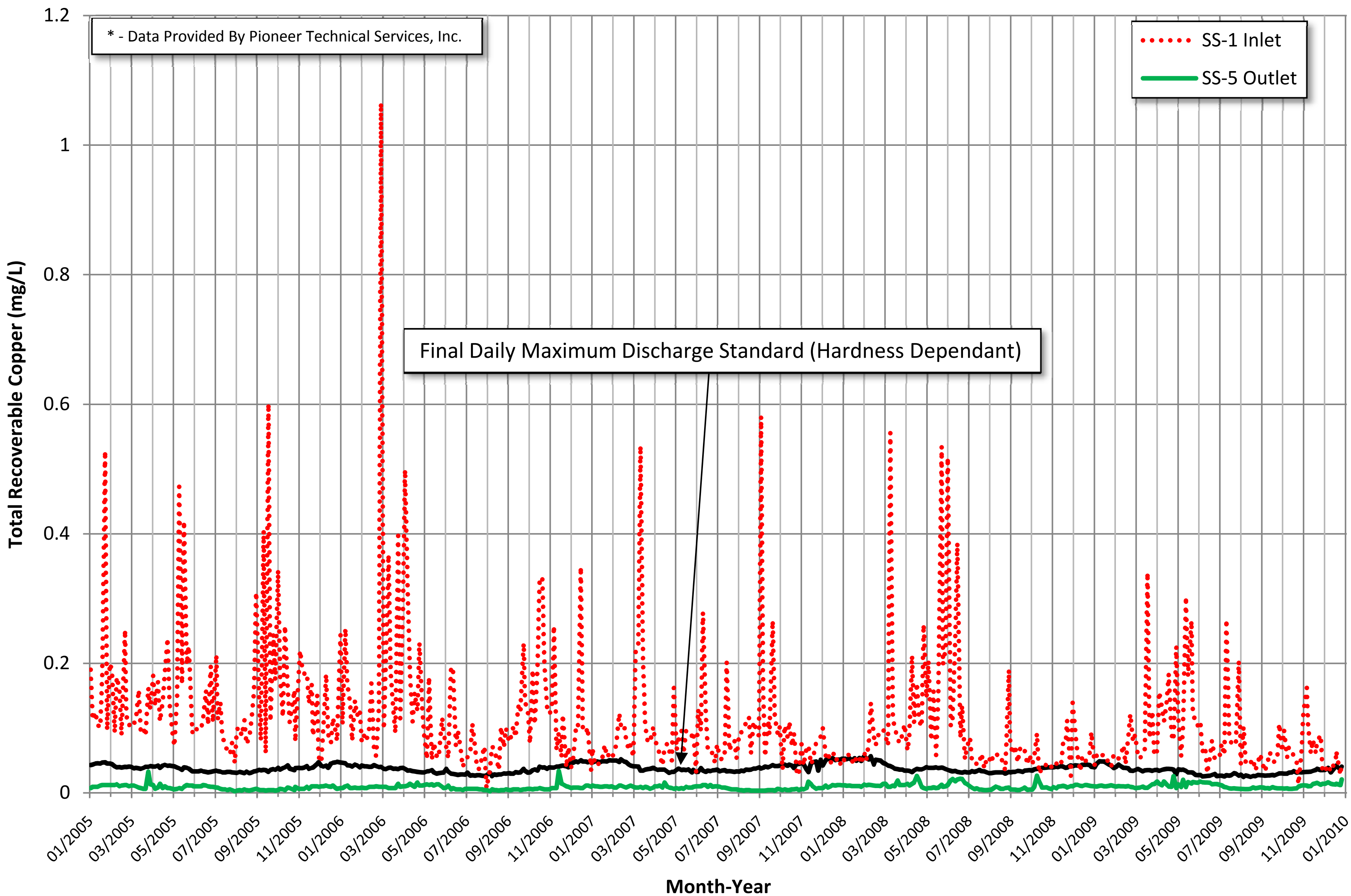

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Figure 6-9
Comparison of Influent (SS-1) and Effluent (SS-5) Total Recoverable Copper Concentrations with Final Monthly Average Standard
Silver Bow Creek/Butte Area Superfund Site, Five-Year Review, 2010

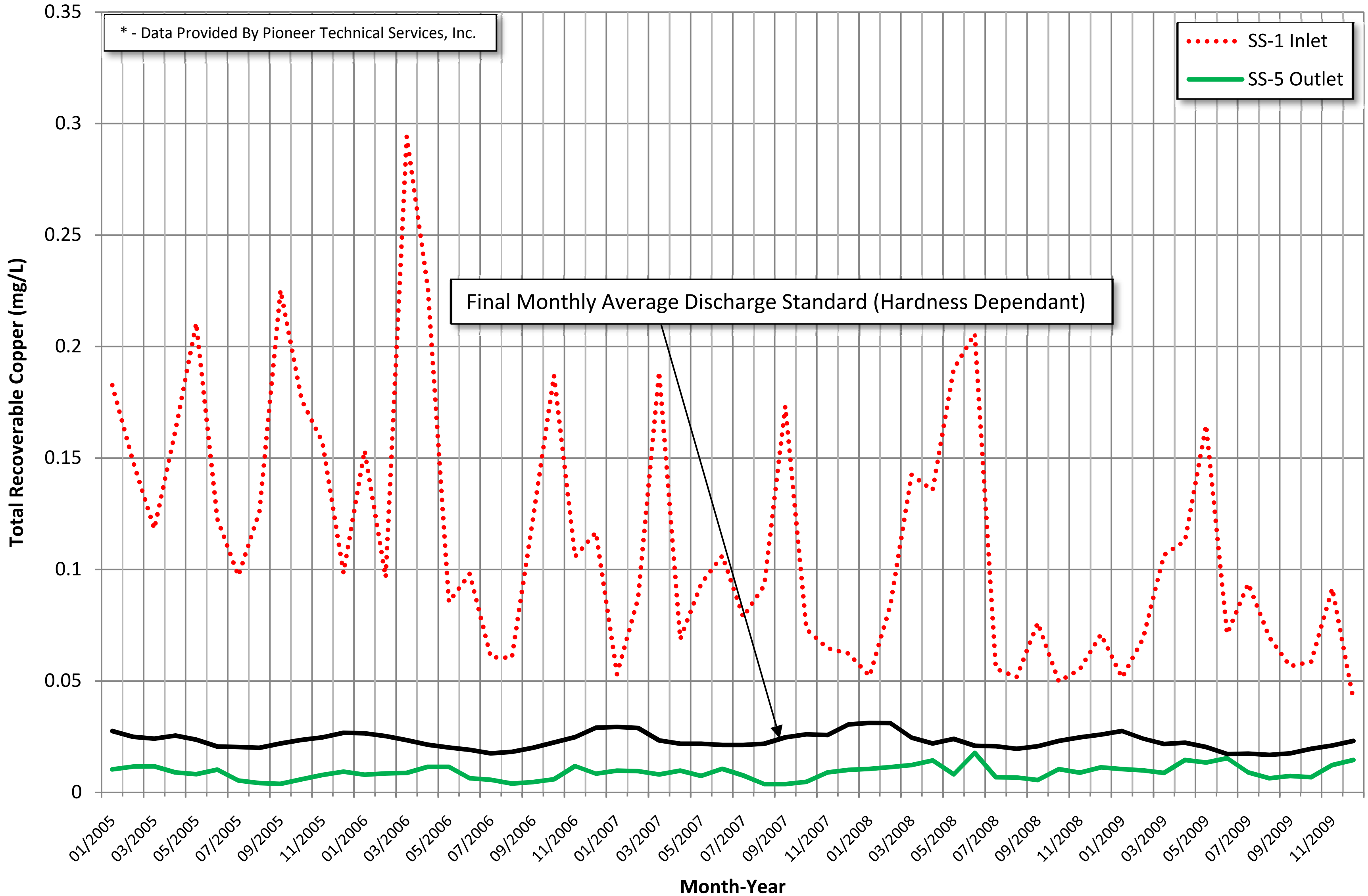

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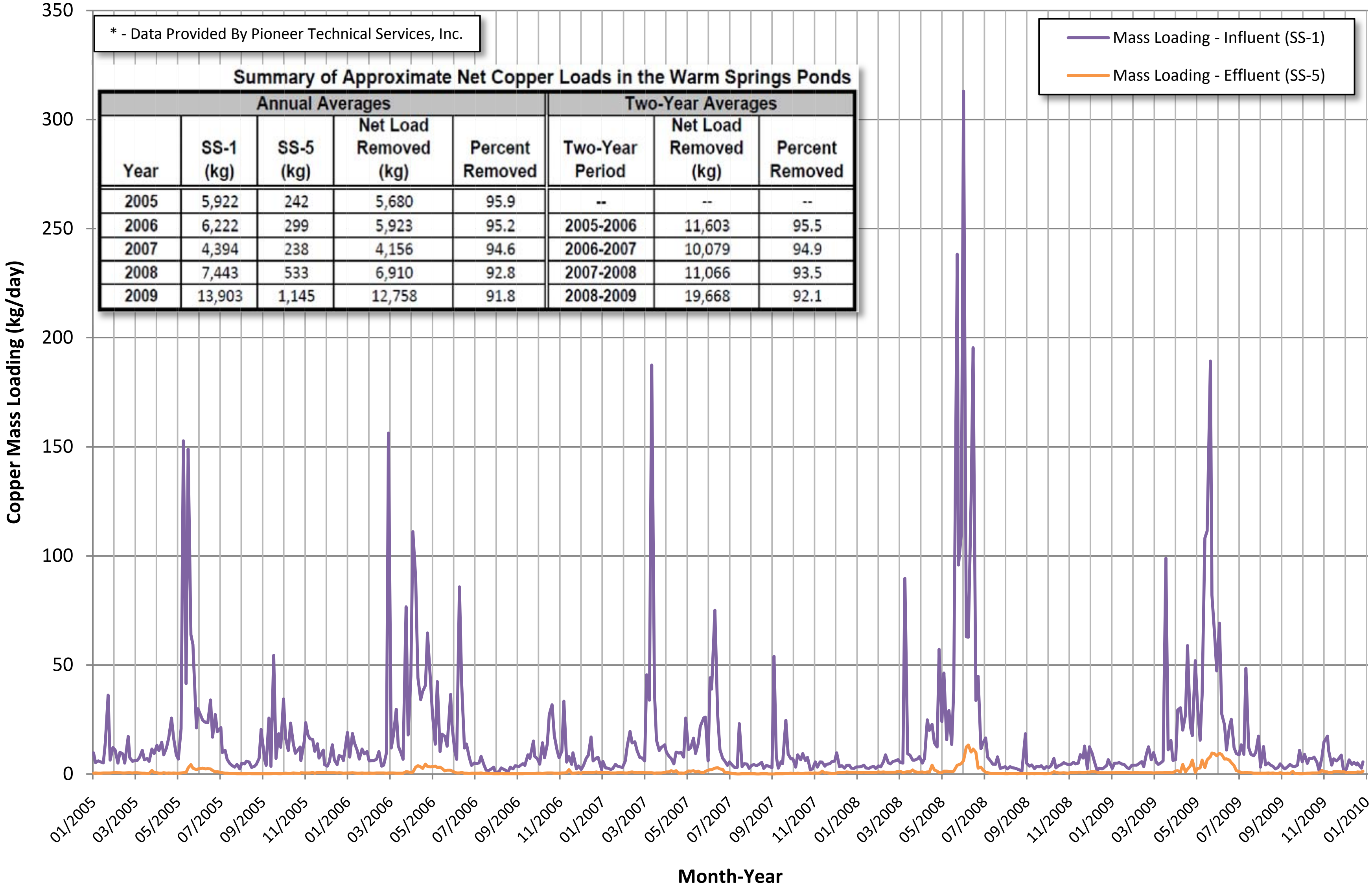
Figure 6-10
Comparison of Influent (SS-1) and Effluent (SS-5) Copper Mass Loading
Silver Bow Creek/Butte Area Superfund Site, Five-Year Review, 2010



Summary of Approximate Net Copper Loads in the Warm Springs Ponds

Annual Averages					Two-Year Averages		
Year	SS-1 (kg)	SS-5 (kg)	Net Load Removed (kg)	Percent Removed	Two-Year Period	Net Load Removed (kg)	Percent Removed
2005	5,922	242	5,680	95.9	--	--	--
2006	6,222	299	5,923	95.2	2005-2006	11,603	95.5
2007	4,394	238	4,156	94.6	2006-2007	10,079	94.9
2008	7,443	533	6,910	92.8	2007-2008	11,066	93.5
2009	13,903	1,145	12,758	91.8	2008-2009	19,668	92.1

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Figure 6-11
Comparison of Influent (SS-1) and Effluent (SS-5) Total Recoverable Iron Concentrations with Final Daily Maximum Standard
Silver Bow Creek/Butte Area Superfund Site, Five-Year Review, 2010

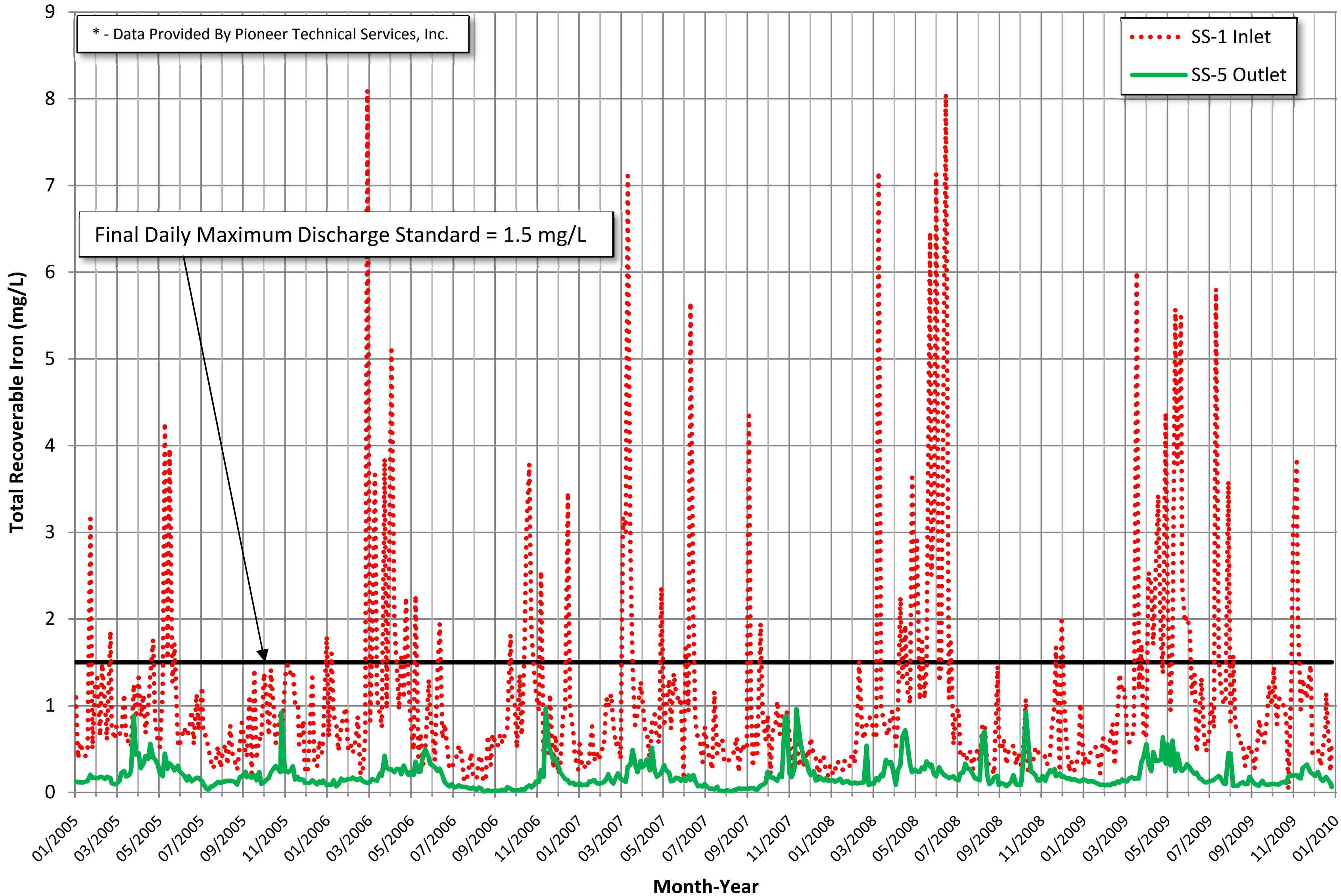

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Figure 6-12
Comparison of Influent (SS-1) and Effluent (SS-5) Total Recoverable Iron Concentrations with Final Monthly Average Standard
Silver Bow Creek/Butte Area Superfund Site, Five-Year Review, 2010

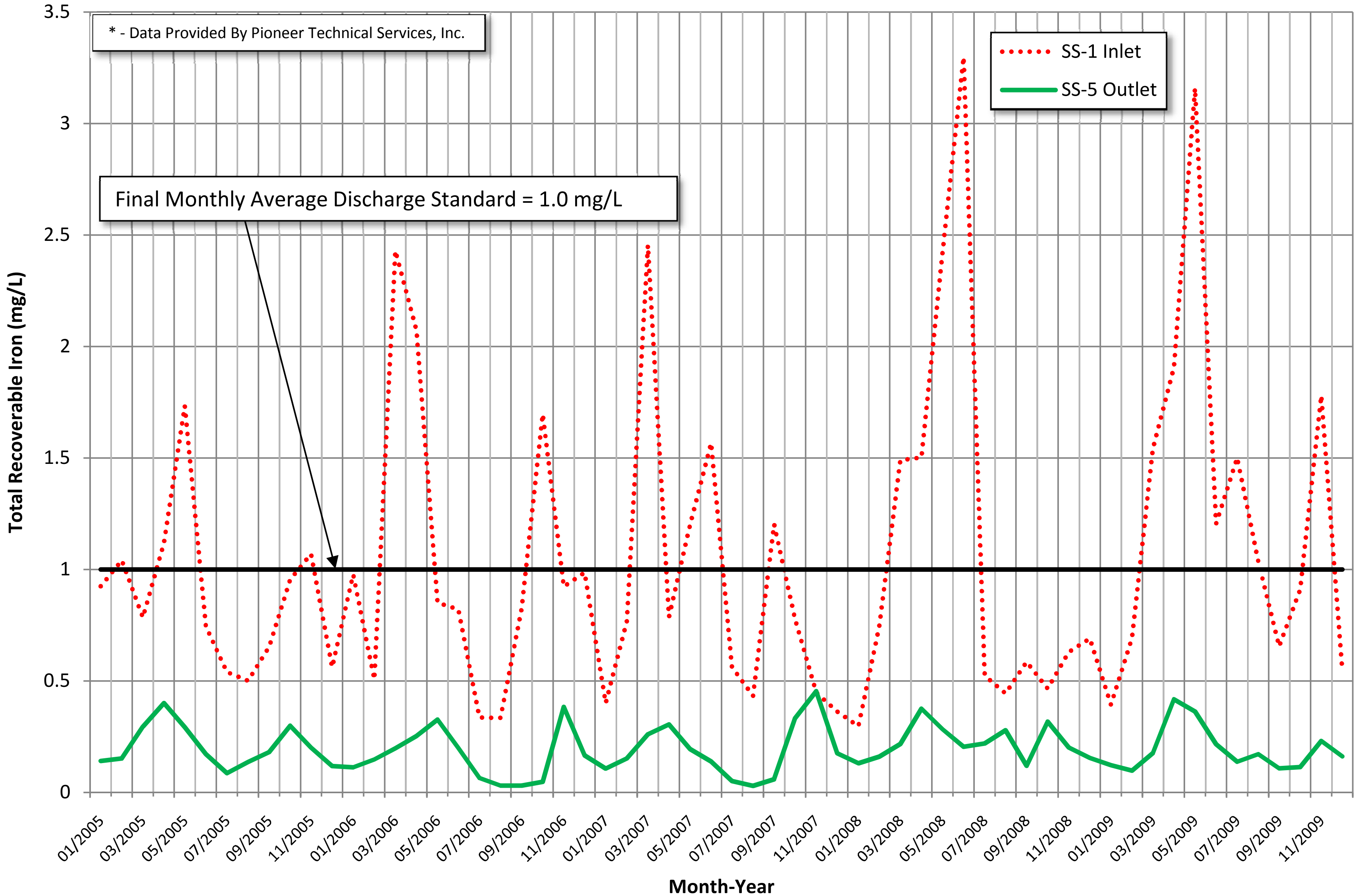

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Figure 6-13
Comparison of Influent (SS-1) and Effluent (SS-5) Total Recoverable Lead Concentrations with Final Daily Maximum Standard

Silver Bow Creek/Butte Area Superfund Site, Five-Year Review, 2010

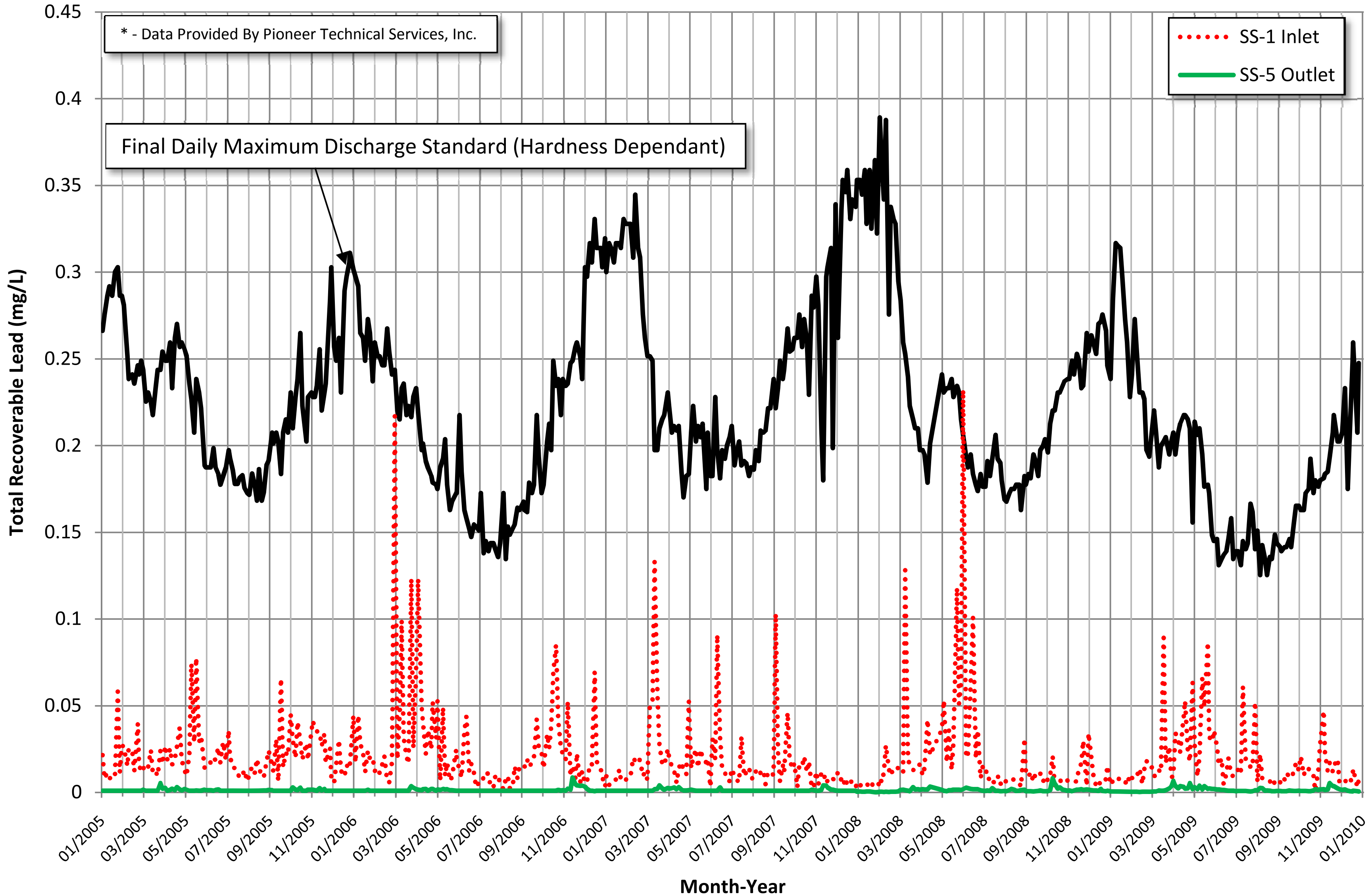

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Figure 6-14
Comparison of Influent (SS-1) and Effluent (SS-5) Total Recoverable Lead Concentrations with Final Monthly Average Standard
Silver Bow Creek/Butte Area Superfund Site, Five-Year Review, 2010

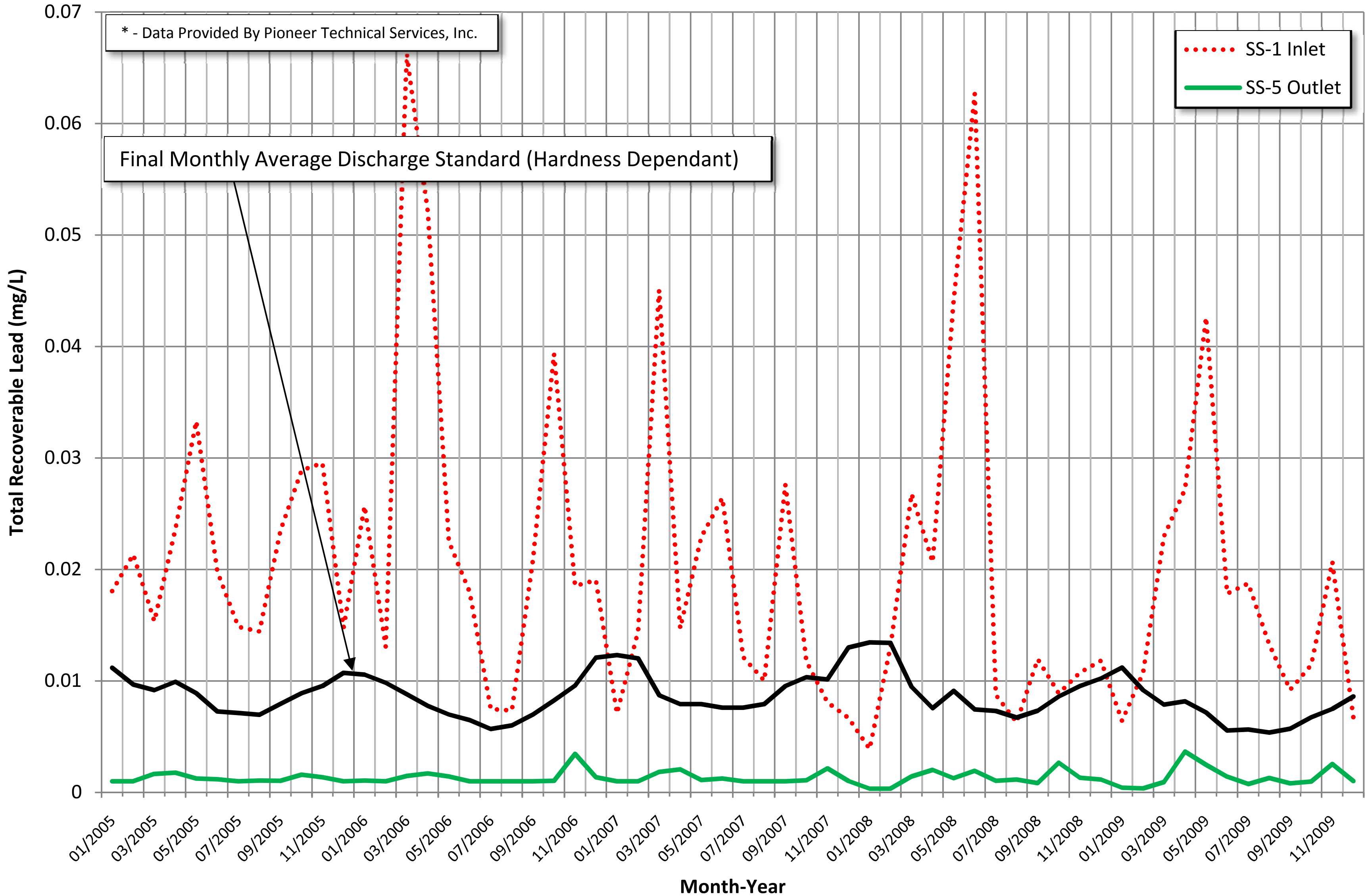

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Figure 6-15
Comparison of Influent (SS-1) and Effluent (SS-5) Total Mercury Concentrations with Final Daily Maximum Standard
Silver Bow Creek/Butte Area Superfund Site, Five-Year Review, 2010

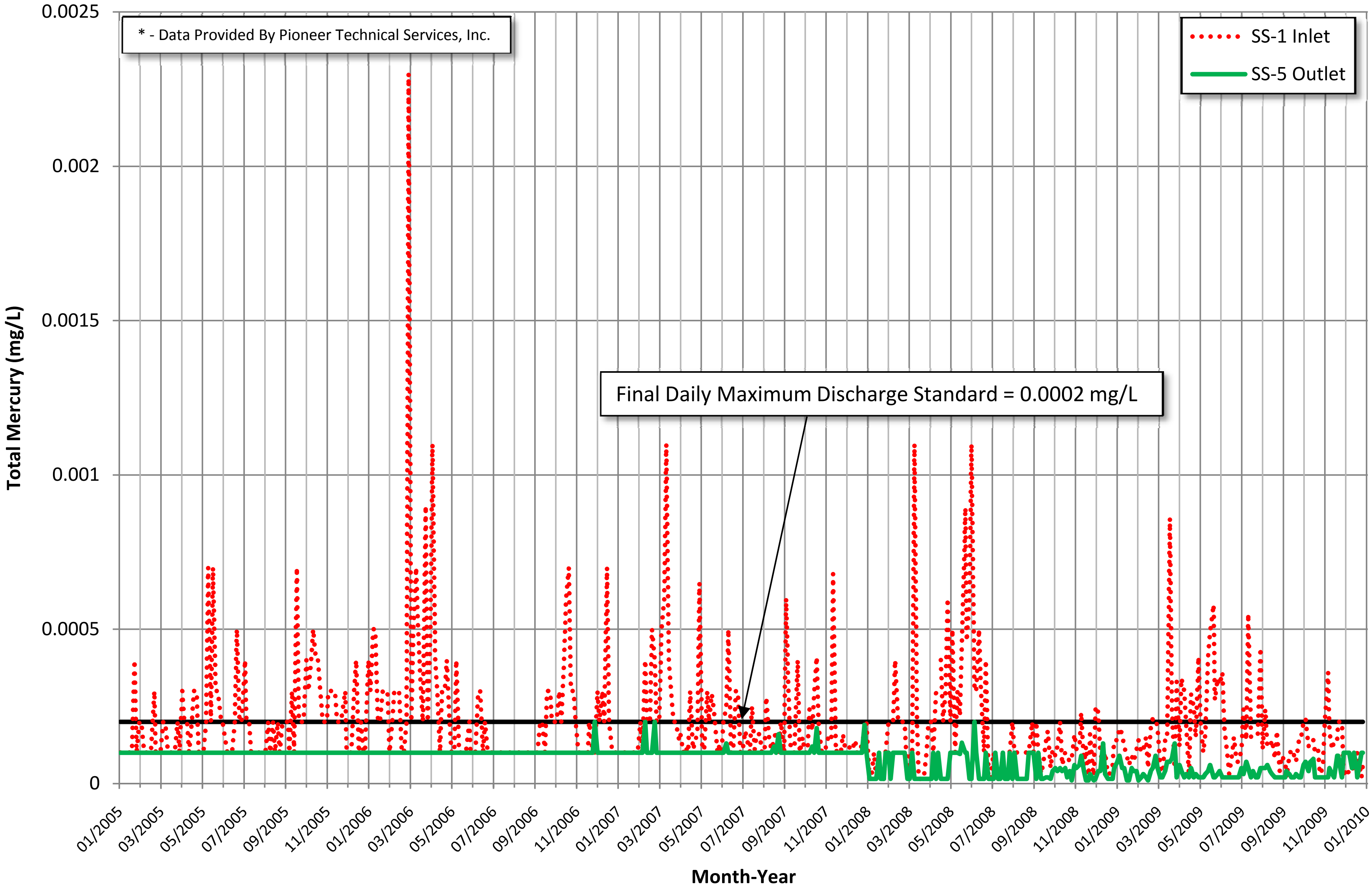

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Figure 6-16
Comparison of Influent (SS-1) and Effluent (SS-5) Total Mercury Concentrations with Final Monthly Average Standard
Silver Bow Creek/Butte Area Superfund Site, Five-Year Review, 2010

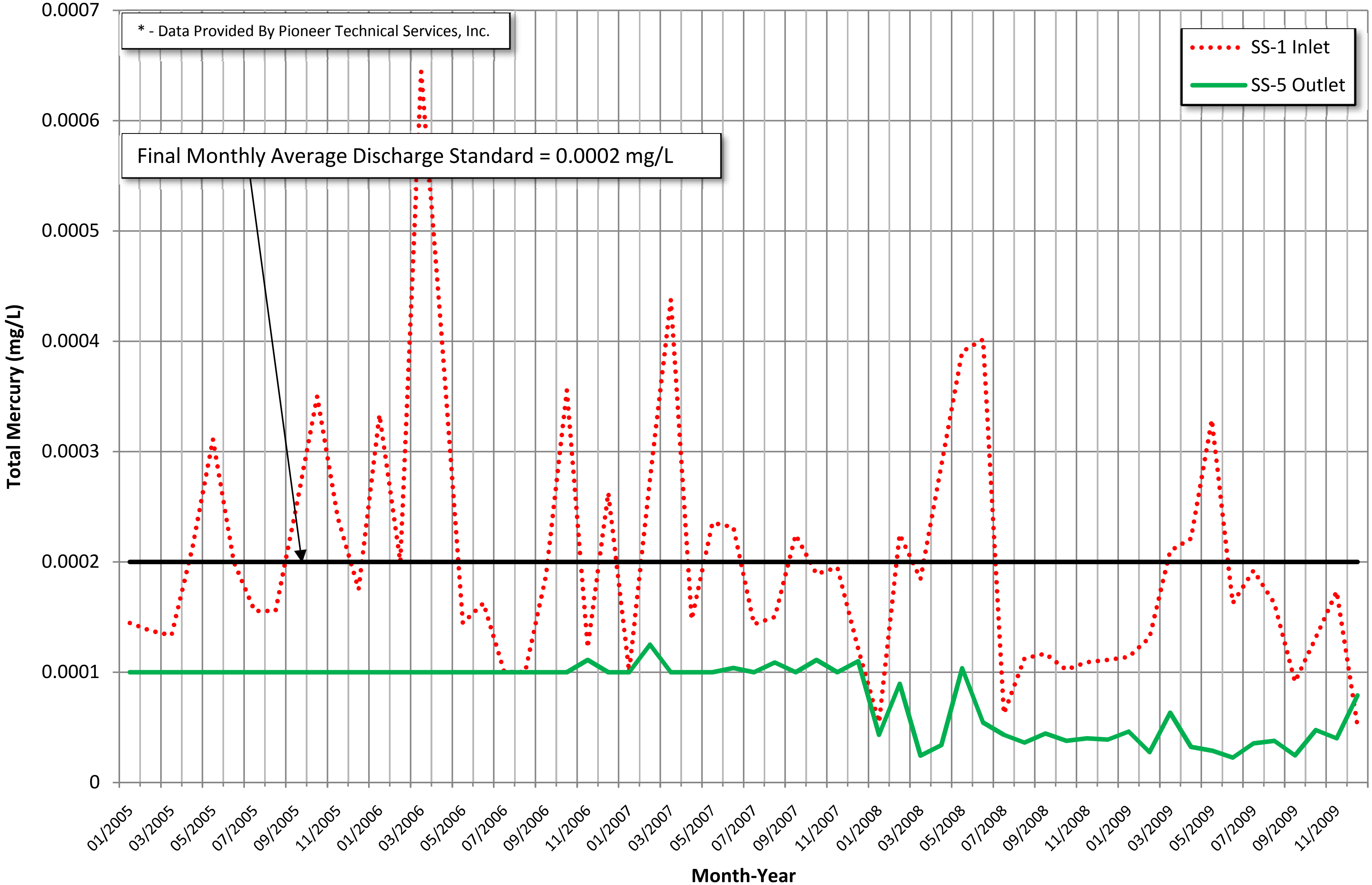

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Figure 6-17
Comparison of Influent (SS-1) and Effluent (SS-5) Total Recoverable Selenium Concentrations with Final Daily Maximum Standard
Silver Bow Creek/Butte Area Superfund Site, Five-Year Review, 2010

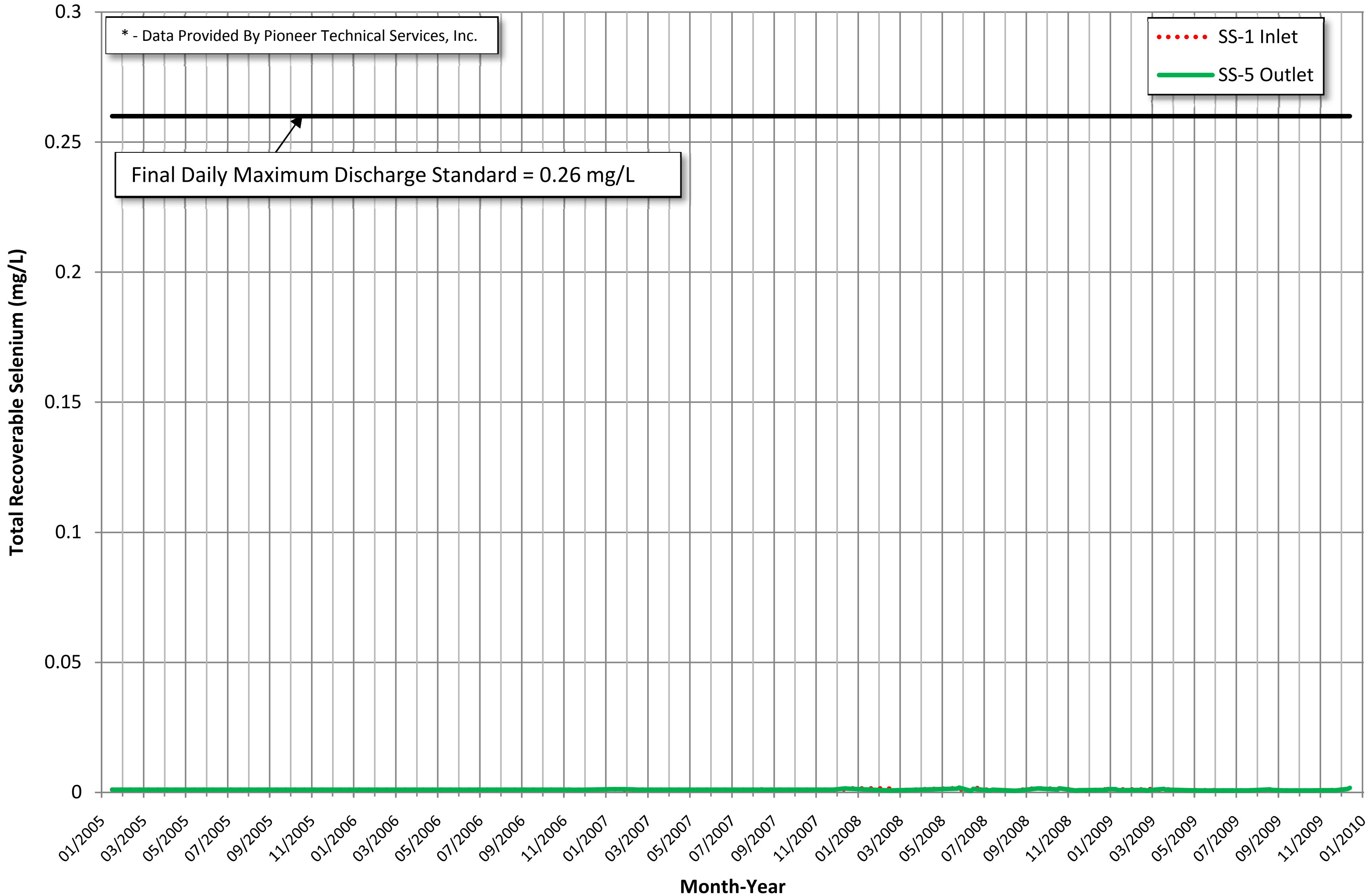

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Figure 6-18
Comparison of Influent (SS-1) and Effluent (SS-5) Total Recoverable Selenium Concentrations with Final Monthly Average Standard
Silver Bow Creek/Butte Area Superfund Site, Five-Year Review, 2010

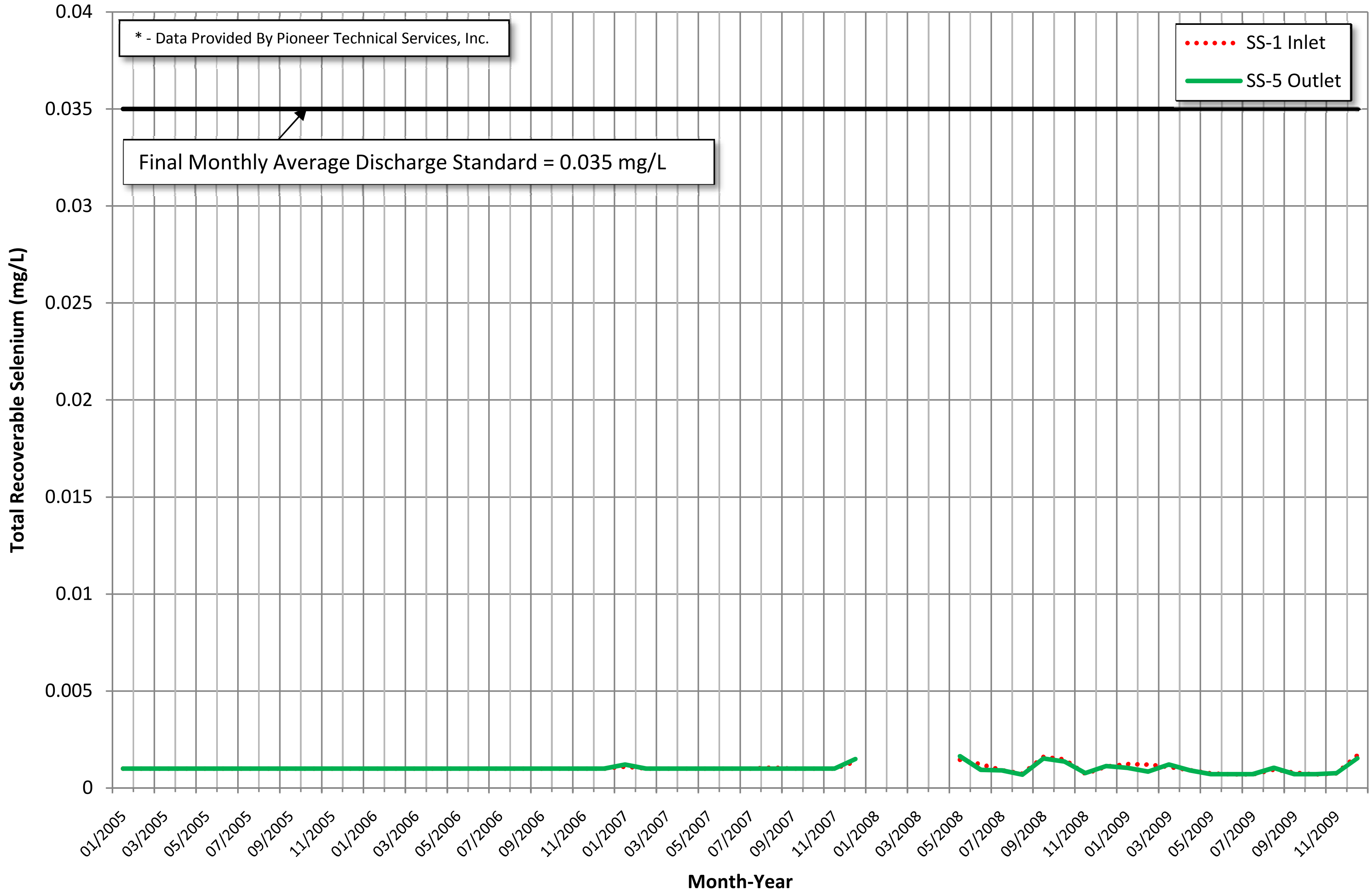

Figure 6-19
Comparison of Influent (SS-1) and Effluent (SS-5) Total Recoverable Silver Concentrations with Final Daily Maximum Standard
Silver Bow Creek/Butte Area Superfund Site, Five-Year Review, 2010

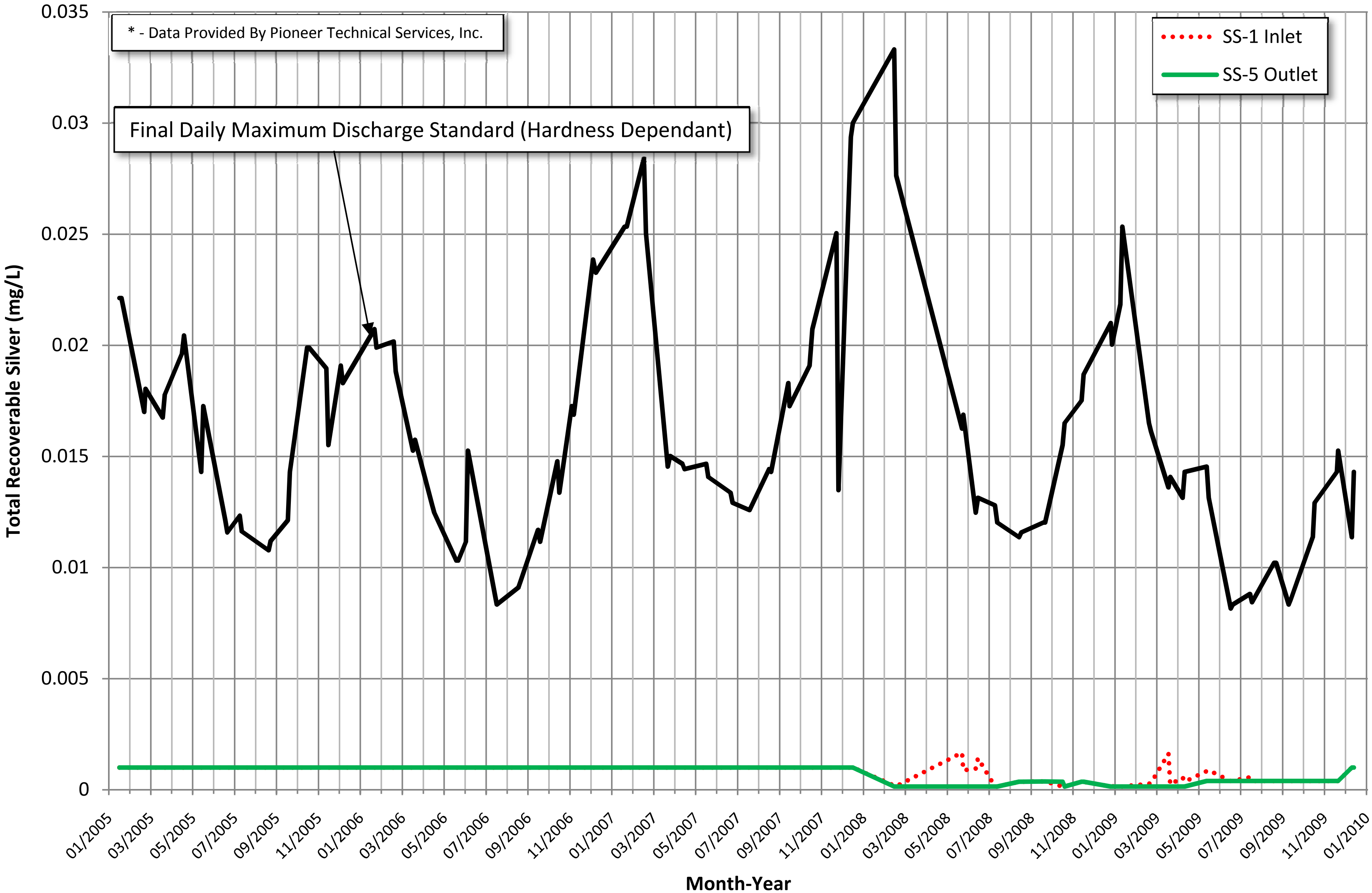

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Figure 6-20
Comparison of Influent (SS-1) and Effluent (SS-5) Total Recoverable Zinc Concentrations with Final Daily Maximum Standard
Silver Bow Creek/Butte Area Superfund Site, Five-Year Review, 2010

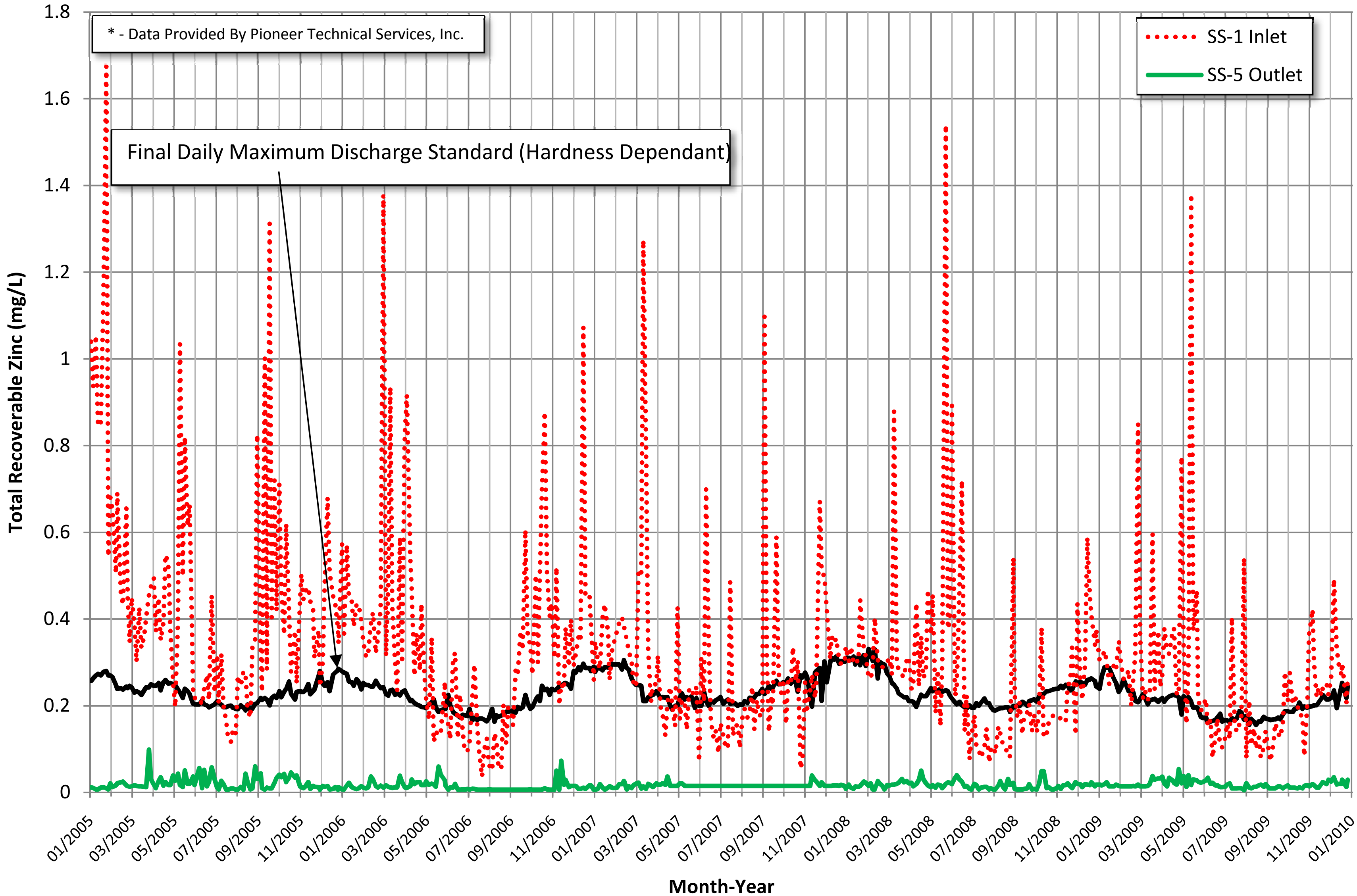

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Figure 6-21
Comparison of Influent (SS-1) and Effluent (SS-5) Total Recoverable Zinc Concentrations with Final Monthly Average Standard
Silver Bow Creek/Butte Area Superfund Site, Five-Year Review, 2010

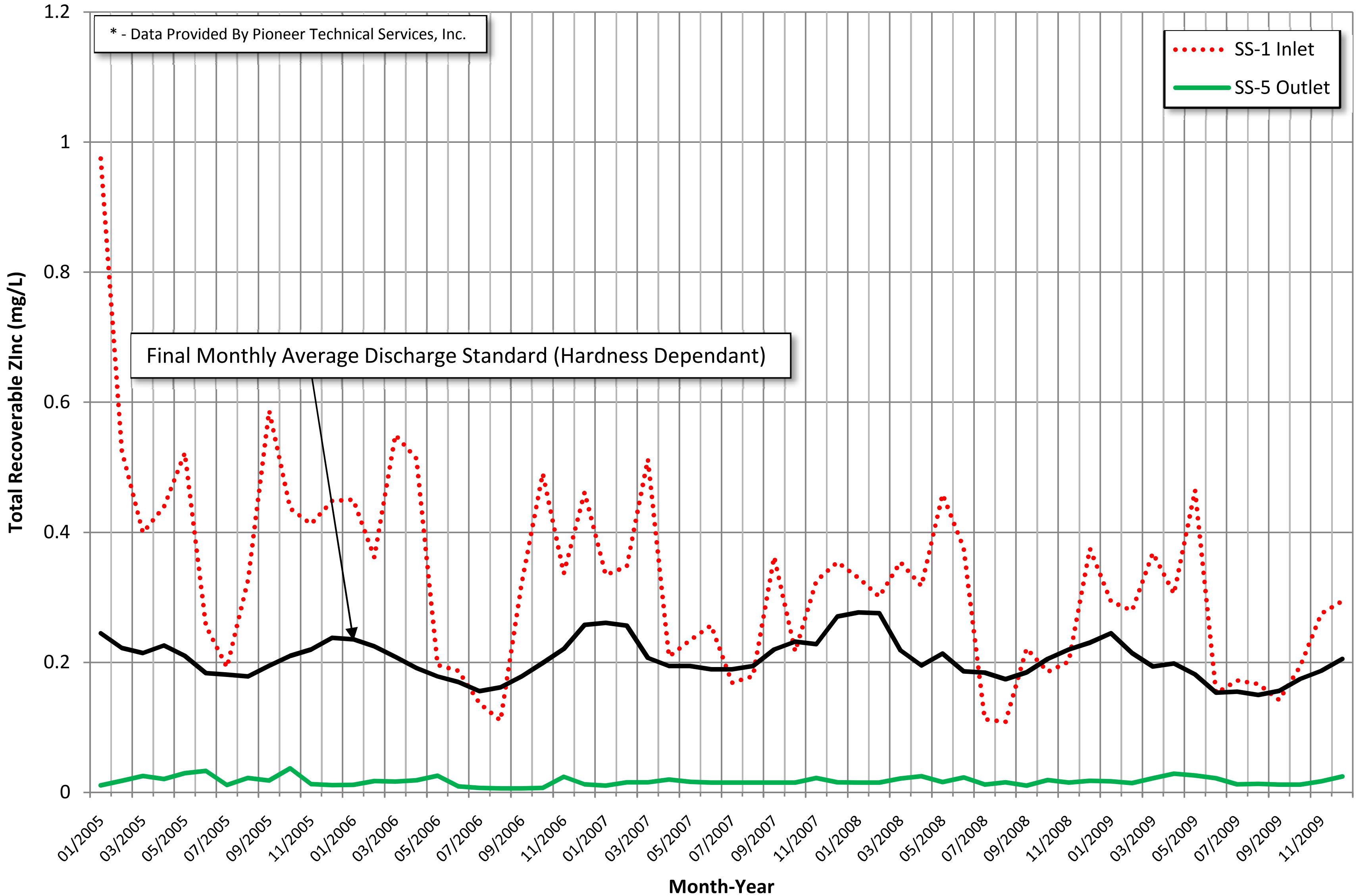

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Figure 6-22
Comparison of Influent (SS-1) and Effluent (SS-5) TSS Concentrations with Final Daily Maximum Standard
Silver Bow Creek/Butte Area Superfund Site, Five-Year Review, 2010

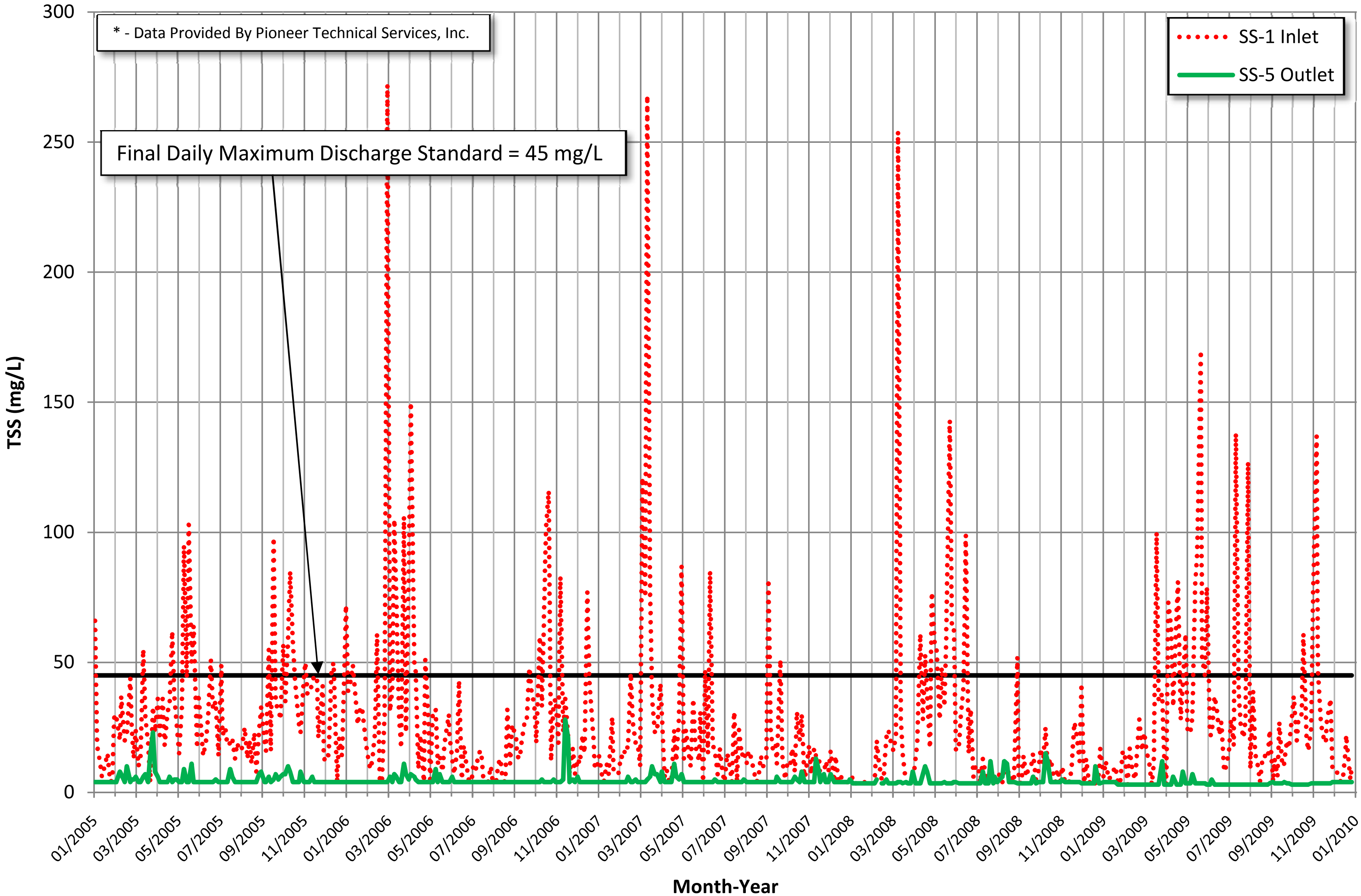

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Figure 6-23
Comparison of Influent (SS-1) and Effluent (SS-5) TSS Concentrations with Final Monthly Average Standard
Silver Bow Creek/Butte Area Superfund Site, Five-Year Review, 2010

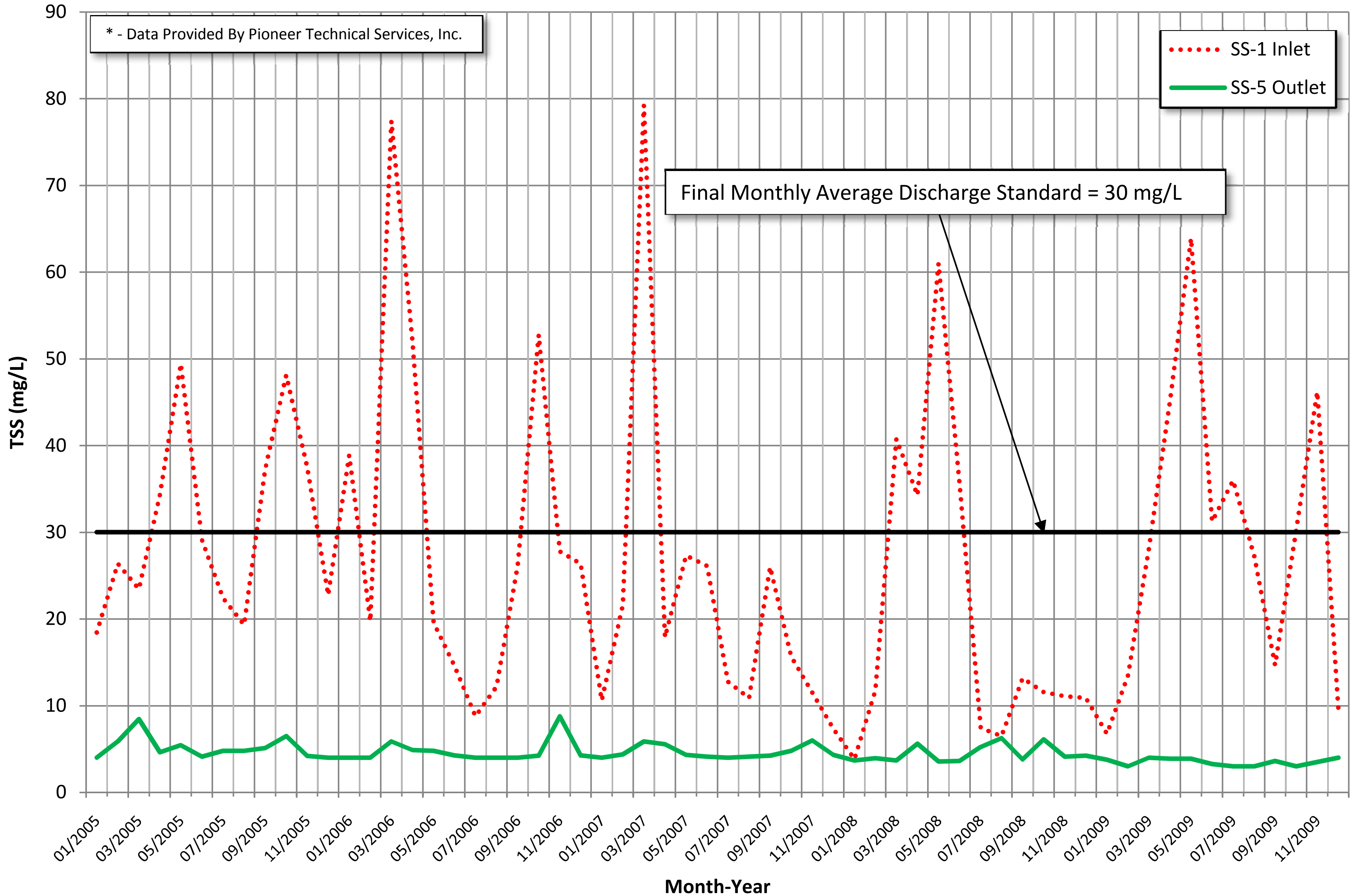

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Figure 6-24
Comparison of Influent (SS-1) and Effluent (SS-5) pH Measurements with Final Daily Maximum Standard
Silver Bow Creek/Butte Area Superfund Site, Five-Year Review, 2010

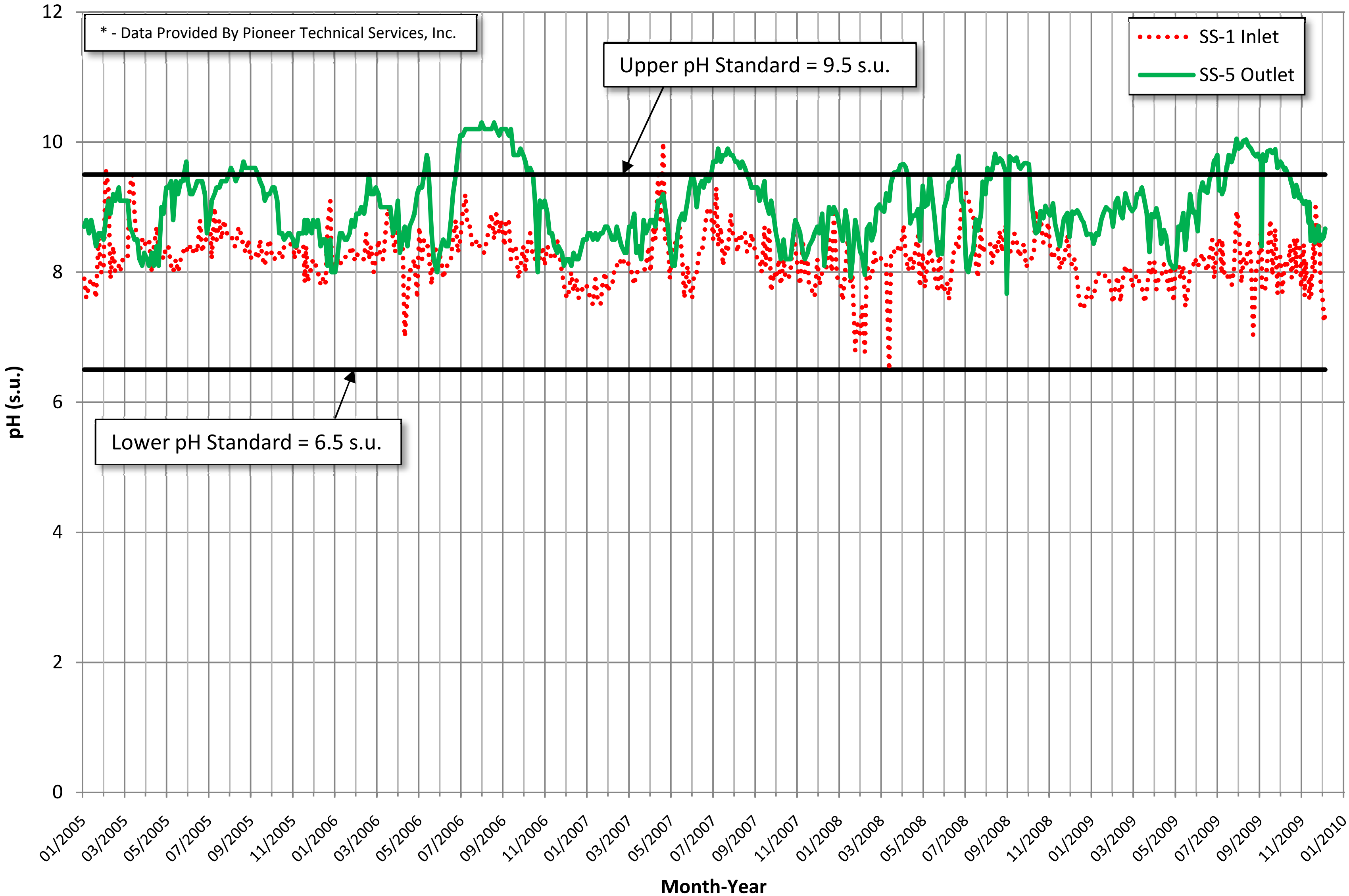

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Figure 6-25

Arsenic Concentrations in Pond 3 Effluent Compared to East and West Wet Closure Ponds

Silver Bow Creek/Butte Area Superfund Site, Five-Year Review, 2010

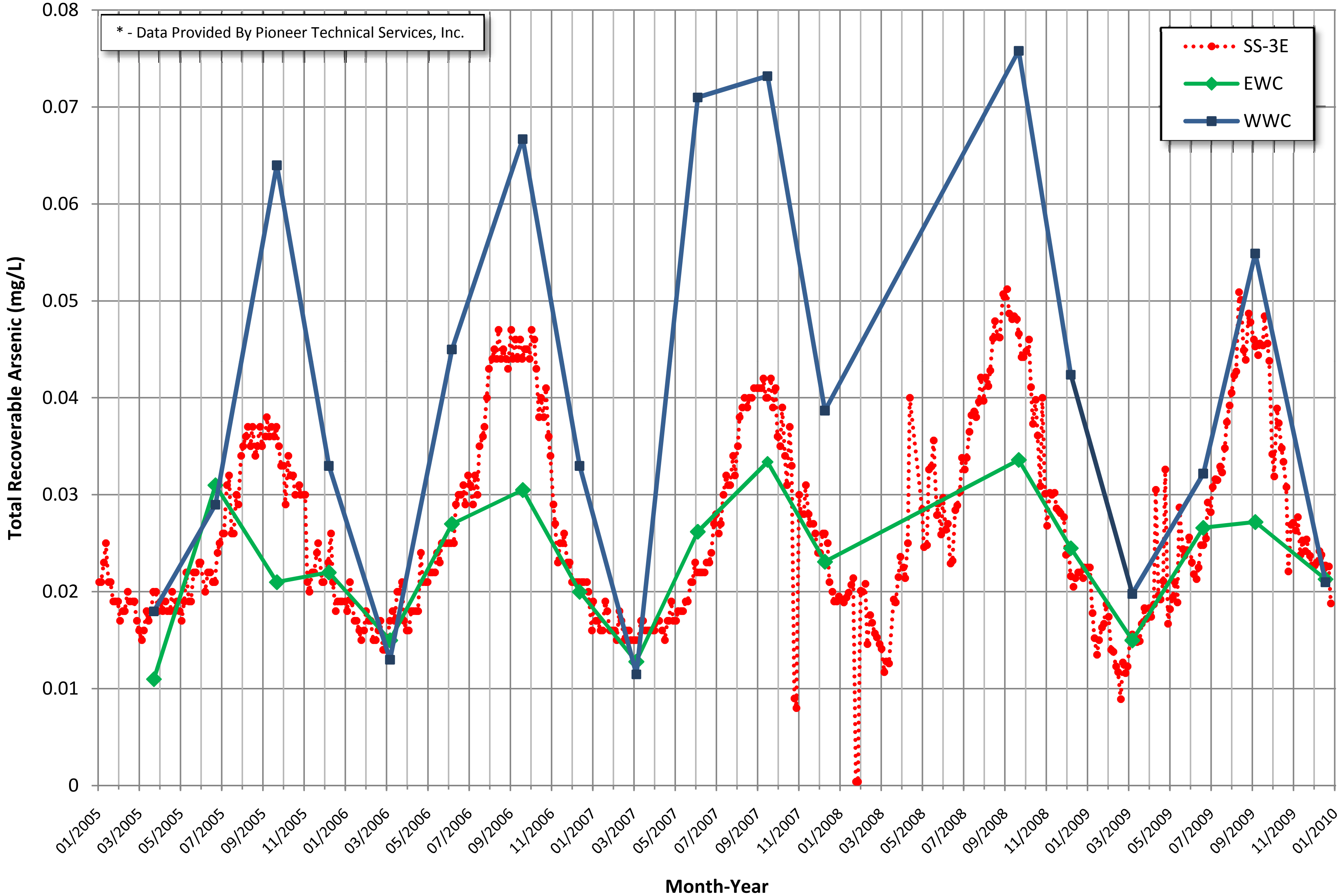

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Figure 6-26
Copper Concentrations in Pond 3 Effluent Compared to East and West Wet Closure Ponds
Silver Bow Creek/Butte Area Superfund Site, Five-Year Review, 2010

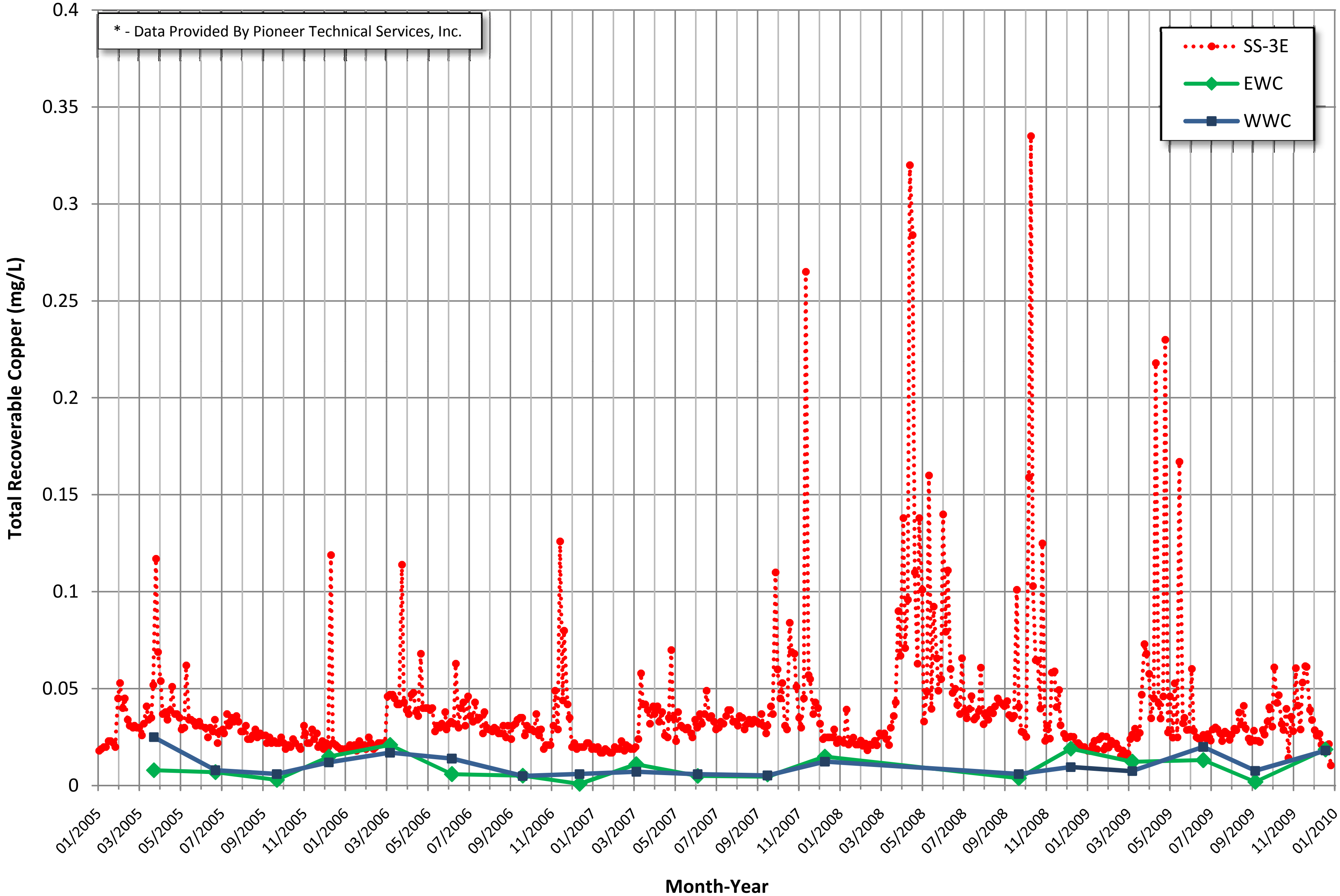

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Figure 6-27
Iron Concentrations in Pond 3 Effluent Compared to East and West Wet Closure Ponds
Silver Bow Creek/Butte Area Superfund Site, Five-Year Review, 2010

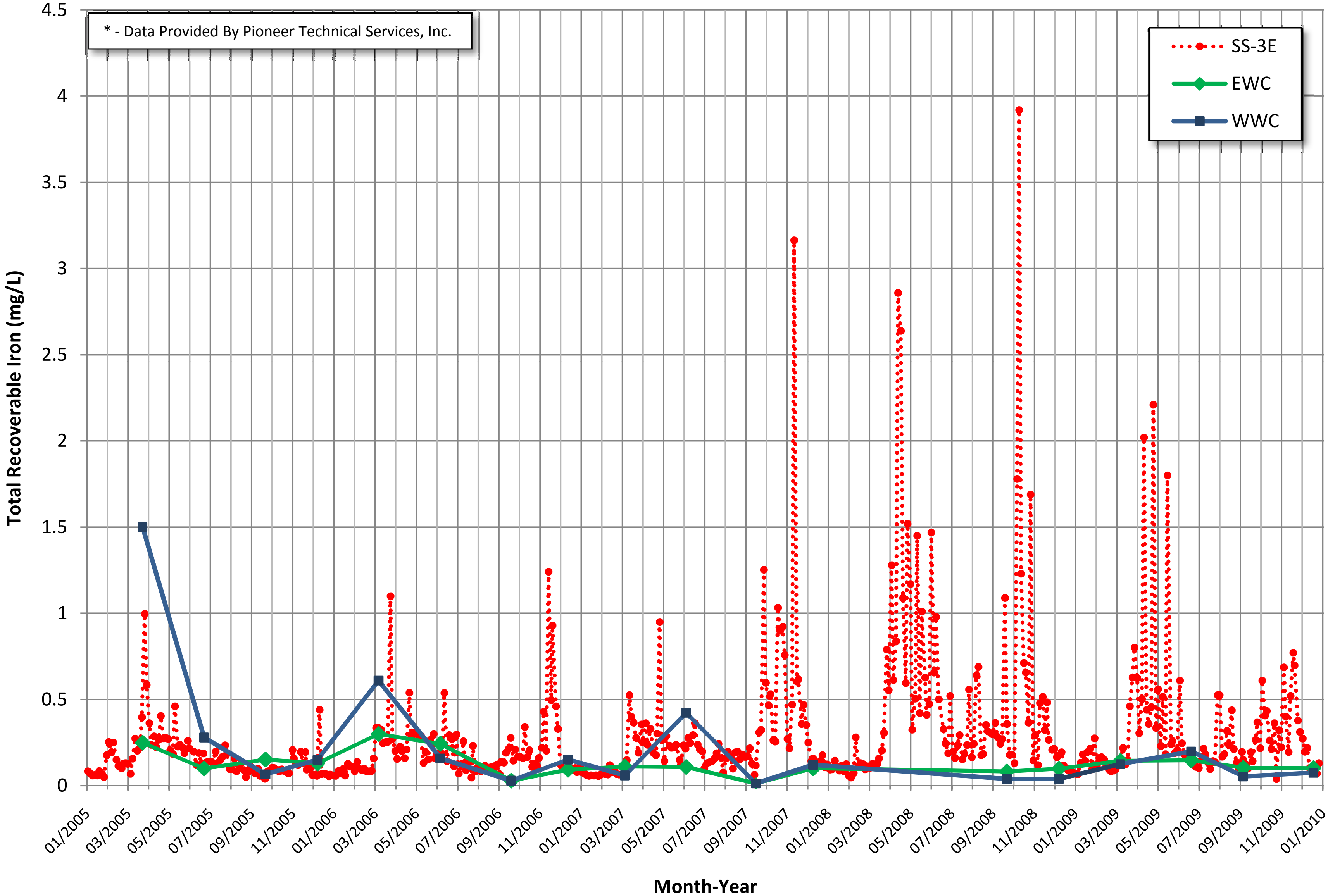

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Figure 6-28
Zinc Concentrations in Pond 3 Effluent Compared to East and West Wet Closure Ponds
Silver Bow Creek/Butte Area Superfund Site, Five-Year Review, 2010

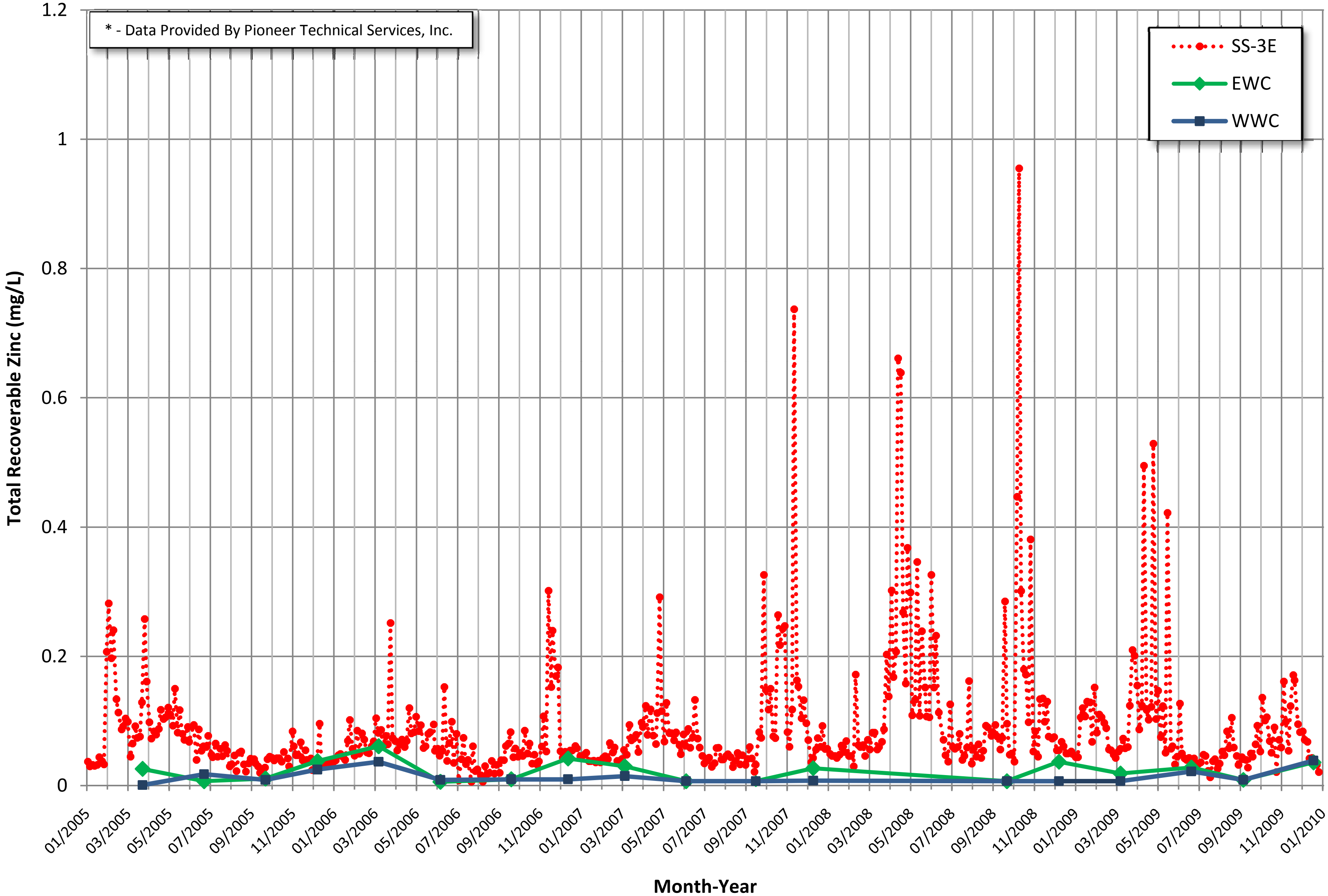

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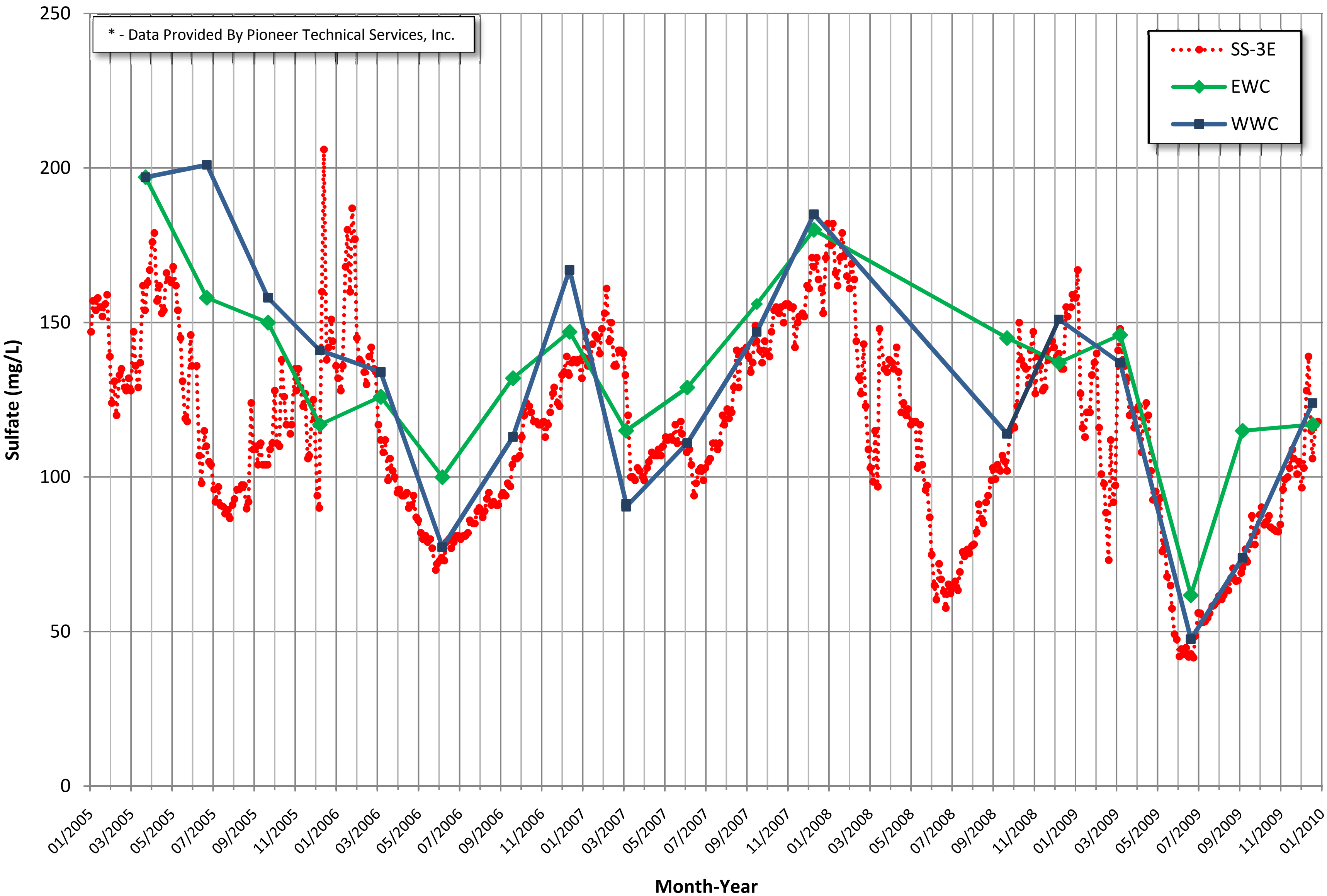
Figure 6-29
Sulfate Concentrations in Pond 3 Effluent Compared to East and West Wet Closure Ponds
Silver Bow Creek/Butte Area Superfund Site, Five-Year Review, 2010



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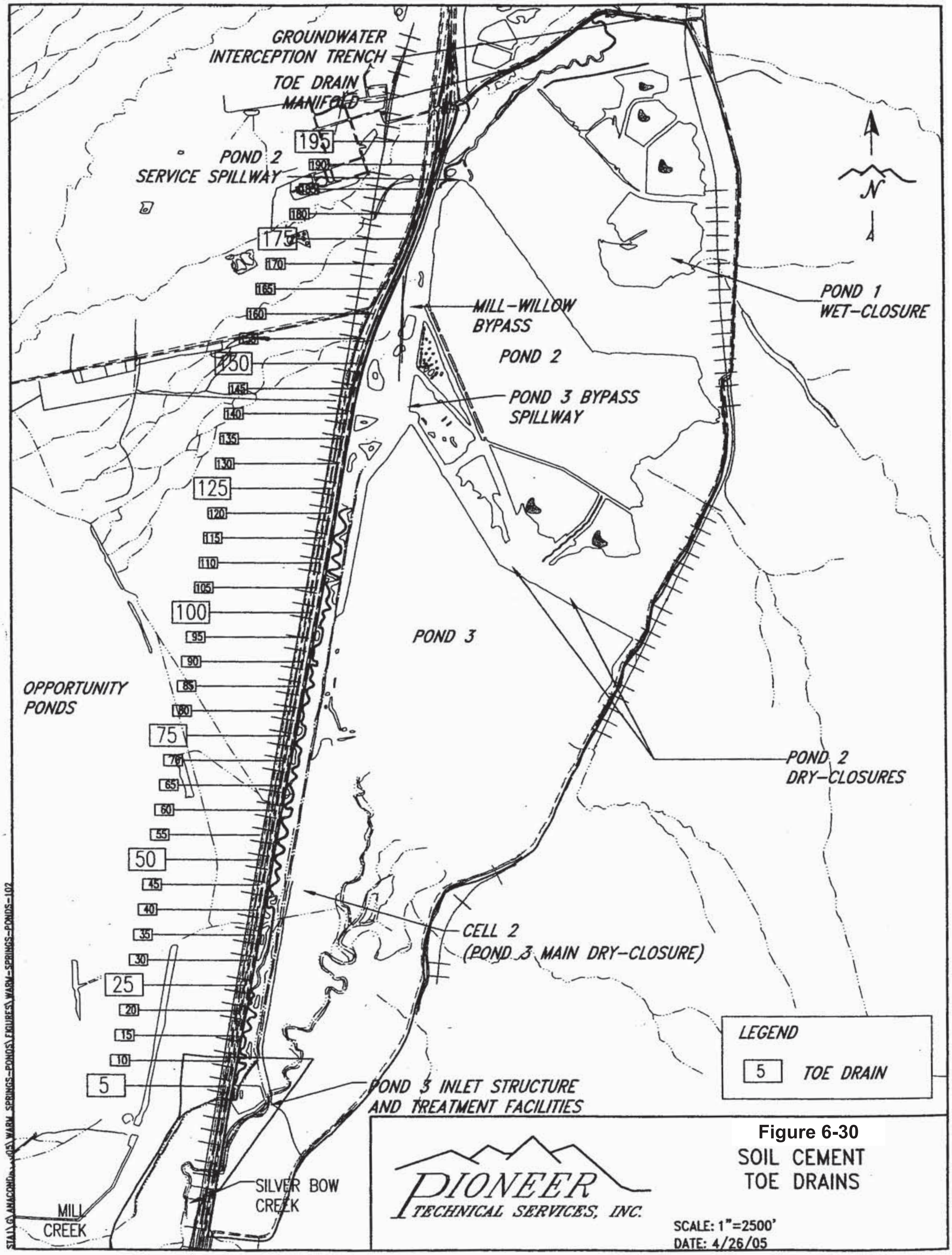

Figure 6-30
SOIL CEMENT TOE DRAINS

Figure 6-31
Arsenic Concentrations in the Mill-Willow Bypass
Silver Bow Creek/Butte Area Superfund Site, Five-Year Review, 2010

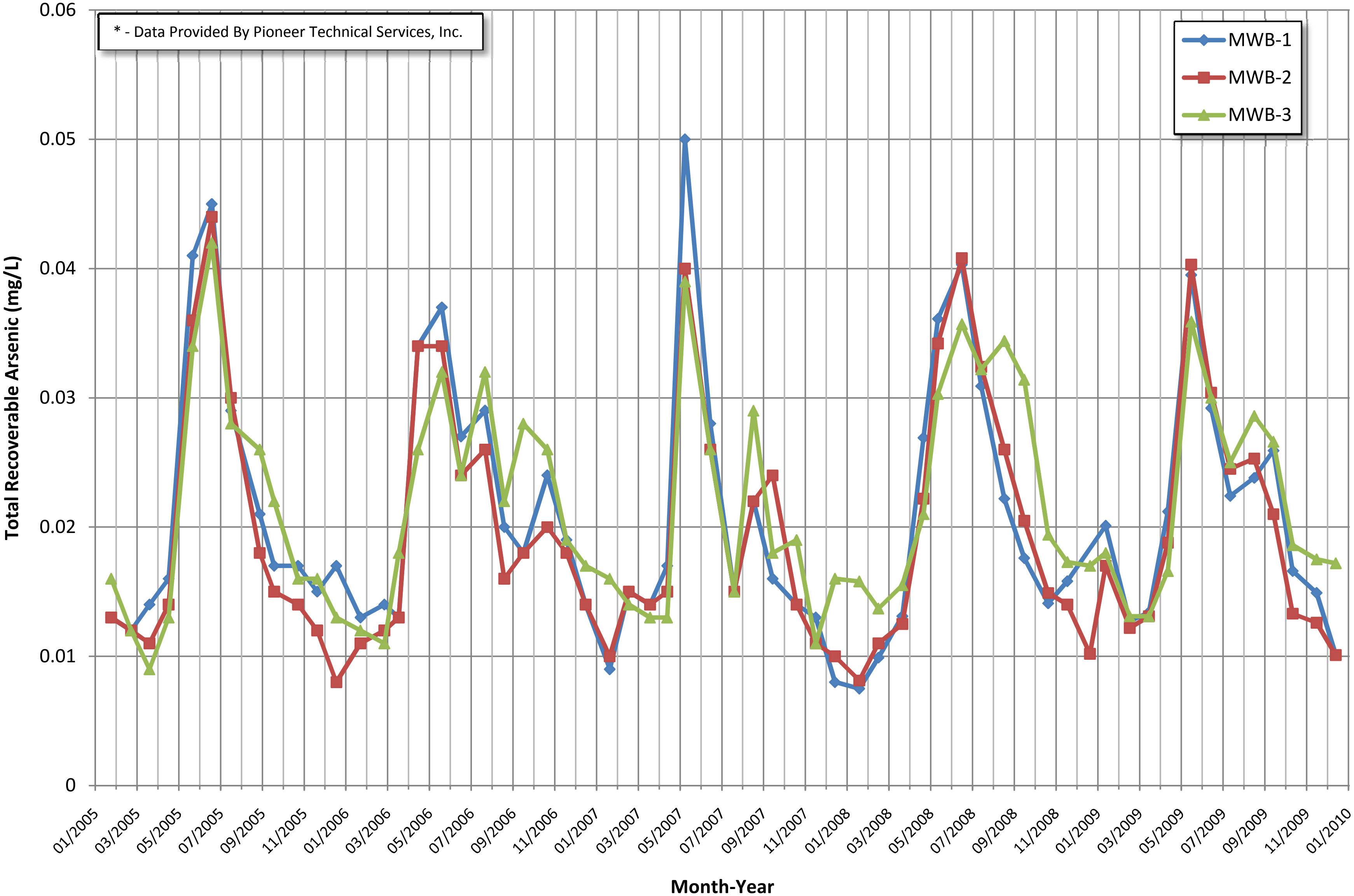

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Figure 6-32
Copper Concentrations in the Mill-Willow Bypass
Silver Bow Creek/Butte Area Superfund Site, Five-Year Review, 2010

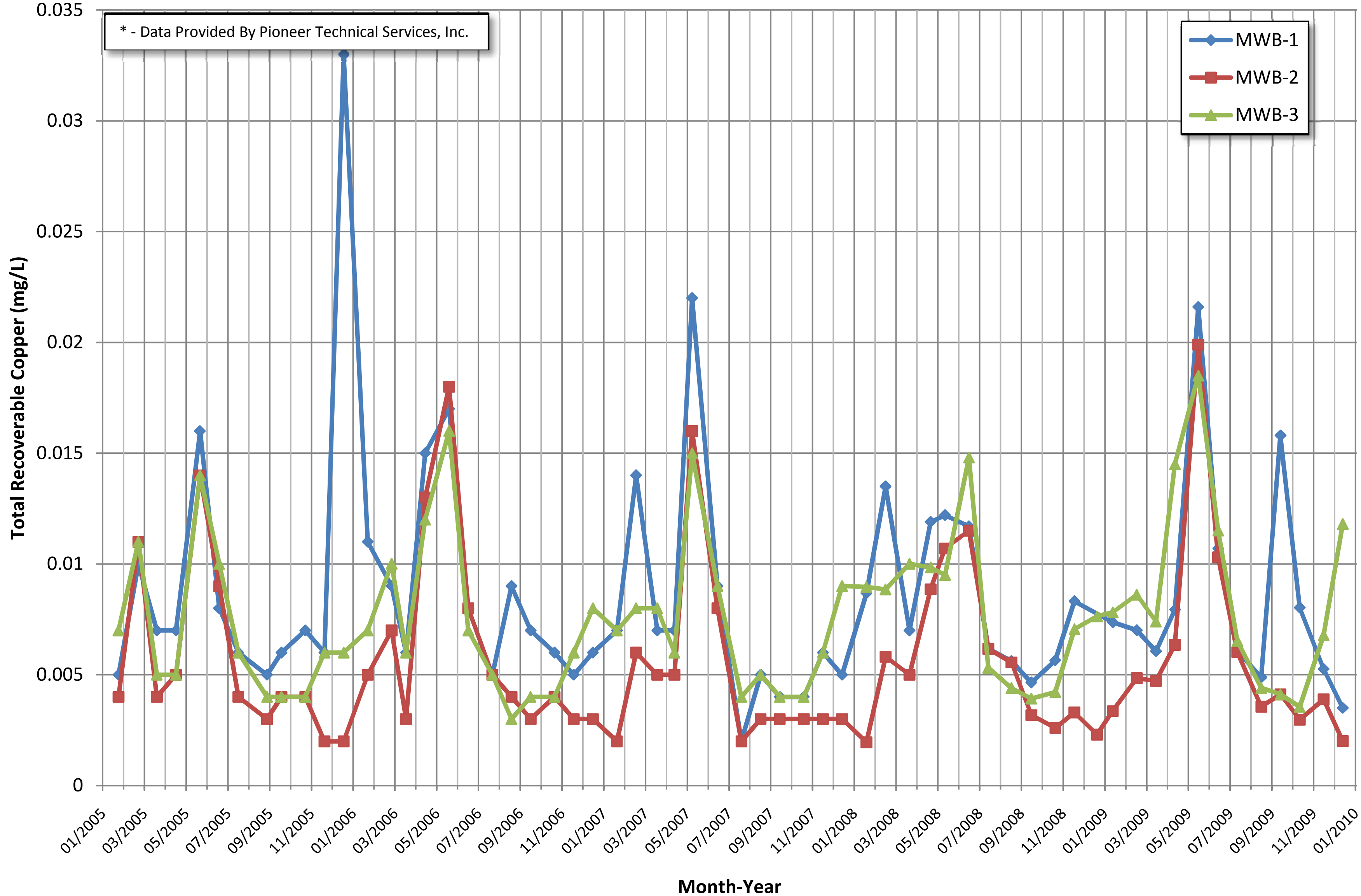
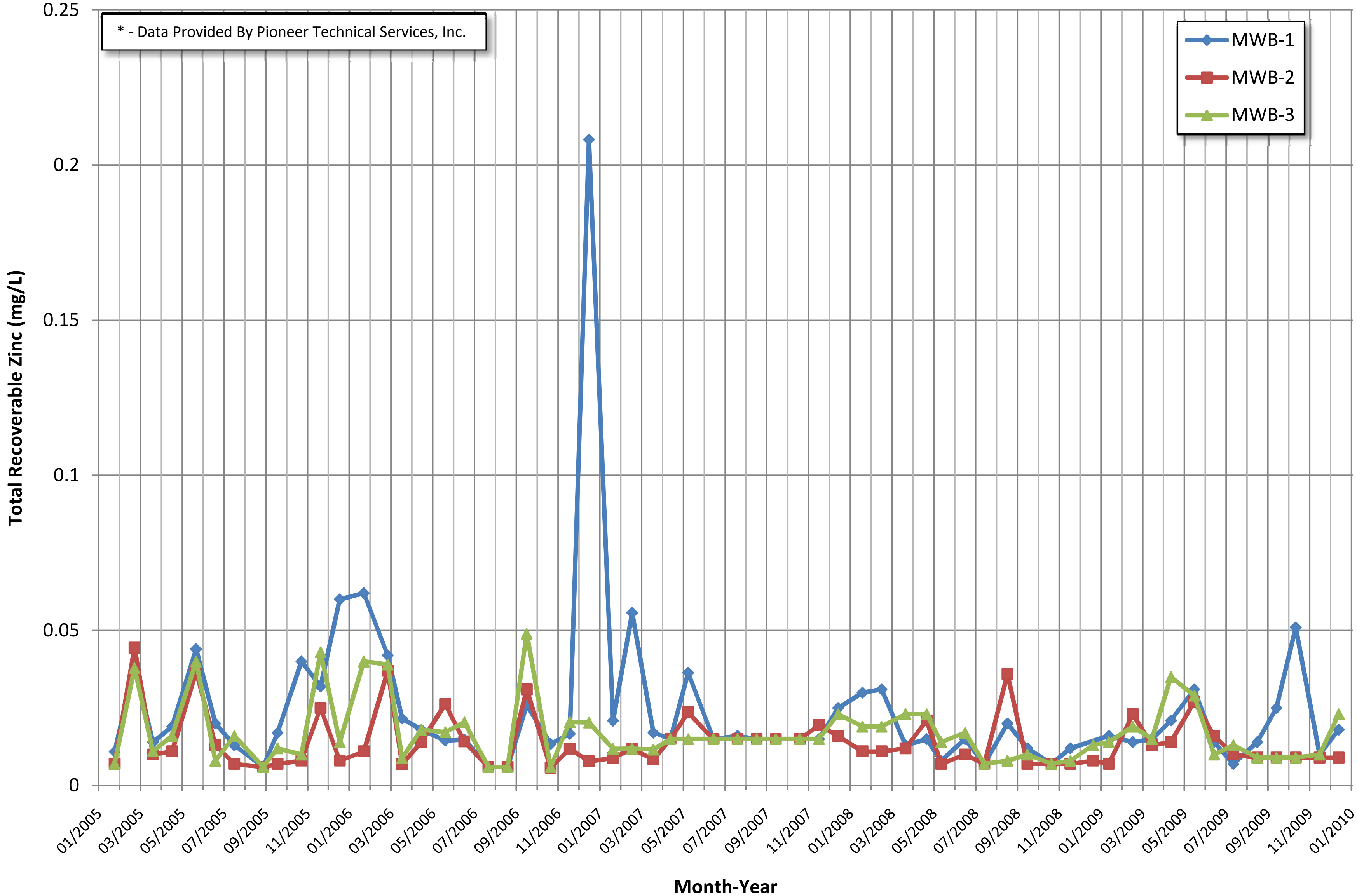


Figure 6-33
Zinc Concentrations in the Mill-Willow Bypass
Silver Bow Creek/Butte Area Superfund Site, Five-Year Review, 2010



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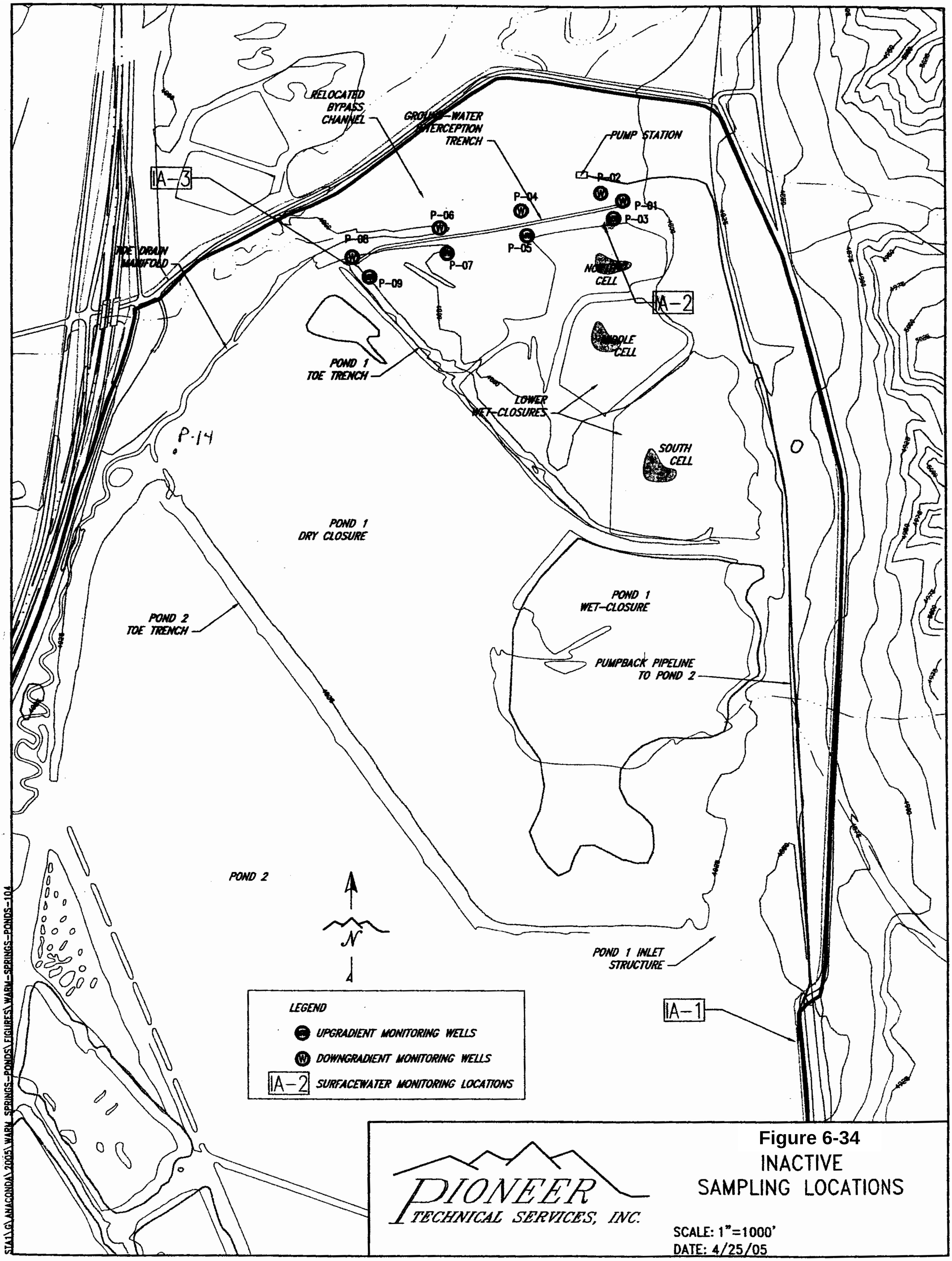

Figure 6-34
INACTIVE SAMPLING LOCATIONS

SCALE: 1"=1000'
DATE: 4/25/05

Figure 6-35
Dissolved Arsenic in Down-Gradient Piezometers
Silver Bow Creek/Butte Area Superfund Site Five-Year Review, 2010

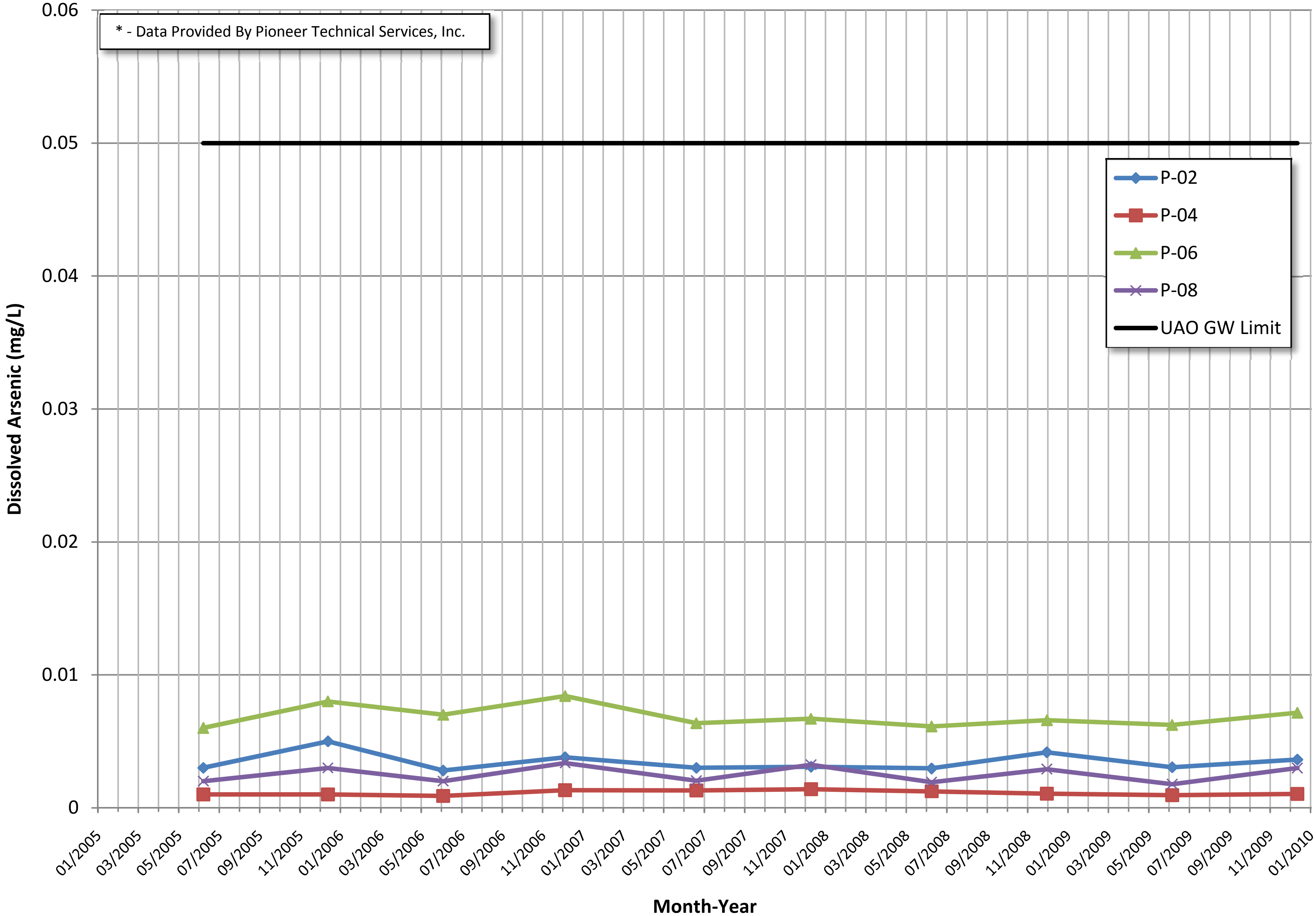

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Figure 6-36
Dissolved Cadmium in Down-Gradient Piezometers
Silver Bow Creek/Butte Area Superfund Site Five-Year Review, 2010

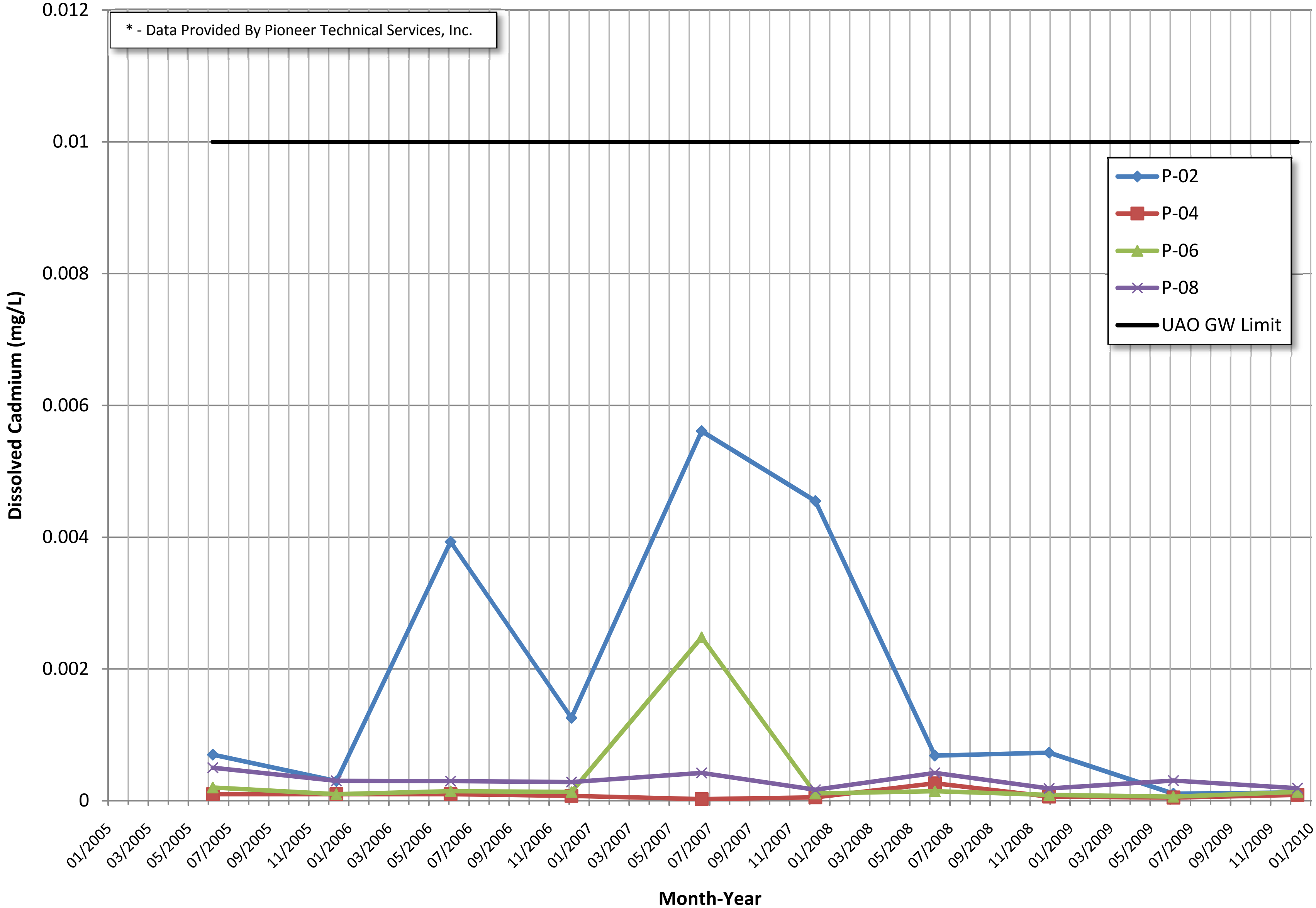

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Figure 6-37
Dissolved Chromium in Down-Gradient Piezometers
Silver Bow Creek/Butte Area Superfund Site Five-Year Review, 2010

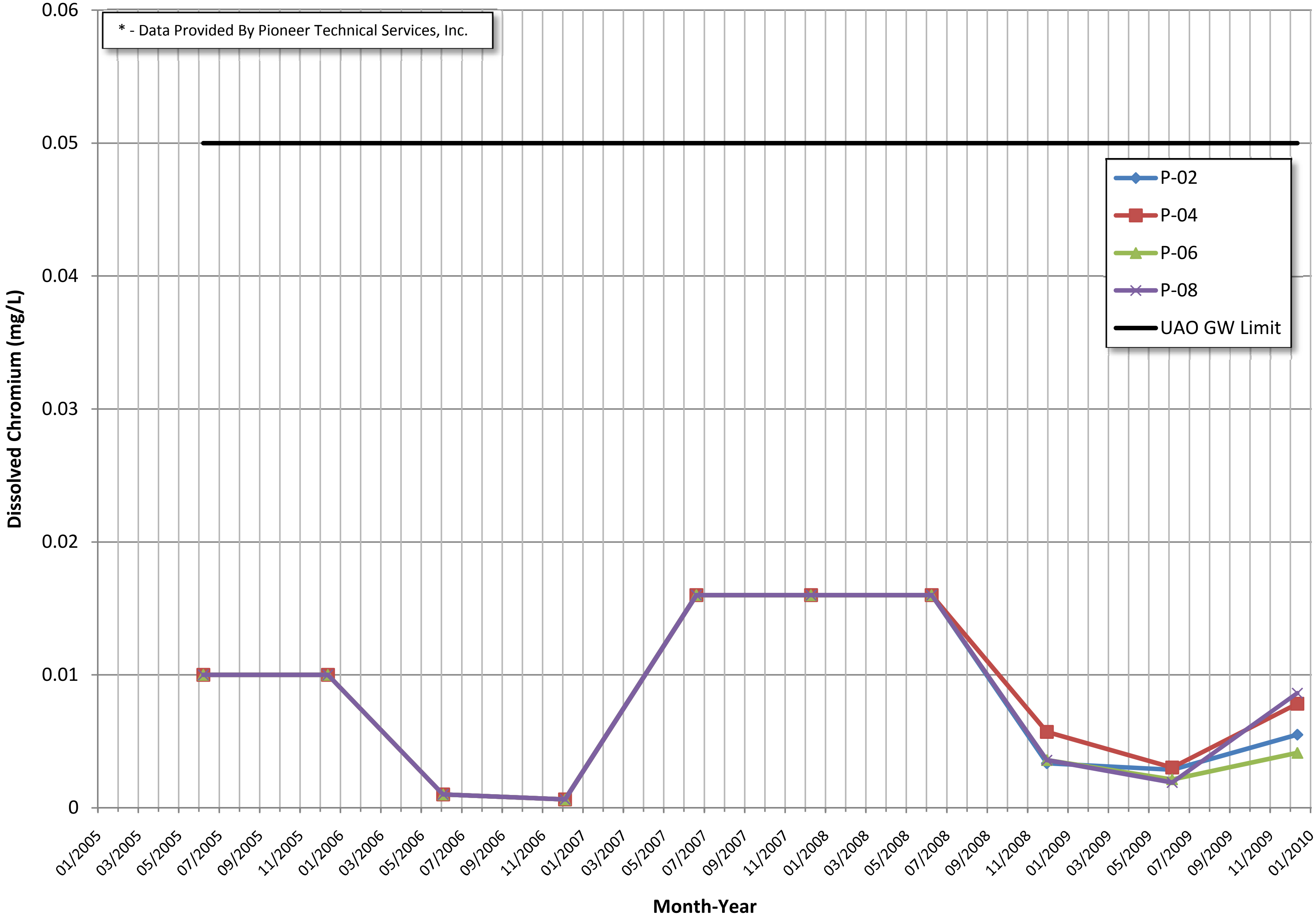

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Figure 6-38
Dissolved Lead in Down-Gradient Piezometers
Silver Bow Creek/Butte Area Superfund Site Five-Year Review, 2010

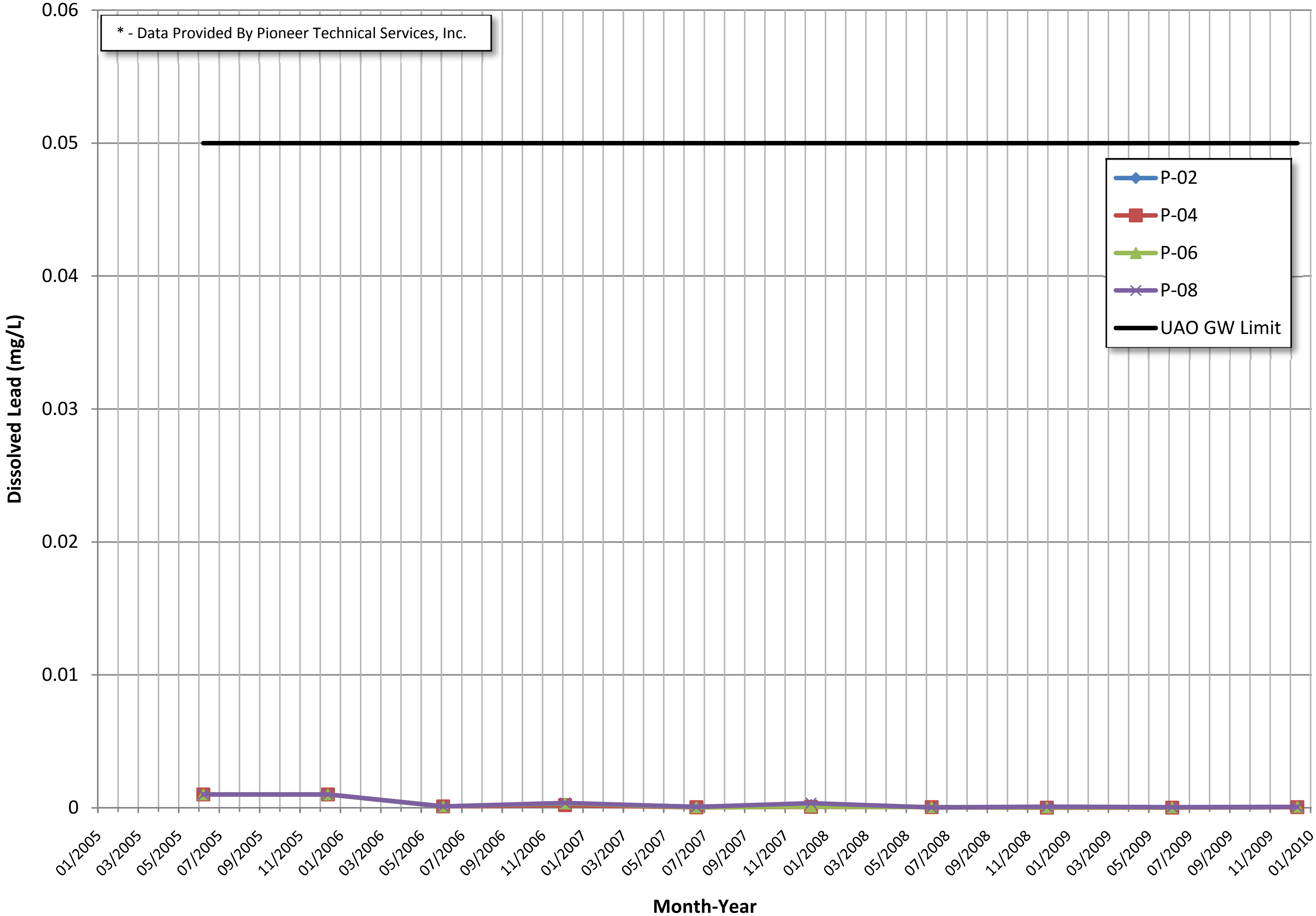

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Figure 6-39
Dissolved Mercury in Down-Gradient Piezometers
Silver Bow Creek/Butte Area Superfund Site Five-Year Review, 2010

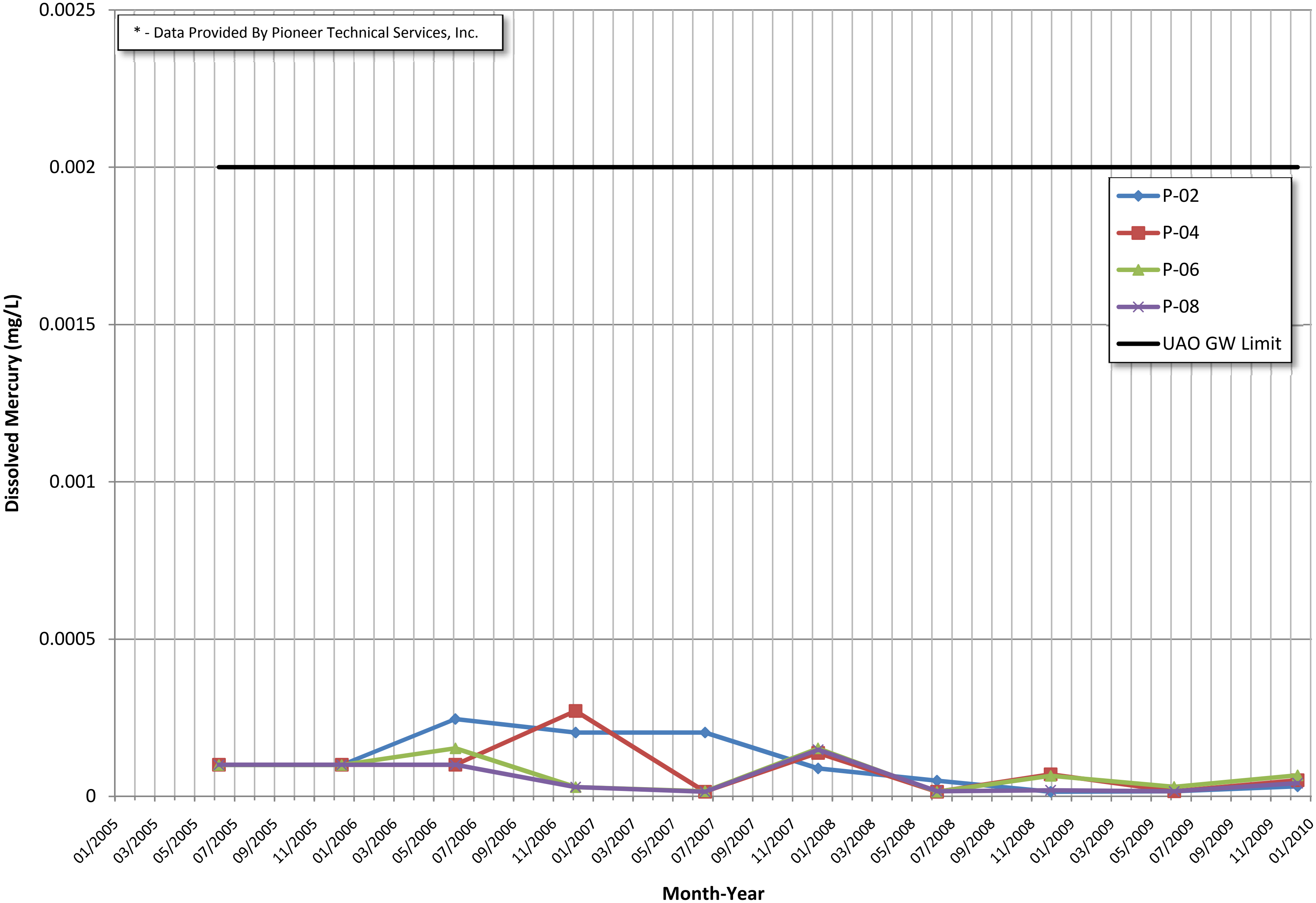

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Figure 6-40
Dissolved Nitrate in Down-Gradient Piezometers
Silver Bow Creek/Butte Area Superfund Site Five-Year Review, 2010

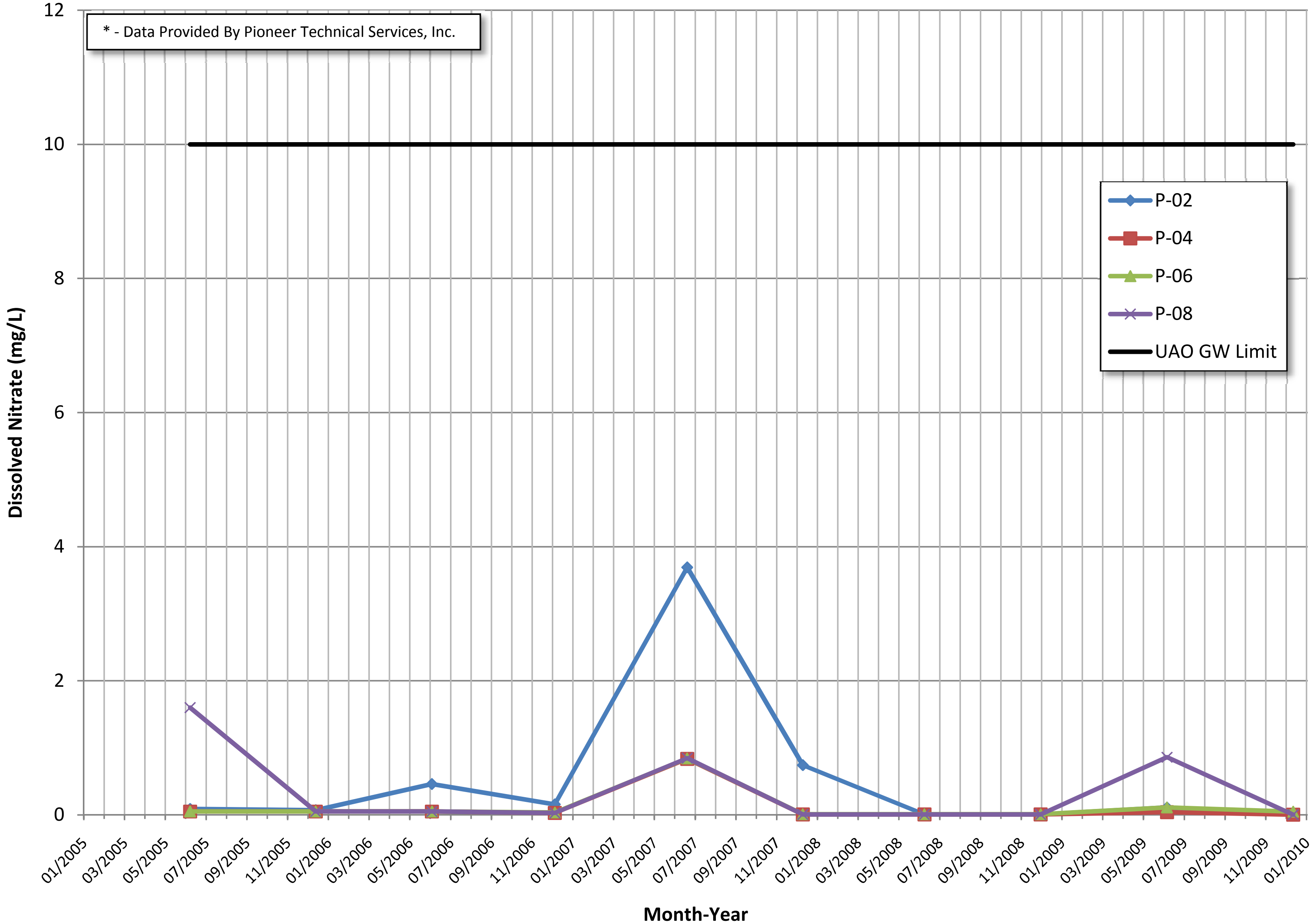

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Figure 6-41
Dissolved Arsenic in P-14 Piezometer
Silver Bow Creek/Butte Area Superfund Site Five-Year Review, 2010

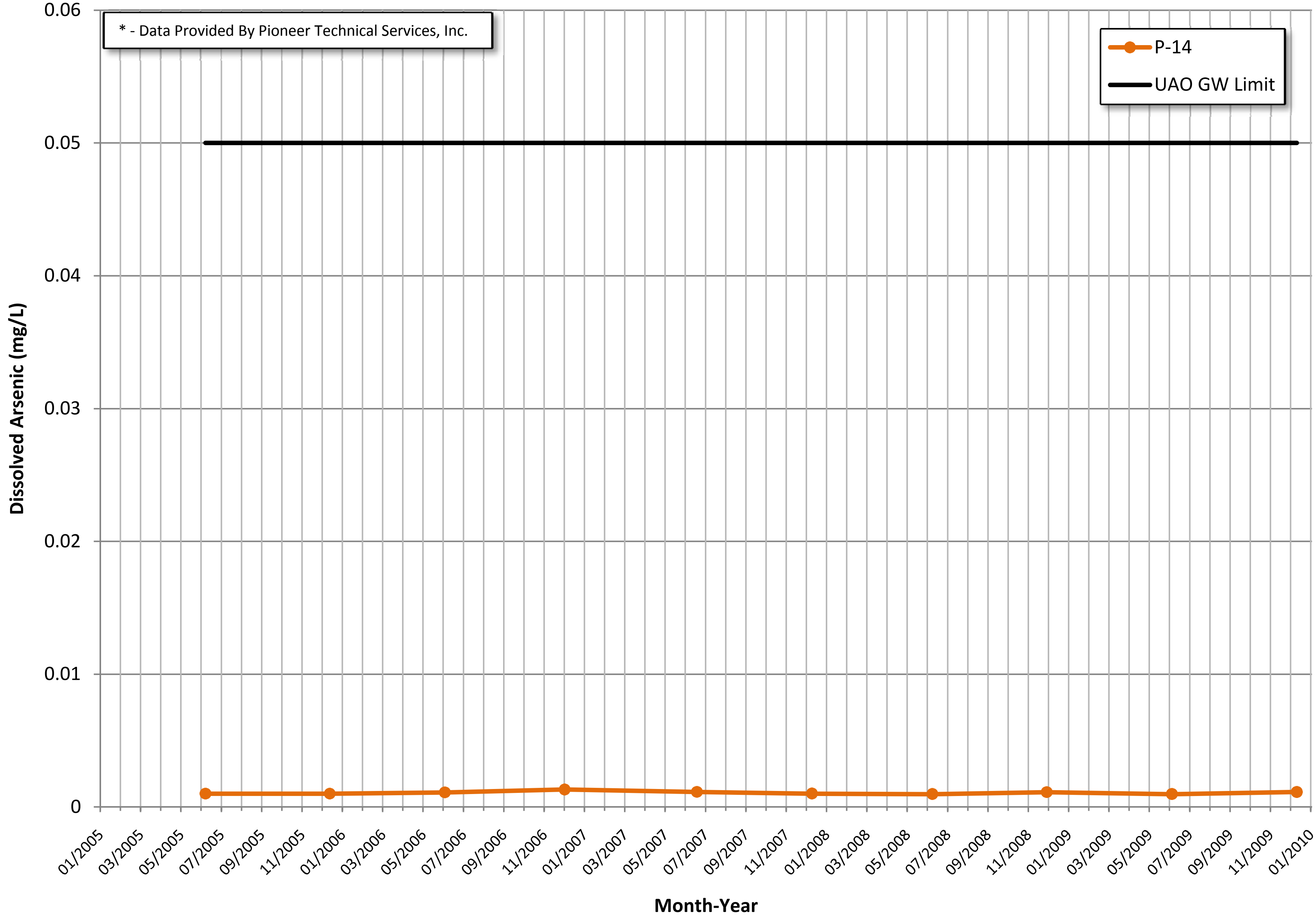

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Figure 6-42
Dissolved Cadmium in P-14 Piezometer
Silver Bow Creek/Butte Area Superfund Site Five-Year Review, 2010

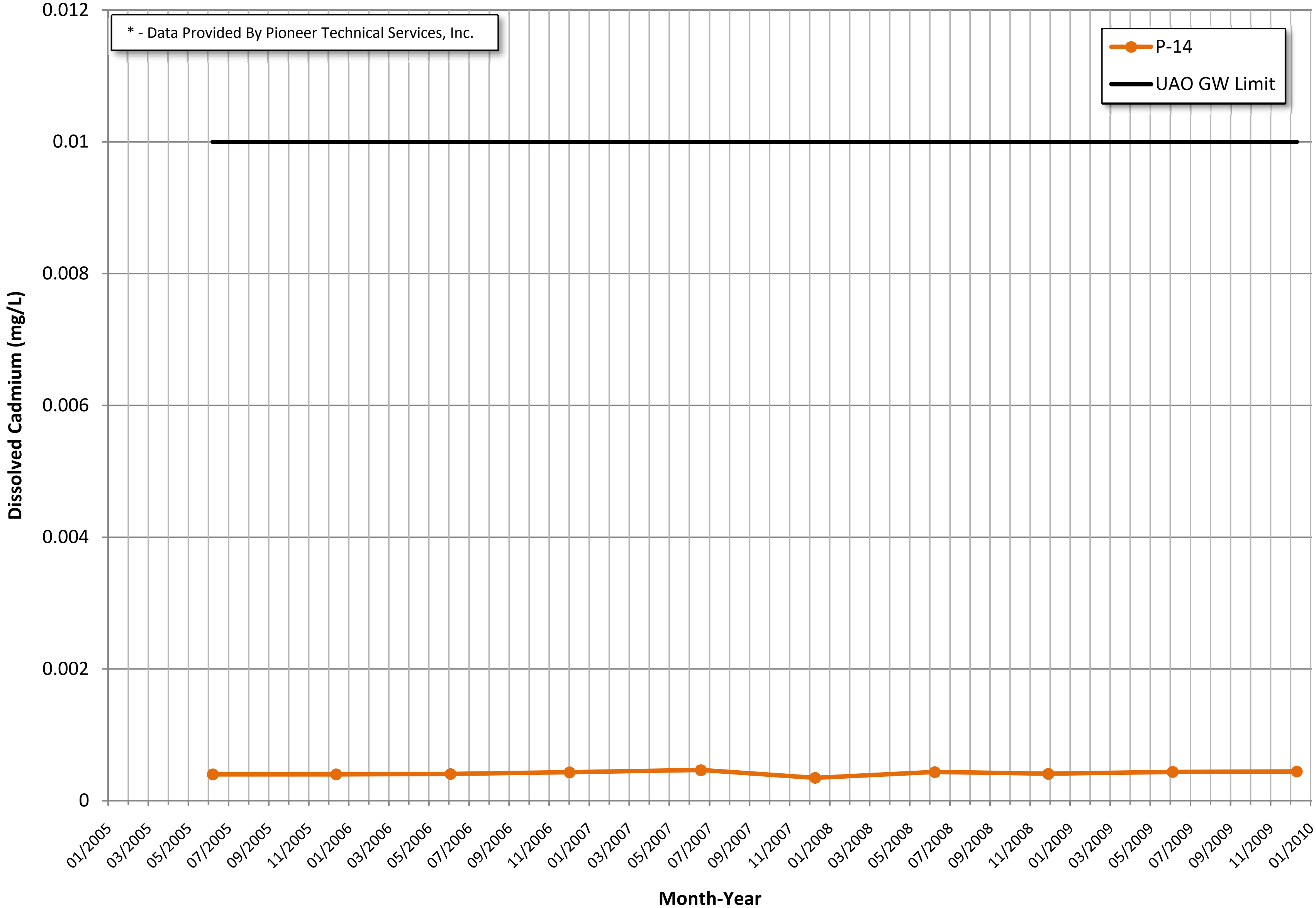

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Figure 6-43
Dissolved Chromium in P-14 Piezometer
Silver Bow Creek/Butte Area Superfund Site Five-Year Review, 2010

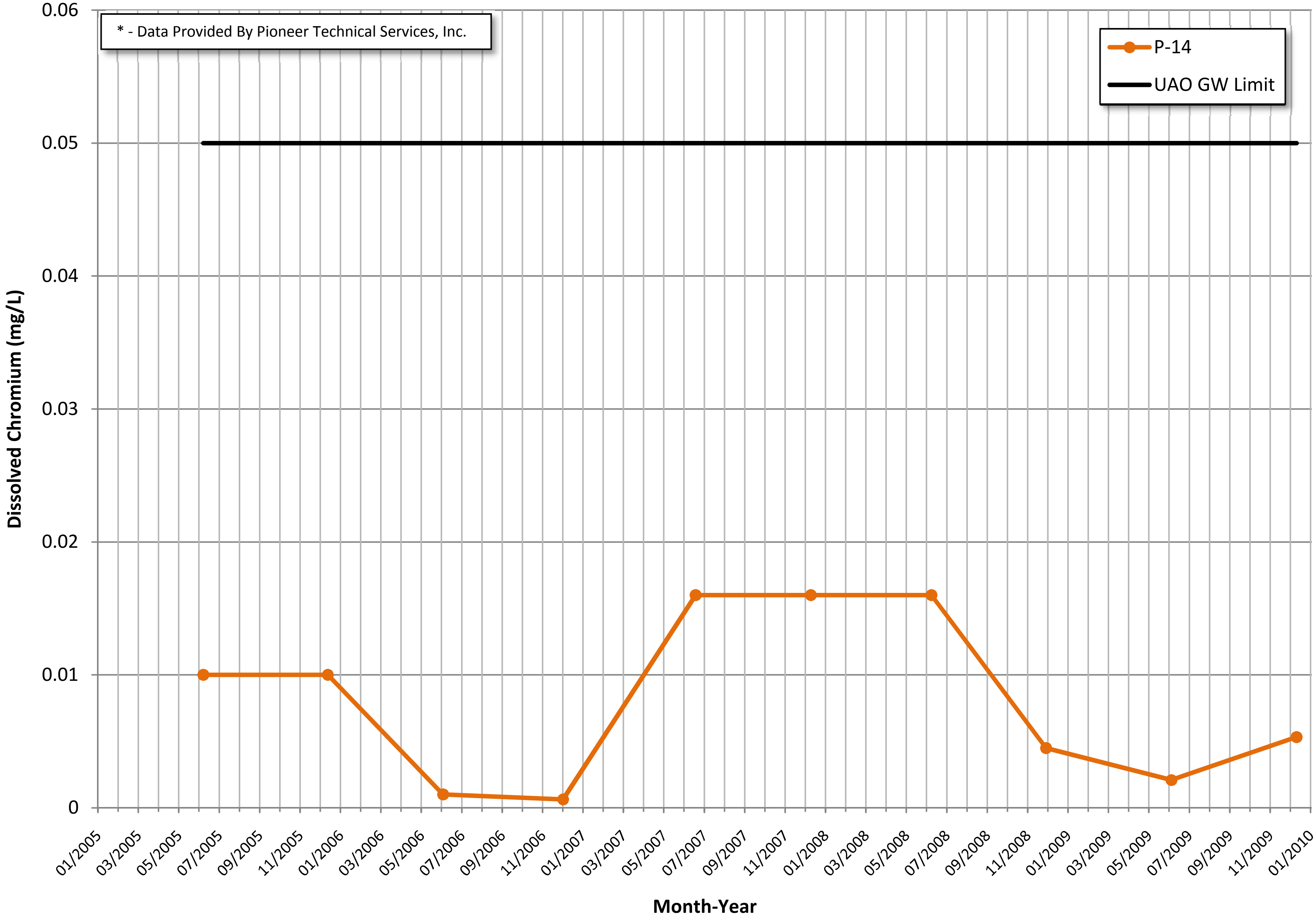

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Figure 6-44
Dissolved Lead in P-14 Piezometer
Silver Bow Creek/Butte Area Superfund Site Five-Year Review, 2010

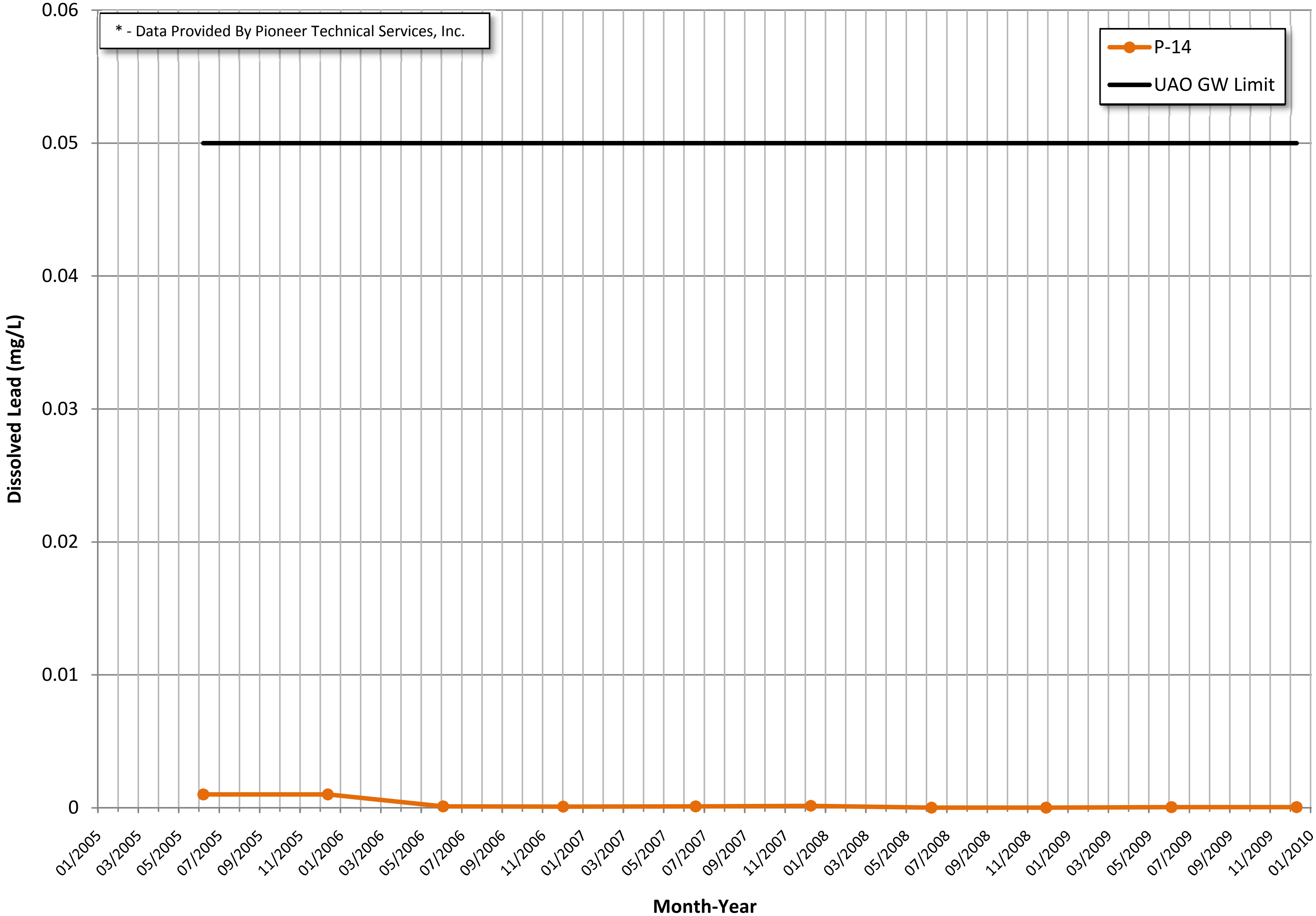

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Figure 6-45
Dissolved Mercury in P-14 Piezometer
Silver Bow Creek/Butte Area Superfund Site Five-Year Review, 2010

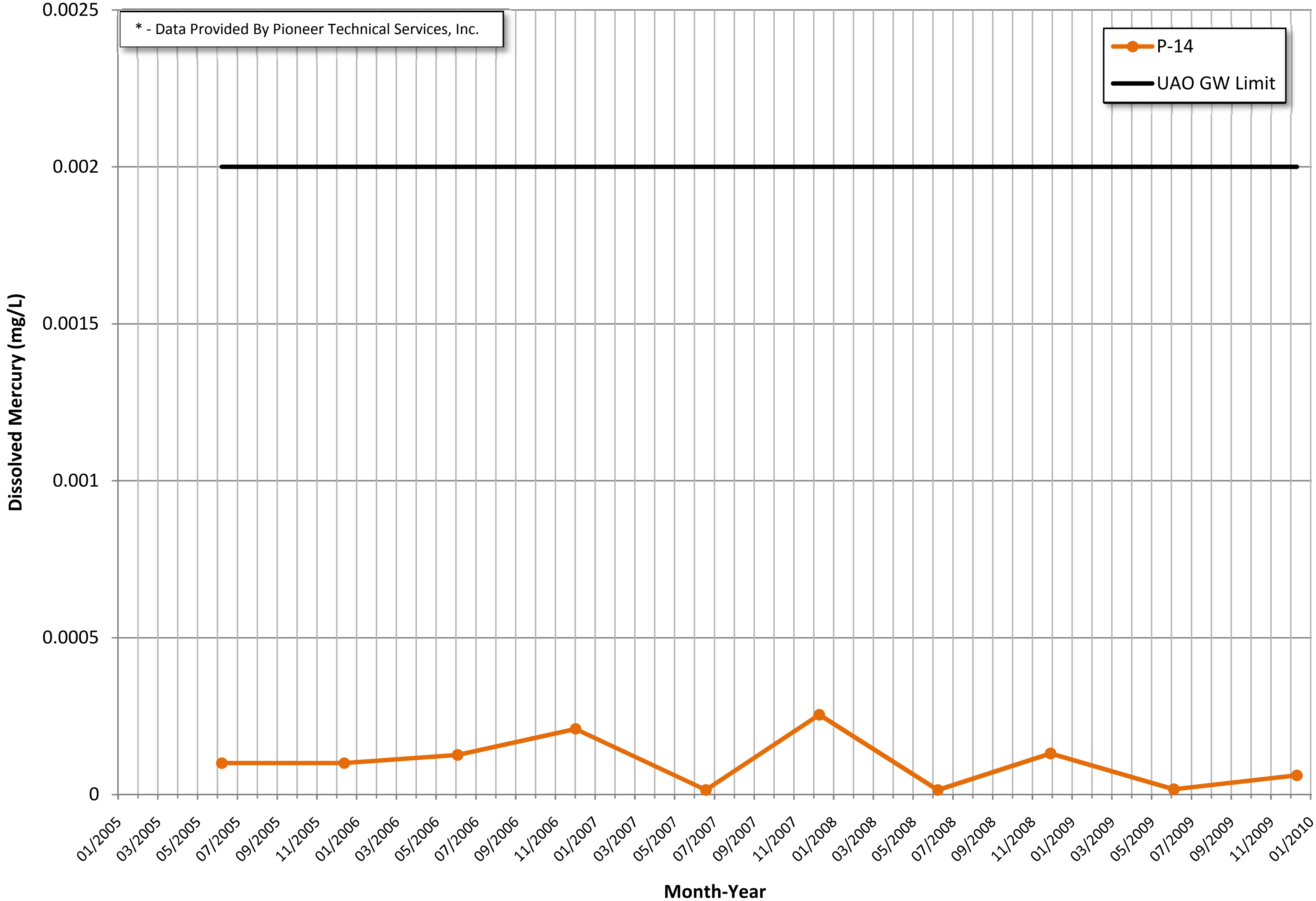

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Figure 6-46
Dissolved Nitrate in P-14 Piezometer
Silver Bow Creek/Butte Area Superfund Site Five-Year Review, 2010

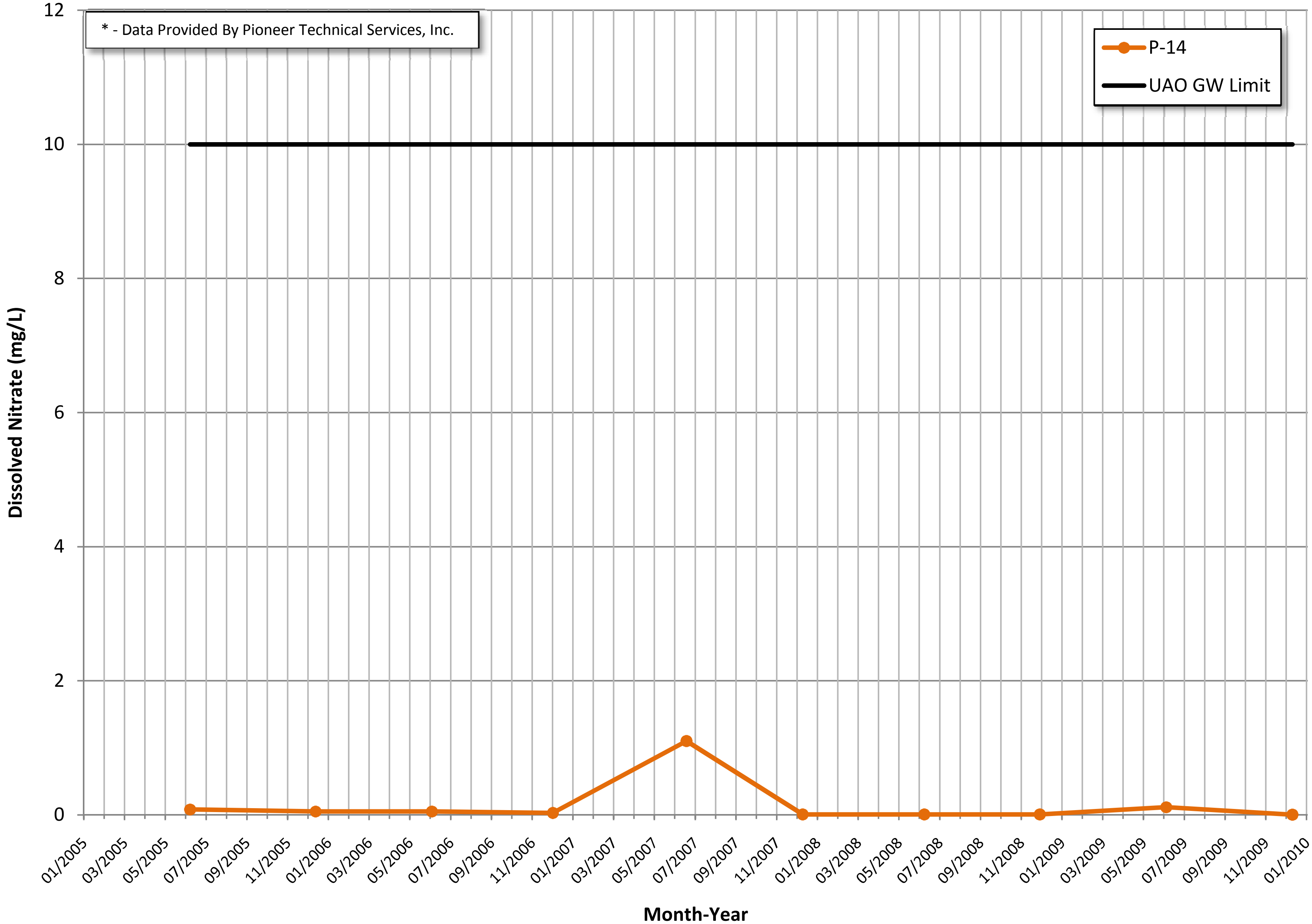

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Figure 6-47
Dissolved Arsenic in Up-Gradient Piezometers
Silver Bow Creek/Butte Area Superfund Site Five-Year Review, 2010

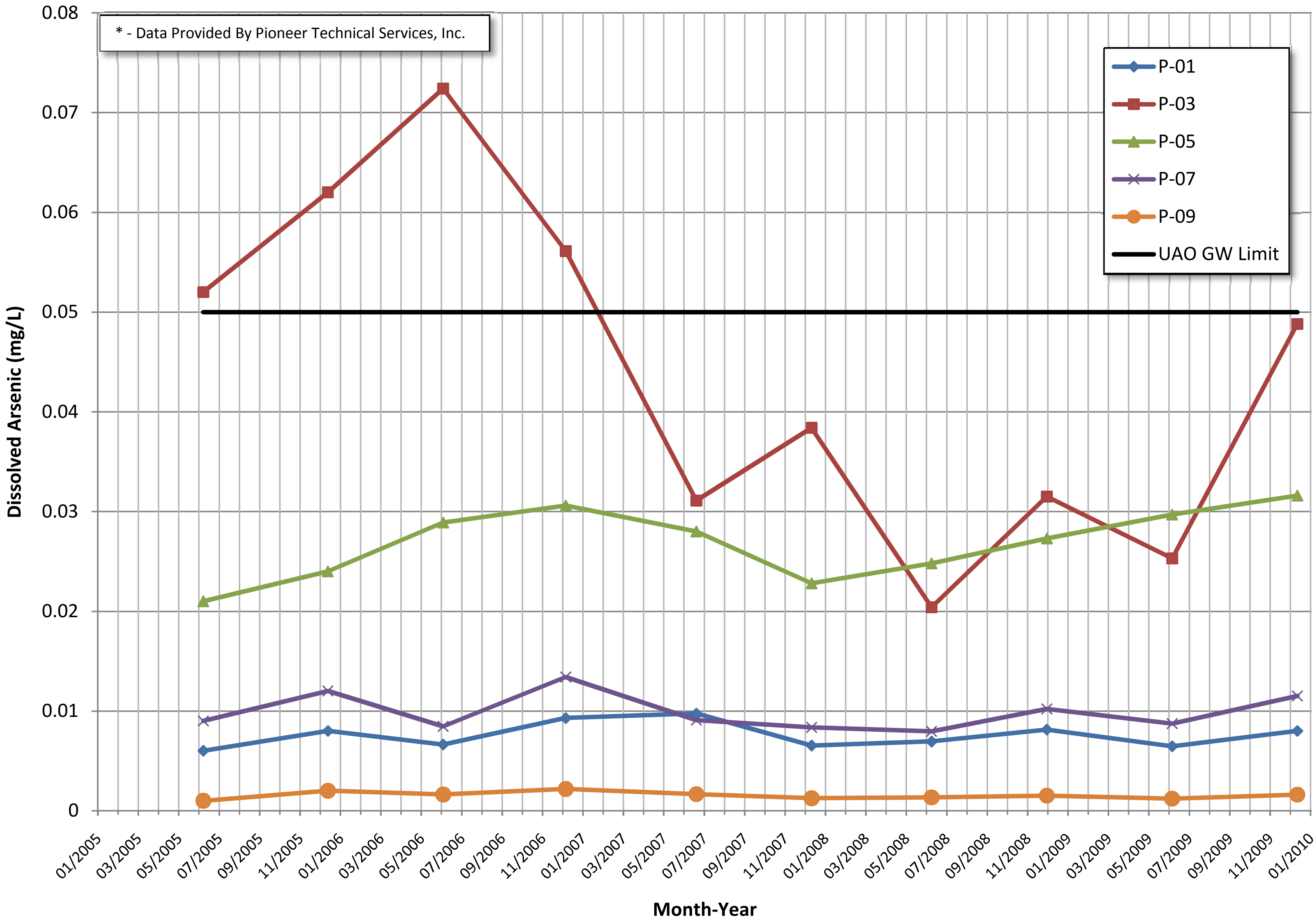

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Figure 6-48
Dissolved Cadmium in Up-Gradient Piezometers
Silver Bow Creek/Butte Area Superfund Site Five-Year Review, 2010

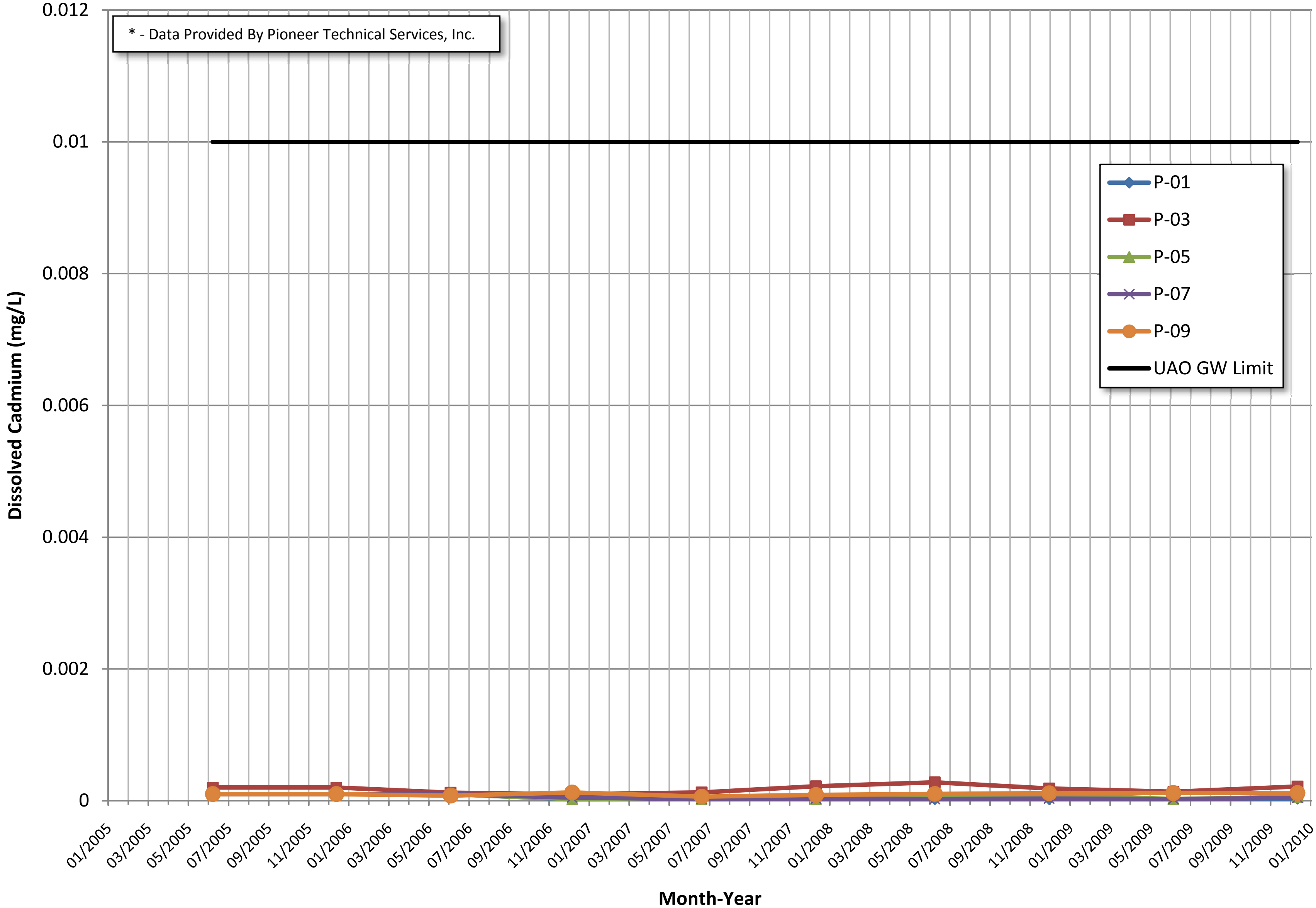

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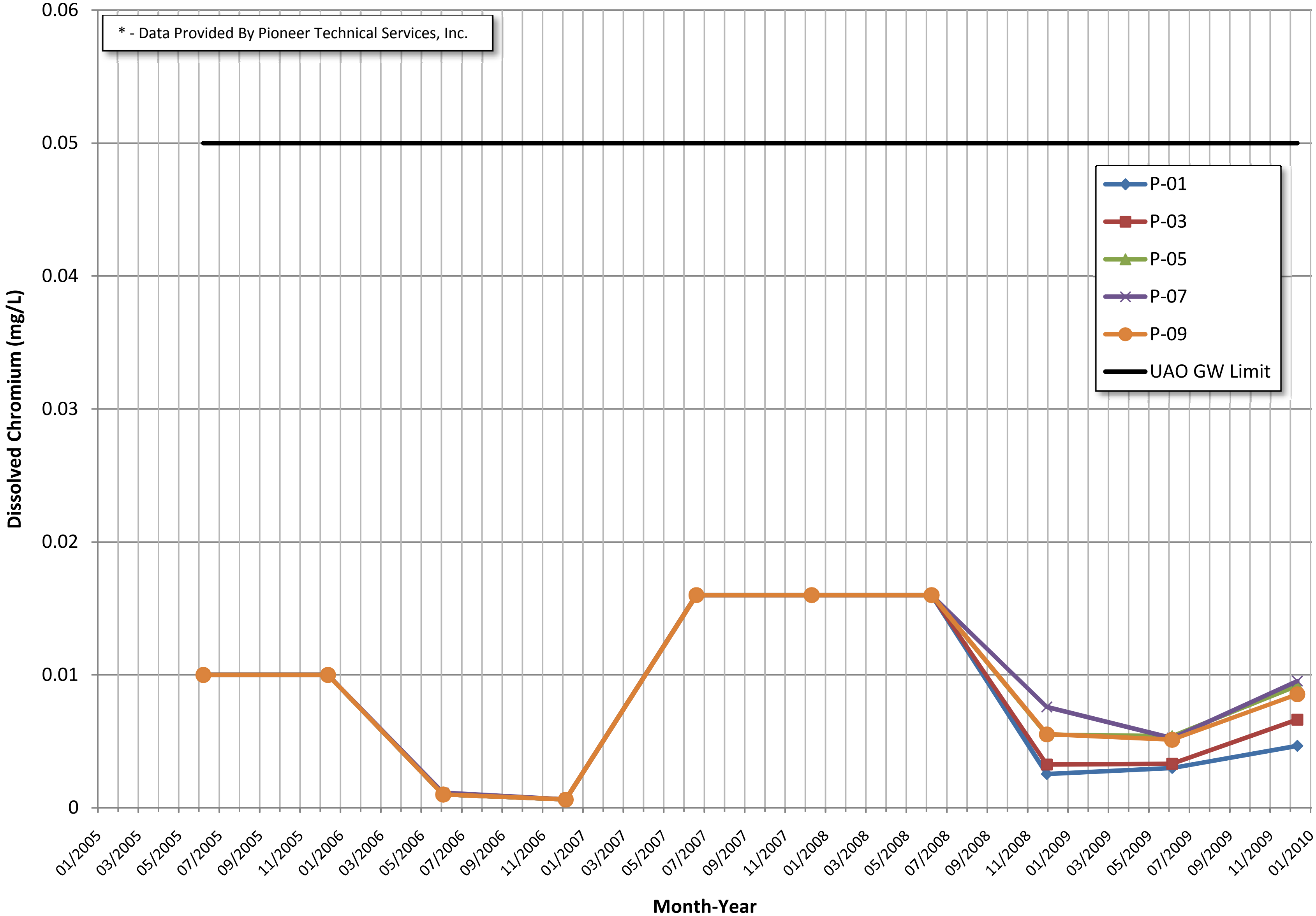
Figure 6-49
Dissolved Chromium in Up-Gradient Piezometers
Silver Bow Creek/Butte Area Superfund Site Five-Year Review, 2010



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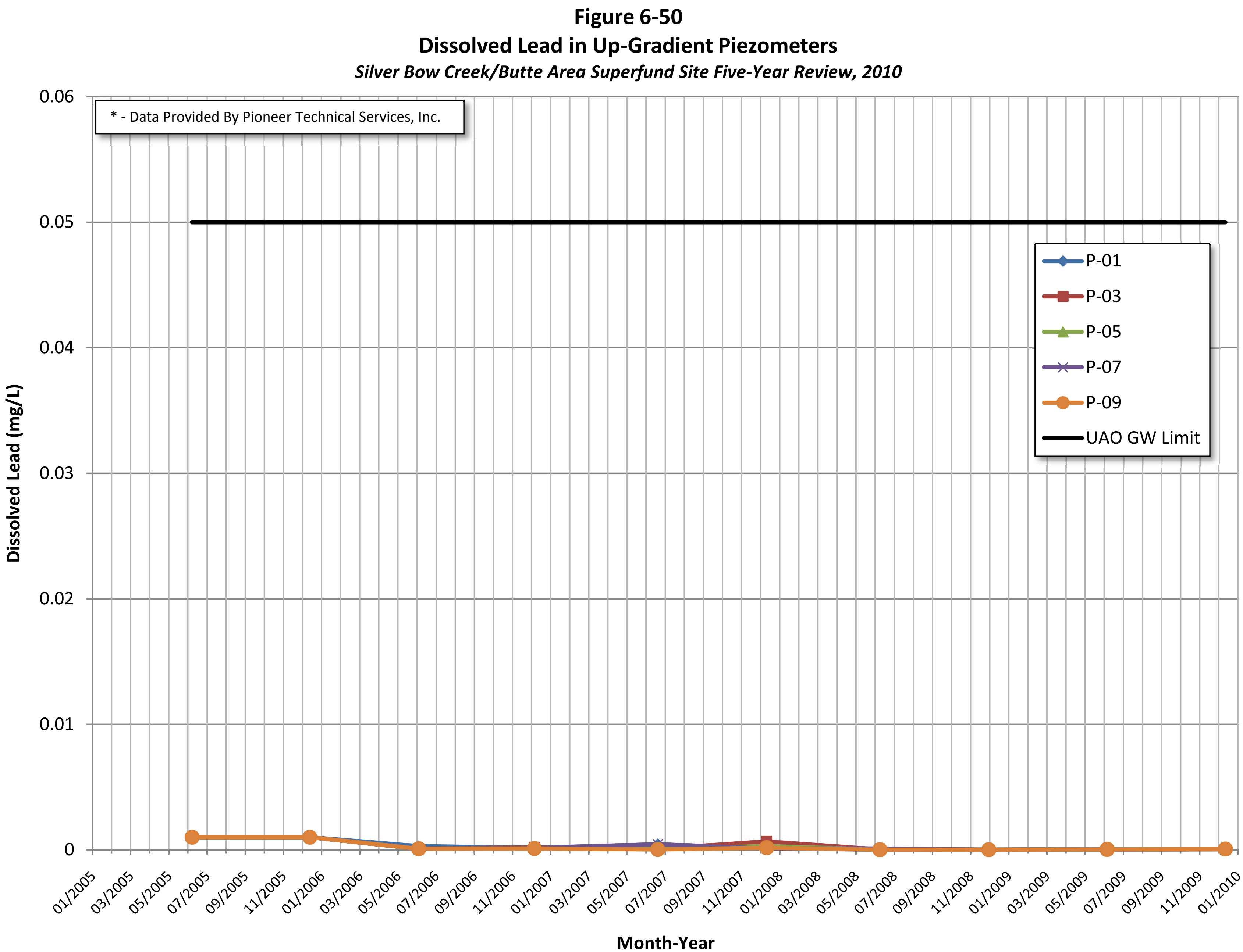

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Figure 6-51
Dissolved Mercury in Up-Gradient Piezometers
Silver Bow Creek/Butte Area Superfund Site Five-Year Review, 2010

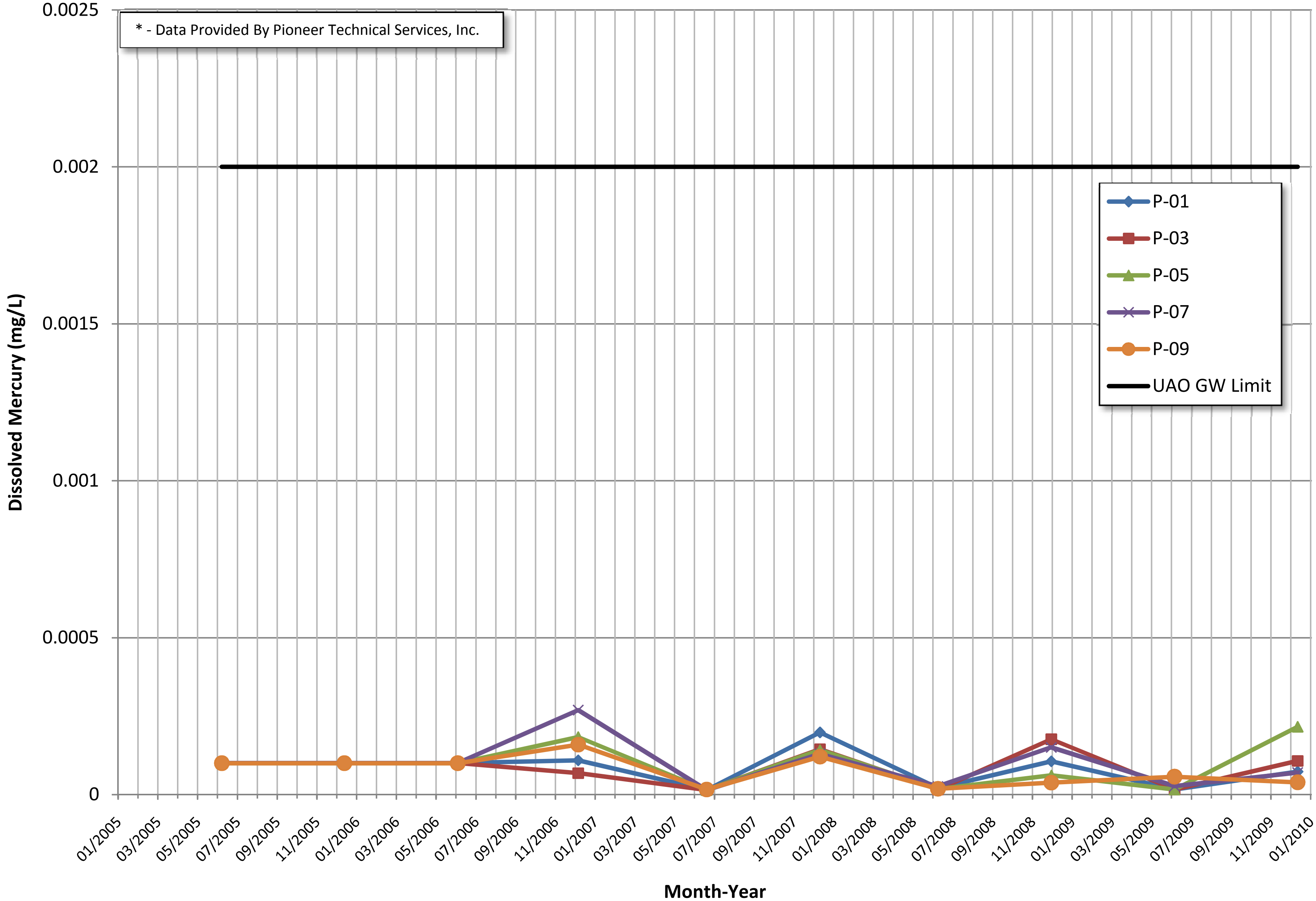

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Figure 6-52
Dissolved Nitrate in Up-Gradient Piezometers
Silver Bow Creek/Butte Area Superfund Site Five-Year Review, 2010

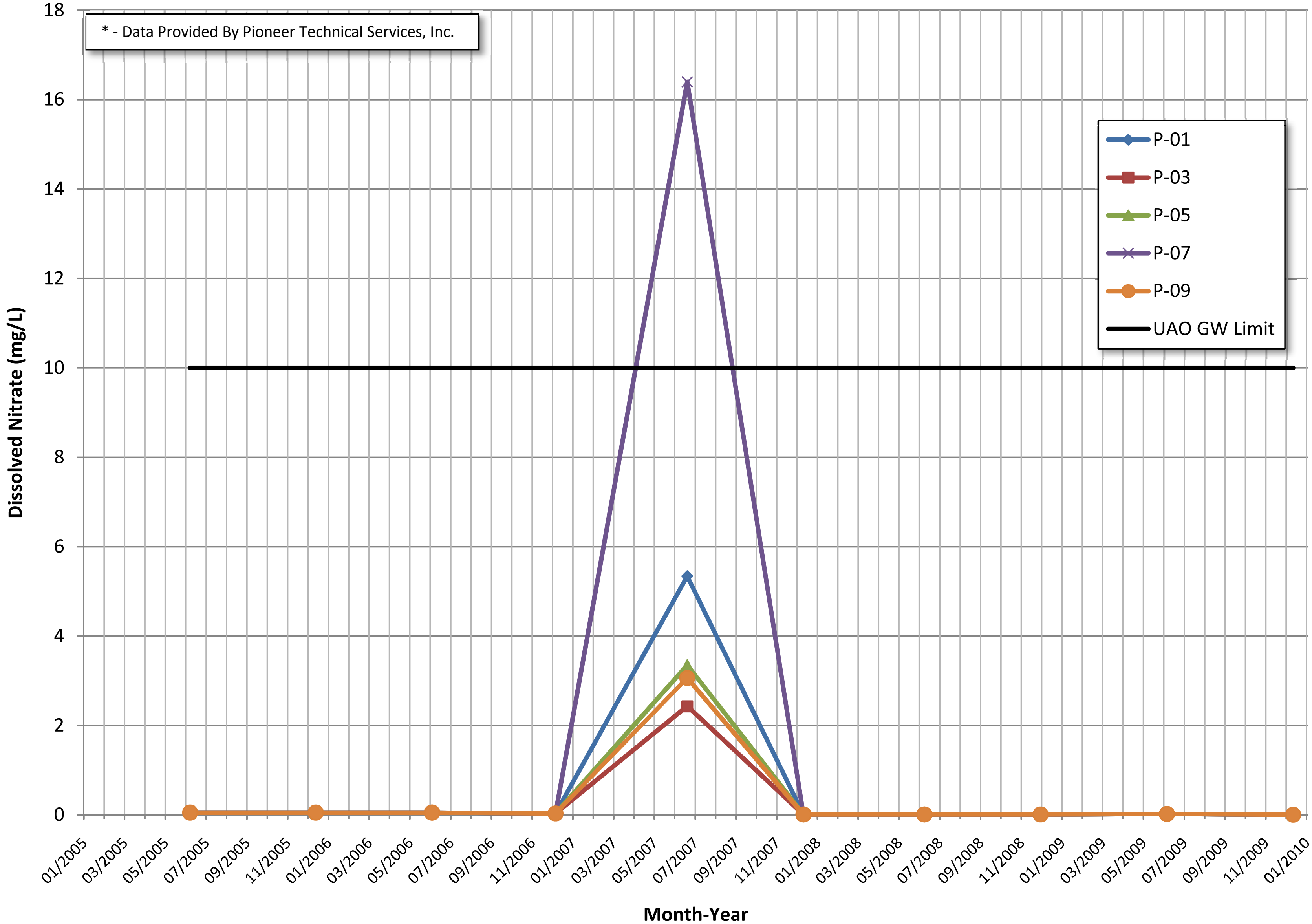

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Figure 6-53
Total Recoverable Copper Concentrations in Inactive Area Wet Closure Discharge (IA-2) Relative to Pond 3 (SS-3E) and Pond 2 (SS-5)
Silver Bow/Creek Area Superfund Site, Five-Year Review, 2010

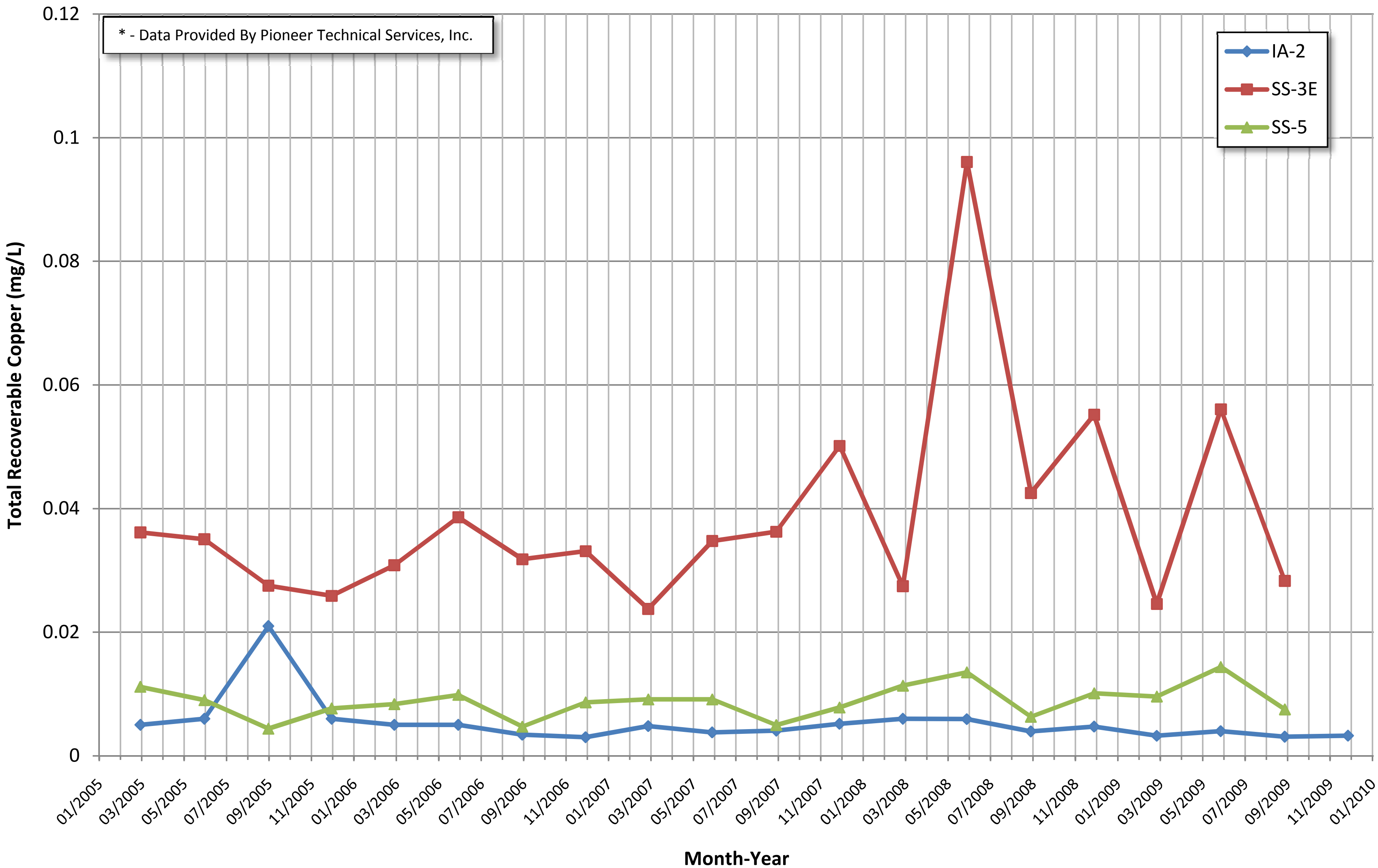

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Figure 6-54
Total Recoverable Zinc Concentrations in Inactive Area Wet Closure Discharge (IA-2) Relative to Pond 3 (SS-3E) and Pond 2 (SS-5)
Silver Bow/Creek Area Superfund Site, Five-Year Review, 2010

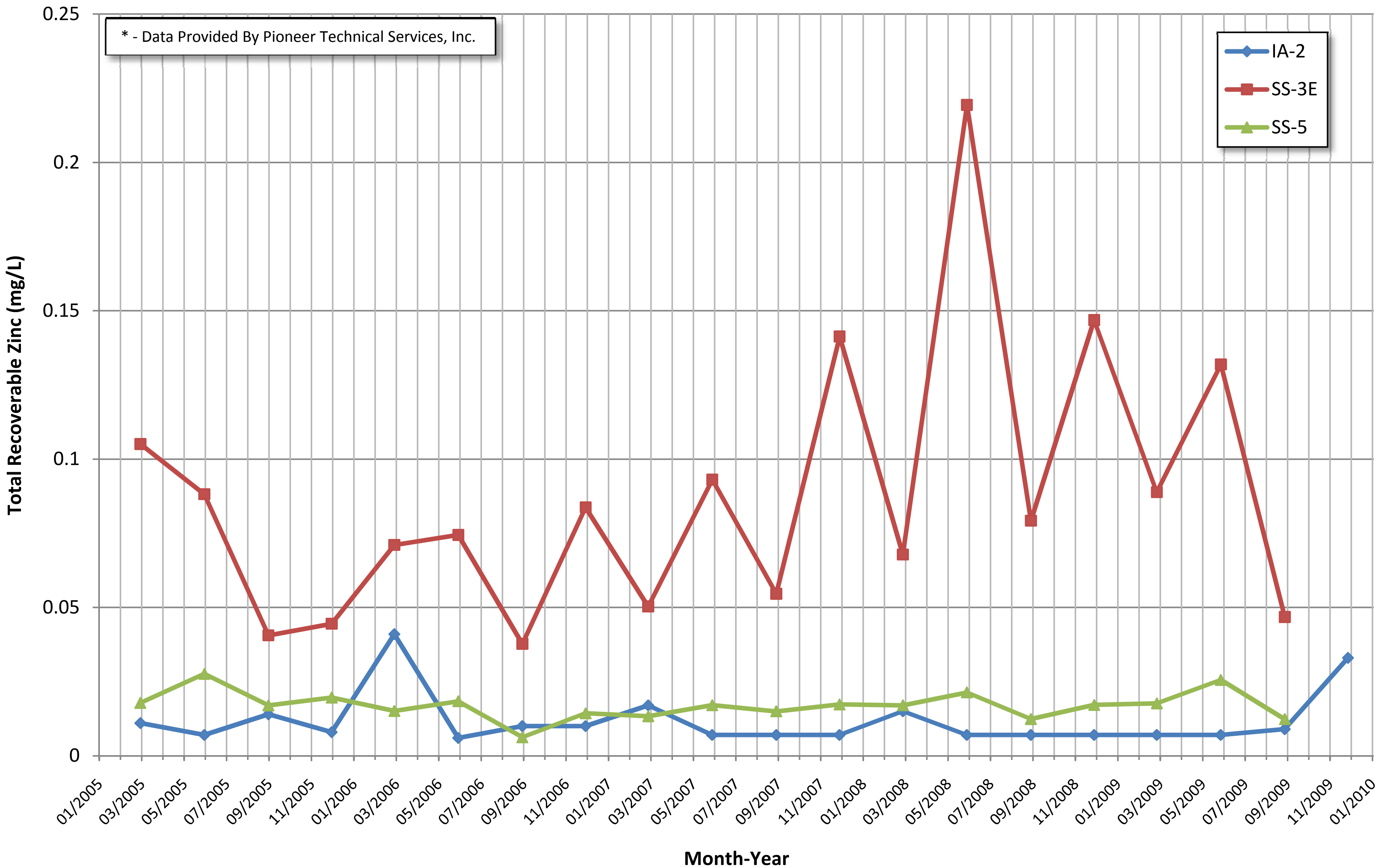

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Figure 6-55
Total Recoverable Arsenic Concentrations in Inactive Area Wet Closure Discharge (IA-2) Relative to Pond 3 (SS-3E) and Pond 2 (SS-5)
Silver Bow/Creek Area Superfund Site, Five-Year Review, 2010

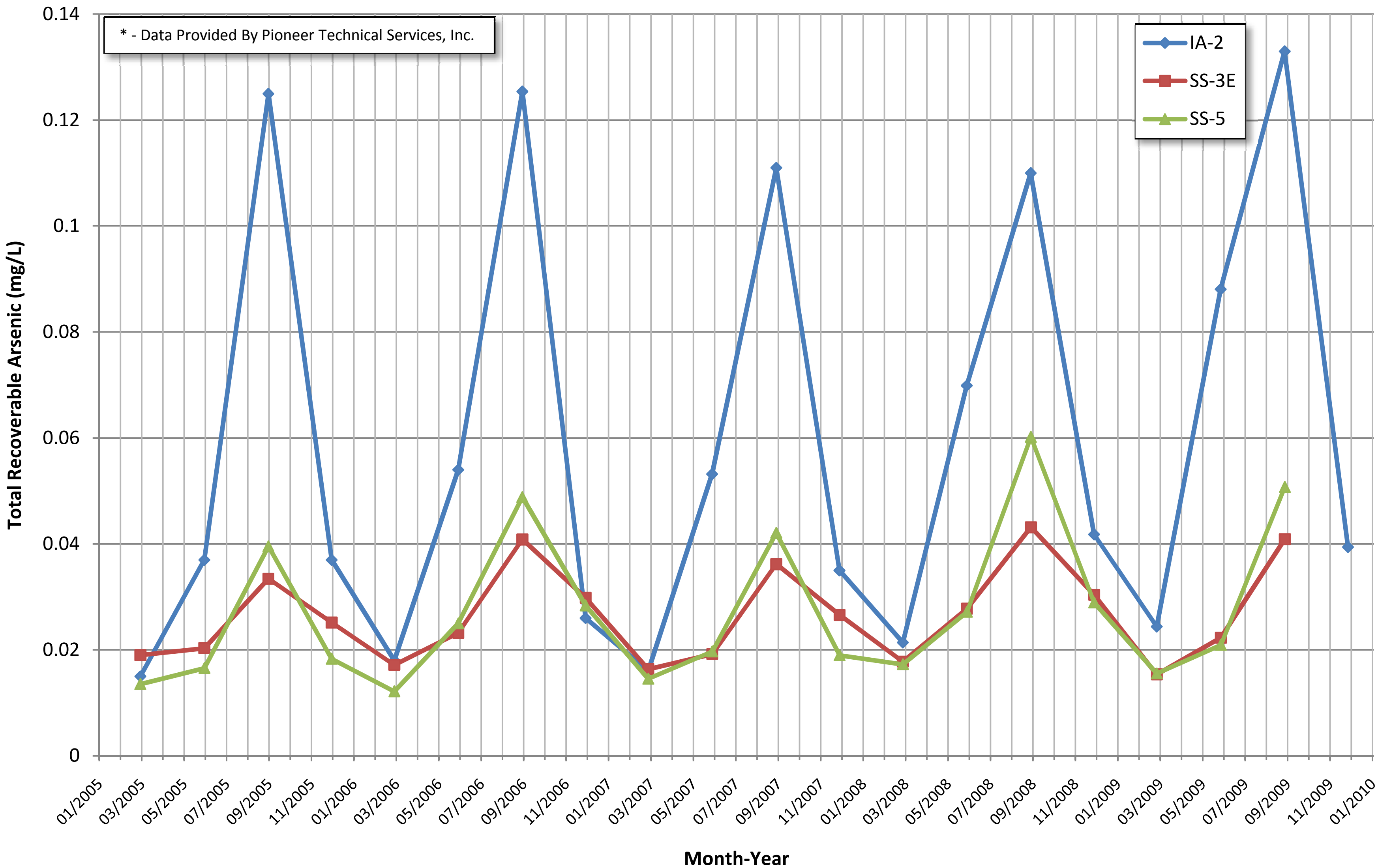

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Figure 6-56

Total Recoverable Copper Concentrations in Pump-back Pipeline (IA-1) Relative to Pond 3 (SS-3E) and Pond 2 (SS-5)

Silver Bow/Creek Area Superfund Site, Five-Year Review, 2010

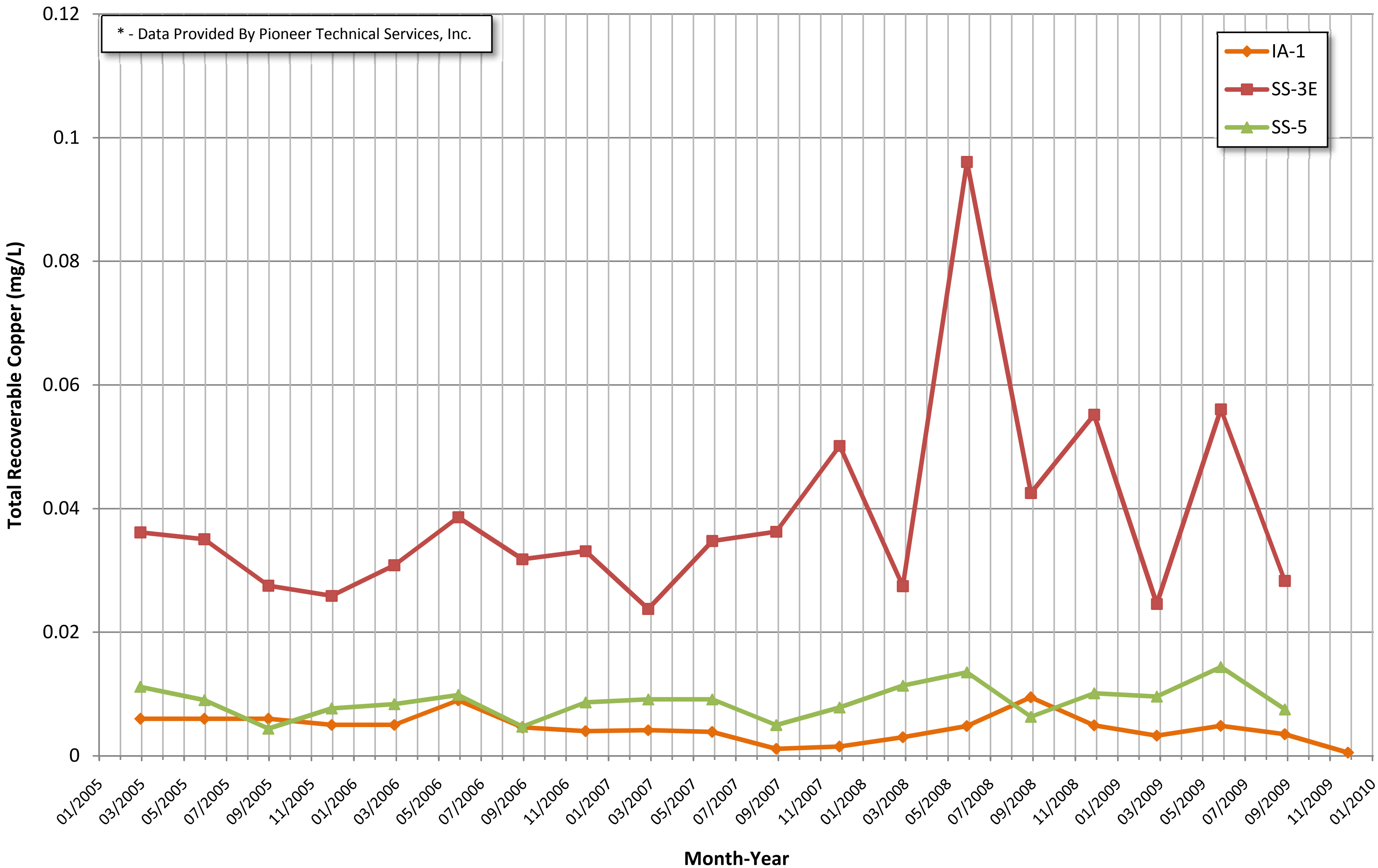

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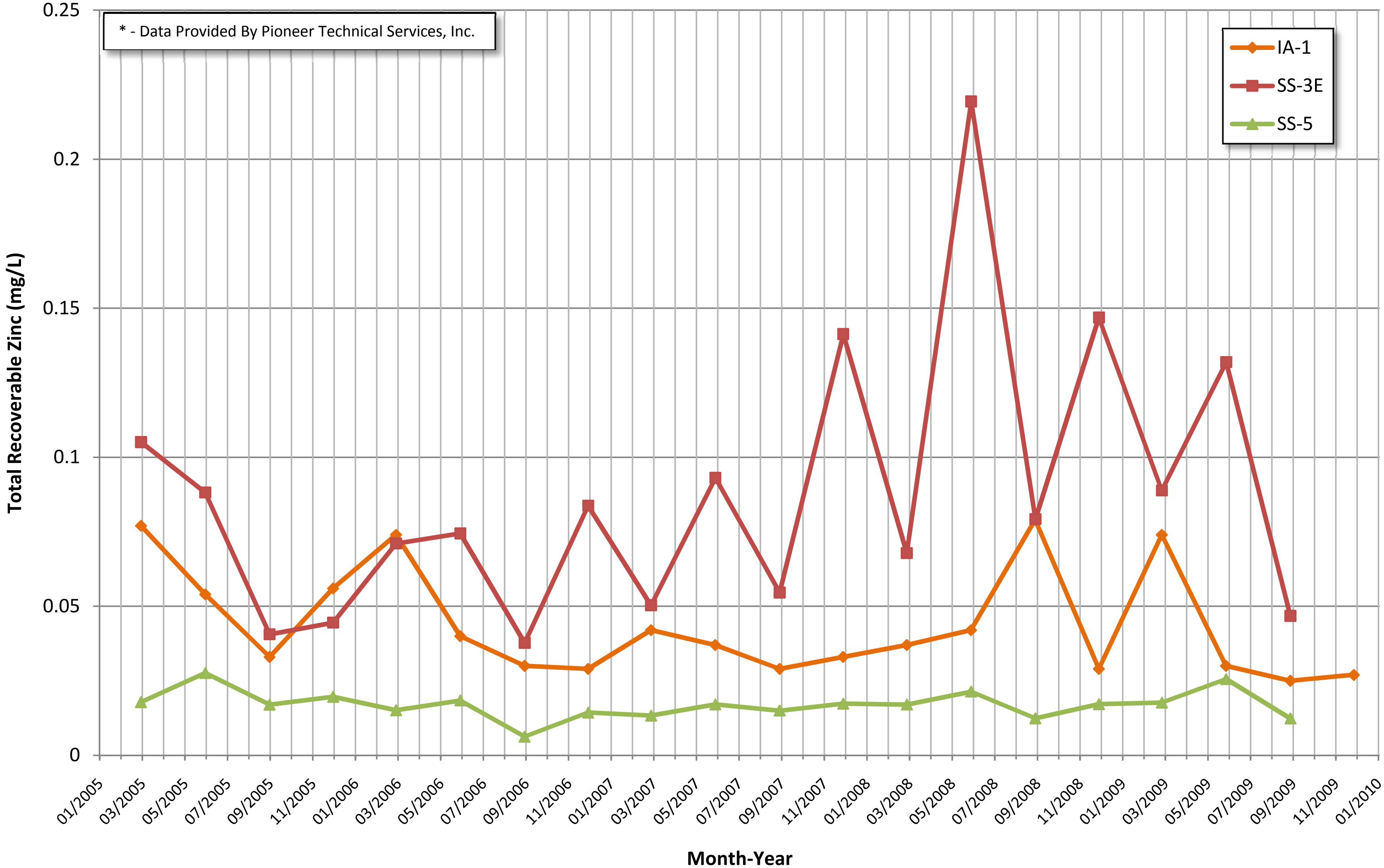
Figure 6-57
Total Recoverable Zinc Concentrations in Pump-back Pipeline (IA-1) Relative to Pond 3 (SS-3E) and Pond 2 (SS-5)
Silver Bow/Creek Area Superfund Site, Five-Year Review, 2010



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Appendix A

Site Inspection Photographs

Photographs Taken During Site Inspection: October 7, 2009

Photo 1. Silver Bow Creek entering the WSP hydraulic control structure and trash racks.Lime silos in background center.

Photo 2. Downstream side of the WSP hydraulic control structure with lime silo towers in background left.

Photographs Taken During Site Inspection: October 7, 2009

Photo 3. Looking upstream along Silver Bow Creek (left side) from the WSP inlet berm. Mill-Willow Bypass is on the right side.

Photo 4. Waste Cap at the WSP upgradient from the Wet Closure Ponds.

Photographs Taken During Site Inspection: October 7, 2009

Photo 5. Meandering Mill-Willow Bypass with healthy vegetation growth along banks.

Photo 6. One of many toe drains along Pond 3 dam adjacent to Mill-Willow Bypass.

Photographs Taken During Site Inspection: October 7, 2009

Photo 7. Riprap repair work to protect against wave run-up along banks of Pond 2.

Photo 8. Pond 2 discharge hydraulic control structure (station SS-5).

Photographs Taken During Site Inspection: October 7, 2009

Photo 9. Manifolded Toe Drain.

Photo 10. Groundwater interception channel pump house.

Photo 11. Scott Brown (EPA RPM) and tour group in the snow.

Responsiveness Summary – Warm Springs Ponds Operable Units

The responsiveness summary includes comments received on the draft report during the December 12, 2010 through January 31, 2011 comment period. The comments are shown as received but were edited to include only those comments pertaining to the WSPOUs. EPA responses are included in italicized text.

Comments from Atlantic Richfield

WARM SPRINGS PONDS OPERABLE UNIT
AR appreciates the level of data analysis incorporated into EPA's review of the Warm Springs Ponds Operable Unit (WSPOU) site and agrees with its major finding on the amount of progress made in water quality improvement to date.

EPA Response: Comment noted.

Specific Comments

1. EPA concludes that "The soil and groundwater remedies at the WSPOUs are protective of human health and the environment in the short term" (Vol. 4, pg 10-1): AR agrees with this conclusion. Water effluent chemistry; biomonitoring studies conducted by AR in 2006, 2009, and 2010, and benthic macroinvertebrate monitoring conducted by EPA contractor Dan McGuire all indicate that the remedy has been, and continues to be, protective.

   EPA Response: Comment noted. Please see the revised protectiveness findings contained in the final five year review report.

   EPA also indicates that the long-term effectiveness of the remedy is not necessarily assured: "information gathered in the last five years calls into question the long-term protectiveness of the remedy" (p. 10-1). AR questions what specific information leads to this conclusion, and requests that EPA identify the specific "information" that supports this statement.

   EPA Response: EPA findings have been revised in the final five year review report. The report's conclusions are explained in the document itself.

   As described below, EPA's statement regarding catch and release regulations at the ponds to prevent consumption of contaminated fish is incorrect; there is no indication of bioaccumulation of metals in fish tissue to concentrations that would be a concern to human health or other ecological receptors. Also, there have been no population level effects observed in wildlife receptors such as waterfowl, as documented in the biomonitoring reports. All indications are that the current remedy will be effective in the long-term, and on-going monitoring will continue to be used to confirm this.

   EPA Response: See response to detailed comment on this subject.

2. EPA recommends continued arsenic treatment optimization studies (Table 9-1): AR agrees that this ongoing effort does not affect the protectiveness of the remedy. The peak arsenic concentration observed in the discharge during the remedy review period was 78 ug/L, which is 77% below the acute aquatic life standard of 340 ug/L.

   EPA Response: Comment noted. However, CERCLA requires that remedial actions meet all performance standards, and the ponds system is currently exceeding arsenic standards, including *human health arsenic standards, on occasion. Treatment optimization to control arsenic in better and more consistent ways, as well as improvement in incoming water quality, must continue under the interim remedies, and these considerations will be an important part of the final remedy decisions for the ponds area.*

In 2008, AR initiated a study of arsenic, nutrient, and metals cycling in the ponds system in an attempt to better understand release mechanisms. This ongoing study led to a hypothesis that increased mixing of the active treatment lagoon cells, to increase gas exchange with the atmosphere and sediment and to reduce temperatures, may help to mitigate the seasonal release of arsenic from the bed sediments. Therefore, in 2010, AR began a pilot study with SolarBee® mixers in Ponds 2 and 3 and the West Wet Closure. Data collection and analysis are on-going. To date, AR is not able to draw definitive conclusions with respect to the Solar Bee's effectiveness. However, based upon performance to date it does not appear that the solar mixers are able to achieve compliance with the 20 ug/L arsenic discharge standard at all times. AR plans to continue the study into 2011. Existing institutional controls prevent consumption of water: from the WSP, the UCFR, and groundwater affected by these surface water bodies. Therefore, protection of human health is assured. Ecological health is also protected as arsenic concentrations discharged from the ponds system do not exceed concentrations protective of aquatic life.

EPA Response: Comment noted. EPA understands these limitations. However, performance standard compliance is legally required and must be pursued. EPA is not aware of institutional controls which prevent the consumption of surface water in the area, but does note that the area is not used currently to provide domestic drinking water.

3. Metals Bioaccumulation:

The WSPOU provides a diverse and valuable habitat for wildlife and an opportunity for the public to enjoy these natural resources, while maintaining protectiveness of human health and the environment. AR does not perceive a need for additional metals bioaccumulation studies. If deemed necessary, the studies should be conducted consistent with AR's comments on issues and recommendations related to site-wide integrated monitoring, and the potential need to evaluate (from a risk perspective) new pathways associated with ecological improvements that have followed response actions. AR recommends that this issue be addressed via a DQO process which carefully considers goals and objectives of additional studies. Goals and objectives of additional data collection should consider the overall objective of the five-year review process, (i.e., "to determine whether the remedies or other response actions in place or under construction within the Site are protective of human health and the environment and otherwise in compliance with the decision documents"), and specific data collected should directly support the stated goals and objectives. Goals and objectives should furthermore, be directly linked to specific management decisions. This should all be pursued in a coordinated manner with other similar efforts on a site-wide basis, recognizing that "one size may not fit all" and specific approaches will likely need to be developed for individual OUs, such as WSPOU.

- *EPA Response: EPA agrees. In consideration of AR's and others' comments on the site-wide biological monitoring program, EPA will modify its recommendation for development and implementation of a more narrow plan with appropriate DQOs and measurement endpoints on this issue to ensure usefulness of the data, if funding allows.*

4. Final Remedy (begin final ROD planning - data collection, risk assessment):

   The recommendations here discuss working toward the final ROD for the WSPOU as well as developing a site-wide ecological study "for determining if a stream is supporting or not supporting a designated aquatic life use". Given that upstream remedial and municipal activities will continue to impact the WSP system and SBC water quality, consideration should be given to these activities on the WSP system as part of a Final Remedy assessment. That said, biomonitoring activities have been in place at several locations, and for several COCs, within the WSPOU from 1995 through 2010. This includes monitoring for metals bioavailability in different receptor species as well as in the sediment (assessing both toxicity and bioavailability). Species diversity and abundance have also been monitored for the benthic macroinvertebrate (BMI) community during this time. While there has been no comprehensive ecological risk assessment performed with the data collected, as this was not one of the original objectives, temporal trends have been evaluated with the datasets as well as comparisons among sites within the ponds (e.g., comparing whole body metal residues near the influent versus the outfall). As stated, the ponds may be operating at their maximum capacity until upstream activities are resolved, including nutrient inputs.

   In moving forward with the planning for the final ROD, AR understands that an integrated "site-wide" approach to evaluating potential risks across different OUs may be required, and if pursued correctly may be useful, as many of the issues are similar within the drainage basin. Consistent with AR's comments on issues and recommendations related to site-wide integrated monitoring, and the potential need to evaluate (from a risk perspective) new pathways associated with ecological improvements created by remediation and restoration, AR recommends that, if pursued, this issue be addressed via a DQO process which carefully considers goals and objectives of additional studies.

   Goals and objectives of additional data collection (if pursued) should consider the overall objective of the five-year review process, (i.e., "to determine whether the remedies or other response actions in place or under construction within the Site are protective of human health and the environment and otherwise in compliance with the decision documents"), and specific data collected should directly support the stated goals and objectives. Goals and objectives should furthermore, be directly linked to specific management decisions. This should be pursued in a coordinated manner with other similar efforts on a site-wide basis, recognizing that "one size may not fit all" and specific approaches will likely need to be developed for individual OUs (such as WSPOU). For example, differences between stream and lake systems need to be considered, as metrics and endpoints developed for lotic (i.e., stream) systems may not be appropriate for lake (lentic) systems (e.g., periphyton and BMI metrics). In addition to developing specific DQOs which are appropriate and provide realistic and achievable (remedial) objectives for this site, specific sediment management and risk management principals should be considered. For example:

- The performance of multi-year field studies at Superfund sites to try to quantify or predict long-term changes in local populations is not necessary for appropriate risk management decisions to be made (OSWER Directive 9285.7-28).
- Ensure that any sediment cleanup is consistent with and supported by site-specific risk management goals. While it is generally more practical to use measures such as contaminant concentrations in sediments to identify areas to be remediated, other measures should be used to ensure that human health and/or ecological risk reduction goals are being met. (OSWER Directive 9285.6-08)
- Long-term impacts (e.g., recreational uses if the waterbody) of each alternative on societal and cultural practices should be identified and considered as appropriate, and a comparative analysis of impacts may be useful to fully assess and balance tradeoffs associated with each alternative (OSWER Directive 9285.6-08).

EPA Response: EPA recognizes the importance of the biological monitoring done to date. In fact, these data should be assessed for their usability and completeness prior to recommending any further data collection for the purposes of any further action. EPA will also consider this input as it plans for regulatory steps that will be necessary to issue final, as opposed to interim, RODs for the Ponds sites. A date for beginning this process has not yet been set, and EPA agrees that upstream water quality and remedial actions are an important part of that planning process.

5. Page 4-2. EPA correctly states that the Mill Willow Bypass (MWB) channel was designed to safely route 70,000 cfs (one half the estimated Probable Maximum Flood [PMF]). Recent analysis completed by AR indicates that the PMF is lower than originally calculated, and the appropriate design flow for the MWB would be 55,055 cfs. Supporting documentation for this change was provided to EPA with submittal of the revised WSPOU O&M manual.

   EPA Response: EPA will continue to have discussions with DNRC about the effect of recalculating the PMF may have on vegetation efforts in the bypass. Although the information described above and provided by ARCO is appreciated, a formal re-evaluation of the PMF for the MWB channel is not necessary since the channel is already constructed.

6. Page 4-6, first bullet and paragraph labeled "Lime Addition": These sections state that lime is added to raise the pH. It should be pointed out that this is not always the case; during those times of the year when photosynthesis naturally raises the pH of the pond system, no lime is added.

   EPA Response: EPA agrees. The bullet and paragraph will be clarified as suggested.

7. Table 5-1, EPA states that "Increased abundance observed in latest surveys (2009) is considered an indication of reduced toxicity at the WSP." AR acknowledges that there was increased abundance in the 2009 surveys, which would suggest better overall habitat conditions (as correctly stated by EPA in the 5-year review on page 6-28, first full paragraph). However, it is important to note that the overall trend at this station has been positive since monitoring was started in 1986. Regarding recent and slight declines in invertebrate biointegrity indices below the Pond 2 outfall, McGuire (2008) and others have hypothesized that such impacts may be related to intermittent or episodic events regarding pulses of ammonia, arsenic and/or elevated pH. A variety of aquatic toxicity data for arsenic and ammonia, were combined with a review of the taxonomic composition of the fauna documented at the SBC station below the Pond outfall (CFR 04.5; McGuire, 2009). One of the most abundant invertebrates at Station CFR 04.5 (the amphipod *Hyalella azteca*) is also one of the most sensitive species to ammonia as determined by laboratory toxicity testing reported in the EPA ammonia criteria database (EPA, 1999a). In quantitative macroinvertebrate samples collected in 2004 and 2007 at Station CFR 04.5, *Hyalella azteca* densities averaged ~1,800 and ~1,200 per square meter of river bottom, respectively, one of the most abundant species in both years. A related amphipod (genus *Gammarus*) was also a common invertebrate at station CFR 04.5, occurring in 2004 and 2007 at average densities of ~230 and ~110 per square meter of river bottom, respectively. At least one species of this crustacean genus (*Gammarus pseudolimnaeus*) is documented to be sensitive to arsenic in both the EPA arsenic criteria database (EPA, 1985) as well as the EPA's web-based ECOTOX database. In addition to amphipod data from Station CFR 04.5, amphipod data from WSP indicate that *Hyalella azteca* as well as a species of *Gammarus* (*Gammarus lacustris*) occurred abundantly or commonly in substrate cores and/or qualitative sweep net samples throughout the WSP System as indicated by sampling conducted between 1995 and 2006. Proximate to the Pond 2 discharge location, average *Hyalella azteca* density represented 48% of total macroinvertebrate sample density while *Gammarus lacustris* averaged 7% of total macroinvertebrate density during sampling years 1995-2006. Similar to the amphipod data from Station CFR 04.5, these WSP data do not support a thesis of explicit/episodic toxicity in the Ponds. Indeed, observations of the macroinvertebrate community during periodic WSP biomonitoring collections (during AR sampling periods), amphipods have always occurred in dense accumulations on and among these plant substrates in each of the sampled ponds.

   Therefore, the reduced abundance of benthic macroinvertebrates in the years immediately preceding the 2009 surveys cannot be attributed to metals or arsenic concentrations in the WSP discharge. The text in Table 5-1 should be modified accordingly. As noted in AR's site-wide comments regarding the impacts of the BPOTW and comments regarding fish toxicity in SSTOU, nutrient management is an important aspect of future surface water quality and beneficial use attainment in SBC and downstream in the CFR. However, this particular instance of periodic reductions in BMI abundance downstream of the WSP cannot be directly attributed to toxicity of ammonia discharging from the WSP.

EPA Response: This comment acknowledges the decreased measurement of aquatic biota immediately downstream of the Pond 2 discharge, and then hypothesizes causes and presents additional data. All of this information is interesting and an important part of the discussion, but does not change the legal requirement that Superfund remedial actions must meet performance standards, including arsenic standards.

8. Page 6-14, 3rd full paragraph: EPA states that the groundwater point of compliance shifts to the south side of the interception trench if the "pump-back system is deemed by EPA to be no longer needed". The ROD specifies that the decision to shut down the pump-back system is to be based on demonstrated compliance with the groundwater performance standard. As stated in Section 1 of Exhibit 4 of the Inactive Area UAO (EPA, 1993), this can be done "upon demonstration of consistent compliance with groundwater standards immediately south of the groundwater interceptions trench for a period of twenty four months".

   EPA Response: The comment is noted but there is no real inconsistency between the ARCO comment and the text of the report. EPA must approve of any change to the pump-back system and/or groundwater compliance points.

9. EPA correctly points out that the ESD and ROD include ICs that ban fish consumption. EPA goes on to indicate that it believes that the catch and release institutional control may not be appropriate (Sec 6.5.1, p. 6-36). In Section 7.2, EPA says that "Fishing….is restricted to catch and release only protecting recreational anglers from possible contaminants in fish" (p. 7-5, first full paragraph). Section 10 includes similar statements. This infers that the decision to implement the catch and release IC is based on protection of human health. This is not correct based on the record.

   The Active Area ROD was issued with a ban on fish consumption. AR commented at the time that there was no human health reason for the ban, and EPA agreed. Therefore, the catch and release restriction was clarified in the June 1991 ESD issued by EPA. This clarification is quoted from the ESD in the Five-Year Review (p.7-5), as follows:

   > *"The ROD describes institutional controls which would ban fish consumption at the Site. EPA has considered this issue further, in consultation with the DFWP, and has determined that the ban on taking fish for consumption may not be appropriate for the Site. EPA will continue to evaluate this issue, and may require such action at a later time, if data indicates such a ban is appropriate. DFWP retains the ability to implement catch and release policies in order to manage the fishery most effectively."*

   Therefore, EPA's recommendation in the Five-Year Review report to assess the "continued appropriateness" of the catch and release policy is at odds with EPA's conclusion in 1991 that it was not necessary to protect human health.

   Furthermore, there are no new data to suggest the need for such a ban to protect human health. One comment that is unclear in the 5-year report is that "fish tissue metals are slightly elevated". To our knowledge fish metals residues have not been collected at the ponds since the 1998 biomonitoring effort, so we are not aware of fish data supporting this statement. While aqueous arsenic concentrations and BMI residues have increased at the outfall of the WSP or just below, aqueous arsenic concentrations are below chronic aquatic life standards. Furthermore, concentrations measured in various BMI receptors are below dietary toxicity reference values. Therefore, the interim remedy remains protective of the environment.

In summary, EPA (p. 7-5) misstates the purpose of the present ban to be "protecting recreational anglers from possible contaminants in fish". The catch and release policy has been implemented by the Department of Fish Wildlife and Parks (DFWP) as DFWP's preferred approach to managing sport fishing at WSP.

The text in the above referenced sections should be removed or modified to correct the error caused by this apparent mis-interpretation of the ESD text.

EPA Response: EPA agrees with this comment in part. The cited ESD did clarify that the fish ban was not needed for protection of human health but also noted continued evaluation of this issue would be done. Currently, the fish ban is in place at the ponds as part of the Fish, Wildlife and Parks efforts at wildlife management. Continued evaluation will continue. EPA will clarify the text accordingly.

10. Page 7-2, first paragraph: AR agrees with EPA's conclusion that silver and selenium could be dropped from the analytical list, since they are rarely detected in the influent or effluent from the system. AR also believes that other constituents that are rarely detected or are consistently well below their discharge standards should be considered for deletion from the analyte list or at least measured on a reduced frequency.

    EPA Response: Comment noted. ARCO should submit a proposal that silver and selenium be dropped from the required monitoring plan and EPA will consider this and respond. EPA does not believe other constituents should be considered for deletion or reduced frequency at this time based on its review of the existing data. ARCO is free to submit a more detailed proposal for reduced monitoring of other constituents, with appropriate justification, at a future date.

<u>Comments from Clark Fork Coalition</u>

Warm Springs Ponds OU

7. <u>Arsenic, pH, and Ammonia</u>. We recognize that research continues into the geochemical status of the Warm Springs Ponds and the increasing problem of arsenic release to the Clark Fork River and to groundwater. The five year review recognizes the arsenic problem, but does not mention that pH and ammonia have also become issues at the WSP. As the ponds have become more and more eutrophic, these issues are becoming more pronounced, with worsening water quality in the ponds and just downstream of the outlet. Aquatic life in the river is affected, included macroinvertebrates and fish, most likely from pH over 9, as ammonia becomes stable in alkaline conditions. Although the impact may be in the Clark Fork River Superfund site, the WSP are the source, and this overlapping problem between operable units should be acknowledged and explained in the five year review.

- *EPA Response: EPA recognizes the arsenic, ammonia, and pH issues raised by this comment. First, EPA notes that the main source of these constituents is not the ponds system but upstream sources. These problems can largely be traced to incoming water quality issues, such that both the Silver Bow Creek/Butte Area site and the Anaconda Smelter Site affect water quality in the Clark Fork River. Work is ongoing to constantly improve water quality in the watersheds, and address these issues. As noted above and in the report, optimization studies to improve pond performance are ongoing. If the CFC has technically sound suggestions on how to improve the water quality discharging from the ponds that are not being planned (WWTP nutrient removal and optimization, storm water improvements in Butte), and implemented (ongoing remediation in SSTOU and in BPSOU), EPA would welcome specific suggestions and ideas.*

<u>Comments from CTEC</u>

8) CTEC would like to be assured that a flood will not severely recontaminate the rebuilt reaches of Silver Bow Creek or overwhelm the Warm Springs Ponds and release contaminants further downstream.

EPA Response: All remedial designs were completed using conservative, engineering practices and standards to account for reasonably foreseeable high flows with appropriate design standards. In addition, at the WSP, there are overflow structures within the dikes in the constructed channel above the lime addition system. The elevations are specifically lower, and the dike is constructed of a material purposefully designed to give way in a large flow event, to prevent massive flooding of the ponds. In addition, the ponds themselves have emergency overflow structures in the dikes.

1.1 Warm Springs Ponds

13. Warm Springs Ponds (WSP) is an interim action and not necessarily the final remedy for the downgradient edge of the SBC NPL site. While work is ongoing upstream, the ponds will continue to store water and sediment, after which the ponds could be removed to naturalize the river, similar to Milltown Dam. During the interim period while final remedy is underway upstream, there is concern about the ability of WSP to handle large flow events. There is also concern about the downstream water quality and sediment impacts of extreme high flow conditions. The review states that improvements made to the ponds during the early 1990's increased the storage capacity of Pond 3 to receive and treat flows up to the 100-year flood. However, the review does not evaluate whether improvements to pond infrastructure or operations will prevent flows below the 100-yr flood from bypassing the ponds and dumping into the Mill-Willow Bypass as occurred during the approximate 2-5 year flood on March 13, 2003. The Five Year Review on WSP should include an evaluation of flood capacity of the ponds as well as potential aquatic impacts downstream from large flood events. Lastly, CTEC would like to know whether sedimentation in the WSP could reduce the amount of time the ponds can be used while a final remedy is developed for the area.

> *EPA Response: The overflows in 2003 were a result of the inlet trash rack becoming clogged with debris, not because of underdesign of overflow structures. The overflow structures performed as designed. EPA has since required ARCO, the pond operator, to take actions which should prevent the trash rack clogging problem and it has not re-occurred. The requested evaluation of the flood capacity of the ponds is outside of the scope of the 5 year review, however, as a part of the planning towards the final site remedy, the capacity and hydraulic control structures will be re-evaluated to ensure their protectiveness. AR has been looking into conducting a bathymetric survey of the pond bottom and sediment capacity, but the results of these evaluations were not available at the writing of the five year review report. The results will be provided to interested public members when they are available.*

14. The Five Year Review should evaluate bioaccumulation of metals and arsenic in wildlife and the fishery associated with WSP. Some ecological risk work has been done, but the quality and completeness of this work needs assessment. Now that the ponds have been operating for some time, it is ideal to evaluate prior assumptions concerning exposure of biota to metals and arsenic from WSP. CTEC recommends the Five Year Review evaluate information available on metal and arsenic levels in animal tissue and how these contaminants are passed up the food chain. Additionally, the levels of contaminants in fish tissue that humans may be exposed to by eating fish from the ponds or discharge area should be reported. If adequate information is not available to understand these exposures, the Five Year Review should provide a plan for more detailed bioassessment.

The final review should present and describe the data used to reach the conclusion in table 8-1 (vol. 4): "Fish tissue metals are slightly elevated; however, there is no observable effect on the health of individuals within the fish population, or the population as a whole." The fish tissue data appears to be omitted from the draft review. Additionally, it needs to be made clear whether human consumption of fish at WSP is currently controlled. If catch and release rules are not in-effect, the review should evaluate risks of human consumption using available fish tissue data.

> *EPA Response: A fish consumption ban is currently in place at the ponds, which prevents human consumption of fish and therefore protects human health from any exposure pathway described in this comment. The need for a more detailed look at these ecological issues is an issue that should be addressed when a final remedial action is chosen for the ponds area. In the meantime, existing bio-monitoring efforts are sufficient to address any near term concern regarding wildlife exposure or food chain uptake in EPA's opinion.*

CTEC supports EPAs proposal for a comprehensive ecological screening study. The screening study should include metal and arsenic concentrations in fish tissues from WSP and downstream in Silver Bow Creek and evaluate the potential pathway for human consumption exposure.

> *EPA Response: Additional biological monitoring may be considered appropriate after careful consideration of the use of the data and also the specific data needs for an ecological risk assessment. As noted, this is an issue that will be discussed and addressed in more detail, on a pond-specific basis, when the evaluation for a final remedy is done at the Warm Springs Ponds. EPA is considering suggestions for more comprehensive ecological monitoring or assessment.*